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PROCEEDINGS
OF THE
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VOL. XII, NO. 1, PP. 1-25. PL. 1, FIGS. 1-7 FEBRUARY 15, 1910.

ON THE MANNER OF LOCOMOTION OF THE DINOSAURS ESPECIALLY *DIPLODOCUS*, WITH REMARKS ON THE ORIGIN OF THE BIRDS.

BY OLIVER P. HAY.

In a paper published some months ago (Amer. Naturalist, vol. xliii, 1908, pp. 672-681) the writer advanced the proposition that the sauripodous dinosaurs, especially *Diplodocus*, did not walk, as the elephants do, with the body high up from the ground and with the legs straight or nearly so, and moving in approximately perpendicular planes, but rather as do the crocodiles, with the body low down, and with the thighs standing well out from the animal's sides. While I was further considering the subject I received from my friend Dr. O. Abel, of Vienna, a paper¹ in which, while endorsing my views regarding the nature of the food of *Diplodocus* and the manner of taking it, he endeavors to show that I am in error as to the bodily pose and the manner of locomotion of the sauropods. Dr. Abel maintains that the accepted views of the way in which these animals walked is the correct one and he finds support for this view in the structure of the feet. He accepts Hatcher's opinion that *Diplodocus* and *Brontosaurus* were digitigrade and argues that therefore they walked as represented in Hatcher's restoration of the reptile. The evidences that they were digitigrade are found in the belief, probably correct, that the upper ends of the metatarsals and metacarpals were not arranged in a straight line, but

¹ Verhandl.-zool.-botan. Gessellsch. Wien. 1909, pp. 117-123.

in an arc of a circle; further, that the feet were entaxonic, that is, had the inner digits more strongly developed than the outer ones.

Now, it is the writer's opinion that these evidences of digitigrady will hardly stand a test. The hinder feet of the bear are certainly plantigrade and yet the metatarsals are arranged very distinctly in an arc of a circle. On the other hand, the tiger and the hyæna are digitigrade, but their metatarsals are almost in a plane. Various animals will, I think, be found to transgress Dr. Abel's rule, as one may see by looking through a collection of skeletons. Furthermore, if it is desired to see an entaxonic foot in which the metatarsals are arranged in an arc of a circle and which is nevertheless plantigrade one has only to examine the foot of the human skeleton.

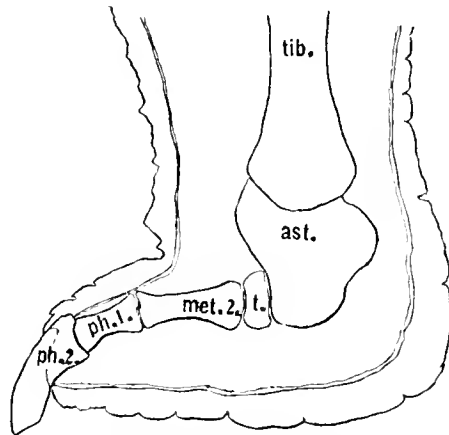


FIG. 1 SECTION THROUGH HIND FOOT OF TESTUDO. \times 1. *ast.*, ASTRAGALUS; *met.* 2, METATARSUS OF SECOND DIGIT; *ph. 1.*, *ph. 2.*, FIRST AND SECOND PHALANGES; *t.*, TARSAL OF SECOND ROW; *tib.*, TIBIA.

The writer is not disposed to deny that *Diplodocus* and its relatives were more or less digitigrade; but this digitigrady, through perhaps equal to that of the hinder foot of the elephant, does not prove that these reptiles walked like the elephant. The land tortoises of the genus *Testudo* have the feet constructed much like those of the elephant, being provided with a thick pad of skin, muscles, tendons, and connective tissue under the astragalus and the metatarsals and applying only the ungual phalanges to the ground. Nevertheless the legs of these reptiles stand out from the sides of the body as I have supposed that those of *Diplodocus* did. A figure (Fig. 1) is here presented showing a section made through the hind foot of *T. tabulata*. Unfortunately I have not been able to find or make a similar section through

the hind foot of the elephant; but, to judge from various mounted skeletons and from good figures of others, one can hardly suppose that the heel of the elephant is lifted farther from the ground relatively than that of the tortoise.

I grant that Dr. Abel's efforts are along a line where they are needed. Those who believe in the mammal-like gait of *Diplodocus* ought to give their reasons therefor. I do not assert that reasonable arguments for their view cannot be produced, but hitherto the correctness of this view has been assumed. The subject is a difficult one and needs to be studied from various points of view and by all who have the opportunity. And in studying the movements of animals one soon learns that they can assume so many positions that one may be at loss, in the case of an extinct creature, to determine which positions were the usual ones.

In the primitive condition the limbs of the Tetrapoda stand out at right angles with the body,² and in approximately this position they are found in most Amphibia and Reptilia. When these animals are walking, the humerus and the femur move backward and forward mostly in horizontal planes. In most mammals, on the contrary, the humerus is turned backward against the thorax and the femur forward against the flank. The hand, which otherwise would be directed backward, is turned forward by the crossing of the bones of the lower arm. The movements of arm and leg are then mostly in sagittal planes. In the duckbill and the echidnas the limbs have retained the position found in most reptiles.

Now, among all the reptiles that live today there are none, except perhaps the chameleons, that have attained even an approach to the condition found among the mammals.

It is evident that before the close of the Jurassic there existed both carnivorous and herbivorous dinosaurs that went about habitually on only their hinder legs; but it is by no means necessary to believe that the immediate ancestors of these bipeds walked first like mammals and afterwards like birds. It is well known that certain lizards can run swiftly on their hind legs, the fore legs and the tail being held free from the ground. Furthermore, as may be seen from W. Saville-

² Huxley, *Anat. Vert. Animals*, 1872, p. 33; Flower's *Osteology of the Mammalia*, 1885, p. 362.

Kent's figures³ the hinder limbs are not carried backward and forward in sagittal planes like those of mammals.

It seems not difficult to understand the history of the attainment of the bipedal habit among lizards and dinosaurs. When the forelegs of a quadrupedal reptile are of nearly the same length and have the same structure as the hind legs there seems to be no good reason why the animal cannot run as fast on four legs as on two. However, the hinder limbs, being nearer the center of gravity of the animal, receiving more of the weight, and being more devoted to propulsion of the body, are likely to become larger and more powerful, while the fore legs may become more or less reduced, with or without special modification for other purposes. If now a reptile whose fore legs have become relatively much shorter than the hinder ones has occasion to run with the greatest possible speed, it is likely to find that the fore legs cannot take as long steps as the hinder ones; and naturally it endeavors to get them out of the way by lifting them up in the air.

This practice would be of great advantage and would tend to become fixed. The reduced limbs might then become modified for other purposes or undergo further reduction. In the beginning, the femora would stand out from the body, giving the animal a wide tread. In time, however, the knees might be drawn closer to the flanks, the tread would become narrower and the pace more rapid. At no stage, however, would the reptile walk like a quadrupedal mammal; and no argument in favor of such a gait for *Diplodocus* can be deduced from bipedalism in lizards.

If the mammal-like gait of *Diplodocus* be insisted upon on the ground of straightness of the femur it may be pointed out, as I did in the article in the *American Naturalist*, that the femora of sphenodon and of lizards, animals that creep, are straight. If it be contended that it is in the heavy-bodied animals that a straight femur is correlated with a lifting of the body from the ground during locomotion, it may be permitted to recall that the femora of *Allosaurus* and *Tyrannosaurus*, great carnivorous dinosaurs, are distinctly bent. The femora of *Trachodon* are straight, while those of *Camptosaurus* and *Laosaurus* are curved. Curvature of the femur seems, therefore, to have no relation to size of body or erectness of pose. The femora of

³ *Nature*, vol. 53, 1895, pp. 396-397.

crocodiles, little and great, are curved; as were too those of their predecessors, *Aetosaurus*, of the Triassic, and of *Alligatorellus*, of the Jurassic, the former with femora hardly four inches long, the latter with these bones about an inch in length.

Diplodocus has been erected on column-like legs partly because it has been supposed that the great weight of its body required this. However, the legs of animals are not straight in proportion to the weight of their bodies. The legs of the largest camels seem not to be straighter than the legs of the llamas. Some rhinoceroses and some oxen have very heavy bodies; nevertheless, their femora lack much of being in line with their tibia and these much of being in line with the metapodials. Certainly it is not because of the immense weight of the body that the legs of a man are straight.

There must, of course, be a limit to the size of an animal that can move itself about on land, in whatever position; but it may be suggested that a reptile that could not walk about as crocodiles do, resting at least now and then, its body on the ground, could not well have erected itself when once it had lain down. That the largest crocodiles are far from the limit of active movement on the land may be judged from the following extract taken from W. Saville-Kent.⁴

The celerity with which a huge 25-footer, as witnessed by the writer in the Norman River, North Queensland, will make tracks for and hurl itself into the water, if disturbed during its midday siesta by the near impact of a rifle bullet, is a revelation.

It must be further taken into consideration that the weight of a crocodile 25 feet long, with short, thick neck, large head, long body, and heavy tail, would be much greater than that of a sauropod of the same length, in which most of the length is composed of slender neck and comparatively slender tail.

It is generally conceded that such carnivorous dinosaurs as *Allosaurus*, *Dryptosaurus*, and *Tyrannosaurus*, and such herbivorous forms as *Trachodon* and *Camptosaurus* walked bipedally erect. If now comparison be made of the femora of any of these with those of the sauropods great differences will be noted. The shaft of the former appears to be more elaborately modeled and to consist of finer and harder bone; all the articular surfaces are smooth and they carry the

⁴ Living Animals of the World, p. 547.

conviction that the original surfaces, barring a thin layer of cartilage, are preserved; there is a definite head, separated from the shaft by a distinct neck and nearly filling the acetabulum; and there is a definitely formed trochanter major. In the *Sauropoda*, on the contrary, the shaft seems to be composed of coarser bone; the articular surfaces are rough and show that they were covered by a thick layer of cartilage; the head merges imperceptibly into the supposed great trochanter and into the shaft; and the head lacks much of filling the acetabulum. In its low stage of differentiation the femora of the sauropods resemble greatly those of the crocodiles and are hardly above those of the lizards. They furnish no warrant for the belief that their possessors walked in mammalian fashion.

The structure of the foot of *Diplodocus* indicates that this reptile walked in a way very different from that in which the bipedal dinosaurs walked. In the latter the foot had the third toe most strongly developed (mesaxonic); in the sauropods the two inner toes were the strongest, the third somewhat weaker, while the other two were greatly reduced. This difference of structure must have had its history and its meaning. That the feet of *Diplodocus* were shortened and more or less digitigrade indicates that they were employed for walking, not at all for swimming. The feet of the crocodiles are to be regarded as entaxonic, the inner digits being of stouter build, although slightly shorter than the third; but here the digits are elongated and webbed to assist in swimming. When the animal is walking, the pressure comes against principally the inner side of the foot. The trionychid turtles have the three inner digits most strongly developed and clawed; the others are slender and unarmed. The clawed digits are, of course, the ones employed for excavating hiding places in the sand and mud and getting foothold in walking and running; and these turtles are, for moderate distances, rapid and powerful runners on the land and on the bottoms of streams.

It is true that the foot of man is entaxonic and is directed nearly forward, but its history is wholly different from that of the sauropod foot. It is certain that the ancestors of man were climbing animals, with hallux strongly developed and opposable to the other digits. Being later employed for locomotion on the ground, the foot underwent a transformation to its present form. The form assumed at any time by an organ must depend greatly on the form previously pos-

sessed. Doubtless the Sauropoda and the Theropoda started out with the same pedal outfit, and there seems to be no reason for supposing that the former passed through an arboreal stage and back into an ambulatory stage.

The position of the trochanter major of the sauropods is open to question and there are differences of opinion. Marsh⁵ regards as this trochanter the outer upper angle of the femur, including a part of the rough surface forming the proximal end of the bone. Hatcher's view (Mem. Carnegie Mus., I. p. 46) appears to be the same. Osborn⁶ has identified as the trochanter the rough surface which descends for some distance below the upper end of the femur on the fibular border. Neither of these views seems to the writer satisfactory. If the femora of the Triassic dinosaurs described by v. Huene in his monograph, *Die Dinosaurier der europäischen Triasformation*, be examined it will be found that the trochanter in question is placed at a considerable distance below the head of the bone, on the dorsal surface, and near the fibular border. In the more highly specialized dinosaurs of the Jurassic the trochanter is a distinct process arising from the position described and ascending nearly to the level of the head. In such dinosaurs as *Trachodon* and *Triceratops* the trochanter has reached the outer upper angle of the femur, and is well separated from the head by a distinct neck. The writer believes that in the sauropods the trochanter occupied the same primitive position that it has in the Triassic Theropoda. It is not essential that it should be represented by a process or even by any unusual roughness, as is shown by the femur of the crocodile.

This being the case, what explanation is to be made of the outer portion of the rough surface on the proximal end of the femur? The writer believes that it forms a part of the head of the bone and entered into the acetabulum. The matter will be discussed. In order to illustrate a possible position of the femur in the acetabulum a figure is here presented (Fig. 2). This has been obtained by placing a section of the proximal end of the femur, taken from Hatcher's figure in *Memoirs of the Carnegie Museum*, vol. I, p. 46, in the acetabulum as shown in the same writer's figure in the second volume of the same

⁵ *Dinosaurs N. A.*, Pl. XVI, fig. 3, t.

⁶ *Mem. Amer. Mus. Nat. Hist.*, i, p. 211, fig. 14.

Memoirs, plate IV, fig. 2. The so-called head of the femur is toward the left, against the pubic process. According to this figure, there was room in the acetabulum for the femur, standing at right angles with the pelvis, so that it could rotate on its longer axis and could swing backward and forward. Such movements would be required in case the reptile walked as does the crocodile. In the execution of these movements it would probably happen, as it does in the lizards, that some part of the head would at times be outside of the acetabulum. in order to show the resemblance of this joint in the lizards to the one

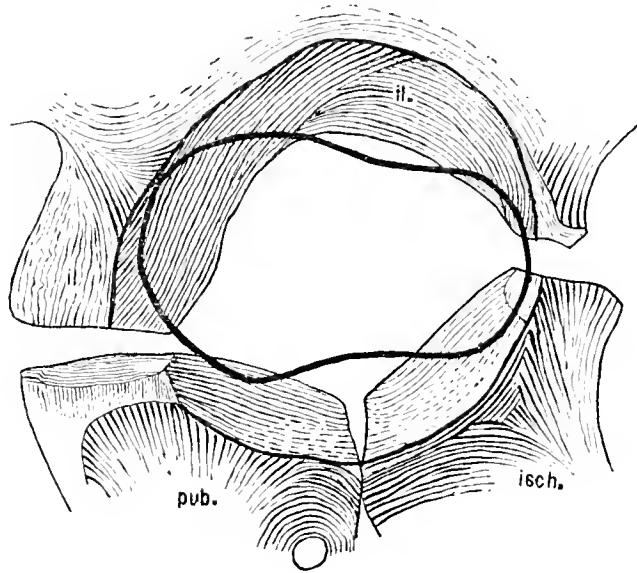


FIG. 2 LEFT ACETABULUM, CONTAINING SECTION OF PROXIMAL END OF FEMUR; THIS SECTION SHOWN BY HEAVY LINE. $\times \frac{1}{10}$; *il.*, ILIUM; *isch.*, ISCHIUM; *pub.*, PUBIS.

depicted, a drawing (Fig. 3) is shown of the acetabulum and head of the femur of *Metapoceros*.

However, the articulation at the hip was probably not effected in just this way. It appears that in some cases the proximal end of the femur is wider than the acetabulum. Dr. E. S. Riggs informs me that in *Apatosaurus* (*Brontosaurus*) and *Brachiosaurus* the upper end of the femur is about 23 inches wide, exceeding the fore-and-aft diameter of the acetabulum by 3 or 4 inches. I do not regard this fact as wholly irreconcilable with the view illustrated by figure 2, the head of the femur having sometimes a greater diameter than the acetabulum, as in the land tortoises. Nevertheless, I will not argue the matter. A somewhat different arrangement at the articulation is more probable.

Certain principles must be regarded as indisputable. One of these is that primitively, in the common ancestor of the dinosaurs, the crocodiles, and the lizards, probably in the early dinosaurs themselves, the whole proximal end of the femur constituted the anatomical head. Another is that before there could be any such structures and conformations of these as we find at the hip joint of *Allosaurus*, for instance, or of *Trachodon*, every possible stage from the one just described must have been passed through. Through countless generations the thigh must gradually have assumed a more and more forward position in habitual locomotion. While muscles and nerves were being trained

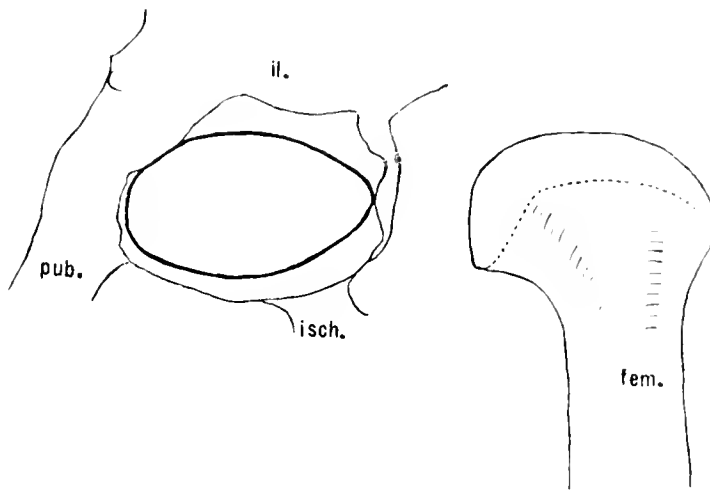


FIG. 3 ACETABULUM OF LIZARD METAPOCEROS, CONTAINING SECTION OF HEAD OF FEMUR. $\times 2$. SECTION OF FEMUR SHOWN BY HEAVY LINE. ALSO SIDE VIEW OF FEMUR $\times 2$. *Fem.*, FEMUR; *il.*, ILIUM; *isch.*, ISCHIUM; *pub.*, PUBIS.

to this end the femur must have been developing a projecting head, that part of the proximal end on the fibular side was being excluded from the acetabulum, and the rotation of the proximal end of the femur around a perpendicular axis was being changed to rotation around a horizontal axis, which in mammals would pass through both femoral heads. Now, as regards the hinder leg and the hip joint, at what stage in the long journey indicated above, do we find *Diplodocus*? Obviously those who believe that this animal ought to be set up on its legs in the way seen in drawings, plaster restorations, mounts of the actual bones, and the plaster facsimiles of the skeleton that are being distributed over the world, must hold that *Diplodocus* had reached

practically the ultimate, or mammalian stage. The writer believes that it had attained only the first station in the journey.

A study of the femora of the sauropods shows that the proximal end varies somewhat in shape. Usually it is more or less truncated or it is slightly concave toward the fibular side and convex toward the tibial side. Figure 4 represents in outline a side view of the proximal half of the bone, as represented by Hatcher. As already stated, the

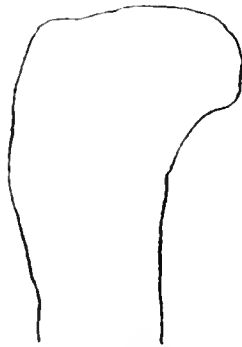


FIG. 4 OUTLINE OF SIDE VIEW OF PROXIMAL END OF FEMUR OF DIPLODOCUS.
 $\times \frac{1}{16}$.

proximal border is very rough, as shown by figure (Fig. 5) also taken from Hatcher. Undoubtedly this was covered by a thick layer of cartilage. Cope (Amer. Naturalist, xii, 1878, p. 84) says that if the layer of cartilage were ossified it would be an epiphysis, like that of the mammals. Figure 6 presents the same outline as does figure 4,

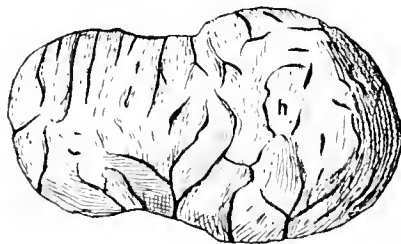


FIG. 5 PROXIMAL END OF FEMUR OF DIPLODOCUS. *h*, THE SO-CALLED HEAD

but to it there has been added a dotted line which is intended to indicate the writer's view of the form of the upper end of the femur when the cap of cartilage was present. The stage of development reached by the animal was that at which a femoral head was being developed on the tibial side of the bone and the fibular border was being freed from the articular cup. Although the whole proximal end may, in some genera, have been too broad to enter the cavity

the greater part did so enter. Doubtless, when the leg was extended forward, a considerable part of the cartilage-covered surface on the fibular border was out of the cup, and when the leg was directed backward the rounded anterior part of the head was out. This is exactly what happens in the lizard and, for that matter, in most animals. The head of the femur of *Diplodocus*, compared with that of the crocodile, differed in having its long axis coincident with the plane through both condyles; while in the crocodile the head is twisted from the plane mentioned about 75° . Figure 7 represents the same humerus as figure 6, but lines are drawn across the head to show the varying relations of the bone to the acetabulum. The line *aa* may

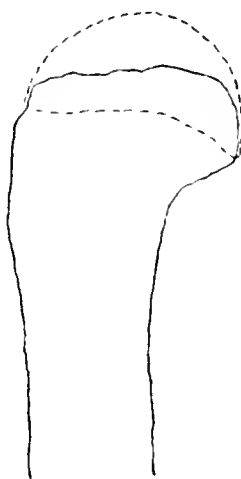


FIG. 6 PROXIMAL END OF FEMUR OF DIPLODOCUS. $\times \frac{1}{16}$. THE DOTTED LINE SHOW THE LIMITS OF THE CARTILAGE.

be regarded as a section through the acetabulum when the leg is thrown far forward; *bb*, when the leg is at right angles with the body; *cc*, when the leg is thrown well backward. Of course, as the leg is swung from front to rear, the femur will turn also on its long axis.

As is well known, the acetabulum of the Sauropoda is widely open in the skeleton. I am not aware that any one has discussed the way in which in life this opening was filled. It seems improbable that it was shut simply by membrane, for this would have been too yielding to the pressure of the head of the femur, if inserted as generally supposed. It seems most probable that the opening was occupied by a mass of cartilage, an unossified portion of that common cartilage from which were developed the ilium, the pubis, and the ischium. This would have formed a firm concave bed on which the convex head

of the femur could rotate. If the femur was inserted as the writer supposes it was, its pressure would have been exerted mostly against the bony side-walls of the acetabulum and but little against the tissue filling the inner opening.

In his splendid monograph on *Die Dinosaurier der europäischen Triasformation* Dr. v. Huene has presented numerous restorations of the Triassic carnivorous dinosaurs (Pls. IC-CX). In order to show the author's conception of their modes of progression, three species, *Plateosaurus reinigeri*, *Thecodontosaurus antiquus* and *Anchi-*

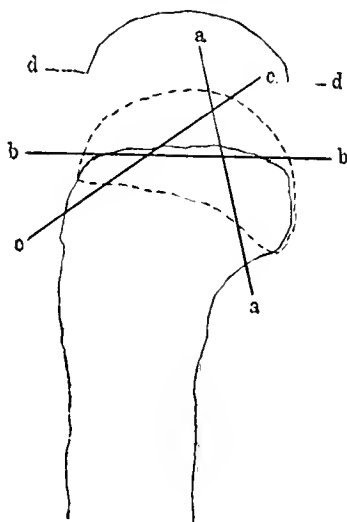


FIG. 7 PROXIMAL END OF RIGHT FEMUR, WITH ITS CAP OF CARTILAGE, AND HORIZONTAL SECTION THROUGH ACETABULUM. *dd*, SECTION OF ACETABULUM; *aa*, LINE CORRESPONDING TO *dd* WHEN LEG IS THROWN FORWARD; *bb*, LINE CORRESPONDING TO *dd* WHEN LEG IS AT RIGHT ANGLES WITH BODY; *cc*, LINE CORRESPONDING TO *dd* WHEN LEG IS THROWN BACKWARD.

saurus colurus are restored each in two positions, walking on all fours and on their hinder extremities only. Dr. v. Huene has the following to say (p. 291) regarding the position of the hinder limbs:

Das Femur passt in der Weise in den Acetabularschnitt, dass das verbreiterte medial abstehende Proximalende nicht transversal unter dem Ileum liegt, sondern schräg nach vorn und medial gerichtet ist (daher wendet sich auch das Knie etwas auswärts).

Notwithstanding this explanation, one is struck by the very mammal-like position of the body and the limbs of these reptiles in the quadrupedal pose. Elbows and knees are drawn well towards the sides and the digits are directed straight forward. At least, the pose of these restorations is quite different from that of any living reptiles.

One of these species, *Anchisaurus colurus* was described by Marsh from the Triassic of the Connecticut Valley, and he published a restoration of the skeleton in his work *The Dinosaurs of North America*, Pl. IV. Dr. R. S. Lull⁷ has identified this dinosaur as the maker of the tracks known as *Anchisauripus dananus* (Hitch.) This identification is extremely interesting, in case it can be substantiated. The bones of the hind foot of *Anchisaurus colurus* fit accurately in the tracks named. These tracks are placed close to or on the line along which the animal was moving, the "line of direction" (Beckles), and there are, in the several specimens known, no indication of impressions of either the fore feet or the tail.

A study of the various printed restorations of this species reveals an animal of elongated body, with limbs not greatly unlike those of a crocodile, the hinder legs being a little longer in proportion to the length of the body than in the crocodile, while the fore legs are about three-fourths the length of the hinder ones. In the crocodile the fore limb is little more than two-thirds as long as the hinder.⁸ As compared with the hind foot of the crocodile that of *Anchisaurus* is a little longer. Now, with this view of the creature, what is there in it to lead one to suppose that it erected itself on its hinder limbs, unless it were on rare occasions; and on such occasions would it not have borne itself as did the running lizard figured by Saville-Kent? What one is asked to believe is that it bore itself so loftily that it is never found to have put its hands on the ground or to have dragged its tail in the mud. Furthermore, this reptile walked with all the skill and the circumspection of the heron and the barn-yard fowl; for each foot was brought forward and placed very near or on the line of direction and thus immediately under the center of gravity. This is very different from the way in which Saville-Kent's lizard ran; for when a foot was advanced it was placed far from the line of direction and at the same time the tail was jerked violently toward the same side, in order to bring the center of gravity over the advanced foot. The dinosaur in question seems to have had no other use for its tail than to serve as a counterpoise to the weight of the head and trunk.

Omitting the feet, the legs of most birds consist of three long segments, viz: the femur, the tibia, and the tarsometatarsus. The

⁷ Mem. Bost. Soc., Nat. Hist., v. p. 487.

⁸ Dollo, Bull. Mus. roy. d'Hist. nat. Belgique, ii, 1883, p. 107.

relatively short femora diverge downward so that the knees are almost always farther apart than are the great trochanters, sometimes much farther. Nevertheless the feet in walking are generally placed on the line of direction, a result brought about through the convergence of the elongated middle and lower segments of the two legs. If they are not brought close to this line, as in the short-legged ducks and geese, the walk becomes a waddle.

The femur of *Allosaurus*, of the Upper Jurassic, possesses a head that projects strongly inward; and this was provided with a well-defined smooth articular surface, which is elongated transversely to the animal and convex from front backward. The surface of the ilium against which this head fitted is also smooth. Now the conformation of the head of the femur and the ilium is such that the femur must have diverged considerably from its fellow, thus widely separating the knees. The tibia is shorter than the femur, and the inner condyle appears to stand lower than the outer. The metatarsus is relatively short. I see no way, therefore, for the feet to be brought, except with unusual effort, near the line of direction in walking or near each other in standing. The limbs of *Allosaurus* may be compared to those of the penguins, although in *Allosaurus* the femora may not have been directed so strongly forward and the feet may have been more digitigrade. It would probably be very difficult for the penguin to plant its feet one in front of the other in walking. I believe therefore that *Allosaurus* had a wide trackway and that when it walked and ran it preserved its equilibrium by whisking its tail from side to side.

Examination of a femur, accompanied by the tibia and the fibula, in the U. S. National Museum, apparently that of *Tyrannosaurus*, shows the same form of the head of the femur that is found in *Allosaurus*, thus making it probable that this dinosaur also had a straddling gait. Professor Osborn (Bull. Amer. Mus. Nat. Hist., xxii, p. 293) presents a figure of the femur of *Tyrannosaurus*. He says that the plane of the head makes an angle of 45° with the axis of the vertebral column, and that therefore the distal ends of the femora are approximated. Whether the angle is in front of or behind the head of the femur is not stated. In *Allosaurus* the head is directed inward and forward. The effect of this would certainly be to throw the knees outward and to plant the foot farther away from the line of direction.

The convergence of the femora is rare even among the mammals. If Professor Osborn is right the hind legs of *Tyrannosaurus* had attained the human stage in the respect mentioned.

Another potent reason for believing that the dinosaurs just named, together with *Iguanodon* and *Trachodon*, walked with a wide tread is found in the form of the body. In mammals the abdomen is usually contracted posteriorly, so that between the thighs it is shallow, permitting the femora to remain parallel with each other or even to converge. Therefore, in walking, the feet are placed near or on the line of direction. In the birds the baggy abdomen descends between the thighs and spreads these, thus requiring the convergence of the long lower segments to bring the feet together. The kangaroos have the abdomen much like that of the birds; and in them the thighs are found to diverge toward the knees, but the long tibiæ permit the feet to be placed close to each other in standing and leaping. In *Allosaurus* and *Iguanodon* the belly came down nearly to the knees and passed backward between the thighs into the tremendous tail. It must be that the knees were much farther apart than the upper ends of the femora were and that the tread was wide. The writer is further of the opinion that in the bipedal dinosaurs the femora were directed more strongly forward than they are usually placed in restorations, although not so much so as in birds. This position would tend to reduce the height of the reptiles and would make the thighs more divergent.

In a paper published by Mr. William H. Ballou (*Century Mag.*, lv, 1897, pp. 15-23), but the facts and suggestions of which were furnished by Professor E. D. Cope, there is a figure representing two individuals of *Hadrosaurus* (*Trachodon*) *mirabilis*. One of these is on the shore, resting on its hind legs and haunches, the other is standing and feeding in the water. By examining these restorations, made by Mr. Charles R. Knight, one may judge regarding the probability that these reptiles could leave a straight row of tracks behind them.

Mr. S. H. Beckles⁹ has described and figured some series of large footprints found in the Wealden near Hastings, England. These have been identified by Dollo (*Bull. Mus. roy. d'Hist. nat. Belgique*,

⁹ *Quart. Jour. Geol. Soc.*, x, 1854, 456, pl. xix.

ii, 1883, p. 117, pl. iii, fig. 8) as the tracks of *Iguanodon mantelli*. A study of these footprints shows that in the case of the series designated by *cc* the length of the step was close to 5 feet while the width of the trackway was about 2 feet 2 inches. The tips of the inner toes came, however, pretty close to the line of direction. It must be observed that in all of these tracks the toes are turned inward so much that the axis of the middle toe prolonged passes through the next imprint in front, made by the opposite foot. Now, I find no reason for supposing that in life the toes were so directed inward. None of the figures of *Iguanodon* so represent them; nor are the toes thus placed in any of the restorations of *Trachodon*. The explanation of the matter seems to be that the reptile, if reptile it was, was lounging leisurely along, with short steps, and, to keep its equilibrium, was swinging its body around a perpendicular axis passing through the pelvis, the tail being thrown in one direction, the trunk in the opposite. In this way the feet would be planted not far from the line of direction and pointing toward it. Had the animal been running, the feet would have been planted farther from the line of direction and with toes directed forward.

Now, if these conclusions regarding the gait of the Upper Jurassic and Upper Cretaceous carnivorous dinosaurs are justified, is it probable that the Triassic *Anchisaurus colurus*, with an equally heavy abdomen and with less elongated and more primitive limbs, had the ability to walk, just as a bird does, accurately placing one foot directly in front of the other and under the center of gravity? It seems to the writer that we need more proof of it. If it could so walk, one might inquire what was the use of all the modifications undergone by the dinosaurs up to the end of the Cretaceous. It seems most probable that *Anchisaurus* walked usually in crocodilian or lacertilian style, with, however, the femora drawn somewhat more closely to the sides. Now and then, when in great haste and for short distances, it was probably able to progress bipedally in an awkward fashion. In the same category may be placed some of the European dinosaurs figured by Dr. v. Huene, such as *Thecodontosaurus antiquus* and the species of *Plateosaurus*. Others, as *Pachysaurus ajax* and *Massosaurus carinatus*, probably walked more or less habitually on their hinder limbs, but with a wide trackway and with much swinging of the tail from side to side.

Dr. v. Huene's statement of his view of the manner of insertion of

the femur has been quoted above. To the writer it seems probable that the whole proximal end of the bone constituted the head and was inserted into the acetabulum, as in lizards and crocodiles, and that the thigh was directed outward still more than Dr. v. Huene has supposed.

What then made those bird-like tracks that are so abundant in the sandstones of the Connecticut River valley? Why not birds, indeed? Although remains of birds have not yet been found in Triassic rocks there can be little doubt that these animals had already freed themselves from the dinosaurs. Already long before the close of the Jurassic the hinder limbs of birds had, as we learn from *Archæopteryx* taken on its present form, with doubtless ability to plant its footsteps on the line of direction. This limb was at that early time far in advance of the hind leg of the dinosaurs of even the Upper Cretaceous; and it was doubtless even in the Triassic far in advance of the limb of the dinosaurs of that time. No bird remains have been found where those famous tracks occur, it is true. It is also true that nearly 100 kinds of tracks have been distinguished, while only 8 or 10 species of dinosaurs have been discovered in the North American Triassic; and of these only one has had its tracks identified. Therefore, it seems to the writer entirely reasonable to suppose that those bird-like tracks, even some of them that show the presence of fore feet and tail, were really made by birds. For if the birds diverged from the dinosaurs early in the Triassic their wings were as yet probably unfitted for continuous flight in the air. Many of them were probably running animals and some of them may still have retained a tendency to grow to a large size. Success in flying necessitated in later times a reduction in size of body. In the Trias the hands had not yet become reduced and transformed through the development of great pinion feathers, and they may have been at times applied to the ground in walking and resting. The tail was yet long, little befeathered, and might drag on the ground and leave a trail. And it must not be regarded as wholly certain that the tracks of large bipedal animals of later times were made by dinosaurs. There may have been in the Jurassic and the Cretaceous, as well as in the Tertiary, running birds of even greater size than the largest moa, whose foot was hardly inferior in size to that of many dinosaurs. On the other hand, such dinosaurs as *Compsognathus* and *Hallopus* may have walked like

birds, but the remains of such are found in the Triassic no more than those of birds.

If now such Theropoda as *Anchisaurus colurus*, more advanced probably in every respect than the Sauropoda ever were, did not walk habitually erect, like mammals, on either two or four legs, but progressed either in more or less crocodilian manner on all fours or in a straddling way on the hind legs, is it probable that the sauropods ever walked high up on four legs in the jaunty manner in which they have been represented? It is to be considered that these great herbivorous reptiles possessed a huge abdomen, deep and probably broad, which extended backward and merged into the tail, necessitating the divergence of the relatively long femora. The outer surfaces of the pubic and ischiadic bones were clothed with great masses of muscles, as were too the insides of the femora. Assuming that the legs were as straight as they have been represented, the feet could have been hardly closer together than the knees, probably considerably farther apart. A bulky animal walking thus could preserve its equilibrium only by either swaying the body from side to side, to throw it over the advanced foot, or throwing the tail toward that side. In the case of the fore foot the long neck might be used to preserve the balance. One might amuse and instruct himself by working out the movements of the animal according as it was walking, trotting, pacing, or perchance galloping.

The writer is not willing to assert that *Diplodocus* and its relatives never straightened out their legs, thus lifting themselves well above the ground, and never walked thus. Even the crocodiles have been known to do this, as a rare occurrence.¹⁰ In the U. S. National Museum there is a specimen of the Florida crocodile mounted in this position. The femora are directed forward and outward, the tibiae downward. The feet are widely separated as a mechanical necessity. What is disputed by the present writer, is that this was the customary attitude of the sauropods; and their great bulk makes it doubtful if it was ever assumed.

The writer is of the opinion that the feet of the primitive dinosaurs had the inner digits somewhat more strongly developed than the median and outer ones; that is, they were entaxonic, not mesaxonic,

¹⁰ Hornaday, *Two Years in the Jungle*, pp. 55, 266.

resembling in this respect the feet of the crocodiles. A reason for this conclusion is found in the fact that all the feet of the sauropods are entaxonic and also the fore feet of the earliest known theropods. It is therefore more probable that the hinder feet of the latter reptiles became mesaxonic from an entaxonic condition than that their fore feet and both fore and hind feet of the sauropods should be transformed. That the manus of the theropods was entaxonic may be seen from Marsh's figure of the fore foot of *Anchisaurus colurus* and *A. polyzelus* (Dinosaurs N. A., pls. ii, iii) and from Dr. v. Huene's figures. Furthermore, the hinder feet of the early theropods present plain indications of a former entaxonic arrangement. The foot of *Ammosaurus*¹¹ shows a very stout first digit, not greatly shorter than the others, while the second does not fall behind the third and fourth in diameter of the bones, little in length. The superiority of the second to the third seems to have been retained in *Allosaurus*. When the hind leg began to be drawn forward against the side and the weight of the body was thrown to a greater extent on the median digits a stimulus appears to have been given to the development of the third digit, while the first, relieved to some extent of its former duty, became reduced and turned backward.

In the later theropods the manus also became mesaxonic. This is seen in Marsh's restoration of the skeleton of *Ceratosaurus* (op. cit., pl. xiv). Mr. C. W. Gilmore, who has recently mounted this skeleton has shown me the remains of the one hand preserved. Most of the phalanges are missing. There are present four metacarpals, and there are no traces of the fifth in the rock. The first is considerably reduced, the second is the largest. Thus, there is evidence that all the feet of the carnivorous dinosaurs became transformed from the entaxonic to the mesaxonic condition. It further appears that the sauropods retained the primitive condition of the feet, fore and hinder, more persistently than did the other groups of the order.

For reptiles that progress by creeping, having the humerus and the femur at right angles with the body in the middle of the step, the entaxonic condition seems most effective. It is found in the crocodiles and the turtles, being especially well displayed in the trionychids and the land tortoises. In reptiles the first digit is usually

¹¹ Marsh, op. cit. pl. iii. fig. 6.

retained long after the disappearance of the fifth. In the lizards, however, the fifth is often larger than the first, a condition dependent perhaps on their habit of climbing about on rocks and trees. In the mammals, on the other hand, it is the first digit that earliest suffers reduction.

An attempt has already been made on a previous page to account for the origin of the bipedal habit in reptiles. Evidences are present, it is believed, which show that bipedalism in the dinosaurs was not due to specialization of the anterior limbs. If an examination be made as to the relative lengths of the fore and the hinder limbs in the carnivorous dinosaurs, it will be found that in *Anchisaurus colurus* the fore limb is about three-fourths as long as the hinder; in *Plateosaurus quenstedti* about two-thirds; in *Pachysaurus ajax*, about one-half. These are Triassic dinosaurs. In *Ceratosaurus*, of the Upper Jurassic, the fore limb is only about two-fifths as long as the hinder. In *Tyrannosaurus*, of the Upper Cretaceous, the fore limb is diminutive, in case the humerus found with the specimen really belonged to it.¹² As we have seen, the great pollex of the late Triassic forms had become much reduced in the Upper Jurassic species. Therefore, in place of specialization, the whole limb suffered degeneration. If now it be asserted that bipedalism in the theropods was occasioned by specialization of the fore limb for other purposes than locomotion, we shall have the case presented of an organ which, as soon as it was free to continue its specialization, began to degenerate. Without doubt however, the fore limb continued to be used for various purposes, just as the ostrich continues to use its diminutive wings.

Various opinions have been expressed regarding the origin of the Sauropoda. Marsh¹³ expressed the opinion that the group included the most primitive forms of dinosaurs. Baur¹⁴ held that the Sauropoda had no close relationships to the other reptiles usually classed with them as dinosaurs. Osborn¹⁵ believes that it is possible to derive the sauropod type from a primitive quadrupedal theropod type. In his work already so often quoted, Dr. v. Huene expresses

¹² Osborn. Bull. Amer. Mus. Nat. Hist., xxii, pl. xxxix.

¹³ Dinosaurs N. A., p. 164.

¹⁴ Amer. Naturalist, xxv, p. 450.

¹⁵ Nature, vol. 73, 1906, p. 284.

his view that the sauropods were derived from the carnivorous dinosaurs. He sums up his conclusion as follows (p. 351):

Die Sauropoden ein frühes Theropoden-Stadium festhalten and fixiren und so eine gleichartige und relativ wenig weiterbildungsfähige Masse bilden, die sich wohl nur infolge des Riesenwuchses bis zum Schluss der Kreidezeit behaupten konnte.

Regarding the time of origin of the Sauropoda Dr. v. Huene has the following to say (p. 351):

In der Zeit zwischen dem Schluss der Trias und dem Auftreten von *Dystrophæus* im älteren Jura ist die erste Umprägung zum Sauropoden-Typus erfolgt.

Dr. v. Huene calls attention to the numerous characters common to the Theropoda and the Sauropoda, and he believes that the latter inherited these common characters from the former suborder. Such a derivation would, the present writer holds, require extremely important modifications in the structure of the early Theropoda. The hind foot had, at the end of the Trias, become decidedly mesaxonic, with the hallux greatly reduced and probably somewhat turned backward. To create the foot of *Diplodocus*, for example, the hallux and the second digit must have been stimulated to increased growth; that is, the foot must have been made entaxonic; whereas, the upright gait that is usually attributed to *Diplodocus* ought to have increased the size of the middle digits and further reduced the hallux. The metatarsals that had become lengthened had to be shortened. The fore limb, that in the late Triassic theropods had become reduced in length, sometimes greatly so, must have taken on renewed vigor and increased size. All the modifications that had been attained and all the tendencies established that looked toward making bipeds out of these theropods had to be reversed.

Probably little or no importance can be attached to the fact that no remains of sauropods have yet been encountered in the Triassic deposits. It is certain that but a small proportion of the animals that made those Connecticut Valley tracks have left us other traces of their existence. Then, it is extremely probable that comparatively few of the residents of that region were accustomed to parade on those desolate and dangerous tidal flats. The sauropods especially, being slow-footed plant-eaters, would naturally have sought localities where

there were fewer long-legged enemies and where the grazing was more satisfying.

To the writer, therefore, it appears most reasonable to suppose that the Sauropoda were a more primitive stock than the Theropoda and that the latter were derived from the early Triassic representatives of the former. Those primitive sauropods were no doubt far smaller than any of the group that are known to us. They probably had shorter necks, although with no fewer vertebræ; the vertebræ were less complexly constructed than those of their Jurassic descendants, and fewer of these had coösisified to form the sacrum. The digits, too, were probably longer and the outer ones were less reduced. We can hardly doubt that they crawled on their bellies.

The conviction has been expressed that bipedalism in the dinosaurs was caused by the relative reduction of the fore limbs. On the other hand, the writer believes that bipedalism among the birds was the result of specialization of the fore limbs. These different tendencies gave the signal for the parting of the dinosaurs and the birds. The birds were the gainers by the separation. They secured all that the dinosaurs got and far more besides. The two groups separated at an early period, early in the Triassic, possibly even in the Permian. It was undoubtedly at a time when the members of neither the one group nor the other had begun to walk on the hinder legs only. The feet, fore and hinder, were yet entaxonic. The hinder fifth digit was probably somewhat reduced, while the hallux was large and directed forward. Not until after the divergence of the two groups did the legs of the birds begin to be turned against the flanks and the body to be lifted from the ground. As greater and greater pressure began to be thrown on the middle digits the hallux began to be dwarfed and to be relegated to the hinder part of the foot. *Archæopteryx* shows that the hand had been entaxonic, for in it the two outer digits had wholly disappeared; while the pollex, though somewhat reduced, was yet large and functional.

It seems quite certain that the differentiation of the fore limb was initiated by the appearance of incipient feathers in the form, perhaps, of enlarged scales, which stood out from the ulnar side of the arms. The presence of these feathers, or scales, led to the flapping of the wings in the air, not conversely. Perhaps the individuals on which these rudimentary feathers first appeared were accustomed to clamber

about over rocks and shrubs and the limbs of trees. Possibly the primitive birds, although not more than many lizards, strictly arboreal, often found safety and repose amid the branches and leaves of the Triassic ferns, calamites, and conifers. Possessing a fringe of feathers on their arms, they soon found these of advantage when they were running or making leaps to catch their prey or to escape capture by their enemies. When once they had made this discovery, the race entered on the conquest of the realms of the air.

It will be observed that the writer, in opposition to Dr. Francis Nopcsa¹⁶ holds that the primitive birds became bipedal while they were learning to fly and because of it, instead of becoming so long before the flying habit was initiated. It will be observed that the fore limbs of Dr. Nopcsa's "Pro-avis" are already greatly reduced, and it might be questioned whether such limbs could be rejuvenated. It is certain that the ostriches have for untold generations been flapping their wings, to aid in running, but these limbs have steadily degenerated.

As believed by Dr. v. Huene, the Orthopoda probably took their origin from the Theropoda. If the views expressed by the present writer are true or approach truth, birds came on the arena before either of the suborders of dinosaurs just named; and hence most of the characters which have suggested relationship between the birds and the dinosaurs, which characters have been so clearly presented by Dollo and Nopcsa in the papers already quoted, have all arisen independently in the two groups as a result of their starting from the same goal and speeding in nearly the same direction. On the other hand, the sauropods are nearest the stock from which sprang the birds, and it is in their skeletons that we must seek for the primitive common characters.

To the writer it seems probable that the aviodinosaurs were not amphibious animals, but dwellers on the land. It is not likely that wings were developed on animals that lived much in the water. The Theropoda and the Orthopoda continued to inhabit the land, although this did not prevent them from seeking their food in swamps or from refreshing themselves in the water. After the sauropods had attained such bulk that locomotion on the land became troublesome they

¹⁶ Proc. Zool. Soc. London, 1907, p. 234.

betook themselves to the streams, in order to enjoy the advantages of easier transportation; and then they became still more massive. Had they originally been aquatic and had they continued so, their feet would have remained more like those of crocodiles, less digitigrade and less shortened than they were in *Diplodocus*.

In his paper on the relationships of the birds and the dinosaurs¹⁷ Professor Osborn says:

Thus tridactylism is correlated with rapid bipedal progression, the inner and outer digits suffering reduction.

In formulating this apparently important generalization Professor Osborn did not qualify it with the statement that most of the so-called tridactyl animals are really tetradactyl, the hallux being present and usually functional. Nor could he have had before him the skeleton of any of the sloths, animals that are strictly tridactyl behind, but which are neither bipedal nor endowed with great speed. Tridactylism prevailed among the extinct horse-like perissodactyls and is a characteristic of modern tapirs. On the other hand, there may exist swift bipedal progression independently of tridactylism. The ostrich makes rapid headway with only two toes, one might almost say, with a toe and a half. The kangaroos are wonderful bipedal leapers, whose functional digits are reduced to two, the fourth and the fifth. Man may be justly counted among the swift runners, trained individuals making their mile in four and a quarter minutes, and he possesses a pentadactyl entaxonic foot. No bipedal artiodactyl is recalled, but, as illustrating a possibility, one must not forget to mention Pan, the shepherd god of old Arcady. From which considerations it may be concluded that the bipedal rapid runners have adopted no standard form of foot.

Accompanying the present paper is a drawing (Pl. I) which is intended to represent the habits of *Diplodocus*, especially as regards its habitual pose of body and its manner of locomotion, as conceived by the writer. This drawing was executed by Miss Mary Mason Mitchell, after consultation with the author of the paper. Two individuals are in the foreground. One is collecting food from the surface of the water; the other has the head high in air and is jealously

¹⁷ Amer. Naturalist, xxxiv, 1900, p. 796.

regarding the approach of another, which is swimming. In the far distance is a fourth specimen lying stretched out at full length on the bank.

In the paper published by Mr. Ballou, referred to on page 15, there is a figure which represents a group of four individuals of *Amphicalias latus*, a dinosaur closely related to *Brontosaurus* and attaining a length of from 60 to 80 feet. These animals are shown as walking about on the bottom of a river, feeding on the vegetation there and rising on their hind legs to reach the air. The idea here suggested is adopted by Professor Osborn¹⁸ as correct. Mr. Knight, under Professor Osborn's direction, has made a restoration of *Brontosaurus*¹⁹ in which the same idea regarding the habits of the sauropods is inculcated. In this restoration a number of individuals, otherwise invisible, are sticking their heads out of the water. The ability of any large animal to walk thus submerged must depend on its having a massive skeleton, as have the hippopotamus and the manatee. In *Diplodocus*, on the contrary, almost every conceivable device has been employed to reduce the weight of the skeleton. The great vertebræ contain large and small internal cavities, while externally the processes are carved into thin plates and buttresses and the centra are deeply excavated on each side. Moreover, as has been shown by Hatcher,²⁰ the limb bones are hollow. It would seem to have been hardly more possible for *Diplodocus* to walk about immersed in water than it would be for a man to do the same. Even if the reptile could have remained sunken, any pressure by the feet in the effort to walk would have sent it to the surface.

After the text and the drawings of this paper had been completed the writer received the *Scientific American* of November 6, 1909, in which is printed a popular article on the attitude of *Diplodocus*. In this article mention is made of a paper on this subject recently published by Dr. Gustav Tornier of Berlin, a paper not previously seen by the present writer. Unfortunately too, he has not seen the original papers of Messrs. Drevermann and Boule. No numbers of the *Umschau*, of Frankfort, for the present year are accessible.

¹⁸ Bull. Amer. Mus. Nat. Hist., x, p. 220.

¹⁹ Amer. Mus. Jour., V. p. 68.

²⁰ Mem. Carnegie Mus., i, p. 53, fig. 23.



THE FORM AND ATTITUDES OF DIPLODOCUS

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THE LICHEN FLORA OF THE SANTA CRUZ PENINSULA,
CALIFORNIA.*

BY ALBERT W. C. T. HERRE.

Wer hat je die Flechten, wer hat die Moose gezählet,
Deren Frühling beginnt, wen Fröste den Herbst entblättern,
Deren üppiger Wuchs die Scheitel ätherischer Alpen
Da, wo sie Flora verläst, mit Tausend Farben bekleidet?

J. G. HERDER.

The present paper is a synopsis of the author's studies of the systematic limitations and relationships of the lichens of the Santa Cruz Peninsula of California.

As already explained in earlier papers (Proc. Wash. Acad. Sci., vol. vii, p. 325, et seq., and Botanical Gazette, vol. xliii, pp. 267-273), the Santa Cruz Peninsula forms a natural biological region, and as such naturally commends itself to the study of the naturalist interested in geographical distribution.

The region here treated is a roughly triangular area lying west of San Francisco Bay and the broad, originally treeless Santa Clara-San Benito valleys, and north of Monterey Bay and the Pajaro river. Rising from sea level along most of its border, its surface is greatly broken by a spur of the Coast Range, the Santa Cruz mountains, which rise at their highest point to an elevation of 3793 feet. Within this region, measuring no more than 90 miles in length and tapering from about 35 miles in breadth at the south to perhaps 6 at the Golden

* A Thesis presented as a part of the requirements for the Degree of Doctor of Philosophy at Leland Stanford Junior University, California.

Gate, are to be found the dense redwood forest and the naked ocean rock, the cold, foggy mountain crag and the bare, blistering expanse of sand-dune, the monotonous salt marsh and the impenetrable chaparral.

The earliest collector of lichens in California was Archibald Menzies, a Scotch botanist and collector, who visited the northwest coast of America during the years from 1779 to 1796; in November and December, 1792, he visited San Francisco Bay, Santa Clara, and Monterey and obtained specimens which were described by Acharius and also supplied Tuckerman with material more than 50 years later. Charles Wright, botanist of the North Pacific Expedition, collected a number of lichens at various points in the peninsula in 1855 and 1856.

The most important collections were those made by H. N. Bolander, who collected over a great part of the peninsula, and in fact over most of California, discovering a large number of most remarkable lichens during the years from 1863 to 1875.

Since Bolander's time no special work has been done on the lichens of the Santa Cruz region, though more or less important collections were made by the following: Dr. C. L. Anderson, of Santa Cruz; Dr. W. G. Farlow, who published a valuable set of Californian lichens, part of which were collected in the Santa Cruz mountains; Dr. L. M. Underwood; Dr. Marshall Howe; and C. F. Baker.

The present paper describes 307 species and subspecies; but it is believed that further investigation will raise this number very materially. In fact there are in the author's herbarium many specimens which he has as yet been unable satisfactorily to determine in the absence of authentic material for comparison, and literature which is not at present accessible.

In the matter of generic nomenclature, the treatment of the best students of lichens of the present day has been followed. In the case of species names the earliest recognizable name found in accessible authorities has been adopted.

Synonymy too often is the bugaboo of science, and the habit of many of our most eminent lichenologists of the past, as Nylander and Tuckerman, of changing names to suit their opinions, has not improved matters. No scientist, however eminent, has any right to change a name because it is inapplicable or denotes a character which may be common to a number of species within a genus. A name should have

an appropriate and distinctive meaning, but it need have no special significance and may be totally devoid of meaning or may even be misleading, as when *minima* is applied to the largest species of a genus. In the present unsettled condition of botanical nomenclature one is often in doubt as to what to do, but it seems clear that the law of priority should be observed.

Perhaps no more important work could be done than the careful overhauling of the synonymy of American lichens by someone who has access to the published exsiccata of Europe and America as well as the literature of the subject.

The author has endeavored to avoid the old conception where the word species was almost a generic term, including a large number of subspecies, varieties, and forms. Nature has no clean-cut, sharply drawn definitions, and perhaps in no organisms are the actual variations and gradations so numerous or more puzzling than in lichens. But, nevertheless, a species should be a pretty distinct and well defined group in which the degree of variability is relatively small. Those forms which present constant differences in the field, or in structure, may be regarded as distinct species, while instead of giving every minor variation a varietal name we should rather work out the ecological factors producing them, and not overload an already too burdensome synonymy.

While every part of the Santa Cruz Peninsula has been visited many times, certain localities naturally, have been found the richest in numbers or rarity of species. Perhaps first of these stands the region at the head of Devils Cañon, a wild region where is found the largest mass of bare rock in the peninsula, and where there is a nearly vertical descent of perhaps 800 feet. Other localities offering peculiar attractions to the collector are the cliffs of the Golden Gate, and of the ocean shore from Point San Pedro to Pigeon Point, and the sandstone ridges of Castle Rock and vicinity. But as a matter of fact there is not a cañon winding down to the ocean, not a group of old forest trees, not an insignificant reef of igneous rock outcropping in the foothill pastures, but will amply repay the intelligent efforts of any collector.

The Santa Cruz Peninsula is peculiarly rich in endemic species, and although collections in other parts of the state may considerably extend the range of some of them, it is probable that a goodly number

may never be found elsewhere. The climatic conditions which cause this have already been discussed by the author elsewhere. Yet these same climatic conditions also give us an exceedingly diversified lichen flora, and it is believed that the present work can therefore be used as a manual for the identification of lichens over a great part of the western half of the United States.

In taking up the study of lichens, while the habit and general macroscopic structure is of importance and nothing can quite take the place of careful field work, the student must also be careful and accurate in the microscopic examination of all material. For this examination careful sections should be made both of thallus and fruit. A comparison of sections of the thallus of two plants may show constant differences when the fruit is similar in structure. The algæ, too, need special attention, since some of the features relied upon by algologists may be absent when living under the conditions found within the lichen thallus. This is especially true of some of the filamentous blue-green algæ.

As a corroborative test in the determination of species, one often finds certain chemical tests of considerable value. For this purpose a bit of the cortex, medulla, or apothecium is subjected to the action of potassium hydrate, or KOH, using a 25 per cent or 50 per cent solution. In the same way a saturated solution of calcium chloride, CaCl_2O_2 , is used, either by itself or applied immediately after KOH. The ordinary solution of iodine used in the botanical laboratory, designated as I, is used frequently, most often in the examination of sections of apothecia.

Results of the above tests are not to be considered as sufficient to separate species when there are no other differences, but are secondary characters, to be considered with other characters based on structure or primary differences. Personally, the author has found the tests to be quite uniform and reliable, even when examining specimens obtained from regions thousands of miles apart, or growing on different substrata.

In examining the spores of lichens, the beginner or general student must be cautious about observing and measuring any spores which may happen to be within the field of the microscope. In addition to the spores of various fungi which occur on the surfaces of all plants, the thallus of some lichens is frequently infested with parasitic fungi,

while the apothecia of others are covered with minute parasitic apothecia. For example, the thallus of *Heppia guepini* is commonly the host of a parasitic *Endococcus*. As *Heppia* is very often sterile and the apothecia are not visible to the naked eye, one is exceedingly apt to be confused by the *Endococcus* spores unless very careful sections are made.

Nylander, Tuckerman, and others, described the minute apothecia covering the disk of the fruit of many lichens as parasitic Buellias, Lecideas, and the like. But as they never contain algæ, and have no thallus of their own, they are undoubtedly parasitic fungi, and accordingly are not considered in the present work.

In the preparation of this paper the author has been assisted at all times, and especially in the study of the Lecideaceæ, by his fellow worker, Dr. H. E. Hasse, of Sawtelle, California, who has given his time and energy without stint.

To my friend and teacher, Dr. Alexander Zahlbruckner, curator of the botanical section of the Imperial Natural History Museum of Vienna, Austria, I wish to express my gratitude for help while studying in the Museum and collecting with him in the Styrian Alps. His masterly treatment of lichens in Engler and Prantl's *Die Natürlichen Pflanzenfamilien* has been followed in this paper.

To Dr. W. G. Farlow of Harvard University I am indebted for many favors and the gift of valuable specimens, while to him and Mr. A. B. Seymour I owe the privilege of examining the Tuckerman Herbarium.

To the authorities of the British Museum and Kew Garden I am indebted for courtesies while examining the herbaria there.

The veteran Californian botanist, Volney Rattan, long time professor in the San José State Normal School, generously gave me a considerable collection of Californian lichens, presented him by H. N. Bolander; this collection has been of great service in deciding many difficult points.

Prof. Bruce Fink, of Miami University, Oxford, Ohio, has kindly determined a set of my collections of *Cladonias*, a labor of love which I greatly appreciate.

To Dr. William Trelease, the U. S. National Museum and the Bureau of Plant Industry, at Washington, D. C., and to the Botanical

department of the University of California, I am indebted for the loan of literature otherwise inaccessible.

My sincere thanks are due Prof. William Russell Dudley, head of the department of systematic botany at Leland Stanford Junior University, for timely assistance and helpful criticism in many ways, especially in the final preparation of this paper. To him I dedicate this work, as long since he called my attention to the distinctiveness of the Santa Cruz Peninsula as a biological region.


Los Gatos, California, October, 1908.

ARTIFICIAL KEY TO GENERA OF LICHENS OF THE SANTA CRUZ PENINSULA, CALIFORNIA.

Crustaceous Lichens.

- A. Thallus absent.
 B. On thallus of *Pertusaria*; apothecia top-shaped. IX. *Sphinctrina*
 BB. On rock, wood, or bark.
 C. Asci multisporeous, spores minute.....XXVI. *Biatorella*
 CC. Spores not more than 8.
 D. Apothecia lecideineXIX. *Lecidea*
 DD. Apothecia lecanorineXLIII. *Lecanora*
 AA. Thallus more or less developed.
 E. Apothecia pyrenocarpous, more or less globose, immersed, hemispherical or sessile, with a terminal pore.
 F. Algæ *Trentepohlia*.
 G. Paraphyses branched and twining.....IV. *Arthopyrenia*
 GG. Paraphyses simple and freeV. *Porina*
 FF. Algæ *Pleurococcus*.
 H. Thallus uniform crustaceous; spores 8, simple...I. *Verrucaria*
 HH. Thallus of sub-foliaceous to minute squamules.
 I. Spores 8, simple, colorlessII. *Dermatocarpon*
 II. Spores 2, muriform, yellowish to brown..III. *Endocarpon*
 EE. Apothecia not pyrenocarpous.
 J. Apothecia more or less stalked, or sessile, spores extruded and forming a sporal mass or mazædium covering the disk.
 K. Apothecia containing algæ.....IX. *Sphinctrina*
 KK. Apothecia not containing algæ.
 L. Apothecia on long stalks.
 M. Thallus and stipe greenish-yellow, powdery. VII. *Coniocybe*
 MM. Thallus and stipe not yellow.
 N. Spores bilocular VI. *Calicium*
 NN. Spores 4-8 celled VIII. *Stenocybe*
 LL. Apothecia short-stipitate or sessile.

- O. Apothecia pear or top-shaped, growing on *Pertusaria* thallus, containing algæ; spores simple . . . IX. *Sphinctrina*
- OO. Apothecia crateriform, not containing algæ; spores bilocular, or simple in 1 form. X. *Cyphelium*
- JJ. Apothecia without a mazædium.
- P. Apothecia usually linear or elongate, with a fissure-like disk; seldom circular; algæ *Trentepohlia*.
- Q. Thallus very thin, uniform crustaceous.
- R. Apothecia without margin, more or less stellate, branching, or irregular. XII. *Arthonia*
- RR. Apothecia with a margin.
- S. Apothecia innate, fissure-like, with evident disk; spores caterpillar-like, brown. XIV. *Phæographis*
- SS. Apothecia sessile, not innate or fissure-like; apothecia irregular, linear or ellipsoid. XIII. *Opegrapha*
- QQ. Thallus thick, irregular, often warty or sub-plicate; apothecia circular or nearly so, with both proper and thalline margins. XV. *Dirina*
- PP. Apothecia more or less circular and dish or shield-like; never linear, though often angular or variously shaped from pressure or crowding.
- T. Algæ blue-green (*Cyanophyceæ*).
- U. Algæ *Nostoc*.
- V. Apothecia biatorine or lecideine. XXXV. *Parmeliella*
- VV. Apothecia lecanorine XXXVII. *Pannaria*
- UU. Algæ not *Nostoc*.
- W. Algæ *Scytonema*.
- X. Thallus squamulose to small-foliaceous, mostly of parenchyma; spores simple, colorless. XXXIV. *Heppia*
- XX. Thallus crustaceous, coralloid, to small squamulose, spores colorless, 2-8 locular. XXXVI. *Placynthium*
- WW. Algæ not *Scytonema*.
- Z. Algæ *Stigonema*; thallus microscopically fruticose, of terete filaments. XXVIII. *Zahlbrucknera*
- ZZ. Algæ *Glaucapsa*; thallus diffract-crustaceous to minutely squamulose. XXXI. *Pyrenopsis*
- TT. Algæ not blue-green.
- a. Algæ *Trentepohlia*. XVII. *Lecanactis*
- aa. Algæ *Pleurococcus*, *Protococcus*, or *Palmella*.
- b. Spores simple, colorless, minute, exceedingly numerous; thallus of scales or squamules, with usually innate apothecia. XXVII. *Acarospora*
- bb. Spores not excessively numerous.
- c. Spores bi-locular, typically polari-locular, or becoming muri-form by interpolation of cross-walls.
- d. Spores colorless, polar-bilocular.
- e. Apothecia lecanorine LVIII. *Caloplaca*

- ee.* Apothecia biatorine or lecideine.LVII. *Blastenia*
- dd.* Spores brown, bilocular to muriform.
- f.* Apothecia urceolate; spores muriform from beginning.
XVIII. *Diploschistes*
- ff.* Apothecia not urceolate.
- g.* Spores with a distinct halo. . . .XXIII. *Rhizocarpon*
- gg.* Spores without a halo.
- h.* Apothecia lecideineLXI. *Buellia*
- hh.* Apothecia lecanorineLXII. *Rinodina*
- cc.* Spores simple to multilocular, but not polar-bilocular; colorless. 
- i.* Apothecia lecideine.
- j.* Spores simpleXIX. *Lecidea*
- jj.* Spores bi- to multilocular.
- k.* Spores bilocularXX. *Catillaria*
- kk.* Spores 4-16 locular
- l.* Thallus without cortex, areolate or uniform.
XXI. *Bacidia*
- ll.* Thallus with cortex; of swollen or plicate warts or squamules . .XXII. *Toninia*
- ii.* Apothecia lecanorine.
- m.* Apothecia single or grouped, immersed in thal-line warts; disk very narrow; spores large to very largeXLII. *Pertusaria*
- mm.* Apothecia solitary, not immersed in thal-line warts; disk relatively broad.
- n.* Spores simple.
- o.* Paraphyses free, simple; spores small to medium.
- p.* Spermata thread-like; thallus variously colored but not orange-yellow.
XLIII. *Lecanora*
- pp.* Spermata ellipsoid; thallus orange-yellow.XLVII. *Candelariella*
- oo.* Paraphyses branched and entwined; spores quite largeXLIV. *Ochrolechia*
- nn.* Spores bilocular.
- q.* Sterigmata exobasidial.
- r.* Thallus orange-yellow; spermata ellipsoid.
XLVII. *Candelariella*
- rr.* Thallus not orange-yellow; spermata thread-likeXLV. *Lecania*
- qq.* Sterigmata endobasidial; thallus marginally lobed or of more or less lobate squamules.
XLVI. *Placolecania*

Foliaceous Lichens.

- A. Thallus gelatinous when wet; color always dark; algæ blue-green (*Cyanophyceæ.*)
- B. Algæ *Scytonema*.....XXX. *Polychidium*
- BB. Algæ *Nostoc*.
- C. Thallus dark green without cortical layer.....XXXII. *Collema*
- CC. Thallus usually lead-colored, with distinct cortical layer.
XXXIII. *Leptogium*
- AAA. Thallus not gelatinous when wet.
- D. Apothecia never present.
- E. Thallus dark.
- F. Plant apparently black, the surface covered with black isidia.
XXXIX. *Sticta*
- FF. Plant dark brown, sub-fruticose; the ascendant, irregularly cut lobes with narrow white edge.....L. *Cetraria*
- EE. Thallus green or pale.
- G. Yellowish green with gray soredia; beneath villous or with naked pale spots XXXVIII. *Lobaria*
- GG. Plant more or less orbicular, often very large, grey, yellowish or bright green; beneath black, usually brown-margined, more or less black-fibrillose.....XLIX. *Parmelia*
- DD. Apothecia usually present and abundant.
- II. Thallus attached at a single point near the center by an umbilicus.
- I. Apothecia visible to naked eye; thallus large or of medium size.
- J. Apothecia adnate, gyrose; thallus brown...XXV. *Gyrophora*
- JJ. Apothecia immersed, appearing as minute dark specks on the ashy gray thallusII. *Dermatocarpon*
- III. Apothecia not visible to naked eye; thallus very small, dark olive or blackish brown, expanded or ascendant.
XXXIV. *Heppia*
- HH. Thallus attached by numerous rhizoids, not umbilicate.
- K. Apothecia adnate on under side of marginal lobes.
- L. Algæ *Nostoc*; spores 2-4 locular.....XI. *Nephroma*
- LL. Algæ *Protococcus*; spores simple.....LI. *Nephromopsis*
- KK. Apothecia always on upper surface of thallus.
- M. Thallus bright yellow or orange.
- N. Apothecia chestnut; spores simple, colorless.
L. *Cetraria*
- NN. Apothecia yellow or orange.
- O. Spores polar-bilocular, colorless, 8.
LIX. *Xanthoria*
- OO. Spores simple, 16 to 60.....XLVIII. *Candelaria*
- MM. Thallus not bright yellow or orange.
- P. Thallus horizontal, orbicular or variously lobed; under surface with veins or cyphels.
- Q. Under surface with small white cyphels, villous or fleecy.....XXXIX. *Sticta*

QQ. Under surface without cyphels.

R. Thallus pale villous beneath with large, pale, naked spotsXXXVIII. *Lobaria*

RR. Thallus pale or whitish beneath, with brown veins and fibrils; apothecia adnate on tips of more or less elongate lobes.

XLI. *Peltigera*.

PP. Without veins or cyphels on under surface.

S. Spores bi-ocular, brownLXIV. *Physcia*

SS. Spores simple, colorless.

T. Thallus flat, appressed; under surface brown or black, more or less black fibrillose; apothecia scattered over surface.XLIX. *Parmelia*

TT. Thallus sub-fruticose, compressed; apothecia marginal or on tips of ascendant lobes.

L. *Cetraria*

Fruticose Lichens.

Plants more or less erect and shrub-like, or drooping and pendulous.

A. Thallus of two kinds: (1) a horizontal, more or less leafy or granulose one; (2) a more prominent, erect, and caulescent one, really stalks for the apothecia but apparently the plant; simple, and club, cup, or funnel-shaped, or slender and much branched; apothecia scarlet or brownXXIV. *Cladonia*

AA. Thallus uniform, not two-fold.

B. Apothecia globose, terminal; plant tufted, shrub-like, gray.

XI. *Sphaerophorus*

BB. Apothecia dish or shield-like; terminal, marginal, or more rarely scattered.

C. Thallus hair-like.

D. Black or brown, like tangled mats of fine hair.

LIV. *Alectoria*

DD. Color not black or brown.

E. Thallus erect or decumbent, densely tufted, intricately branched, terete, gray, sterile; on maritime rocks.

XVI. *Dendrographa*

EE. Thallus coarser, gray or pale straw-color, rarely red; tufted or pendulous, becoming enormously elongated; apothecia concolorous or pale tan, with fibrillose margin.

LVI. *Usnea*

CC. Thallus not hair-like.

F. Plants not gray or green.

G. Thallus brown or black.

H. Sooty black, very small, compact, sterile: on vertical sandstone wallsXXIX. *Ephebe*

III. Greenish black or brown, spreading, compressed; apothecia abundant, terminal.L. *Cetraria*

- GG. Thallus yellow.
- I. Spores simple, colorless; thallus bright lemon-color; apothecia chestnutLIII. *Letharia*
- II. Spores polar-bilocular, colorless; plants and apothecia reddish yellow or orange.
- J. Thallus erect, lax, pendulous or decumbent; on trees and maritime rocksLX. *Theloschistes*
- JJ. Thallus short, rigid, becoming decumbent; on maritime rocksLVIII. *Caloplaca*
- FF. Plants gray, green, or pale.
- K. Apothecia present.
- L. Apothecia concolorous; thallus tufted, compressed or terete, or elongate, pendulous, and greatly compressed.LV. *Ramalina*
- LL. Apothecia not colored like thallus.
- M. Apothecia black, pruinose or naked; thallus marginally fibrillose and fuzzy ..LXIV. *Anaptychia*
- MM. Apothecia not pruinose or black.
- N. Apothecia chestnut; lobes long, ascendant, white beneath, on trees.....L. *Cetraria*
- NN. Apothecia yellowish or dusky; plants very short, stout, erect, rigid, sub-crustaceous; on maritime rocksXLIII. *Lecanora*
- KK. Apothecia absent.
- O. Lobes narrow, ascendant, margined with stout, usually branching fibrilsLXIV. *Anaptychia*
- OO. Lobes not marginally fibrillose.
- P. Sub-crustaceous; short, stout, terete; powdery, simple or branched; on maritime rocks ..XLIII. *Lecanora*
- PP. Thallus pendulous or erect; more or less white soresiate; on trees and shrubsLII. *Evernia*

LICHENES.

ASCOLICHENES.

Composed of Fungi belonging to the Ascomycetes, living in union (symbiosis ?) with Algæ, these two distinct classes of plants apparently forming a morphological and physiological unit.

I. PYRENOCARPEÆ: Apothecia globular, usually opening at the summit by a minute pore.

II. GYMNOCARPEÆ: Apothecia more or less open and the disk exposed, circular and shield-like or dish-like, elongated and variously shaped, or crater-like.

PYRENOCARPEÆ.

Thallus crustaceous, squamulose, rarely foliaceous, more rarely fruticose. Gonidia of *Pleurococcus*, *Chroolepus* or *Trentepohlia*, *Phyllactidium*, *Nostoc*, or *Sirisiophon* algæ. Soredia are absent or very rare. Apothecia globular or hemispherical, opening only by a pore at the summit, immersed in the thallus with only the apex protruding, or sessile; naked or more or less covered by a thalline layer; solitary, or confluent and forming a stroma; a proper exciple or margin, known as the perithecium, pale to black, closed or open below (dimidiate); within this a more or less distinct envelope, the amphithecium, enclosing a globose hymenium, the nucleus of many authors, which is soft, gelatinous, and often contains algæ or oil drops. Paraphyses simple, or branched and then twining and net-like; commonly soon gelatinizing and apparently lacking. The Angiocarpous lichens of many authors.

KEY TO FAMILIES.

Thallus with *Pleurococcus* or *Parmelia* alga.

Thallus crustaceous, without cortex *Verrucariaceæ*

Thallus foliaceous or squamulose, cortex present . . . *Dermatocarpaceæ*

Thallus with *Trentepohlia* alga, crustaceous, the apothecia solitary or sub-confluent but not forming stroma *Pyrenulaceæ*

VERRUCARIACEÆ.

Thallus uniform crustaceous, growing upon or within the upper layers of the substratum, without cortex, the gonidia of *Pleurococcus* or *Parmelia* algæ. Apothecia single, erect, with an apical pore.

I. *Verrucaria* (Web.) Th. Fr.

Verrucaria Weber, Prim. Flor. Hols. p. 85.

Verrucaria Th. Fries, Gen. Heterol. Europ. 109. 1861.

Verrucaria A. Zahlbr., Ascolichenes, 54. 1907.

Thallus crustaceous, rimose areolate, or powdery, commonly with an evident hypothallus, rarely sorediate, usually upon the substratum, rarely within. Apothecia entirely immersed, half sunken, or sessile; perithecium coal-black, horny, globular, flask-like, or hemispherical with the underside open; paraphyses soon gelatinizing; spores 8, ellipsoid, oval, or globose, one-celled, colorless or rarely brown.

About 100 species, often difficult to define.

KEY TO SPECIES.

- A. Thallus thin to very thin.
 - B. Black, resembling a smear of black paint; on maritime rocks. 5. *melas*
 - BB. Not black.
 - C. Very thin and powdery, or mostly obsolete; forming white spots on limestone6. *calciscda fusca-spora*
 - CC. Of minute ashen or gray granules; on sandstone. 4. *muralis*
- AA. Thallus more or less areolate or scaly; from thin becoming thick.
 - D. Color pale.
 - E. Areoles thick, bluish gray7. *stanfordi*
 - DD. Color dark to the naked eye.
 - F. Thallus areolate or scaly, ashy gray under lens; black appearance due to the numerous apothecia1. *rupestris*
 - FF. Thallus some shade of brown.
 - G. Pale to dark olive brown, with a more or less greenish cast when wet.....2. *viridula*
 - GG. Dark brown to black, not becoming greenish when wet. 3. *nigrescens*

1. VERRUCARIA RUPESTRIS Schrader.

Verrucaria rupestris Schrad. Spicil. Fl. Germ. 109. 1794.
Verrucaria rupestris Leighton, Brit. Angiocarp. Lich. 60. Pl. 25.
 f. 4. 1851.

Thallus effuse, thin to thickish, apparently continuous, but really minutely fissured and areolate or scaly; black to the naked eye, but examination with the lens shows it to be ashy gray.

The black color is due to the numerous, large, prominent, hemispherical, and semi-immersed apothecia; perithecium thick, black, dimidiate; amphithecium thin, pale brown; hymenial gelatine blue with I; spores colorless to pale yellow, ellipsoid or sometimes pointed

at one end, $\frac{8\frac{1}{2} - 11}{20 - 25} \mu$.

On rocks at Point Lobos, San Francisco, and elsewhere along the ocean shore; probably occurring throughout our territory. Commonly distributed over the North Temperate region.

I also doubtfully refer here a plant on sandstone, Castle Rock Ridge, altitude 2000 feet, differing as follows:

Thallus areolate, fissured, the areoles distinct or running into a

continuous crust, chaffy or microscopically corallinoid, dingy brown in color; resembling a crustaceous *Pannaria* or Collemaceous lichen.

Apothecia not numerous or conspicuous, small, black, semi-immersed; spores larger than in the previously described form, $\frac{12 - 15}{24 - 30} \mu$.

In other respects agreeing.

Unlike anything in the accessible literature or specimens, and perhaps new.

2. VERRUCARIA VIRIDULA Ach.

Verrucaria viridula Acharius, Lich. Univ. 675. 1810.

Thallus forming a thickish, effuse, rough or uneven, chinky or fissured crust of minute, polygonal areoles, closely compacted; their surface smooth or rough or warty; color varying from pale to dark olive blackish brown, with a more or less evident greenish cast when wet; KOH—; CaCl₂O₂—.

Apothecia usually but one in an areole, rather large, black, immersed, with only the apical portion visible; usually without an ostium; perithecium dimidiate, thick, black; amphithecium thin, black; hymenial gelatine bluish with I; spores broadly elliptical, colorless, often with one or two very large oil drops, $\frac{12\frac{1}{4} - 17\frac{1}{2}}{24 - 34} \mu$.

Abundant on sandstone in the foothills and probably occurring all through the mountains.

A plant of Europe, North America, and northern Africa.

3. VERRUCARIA NIGRESCENS Pers.

Verrucaria nigrescens Persoon, Ust. Ann. Bot. 14: 36. 1795.

Thallus effuse or sub-determinate, thin or becoming moderately thick, of minute areoles, compacted into a nearly uniform crust; color dark brown to black.

Apothecia numerous, of moderate size, hemispherical, more or less immersed and with the apex often covered by the thallus; the apical pore usually not visible; perithecium entire; hymenial gelatine pale salmon or reddish with I, or part reddish and part blue with I; spores ellipsoid to short and broadly ovate, often falsely bi-nucleolate or

containing a large oil drop, $\frac{6 - 8\frac{1}{2}}{14 - 18} \mu$, $\frac{11 - 13\frac{1}{3}}{19\frac{1}{2} - 23} \mu$, and $\frac{8 - 15}{19 - 29} \mu$;
 according to Nylander, $\frac{12 - 15}{23 - 27} \mu$.

On sandstone in the foothills and mountains. Common in Europe, Africa, and North America.

4. VERRUCARIA MURALIS Ach.

Verrucaria muralis Acharius, Meth. Lich. 115. 1803.

Verrucaria muralis Tuck. Gen. Lich. 269. 1872.

Verrucaria muralis Jatta, Lich. Syll. Ital. 1325. 1900.

Thallus thin, effuse, and disappearing, ashen or gray in color, of minute granules.

Apothecia, very small, scattering, black, pruinose or naked, hemispherical, rather prominent; the ostiolum very minute, hardly visible under the lens; perithecium dimidiate, black; amphithecium pale brown or yellowish; hymenial gelatine blue with I; spores ellipsoid, colorless and pale yellowish, $\frac{10 - 12}{13 - 24} \mu$.

Rarely on sandstone on the highest peaks. Generally distributed over Europe and North America.

5. VERRUCARIA MELAS Herre, new species.

Thallus thin or very thin, effuse, microscopically areolate and intricately fissured, appearing to the naked eye as a daub of dead black paint; KOH- ; CaCl₂O₂-.

Apothecia not numerous, at first low and covered by the thallus, becoming more prominent and emergent, hemispherical, finally sessile and sub-globose, the apical portion then irregularly depressed and the ostiolum comparatively large; perithecium entire, black; asci oval, clavate, and pear-shaped, the hymenial gelatine blue with I; spores ellipsoid, $\frac{8\frac{1}{2} - 12\frac{1}{4}}{19\frac{1}{2} - 27} \mu$.

Rare; on rocks a few feet above the sea at Point Lobos, San Francisco, associated with *Arthopyrenia halodytes*.

Strongly resembling *Verrucaria maura* in general appearance, but

differing in the thinner thallus, the much larger and somewhat differently shaped spores, and the chemical reaction. A specimen of *Verrucaria maura* from Dr. Farlow, collected at Campobello, New Brunswick, yields me oblong spores, measuring $\frac{7\frac{1}{3} - 10}{12\frac{1}{4} - 16} \mu$, while the reaction with I is vinous red.

(melas, μέλας, black.)

6. VERRUCARIA CALCISEDA FUSCA-SPORA Herre, n. subsp.

Verrucaria calciseda DC. Fl. Fr. 2: 317. 1805.

Verrucaria calciseda Leighton, Lich. Fl. Grt. Britain, ed. 3, 458. 1879.

Thallus effuse, endolithic, very thin and powdery or obsolete, forming white spots on the rock.

Apothecia numerous, minute, black, immersed in tiny pits in the rock, becoming slightly protuberant; ostiolum depressed, circular, pore-like, or often irregularly fissured; perithecium broad, dimidiate, black; gelatinous thecium bluish or blue with I; asci clavate; spores ovoid or elliptical, from colorless becoming dusky and finally dark brown, $\frac{9\frac{3}{4} - 14.7}{17\frac{1}{2} - 28} \mu$.

Abundant on limestone near the summit of Black Mountain, altitude 2700 feet, mixed with *Rinodina bischoffi immersa*, from which it is with difficulty externally distinguishable. The internal structure not satisfactorily made out owing to the difficulty of extracting the apothecia from their holes without breaking them.

Differs from the type in having dark spores. Leighton says (Brit. Angiocarpous Lichens, 60, 1851, pl. 25, f. 4) that the spores of *V. rupestris* are pale yellow, but elsewhere he and other authors call the spores of all this group colorless.

(fusca, dark; spora, σπόρος, seed.)

7. VERRUCARIA STANFORDI Herre, new species.

Thallus of thick, somewhat convex arcoles, reaching a thickness of 2 mm., either separate or arranged in small groups or finally compacted into a deeply fissured, continuous, chinky crust; the surface very min-

utely granulose, of a handsome bluish gray color, shading off to ashen; KOH—; CaCl₂O₂—.

Apothecia one to several in each areole, the perithecium sunken in the thallus, globular, entire, thick, black; ostiole from sunken becoming elevated, circular, thickish; hymenial gelatine blue with I; spores 8, simple, colorless at first, at last brownish, elongate-ellipsoidal,

$$\frac{6 - 8.5}{14\frac{1}{2} - 22} \mu.$$

On rocks in the foothills near Stanford University, at an altitude of 150 feet. On a rock beside the road to Lick Observatory, alt. about 800 feet, Mt. Hamilton Range.

(stanfordi, because found near Stanford University.)

DERMATOCARPACEÆ.

Thallus foliaceous or squamaceous, with a cortex of pseudoparenchyma upon one or both sides; fastened to the substratum by an umbilicus, by rhizoids, or adherent by the medulla; gonidia of *Pleurococcus* algæ. Apothecia solitary, erect, with a minute pore at the summit, more or less immersed in the thallus.

KEY TO GENERA.

Apothecia without gonidiaII. *Dermatocarpon*
 Apothecia containing gonidiaIII. *Endocarpon*

II. *Dermatocarpon* (Esch.) Th. Fr.

Dermatocarpon Eschweiler, Syst. Lich. Gen. 21. 1824.

Dermatocarpon Th. Fries, Gen. Het. Europ. 103. 1861.

Thallus leafy and greatly expanded or reduced to areolate squamules; umbilicate, or appressed and adnate; the algal layer beneath the upper cortex. Apothecia solitary, erect, minute, immersed, or with only the apical portion emergent upon the surface, upon which they appear as minute specks; perithecium clear or black, globular or ovoid, without algæ; paraphyses usually gelatinizing, rarely poorly developed and then branched and net-like; asci 8 — 16 spored; spores ellipsoid, simple, colorless.

Proc. Wash. Acad. Sci., May, 1910.

KEY TO SPECIES.

Thallus of flat or flattish adnate squamules.

Perithecium black; thallus more or less olive or blackish brown; on bark.....1. *squameella*

Perithecium clear; squamules more or less reddish or chestnut brown; on earth.....2. *hepaticum*

Thallus foliaceous, umbilicate.

One-leaved, large.....3. *minatum*

More or less polyphyllous

The convolute, complicate lobes ascendant, the plant more or less cespitose.....4. *miniatum complicatum*

Thallus pseudo-crustaceous, small, closely appressed.

5. *aquaticum*

Section CATOPYRENIUM.

Thallus squamulose; or minutely foliaceous, but not umbilicate; perithecium black.

I. DERMATOCARPON SQUAMEELLA (Nyl.).

Verrucaria squameella Nyl. *in litt.* to Dr. Hasse. 1897.

Thallus foliaceous, small to minute, irregularly lobate, with uneven, undulate surface; the more or less upturned margin crenate, sometimes minutely orbicular-lobulate fringed; color dark olive or reddish brown to blackish; beneath whitish or pale, fastened to the substratum by numerous rhizoids.

Apothecia rather numerous, immersed, minute, pear-shaped or subglobose, the perithecium entire, dark brown or blackish; asci clavate to short ventricose; hymenial gelatine vinous red with I, but when KOH is applied first and then I the reaction is a quickly fading

blue; spores narrowly ellipsoid, $\frac{2\frac{1}{2} - 5}{12\frac{1}{4} - 17\frac{1}{2}} \mu$; "6 - 7 μ ," Nyl. *in litt.*

Very rare; collected but once, on the bark of *Quercus lobata*, in the foothills 5 miles south of Stanford University. Originally collected by Dr. Hasse near Los Angeles, where it is also very rare.

Section ENDOPYRENIUM.

Thallus of adnate squamules or sub-foliaceous, but not umbilicate; perithecium clear.

2. DERMATOCARPON HEPATICUM (Ach.) Th. Fr.

Endocarpion hepaticum Acharius, Lich. Univ. 298. 1810.

Dermatocarpion hepaticum Th. Fr. Lich. Arct. 255. 1860.

Thallus of small, rounded, closely adnate squamules, these becoming wavy; margin more or less incised or crenate, upturned, blackening; usually distinct, but sometimes slightly imbricate; color varying from bright reddish brown to chestnut, and dull dusky brown.

Apothecia numerous, immersed, the ostioles minute, becoming protuberant with black margin; spores oval, $\frac{5}{12} - 7\frac{1}{2}$ μ .

On bare earth or in crevices of rocks in the foothills and mountains. In Tuckerman Herbarium (Bolander's collection) from San Francisco and Oakland. Common on calcareous soil throughout the North Temperate Zone.

Section ENTOSTHELIA.

Thallus foliaceous, attached by a central umbilicus.

3. DERMATOCARPON MINIATUM (L.) Mann.

Lichen miniatus Linn. Sp. Pl. 2: 1149. 1753.

Dermatocarpion miniatum Mann, Lich. in Bohemia observ. p. . 1826.

Dermatocarpion miniatum Herre, Proc. Wash. Acad. Sci. 7: 394. 1906.

Thallus medium to large, smooth, coriaceous, one-leaved or lobate, the margin rounded, undulate, or crenate, and more or less recurved; attached by an umbilicus; color whitish to bluish gray or occasionally brownish; sometimes granulose pruinose; beneath varying from a bright to a dark brown or black, smooth or minutely pustulate.

Apothecia very numerous, minute, scattered, immersed in the thallus; opening by small dark or brown pores, which appear as specks thickly distributed over the entire surface. Spores ellipsoid,

$\frac{4\frac{1}{2}}{9\frac{3}{4}} - \frac{6\frac{1}{2}}{17}$ μ .

On rocks, in shaded or damp situations. A common and conspicuous lichen throughout the foothills and to the summit of the Santa Cruz range, the thallus reaching a diameter of more than four inches in specimens from San Bruno Mountain. Common in the

mountains of Europe, northern Africa, North America, and New Zealand.

(*miniatum*, red, of no application here.)

Of several named varieties one is common here.

4. DERMATOCARPON MINIATUM COMPLICATUM (Sw.)
Th. Fr.

Lichen complicatus Swartz, Nov. Act. Upsal. 4: 38. 1776.

Dermatocarpon miniatum complicatum Th. Fr. Nov. Act. Soc. Sci. Ups. III, 3: 353. 1861.

Thallus small to medium, polyphyllous, densely compacted, the imbricate and complicate lobes rotund, convolute, and more or less ascendant, with recurved margin; the surface more or less roughened and wrinkled. Otherwise like the species.

Common in the foothills with the type, but most abundant on sunnier or more exposed rocks.

5. DERMATOCARPON FLUVIATILE (Weber).

Lichen aquaticus Weis, Pl. Crypt. 77, 1770. Not L. 1753.

Lichen fluviatile Weber, Spec. Fl. Gott. 265. pl. 4. 1778.

Dermatocarpon aquaticum A. Zahlbr. Annalen des K. K. Naturh. Hofm. Band XVI, Heft I, p. 81. 1901.

Dermatocarpon aquaticum Herre, Proc. Wash. Acad. Sci. 7: 394. 1906.

Thallus small, thick, smooth, lobes densely imbricate and compacted; margin rounded, entire or crenate-lobulate; closely appressed, umbilicate; resembling an intricately convolute, adnate, crustaceous lichen; color dull gray or olive-brown; sometimes white granulose pruinose; beneath smooth, dark brown to dingy black.

Apothecia as in *Dermatocarpon miniatum*, but proportionately larger and less numerous; spores ellipsoid, $\frac{7 - 8\frac{1}{2}}{14\frac{1}{2} - 19\frac{1}{2}} \mu$.

Abundant on granite cliffs 200 feet above the sea, near Point San Pedro; occurring also on wet sandstone in Devils Cañon, altitude 2300 feet, and at the head of Kings Creek at about 2800 feet. Widely distributed in the North Temperate region.

2. ENDOCARPON PALLIDUM Ach.

Endocarpion pallidum Acharius, Lich. Univ. 301. 1810, Switzerland.

Thallus of small pale reddish or darker scales, these overlapping, flexuous, and more or less marginally upturned; the rounded lobes with more or less crenate margin; KOH—; CaCl₂O₂—.

Apothecia minute, immersed, opening to the surface by a pore which sometimes becomes enlarged; perithecium dark brown, entire; spores 2, from pale becoming light brown, $\frac{14 - 20}{31.8 - 37} \mu$; Dr. Hasse gives

them as $\frac{20 - 24}{45 - 52} \mu$.

Rare, on stones in the foothills; found in Europe, North America, and New Zealand.

3. ENDOCARPON PULVINATUM Th. Fr.

Endocarpion pulvinatum Th. Fr. Lich. Arctoi, 257. 1860.

Polyblastia pulvinata Jatta, Syll. Lich. Ital. 562. 1900.

Thallus dark chocolate-brown, the squamules more or less imbricate, lobulate, with irregularly crenate or incised margin, the whole plant resembling a minute *Gyrophora*; apothecia very small, immersed, the perithecium more or less protruding, black; asci clavate; spores 2, muriform multilocular, $\frac{24 - 41\frac{1}{2}}{14 - 17} \mu$.

On boulders in the foothills; rare. A lichen of arctic and alpine Europe.

PYRENULACEÆ.

Thallus uniform crustaceous, without cortex or rhizoids; growing upon or within the substratum; the algæ *Trentepohlia*. Apothecia single or confluent, erect, with a terminal pore; spermatia exobasidial.

KEY TO GENERA.

Paraphyses branched and twining, or becoming gelatinous; spores 2-6 celled IV. *Arthopyrenia*
Paraphyses unbranched, free; spores 2—many celled. V. *Porina*

IV. *Arthopyrenia*.

Thallus thin, with an indistinct hypothallus as a rule. Apothecia with a globose or hemispherical, horny, black perithecium; paraphyses permanent or gelatinizing; spores wedge-shaped, oval, or elongate, with usually blunt ends.

KEY TO SPECIES.

- A. On maritime rocks1. *halodytes*
 A.A. On bark.
 B. Spores bilocular, arranged in one row in the asci.
 C. Paraphyses slender, distinct.....6. *conformis*
 CC. Paraphyses threadlike, branched, entangled.....5. *biformis*
 BB. Spores bilocular, often with a halo, variously arranged in the asci.
 D. Paraphyses gelatinizing.....2. *analepta*
 DD. Paraphyses distinct.
 E. Apothecia naked3. *analeptella*
 EE. Apothecia more or less pruinose.....4. *cinerea-pruinosa*

Section EUARTHOPYRENIA.

Perithecia usually hemispherical; paraphyses normally becoming gelatinous; spores usually with a gelatinous halo, constricted in the middle, of 2 dissimilar cells, either cell or both sometimes further divided.

1. *ARTHOPYRENIA HALODYTES* (Nyl.) Wedd.

Verrucaria halodytes Nyl. Enum. générale des Lichens, 142. 1858.

Arthopyrenia halodytes Weddell, Excurs. lich. d. l'île d'Yeu, 307. 1874.

Arthopyrenia halodytes Olivier, Lich. de l'Ouest et Nord-O. France. 2 : 261. 1900.

Thallus effuse, thin and uniform, or irregularly thickened, when it becomes somewhat fissured; blackish reddish or reddish brown; KOH — ; CaCl₂O₂ — .

Apothecia very small and numerous, black, more or less immersed, or emergent and sub-globose; scattered or becoming clustered and crowded; paraphyses mostly lacking, rather thick and jointed when present; asci ventricose, $\frac{12\frac{1}{4} - 14.7}{49 - 62} \mu$; no reaction with I; spores

bilocular, ellipsoid, irregularly arranged in the asci, $\frac{3\frac{1}{3} - 4.9}{11 - 14.7} \mu$.

Abundant on precipitous rocks just above high tide, Point Lobos, San Francisco. Described from the northern coast of France.

2. ARTHOPYRENIA ANALEPTA (Ach.) Körber.

Lichen analeptus Ach. Lich. Suec. Prodr. 15. 1798.

Verrucaria analepta Ach. Meth. Lich. 119. 1803.

Arthopyrenia analepta Körber, Syst. Lich. Germ. 367. 1855.

Thallus effuse, thin to obsolete, forming olive or coppery patches on bark.

Apothecia small to minute, usually not numerous, scattered, black, sessile or hardly innate, hemispherical to conical; perithecium dimidiate; paraphyses disappearing in a gelatinous mass; asci long, tubular, $\frac{12 - 14}{90 - 122} \mu$; spores 4, 6, and 8 in the asci, bilocular, ellipsoidal, constricted at the middle, the divisions wedge-shaped, one often larger than the other, $\frac{7 - 10}{17 - 25} \mu$; once observed 3-locular; asci and their contents yellowish-brownish with I.

Rare; on the bark of *Schinus molle* (pepper tree) at Mayfield. Originally described from Northern Europe, but found throughout the world.

3. ARTHOPYRENIA ANALEPTELLA (Nyl.).

Verrucaria analeptella Nyl. Flora, 363. 1872.

Thallus very thin, effuse, smooth, continuous, shining; whitish, to drab and olive; brownish with KOH; CaCl_2O_2 —.

Apothecia not very numerous, minute, semi-immersed, flattened hemispherical, spreading basally; ostiolum depressed, dot-like; perithecium dimidiate, thick, black; paraphyses free, distinct, branched, twining; asci tubular to ventricose, $\frac{14 - 18.5}{52 - 73} \mu$, averaging $\frac{16}{58} \mu$; spores in 2 rows in asci, bilocular, or with several false septa, surrounded by a halo, oblong-ellipsoidal, $\frac{5 - 8}{16 - 22} \mu$; no reaction with I.

Rare; on the bark of *Platanus racemosa*, in Stevens Creek Cañon. Common in Europe on smooth-barked trees; near *Arthopyrenia analepta* (Ach.), but differing in the distinct paraphyses.

DIDYMELLA FALLAX Wainio.

Arthopyrenia fallax Nyl. Flora, 363. 1872.

This fungus, long considered to be a lichen, but which is apparently not a lichen as it seems to lack algæ, is common on the trunks and limbs of smooth-barked trees in the foothills. It may be recognized as follows: Thallus thin, rather effuse, forming smooth, whitish, cream-colored or pale olive patches; sprinkled with the minute, black, sub-globose, sessile or half-innate apothecia; paraphyses hair-like, free, simple and straight or branched and more or less twining; I —; asci elongate, brownish with I; spores bilocular or becoming 4-locular, constricted at the middle, $\frac{4.9 - 9.75}{12\frac{1}{4} - 20} \mu$.

4. ARTHOPYRENIA CINEREO-PRUINOSA (Schaer.) Jatta.

Verrucaria cinereo-pruinosa Schaerer, Spicilegia, 342. 1836.

Arthopyrenia cinereo-pruinosa Jatta, Syll. Lich. Ital. 529. 1900.

Thallus diffuse, thin, uniform, pale gray to olivaceous; KOH yellow; CaCl₂O₂ —.

Apothecia scattered, black, small to minute, more or less immersed and sessile, hemispherical or sub-globose; covered with the epidermal thalline layer, and hence ashy-pruinose, or naked; perithecium dimidiate, black, thickish; paraphyses branched and twining, or simple; I —; spores bilocular, pointed and slender ellipsoid, $\frac{2\frac{1}{2} - 4\frac{1}{2}}{12 - 15} \mu$.

On the bark of *Umbellularia californica*, in Stevens Creek Cañon. The above seems to be a variety of this European lichen, characterized by smaller spores than the type.

Section ACROCORDIA.

Apothecia solitary, hemispherical, globular, or conical; paraphyses permanent, hair-like, twining and net-like; asci cylindrical or ventricose, the spores of 2 similar cells arranged in a single row.

5. ARTHOPYRENIA BIFORMIS (Borr.) Müll. Arg.

Verrucaria biformis Borrer, Eng. Bot. Suppl. 2617, f. 1. 1829.

Arthopyrenia biformis Müll. Arg.

Thallus effuse, thin, uniform or nearly so, white to dark gray in color; KOH yellow brown.

Apothecia black, numerous, of medium size, hemispherical or sub-globose, the base immersed, with a minute pore at the apex; perithecium entire, thick, black; paraphyses abundant, distinct, long and thread-like, branched and entangled; asci tubular, mostly sterile with granular contents, yellowish with I; a fertile ascus measured $\frac{12}{62} \mu$;

spores bilocular, pointed-ellipsoid, $\frac{5-9}{18-24} \mu$.

On the twigs of an oak in the hills west of Los Gatos, altitude about 1500 feet. Much resembling *Arthopyrenia gemmata*, but differs in the entire perithecium. Referred here with doubt, the apothecia and spores being larger than in European specimens in my herbarium. The reaction with I is also different from that given by Leighton. *A. biformis* is found pretty generally over Europe and North America.

6. ARTHOPYRENIA CONFORMIS (Nyl.).

Verrucaria conformis Nylander, Flora, 257. 1864; France.

Verrucaria conformis Leighton, Lich. Fl. Grt. Brit. ed. 3. 463. 1879.

Thallus effuse, thin and uniform, finally chinky about the apothecia; silvery gray in color; brown with KOH; CaCl_2O_2 -.

Apothecia very numerous, small to minute, hemispherical, semi-immersed, black; perithecium dimidiate but extending so far basally as to be nearly entire; paraphyses long, very slender and hair-like; asci long, tubular; I-; spores usually in a single row, slender ellipsoid, bilocular, constricted at the middle; each cell very strongly constricted, so that the spores appear 4-locular, as if made up of four balls, the end ones being much smaller than the others; from falsely 2 or 3-septate, sometimes distinctly 3-septate, $\frac{3\frac{2}{3}-5\frac{1}{2}}{8\frac{1}{2}-16} \mu$.

On the bark of *Pseudotsuga taxifolia*, in the mountains. Recorded from France and the British Isles.

V. *Porina* (Ach.) Müll. Arg.

Porina Acharius, Lich. Univ. 60. 1810.

Porina Müll. Arg.,

Thallus uniform crustaceous, upon or within the substratum, with *Trentepohlia* algæ. Apothecia simple, scattered, with clear or dark, entire or dimidiate perithecium, with an apical pore. Paraphyses simple, free. Spores 6 to 8, ellipsoid, spindle-shaped and needle-like, bilocular or multilocular, colorless.

A genus of wide distribution, with about 150 species dwelling on bark and rocks, of which but one seems to occur here.

I. *PORINA CARPINEA* (Pers.) A. Zahlbr.

Verrucaria carpinea Persoon, in Ach. Meth. Lich. 120. 1803.

Verrucaria carpinea Schaerer, Enumer. Crit. Lich. Europ. 221. 1850.

Porina carpinea A. Zahlbr., Ascolichenes, 66. 1907.

Thallus thin, uniform, effuse or sometimes limitate, pale ashy or greenish brown to brown; KOH leaves a brown stain.

Apothecia numerous, scattered, minute, black, often shining or apically polished, rather prominent, hemispherical or sometimes subglobose; the minute apical pore readily seen; perithecium dimidiate, the amphithecium pale; spores fusiform, bilocular to quadrilocular,

$$\frac{4 - 5}{15 - 18} \mu.$$

Common on various trees in the foothills and mountains. Common over the temperate regions of Europe and America.

GYMNOCARPEÆ.

A. Disk of the apothecia more or less open; paraphyses forming a network over the asci and holding a protruding sporal mass which conceals the disk, the mazædium of authors *Coniocarpineæ*

AA. Paraphyses and spores not forming a mazædium.

B. Apothecia linear, elongate, ellipsoid, or rarely circular.

Graphidineæ

BB. Apothecia circular *Cyclocarpineæ*

CONIOCARPINEÆ.

Thallus crustaceous, leafy, or fruticose, without rhizoids; algæ *Pleurococcus*, *Protococcus*, *Stichococcus*, or *Trentepohlia*. Apothecia with a more or less open disk; asci usually cylindrical and soon dis-

appearing, the ripe spores then forming with the paraphyses a protuberant, powdery mass, the "mazædium," which remains a long time; spores 8, colorless or dark, globose and simple, or septate and ellipsoid or elongate.

KEY TO FAMILIES.

- A. Thallus crustaceous, without cortex.
 B. Apothecia on a stalk or stipe, with a proper margin. .*Caliciaceæ*
 BB. Apothecia sessile, with a proper or a thalline margin. *Cypheliaceæ*
 AA. Thallus fruticose, with a cortex; apothecia sessile. .*Sphærophoraceæ*

CALICIACEÆ.

Thallus crustaceous, with *Proto-*, *Pleuro-*, and *Stichococcus* algæ, Apothecia usually a circular or globose head lifted on a slender stipe. which is rarely branched or with more than one head.

KEY TO GENERA.

- A. Apothecia urn-like, on a very short thick stipe, practically sessile. IX. *Sphinctrina*
 AA. Apothecia on a long stipe.
 B. Spores globose, simple..... VII. *Coniocybe*
 BB. Spores septate.
 C. Spores bilocular; disk broadVI. *Calicium*
 CC. Spores 4-8 locular; disk very narrow or dot-like. VIII. *Stenocybe*

VI. *Calicium* (Pers.) DeNotrs.

Calicium Persoon.

Calicium DeNotaris, Giorn. Bot. Ital. an. 2, *pl.* 1. 309. 1847.

Thallus crustaceous, thin to obsolete, warty, or of dustlike or mealy granules. Apothecia stalked, with a circular or topshaped head, with a flat or convex disk; proper margin black or pruinose; spores bilocular or sometimes with an indistinct septum and apparently one-celled, constricted at the middle, smoky to blackish brown.

Occurring in all parts of the world on dead or rotting wood, on bark, and also on rocks.

I. CALICIUM POPULNEUM De Brond.

Calicium populneum De Brond. in Duby, Bot. Gall. 2: 638. 1830.

Thallus white or grayish white, thin, uniform, effuse; KOH yellow; CaCl₂O₂-.

Apothecia minute, black, the stipe very short; capitulum sub-cylindrical to top-like; paraphyses short, thread-like; asci not properly observed; spores ellipsoid, simple or apparently so, but really becoming bilocular, with a narrow, almost invisible septum, best seen as a darker portion of the spore when examined under a medium power of the microscope, $\frac{5 - 8}{12 - 16} \mu$.

Rare; forming rather shiny, whitish patches on the smooth bark of *Quercus agrifolia* at Devils Cañon, altitude 2300 feet.

In the absence of authentic material for comparison referred here with some doubt, but in all probability correctly.

2. CALICIUM CURTUM (?) Turn. & Borr.

Calicium curtum Turner and Borrer, Lich. Br. 148. 1839.

Calicium curtum Crombie, British Lichens, 1: 93. 1894.

Thallus thin, granulose, or occasionally wanting, whitish to dusky or blackish gray.

Apothecia small to moderate, usually abundant, black, the stipe usually stout, quite short; capitulum at first sub-cylindrical, then flattened, until they are much like the lower half of a top or an urn; disk broad, plane, black, with a concolorous, narrow, erect, entire margin; disk and margin finally concealed by the extruded spore mass; margin very narrowly whitish pruinose at times; paraphyses branched, thread-like, entangled; asci narrow, cylindrical, $\frac{5 - 6\frac{1}{2}}{50 - 57} \mu$; spores ellipsoid to oblong, bilocular, nearly always constricted at the middle, $\frac{5\frac{1}{2} - 8\frac{1}{2}}{11 - 14\frac{1}{2}} \mu$.

On an old fence on the Stengel ranch, near the head of Alpine Creek, altitude 1400 feet.

While differing in several important respects from the published descriptions of *C. curtum*, our plant is nearer to it than to anything else.

A lichen widely distributed in both the northern and the southern hemispheres.

VII. **Conicybe** Ach.

Coniocybe Acharius, Vet. Ak. Handl. 283. 1816.

Thallus crustaceous, powdery to obsolete; algæ *Protococcus* or *Stichococcus*. Apothecia on a long stipe, the head becoming globose from the mazædium; spores simple, globose, yellowish or nearly colorless.

Found on wood and bark, exposed roots, and rarely on stone.

I. CONIOCYBE FURFURACEA (L.) Ach.

Mucor furfuraceus Linné, Sp. Pl. Ed. 3, 1655. 1764.

Coniocybe furfuracea Ach. Vet. Ak. Handl. 288. 1816.

Coniocybe furfuracea Tuck. Gen. Lich. 243. 1872.

Thallus indeterminate, of loose, powdery, scurfy granules; greenish-yellow or sulfur-colored.

Apothecia small, on long, slender, weak stems, globose, concolorous; the stems dark, their color concealed by sulfur-colored powder; sporal mass globose, from yellow becoming pale brown; paraphyses short, thread-like, from simple becoming branched; asci short, slender, cylindrical; spores simple, colorless or very pale brown, spherical, 2.5 to 4.9 μ in diameter.

On roots and earth on high, overhanging, shady banks along the road above Congress Springs, at an altitude of 500 to 600 feet. Widely distributed over Europe and North America, usually on exposed roots.

VIII. **Stenocybe** Nyl.

Stenocybe Nylander, Bot. Not. 84. 1854.

Thallus nearly obsolete, or the apothecia upon a foreign thallus. Apothecia long-stipitate, scattered, black, with globose or pear-shaped head, the disk at first closed, then dot-like, with a black margin. Spores ellipsoid to spindle-shaped, 2–8 celled, large, dark. Four species, found in Europe, California, and Japan.

I. STENOCYBE MAJOR Nyl.

Stenocybe major Nylander, Bot. Not. 84. 1854.

Stenocybe euspora Nyl. with Crombie, Journ. Bot. 272. 1882.

Stenocybe euspora Crombie, Brit. Lich. 1: 97. 1894.

Thallus very thin, of white or gray granules, or altogether absent; apothecia also growing upon the thallus of *Cyphelium inquinans*.

Apothecia not abundant, small, shiny, black, the stipe slender or sometimes robust; capitulum like a smooth cylindrical club in shape; margin thin, entire, erect, concolorous; disk from dot-like becoming small, circular, plane; section of fruit light brown, becoming violaceous-reddish basally; paraphyses abundant, hair-like, about $\frac{1}{2}$ μ thick; asci elongate cylindrical, $12 - 15 \times 190 - 230 \mu$; thecium bluish with I; spores dark brown, pointed-ellipsoid to elongate spindle-shaped, mostly 4-locular, but also simple and then containing large oil drops, or bilocular, trilocular, 5- and 6- locular; $\frac{9\frac{1}{2} - 14}{36.7 - 51\frac{1}{2}} \mu$.

On the bark of *Pseudotsuga taxifolia*, mingled with *Cyphelium inquinans*, at Devils Cañon, alt. 2300 feet. Found on the bark of various Coniferæ in the mountains of Europe.

IX. *Sphinctrina* E. Fr.

Sphinctrina E. Fries, Syst. Orb. Veg. 120. 1825.

Sphinctrina Crombie, Brit. Lich. 1: 83. 1894.

Thallus obsolete, the apothecia growing upon crustaceous bark lichens, usually some species of *Pertusaria*. Apothecia sessile or very short-stipitate, pear-shaped to globose, shiny black, at first closed with a dot-like, deeply impressed disk; spores simple or rarely bilocular, from colorless becoming dark.

I. SPHINCTRINA TUBÆFORMIS Mass.

Sphinctrina tubæformis Massalongo, Mem. Lich. 155. 1853.

Sphinctrina tubæformis Tuck., Gen. Lich. 241. 1872.

Calicium microcephalum Tulasne, Mem. Hist. Lich. 78, pl. 15, f. 20. 1852.

Sphinctrina microcephala Nyl. Mem. Soc. Cherb. 5: 91. 1857.

Sphinctrina microcephala Crombie, Brit. Lich. 1: 84. 1894.

Thallus wanting; apothecia minute, globose to top-shaped, sessile or almost stalked; color a very dark polished brown; at first closed; when open the disk is very small, concave or plane, bordered by the thick, entire proper margin; asci slender, long, cylindrical; paraphyses septate, thread-like, simple or slightly branched; thecium bluish with

I; spores simple, globose to ellipsoid, arranged in a straight row in the asci, dusky when mature, $\frac{9 - 9\frac{3}{4}}{9\frac{3}{4} - 14\frac{3}{4}} \mu$.

On the thallus of *Pertusaria pustulata*, growing on the bark of *Quercus agrifolia*, at Santa Cruz. As yet not seen elsewhere. Occurring on the thallus of various *Pertusarias* in Europe and North America.

The name given by Massalongo must supersede that of Tulasne, since the name *microcephala* had already been applied to a member of the same genus by Smith, Eng. Bot. 5: 138 (1795?) and Turner and Borrer, Lich. Brit. 130. 1839.

CYPHELIACEÆ.

But one genus occurs with us, with characters as follows:

X. *Cyphelium* Th. Fr.

Cyphelium Th. Fries, Gen. Heter. Europ. 100. 1861.

Thallus warty-crustaceous or smooth, uniform or radiately lobed at the circumference. Apothecia innate to elevated-sessile, hemispherical or globose, at first closed, at last open and often crateriform. Proper margin varying from a mere trace beneath the hymenium to well developed, when it may be accompanied by a thalline margin. Paraphyses few, thread-like; spores in a single row, in our species simple or bilocular.

Usually occurring on dead wood, the bark of large old trees, rarely on stone.

KEY TO THE SPECIES.

Section *Cypheliopsis* A. Zahlbr.

Spores simple, more or less globose 1. *bolanderi*

Section *Eucyphelium* A. Zahlbr.

Spores bilocular, usually constricted at the middle.

A. Thallus uniform.

B. Thallus yellow or greenish yellow 2. *tigillare*

BB. Thallus white or whitish 3. *inquinans*

AA. Thallus marginally lobed.

C. On rocks.

D. Thallus thick; spores large 4. *californicum*

DD. Thallus rather thin; spores small or medium. 5. *farlowi*

CC. On dead wood.

E. Thallus thick; whitish or ashy; KOH— 6. *occidentalis*

EE. Thallus brownish yellow; KOH decided yellow .. 7. *andersoni*

1. CYPHELIUM BOLANDERI (Tuck.) A. Zahlbr.

Acolium bolanderi Tuck. Lich. Calif. 27. 1866.

Acolium bolanderi Tuck. Syn. N. Am. Lich. II: 136. 1888.

Acolium bolanderi Cummings, Williams, and Seymour, Lichenes Boreali-Americana, no. 141, San Diego, Calif.

Cyphelium bolanderi A. Zahlbr. Ascolichenes, 84. 1907.

Thallus orbicular, passing into indeterminate, often large, patches or sometimes with the thallus almost disappearing; of convex wart-like areoles, sometimes sub-lobate at the circumference, usually sparsely distributed, rarely contiguous; fertile warts becoming greatly enlarged, so that they seem to be foreign; color whitish, and light to dark ashy gray; the fertile areoles darker and somewhat tawny or even yellowish brown; sometimes nearly the whole thallus passes into the same color; a black hypothallus sometimes evident; KOH yellow, CaCl_2O_2 —.

Apothecia innate, crateriform, the disk plane, black, more or less gray pruinose, the proper margin obsolete; paraphyses long, slender comparatively few in number, simple; I—; asci small, cylindrical; hypothecium narrow, brown, underlaid by a broad black band, the remains of the proper margin; spores spherical, simple, 7.5 to 16 μ in diameter; specimens in Tuck. Herbarium from San Bruno Mountain have spores 5—12 and 8—13 μ in diameter; spores becoming protruded in a black, columnar mass.

Abundant throughout on various rocks. Reported only from the coast region of central and southern California.

(Named for H. N. Bolander, Californian educator, collector, and botanist.)

2. CYPHELIUM TIGILLARE (Ach.) Th. Fr.

Lichen tigillaris Ach. Lich. Suec. Prodr. 67. 1798.

Cyphelium tigillare Th. Fries, Gen. Heter. Europ. 101. 1861.

Acolium tigillare Tuck. Gen. Lich. 238. 1872.

Thallus indeterminate, often spreading very extensively, of closely appressed, irregular, often coalescing areoles, more or less fissured and plicate, or reduced to small, scattered, sub-lobate warts; color bright to dusky greenish yellow; KOH—; CaCl_2O_2 —.

Proc. Wash. Acad. Sci., May, 1910.

Apothecia numerous, small, innate, in swollen warts, the disk plane, black, the narrow, entire margin soon excluded; paraphyses short, slender, entangled; I—; spores bilocular, broad ellipsoid to subglobose, $\frac{9\frac{3}{4} - 14.8}{14\frac{1}{2} - 21} \mu$.

Abundant on old fences and rails in the Bay and coast regions and in the foothills. Found on dry dead wood and bark of conifers throughout Europe and North America.

(*tigillare*, pertaining to beams, because found growing on old beams.)

3. CYPHELIUM INQUINANS (Sm.) Trevis.

Lichen inquinans Smith, Engl. Bot. 12: t. 810. 1801.

Cyphelium inquinans Trevis, Flora, 4. 1862.

Calicium tympanellum Ach. Meth. Lich. 89. 1803.

Acolium tympanellum Tuck. Gen. Lich. 238. 1872.

Acolium tympanellum Cummings, Seymour, and Williams, Decades of N. Amer. Lichens. no. 234, Yosemite.

Thallus effuse, of white or whitish granules or irregular warty nodules, forming a more or less continuous crust of moderate thickness, or thin and dispersed, or nearly disappearing; KOH—; CaCl_2O_2 —.

Apothecia small or of moderate size, numerous, sessile but not appressed and often sub-stipitate, plane, black; the disk naked or often gray or whitish pruinose; the entire margin black, or white pruinose, at length concealed by the protruding sporal mass which stains the fingers; paraphyses slender, simple or branched and twining, $1\frac{1}{2}$ to 2μ broad; hypothecium a broad straight brown-black band;

asci cylindrical, $\frac{6 - 7\frac{1}{3}}{35 - 49} \mu$; thecium more or less light blue with I; spores broadly ellipsoid or oblong, bilocular, often constricted at the middle, $\frac{9\frac{3}{4} - 14}{12\frac{1}{2} - 22} \mu$; spores of a specimen from H. Sandstede,

Oldenberg, Germany, are $\frac{16}{28} \mu$.

On the bark of *Pseudotsuga taxifolia*, Devils Cañon, alt. 2300 feet. In North America found only in California, but occurring in Algiers and throughout Europe.

(*inquinans*, filthy.)

4. CYPHELIUM CALIFORNICUM (Tuck.) A. Zahlbr.

Trachylia californicum Tuck.

Acolium californicum Tuck. Lich. Calif. 27. 1866.

Acolium californicum Tuck. Gen. Lich. 237. 1872.

Cyphelium californicum A. Zahlbr. Ascolichenes, 84. 1907.

Thallus orbiculate to effuse, thick, uniform, with plicate irregular surface and crenate, radiately lobulate margin; often sub-imbricate or else fissured and lobulate-areolate; color white, whitish, and brownish gray, the margin much lighter-colored than the central portion; the fertile warts not so enlarged proportionately as in *Cyphelium bolanderi*, but exhibiting the same tendency to become brown; KOH yellowish; CaCl_2O_2 —.

Apothecia from small becoming medium or large, innate, crateriform, the disk broad, concave or plane, black; not pruinose in the specimens seen; thecium colorless, the paraphyses very long, slender, and intricately entwined; asci slender, cylindrical; underlaid by a thick brown-black band, the remains of the proper margin, of the following shape,



spores dark, bilocular, constricted in the middle, the sporoblasts

approximate, $\frac{9\frac{3}{4} - 15}{13\frac{1}{3} - 25} \mu$; according to Tuck., $\frac{10 - 18}{18 - 25} \mu$.

Common on rocks in the San Bruno Hills, at from 500 to 1000 feet altitude. Collected but once elsewhere, among some specimens of *Lecanora pinguis*, 50 feet above the sea at Point Lobos, San Francisco. Specimens examined in the Tuckerman Herbarium, the herbarium of Dr. C. L. Anderson, and the author's own material collected by Bolander. Probably confined to the coast of California.

5. CYPHELIUM FARLOWI (Tuck.) Herre.

Acolium farlowi Tuck. in Tuck. Herbarium (1885); Monterey.

Acolium farlowi in Anderson Herbarium?

This lichen has not been positively identified as yet by me from our territory, but probably occurs along the north shore of Monterey Bay. It differs from *Cyphelium californicum*, to which it is closely related, in its smaller and thinner thallus and in the much smaller spores which,

according to Tuckerman, measure $\frac{7\frac{1}{2} - 9\frac{1}{2}}{12 - 15} \mu$.

Specimens in the Tuck. Herb. were collected by Dr. W. G. Farlow at Monterey, in August, 1885, growing on rocks.

In the herbarium of Dr. C. L. Anderson of Santa Cruz, are several specimens labelled *Acolium farlowi* which were collected by him on shale about Santa Cruz. Probably some of these were identified by either Tuckerman or Farlow and are therefore correct, but the one now in my possession is *Cyphelium bolanderi*.

Apparently very rare and local in its distribution. (Named in honor of the eminent professor of cryptogamic botany at Harvard University, Dr. W. G. Farlow.)

6. CYPHELIUM OCCIDENTALIS Herre, new species.

Acolium sp. Hasse determ., in Baker, Pacific Coast Lichens, No. 436, 1902; Stanford University.

Thallus determinate, forming rounded or oval patches, or effuse and spreading extensively; of rounded thick areoles, with their surfaces made up of many small rounded nodules, the whole forming a chinky, deeply fissured crust of a whitish or ashy gray color; KOH — ; CaCl₂O₂ —.

Apothecia innate in swollen warts, from small becoming medium or large; disk black; the thickish, entire, white margin concealed by the protruding spore mass, the surface of which with age often becomes tinged more or less with green; the long slender paraphyses broader than in the other members of the genus occurring with us; thecium bounded basally by a very broad, sub-crescentic brown-black band; asci rather slender, cylindrical; spores bilocular, strongly constricted at the middle, oblong-ellipsoid, $\frac{9\frac{3}{4} - 15.9}{17 - 30} \mu$.

On old fences in the mountains and formerly in the foothills, but the fences on which it occurred there some years ago have since been replaced by wire fences.

The protruding spore mass marks the fingers with black when touched, as is also the case with some other members of the genus.

7. CYPHELIUM ANDERSONI Herre, new species.

Thallus orbicular, thickish, margin radiately crenate-lobed, fissured crustaceous, the smooth surface plicate and rugulose con-

torted, passing at the center into areoles; color a pale brownish yellow; KOH gives a decided yellow; CaCl_2O_2 —.

Apothecia innate in large thick warts of a deeper yellow than the thallus, strongly resembling those of *C. bolanderi*; disk broad, black, plane, bordered by the persistent, rather broad, white and conspicuous entire margin; paraphyses numerous, long, slender, $1 - 2\frac{1}{2}$ broad, serpentine; asci very slender, $4 - 5 \mu$ broad, curved or straight, cylindrical, the tip slightly pointed; thecium underlaid by a rather narrow, convex, blackish-brown band; I — ; spores constricted at the middle, bilocular, broadly ellipsoid to oblong, $\frac{8\frac{1}{2} - 11}{13\frac{1}{3} - 20} \mu$.

Here described from two specimens collected on old redwood boards near Santa Cruz, by Dr. C. L. Anderson

A very singular plant, with a thallus much like that of *C. californicum* but with different apothecia, spores, and chemical reaction.

I take pleasure in naming this for the veteran algologist of Santa Cruz, colleague of Asa Gray and Tuckerman.

SPHÆROPHORACEÆ.

We have but one genus of the family.

XI. Sphærophorus.

Sphærophorus Persoon in Ust. Ann. Bot. 7: 23. 1794.

Thallus erect, bushy, brittle, with cylindrical or flattened branches; alga *Protococcus*. Apothecia terminal, in globose swellings of the tips of branches, which are at first closed and later open by an irregular fissure at the tip.

1. SPHÆROPHORUS GLOBOSUS (Huds.) Herre.

Lichen globosus Hudson, Fl. Anglica, 1: 460. 1762.

Sphærophorus globosus Herre, Proc. W. Acad. Sci. 7: 393. 1906.

Lichen globiferus Linné, Mantissa, 133. 1767.

Sphærophorus globiferus De Candolle, Fl. Fr. 2: 327. 1805.

Sphærophorus globiferus Tuck. Gen. Lich. 231. 1872.

Sphærophoron coralloides Persoon, Usteri Annal. d. Bot. 1: 23. 1794.

Thallus fruticose, tufted and shrub-like, erect, branched, terete, smooth, with short, fine, and very numerous terminal branchlets, these often in clumps which shatter off very readily; color silvery gray or whitish, but varying to brownish or a decided brown; rarely reddish. Alike on all sides; KOH —. Medullary layer densely cottony; violet with I.

Apothecia terminal, within the swollen and globular tips of the fertile branches, which split open, exposing the globose apothecia; spores violet-black, simple, spherical, 7 — 10 μ in diameter.

On trees, dead wood, and sandstone. On the Pacific side of the peninsula occurring from near sea-level to the summit of the range, but not descending on the Bay side more than a few hundred feet, remaining within the limits of the redwood and spruce forests. Occasionally found in great abundance. A strikingly handsome plant. Described from Europe and recorded from Arctic and cool temperate America, Madeira, and Australasia.

GRAPHIDINEÆ.

Thallus crustaceous, uniform, without cortex or with a cortex on the upper side; or fruticose, erect or decumbent, with an evident cortex and medulla; alga *Palmella*, *Trentepohlia*, *Phycopeltis* or *Phyllactidium*.

Apothecia compressed, more or less linear, with small, fissure-like disk, are characteristic of the group. Proper margin well developed or absent; sometimes with a thalline margin; innate or sessile, rarely on a short stipe. Spores colorless or dark, variously shaped, but more often spindle or needle-shaped, and multi- or murilocular.

KEY TO FAMILIES.

- A. Apothecia without margin *Arthoniaceæ*
 AA. Apothecia with margin.
 B. Thallus crustaceous.
 C. Without cortex *Graphidiaceæ*
 CC. Cortex present on upper side. *Dirinaceæ*
 BB. Thallus fruticose, erect or decumbent. *Roccellaceæ*

ARTHONIACEÆ.

Thallus uniform crustaceous; gonidia of *Palmella*, *Trentepohlia*, or *Phyllactidium* algæ. Apothecia forming irregular dots, lines, or spots, simple or branched; single or forming a stroma, without proper margin. But one genus occurs with us.

XII. Arthonia.

Arthonia Ach. Lich. Univ. 25. 1810.

Arthonia A. Zahlbr., Ascolichenes, 89. 1907.

The alga is *Trentepohlia*. Apothecia innate, surrounded by the thallus, circular, dot-like, or irregularly stellate, or more or less elongate; spores variously shaped, oval, ellipsoid, wedge-like, or needle shaped; bi- or multilocular, the cells often of unequal size; colorless or rarely brown.

About 500 species, mostly of the warmer parts of the earth, on bark and rocks.

KEY TO SPECIES.

Thallus pinkish or reddish when wet; spores 4-locular *punctiformis*
Thallus not changing color when wet; spores 4-locular *radiata*

1. ARTHONIA PUNCTIFORMIS Ach.

Arthonia punctiformis Ach. Lich. Univ. 141. 1810.

Arthonia punctiformis Willey, Synopsis Genus Arthonia, 41. 1890.

Thallus white or whitish, forming more or less determinate spots or blotches, thin, uniform, sometimes evanescent; when moistened becoming pinkish or reddish; no reaction with chemicals.

Apothecia small or minute, slightly elevated, rounded, oblong or irregular, black; epithecium granulose, blackish; thecium pale, the asci pear-shaped; reaction with I first bluish, than wine-red; according to Hasse "indigo-blue"; spores oblong-ovoid, 4-to 6-locular, $\frac{4-6}{12-19\frac{1}{2}}$ μ.

Found fertile on *Vaccinium* on White Horse Creek, and on *Alnus* on the Gazos Creek, near the sea coast; I also refer here a sterile lichen which is abundant on the stems of *Baccharis pillularis* and other shrubs. A lichen of Europe and North America.

2. ARTHONIA RADIATA (Pers.) Th. Fr.

Opegrapha radiata Persoon, Ust. Ann. 29. 1794.

Arthonia radiata Th. Fr. Lich. Arctoi, 240. 1860.

Arthonia radiata Willey, Synopsis Genus Arthonia, 44. 1890.

Thallus thin, uniform or slightly scaly, determinate, often limited by a black hypothalline line; color, various shades of gray to olive and fawn-color; no reactions with KOH or CaCl₂O₂.

Apothecia numerous, linear, very irregularly shaped, branching, stellate, curved, or straight; innate, with sunken disk, or becoming somewhat elevated; brown to black; epithecium granulose, blackish; thecium colorless, the asci short, pear-shaped or almost oval; blue with I, then slowly turning to vinous red, only the asci stained yellowish; spores ovoid-oblong, 4-locular, $4\frac{1}{2} - 5\frac{1}{2}$ and $6 - 7\frac{1}{2}$ μ .
 $10 - 14.7$ and $15 - 20$

Abundant on trees throughout; an exceedingly variable plant, found all over the world.

I have referred to this species a large series of Arthonias which vary in several particulars, but which agree pretty well in spore characters.

GRAPHIDACEÆ.

Thallus uniform crustaceous, cortex absent or poorly developed, with *Palmella* or *Trentepohlia* alga, in our species only the latter. Apothecia usually linear, rarely circular or spot-like, solitary, or aggregate, but not forming stroma; simple or branched, with a well developed proper margin, frequently with a thalline margin; disk usually narrow and fissure-like; paraphyses simple and unbranched or branched and twining; rarely gelatinizing. Spermatia exobasidial.

KEY TO GENERA.

Paraphyses branched, twining. XIII. *Opegrapha*
 Paraphyses simple, not twining. XIV. *Phæographis*

XIII. *Opegrapha*.

Opegrapha Humboldt, Fl. Frib. 57. 1793.

Alga *Trentepohlia*. Apothecia innate, appressed or sessile, usually more or less elongate, with a black proper margin; hypothecium clear or dark; spores 8, oval, ellipsoid, or spindle-shaped, straight or bowed, colorless, 2-18-locular.

Numerous species, on rocks, wood, and bark, distributed all over the world.

KEY TO THE SPECIES.

Spores 6-locular. 3. *varia*
 Spores 4-locular
 On maritime rocks. 1. *saxicola*
 On bark of trees. 2. *prosilicus*

1. OPEGRAPHIA SAXICOLA Ach.

Opegrapha saxicola Ach. Syn. Meth. Lich. 71. 1814.

Opegrapha saxicola Stizenberger, Ueber die Steinbew. Opegr.-Arten, 23. 1865.

Thallus effuse and very thin, or almost entirely disappearing, of minute whitish, gray, or yellowish granules.

Apothecia thickly or sparsely scattered, mostly bluntly ellipsoid, or nearly circular, or compressed and sub-linear; straight or crooked; dead black; margin at first thick and rounded, later thin, sharp-edged, the disk then broadly visible; epithecium granulose, blackish brown (reddish brown according to Stiz.); hypothecium broad, dark brown; thecium colorless, slightly wine-red with I; paraphyses threadlike, with tips not at all or very slightly thickened; asci oblong or sub-clavate; spores 4-locular, ellipsoidal or ovoid, straight or rarely slightly curved, with a more or less evident halo, $\frac{6-10}{20-29} \mu$; according to Stizenberger they are "wasserhell bis braun, 20 - 30 mik. lang und 5 - 8 mik. dick."

Spermogonia abundant, appearing as small or minute black dots; spermatia small, short, 3.5 - 4 μ long.

Abundant on sandstone near the old Cliff House, San Francisco; originally described from Europe, where it is widely distributed.

Our plant is a variety, differing in several respects from typical *O. saxicola*.

2. OPEGRAPHIA PROSILIENS Stirton.

Opegrapha prosiliens Stirton, Grevillea, 3: 36. 1874.

Opegrapha prosiliens Leighton, Lich. Fl. Grt. Britain ed. 3, 403. 1879.

Opegrapha prosiliens Hasse, Bull. So. Calif. Acad. Sci. 5: 42. 1906.

Thallus white, whitish, yellowish white, and yellowish-greenish, thin to very thin, becoming almost or entirely obsolete, forming small, variously shaped distinct patches, or effuse and spreading indefinitely; KOH - ; CaCl₂O₂ - .

Apothecia black, prominent, straight or curved, narrowly oblong or ovoid, the margin broad, rounded, or rarely thin and erect, when the disk is visible; disk ordinarily but a crevice; epithecium granulose, dark brown; hypothecium from very dark brown merging into black; paraphyses very slender, much branched and entwined, their

tips clear or slightly darkened; bluish with I; asci subcylindrical or clavate, usually with a halo, at least at the upper end, $\frac{12\frac{1}{4} - 22}{44 - 68\frac{1}{2}}$ μ ; spores ellipsoid-spindle shaped, or slipper-shaped, blunt, straight, 4 - locular, the third cell usually the largest, surrounded by a broad gelatinous halo, $\frac{6 - 9\frac{3}{4} - 11}{20 - 28}$ μ ; "6 - 7" μ , Stirton. Spermogonia numerous, forming minute black specks over the thallus spermatia straight, very slender, $\frac{\frac{1}{3} - \frac{1}{2}}{4\frac{1}{2} - 7\frac{1}{3}}$ μ .

On twigs and trunks of *Alnus*, Gazos Creek, alt. 75 feet, and on dead twigs of *Lupinus arboreus* at Pescadero Point, 10 to 25 feet alt.; on *Quercus agrifolia* at Laguna Creek, and on bark of *Pseudotsuga taxifolia* at Santa Cruz. Dr. Hasse has also collected it on *Juglans* in the Santa Monica Range near Los Angeles.

The reference of our material to Stirton's plant may be incorrect, but it agrees with no other described in the accessible literature.

Specimens in the Anderson Herbarium at Santa Cruz, marked *Opegrapha varia* seem to be this same species.

XIV. Phæographis Müll. Arg.

Phæographis Müll. Arg. Mem. Soc. Phys. et Hist. Nat. Genève, 29: 1887.

Thallus uniform crustaceous, with *Trentepohlia* alga. Apothecia innate, appressed, or sessile, usually linear, simple or branched; disk usually narrow, fissure-like; proper margin and hypothecium black to colorless; hymenium gelatinizing, not turning blue with I; spores dark, spindle-shaped or caterpillar-like, bi-locular to many-celled.

About 100 species, mostly on bark in the warmer parts of the earth, represented with us by but one species.

1. PHÆOGRAPHIS INUSTA (Ach.) Müll. Arg.

Graphis inusta Ach. Syn. Meth. Lich. 85. 1814; Canada.

Graphis inusta Leighton, Lich. Flora Grt. Brit. ed. 3, 431. 1879.

Thallus determinate, thin, uniform, smooth or slightly wrinkled, yellowish white to white; with KOH yellowish brown.

Apothecia numerous, rather large, slightly sunken, variously and irregularly shaped, curved, wavy, often branching, much resembling characters in Oriental script; disk broad, plane, brownish-black to black, more or less pruinose; thalline margin white, mostly entire, somewhat overhanging, seemingly burst out from below; proper margin blackish brown, merging into the clear or very pale yellow hypothecium; paraphyses not very abundant, slender, simple, free, pale blue with I; asci elongate-clavate or sub-cylindrical; spores brown, 8-celled or rarely 6- or 7-celled; mature spores at first pale brown, broadly ellipsoid or oblong, often pointed at one end, violaceous with I, the septa rather indistinct, $\frac{11 - 12\frac{1}{2}}{31.8 - 51.4}$ μ ; later becoming darker, thick-walled with heavy septa, caterpillar-like in shape, $\frac{7\frac{1}{3} - 9\frac{3}{4}}{28 - 37}$ μ .

A single specimen collected on *Alnus*, on the Gazos Creek, with *Opegrapha prosiliens*.

Widespread in the tropics; occurring also in Great Britain, France, Germany, Japan, and temperate America.

DIRINACEÆ.

Thallus uniform crustaceous, corticated; alga *Trentepohlia*. Apothecia circular or elongate, with both proper and thalline margin; hypothecium thick, black; spores spindle-shaped, 4 to 8-locular, colorless or brown.

XV. *Dirina* E. Fr.

Dirina E. Fries, Syst. Orb. Veg. 244. 1825.

Cortex of unseptate hyphæ arranged perpendicularly to the cortex. The proper margin thin, the thalline margin thick; paraphyses simple, unbranched; spores 8, colorless.

A genus of few species, on maritime rocks and on bark of trees near the sea.

1. *DIRINA FRANCISCANA* A. Zahlbr.

Dirina franciscana A. Zahlbr., in Herre Botanical Gazette, 43: 270, 1907.

Thallus effuse, of thick, rounded, irregular tuberculate areoles, uniform crustaceous, sub-cartilaginous, forming heaped patches.

Color varying from yellowish or brownish yellow to a dingy ashy gray, the last most common; KOH — ; CaCl₂O₂ — .

Apothecia numerous, of medium size, rounded elevated, sessile; surface of disk minutely granular, ashy-gray pruinose; the thalline margin thick, prominent, white, obtuse, soon flexuous, often intricately so; epithecium dark, 56 μ high; hypothecium black, thick, 140 μ high, blue or bluish with I; paraphyses typical, thecium wine-red with I; asci clavate, straight or curved, long stalked, $\frac{70 - 134.5}{16.8 - 22.4}$ μ ; spores fusiform, straight or slightly curved, quadrilocular, $\frac{5 - 8.5}{23.8 - 33.5}$ μ

On rocks 50 to 75 feet above the sea at Point Lobos, San Francisco, growing with *Dendrographa minor*.

Near *Dirina repanda* of Europe and Northern Africa, but with a thicker and differently colored thallus and with different spores.

ROCELLACEÆ.

Thallus fruticose, erect or decumbent, attached to the substratum by a holdfast; with distinct cortex and medulla; alga *Trentepohlia*. Apothecia circular and linear, innate or sessile.

A maritime family, on trees and rocks, mostly found on tropical coasts. Some species furnish a valuable dye.

XVI. *Dendrographa* Darb.

Dendrographa Darbshire, Ber. der Deutsch. Bot. Gesellsch. **13**: 313. 1895; Monograph. Roccell., Bibliotheca Botanica, **45**: 1898.

Thallus erect or decumbent, tufted or matted; filaments terete or compressed basally, branched, with infrequent lateral soredia; color gray. Apothecia lateral, circular, the disk black, white pruinose; spores quadrilocular, colorless, spindle-shaped or slightly curved.

On maritime shrubs or on rocks and earth, on the coast of California.

1. DENDROGRAPHA MINOR (Tuck.) Darb.

Roccella leucophæa var. *minor* Tuck.,

Dendrographa minor Darbishire, Ber. der Deutsch. Bot. Gesellsch. 16: 13. 1898.

Dendrographa minor Herre, Proc. Wash. Acad. Sci. 7: 393. 1906.

Thallus erect or more often lax and decumbent, tufted; terete and hair-like or slightly flattened below, much and intricately branched, forming dense tangled clumps; color gray, or basally blackening. Sterile. Large globose lateral soredia sparingly present, these apparently taking the place of apothecia.

Abundant on rocks and earth 50 to 100 feet above the sea near Golden Gate, San Francisco; collected on rocks at Mission Dolores by Bolander, but now extinct there. Fertile specimens collected on rocks at Monterey by Dr. W. G. Farlow, in 1885. On high bluffs at Tomales Bay, Marin County, Bolander in Tuck. Herb. Recorded from the islands of Lower California by Dr. Hasse.

Specimens in the Tuck. Herbarium are marked "A *R. leucophæa* vix *diversa*."

CYCLOCARPINEÆ.

Thallus from the simplest uniform crust to the highest foliaceous or fruticose form; in the crustaceous forms fastened to the substratum by the hyphæ of the hypothallus or the medulla, in the other forms usually by rhizoids, holdfasts, or an umbilicus. Cortex absent in most crustaceous forms, or variously developed, on the upper side or on both sides. Algæ of various families, *Protococcus*, *Pleurococcus*, *Palmella*, *Trentepohlia*, *Glæocapsa*, *Nostoc*, *Scytonema*, *Stigonema*, *Calothrix* and *Rivularia*.

The apothecia are usually disk, shield, or plate-like; sometimes they are urn-like or globose with a very narrow or minute disk and immersed in the thallus so that they resemble the Pyrenocarpeæ. The apothecia vary from innate and sessile to stalked, in some forms the stalk resembling a fruticose thallus, the podetia of authors. A proper margin usually evident, sometimes lacking; when formed of hyphæ which enclose no algæ, soft and nearly or quite colorless, it is biatorine; when formed of the thallus, black and coal-like, it is lecideine; when formed of the thallus and enclosing algæ, it is lecanorine. Hypothecium variously colored, clear to black; paraphyses

very diverse, but no mazædium is formed; asci permanent, one to many spored. Spores simple, or two to many celled, polar-bilocular, and muriform, colorless to dark brown, sometimes with a halo. Soredia often greatly developed and in some families of the highest importance.

KEY TO FAMILIES.

- A. Spores typically bi-locular or polar-bilocular, with much thickened walls, the cells often connected by a thin tube or canal.
- B. Spores colorless, polar-bilocular.
- C. Thallus uniform crustaceous or with a radiately plicate margin, without cortex. *Caloplacaceæ*
- CC. Thallus foliaceous or fruticose, corticated. *Theloschistaceæ*
- BB. Spores brown, polar-bilocular or with a septum.
- D. Thallus crustaceous, uniform or lobed at the circumference, without cortex. *Buelliaceæ*
- DD. Thallus foliaceous or fruticose, corticated. *Physciaceæ*
- AA. Spores simple, multilocular, or muriform, colorless or rarely brown.
- E. Algæ belonging to the *Cyanophyceæ*; thallus more or less gelatinous when wet.
- F. Algæ *Nostoc*; apothecia sessile, dish-like. *Collemaceæ*
- FF. Algæ not *Nostoc*.
- G. Algæ *Scytonema* or *Stigonema*; apothecia urn or dish-like. *Ephebaceæ*
- GG. Algæ *Glæocapsa*; apothecia often not visible, apparently pyrenocarpous, urn or dish-like. *Pyrenopsidaceæ*
- EE. Thallus not gelatinous when wet.
- H. Thallus crustaceous, uniform or marginally lobed, attached by the hyphe of the hypothallus or medulla.
- I. Thallus with *Trentepohlia* algæ. *Lecanactidaceæ*
- II. Thallus with *Pleurococcus* or *Palmella* algæ.
- J. Asci many-spored; apothecia lecideine, biatorine, or lecanorine. *Acarosporaceæ*
- JJ. Asci 1-8 spored, or rarely 16-32 spored.
- K. Apothecia with a proper margin, not enclosing algæ. *Lecidaceæ*
- KK. Apothecia with a thalline margin, enclosing algæ.
- L. Proper margin well developed, black or dark, usually entire; apothecia innate; thalline margin poorly developed. *Diploschistaceæ*
- LL. Proper margin wanting or poorly developed and clear; thalline margin well developed.
- M. Apothecia sessile, the disk large. *Lecanoraceæ*
- MM. Apothecia solitary or several, enclosed in thalline warts; disk usually very small. *Pertusariaceæ*
- III. Thallus usually foliaceous or fruticose, or occasionally reduced to squamules.

- N. Thallus fruticose, erect or decumbent, structure radial, corticated, with a holdfast. *Usneaceæ*
 NN. Thallus foliaceous or squamulose.
 O. Thallus large, attached by a central umbilicus. *Gyrophoraceæ*
 OO. Thallus not umbilicate.
 P. Apothecia long-stalked, the podetia simple or branched, naked or covered with leafy squamules. . . *Cladoniaceæ*
 PP. Apothecia not long-stalked.
 Q. Apothecia adnate by their entire under surface to the foliaceous thallus *Peltigeraceæ*
 QQ. Apothecia sessile or elevated sessile.
 R. Medulla lacking or feebly developed; thallus mostly of pseudoparenchyma; algæ *Scytonema*. *Heppiaceæ*
 RR. Medulla well developed.
 S. Spores spindle-shaped, multilocular; under side of thallus usually with cyphellæ. *Stictaceæ*
 SS. Spores oval or ellipsoid, simple or rarely 2-4 locular; thallus never with cyphellæ.
 T. Alga *Scytonema*. *Pannariaceæ*
 TT. Alga *Pleurococcus* or *Parmella*; apothecia lecanorine. *Parmeliaceæ*

LECANACTIDACEÆ.

Thallus uniform crustaceous, without cortex, alga *Trentepohlia*. Apothecia circular, sessile or innate; proper margin lacking, or rudimentary, or occasionally well developed; with or without thalline margin. Paraphyses branched, more or less entangled and twining. Represented with us by only one genus.

XVII. *Lecanactis* (Eschw.) Wainio.

Lecanactis Eschweiler, 4, Syst. Lich. Gen., 14. 1824, in part.

Lecanactis Wainio.

Apothecia circular, lecideine, with black proper margin; a thalline margin wanting; hypothecium black, merging into the margin; asci 4 — 8 spored; spores colorless, ellipsoid, spindle or needle-shaped, 2 — 16 locular.

Rock and bark lichens, mostly of the warmer regions.

1. *LECANACTIS ZAHLBRUCKNERI* Herre.

Lecanactis zahlbruckneri Herre, Botanical Gazette, 43: 270. 1907.

Thallus effuse, of small, irregular (sometimes plicate) squamules, which at first are scattered but soon become a thick, uniform, tarta-

reous crust. Color a more or less evident rose-pink which soon fades out in herbarium specimens, leaving them whitish or ashy gray.

Apothecia small, round, sessile, becoming convex; black, the disk gray pruinose, but eventually naked; the proper margin prominent but finally excluded. Epithecium dark or black, thick, 45μ to 50μ high, blue with I; hypothecium black, broad, 42 to 60μ high; paraphyses typical; thecium brick- or vinous-red with I; asci clavate, straight or curved, sometimes pointed at tip, $\frac{16.8}{78 - 106} \mu$; spores 8,

colorless, fusiform, straight or slightly curved, $4 -$ locular, $\frac{5 - 7}{19.6 - 28} \mu$.

Rare on maritime rocks, 50 to 75 feet above the sea, at Point Lobos, San Francisco; associated with *Dendrographa minor*, *Arthopyrenia halodytes*, and some species of *Trentepohlia*.

2. LECANACTIS CHLOROCONIA Tuck.

Lecanactis chloroconia Tuck. Trans. Am. Phil. Soc., p.

Lecanactis premnea b. *chloroconia* Tuck. Syn. N. Am. Lich. II: 115. 1888.

Thallus small, thin, uniform, smooth to granulose; definite and limited by a black hypothalline line, or this obsolete, and the thallus diffuse; yellowish-greenish to yellowish-ashen; KOH yellow; $\text{CaCl}_2\text{O}_2 -$.

Apothecia small to medium size, circular, sessile, black; the disk pruinose or finally naked; the proper margin erect, rather thin, mostly entire, becoming somewhat angulose or wavy; epithecium granulose, greenish-blackish; hypothecium broad, black, continuous with the broad black margin; paraphyses branching or simple, free, their tips thickened and dark green; thecium colorless, turning wine-red with I; spores mostly $4 -$ locular, very rarely $3 -$ or $5 -$ locular, finger-shaped or broadly spindle-shaped, straight or slightly curved,

$\frac{3\frac{1}{3} - 4.9}{11 - 15}$ and rarely 17μ .

On bark of *Alnus*, in tiny patches mixed with *Opegrapha prosiliens*, on Gazos Creek, near the Pacific.

A tropical lichen of wide distribution and occurring also in Europe and over a great part of North America.

DIPLOSCHISTACEÆ.

Thallus uniform crustaceous, corticated, attached to the substratum by the hyphæ of the hypothallus or of the medulla; alga *Proto-coccus*. Apothecia circular, sunken in the thallus or appressed, with crater-like, or finally flat disk; proper margin well developed, entire, or only laterally developed; spores two- to many-celled or muriform.

XVIII. *Diploschistes* Norman.

Diploschistes Norman, Con. Præ. Nov. Gen. Lich. 20. 1852.

Thallus as above, as are the apothecia. Proper margin well developed, black or clear; paraphyses simple or branched at the tips; asci thin-walled, with 4–8 spores; these muriform, dark.

KEY TO THE SPECIES.

Apothecia medium-sized, from pit-like becoming open and plane with broad disk, black or gray pruinose 1. *scruposus*
 Apothecia minute, immersed, opening by a pore surrounded by a radiately striate margin 2. *actinostomus*

1. DIPLOSCHISTES SCRUPOSUS (L.) Norman.

Lichen scruposus Linné, Mantissa, 2: 131. 1771.

Diploschistes scruposus Norman, Con. 1852.

Urceolaria scruposa Ach. Meth. Lich. 147. 1803.

Urceolaria scruposa Tuck. Syn. North Am. Lich. I: 222. 1882.

Thallus determinate to effuse, of rough, irregularly shaped, sometimes contorted and plicate, chinky or fissured areoles, forming a thick and hard or more or less crumbly and mealy crust; KOH –; CaCl₂O, reddish; color various shades of gray, whitish, and ashen; rarely gray-brown and rusty.

Apothecia numerous, from small and immersed becoming superficial and medium-sized or large; from deep and pit-like finally open, plane, with broad black disk, often gray pruinose; the thalline margin thick, swollen, from entire to more or less rugose; the proper margin arched, blackish, more or less denticulate; sometimes the thalline margin disappears, when the proper margin becomes prominent, thickened, and exceedingly fine, intricately entwined, transverse striæ become visible; paraphyses slender, branching,

their tips enlarged, brown; spores 4 – 8 in the asci, variously shaped, $\frac{10 - 15.5}{26 - 41.5} \mu$.

Abundant throughout; occurring on various kinds of rocks, earth, the bases of old tree trunks, and the thallus of *Cladonia pyxidata*.

When the thallus is thick, soft, and crumbly or mealy, it forms the variety or species *gypsacea* of various authors. When it is on *Cladonias* and mosses it is the subspecies *bryophila*; sometimes in this habitat it grows without a thallus and is then variety *parasitica* Sommerf.

All of these variations occur with us, as well as some others, but none of them depart widely enough from the average form to merit special description. Several varietal forms may be secured from one extensively spreading patch covering an irregular rock mass, where different conditions of light and moisture may affect the growth of different portions of the thallus.

Widely distributed in both the north and the south temperate zones.

2. DIPLOSCHISTES ACTINOSTOMUS (Pers.) A. Zahlbr.

Urceolaria actinostoma Persoon, in Ach. Lich. Univ. 288. 1810.

Urceolaria actinostoma Tuck. Syn. North Am. Lich. I: 222. 1882.

Diploschistes actinostomus A. Zahlbr. Ascolichenes, 122. 1907.

Thallus of smooth, thick, closely compacted, angular or difform areoles separated by deep cracks and fissures; the whole forming a dense, determinate, suborbicular crust; rarely the crust is thin and indeterminate; color whitish, gray, mouse-colored, dusky, and in one specimen collected, black; the margin usually much paler and a white hypothallus more or less evident; KOH – ; CaCl₂O₂ faint reddish.

Apothecia numerous, immersed, very small, opening at the surface by a minute pore, which is surrounded by an at length fully visible, radiately striate or stellate proper margin; said by authors to be gray pruinose, but not so with us; epithecium deep blackish-brown; paraphyses thread-like, densely entangled; spores 3, 4, and 8 in the asci, variously disposed, ovoid to broadly ellipsoid, from colorless turning dusky with age, then dark brown and much shrunken and misshapen;

$\frac{12 - 15}{18 - 26.9} \mu$.

A handsome lichen common on rocks in the foothills. The fruit superficially resembles that of the *Verrucariaceæ*. Found in the temperate parts of Europe and North America.

LECIDEACEÆ.

Thallus crustaceous, horizontally outspread, uniform or marginally lobed, fissured, areolate to scale-like or squamulose, without rhizoids; alga *Protococcus*; with or without a poorly developed cortex. Apothecia circular, sessile upon the thallus or rarely innate or elevated; the proper margin clear or black, the apothecia without thalline margin and without algae; hypothecium colorless to black; paraphyses rarely branched, their tips usually more or less thickened; asci usually with 8 spores, in some genera 1 — 8, rarely 16 — 32; spores colorless or brown in one genus, simple, to plurilocular or muriform.

KEY TO GENERA.

- Thallus with a cortex; spores 2-8 locular. XXII. *Toninia*
 Thallus without cortex.
 Spores simple, colorless. XIX. *Lecidea*
 Spores not simple.
 Spores muriform, brown. XXIII. *Rhizocarpon*
 Spores not muriform, colorless.
 Spores bilocular. XX. *Catillaria*
 Spores 4-16 locular. XXI. *Bacidia*

XIX. *Lecidea* (Ach.) Th. Fr.

Lecidea Ach. Meth. Lich. 32. 1803.

Lecidea Th. Fries, Gen. Heterol. Europ. 88. 1861.

Lecidea A. Zahlbr. Ascolichenes, 130. 1907.

Thallus crustaceous, varying from uniform to lobate at the circumference, and from small areoles to warty, scale-like, or more or less leafy squamules, without rhizoids, not corticated or with a thin cortex, naked or sorediose; alga *Protococcus*. Apothecia circular or angulate or irregular from lateral pressure, innate, sessile, or elevated-sessile, the proper margin not enclosing algæ and varying from clear to black; hypothecium colorless to black; paraphyses unbranched; spores 8 or rarely 16, small, simple, colorless, usually ellipsoid, ovoid, or narrow-oblong, straight or slightly curved. ,

- L.* Thallus yellow or sulfur-colored; hypothecium dark brown. 23. *enteroleuca theioplaca*
LL. Thallus whitish gray, ashen, or bluish-gray.
M. Yellow with KOH.
N. Hypothecium thick, brown. Hymenium blue, then brown with I. 21. *latypæa*
NN. Hypothecium colorless to dusky; hymenium blue with I. 22. *enteroleuca*
MM. Thallus without reaction to KOH.
O. Without evident hypothallus, ash-colored or leaden gray; apothecia small. 15. *platycarpa*
OO. A black hypothallus more or less evident. Apothecia from small or medium to very large.
P. Apothecia more or less gray pruinose; thallus ash-colored. 12. *lithophila*
PP. Apothecia not pruinose.
Q. Thallus ashy-gray or whitish. . . . 13. *tessellata*
QQ. Thallus bluish-gray or gray . . . 14. *lapicida*

I. LECIDEA DECIPIENS (Ehrh.) Ach.

Lichen decipiens Ehrhart, Hedwig Stirpes Crypt. 2 : 7. 1789.

Lecidea decipiens Ach. Meth. Lich. 80. 1803.

Biatora decipiens Tuck. Syn. N. Am. Lich. II: 13. 1888.

Thallus of scattered to crowded, rather thin, appressed, smooth scales of medium size; often shield-shaped or round-lobed and crenate; more or less concave or furrowed, sometimes plicate; of a bright reddish flesh-color, brick-red, or darkening; the margin more or less white-edged; beneath white; with KOH the thallus is first rose pink, than a plum color; CaCl_2O_2 —.

Apothecia small to rather above medium size, usually marginal but also occurring in the middle of a scale, closely adnate, from circular becoming angular in shape; the black disk soon convex; generally the small, paler margin is hardly visible and soon entirely disappears; occasionally it is white and persistent; paraphyses conglutinate, their tips umber; hypothecium clear to pale brown; asci narrowly clavate; thecium blue with I; spores ellipsoid or ovoid,

$$\frac{5 - 7}{9.5 - 16} \mu.$$

On earth in lime rock crevices, near the summit of Black Mountain, at an altitude of 2700 feet, mingled with *Toninia caeruleo-nigricans* and *Dermatocarpon hepaticum*.

A common xerophyte of calcareous earth throughout Europe and North America; in this country most abundant in the western half.

2. LECIDEA GLOBIFERA Ach.

Lecidea globifera Ach. Lich. Univ. 213. 1810; Switzerland.

Biatora globifera Tuck. Syn. N. Am. Lich. II: 10. 1888.

Thallus of small or medium size, thickish, rigid, rounded and crenate lobate, ascendant and imbricate scales; their surface usually polished and often concave; color pale or whitish brown and greenish to various shades of chestnut, the under side white; KOH —; CaCl_2O_2 —.

Apothecia numerous, small to medium size, marginal, elevated-sessile, black or brown-black, moderately convex to sub-globose, solitary and circular or often confluent and irregular; margin visible only on young apothecia; white within to the naked eye; paraphyses conglutinate and difficult to make out, the epithecium a broad dark brown (reddish-brown?) band; hypothecium very pale brownish; thecium very pale reddish or becoming colorless, blue with I, the asci narrow, clavate; spores rare, ellipsoid and ovoid,

$\frac{5.5 - 7.5}{9.75 - 14.7} \mu.$

On dry rocks in sunny places in the foothill cañons; the only locality from which I have specimens obtained within our territory is Stevens Creek Cañon, alt. 900 feet. It is common in Alum Rock Park, Mt. Hamilton Range, near San José, at an altitude of about 500 or 600 feet. In our plant the scales are smaller than given by Tuckerman, and smaller and darker than in a specimen from the Sprague Herbarium, collected in Washington.

A lichen of calcareous earth, occurring over the greater part of Europe and North America; in the latter region most abundant on the Pacific Coast.

3. LECIDEA SCOTOPHOLIS (Tuck.) Herre.

Biatora scotopholis Tuck. Lich. Calif. 24. 1866.

Biatora scotopholis Tuck. Syn. N. Am. Lich. II: 11. 1888.

Thallus effuse, of minute, rather thin, rounded, areolate squamules with rugulose surface; their borders finely crenate and slightly

elevated; fissured or crowded and sub-imbricate; dull brown-black, the irregular thallus dull black to the naked eye, by which the minute scales are hardly visible; upon a black, fringing hypothallus; KOH — ; CaCl_2O_2 — .

Apothecia small, innate-sessile or adnate; disk flat, red-black to black, finally becoming convex, and the stout, slightly lighter colored margin then disappearing; epithecium granulose, pale brown; paraphyses strict, coherent; hymenium 44 to 56 μ high, blue with I; hypothecium colorless; asci clavate; spores ovoid-ellipsoid,

$$\frac{3 - 5}{8 - 11} \mu.$$

On sandstone and other rocks at 1000 feet alt., on Mt. San Bruno, also in the foothills and mountains, probably throughout, up to an altitude of 1800 feet. Recorded by Tuckerman from the coast of California and the Dalles of the Columbia, Oregon.

Often intermingled with the thallus of *Rhizocarpon bolanderi* (Tuck.), to which it bears a curious resemblance.

4. LECIDEA GRANULOSA PHYLLIZANS A. Zahlbr.

Lecidea granulosa Schaer var. *phyllizans* A. Zahlbr. Beih. Bot. Centralbl. **13**: 159. 1902.

Biatora glebulosa Tuck. Syn. N. Am. Lich. II: 16. 1888, in part.

Thallus determinate to effuse, often spreading extensively, of wavy, undulate, sub-cartilaginous, rounded squamules, incised or crenate, imbricate, at the circumference becoming radiate and lobate; whitish ash-colored to pale buff; KOH distinct yellow; CaCl_2O_2 red.

Apothecia scattered, or grouped, and then becoming conglomerate, sessile, large, 1.75 mm. wide, from plane to turgid convex; at first with a thin proper margin which is finally excluded; disk dull reddish or yellowish brown, or blackening, papillate, with a faint bloom. In the field the disk is reddish flesh-color. Epithecium granulose, of a sordid yellow-brown color; paraphyses coherent, indistinct; hymenium pale sordid yellowish; hypothecium colorless

or nearly so; asci narrowly clavate; spores $\frac{3 - 6}{9 - 14} \mu$; sterigma simple,

straight; spermatia acicular, $\frac{1.2 - 1.5}{7 - 9} \mu$.

Common in the foothills on sandstone and occasional in the mountains on the same substratum, up to 3000 feet. Specimens collected by Bolander at Mission Dolores, San Francisco, and at Ukiah, were named *Biatora glebulosa* by Tuckerman.

Described by Dr. Zahlbruckner from specimens collected by Dr. Hasse on Mt. San Gabriel, in southern California.

5. LECIDEA COARCTATA (Sm.) Nyl.

Lichen coarctatus Smith, English Bot. 5: 8. t. 534. 1795.

Lecidea coarctata Nyl. Lich. Scand. 196. 1861.

Biatora coarctata Tuck. Syn. N. Am. Lich. II: 15. 1888.

Parmelia elacista Ach. Meth. Lich. 159. pl. 4. f. 4. 1803.

Lecanora ornata Sommerf. Suppl. Fl. Lapp. 92. 1826.

Thallus whitish or gray, areolate, scattered; thin or disappearing or forming a continuous, fissured crust; areolæ quite small, the largest scarcely exceeding $\frac{3}{4}$ mm. in width, furfuraceous, convex, and mostly approximate; the red reaction of authors with CaCl_2O_2 is not seen in our plant.

Apothecia sessile and sub-innate, small or minute; disk reddish brown, flat, finely papillate, with a thin, slightly elevated margin, which is concolorous or a little darker, persistent; frequently with a coarctate, spurious, pulverulent thalline margin; paraphyses indistinct, thread-like and twining; hypothecium and epithecium colorless; thecium blue or brown with I; asci oblong saccate; spores ovoid-

ellipsoid, $\frac{7.5 - 11}{17 - 25} \mu$.

On sandstone and earth in the foothills and mountains. The *forma elacista* (Ach.) characterized by the effuse, very thin, scurfy, or almost entirely disappearing thallus, occurs on clay, along the summit of the first ridge east of Los Gatos, at about 1500 feet elevation, and on sandstone at 2000 feet elevation on Castle Rock Ridge.

The *forma ornata* of authors, characterized by a more luxuriant development of the thallus, with marginally crenate, flat to convex squamules, occurs on sandstone in the foothills.

A variable and quite common lichen of Europe and North America.

(*coarctata*, narrow or appressed, from the appearance of the false thalline margin.)

6. LECIDEA FUMOSA (Hoffm.) Ach.

Patellaria fumosa Hoffmann, Deutsch. Fl. 2: 190. 1791.

Lecidea fumosa Acharius, Meth. Lich. 41. 1803.

Lecidea fusco-atra Tuck. Syn. N. Am. Lich. II: 75. 1888.

Thallus spreading extensively, areolate squamulose, fissured, or the small squamules crowded and uniform, concave, rarely flat or convex, with a distinct, often paler margin, which from entire becomes intricately flexed; from shining brown varying to dark brown and nearly black, with a fringing black hypothallus; KOH — ; CaCl₂O₂ — .

Apothecia sessile, not very numerous, scattered or sometimes conglomerate, 1 to 1.25 mm. wide; disk smooth, flat, black, with a thin, grayish-black, at first entire, finally flexuous or lobate margin; becoming strongly convex and finally immarginate; hymenium colorless, blue with I; paraphyses coherent; epithecium bluish black; hypothecium horny, dark brown, about half the thickness of the hymenium; asci narrowly clavate; spores ellipsoid, $\frac{5 - 7.5}{11 - 16} \mu$.

On various rocks at all elevations, in the foothills and mountains, from 200 feet to the summit of the range.

Generally distributed in the mountainous regions of Europe and North America.

7. LECIDEA INTUMESCENS (Flot.) Nyl.

Lecidea badia var. *intumescens* Flotow, Lich. Siles. no. 175, 1829.

Lecidea intumescens Nyl. Lich. Paris. no. 58, 1854.

Lecidea insularis Nyl. Bot. Not. 177. 1852.

Lecidea insularis Tuck. Syn. N. Am. Lich. II: 76. 1888.

Thallus a tartareous, determinate, warty, plicate or broken crust, of convex, cervine-brown squamules, several grouped to form small islands scattered among other crustaceous lichens, especially *Lecanora sordida* and *Rhizocarpon geographicum*; hypothallus not distinct.

Apothecia small or minute, innate to sessile; disk black; margin thin, persistent; epithecium brown; paraphyses coherent; hypothecium brown; asci clavate; thecium blue with I; spores broadly ellipsoid, $\frac{5 - 7}{10 - 13} \mu$.

On sandstone in the mountains, at 3000 feet altitude, and also rarely at lower elevations. Occurring in the Oakland Hills (Boland), and probably elsewhere in California. Generally distributed in Europe.

8. LECIDEA MANNI Tuck.

Lecidea manni Tuck. Syn. N. Am. Lich. II: 75. 1888.

Lecidea manni Hasse, The Bryologist 11: 6. 1908.

Thallus indeterminate, of rather large and conspicuous, thick, convex scales or areoles, from scattered becoming crowded and imbricate; their surface smooth, with rounded or occasionally crenate or finely toothed edge, often with a gray, dusky, or blackish margin; color buff to yellow brown; the dusky or blackish hypothallus indistinct; KOH+ CaCl₂O₂ reddish.

Apothecia not numerous, innate, sessile, of medium size, circular or irregular, the black disk flat, soon plano-convex or moderately convex; bordered by a paler, erect, rather thick, entire, and sinuous margin; hypothecium colorless or slightly brownish; I-; spores ellipsoid, $\frac{4.8 - 5}{12 - 19.5} \mu$; $\frac{5 - 7}{11 - 16} \mu$ " Tuck.

A single specimen collected on felspathic rock, at the summit of Loma Prieta, at an elevation of 3793 feet. A comparison of this with Tuckerman's type specimen shows them to be identical in every respect except the paler color of my specimen. Mt. Diablo, the type locality, is about 75 miles north of Loma Prieta, and is the terminal peak of the Inner Coast Range east of San Francisco Bay. The plant has also been found by Dr. Hasse in Ventura County. (Named for Horace Mann, Jr. who collected lichens in California and the Hawaiian Islands in the '60s.)

9. LECIDEA ATROLUTESCENS Nyl.

Lecidea atrolutescens Nyl. *in litt.*, 1896.

Thallus cartilaginous, indeterminate, composed of convex to sub-globose squamules, from $\frac{1}{2}$ to 2 mm. wide; fawn-colored or buff, paling toward the margins, often crenulate and lobulate, either scattered or approximate; hypothallus indistinct.

Apothecia sessile, becoming large, 1 to 2 mm. wide, circular, numerous, often crowded, and then irregular or distorted; disk black, usually with a white or gray bloom; at first moderately convex, with a turgid and lighter colored margin, becoming subglobular, the margin persistent and in larger apothecia sinuate or distorted; epithecium granulose, brown; paraphyses conglutinated; hymenium colorless to light brownish, deep blue with I, 80 to 100 μ high; hypothecium very dark brown; spores oblong ellipsoid, $\frac{5 - 6}{12 - 14}$ μ . and $\frac{8}{15}$ μ . Spermatia not seen.

On sandstone at Grizzly Peak, at an altitude of 2700 feet. Heretofore known only from Southern California, where it was discovered by Dr. Hasse.

10. LECIDEA GRISELLA (Flk.) Nyl.

Lecidea fumosa var. *grisella* Floerke, *in litt.*

Lecidea fumosa var. *grisella* Schaerer, Enum. Crit. Lich. Europ. 110. 1850.

Lecidea grisella Nylander, Lich. Lapp. Or. 160. 1867.

Thallus indeterminate, of minute, then scattered or barely contiguous areoles, plane or moderately convex, dull ashy gray or dusky gray in color; KOH- or faintly yellowish; CaCl_2O_2 red.

Apothecia small to medium, numerous, innate-sessile, closely appressed, black; the disk plane or soon moderately convex, bordered by a thin entire margin, which becomes angulose and is long persistent, finally disappearing; epithecium dark brown; paraphyses conglutinate, thecium deep blue with I; hypothecium blackish brown, broad; spores not observable in my specimens, the asci poorly developed or their contents not differentiated; $\frac{6 - 7}{11 - 15}$ μ according to Hue.

On rocks in the foothills near Stanford University. A European lichen apparently not distinguished by American authors.

11. LECIDEA CRUCIARIA Tuck.

Lecidea cruciaria Tuck. Syn. N. Am. Lich. II: 67. 1888; Santa Cruz.

Thallus effuse, thin to very thin, of minute scurfy scales, or closely areolate; white, more or less plainly marked by tortuous black hypothalline lines, best seen when wet; medulla with I-; hypothallus black.

Apothecia numerous, small to medium, sessile, flat; disk black, opaque, from smooth becoming minutely roughened; from flat becoming moderately convex and the originally stout, wrinkled, at length flexuous margin disappearing; epithecium bluish or greenish black, with KOH becoming sooty brownish black; paraphyses coherent, capitate, with bluish black apices; asci clavate and inflated-clavate, $\frac{16}{50}$ μ ; hypothecium pale greenish brown and darkening; spores ellipsoid, $\frac{4.8 - 7\frac{1}{3}}{9\frac{3}{4} - 17\frac{1}{4}}$ μ ; hymenium blue with I.

Tuckerman's specimens were from Santa Cruz, on sandstone. I have found it, however, only on Monterey shale, along the coast for 50 miles north of Santa Cruz and extending back into the "chalk hills" ten miles or more from the coast, at altitudes from 50 to 1400 feet.

12. LECIDEA LITHOPHILA (Ach.) Th. Fr.

Lecidea lapicida i. *lithophila* Ach. Lich. Univ. 160. 1810.

Lecidea lithophila Th. Fr. Lich. Scand. II: 495. 1874.

Lecidea pruinosa Tuck. Syn. N. Am. Lich. II: 66. 1888.

Lecidea pruinosa Macoun, Cat. Canadian Plants, VII: 154. 1902.

Thallus thin, tartareous, of small ash-colored squamules, loosely approximate; the rimose-areolate character of the thallus mentioned by various authors not marked; the black hypothallus but little evident; KOH-; CaCl₂O₂-.

Apothecia sessile, $\frac{1}{4}$ to $\frac{3}{4}$ mm. wide; disk concave to flat, black, more or less light gray pruinose, the thin black margin finally disappearing; epithecium brown; paraphyses simple, erect, coherent; hypothecium almost colorless; asci clavate; spores rarely seen, ellipsoid, $\frac{6 - 7}{9 - 15}$ μ .

On sandstone at Grizzly Peak at an altitude of 2775 feet. A lichen of northern and alpine Europe; in America reported from Greenland, Newfoundland, a number of localities in Canada, and in Texas.

13. LECIDEA TESSELLATA Flk.

Lecidea tessellata Floerke, Deutsch. Lich. no. 64. 1815.

Lecidea tessellata Tuck. Syn. N. Am. Lich. II: 68. 1888.

Thallus usually determinate and more or less orbiculate, limited by a black hypothalline band or line which is rarely obsolete; uniform crustaceous, thick, sub-tartareous, of flat areoles, from delicately rimose becoming plainly fissured; pale ashy gray or whitish with a faint blue tinge; KOH —; CaCl_2O_2 —; medulla without reaction with I.

Apothecia numerous, scattered or occasionally thickly grouped, from small to medium and very large (2.5 mm. broad), innate to sessile; disk flat to moderately convex, black, occasionally with a faint bloom; margin thick, black, erect; persistent, sometimes crisped or flexuous; a spurious thalline margin is seen with some apothecia; epithecium bluish-black, paling downward; paraphyses, coherent, strict; hymenium colorless or very pale blue, 80 μ high, blue with I; hypothecium colorless to pale ash-color, as high as the hymenium; asci narrowly spatulate; spores rarely to be seen, $\frac{3.5}{6}$ μ ; $\frac{4-6}{6-10}$ μ ," Tuck.

A handsome and conspicuous lichen on igneous rocks in the foothills, at elevations of a few hundred feet. Generally distributed over Europe and North America.

(*tessellata*, checkered, like a mosaic pavement, alluding to the contrasting thallus and apothecia.)

14. LECIDEA LAPICIDA (Ach.) Arn.

Lichen lapicida Ach. Lich. Suec. Prodr. 61. 1798, exclud. synonymy.

Lecidea lapicida Ach. Meth. Lich. 37. 1803.

Lecidea lapicida Arn.,

Lecidea pantherina v. *lapicida* Th. Fr. Lich. Scand. 2: 493. 1874.

Lecidea polycarpa Tuck. Syn. N. Am. Lich. II: 69. 1888.

Thallus thick to moderately thin, determinate, limited by a more or less evident black hypothallus, uniform crustaceous, of flat areoles separated by minute fissures which later become broad and conspicuous cracks; KOH -; CaCl_2O_2 -; medulla without reaction with I.

Apothecia at first small and innate, then appressed and large to very large, numerous, single and circular or usually grouped and then angular, 1 to 2.5 mm. wide; disk at first flat, soon slightly convex, black; margin thin, persistent, slightly elevated; epithecium brown; thecium colorless, 80 μ high, blue with I; hypothecium almost colorless or faint yellowish-gray or yellowish-brown; asci inflated oblong-clavate; spores oblong ellipsoid, $\frac{6 - 8}{10 - 14} \mu$.

On sandstone; at Castle Rock, altitude 3000 feet, and elsewhere along the summit of the ridge.

A lichen of alpine regions and the cooler parts of Europe and North America.

15. LECIDEA PLATYCARPA Ach.

Lecidea platycarpa Ach. Lich. Univ. 173. 1810.

Lecidea platycarpa Tuck. Syn. N. Am. Lich. II: 73. 1888.

Thallus ash-colored or leaden gray, indeterminate, uniform, thick and tartareous, becoming more or less fissured, or thin and granulose to finely pulverulent; no hypothallus evident; KOH -; CaCl_2O_2 -.

Apothecia numerous, small, $\frac{1}{4}$ to 1 mm. wide, appressed, scattered; disk black, slightly papillate, flat; margin thin, becoming obsolete; the younger apothecia show a spurious, thin thalline margin now and then; margin slightly horny; epithecium brown, much narrower than the hypothecium; paraphyses conglutinate; hypothecium brownish-black or blackish-brown; asci ventricose; spores ovoid-ellipsoid, $\frac{6 - 7.5}{15 - 20} \mu$.

On sandstone in Santa Cruz, altitude about 50 feet. A lichen of the subarctic and temperate regions of Europe and America.

In our plant the thallus is much more developed and the apothecia smaller than in specimens gathered by me in the Alps.

16. LECIDEA GONIOPHILA (Flk.) Schaer.

Lecidea immersa var. *goniophila* Floerke, Berl. Mag. 311. 1809.

Lecidea goniophila Schaerer, Lich. Helvet. Exsicc. no. 531.

Lecidea goniophila Schaerer, Enum. Lich. Europ. 127. 1850.

Thallus effuse, of small, dingy white crumbs or minute scales, or quite obsolete; KOH pale yellow; CaCl_2O_2 very pale reddish.

Apothecia sessile, medium to small, $\frac{1}{4}$ to 1 mm. wide, scattered; disk from a little concave to flat, finally convex, dull black, when wet suggesting red-black; margin concolorous, entire, somewhat turgid, glistening, finally obsolete; epithecium dark bluish-black; paraphyses coherent, hair-like; hymenium about 60 μ high, pale blue with I; hypothecium pale dingy yellow; asci saccate, 20 x 50 μ ; spores ovoid ellipsoid, one end often pointed, the episporium distinctly double, $\frac{7 - 10}{14 - 16}$ μ .

On comparison with authentic specimens in the museum at Vienna, our plant seems to be closest to the variety *atro-sanguinea* Holm., distinguished by the nearly obsolete thallus and dark red-black scattered apothecia.

On sandstone near Devils Cañon, at an altitude of 2500 feet. Described originally from Germany and found also in France, Switzerland, Austria, and Italy.

17. LECIDEA AURICULATA DIDUCENS Th. Fr.

Lecidea auriculata diducens Th. Fries, Lich. Scand. 2: 499. 1874.

Lecidea auriculata deducens Jatta, Syll. Lich. Ital. 347. 1900.

Thallus absent. Apothecia medium to large; disk flat or slightly convex, black; margin persistent, thin to almost turgid, black, at first regular, at last sinuate; epithecium brownish black; paraphyses coherent, their capitate tips brownish black; hymenium colorless; hypothecium dusky; asci clavate, thecium intensely blue with I; spores oblong ellipsoid, $\frac{3 - 3.5}{9 - 11}$ μ ; according to Fries $\frac{2.5 - 3.5}{6 - 11}$ μ .

On various rocks and at various elevations, from near sea level ascending to 3000 feet at Castle Rock.

18. LECIDEA MELANCHEIMA Tuck.

Lecidea melancheima Tuckerman, Proc. Am. Acad. Arts. and Sci. 260. 1847.

Lecidea melancheima Tuck. Syn. N. Am. Lich. II: 81. 1888.

Thallus creamy white, indeterminate, moderately thick, of irregularly shaped, conjoined and rimose, rugulose, sub-lobate squamules or warts; KOH yellow; CaCl_2O_2 —.

Apothecia numerous, $\frac{1}{4}$ to 1 mm. wide, appressed to sessile; disk glistening and very black, flat to strongly convex, and then at times tuberculate, often wavy; margin very thin, becoming flexuous, finally excluded; epithecium dark brown, gradually paling downward; paraphyses loosely coherent; hypothecium pale or colorless; thecium 60μ high, colorless to light brown, blue with I; asci inflated clavate; spores ellipsoid, $\frac{3-4}{7-12}\mu$; spermatia not seen.

On dead wood, fences, roofs, limbs of *Pseudotsuga taxifolia*, etc., from sea level up to 3000 feet.

Common in New England; Colorado; Central Europe.

Lecidea elabens E. Fries, Act. Stock. 256, 1822, a similar plant from northern and Alpine Europe, is different. Schaerer, Enum. Crit. Lich. Europ. 131, says: "Apothecia atra, sub lamina cornea strato inferiore carbonaceo, innata, immarginata; disco exasperato, papillato."

19. LECIDEA OLIVACEA (Hoffm.) Mass.

Verrucaria olivacea Hoffmann, Deutsch. Fl. 2: 192. 1791.

Lecidea olivacea Mass. Ric. Aut. Lich. Crost. 71. 1852.

Lecidea enteroleuca f. *flavida* Tuck. Syn. N. Am. Lich. II: 80. 1888.

Lecidea enteroleuca Hasse, Pacific Slope Lichens distrib. C. F. Baker, no. 628. 1902.

Thallus thin, effuse, of scattered, minute, scale-like granules, or uniform crustaceous, of tiny areolate granules or crumbs, or becoming warty and uneven; color from an olive-brown or yellowish to greenish gray and whitish; KOH —; CaCl_2O_2 brick-red or clay-red.

The *forma geographica* Baglietto is distinguished by the small, thin to very thin, determinate thallus, sharply limited by the con-

spicuous black hypothalline lines, and the yellowish or greenish-brown color.

Apothecia small or minute, numerous, scattered, black or rusty black, sessile or sub-immersed, the disk concave to plane, finally moderately convex, with a thin, erect, entire margin which is finally excluded; epithecium dusky greenish; thecium blue with I; hypothecium brown; spores ellipsoid or ovoid $\frac{7 - 8\frac{1}{2}}{12 - 15} \mu$.

Common on the bark of various trees from the foothills to the summit of the highest peaks. A European lichen particularly abundant in the Mediterranean region. We have both the typical plant and the *forma geographica*.

20. LECIDEA PARASEMA Ach.

Lichen parasemus Ach. Lich. Suec. Prodr. 64. 1798.

Lecidea parasema Ach. Meth. Lich. 35. 1803.

Lecidea enteroleuca e. *achrista* Tuck. Syn. N. Am. Lich. II: 80. 1888.

Thallus effuse, thin, contiguous and rather smooth, or tartareous, becoming chinky or dispersed and made up of minute scurfy or warty areoles; whitish, gray, ashen, to brownish ash color; KOH — or sometimes yellowish; CaCl_2O_2 —; hypothallus indistinct or absent.

Apothecia small, sessile, black; disk at first flat and often more or less tuberculate, with an evident entire margin which is sometimes flexuous; soon convex and tumid, rugulose or papillate, the margin finally obsolete; epithecium bluish black; paraphyses free, their bluish black tips abruptly thickened; hypothecium faintly colored to brown; asci clavate, thecium blue with I; spores oblong ellipsoid, $\frac{6 - 8}{12 - 16} \mu$.

A variable bark lichen occurring throughout our territory and found all over Europe and North America; one of the commonest species in most temperate regions, but with us less abundant than the closely related *Lecidea olivacea*.

21. LECIDEA LATYPÆA Ach.

Lecidea latypæa Ach. Meth. Lich. Suppl. 10. 1803.

Lecidea enteroleuca Tuck. Syn. N. Am. Lich. II: 79. 1888, in part.

Proc. Wash. Acad. Sci., May, 1910.

Thallus indeterminate, of thickish, unequal, whitish, gray, or yellowish brown warts, more or less dispersed or continuous and granulate-areolate; hypothallus indistinct, black; KOH yellow; CaCl_2O_2 faintly reddish yellowish.

Apothecia numerous, scattered or conglomerate, from innate to sessile, $\frac{1}{2}$ to $1\frac{1}{4}$ mm. wide; disk black, long remaining flat, but finally convex and tuberculate or rugulose; margin at first elevated, entire or crenulate and sinuate, later disappearing; epithecium bluish black; paraphyses loosely coherent; hymenium colorless or pale gray, with I blue, soon turning brown; hypothecium brown, thick; asci inflated clavate; spores broadly ellipsoid, $\frac{5-10}{10-16}$ μ .

Common on various rocks in the maritime region and in the foothills, at no very great elevation. Originally described from Sweden and not rare in the mountains of Europe.

22. LECIDEA ENTEROLEUCA Ach.

Lecidea enteroleuca Ach. Lich. Univ. 177. 1810.

Lecidea enteroleuca Tuck. Syn. N.Am. Lich. II: 79. 1888, in part.

Thallus a thin, effuse, granulose or minutely areolate or warty crust, or now and then disappearing; the small areoles or warts scattered, loosely approximate, or becoming crowded and even heaped; grayish white to dark ashy gray; KOH yellow; CaCl_2O_2 — or faintly reddish; hypothallus black.

Apothecia from .5 to 1.5 mm. wide; disk black, at first flat, soon convex, becoming subglobose; the thin, black, horny margin finally disappearing; paraphyses loosely coherent; epithecium bluish to brownish black; asci clavate, thecium pale reddish to colorless, becoming blue with I; hypothecium colorless to dusky; spores ellipsoid to broadly ellipsoid, sometimes falsely bilocular, $\frac{5-10}{12-18}$ μ ; spermatia long, needle-like, curved.

Common on various rocks in the foothills and widely distributed both as to latitude and altitude; a variable plant.

According to the character of the thallus and color of the hypothecium several forms are recognized, of which we have the following:

var. AEQUATA (Flk.)

Lecidea sabuletorum aequata Floerke, in Schaer. Spicil. 152. 1828.

Lecidea enteroleuca aequata Tuck. Syn. N. Am. Lich. II: 80. 1888.

Thallus of whitish or gray squamules, irregularly distributed or crowded and then rimose areolate; KOH yellow; CaCl_2O_2 red.

Apothecia at first innate, then sessile to superficial, often crowded but retaining their regular circular form; disk black, from flattish to convex; margin regular, entire, but eventually disappearing as the disk becomes more convex; tips of the loosely coherent paraphyses bluish black; hypothecium pale or colorless; asci inflated clavate or wedge-shaped; spores $\frac{6 - 8.5}{9 - 15} \mu$.

On various rocks in the foothills and mountains. A lichen of Central and Northern Europe, also occurring along the Atlantic coast of America.

var. THEIOPLACA Tuck.

Lecidea enteroleuca var. theioplaca Tuck. Genera Lichenum, 179. 1872.

Lecidea enteroleuca var. theioplaca Tuck. Syn. N. Am. Lich. II: 79. 1888.

Thallus of pale yellow or sulfur-colored, globose or crenulate warts, mostly irregularly distributed and areolate, or closely compacted into a thin, uniform crust; KOH —; CaCl_2O_2 vermilion; the color of the thallus precludes a reaction with KOH.

Apothecia small to medium, numerous, irregular, concave or plane, the thin, entire, greenish margin paler than the black disk, and finally excluded; hymenium colorless or brownish; hypothecium dark brown; spores as in the type.

On cliffs bordering the sea, at Point Lobos, San Francisco, and southward along the coast, at Point San Pedro and Pescadero.

Described by Tuckerman from about San Francisco and also determined by him from South Carolina and New Jersey.

In the author's opinion this is a species rather than a variety, distinguished by the different hypothecium, the different chemical reactions, and other minor distinctions.

XX. *Catillaria* (Mass.) Th. Fr.

Catillaria Massalongo, Ric. sul. Aut. Lich. Crost. 78. 1852.

Catillaria Th. Fries, Gen. Heterol. Europe. 88. 1861.

Thallus crustaceous, uniform or marginally lobed, without cortex. Apothecia circular, innate or sessile, with clear to black proper margin but no thalline margin; disk concave to convex, variously colored; hypothecium clear to black; paraphyses simple, free or coherent, capitate; spores 8, rather small, colorless, ovoid or ellipsoid, elongate or short, straight or curved, bilocular, with thin walls and without a halo.

A large genus, representatives occurring in all parts of the world and upon all kinds of substrata.

KEY TO THE SPECIES.

A. On rocks.

B. Thallus purplish black; apothecia black.....1. *subnigrata*

BB. Thallus ash-colored; apothecia dark brown and blackening; white pruinose.....2. *franciscana*

AA. On bark.

C. Thallus whitish ash-color or gray; becoming yellow with KOH
3. *tricolor*

CC. Thallus greenish white; no reaction with KOH.....4. *globulosa*

1. CATILLARIA SUBNIGRATA (Nyl.)

Lecidea subnigrata Nyl. Flora, 370. 1866.

Lecidea subnigrata Leighton, Lich. Fl. Grt. Brit. ed. 3. 331. 1888.

Thallus indeterminate, of purplish black squamules, imbricate, lobed and crenulate, rugulose; KOH —; CaCl₂O₂ —.

Apothecia sessile, .5 to 1 mm. wide; disk flat, black, finely papillate, at last markedly convex; margin at first thick but becoming partly or wholly obsolete; hymenium 68 μ thick, pale purplish gray, paling downward, blue with I; paraphyses subcoherent, the tips clavate; hypothecium colorless; spores ellipsoid, $\frac{5-7}{10-12}$ μ .

On rocks near Stanford University, at an elevation of 500 feet. A lichen of the British Isles.

2. CATILLARIA FRANCISCANA (Tuck.) Herre.

Biatora franciscana Tuck. Syn. N. Am. Lich. II: 32. 1888.

Thallus effuse, of small but thick and coarse squamules; these numerous and close together, concave, rugose, undulating, often crenate and lobulate, or sometimes closely appressed, few in number, or nearly disappearing; occasionally passing into warty areolate conditions; ash-colored with lighter colored margin, hardly darkening; hypothallus indistinct or absent; KOH —; CaCl_2O_2 —.

Apothecia of medium size, 1 to 1.25 mm. wide; disk from slightly to strongly convex, dark dull brown to blackening, with a white bloom; the rather stout, lighter colored margin finally excluded; epithecium brown; hypothecium colorless or faintly colored; paraphyses strict, not septate, their slightly thickened tips light brown; asci elongate clavate, about as high as paraphyses; hymenium colorless, blue with I; spores narrowly oblong-ellipsoid, $\frac{3-5}{14-22} \mu$.

On rocks all along the Pacific coast, from near the Cliff House, San Francisco, southward. Recorded by Tuckerman from the Oakland Hills and by Dr. Hasse from the coast of Southern California.

3. CATILLARIA TRICOLOR (With.) Th. Fr.

Lichen tricolor Withering, Arrang. 4: 20. 1796.

Catillaria tricolor Th. Fr. Lich. Scand. 2: 574. 1874.

Biatora mixta E. Fries, Vet. Ak. Handl. 267. 1822.

Biatora mixta Tuckerm. Syn. N. Am. Lich. II: 30. 1888.

Thallus whitish ash-color to dull gray, and from nearly smooth to granulate, becoming almost chinky, areolate, the small areolæ rugulose; usually limited by a black hypothalline line; KOH yellow; CaCl_2O_2 —.

Apothecia small to minute, appressed sessile; disk at first flat, soon becoming convex, flesh-color to reddish brown and blackish, pruinose; the thin margin usually persistent; epithecium and hypothecium colorless; paraphyses simple, free, thread-like, slightly knob-

like at the apex; thecium blue with I; asci inflated clavate, $\frac{16}{40} \mu$;

spores ellipsoid to spindle-shaped, straight or slightly curved,

$$\frac{2.8 - 5.6}{9.75 - 18} \mu.$$

Abundant on the bark of various living trees in the foothills and along the coast; rarely on old fences in the mountains.

The var. *pacifica* of Tuck., distinguished by a black, limiting hypothallus and more distinct septum in the spores, and the var. *atlantica* of the same author, are both found on this coast.

Common in Europe, on bark and dead wood, in New England, and on the Pacific coast.

4. CATILLARIA GLOBULOSA (Flk.) Th. Fr.

Lecidea globulosa Floerke, Deutsch. Lich. 181. 1815.

Catillaria globulosa Th. Fr. Lich. Scand. 2: 575. 1874.

Biatora globulosa Tuck. Syn. N. A. Lich. II: 32. 1888.

Thallus greenish white, thin, effuse, of minute, crowded warts or granules, or these now and then scattered; KOH—; CaCl₂O₂—.

Apothecia small to very small, sessile or semi-immersed in the thalline warts, soon convex and sub-globose, immarginate; very young and small apothecia are flat with a thin margin; disk dark brownish black to black, opaque; epithecium pale sordid yellowish; paraphyses conglutinated, indistinct, their tips thickened; hymenium colorless, blue with I; hypothecium colorless; asci clavate; spores narrowly oblong, faintly septate, at times a little curved, $\frac{3-3.5}{8-16} \mu.$

On old fences near Los Gatos, at an altitude of 450 feet.

A European lichen reported in this country from the White Mountains and from British America.

XXI. Bacidia (DeNotaris) A. Zahlbr.

Bacidia DeNotaris, Giorn. Bot. It. an. 2, tom. I: 189. 1846.

Bacidia A. Zahlbruckner, Ascolichenes, 135. 1907.

Thallus uniform crustaceous, without cortex. Apothecia circular, sessile or rarely innate or elevated, the disk plane or strongly convex; the proper margin colorless or dark; paraphyses simple, free or coherent, their ends often thickened; hypothecium clear to dark;

asci with 8, rarely 16 spores; these from 3-to multilocular, spindle to needle-shaped, with both ends alike or one end prolonged into a tail, straight, curved, or spiral, without a halo.

A large genus, of more than 200 species, found all over the world, on stones, bark, wood, moss, etc.

KEY TO THE SPECIES.

- A. Thallus usually pale yellow, and yellow with KOH; apothecia blue, then violet with KOH.....1. *herrei*
 AA. Thallus never yellow and not changed by KOH.
 B. On rocks; thallus black with greenish or grayish cast.2. *ioessa*
 BB. On trees; thallus not blackish.
 C. Apothecia clouded flesh-color and darker; thecium blue with I 3. *nægeliï*
 CC. Apothecia black; thecium not blue with I.....4. *akompsa*

1. BACIDIA HERREI A. Zahlbr.

Bacidia herrei A. Zahlbruckner, Annales Mycologici, 6: 130. 1908.

Thallus sub-orbulate, becoming effuse, more or less chinky, of granulose, densely imbricated and crowded, thickish squamules, or thin and reduced to mere granules; without soredia or isidia, but the granules sometimes almost coralloid; usually of a pale yellow color, sometimes whitish, rarely greenish gray; KOH yellow; CaCl_2O_2 —.

Apothecia sessile, small to medium, sparsely distributed to approximate, sometimes forming a heap of several together, basally constricted, circular, or sub-angulose when crowded; disk plane to convex, red, not pruinose; the proper margin thin, concolorous, entire, from prominent finally excluded; with KOH an apothecial section turns an intense deep blue, soon changing to violet, the epithecium losing the blue last; epithecium granular, broad, dark red; hypothecium colorless; hymenium more or less reddish, 90 — 110 μ high, bluish with I; paraphyses close together, free, simple, not septate; asci short, oblong-clavate; spores arranged lengthwise in the asci, colorless, needle-like to narrowly spindle-shaped, usually much attenuated at one end, straight to slightly curved, indistinctly pluri-

septate (5 — 8), $\frac{2-3}{35-48}$ μ ; "35 — 40 μ longis et 1.7 — 1.8 μ latis", A.

Zahlbr.

On sandstone and the bark of *Pseudotsuga taxifolia* and on dead wood of *Pseudotsuga taxifolia* and *Adenostoma fasciculatum*, at Devil's

Cañon, altitude 2300 feet, Castle Rock, 3000 feet, and Grizzly Peak, 2700 feet. Probably found all along the summit of the range in similar localities.

The above description somewhat altered from Dr. Zahlbruckner's excellent diagnosis. While the specimen he described was found on dead *Adenostoma*, I regard the typical plant to be the one with yellow, orbiculate, thickish thallus, growing on sandstone.

A handsome, conspicuous, but not very abundant plant.

Strongly characterized by the color of the thallus and apothecia, as well as by the beautiful apothecial reactions with KOH.

2. BACIDIA IOESSA Herre, new species.

Thallus effuse, thin, of scattered, minute to small, thick, rounded or sub-globose, sometimes sub-plicate or difform granules or crumb-like squamules, which are occasionally aggregate; on a thick, prominent, often scurfy hypothallus; color black with a greenish or grayish cast; dark olive-green when wet; KOH — : CaCl₂O₂ —.

Apothecia numerous, small, sessile, black; the flat disk bordered by a small, entire, sometimes paler margin, but soon becoming convex, when the margin is excluded finally; epithecium blackish, with KOH becoming purplish or rosy violet, the color suffusing the thecium; the latter blue with I; paraphyses free, thread-like, rather lax, with sub-globose tips which are violaceous dusky to blackish; hypothecium colorless to pale brownish; asci subcylindrical to clavate,

$\frac{10 - 15}{35 - 45}$ μ ; spores 4 — locular, spindle-, finger-, and sickle-shaped,

$\frac{3.5 - 6}{14.5 - 20}$ μ .

On igneous rocks on a dry hill side, Hidden Villa Cañon, at an altitude of 800 feet, and probably in similar situations all through the foothills. The specimens scanty; apparently close to Tuckerman's *Bialora arlyta*, Synopsis, II: 37, but I cannot bring the two together. (*ioessa*, from $\iota\omicron\sigma\sigma\alpha$ violet colored, from the epithecial reaction with KOH.)

3. BACIDIA NÆGELII (Hepp.) A. Zahlbr.

Biatora nægelii Hepp. Exiscc. no. 19. 1853.

Biatora nægelii Tuck. Syn. N. Am. Lich. II: 36. 1888.

Bacidia nægelii A. Zahlbr. Ascolichenes, 135. 1907.

Thallus of minute, thickish, scale-like granules, forming a more or less chinky crust, or occasionally thin; color ashy gray or greenish ashen; KOH — ; CaCl₂O₂ — .

Apothecia numerous, minute to small, sessile, circular, at first plane but very soon becoming strongly convex and excluding the thin, entire, scarcely evident margin; color a clouded flesh-color as nearly as can be defined, soon darkening and then blackening; paraphyses distinct but coherent, slender; hypothecium clear; thecium blue with I; spores spindle-shaped to ellipsoid, $\frac{6 - 7.5}{16.5 - 19.5} \mu$; with 1, 2, 3, 4 septa, mostly 4-locular. Dr. Zahlbruckner states in Ascolichenes "sporen bis 8 zellig" but I find none with more than 5. Th. Fries states, Lich. Scand. II: p. 379, "sporæ primitus simplices, dein 2-4, raro 6-8 blastae."

On bark of *Umbellularia* and other trees, mixed with *Lecania dimera*, *Catillaria tricolor*, and other lichens.

× A bark lichen of both Europe and North America. (Named for Karl Wilhelm von Naegeli, botanist and philosopher, professor at Munich from 1858 to 1891.)

4. BACIDIA AKOMPSA (Tuck.) Herre.

Biatora akompsa Tuck. Syn. N. Am. Lich. II: 47. 1888.

Thallus pale ash-colored to dusky greenish ash-colored, effuse, interruptedly granulose or scurfy, as if poorly developed; no chemical reaction evident.

Apothecia scattered, small to minute, sessile; disk dull black, more or less convex; margin thin, indistinct; epithecium pale grayish brown; paraphyses coherent, hair-like; hypothecium colorless; asci clavate or narrowly spatulate; spores needle-shaped, 4 to 5 locular, $\frac{2 - 3}{18 - 20} \mu$; according to Tuck., $\frac{1.5 - 2.5}{18 - 24} \mu$; thecium not colored by iodine.

On bark of *Pinus radiata* near Stanford University, at an altitude of 200 feet. Given by Tuck. as collected by Bolander on the bark of *Pinus insignis*, coast of California. The Monterey pine, *Pinus radiata* (*Pinus insignis*) occurs wild only about Monterey and on the southwestern coast of the Santa Cruz peninsula. Bolander's specimens were undoubtedly collected on the coast between Pescadero and Santa Cruz, a locality where he collected a number of lichens.

XXII. *Toninia* (Mass.) Th. Fr.

Toninia Mass. Ric. sul. Aut. Lich. Crost. 107. 1852.

Toninia Th. Fries, Gen. Heterol. Europ. 80. 1861.

Thallus crustaceous-squamulose to sub-foliaceous, swollen or inflated and sub-pedicellate, marginally lobed; without true rhizoids; upper side with a firm cortex.

Apothecia circular, sessile, the proper margin variously colored, horny, of radiately arranged, thickened hyphæ; paraphyses simple, free or confluent, often capitate; hypothecium clear or dark; spores 8, elongate or ellipsoid, 2 to 8-locular, without halo.

About 80 species, on rocks and earth, mostly xerophytes of the cool temperate and alpine regions.

KEY TO THE SPECIES.

A. Spores bilocular.

B. Thallus compact crustaceous; usually white pruinose; with KOH dusky brown.....1. *cæruleo-nigricans*

BB. Thallus scattered; not pruinose.....5. *massata*

AA. Spores 4-plurilocular.

C. Thallus of livid brown and blackening squamules, slightly reddish with KOH.....2. *squalida*

CC. Thallus not affected by KOH.

D. Thallus tawny brown, extending downward in stout brownish stems.....3. *caulescens*

DD. Thallus of minute squamules forming a dark greenish black or dusky gray crust.....4. *aromatica*

1. *TONINIA CÆRULEO-NIGRICANS* (Lightf.) Th. Fr.

Lichen cæruleo-nigricans Lightfoot, Flora Scot. 805. 1777.

Toninia cæruleo-nigricans Th. Fr. Lich. Scand. 2: 336. 1874.

Lecidea cæruleo-nigricans Tuck. Syn. N. Am. Lich. II: 61. 1888.

Thallus indeterminate, of thick, gyrosely plicate, turgid, medium sized or small squamules crowded into a compact crust, appressed,

or sometimes extended downward into stipes; mostly dusky greenish but varying also from whitish to brown-green and black-green, usually white pruinose; with KOH turning dusky brown.

Apothecia medium to large, sub-innate to sessile, at first concave but soon plane or plano-convex, finally strongly convex; the black disk with a thick, whitish or pruinose margin which soon disappears; epithecium granulose, dark; paraphyses thick, free, their enlarged or spatulate and blunt tips dark greenish; thecium colorless, blue with I; hypothecium brownish; spores bi-locular, spindle-shaped to nearly needle-like, $\frac{2.5 - 3.5}{20 - 30}$ μ ; “ $\frac{2 - 4}{14 - 27}$ μ ,” Tuck.

On earth in rock crevices on Black Mt., at from 2400 to 2700 feet elevation. An earth and lime-rock lichen of Europe; in America only in cold mountains or the far north.

In our specimens the disk is naked, but in specimens collected by me in Styria the apothecia are mostly white pruinose, the whole plant often seemingly covered with hoar frost.

2. TONINIA SQUALIDA (Schleich.) Mass.

Lichen squalidus Schleicher, Pl. Crypt. Helvet. Cent. III, no. 75. 1807.

Toninia squalida Mass., Ric. Aut. Lich. Crost. 108. 1852.

Lecidea squalida Ach. Lich. Univ. 169. 1810.

Lecidea squalida Tuck. Syn. N. Am. Lich. 64. 1888.

Thallus a close, uneven crust of small, rather thick and closely appressed, rugose-plicate squamules, often sub-lobate; livid brown and blackening; slightly reddish with KOH.

Apothecia numerous, small, closely adnate, the black disk plane, bordered by a thickish, regular margin; apothecia also larger, becoming irregular, confluent, and convex, when the margin is excluded; pale within; paraphyses free, slender, their blackish tips enlarged and rounded; hypothecium pale reddish brownish; epithecium granulose, violaceous or purplish with KOH, the entire internal structure becoming more or less suffused with the same tint; thecium blue with

I, the asci clavate, $\frac{12 - 15}{48 - 52}$ μ ; spores 4 - 6 locular, finger or needle-

shaped, straight or curved, $\frac{2.5 - 4}{28 - 37}$ μ .

Rare; on earth in rock crevices near the summit of Black Mountain, at an elevation of 2700 feet. A lichen of alpine and arctic Europe; in North America recorded from Greenland and the mountains of the Pacific Coast.

3. TONINIA CAULESCENS Anzi.

Toninia caulescens Anzi, Cat. Lich. Prov. Sondr. 67. 1860.

Lecidea squalida caulescens Tuck. Syn. N. Am. Lich. II: 64. 1888.

Thallus tawny brown, squamulose, the turgid squamules convolute, scattered or usually crowded and imbricate, extending downward in stout brownish stems; KOH — ; CaCl₂O₂ — .

Apothecia closely sessile, deeply concave, from small and round to large and lobulate; disk dull black, papillate; the prominent turgid margin persistent, at first regular, round, becoming at length sinuate on the larger apothecia; epithecium brown, with KOH violaceous brown; hypothecium dark reddish brown; paraphyses separate, the brown tips abruptly capitate; hymenium pale yellowish, intense blue with I, soon changing to a sordid vinous red; asci spatulate, almost equaling the hymenium in height; spores fusiform, 4 to 8 (10?) locular, $\frac{2.5 - 5}{24 - 50} \mu$.

On earth and rocks at 50 to 100 feet above the sea, Point Lobos, San Francisco, and on earth above the sea a few miles south of Point San Pedro.

A lichen of alpine and arctic Europe and of the Pacific coast of the United States.

4. TONINIA AROMATICA (Sm.) Mass.

Lichen aromaticus Smith, Eng. Bot. pl. 25, f. 1777. 1807.

Toninia aromatica Mass. Symm. 54. 1855.

Lecidea aromatica Ach. Lich. Univ. 168. 1810.

Lecidea aromatica Tuck. Syn. N. Am. Lich. II: 131. 1888.

Thallus effuse, of minute squamules or crumb-like granules, mostly contiguous, imbricate, irregularly and confusedly rugose, forming a dark greenish black or dusky gray crust.

Apothecia sessile, often clustered, $\frac{3}{4}$ to 1 mm. wide; disk black, at first slightly concave with a thin, entire or crenulated margin, soon

flat, the margin not elevated, and finally convex and distorted, the margin disappearing; epithecium dark, brown-black and purplish black, with KOH violet; hypothecium dark yellowish brown; paraphyses separate, some with grayish violet, globose tips; hymenium pallid or pale violaceous gray, intensely blue with I; spores quadrilocular, narrow fusiform with obtuse ends, $\frac{3-4}{13-24}$ μ ; spores straight or sometimes slightly curved.

On sandstone near Mayfield, at an altitude of 400 feet.

This plant of Europe and Northern Africa has been reported only from Ontario and California in North America.

5. TONINIA MASSATA (Tuck.) Herre.

Lecidea massata Tuck. Lich. Calif. 25. 1866.

Lecidea massata Tuck. Syn. N. Am. Lich. II: 63. 1888.

“Thallus of small, scattered, turgid, glebous squamules becoming at length plicate, pale greenish and glaucescent; apothecia small to middling-sized (0 mm., 5 – 1 mm, 5 in width) peltate, flat, but the t in uneven margin at length disappearing, finally convex and irregular, pale within, the hypothecium rufous-brown. Spores cymbiform, bilocular, 9 – 16 by 3 – 5 μ .”

On the earth in gravelly soil, San Francisco, California (Bolander, Tuckerman, *l. c.* 1866). Colorado, Brandegee in Herb. Sprague. Spermogones not observed.”

I have not been able to find the above lichen and give the description written by Tuckerman.

6. TONINIA RUGINOSA (Tuck.) Herre.

Lecidea ruginosa Tuck. Lich. Calif. 25. 1866.

Lecidea ruginosa Tuck. Syn. N. Am. Lich. II: 64. 1888.

“Thallus of rounded, turgid, glebous squamules which become more or less crowded together, wavy, and rugose-plicate, and are finally cancellated, from greenish to at length tawny brown; apothecia ample to large (1 mm., 5 to 3 mm. in width,) flat, at length flexuous-lobate, scarcely excluding the stout margin, pale within, the hypothecium brownish. Spores acicular, 4 – plurilocular, 25 – 40 by 2 – 3 mic. Spermata filiform, bowed, on sub-simple sterigmas.

Serpentine rocks on the coast of California, (*Bolander*). Squamules less developed than in the last preceding, scarcely lobed. Apothecia originally rufous."

The above copied from Tuckerman's description in the Synopsis, II: 64. "The last preceding" refers to "*Lecidea squalida*."

As yet I have been unable to find the above described lichen, though Bolander's specimens undoubtedly came from about San Francisco.

XXIII. *Rhizocarpon* (Ram.) Th. Fr.

Rhizocarpon Ramond, in DC. Fl. Fr. 2: 365. 1805, in part.

Rhizocarpon Th. Fr. Gen. Heterol. Europ. 92. 1861.

Thallus uniform crustaceous, without cortex; often with a strongly developed hypothallus.

Apothecia circular, sessile upon the thallus, innate, or between the areoles, with a black or brown proper margin and a dark hypothecium; paraphyses lax, branched and twining; asci with from 1 to 8 spores which are colorless to dark, bilocular to multilocular, or muriform, with a plainly visible halo.

Species numerous, on rocks in arctic and temperate regions.

KEY TO THE SPECIES.

- A. Spores colorless, muriform. 1. *distinctum*
- AA. Spores brown, 4-locular to muriform.
 - B. Thallus yellow.
 - C. Thallus sulfur-yellow; medulla with I- 2. *viridi-atrum*
 - CC. Thallus lemon-yellow; medulla blue with I. . 3. *geographicum*
 - BB. Thallus not yellow.
 - D. Thallus of dark brown or reddish black squamules. . 4. *bolanderi*
 - DD. Thallus more or less gray.
 - E. Asci with 2 spores; thallus dark gray and blackening.
 - 5. *geminata*
 - EE. Asci with 8 spores; thallus brownish, bluish-gray or blackish gray. 6. *petraeum*

1. RHIZOCARPON DISTINCTUM Th. Fr.

Rhizocarpon distinctum Th. Fr. Falk. Bleck, 16 (nomen); Lich. Scand. 2: 625. 1874.

Thallus sub-determinate to effuse, thin, rimose-areolate, the areolae minute to small, slightly concave or flat; hypothallus black; color of plant whitish to leaden gray and darkening; KOH -; CaCl₂O₂ -.

Apothecia small, .5 to .75 mm. wide; disk black, papillate, with a thin grayish, at first slightly elevated, margin, continuing plane with the finally convex disk, but not wholly excluded; epithecium brown black, gradually paling downward, with KOH pale violaceous; hypothecium pale brown and darkening; hymenium pallid, with I turning intensely blue; paraphyses conglutinated; asci saccate; spores colorless, muriform, $\frac{10 - 16}{24 - 36} \mu$.

On rocks in the mountains; New Almaden, 1200 feet; Castle Rock, 3000 feet; and on maritime rocks near Pescadero. A lichen of northern, alpine, and southern Europe.

2. RHIZOCARPON VIRIDI-ATRUM (Flk.) Körb.

Lecidea viridi-atrum Floerke,

Rhizocarpon viridi-atrum Körber, Syst. Lich. Germ. 262. 1855.

Diplotomma viridi-atrum Jatta, Syll. Lich. Ital. 432. 1900.

Thallus greenish or sulfur-yellow, of minute, thickish, tartareous, flat or rounded granules or squamules; the hypothallus but little, or not at all evident; KOH —; CaCl_2O_2 —; medulla not affected by I.

Apothecia numerous, of medium size, innate or closely appressed, dull black, not pruinose; the disk more or less minutely roughened, at first plane, with a thin, entire or irregular margin; soon moderately convex and the margin disappearing; paraphyses indistinct, coherent; epithecium broad, black, purplish red with KOH; hypothecium blackish-brown; thecium deep blue with I; spores quadrilocular, ellipsoid or oblong, dark brown, becoming nearly black, $\frac{7.5 - 13.5}{17 - 28.5} \mu$; perhaps murilocular, but too dark to determine positively.

A distinct species, very rare with us; collected but once, on sandstone in the foothills 4 miles west of Stanford University, at an altitude of 400 or 500 feet. Not rare in Europe, but apparently not distinguished by American collectors.

3. RHIZOCARPON GEOGRAPHICUM (L.) DC.

Lichen geographicus Linné, Spec. Plant. 1140. 1753.

Rhizocarpon geographicum DC. Fl. Fr. 2: 365. 1805.

Buellia geographica Tuck. Syn. N. Am. Lich. II: 103. 1888.

Thallus greenish yellow to bright lemon-yellow, determinate, rimose areolate, the flat areolæ crowded into a chinky crust, or else the areolæ are scattered and tumid, forming small clumps; hypothallus distinct, black; medullary hyphæ blue with I; not affected by other reagents.

Apothecia immersed or between the areolæ and on the same level as the thallus, mostly angular from pressure of adjoining areolæ or other apothecia, small, numerous and often grouped; disk always flat, black, opaque, the margin thin, black, indistinct; epithecium brownish-black; paraphyses loosely coherent, the brown tips scarcely thickened; hypothecium brownish black; thecium colorless, blue with

I; spores dark brown, 2 to 4 locular and muriform, $\frac{16 - 20}{28 - 46} \mu$.

The forms *contigua* and *lecanorina* of authors are not rarely found mixed with the type, on the same specimen.

A beautiful and conspicuous lichen. Abundant on various rocks at 2500 feet and above, and in the cold and foggy San Francisco region descending as low as 500 feet. Found in nearly all mountainous regions of the world and characteristic of all very high peaks.

4. RHIZOCARPON BOLANDERI (Tuck.) Herre.

Buellia bolanderi Tuck. Gen. Lich. 189. 1872.

Buellia bolanderi Tuck. Syn. N. Am. Lich. II: 103. 1888.

Thallus indeterminate and spreading extensively, cartilaginous, of small to very small, brown or reddish-black, sometimes shiny, flat or slightly concave, round or sinuate squamules; these with a slightly elevated black border, scattered or approximate; in the latter case forming an areolate-diffract crust upon a conspicuous black hypothallus that to the naked eye gives the predominant color to the thallus; no chemical reactions of thallus or medulla.

Apothecia small, dispersed, from partially innate to sessile; disk flat or slightly convex, naked, black; margin quite thin, becoming finally obscure; epithecium dark brownish violaceous black; thecium pale, deep blue with I; paraphyses conglutinate; hypothecium of same color as epithecium; asci saccate and inflated saccate, about as high as thecium; spores colorless to dark smoky gray and dark brown, solitary or in twos, with a thick gelatinous halo, muriform, oblong

ovoid or broadly ellipsoid, $\frac{20 - 36}{32 - 72}$ μ ; according to Tuckerman,
solitary, in twos or in fours, $\frac{20 - 25}{30 - 50}$ μ .

On igneous rocks and sandstone throughout, but most abundant on the higher peaks. Often intermingled with *Lecidea scotophilis* Tuck., which is very similar in appearance.

Type locality, sandstone rocks in the Oakland Hills. Reported from a number of stations in California, Oregon, and Washington, and probably occurring everywhere west of the Sierras.

5. RHIZOCARPON GEMINATUM (Ft.) Korb.

Lecidea geminatum Flotow, *in litt.*

Rhizocarpon geminatum Körber, Syst. Lich. Germ. 259. 1855.

Buellia petræa c. montagnaei Tuck. Syn. N. Am. Lich. II: 102. 1888, in part.

Thallus of scattered or loosely approximate, thin, round, flat squamules, dark gray and blackening; hypothallus indistinct.

Apothecia small, circular, sessile; disk flat, black; margin slightly turgid and elevated, entire and persistent, black; epithecium granulate, violaceous black; hypothecium blackish brown; paraphyses coherent; hymenium pallid; asci inflated saccate; spores in twos, either colorless or dark smoky gray, from 4 — locular becoming muriform, $\frac{16 - 20}{28 - 32}$ μ .

On rocks in Hidden Villa Cañon and elsewhere in the mountains and foothills, at elevations of a few hundred feet. A common European lichen, which is probably also widely distributed in North America.

6. RHIZOCARPON PETRÆUM (Flow.) A. Zahlbr.

Lecidea petræa Flotow, *in litt.*

Rhizocarpon petræum A. Zahlbr. Ascolichenes, 138. 1907.

Buellia petræa Tuck. Syn. N. Am. Lich. II: 101. 1888.

Thallus usually small, orbiculate to effuse, thin, uniform, and minutely rimose, or becoming thickish and sub-tartareous, more or less roughened and minutely verrucose; upon a black, occasionally

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limiting hypothallus, which is often indistinct; color varying from brownish to bluish or blackish gray; KOH — ; Ca Cl₂O₂ — .

Apothecia minute to small, often crowded, innate or very closely adnate; often concentrically arranged; the flat black disk surrounded by a thickish, elevated, entire or irregular, slightly paler margin; permanent in our specimens though said to be finally excluded; hypothecium brown or blackish brown; thecium dark blue with I, the color evanescent; spores oblong, 4-locular to muriform, dusky, $\frac{12-13}{24-30}$ μ . according to Tuck., 8 — 18 by 24 — 40 μ .

On rocks in the foothills and mountains, in dry localities. Generally distributed over Europe and North America.

CLADONIACEÆ.

Thallus from crustaceous and uniform to foliaceous, usually inconspicuous, of horizontal or ascendant, more or less leafy squamules, or these reduced and only granulose. Apothecia borne on the tips of upright hollow or solid podetia, which form the "plant;" they may be simple, club, cup, or funnel-shaped, or shrub-like and much branched. Spores colorless, simple to 100 celled, or muriform. But one genus in our limits.

XXIV. *Cladonia* (Hill.) Wainio.

Cladonia Hiller, Hist. Pl. 91. 1751, in part.

Cladonia Wainio, Monog. Clad. Univ. 1: 5. 1887.

Cladonia Tuck. Syn. N. Am. Lich. I: 236. 1882.

Podetia hollow, exceedingly variable, cup, club, or funnel shaped, or shrub-like and much branched; apothecia cephaloid, scattered or confluent, red, brown, or flesh-colored, borne on the tips of the podetia; spores simple, ovoid-oblong, small, much alike in all the species.

An exceedingly difficult genus from the highly variable and polymorphic species which seem to intergrade in a manner most puzzling. The group is considered to be one of recent origin and it is probable that many of the forms are still undergoing rapid changes and that the species have not become relatively fixed. This is highly interesting to the ecologist and physiologist but is grievous to the systematist. My material has been passed upon by several workers of recognized

ability and authority on Cladonias, but in several cases they have been unable to agree or even to express a decided opinion. If the following arrangement arouses someone to re-study our Californian Cladonias and define our species clearly I shall feel amply repaid for this entire work.

KEY TO THE SPECIES.

- A. Apothecia scarlet.
 - B. Podetia yellow with KOH; without cups. 1. *macilenta*
 - BB. Podetia not yellow with KOH and bearing small cups
 - 2. *flabelliformis*
- AA. Apothecia brown.
 - C. Podetia irregularly much branched.
 - D. Not cup-bearing, surface smooth or with small leafy squamules
 - 3. *furcata*
 - DD. Small cups more or less present.
 - E. Surface densely clothed with leafy squamules; KOH –
 - 4. *squamosa*
 - EE. Squamules few or cortex merely rough warty or ridged; cups more or less proliferate; KOH + 5. *subsquamosa*
 - CC. Podetia simple or nearly so, cup-bearing.
 - F. Cups proliferous.
 - G. From the centre; not perforated. 6. *verticillata*
 - GG. From the margin; cups perforated. 7. *crispata*
 - FF. Cups not proliferous.
 - H. Podetia turbinate with top-shaped cups, naked or solediose
 - 8. *pyxidata*
 - HH. Podetia cylindrical, trumpet or club-shaped, solediose; cups reduced, often obsolete. 9. *fimbriata*

1. CLADONIA MACILENTA Hoffm.

Cladonia macilenta Hoffmann, Deutsch. Fl. 2: 126. 1796.
Cladonia macilenta Wainio, Rev. Lich. Hoffm. 17. 1886.
Cladonia macilenta Wainio, Monog. Clad. Univ. 1: 98. 1887.
Cladonia macilenta Tuck. Syn. N. Am. Lich. I: 253. 1882, in part.
Cladonia macilenta Herre, Proc. Wash. Acad. Sci. 7: 391. 1903, in part.

Primary thallus scanty, minute to small, squamulose or leafy, crenate or lacinate lobate; pale gray-green to brownish; beneath white.

Podetia rising from the surface of the squamules, short or of medium length, rarely long, cylindrical, slender, or club-like and somewhat swollen, simple or with few and irregular branches, without cups; covered by a dense, pale, gray-green solediose powder which may become granulose; without squamules or the granules becoming squa-

mules and on the lower half finally leafy lobules similar in form and color to those of the primary thallus; the whitish ground color usually but little evident; with KOH more or less yellow.

Apothecia terminal, scarlet; in the field or in freshly gathered material turning black when wet; small to medium, irregular, more or less confluent; spores irregularly arranged in the asci.

On stumps, old logs, and living trunks of *Sequoia sempervirens* and *Pseudotsuga taxifolia*. A common and handsome *Cladonia*.

Part of our material is referred by Prof. Fink to *Cladonia bacillaris*, as the spores are obliquely arranged in the asci; however I am as yet not able to distinguish more than the one species. *Cladonia macilenta* is probably generally distributed over North America and is reported from all the continents. But Dr. Wainio states that many authors have not distinguished it from *Cladonia bacillaris* Nyl.

2. CLADONIA FLABELLIFORMIS (Flk.) Wainio.

Capitularia flabelliformis Floerke, Besch. Rothfr. Becherfl. 216. 1808.

Cladonia flabelliformis Wainio, Monog. Clad. Univ. 1: 112. 1887.

Cladonia macilenta Herre, Proc. W. Acad. Sci. 7: 391. 1906, in part.

Primary thallus of small or medium sized, crenate-lobate or irregularly dissected and lobate, brownish or pale green squamules; scattered or compacted into a dense, leafy crust; white beneath.

Podetia rising from the surface of the squamules, short or of moderate length, usually rather slender, entire or sparingly branched, the surface mostly densely sorediate, granulose, or the granules passing into minute squamules; cylindrical, becoming dilated above and forming small, shallow, entire or perforated cups; these with dentate or lacerate and irregular margins which are often proliferous; the branches likewise dilated apically, or slender and awl-like.

Apothecia scarlet, small to medium, solitary, becoming confluent, on short stalks from the margins of the cups or crowning the tips of the proliferous branches.

Rare; on a stump of *Sequoia sempervirens* on the Bear Gulch road, at an altitude of about 1000 feet. Given by Wainio in his list of cosmopolitan species, though not yet known to occur in Asia.

3. CLADONIA FURCATA (Huds.) Schrad.

- Lichen furcatus* Hudson, Fl. Angl. 458. 1762.
Cladonia furcata Schrader, Spic. Fl. Germ. 107. 1794.
Cladonia furcata Tuck. Syn. N. Am. Lich. I: 247. 1882.
Cladonia furcata Wainio, Monog. Clad. Univ. 1: 316. 1887.
Cladonia furcata Fink, The Bryologist, 7: 54. 1904.
Cladonia racemosa Hoffmann, Deutsch. Fl. 2: 144. 1795.
Cladonia furcata racemosa Floerke, Clad. Comm. 152. 1828.
Cladonia furcata racemosa Wainio, Monog. Clad. Univ. 1: 323.
 1887.
Cladonia furcata racemosa Fink, The Bryologist, 7: 55. 1904.
Cladonia furcata racemosa Herre, Proc. Wash. Acad. Sci. 7: 391,
 1906, in part.
Cenomyce racemosa var. *pinnata* Floerke, in Schleicheri Cat. Absol.
 47. 1821.
Cladonia furcata pinnata Wainio, Monog. Clad. Univ. 1: 332. 1887.
Cladonia furcata pinnata Fink, The Bryologist, 7: 56. 1904.
Cladonia chlorophaea prolifera Herre, Proc. Wash. Acad. Sci. 7: 388.
 1906, in part.
Cladonia squamosa Herre, Proc. Wash. Acad. Sci. 7: 390. 1906, in
 part.

var. RACEMOSA Floerke.

Primary thallus at first of tiny scattered squamules, these eventually quite long, leafy, lobed, with crenate-lobulate margin; pale green above, varying to pale brown or sometimes whitish; white beneath.

Podetia fruticose, rather short to elongated or very much elongated, slender to rather coarse, more or less cylindrical, the lower portion dying, but growth continuing above; branches spreading, curved, from sparingly dichotomously branched becoming intricately branched, the branches recurved; surface smooth, becoming more or less roughened, or, in *forma phyllophora*, more or less thickly clothed with squamules or leafy thalline lobules; usually more or less thickened at the axils which are often gaping or perforated; tips of branches very slender and subulate, or now and then thickened and stumpy; color whitish, very pale greenish-gray, to brown.

Apothecia numerous, terminating the branchlets, small to exceedingly minute, brown, varying from pale, almost flesh-color or yellowish to dark.

Common on earth in the redwood forests and also in the foothills. Dr. Farlow, who has identified the *forma phyllophora* from material which I mistakenly called *Cladonia chlorophæa prolifera*, writes that he has found this form common in California. This form seems to merge at times in forms of *Cladonia squamosa*.

var. PINNATA (Flk.) Wainio.

Podetia erect, $1\frac{1}{2}$ to $3\frac{1}{2}$ inches long, slender and cylindrical below, broad and stout above, dying below but growth continuing apically; sparingly dichotomously branched, the sterile tips usually narrowly subulate, more or less squamulose to the summit, or rough and scabrous; not isidiose or sorediate; color whitish or greenish to brown.

Apothecia minute or small, abundant but inconspicuous, brown and blackish brown.

On earth under woods in the foothills and mountains.

This species or some of its varieties occur all over the world. The varieties described above have been collected in all parts of the earth except Africa. The variety *pinnata*, though little known, is no doubt generally distributed over North America, according to Fink.

4. CLADONIA SQUAMOSA (Scop.) Hoffm.

Lichen squamosus Scopoli, Flora Carniolica, ed. 2 368. 1772.

Cladonia squamosa Hoffmann, Deutsch. Fl. 2: 125. 1796.

Cladonia squamosa Tuck. Syn. N. Am. Lich. I: 246. 1882.

Cladonia squamosa Wainio, Monog. Clad. Univ. 1: 411. 1887.

Cladonia squamosa Fink, The Bryologist, 10: 21. 1907.

Cladonia squamosa Herre, Proc. Wash. Acad. Sci. 7: 390. 1906, in part.

Primary thallus leafy or squamulose, lobulate, crenate or dissected, more or less ascendant, sometimes closely compacted into a dense crust; green, varying from whitish to brownish; white beneath. KOH — .

Podetia arising from the surface of the squamules, sometimes dying basally; sub-cylindrical, clustered, often forming matted

clumps, erect or irregularly flexuous; irregularly much branched, the branches mostly spreading, their axils usually cleft; densely clothed to the summit with light green or brown squamules, these often large, leafy, and lobulate; epidermis pale green or disappearing, the color then variegated from ashy to pale reddish brown; seldom cup-bearing with us, or the cups small, dilated, perforate, with proliferous margins.

Apothecia small or minute, numerous, flesh-brown to dark brown.

On earth in woods on damp hillsides, and on the earth at Twin Peaks, San Francisco. Generally distributed over North America and found in all the continents.

5. CLADONIA SUBSQUAMOSA (Nyl.) Wainio.

Cladonia subsquamosa Nyl. ex Cromb. Journ. Linn. Soc. Bot. **17**: 560. 1880.

Cladonia subsquamosa Wainio, Mon. Clad. Univ. **1**: 445. 1887.

Cladonia subsquamosa Fink, The Bryologist, **10**: 23. 1907.

Primary thallus of small, narrowed, often deeply cleft squamules, the lobes pointed and more or less irregular; usually but little evident or disappearing. KOH +, yellow and then crimson.

Podetia arising from surface of squamules, slender, short to medium or moderately long, more or less cylindrical; irregularly branched or forked, sometimes simple; axils occasionally perforate or the stems gaping; cups sometimes present, small, perforate; apices subulate, slender, more often cup-bearing, perforate, or the cups degenerate, gaping, with proliferate margin of short, slender, rough branchlets; cortex rough-warty, ridged, or almost entirely decorticate: more or less squamulose or the leafy lobules becoming scaly, or entirely naked; from pale grayish or greenish to brownish, becoming rather dark brown, especially in specimens dying basally.

Apothecia numerous, small to medium, clustered at the tips of the branches but not confluent, flat or convex; brown to very dark brown.

Abundant on earth in rock crevices in Pilarcitos Creek Cañon, two miles from the ocean.

A rare plant. Recorded from France, Belgium, Switzerland, North and South America, Australia, and New Caledonia.

6. CLADONIA VERTICILLATA Hoffm.

Cladonia verticillata Hoffmann, Deutsch. Flo. 2: 122. 1796.

Cladonia verticillata Wainio, Monog. Clad. Univ. 2: 176. 1894.

Cladonia verticillata Fink, The Bryologist, 7: 86. 1904.

Cladonia verticillata Herre, Proc. Wash. Acad. Sci. 7: 390. 1906.

Lichen cervicornis Ach. Lich. Suec. Prodr. 184. 1798.

Cladonia verticillata cervicornis Floerke, Clad. Comm. 29. 1828.

Primary thallus leafy, squamules large (sometimes as much as an inch in length) to medium size, somewhat ascendant, usually clustered, rounded or more or less dissected, usually crenate lobulate; color brownish green or sometimes lighter; beneath whitish.

Podetia rising from the lower margin of the squamules, cylindrical, from short to slender and elongated, cup-bearing, usually smooth and without squamules, or here and there roughened or bearing occasional thalline lobules; sometimes with conspicuous and abundant thalline leaflets on the basal joints and on the cups; these marginally denticulate and from 2-5 times proliferous from the center, forming a series of whorls; sometimes two or more branches arise from one cup, or again cups are lacking on the upper ranks or branches; color of podetia gray green to ashy and brownish.

Apothecia light to dark brown, small or medium sized, on short stalks from the margins of the cups, or sessile.

On earth and in crevices of rocks, throughout the foothills, and mountains. Ofttimes growing in the driest situations on the rocky summits of hills where even the chaparral is thin and stunted.

Our plants belong mostly to the variety *cervicornis* (Ach.) Flk., in which the podetia are shorter and more slender, and with 1-3 ranks; sometimes proliferous from the sides of the podetia below the cups. Occurring in the driest and sunniest places.

Another cosmopolitan lichen, but usually lacking in arctic regions and rare in the tropics.

7. CLADONIA CRISPATA (Ach.) Flot.

Baeomyces turbinalus var. *crispatus* Ach. Meth. Lich. 341. 1803.

Cladonia crispata Flotow, Merkw. Flecht. Hirschb. 4. 1839.

Cladonia crispata Wainio, Monog. Clad. Univ. 1: 379. 1887.

Cladonia crispata Fink, The Bryologist 7: 57. 1904.

Cladonia furcata crispata Tuck. Syn. N. Am. Lich. I: 247. 1882.

Primary thallus persistent or finally dying, of medium sized, digitate-laciniate or crenate, ascendant squamules, rather densely clustered, and forming a crust; color greenish and greenish brown; white beneath.

Podetia rising from the surface of squamules, sometimes dying basally but growing above, from short to medium length, sub-cylindrical, with few branches; these sub-erect, with axils commonly dilated; surface smooth or becoming granulose or somewhat squamulose; more or less cup-bearing, or terminating bluntly, or rarely awl-like. Cups small, dilated, perforated, usually with proliferate margins.

Apothecia small, solitary or becoming aggregate, at the ends of the proliferations or on the ends of short stalks which form a ragged margin to the cups; brown to very dark brown.

On earth in the mountains, apparently not common. Generally distributed over the northern part of North America and found in all parts of the world except Africa.

8. CLADONIA PYXIDATA (L.) Fr.

Lichen pyxidatus Linné, Spec. Plant. 2: 1151. 1753.

Cladonia pyxidata E. Fries, Nov. Sched. Crit. 21. 1826.

Cladonia pyxidata Wainio, Monog. Clad. Univ. 2: 209. 1894.

Cladonia pyxidata Tuck. Syn. N. Am. Lich. I: 240. 1882.

Cenomyce chlorophæa Floerke, in Sommerf. Suppl. Lapp. 130. 1826.

Cladonia chlorophæa Floerke, Clad. Comm. 70, 1828.

Cladonia chlorophæa Herre, Proc. Wash. Acad. Sci. 7: 388. 1906.

Cladonia pyxidata costata Floerke, Clad. Comm. 66. 1828.

Cladonia pyxidata costata Herre, Proc. Wash. Acad. Sci. 7: 387. 1906.

Bacomyces pocillum Ach. Meth. Lich. 336. 1803.

Cladonia pyxidata pocillum Tuck. Syn. N. Am. Lich. I: 241. 1882.

Primary thallus of ascendant, minute to medium-sized or large squamules, entire or crenate-lobed; more rarely appressed or adnate and sub-crustaceous; pale or sage-green to ashy or olive-brown.

Podetia simple, short, stout, turbinate, typically naked; usually rising from centre of squamules; in some varieties with the upper part covered with a soresiose powder; KOH — or rarely greenish yellow; cups dilated, with margins entire or more or less denticulate or proliferous. Apothecia rare, small, becoming confluent and even large; brown. An exceedingly variable lichen, with several distinct forms in our territory.

Var. COSTATA Flk.

This form is distinguished by the longitudinally furrowed podetia, which are basally more or less warty or sub-squamulose, while the cups are usually granular warty or even squamulose within.

Var. CHLOROPHÆA Flk.

In this variety the podetia are covered with a yellowish-greenish or sulfur-colored soresiose powder, or with warty granules.

Var. POCILLUM Ach.

In this variety the thallus is of reduced, appressed or adnate squamules, becoming sub-crustaceous; the naked podetia are small, short and narrow, and are rarely seen fruiting.

The typical form occurs on rocks, earth, and old stumps, probably throughout. The variety *chlorophæa* is abundant and finely developed on earth in the foothills and mountains; the variety *costata* is found in the mountains, on rocks and earth; the variety *pocillum* has been collected on the roofs of old houses at Mayfield and elsewhere in the Bay region, and also on earth at Twin Peaks, San Francisco.

A truly cosmopolitan lichen but most abundant in the temperate regions.

9. CLADONIA FIMBRIATA (L.) E. Fries.

Lichen fimbriata Linné, Spec. Plant. 2: 1152. 1753.

Cladonia fimbriata E. Fries, Lich. Europ. Reform. 222. 1831.

Cladonia fimbriata Wainio, Monog. Clad. Univ. 2: 246. 1894.

Cladonia fimbriata Tuck. Syn. N. Am. Lich. I: 241. 1882; (includ. *tubæformis*).

Cladonia fimbriata Fink, The Bryologist, 7: 22. 1904.

Cladonia fimbriata Herre, Proc. Wash. Acad. Sci. **7**: 389. 1906;
varieties *clavata*, *cornuta*, and *tubæformis*.

Cladonia fimbriata simplex (Weis.) Wainio, Monog. Clad. Univ. **2**:
256. 1894.

Cladonia fimbriata simplex Fink, The Bryologist, **7**: 23. 1904.

Cladonia fimbriata coniocraea (Flk.) Wainio, Monog. Clad. Univ.
2: 308. 1894.

Cladonia fimbriata coniocraea Fink, The Bryologist, **7**: 25. 1904.

Cladonia fimbriata cornuta Herre, Proc. Wash. Acad. Sci. **7**: 389.
1906.

Primary thallus of leafy, elongate or medium sized, numerous and often densely imbricate squamules which may pass into an effuse, powdery crust; squamules more or less lobed, with crenate or lacinate margins, flat or concave, more or less ascendant; color pale to dull sage-green or varying to whitish or brownish green, or olivaceous; beneath white.

Podetia rising from surface of squamules, simple or sparingly short-branched in the upper portion, small to medium size, slender or becoming rather stout, terete; apically pointed and thread-like, or coarser, thicker, blunt, with greatly reduced cups; more or less thickly covered with a whitish or greenish solediose powder, or becoming rough and verrucose; usually destitute of squamules, but sometimes more or less squamulose basally.

Cups small to minute, or abortive, with an entire or minutely denticulate margin; sometimes well developed with dentate margin.

Apothecia rare, brown to dark brown, small to very minute, terminal or on tips of the denticulations of the cups.

Most of our specimens belong to the variety *coniocraea* (Flk.) Wainio, in which the podetia are unbranched, usually rather short, solediose, cupless, cylindrical and pointed, or with minute abortive cups; squamules absent or more or less present basally.

Part of our material belongs to the variety *simplex* (Weis) Wainio, in which the plant resembles a slender form of *Cladonia pyxidata*, with simple podetia without squamules, solediose or becoming rough and verrucose, and with the cups better developed than in the other varieties.

The variety *subulata* is also occasionally found here; in this the podetia are much elongated, usually without cups, cylindrical or

Thallus small to medium size; many-leaved, crinkled, cespitose; surface smooth, often polished; irregularly much lobed and dissected, the erectish lobules often slender with dilated and rounded tips; marginally crenate, dentate, unevenly cut, or erose; sometimes minutely and excessively dissected and crisped; color black or very dark brown; beneath naked, finely granulate, dull black. Sterile.

Not rare on the high sandstone cliffs at the head of Devil's Cañon, at an altitude of 2300 feet, mingled with *Gyrophora polyrrhiza*. Also growing alone in considerable abundance on precipitous rocks on Mount San Bruno, at about 1000 feet.

Widely distributed in Europe, Asia and North America.

2. GYROPHORA PHÆA (Tuck.) Herre.

Gyrophora phæa Herre, Proc. Wash. Acad. Sci. 7: 366. 1906.

Umbilicaria phæa Tuck. Lich. Calif. 15. 1866.

Umbilicaria phæa Tuck. Syn. N. Am. Lich. 1: 86. 1882.

Umbilicaria phæa Cummings, Williams, and Seymour, Decades of N. Am. Lichens no. 157, Moreno, California.

Umbilicaria phæa Hasse, in Seedless Plants of So. Calif. by A. J. McClatchie, 369; no date.

Umbilicaria phæa Macoun, Cat. Canadian Plants, VII: 80. 1902. Vancouver Island.

Thallus small to medium, one-leaved or occasionally polyphylous, smooth above; color brown, but varying from greenish or grayish to olive or dark tawny brown; under surface without fibrils. granular; usually darker brown or blackish, but sometimes paler.

Apothecia numerous, black; at first innate but finally prominent; angular or rounded, their surface plicate; asci $\frac{20}{40}$ μ .; spores simple, colorless to brown, variously arranged in the asci, $\frac{5}{10} - \frac{8}{13.5}$ μ .

On bare, exposed sun-blistered rocks; most frequently on sandstone but also on igneous rocks. According to Tuckerman, found only between 1000 and 3000 feet altitude, but really extending much above and below these limits. Occurring in the Santa Cruz Mountains from Searsville Ridge, at an elevation of about 350 feet, to the summit of Loma Prieta, 3793 feet. In the Mt. Hamilton

range across the Santa Clara Valley, it occurs in Alum Rock Park near San José at about 300 feet above sea level. I have also collected it in the Sierra Nevada Mountains, at Verdi, Nevada, at an elevation of 4900 feet. Usually abundant wherever found.

My largest specimens from the Santa Cruz peninsula have a diameter of somewhat more than two inches. This lichen seems to reach a greater thalline development in the drier Inner Coast Range than in the Santa Cruz Mountains. A specimen in the Tuckerman Herbarium from Mt. Diablo has a diameter of 3 inches, while I have collected specimens on Mt. Santa Ana with a breadth of 4 inches.

Ranging from Vancouver Island on the north to Guadalupe Island in Lower California, a specimen from the latter locality, collected by Dr. Edward Palmer, being in the Tuckerman Herbarium.

3. GYROPHORA POLYRRHIZA (L.) Körb.

Lichen polyrrhizos Linné, Sp. Plant. 2: 1151. 1753.

Gyrophora polyrrhiza Körber, Par. Lich. 41. 1859.

Gyrophora diabolica A. Zahlbr. in Herre, Proc. Wash. Acad. Sci. 7: 366. 1906.

Thallus small to medium, one-leaved becoming many-leaved and complicate; more or less orbicular, the edges torn or irregular; coriaceous, rigid, usually smooth and polished; color a very dark rich brown, becoming olive when moist; beneath black, granulate, more or less covered with short, dense, black fibrils.

Fertile plants infrequent; apothecia at first innate, and very small, but finally large, rounded, or irregularly oblong, prominent and dome-like, reaching a diameter of 8 mm.; beautifully gyrose-plicate, black; spores simple, colorless, short ellipsoid, $\frac{5-7}{7.5-13.5}$ μ .

Abundant on high sandstone cliffs in Devil's Cañon, at an altitude of 2000-2300 feet; mingled with *G. phæa* and *G. polyphylla*, but from its greater size and abundance forming the dominant tone of the rock lichen flora. A few specimens also found on Castle Rock, altitude 3000 feet. Abundant in the Yosemite Valley, according to Dr. Hasse. Recorded from Northern Europe and Asia; not given by Tuckerman in his lists of North American species.

I have compared my specimens with authentic fruiting material from Th. Fries in the Imperial Museum at Vienna, and in the Brit-

ish Museum, and with the specimens at Kew in the Leighton Herbarium.

At the time of naming *Gyrophora diabolica* Dr. Zahlbruckner had not seen fertile specimens of *G. polyrrhiza*; later he obtained some from Dr. Fries and saw at once the identity of the plants.

ACAROSPORACEÆ.

Thallus crustaceous, scale-like, almost foliaceous, or obsolete, without rhizoids; alga *Pleurococcus* or *Protococcus*. Apothecia enclosed in thalline warts, from apparently pyrenocarpous globose, and innate, to circular, sessile, or elevated sessile, solitary or grouped, with proper or thalline margin; disk often very small or irregular; asci multisporous, the spores very small, colorless, simple in our species.

KEY TO GENERA.

- A. Thallus obsolete or but little evident.....XXVI. *Biatorella*
- AA. Thallus of small or medium-sized scales or warts in which the apothecia are innate.....XXVII. *Acarospora*

XXVI. Biatorella (DeN.) Th. Fr.

Biatorella De Notaris, Giorn. Bot. It. an. 2, t. 1: 192. 1846.

Biatorella Th. Fr., Gen. Heterol. Lich. 86. 1861.

Thallus crustaceous, uniform or marginally lobed, or, in our species, obsolete or very poorly developed. Apothecia circular or nearly so, sessile or elevated, lecideine in our species, hypothecium clear to dark; spores ellipsoid or globose, very small and thin-walled.

KEY TO SPECIES.

- A. Spores few, often only 8.....1. *revertens*
- AA. Spores very numerous.
- B. Hypothecium clear.....2. *simplex*
- BB. Hypothecium brown to brownish black.....3. *clavus*

1. BIATORELLA REVERTENS (Tuck.) Herre.

Sarcogyne Tuck. Genera Lichenum, 122. 1872.

Lecanora privigna d. *revertens* Tuck. Syn. N. Am. Lich. 1: 204. 1882.

Thallus wanting. Apothecia lecideine, medium to large, from

circular with plane disk, soon wavy, lobate, or difform, sometimes slightly convex; sessile, usually scattered, rarely closely grouped; color a dull black. Proper margin erect, persistent, finally very much flexed or wrinkled; paraphyses rather slender, free, simple, very pale brownish to clear, their tips very dark blackish brown; hypothecium brown or brownish; hymenium dark blue with I; spores few, usually 8 in my specimens, ellipsoid, $\frac{2.4 - 4}{9 - 12} \mu$.

Abundant on sandstone in the mountains, at an altitude of 2300 feet and above.

Recorded by Tuckerman from Yosemite Valley and from Ukiah, California, and from Colorado; also reported from Kadiak, Alaska, by Professor Cummings, in Lichens of Alaska.

2. BIATORELLA SIMPLEX (Dav.) Br. et Rostr.

Lichen simplex, Dav. Trans. Linn. Soc. 2: 283, *pl.* 28, *f.* 2. 1794.

Biatorella simplex Br. et Rostr. Lichenes Daniae, 115. 1870.

Lecanora privigna Tuck. Syn. N. Am. Lich. I: 204. 1882.

Thallus practically obsolete, or present only as a few scattered crumb-like particles.

Apothecia lecideine, minute to small, rarely of medium size, circular, corrugated, folded, or variously shaped; sessile, appressed, scattered or becoming crowded and heaped; disk concave, plane, irregular, dull black or sometimes reddish black; margin rather thick, persistent, elevated, finally flexuose; epithecium dark brownish; hypothecium clear; paraphyses very slender, free, simple; hymenium blue, then red with I; spores very numerous, $\frac{1.5 - 2.5}{2.5 - 6} \mu$.

On sandstone in the foothills and mountains. This seems to be quite a variable plant, some of our forms being with difficulty placed here. One, occurring with *Biatorella revertens*, is strongly marked by its medium sized to large apothecia of a rich red-brown color, with convex and sometimes wavy disk, and small, thin, black margin much crenate or lobate, never entirely disappearing; hymenium blue to dark blue with I; spores $\frac{1}{3 - 4} \mu$.

Another form is characterized by the medium sized, more or less clustered and angulose apothecia, with coal-black, often glistening disk; margin thin, not elevated, entire.

Generally distributed over Europe and North America.

3. BIATORELLA CLAVUS (DC.) Th. Fr.

Patellaria clavus DC. Fl. Fr. 2: 348. 1805.

Biatorella clavus Th. Fr. Lich. Scand. 2: 409. 1874.

Thallus wanting or represented by a few minute black specks
 Apothecia of medium to large size, at first concave, soon plane, circular, becoming irregular; disk black, hardly reddish black, not pruinose; margin thickish, erect, entire, becoming wrinkled; epithecium brown to black; hypothecium brown to brownish black; paraphyses thread-like, thecium deep blue with I; spores $\frac{2 - 2.5}{4.5 - 7.3} \mu$.

Rare; on sandstone in the mountains. Widely distributed over Europe and North America.

XXVII. *Acarospora* Mass.

Acarospora Massalongo, Ric. Sul. Aut. Lich. Crost. 27. 1852.

Acarospora A. Zahlbr., Ascolichenes, 152. 1907.

Thallus crustaceous, of scales or warts, these scattered or crowded, uniform or marginally lobed; apothecia innate or rarely sessile, solitary or several in one scale, with a thalline margin, the disk often narrow, circular or irregular; hypothecium clear or now and then dusky, upon a layer of gonidia; spores minute, simple, broadly ellipsoid to elongate.

Rock and earth lichens distributed over the whole earth but richest in species in arid or semi-arid regions; a considerable number endemic to California.

KEY TO SPECIES.

- A. Thallus yellow.
 - B. Thallus clear bright lemon-yellow with radiately lobate margin; disk of apothecia yellow. 1. *chlorophana*
 - BB. Thallus duller yellow, not radiate-lobate at margin; apothecia not concolorous.
 - C. Greenish yellow; disk reddish to dark red. 2. *bella*
 - CC. Sulfur-yellow; disk red-brown to red-black. 3. *schleicheri*
- Proc. Wash. Acad. Sci., May, 1910.

AA. Thallus not yellow.

D. Thallus brown to chestnut.

E. Thallus pale brown to chestnut; reddish with KOH + CaCl₂O₂

4. *fuscata*

EE. Thallus very dark brown; not affected by reagents... 5. *rufescens*

DD. Thallus not brown, or else suffused with white, and the true color not apparent.

F. Squamules very small, more or less white pruinose... 6. *obpallens*

FF. Squamules not white pruinose.

G. Thallus pale green-clay color to pale yellowish or dirty

brown, of large thick scales... 7. *hassei*

GG. Thallus thin, dirty grayish or sand-colored, of small, closely appressed scales... 8. *arenosa*

1. ACAROSPORA CHLOROPHANA (Wahlb.) Mass.

Parmelia chlorophana Wahlenberg, in Ach. Supplementum, Meth. Lich. 44. 1803.

Acarospora chlorophana Mass. Ric. Auton. Lich. Crost. 27, f. 44. 1852.

Lecanora chlorophana Ach. Lich. Univ. 436, 1810.

Lecanora chlorophana Tuck. Syn. N. Am. Lich. I: 201. 1882.

Thallus of small, closely compacted, irregular, flattish or wart-like areoles, closely appressed, their surface smooth; more or less radiately lobed at the circumference; clear, very bright lemon-color. KOH - ; CaCl₂O₂ - .

Apothecia small, from innate and plane soon emergent and sessile, finally of medium size; the concolorous disk eventually pale brownish or dusky yellow; the thin entire margin becoming very flexuous; I do not find it excluded as stated by Tuckerman; epithecium granular, lemon-yellow; paraphyses free, their tips enlarged; thecium deep blue with I; spores oblong or ovoid, $\frac{1-1.8}{2.4-3}$ μ .

One of the handsomest of crustaceous lichens. Abundant and very noticeable on igneous rocks in the dry Inner Coast Range at elevations of but a few hundred feet, but probably not occurring at all in the moister Santa Cruz Peninsula. Common in alpine and northern Europe and throughout western North America.

2. ACAROSPORA BELLA (Nyl.) Herre.

Lecanora bella Nylander, Ann. Sci. Natur. 4: 3, 156. . (1858 ?).

Lecanora chrysope Tuck. Amer. Journ. Arts. & Sci. 2: 425.

Lecanora xanthophana Nyl. Ann. Sci. Natur. 4: 15, 379, —

Lecanora xanthophana Tuck. Syn. N. Am. Lich. I: 201. 1882.

Thallus of small or medium sized flat or turgid scales, more or less crenate-lobate, either imbricate and crowded into a thickish crust, or more or less scattered, discrete and rimose-areolate, the outer squamules lobulate; color a clear lemon-yellow or greenish yellow, rarely dusky yellow; KOH —; CaCl₂O₂ —.

Apothecia usually but one in an areole, small, or more rarely medium to large, concave, becoming plane, the disk then often uneven from ridges and lumps made by processes coming from the margin and meeting at the centre; seldom convex; reddish and brown to very dark red in color; margin entire, finally wavy and irregular; epitecium pale yellow; paraphyses distinct, free; thecium pale greenish-bluish with I; spores $\frac{1.5 - 2.5}{4 - 6} \mu$.

Abundant and somewhat variable; on rocks in the foothills and along the seashore; sometimes forming very extensive and conspicuous patches on dry, perpendicular rocks, usually in such cases associated with the equally conspicuous and brilliantly contrasting *Caloplaca murorum*.

Originally described from Chili and occurring throughout the Andes and over the greater part of the United States.

3. ACAROSPORA SCHLEICHERI (Ach.) Mass.

Urceolaria schleicheri Ach. Lich. Univ. 332. 1810.

Acarospora schleicheri Mass. Ric. sul. Auton. dei Lich. Crost. 27. 1852.

Lecanora schleicheri Tuck. Syn. N. Am. Lich. I: 202. 1882.

Lecanora schleicheri Farlow, Journey to California, Point Loma. 1885.

Thallus tartareous, of difform, thickish areoles, from flat soon convex, sometimes somewhat crenate or lobate; more or less thinly scattered or crowded into an irregular crust; color pale sulfur-yellow or yellowish-whitish, changing to bright or lemon-yellow when moistened.

Apothecia small or medium size, innate, urceolate, concave, soon plane, finally emergent and sessile, the thin margin usually entire, becoming minutely denticulate and wavy or lobulate; disk dark red-brown to red-black, smooth or becoming roughened; epithecium lemon-yellow; paraphyses sub-conglutinate; hymenium pale bluish with I, the asci not tinged; spores broad, short-ellipsoid, $\frac{1.5-2.5}{3-3.5} \mu$.

Rare; on a rocky clay bank in the foothills near Stanford University, with *Acarospora bella*. Collected on earth at Mission Dolores by Bolander, but not occurring there now, as the locality has become a thickly settled part of San Francisco.

An earth and rock lichen of Europe and Western North America.

4. ACAROSPORA FUSCATA (Schrad.) Arn.

Lichen fuscatus Schrader, Spicil. Fl. Germ. 83. 1794.

Acarospora fuscata Arnold,

Lecanora fuscata Tuck. Syn. N. Am. Lich. I: 203. 1882.

Thallus indeterminate, of small to medium sized, appressed squamules, angular, or when scattered or marginal more or less crenate-lobate; blackish beneath; color varying from pale brown to very dark chestnut; KOH + CaCl₂O₂ reddish.

Apothecia at first dot-like and depressed, then from concave becoming plane, variously shaped, finally superficial with a more or less evident margin; from one to several in an areole; paraphyses agglutinate at their dark brown tips; hymenium pale bluish or yellowish blue with I, the asci pale yellowish; spores $\frac{1-1.5}{3-5} \mu$.

Common on sandstone in the mountains. Found in the temperate and arctic realms of Europe and America.

5. ACAROSPORA RUFESCENS (Sm.) Th. Fr.

Urceolaria rufescens Sm. Eng. Fl. 5: 173. 1795.

Acarospora rufescens Th. Fries, Lich. Scand. 215. 1871.

Lecanora fuscata b. *rufescens* Tuck. Syn. N. Am. Lich. I: 203. 1882.

Thallus of small, angular, flattened squamules, separated more or less by fissures, not confluent; more rarely more or less contiguous, larger, and somewhat lobate incised; color a very dark brown; KOH-; CaCl₂O₂ -.

Apothecia small or very small, one in each scale; irregular in form, concave or plane, concolorous or darker than the thallus; becoming blackish brown; thecium blue with I; spores $\frac{1 - 1.5}{3 - 5} \mu$.

Abundant on rocks in the foothills, forming inconspicuous indeterminate dark blotches on them. Common in Europe and North America.

6. ACAROSPORA OBPALLENS (Nyl.) A. Zahlbr.

Lecanora obpallens Nyl. with Hasse in Bull. Torrey Botan. Club. **24**: 446. 1897.

Lecanora obpallens Nyl. Act. Soc. Sci. Fennic. **26**: 31. 1900 (note).

Lecanora obpallens Hasse, Lichens So. Calif. ed **2**: 13. 1898.

Acarospora obpallens A. Zahlbruckner, Beihefte zum Botan. Centralbl. **13**: 161. 1902.

Thallus of very small to small squamules, reaching a breadth of 1 to 1.5 mm., often forming only a narrow margin to the apothecia, thin, scattered and round or sometimes approximate and angulose, convex, the surface more or less rugose; color typically pale to dark reddish brown, but in our specimens mostly densely white pruinose, often with a more or less roseate cast.

Apothecia but one in an areole, immersed; disk concave to plane, not more than 1 mm. broad, black or reddish, but usually densely white pruinose; thalline margin prominent, thick, often wavy or denticulate; epithecium thin, more or less granulose, pale yellowish; hypothecium pale, thick; paraphyses hair-like and densely conglomerate, dusky, paling with KOH, simple; their tips slightly thickened; thecium pale, very broad, first bluish then soon reddish with I; asci large, clavate or inflated clavate; spores oval or oblong, very numerous, $\frac{1.4 - 2}{3 - 6} \mu$.

On soft crumbly sandstone at Laguna Creek, on the coast 9 miles north of Santa Cruz.

Previously collected only by Dr. Hasse in the Santa Monica range, where it occurs on both rocks and earth. "The type occurs on earth and the squamules are cervine brown; on sandstone the squamules are suffused with white, interspersed with brown ones like the earth form, or partially white suffused;" Hasse, *in litt.*

7. ACAROSPORA HASSEI Herre, new species.

Thallus effuse, of irregular, thick, sometimes lobate scales, thinly scattered to contiguous and fissured-crustaceous; color a pale green-clay to dusky yellowish and dirty brown; beneath pale yellowish to brown; KOH —; CaCl_2O_2 —.

Apothecia numerous, one to several in a scale, small, impressed and slightly concave, soon plane, without evident margin; disk reddish to very dark red-brown; epithecium dark brown, granulose; paraphyses rather broad, straight or curved, their tips pale yellowish brown; thecium blue with I; hypothecium pale yellowish, nearly clear; spores $\frac{1 - 1.25}{3 - 4.9} \mu$.

On sandstone at Castle Rock, altitude 3000 feet. Reminding one of *Acarospora glaucocarpa*, but quite different in appearance from any *Acarospora* I have been able to examine.

I take pleasure in naming this species for the veteran Californian lichenologist, Dr. H. E. Hasse.

8. ACAROSPORA ARENOSA Herre, new species.

Thallus thin, often scanty, of small, closely appressed, flat or very slightly roughened scales; contiguous or marked by slight fissures; dirty grayish or sand-colored; beneath sand-color or pale; KOH —; CaCl_2O_2 —.

Apothecia numerous, small to very small, finally of medium size, rarely more than one in an areole; at first flat, with a thin, erect, entire, proper margin; soon slightly convex, the margin almost disappearing and barely visible; color black or very dark reddish; paraphyses very pale brownish, becoming clear with KOH, agglutinate, their tips brown; hypothecium more or less dusky; hymenium deep blue with I; spores $\frac{1 - 1.25}{2.5 - 3\frac{2}{3}} \mu$.

On sandstone in the foothills a few miles from Stanford University, at an altitude of 400 feet.

EPHEBACEÆ.

Thallus small but fruticose, branched, more or less filiform or foliaceous, with *Scytonema* or *Stigonema* algæ; cortex present or absent.

Apothecia small or minute, sessile and biatorine, or enclosed in the thallus and apparently pyrenocarpous; paraphyses well developed or absent; spores colorless or brown, simple or bilocular.

KEY TO GENERA.

- A. Thallus fruticose, without cortex.
 - B. Thallus filiform fruticose, decumbent, the apothecia lateral, sessile.
 - XXVIII. *Zahlbrucknera*
 - BB. Thallus erect, like a minute shrub, always sterile with us.
 - XXIX. *Ephebe*
 - AA. Thallus foliaceous or fruticose with well developed cortex.
 - XXX. *Polychidium*

XXVIII. *Zahlbrucknera* Herre, new genus.

Thallus minutely fruticulose, decumbent, mat-like, the branches thread-like, of *Stigonema* algæ, the hyphæ running parallel lengthwise in the gelatinous sheath.

Apothecia small, lecideine, lateral, appressed, sub-globose; hypothecium clear; paraphyses slender, sparingly branched or simple, septate, their tips not enlarged; asci cylindrical to subclavate, elongate, their tips often pointed, thin-walled, with from 8 to 24 spores; these simple, globose to ellipsoid, thin walled, without a halo, at last dusky or blackish. Spermatia not observed.

Differs from *Thermutis*, to which it is nearest, in the paraphyses, the multisporeous asci, and the darkening spores.

Named for Dr. Alexander Zahlbruckner, the eminent lichenologist, curator of the botanical section of the Imperial Natural History Museum, at Vienna, Austria.

1. ZAHLBRUCKNERA CALCAREA Herre, new species.

Thallus minute, almost microscopic, of thread-like, entangled, branching, decumbent filaments, forming dense clumps or mats; color black or blackish brown; becoming brown when moistened; KOH —; CaCl₂O₂ —.

Apothecia rare, minute, sub-globose, concolorous, the disk depressed, very narrow, or with entire margin; paraphyses not numerous, 1.5 — 2 μ broad; asci $\frac{9.75 - 17}{80 - 108} \mu$; no reaction with I; spores 8 to 24, usually 18, globose, ovoid, and ellipsoid, mostly colorless but

finally dusky or blackish, $\frac{4.9 - 8.5}{7.3 - 12.25} \mu$.

Rare; forming black stains on limestone at the summit of Black Mountain, altitude 2787 feet.

XXIX. *Ephebe* Fries.

Ephebe E. Fries. Syst. Orb. Veg. 256. 1825.

Thallus fruticulose, branched, composed mainly of the alga *Sirosi-phon pulvinatus* associated with a fungus, the form and habit of the plant being due mainly to the alga; color black; apothecia immersed or superficial and globose; spores ellipsoid and colorless. On rocks. Species few and doubtful.

1. *EPHEBE SOLIDA* Born.

Ephebe solida Bornet, Ann. Sci. 3: 171. 1852.

Ephebe solida Tuck. Syn. N. Am. Lich. I: 132. 1882.

Ephebe pubescens Herre, Proc. Wash. Acad. Sci. 7: 375. 1906.

Thallus small, erect, tufted, stout, minutely shrub-like, compact, much branched; sooty black; always sterile with us.

Abundant on perpendicular sandstone rocks at several different places in the ridge between Searsville and Stanford University, at an altitude of about 400 feet. Apparently not occurring elsewhere in the peninsula.

A very remarkable form unlike any other lichen of our flora. Formerly described by me as *Ephebe pubescens*, but differing from that plant in its much shorter, stouter, and more shrub-like filaments and habit.

A North American lichen, recorded from Georgia, Alabama, Vermont, and Massachusetts.

XXX. *Polychidium* (Ach.) A. Zahlbr.

Collema, section *Polychidium* Ach. Lich. Univ. 658. 1810.

Polychidium A. Zahlbr. Ascolichenes, 156. 1907.

Thallus foliaceous, or more or less fruticose but decumbent, with terete branches, with a well developed pseudoparenchymatous cortex on both sides, or of pseudoparenchyma throughout; alga *Scytonema*.

Apothecia sessile, scattered or terminal, biatorine, the disk flat or slightly convex; paraphyses simple, with the tips septate and somewhat enlarged; spores colorless, boat or spindle-shaped, bilocular.

We have two of the 3 or 4 species.

KEY TO SPECIES.

- A. Thallus foliaceous, under margin with conspicuous, white, fleecy cilia.
 1. *albociliatum*
 AA. Thallus minutely fruticulose, irregularly and intricately branched.
 2. *musciicola*

1. POLYCHIDIUM ALBOCILIATUM (Desmaz.) A. Zahlbr.

Leptogium albociliatum Desmazieres, Ann. Sci. Nat. 4: 4. 132. 1855.

Leptogium albociliatum Tuck. Syn. N. Am. Lich. I: 156. 1882.

Leptogium albociliatum Herre, Proc. Wash. Acad. Sci. 7: 380. 1906.

Polychidium albociliatum A. Zahlbruckner, Ascolichenes, 157. 1907.

Thallus small to medium size, rounded, by coalescence forming extensive, indeterminate mats; lobes imbricate, deeply and sinuately lacinate, their tips rounded or pointed; margin in folds or crisped, up-turned, crenate, lacerate, or denticulate; surface smooth centrally, often granulate or with small erect lobules; color greenish black; the margin ciliate with minute white bristles; under surface paler; marginally with a conspicuous white fleece; this longer, shaggy, and brown within; rarely disappearing.

Apothecia numerous and becoming crowded when present; small to medium size, sessile; disk reddish, plane or convex; margin pale, entire, finally disappearing; often bristly with minute white cilia similar to those on margin of thallus. Spores bilocular, pointed,

slightly constricted in the middle, $\frac{8.5 - 9.75}{19.5 - 28} \mu$.

Found throughout on rocks and on earth, among mosses.

Fruiting abundantly at 3000 feet altitude on Castle Rock ridge and in Devils Cañon, at 2300 feet; still luxuriant in growth as low as 2000 feet. Extending downward to 150 feet in the foothills, but there reduced and sterile.

A European lichen, recorded in this country only from the Pacific slope.

2. POLYCHIDIUM MUSCICOLA (Swartz) S. Gray.

Lichen muscicola Swartz, N. Act. Ups. 4: 248. 1784.

Polychidium muscicola S. Gray, Nat. Arr. 1: 402. 1821.

Leptogium muscicola Fries, Sum. Veg. 122. 1846.

Leptogium muscicola Tuck. Syn. N. Am. Lich. I: 154. 1882.

Leptogium muscicola Cummings and Seymour, Decades N. Am. Lich. no. 65, Franconia Mountains, N. H.

Thallus minute, pulvinate, fruticulose, irregularly and intricately branched and interwoven; branches more or less cylindrical, decumbent; apothecia medium, subterminal, appressed, brownish red; disk flattish, becoming convex when the thin, entire, paler margin is finally excluded; spores bilocular, colorless, cymbiform and fusiform,

$\frac{6-7}{17-25} \mu$; according to Tuck., $\frac{4-7}{18-30} \mu$.

Growing over mosses on rocks in mountains. Not found by me but in the Tuck. Herb. there are specimens collected by Bolander in the mountains back of Redwood City, on the road to Pescadero, and also from Bear Valley, the last locality in Mariposa County.

Probably generally distributed on the Pacific Coast from Central California to Bering Sea. A lichen of Europe and Northern Africa, and in America recorded from New England, California, and the islands of Bering's Straits.

PYRENOPSISIDACEÆ.

Thallus crustaceous, foliaceous, or fruticose, in our species adnate or fastened by rhizoids; alga *Glæocapsa*. Apothecia closed or open, or apparently between the two types; proper margin present or lacking; those with dish-like apothecia have a thalline margin; paraphyses gelatinizing or distinct, unbranched or septate; asci 8 or many spored; spores colorless, simple or bilocular, ellipsoid or globose.

Of the 16 genera recognized by Zahlbruckner, but one has as yet been collected within our limits.

XXXI. *Pyrenopsis* (Nyl.) Forss.

Pyrenopsis Nyl. Mem. Soc. Cherb. 3: 164. 1855.

Pyrenopsis Forssell, Beiträge der Glæolichenen. 1885.

Thallus uniform crustaceous to coralloid or fruticose, attached by the hyphæ of the medulla. Apothecia innate or sessile, lecanorine, the proper margin distinct or obsolete; spores simple.

About 40 species, living on rocks, but one found with us.

1. PYRENOPSIS PHÆOCOCCA Tuck.

Synalissa phæococca Tuck. Gen. Lich. 80. 1872.

Pyrenopsis phæococca Tuck. Syn. N. Am. Lich. I: 136. 1882.

Thallus effuse, thin, of minute coralloid-granulose, distinct or areolate crumbs, which may pass into a thicker, broken crust; color a dark reddish brown.

Apothecia scattered, rather numerous, from very small becoming moderate in size, the disk concolorous or more reddish; disk at first dot-like, finally dilated and lecanorine; margin thickish, entire, concolorous; hypothecium colorless, upon an algal layer; paraphyses simple, long and hair-like, conglutinate but finally distinct; asci mostly cylindrical and the contents usually not well differentiated, or ventricose, rarely clavate; thecium blue with I, the spores uncolored or yellowish; spores ovoid to elongate-ellipsoid, simple, colorless, usually containing a very large oil drop and the protoplasmic contents irregular, $\frac{8.5 - 11}{16 - 22} \mu$; Tuckerman says " $\frac{14 - 25}{8 - 12} \mu$, simple and bilocular." The latter statement is probably an error, the spores often appearing bilocular when within the asci but shown to be simple when extruded. Further material is necessary to clear this point.

A rare plant; found but once on sandstone, in the vicinity of Stanford University. Collected by Dr. Hasse on the same substratum in the Santa Monica Range. Recorded by Tuckerman on granitic rocks from North Carolina, Massachusetts, and New Hampshire.

COLLEMACEÆ.

Thallus gelatinous when wet, usually foliaceous, but varying from sub-crustaceous to fruticose, with *Nostoc* algæ. Apothecia disk-like or globose, sessile or innate, usually lecanorine, or sometimes biatorine, a proper margin present or lacking; the disk broad to dot-like; paraphyses simple; spores 8, colorless, needle-shaped to globose, straight or curved, simple to multilocular and muriform.

Of the eleven genera recognized by Zahlbruckner, we have two, which are by far the most important members of the family.

KEY TO GENERA.

Thallus without distinct cortical layer, beneath naked. XXXII. *Collema*
Thallus with distinct cortex on upper side or both sides; under surface
naked or more or less covered with fleecy rhizoids.

XXXIII. *Leptogium*

XXXII. *Collema* (Hill.) A. Zahlbr.

Collema Hiller, Hist. Pl. 1751.

Collema A. Zahlbr. Ascolichenes, 171. 1907.

Thallus foliaceous or sometimes sub-crustose, very small to medium size, very dark green or blackening; the under surface naked, usually wrinkled or fenestrate; cortical layer not present or very indistinct. Apothecia scattered or crowded, usually numerous, circular, usually dish- or shield-shaped, very small to medium size, lecanorine, a proper margin lacking or present; spores ellipsoid or needle or spindle-shaped, bilocular, plurilocular, or muriform.

A large genus, of wide distribution, the species growing upon bark, mosses, earth, and rocks.

KEY TO THE SPECIES.

A. Confined to trees.

B. Surface with anastomosing edges covered with black granules.

1. *aggregatum*

BB. Surface radiately wrinkled and pustulate.

C. Surface smooth, naked. 2. *vespertilio*

CC. Surface isidiose-pulverulent 3. *nigrescens*

AA. Confined to earth and rocks.

D. Thallus minute squamulose or crustose. 4. *crystalinum*

DD. Thallus not squamulose or crustaceous.

E. Spores bilocular. 5. *coccophorum*

EE. Spores 4-locular to muriform.

F. Thallus rather large, smooth, pustulate and wrinkled; apothecia small. 6. *pulposum*

FF. Thallus usually only a border to the large, crowded, imbedded apothecia. 7. *glaucescens*

1. COLLEMA AGGREGATUM Nyl.

Collema aggregatum Nyl. Mem. Soc. Sci. Nat. Cherb. 2: 318. 1854.

Collema aggregatum Tuck. Syn. N. Am. Lich. I: 146. 1882.

Collema aggregatum Herre, Proc. Wash. Acad. Sci. 7: 376. 1906.

Thallus small or medium size, circular, irregularly lobed, with crenate margin; marked by thick, rough, anastomosing ridges densely covered by black granules; more or less fenestrate; color dark green or black; beneath pale, smooth, much wrinkled and pitted.

Apothecia numerous, mostly on the ridges; disk from concave becoming flat or even convex; reddish or darkening; margin entire;

spores spindle-shaped, long, plurilocular, $\frac{4-5}{45-75}$ μ .

On trees and not rare in the foothills. Found all over the north temperate zone.

2. COLLEMA VESPERTILIO (Lightf.) Wainio.

Lichen vespertilio Lightfoot, Flora Scotica, 2: 840. 1777.

Collema vespertilio Wainio, Act. Soc. Faun. Fl. Fennic. 7: 235. 1890.

Collema vespertilio Herre, Proc. Wash. Acad. Sci. 7: 376. 1906.

Thallus of medium size, orbicular, thin, closely appressed; lobe, rounded, with entire or crenate margin; surface naked, smooths radiately wrinkled and thickly pustulate; color yellow-green, very dark green, and black; beneath paler or concolorous, lacunose or pitted.

Apothecia small, usually very numerous and crowded; disk reddish or blackening; plane, becoming convex; spores needle-shaped or

spindle-like, long, plurilocular, $\frac{5}{47.5-55}$ μ .

On trees and perhaps occasionally on rocks. Common in the foothills at moderate elevations. Our most abundant *Collema*.

Confused by most writers with *nigrescens*, its distribution therefore uncertain, but probably general in all temperate regions.

3. COLLEMA NIGRESCENS (Leers.) Wainio.

Lichen nigrescens Hudson, Flora Anglica, 450. 1762 (?).

Lichen nigrescens Leers. Fl. Herborn. 945. 1775.

Collema nigrescens Wainio, Act. Soc. Faun. Fl. Fenn. 7: 235. 1890.

Collema nigrescens Tuck. Syn. N. Am. Lich. I: 147. 1882. in part.

Collema nigrescens Herre, Proc. Wash. Acad. Sci. 7: 376. 1906.

Thallus of medium size, more or less orbiculate, thin, marginally closely appressed, the rounded lobes with margins more or less undu-

late or crenate; surface radiately ridged and pustulate, finally densely isidiose pulverulent; color very dark green or blackish green; beneath concolorous or paler, lacunose, pitted, or fenestrate.

Apothecia usually infrequent and scattered, rarely numerous, small to medium; the disk dark red-brown; the entire margin rather thick, finally excluded; often isidiose, when it is tuberculate-radiate or toothed. Spores acicular or long-fusiform, more or less curved,

5 - 6 locular, $\frac{4 - 5}{39 - 49} \mu$.

Fairly common on trees in the foothills. A wide spread, probably cosmopolitan lichen.

4. COLLEMA CRISTATELLUM Tuck.

Collema cristatellum Tuckerman, Lich. Calif. 29. 1866.

Collema cristatellum Tuck. Syn. N. Am. Lich. I: 152. 1882.

Collema cristatellum Herre, Proc. Wash. Acad. Sci. 7: 378. 1906.

Thallus scattered, microscopic, forming an indeterminate crustaceous or squamulose crust; lobes minute, ascendant, with more or less dissected and crenate or dentate edges, or reduced to tiny erect lobules; color greenish or brownish black.

Apothecia of medium size, concave; disk concolorous or reddish; margin entire; spores from bilocular and spindle-shaped becoming

muriform and oblong or ellipsoid, $\frac{9 - 12.5}{22 - 31} \mu$; according to Tuck., $\frac{7 - 9}{16 - 30} \mu$.

On clay and crumbling rock on a steep slope in Hidden Villa Cañon, elevation 800 feet. Probably occurring throughout in similar situations but too readily overlooked.

Only recorded so far from New Mexico and California.

5. COLLEMA COCCOPHORUM Tuck.

Collema coccophorum Tuck. Proc. Am. Acad. Arts and Sci. Vol.

Collema coccophorum Tuck. Syn. N. Am. Lich. I: 150. 1882.

Collema coccophorum Hasse, Bull. So. Calif. Acad. Sci. 5: 38. 1906.

Thallus small, effuse to orbicular, black or very dark; the tiny lobules more or less erect, imbricate or complicate, the free end enlarged, crenate or densely tuberculate.

Apothecia very rare, small to medium size, the disk flat, reddish brown; the entire margin upturned and prominent, thin, and becoming minutely denticulate; spores ovoid, bilocular, $\frac{7 - 8.5}{12 - 14.5} \mu$; Tuckerman says "spores ovoid-ellipsoid, bilocular, mostly decolorate, $\frac{11 - 21}{7 - 9} \mu$."

On earth on dry hillsides or in rock crevices, usually growing with *Nostoc commune* and *Dermatocarpon hepaticum*. Not abundant anywhere, but generally distributed in the foothills.

Recorded by Tuckerman from the valley of the Rio Grande, Texas, and from Oakland, California. Dr. Hasse has also found it in Riverside and Los Angeles counties, California, and it probably occurs generally throughout the southwestern states.

6. COLLEMA PULPOSUM (Bernh.) Ach.

Lichen pulposus Bernhardi, in Schrader's Journ. Bot. 1: 7, pl. 1, f. 1. 1799.

Collema pulposum Ach. Lich. Univ. 632. 1810.

Collema pulposum Tuck. Syn. N. Am. Lich. I: 148. 1882.

Collema pulposum Herre, Proc. Wash. Acad. Sci. 7: 377. 1906.

Thallus thin, small to medium size, orbicular or irregular, closely appressed, usually depressed or concave centrally; very soft and gelatinous when moist; lobes rounded, sometimes imbricate, margin varying from entire and sinuous to crenate and slightly lacinate and even denticulate; surface smooth, more or less pustulate and wrinkled; sometimes beset with tiny erect lobules; color dark green or black, sometimes brownish; beneath paler, smooth, wrinkled.

Apothecia small, numerous; disk flat or concave, reddish, with paler, entire margin; spores more or less pointed, ellipsoid or ovoid, often slightly curved, from 4 - locular becoming muriform,

$\frac{7 - 14.5}{20 - 36} \mu$; according to Nylander, whose measurements are copied

by all later writers, they are $\frac{7 - 10}{16 - 24} \mu$.

On earth on damp hillsides, forming rather extensive patches among mosses. Not rare in the foothills and lower slopes of the mountains. Found throughout the northern hemisphere.

7. COLLEMA GLAUDESCENS Hoffm.

Collema glaucescens Hoffmann, Deutsch. Fl. 2: 100. 1795.

Lichen limosus Ach. Lich. Suec. Prodr. 126. 1798, (excl. syn. *Collema graniformis* Hoffm.)

Collema limosum Ach. Lich. Univ. 629. 1810.

Collema limosum Tuck. Syn. N. Am. Lich. I: 150. 1882.

Collema limosum Herre, Proc. Wash. Acad. Sci. 7: 377. 1906

Thallus thin, small to medium, irregular or scattered, very closely appressed; margin irregularly crenate or dentate-lobulate; surface smooth, or here and there beset with small ascendant lobules; color black or dark green.

Thallus mostly disappearing and becoming merely a network or margin about the numerous large, imbedded apothecia; disk mostly flat, reddish or blackening; spores usually in fours in the asci, ellipsoid, muriform, $\frac{11 - 17}{22 - 35} \mu$.

On a wet clay bank beside a spring a mile above Wright's Station; altitude about 1200 feet. Probably occurring in similar situations throughout the mountains.

A lichen of Europe and North America.

XXXIII. *Leptogium* (Ach.) S. Gray.

Collema sect. *Leptogium* Ach. Lich. Univ. 654. 1810.

Leptogium S. Gray, Nat. Arr. 1: 395. 1821.

Thallus mostly foliaceous, but ranging from crustose to fruticulose, with a distinct cortex present on the upper side or on both sides; under surface naked or covered with rhizoids which may become a dense close nap or fleece; color varying from plumbeous, brown, dark green, to black.

Apothecia scattered over the surface, often crowded, and usually numerous; small, at first innate, then sessile, lecanorine, the disk broad, circular; spores colorless, ovoid, ellipsoid, spindle-shaped or needle-like, straight or curved, often with attenuate tips, 4-locular to plurilocular and muriform.

Comprising more than a hundred species distributed all over the world, especially in tropical regions, on bark, mosses, earth, and

rocks. Some species always sterile in temperate regions and often difficult to determine.

KEY TO SPECIES.

- A. On trees.
 B. Dark green to black; smooth beneath; thallus fenestrate, wrinkled, ridged, isidiose. 1. *chloromelum stellans*
 BB. Lead-color to blackish green.
 C. Beneath fleecy with long white or brown fibrils. 2. *hildebrandii*
 CC. Beneath covered with minute velvety pubescence. 3. *saturninum*
 AA. On earth, moss, or rocks.
 D. On limestone only; thallus thick, plicate, orbiculate. 4. *plicatile*
 DD. Not on limestone.
 E. Thallus small to minute.
 F. Thallus small, foliaceous, rather entire. 5. *scotinum*
 FF. Thallus minute or microscopically foliaceous to crustose.
 G. Thallus irregularly cut and divided. 6. *tenuissimum*
 GG. Thallus chaffy or scurvy, areolate, wine-red with I.
 7. *rhyparodes*
 EE. Thallus medium size to large.
 H. Thallus red-brown, chestnut, or lead-color; lobes narrowed with erect corniculate tips. 8. *palmatum*
 HH. Color black.
 I. Lobes erect, crenate, narrowed, complicate. 9. *californicum*
 II. Thallus flat, expanded, more or less orbicular. 10. *platynum*

1. LEPTOGIUM CHLOROMELUM STELLANS Tuck.

Lichen chloromelos Swartz, Fl. Ind. Occident. 3: 1892. 1806.

Leptogium chloromelum Nyl. Syn. Meth. Lich. 1: 128. 1860.

Leptogium chloromelum stellans Tuck. Syn. N. Am. Lich. I: 163. 1882.

Leptogium chloromelum stellans Herre, Proc. Wash. Acad. Sci. 7: 382. 1906.

Thallus orbicular, becoming indeterminate, medium to very large, more or less fenestrate, laciniate; lobes usually narrow, irregular, more or less imbricate or coalescing; surface striate, wrinkled and ridged, the ridges densely covered with black isidiose granules, or by cristate-lacerate isidiose lobules; color dark green, plumbeous, or black; beneath paler, wrinkled; rarely a very minute down sparingly present.

Sterile.

Common on trees; reaching its maximum development at an altitude of from 500 to 800 feet, the loosely connected thallus often 4 or 5 inches in diameter.

Proc. Wash. Acad. Sci., May, 1910.

A plant of very wide distribution, found throughout North America, a large part of South America, Western Europe, the Canary Islands, the East Indies, and New Zealand.

2. LEPTOGIUM HILDEBRANDII (Garovagl.) Nyl.

Lichen saturninus Smith, Trans. Linn. Soc. 1: 84. 1791 (non Dicks. 1790).

Collema hildebrandii Garovaglia, Lich. Ital. ed. I, Dec. 1. no. 1. 1837.

Leptogium hildebrandii Nyl. Act. Soc. Linn. Bordeaux, 21: 272. 1856.

Leptogium saturninus Schaerer, Lich. Helvet. Spicil. 534. 1840.

Leptogium saturninus Herre, Proc. Wash. Acad. Sci. 7: 382. 1906.

Leptogium myochroum a. *saturninum* Tuck. Syn. N. Am. Lich. I: 166. 1882.

Thallus large, orbicular, one-leaved or polyphyllous and imbricate; the long irregular sinuate lobes rounded at the tips; their margins upturned, more or less convolute and elevated; sometimes with finely lacinate edges, margined with isidiose granules; upper surface varying from smooth to granular or finely densely isidiose granulate; lead color to greenish black, with usually a more or less evident metallic rufous or bronze lustre; granules, when present, brownish black; beneath paler, finely wrinkled; covered with a white or brown fleece, this becoming interruptedly long and shaggy.

Sterile.

On trunks of trees; abundant throughout. Generally distributed over the temperate regions.

3. LEPTOGIUM SATURNINUM (Dicks.) Nyl.

Lichen saturninus Dicks. Plant. Crypt. Brit. Fasc. II: 21, pl. 6, f. 8. 1790.

Leptogium saturninum Nyl. Prod. Lich. Gall. in Act. Soc. Linn. de Bordeaux, 21: 272. 1856.

Leptogium myochroum b. *tomentosum* Tuck. Syn. N. Am. Lich. I: 166. 1882.

Leptogium myochroum b. *tomentosum* Herre, Proc. Wash. Acad. Sci. 7: 383. 1906.

Thallus orbicular, flattish, much thinner than *L. hildebrandii*, lobes large, round, somewhat plaited. Color greenish black with very small black granules more or less thickly sprinkled over the surface; beneath pale, smooth, very minutely pubescent.

Sterile.

On trunks of trees, rare. So far collected only on Black Mountain, at an elevation of 2200 feet.

A lichen of general distribution in the north temperate and sub-arctic zones, very rarely found fruiting.

4. LEPTOGIUM PLICATILE (Ach.) Nyl.

Lichen plicatilis Ach. Nov. Att. Acad. Sci. Stockh. **16**: 11. *pl.* 1. *f.* 2. 1795.

Leptogium plicatile Nylander, Cromb. Journ. Bot. 336. 1874.

Collema plicatile Ach. Lich. Univ. 635. 1810.

Collema plicatile Tuck. Syn. N. Am. Lich. **1**: 151. 1882.

Collema plicatile Herre, Proc. Wash. Acad. Sci. **7**: 378. 1906.

Thallus small, orbicular, thick, laciniate; divisions distinct, separate, or disappearing centrally, leaving only the marginal lobes; these rugose, undulate-plicate, compact, more or less ascendant; surface sometimes covered with small erect granules or lobules; color dingy brownish green or black.

Apothecia small or medium, numerous, concave or usually plane; disk reddish or more often blackening, the margin entire or flexuous;

spores ovoid, ellipsoid, quadrilocular, $\begin{matrix} 7.5 - 8 \\ 30 - 35 \end{matrix}$ μ .

On limestone rocks near the summit of Black Mountain, altitude 2700 feet, and on similar rocks at New Almaden, at about 1200 feet; rare.

Found in Europe from Sweden southward into northern Africa. In America recorded only (so far as I am aware) from Iceland and from the Santa Cruz Peninsula.

5. LEPTOGIUM SCOTINUM (Ach.) E. Fr.

Lichen scotinus Ach. Lich. Suec. Prodr. 128. 1798.

Collema scotinum Ach. Lich. Univ. 651. 1810.

Leptogium scotinum E. Fries, Sum. Veg. 122. 1846.

Leptogium scotinum Herre, Proc. Wash. Acad. Sci. **7**: 380. 1906.

Thallus small, suborbicular to effuse, appressed, with upturned edges; lobes rounded, more or less complicate; margin entire, crenate, or somewhat laciniate; greenish lead-color to brown.

Apothecia numerous and comparatively large, reddish brown; margin entire, paler; spores muriform, $\frac{10 - 16}{24 - 40} \mu$.

On earth, among mosses.

On clay banks beside roads, on Black Mountain and probably elsewhere in similar situations. From its small size too readily overlooked. Distribution general in Europe.

6. LEPTOGIUM TENUISSIMUM (Sm.) Körb.

Collema tenuissimum Sm. Eng. Fl. 5: 213. 1795.

Leptogium tenuissimum Körber, Syst. Lich. Germ. 419. 1855.

Leptogium tenuissimum Tuck. Syn. N. Am. Lich. I: 157. 1882.

Leptogium tenuissimum Cummings and Seymour, Decades of N. Am. Lich. no. 125b, Mt. Tamalpais, Marin Co., Calif.

Thallus minute, diffuse, irregularly cut and divided; foliaceous to densely crustose; the lobes unequal, dissected, or crenately incised, ascendant; color pale greenish brown to olive and dark brown or chestnut.

Apothecia numerous, appressed, comparatively large, reddish brown, urceolate, the margin thick, entire; spores muriform, ovoid to oblong, apically attenuate, $\frac{9.75 - 15}{24 - 39} \mu$.

On earth and mossy roots; in the mountains at 1500 feet elevation and above. Generally distributed over Europe and temperate America.

I also doubtfully refer here a very minute *Leptogium* occurring on sandstone in the mountains above Saratoga, at an elevation of 2000 feet; spores 3-septate or ovoid muriform, $\frac{12 - 14}{21 - 28} \mu$.

7. LEPTOGIUM RHYPARODES Nylander.

Leptogium rhyparodes Nyl. Flora, 210. 1865.

Leptogium rhyparodes Leighton, Lich. Flora Grt. Brit. ed. 3. 26. 1879.

Leptogium rhyparodes Crombie, Brit. Lichens, 1: 64. 1894.

Thallus effuse, microphylline, furfuraceous, areolate, sub-granulose, blackish, wine-red with I.

Apothecia concolorous or reddish brown, very small, at first concave, then plane, eventually the margin excluded; thecium blue with I; spores colorless, ovoid to ellipsoid, tapering to a point at one end, more or less muriform-multilocular, $\frac{11 - 15}{20 - 30} \mu$.

Occurring with dwarf mosses on sandstone; described from specimens collected at Grizzly Peak, altitude 2700 feet. Originally described from Scotland. Collected by Dr. Hasse in the Santa Monica Range near Los Angeles.

8. LEPTOGIUM PALMATUM (Huds.) Mont.

Lichen palmatus Hudson, Fl. Ang. ed. 2. 536. 1778.

Leptogium palmatum Montagne, Pl. Cell. Voy. Pol. Sud. 128. 1845.

Leptogium palmatum Tuck. Syn. N. Am. Lich. I: 159. 1882.

Leptogium palmatum Herre, Proc. Wash. Acad. Sci. 7: 381. 1906.

Thallus medium to large, more or less tufted, very irregular, deeply lacinate; lobes more or less convolute, with crenate margin, the 2 — 4 corniculate tips erect, narrow, tubular, pointed or blunt; surface of thallus finely wrinkled and pitted; beneath paler, wrinkled; color usually reddish brown to chestnut, sometimes greenish lead-color.

Apothecia scattered, becoming very numerous and crowded, concolorous or red-brown; the paler elevated margin entire; spores muriform-multilocular, ovoid or ellipsoid, $\frac{12 - 16}{30 - 48} \mu$.

Abundant on earth, mosses, and rocks; often occurring in very extensive patches.

Occurring generally throughout Europe, Algeria, and the Canaries; in America apparently confined to the Pacific Coast from British Columbia southward, but probably not extending into southern California.

9. LEPTOGIUM CALIFORNICUM Tuck.

Leptogium californicum Tuck. Syn. N. Am. Lich. I: 159. 1882.

Leptogium californicum Herre, Proc. Wash. Acad. Sci. 7: 381. 1906.

Thallus of medium size, indeterminate, irregularly and narrowly lacinate and cut-lobed; the margins erect, crinkled or much and intricately folded, more or less crenate, serrate, or dentate-lobulate, or sometimes merely granulate. Thallus occasionally much reduced, the erect, very narrow, much dissected lobes then densely crowded; color black or dark brown; margin often lustrous as if oiled or varnished.

Apothecia infrequent, small, red-brown, the paler margin elevated, entire or more or less dentate; spores muriform-multilocular, rarely

only 6 – 8 locular, $\frac{11 - 16}{29 - 48} \mu$.

Occurring throughout, forming large, coal-black mats on mossy sandstone ledges at moderate elevations in the foothills; reduced forms occurring in rock crevices as low as 150 feet. Found from British Columbia to Lower California.

10. LEPTOGIUM PLATYNUM (Tuck.) Herre.

Leptogium californicum platynum Tuck. Syn. N. Am. Lich. I: 159. 1882.

Leptogium californicum platynum Herre, Proc. Wash. Acad. Sci. 7: 381. 1906.

Thallus medium to large, orbicular, or indeterminate through fusion of adjacent plants; appressed; lobes irregular, elongate and expanded, imbricate, with crenate or dentate margin; surface finely striate or wrinkled, more or less pustulate, occasionally minutely lobulate; beneath paler, finely wrinkled; color black or greenish black, rarely brownish black.

Apothecia very numerous, minute, reddish brown, the prominent entire margin paler; spores ovoid or ellipsoid with attenuate tips,

muriform, multilocular, $\frac{10 - 16}{27 - 48} \mu$.

On earth, exposed roots, and rocks, in damp situations in the mountains. Abundant on Castle Rock Ridge from 1500 feet upwards.

A very distinct and handsome lichen, thus far recorded only from central California.

HEPPIACEÆ.

Thallus varying from very small crustaceous scales or more or less foliaceous squamules to ascendant, branched, sub-fruticose forms; attached by rhizoids or by a central umbilicus; tissue mostly of a large celled pseudoparenchyma; hypothallus well developed or finally disappearing; alga *Scytonema*.

Apothecia scattered over the surface, innate, usually invisible to the naked eye, the disk very narrow and pore-like, or occasionally somewhat emergent; proper margin lacking or indistinct; hypothecium clear; paraphyses simple, usually septate; asci containing from 4 to many spores, these simple, colorless, ellipsoid to spherical, thin walled.

Comprises but a single genus.

XXXIV. Heppia Naeg.

Heppia Naegeli, in Hepp. Exsiccata, no. 49. 1853.

Heppia Th. Fries, Gen. Heterol. Europ. 56. 1861.

Heppia A. Zahlbr. Ascolichenes, 177. 1907.

Characters of the genus as above.

KEY TO THE SPECIES.

- A. Thallus thick, small-leaved, attached by a central umbilicus, appressed.
 - B. Thallus usually with a blue soresiose margin. 1. *guepini*
- AA. Thallus not umbilicate; without blue soresiose margin.
 - C. Squamules more or less ascendant and containing several apothecia.
 - 2. *bolanderi*
 - CC. Thallus of small, closely appressed squamules, each containing but one apothecium. 3. *hassei*

1. HEPPIA GUEPINI (Delise) Nyl.

Endocarpon guepini Delise, apud Duby et DC. Botanic. Gallic. 2: 594. 1830.

Endocarpon guepini Moug. apud Fr. Lich. Europ. 410. 1831.

Heppia guepini Nyl. apud Stizbgr. Lich. Helv. in Jahresb. St. Gallisch. Naturwiss. Ges. 338. 1882.

Endocarpiscum guepini Nyl. Flora, **47**: 487. 1864.

Endocarpiscum guepini Tuck. Syn. N. Am. Lich. I: 113. 1882.

Endocarpiscum guepini Herre, Proc. Wash. Acad. Sci. **7**: 374. 1906.

Thallus small to very small, thick and leathery, one-leaved, becoming polyphyllous, umbilicate, appressed, more or less circular and peltate, or crenate-lobulate, smooth or flexuous; scattered, or densely crowded and imbricate; the sinuous, crenate, usually upturned margin generally blue soresiate; the brownish olive color paling sometimes to gray but more often blackening; beneath naked, smooth, minutely wrinkled, flesh-color, brown, or blackening.

Apothecia deeply imbedded in tiny pits, invisible to the naked eye; rarely becoming superficial, lecanorine, black; spores very numerous, spheroid to oblong, exceedingly minute.

Abundant on sandstone and granite in the foothills at moderate elevations and on cliffs above the sea. A lichen of Europe and North America.

The thallus is very frequently infested with a fungus, *Endococcus pseudocarpus* Nyl., described by him as a lichen; it may be recognized as follows:— fruiting body immersed in the thallus of *Heppia*, globose, blackish-brown, with bi-ocular, ellipsoid, pale brown or dusky spores, measuring $\frac{3.5 - 6.25}{9.75 - 15.75} \mu$.

2. HEPPIA BOLANDERI (Tuck.) Wainio.

Pannaria bolanderi Tuck. Gen. Lich. 51. 1872.

Endocarpiscum bolanderi Tuck. Syn. N. Am. Lich. I: 114. 1882.

Heppia bolanderi Wainio, Étude sur la Classif. Nat. et la Morph. des Lichens du Brésil, 215. 1890.

Thallus small to minute, from scattered soon densely crowded and imbricate, one-leaved, thick, rigid, from simple soon irregularly lobulate, more or less wavy, crisped, the margin often curved upward and microscopically granulose or isidiose, attached by a very few thick rhizoids, either centrally, or else at one edge, and then ascendant or erect; color dull olive and blackening.

Apothecia innate, globose, very minute, rare in our specimens; spores numerous, 35 to 60 in the asci, ellipsoid, $\frac{3 - 3\frac{2}{3}}{4 - 7} \mu$.

Rare; on sandstone at Laguna Creek, near the Pacific Ocean, 9 miles north of Santa Cruz. Generally distributed over California and also found in southeastern Brazil.

Smaller, thinner, and darker than *Heppia guepini*, and, as Tuckerman states, much resembling a *Collema* in appearance. This species is also much infested with *Endococcus pseudocarpus*.

3. HEPPIA HASSEI A. Zahlbr.

Heppia hassei A. Zahlbr. Beiheft. Bot. Centralbl. **13**: 157. 1902.

Thallus thin, closely appressed, of small, rounded, olivaceous squamules, lobulate-crenate to irregular, approximate, or separate and distinct, the margin slightly ascendant; without distinct hypothallus or rhizoids.

A single apothecium immersed in each squamule, the disk ruby, or dark reddish brown, at first dot-like, then enlarging to medium size; the entire thalline margin very thin; hypothecium broad, yellowish, of irregular hyphæ; proper margin broad, of parallel slightly septate hyphæ; hymenium pale rose, 120-170 μ high, blue, soon vinous red with I; asci numerous, ventricose-saccate, straight or slightly curved, $\frac{22 - 27}{100 - 120} \mu$; epithecium reddish; paraphyses gelatinous, simple, septate, about 3 μ broad, their tips hardly broader; spores numerous, simple, colorless, oval, $\frac{3.5 - 4}{5 - 7} \mu$.

Rare; on rocks, on a dry hill-side, at an altitude of about 800 feet, Hidden Villa Cañon. Collected by Dr. Hasse on granite at Palm Springs, the type locality, and also on rock in the Santa Monica Range.

This very inconspicuous and xerophytic lichen probably occurs throughout the drier portions of the southwestern United States. (Named for Dr. H. E. Hasse, army surgeon and botanist.)

PANNARIACEÆ.

Thallus crustaceous, granular, uniform or marginally lobed; or squamulose, passing into foliaceous forms; hypothallus and rhizoids usually well developed; the upper side with a cortex of pseudoparenchymatous tissue composed of hyphæ arranged perpendicularly, irregularly, or horizontally; lower side with or without a cortex; algæ *Nostoc*, *Scytonema*, or in two genera, *Pleurococcus*.

Apothecia circular, marginal or scattered over the surface, lecanorine or biatorine, or occasionally lecideine; paraphyses simple; spores colorless, simple, or 2-4 celled.

A difficult group, nearly related to the *Stictas* and the *Peltigeras*, and also the *Heppias*, with features intermediate between the lecanorine and the lecideine types of lichens.

Following the arrangement of Dr. Zahlbruckner, we have 3 of his ten genera, though the present author feels that some of the genera are hardly separable.

KEY TO GENERA.

- A. Apothecia lecanorine; spores 1-celledXXXVII. *Pannaria*
 AA. Apothecia biatorine or lecideine.
 B. Spores 1-celledXXXV. *Parmeliella*
 BB. Spores 2-8 locularXXXVI. *Placynthium*

XXXV. *Parmeliella* Müll. Arg.

Parmeliella Müll. Arg.,

Parmeliella A. Zahlbr. *Ascolichenes*, 181. 1907.

Thallus of small scales, lobed at the margin, or nearly foliaceous, usually with a well-developed dark hypothallus; alga *Nostoc*. Cortex present on upper side but not on lower.

Apothecia biatorine, scattered over the surface; margin of stellately arranged, septate hyphæ, not enclosing algæ; spores simple, colorless, elongate or ellipsoid.

About 15 species, on rocks, earth, and bark of trees, often difficult of determination.

KEY TO SPECIES.

- A. Thallus usually of minute, steel-blue granules. 4. *cyanolepra*
 AA. Thallus more or less brown, of evident squamules.
 B. Thallus of minute to very minute squamules passing into a continuous areolate crust. 1. *microphylla*
 BB. Squamules small to medium size, crenate lobulate.
 C. Squamules as in BB. 2. *lepidiota*
 CC. Squamules passing into a mass of short, stout, coralloid branchlets. 3. *lepidiota coralliphora*

1. PARMELIELLA MICROPHYLLA (Sw.) Müll. Arg.

Lichen microphyllus Swartz, Vet. Ak. Handl. 301. 1791.

Parmeliella microphylla Müll. Arg.,

Pannaria microphylla Tuck. Syn. N. Am. Lich. I: 121. 1882.

Thallus of minute to very minute, closely appressed, crenate, often imbricate squamules which are mostly run together into a continuous or areolate-chinky crust; sometimes thinly scattered; on a blue-black hypothallus; upper surface of squamules a yellow-brown, with whitish margins, so that the whole crust has an ashy brown appearance.

Apothecia very numerous, small to medium size, from plane soon convex, appressed, the disk pale to dark red-brown, sometimes blackening; the paler, entire, proper margin soon excluded; when the thallus is well developed and thick the apothecia are sub-immersed with a pseudo-thalline margin of denticulate squamules; when the thallus is thin they are superficial; epithecium pale yellow; paraphyses loosely coherent; thecium bluish, then a nondescript yellowish-reddish or tawny yellowish with I; spores long ellipsoid, $\frac{9.75 - 12}{20 - 30} \mu$.

Common on sandstone and also occurring on roots in the foothills and mountains. Differing from the type in the very much larger spores and the reduced squamules, the *forma californica* of Tuckerman.

I am not satisfied with placing it here, but can find no other place for it.

P. microphylla is a common lichen of the mountains of the temperate and sub-arctic realms.

2. PARMELIELLA LEPIDIOTA (Sommerf.).

Lecidea carnosa B. *lepidiota* Sommerf. Suppl. Fl. Lapp. 174. 1826.

Pannaria lepidiota Th. Fr. Lich. Arctoi. 74. 1860.

Pannaria lepidiota Tuck. Syn. N. Am. Lich. I: 121. 1882.

Pannaria lepidiota Cummings and Seymour, Decades of North American Lichens, no. 122, Mt. Tamalpais, Marin Co., Calif.

Thallus of small squamules with crenate-lobulate, digitate, or dissected margin, laterally expanded or somewhat ascendant and imbricate; color grayish to dingy brownish; squamules more or less dispersed when growing among mosses.

Apothecia numerous, medium-sized, sessile, from plane becoming convex, excluding the thin, entire, proper margin; disk pale to dark reddish, brown, and blackening; epithecium pale yellowish; paraphyses simple, septate, free; thecium pale bluish, then more or less brownish-reddish with I; spores pointed ellipsoid, rather slender,

$\frac{9 - 12}{7 - 27} \mu$. A specimen in the Tuck. Herb., collected by

Bolander at Mission Dolores, has spores $\frac{5.5 - 8}{18 - 21} \mu$ and $\frac{5 - 10}{27 - 34} \mu$.

On earth, mosses, stumps, and rocks, in the mountains. A plant of northern Europe and northern and western America.

3. PARMELIELLA LEPIDIOTA CORALLIPHORA (Tuck.).

Pannaria lepidiota b. *coralliphora* Tuck. Syn. N. Am. Lich. I: 122. 1882.

Pannaria lepidiota b. *coralliphora* Macoun, Cat. of Canad. Plants, VII. 94. 1902.

Thallus of small or medium sized squamules which soon become a thick mass of short, stout, irregularly swollen or knotty, coralloid branchlets, leaving no trace of the squamules visible; color dirty brownish-yellowish, grayish, and blackening.

Apothecia numerous, often densely crowded, medium to large; from plane, circular, and depressed, becoming convex and irregularly crenate; disk red, red-brown, and blackening, soon excluding the

thin, entire, paler proper margin; epithecium pale yellow; paraphyses simple, septate, sub-conglutinate; thecium pale blue with I, the asci then more or less dingy reddish-yellowish; spores ellipsoid with

pointed tips, $\frac{8.5 - 12.25}{17 - 24.5} \mu$.

On mossy sandstone and earth in the foothills; not rare. Originally described from specimens collected by Macoun on Vancouver Island; recorded also by Professor Cummings from Alaska. No other localities seem to be noted by any authors.

My material agrees with the type specimens in the Tuckerman herbarium.

4. PARMELIELLA CYANOLEPRA (Tuck.) Herre.

Pannaria cyanolepra Tuck. Lich. Calif. 17. 1866.

Pannaria lepidiota c. *cyanolepra* Tuck. Syn. N. Am. Lich. I: 122. 1882.

Thallus of minute, dissected, dusky yellowish or buff squamules, their edges and soon the whole thallus disappearing under a confused mass of minute, steel-blue granules; the plant ordinarily a thin indeterminate, fragile blue crust, with but few or no squamules visible.

Apothecia minute to small, finally medium in size, closely appressed, plane, becoming convex and excluding the thin, entire, erect proper margin; disk dark red to black red; epithecium yellowish brown; thecium bluish with I; spores ellipsoid,

$\frac{8.5 - 11}{14.5 - 19.5} \mu$; in Tuckerman's specimens, $\frac{8 - 10}{14 - 21} \mu$.

Not uncommon on clay banks and encrusting mosses beside roads in the foothills and mountains, forming more or less conspicuous patches. Usually sterile; fertile specimens collected but once, on clay and broken rock, in Hidden Villa Cañon, at an altitude of 800 feet. Fruiting specimens collected by Bolander near San Francisco and on the American river, near Auburn.

I have removed this from sub-specific to specific rank, in accordance with Tuckerman's original idea.

XXXVI. *Placynthium* (Ach.) Harm.

Collema sect. *Placynthium* Ach. Lich. Univ. 628. 1810.

Placynthium Harm. Cat. Des. Lich. Lor. 1894.

Thallus areolate-crustaceous, granular, coralloid, or of small squamules, with a more or less well developed blue black hypothallus; alga *Scytonema*.

Apothecia sessile, lecideine or biatorine, plane or convex; hypothecium clear or dark; paraphyses simple, septate, the tips thickened and darker; spores colorless, elongate or ellipsoid-ovoid, 2-8 locular.

Species few; obscure lichens of rocks, wood, and mosses.

KEY TO SPECIES.

- A. Thallus more or less coralloid granulose, black. 1. *nigrum*
 AA. Thallus of lobulate appressed squamules, deep brown. . . 2. *dubium*

1. *PLACYNTHIUM NIGRUM* (Huds.) S. Gray.

Lichen niger Hudson, Fl. Angl. 2: 524. 1778.

Placynthium nigrum S. Gray, Nat. Arr. 1: 395. 1821.

Pannaria nigra Nyl. Lich. Scand. 126. 1861.

Pannaria nigra Tuck. Syn. N. Am. Lich. 1: 127. 1882.

Thallus crustaceous, very minutely coralloid granulose or subsquamulose, areolate, scattered or continuous, rather thin; on a thin black or bluish black hypothallus; color very dark, appearing sooty black to the naked eye; specimens from other localities vary from brownish black to dark grayish black and black.

Apothecia minute to small, at first with plane, reddish black disk and entire, thin margin, but soon much larger, convex, dead black, the margin excluded and then lecideine; epithecium blackish green; paraphyses rather stout, septate, their dark green tips enlarged; hypothecium dark brown or blackening basally; thecium colorless, blue with I; the pseudoparenchymatous tissue of the apothecial wall violet with KOH; asci clavate; spores colorless, ellipsoid, bilocular or sometimes rather imperfectly 4-locular,

$$\frac{4\frac{1}{2} - 6\frac{1}{4}}{9 - 12\frac{1}{2}} \mu.$$

On dolomite at New Almaden, at an altitude of about 1200 feet. Rare and inconspicuous with us, but widely distributed in Europe and North America and often common on calcareous rocks.

2. *PLACYNTHIUM DUBIUM* Herre, new species.

Thallus of very small or minute, expanded or sub-erect squamules, fringed with short finger-like lobules, or with irregularly cut margin; squamules often crowded into a rough crust, or again sparsely distributed, sub-orbiculate or effuse; color a very dark brown, seldom paler; black beneath; on a blue-black hypothallus.

Apothecia minute, superficial, sessile, constricted at the base, the disk very slightly convex, blackish red-brown; the thin, entire margin of the same color as the thallus; paraphyses free, from simple finally somewhat branched, at first thread-like, becoming rather broad, septate, with enlarged, very pale brownish tips; hypothecium colorless or very pale yellow; thecium very deep blue with I; spores variously shaped, slender spindle-shaped to broadly ellipsoid, often with one end drawn out to a long tip, from simple with broken contents, and bilocular, to 4-locular, the septa faint,

$$\frac{7\frac{1}{3} - 9\frac{3}{4}}{19\frac{1}{2} - 24\frac{1}{2}} \mu.$$

On sandstone and among mosses on sandstone, in the foothills near Stanford University, at an altitude of 150 feet. Exceedingly rare in fruit.

XXXVII. *Pannaria* Del.

Pannaria Delise, in Duby Bot. Gallic. 606. 1830.

Thallus granulose, squamulose, to minutely foliaceous, upper surface more or less isidiose, or naked; usually with a well developed black or blue-black hypothallus; rarely with rhizoids; alga *Nostoc*; only the upper side with a cortex.

Apothecia at first innate, at last sessile and dish- or shield-shaped, lecanorine; margin of a pseudoparenchyma cortex and a medullary layer enclosing algæ; hypothecium colorless; spores colorless, simple, ellipsoid to spindle-shaped.

A large genus of about 50 species, often difficult to determine, dwelling on a variety of substrata.

1. PANNARIA CONOPLEA (Pers.) E. Fries.

Lichen conopleus Persoon, Ust. Ann. Bot. 1794.

Parmelia conoplea Ach. Lich. Univ. 467. 1810.

Pannaria conoplea E. Fries, Lich. Europ. Reform. 88. 1831.

Pannaria rubiginosa b. *conoplea* Tuck. Syn. N. Am. Lich. 1: 120. 1882.

Thallus of foliaceous, more or less orbiculate, medium-sized, thickish squamules, from scattered or imbricate, and crenate or incised lobate, passing into a thickly compacted, rough, chinky crust; color yellow, brown or buff; the margin gray solediose, soon densely covered with blue or gray-blue granules which finally entirely obscure the whole upper surface except at the immediate circumference.

Always sterile with us.

A common lichen on sandstone and the base of tree trunks, usually among mosses. Found in both Europe and North America.

Pannaria lanuginosa.

The thick, white or yellowish white, powdery, sterile growth described as *Amphiloma* or *Leproloma* or *Pannaria lanuginosa* is not rare with us on perpendicular or overhanging rocks, or on mossy banks.

It is probably an undeveloped stage of some lichen, due to its habitat, and is not to be considered a genuine species. *Pannaria lanuginosa* Tuck. Syn. N. Am. Lich. 1: 117. 1882.

STICTACEÆ.

Thallus foliaceous, large or very large, the fronds expanded, wide lobed, seldom ascendant, attached to the substratum by rhizoids which may form a nap or fleece; both sides with cortex; alga *Palmella* or *Nostoc*; under-surface dotted with cyphellæ or pale bare spots.

Apothecia scattered or marginal, shield-like, sessile, disk red-brown and darkening; spores colorless or brown, spindle or needle-shaped, two-to multilocular.

KEY TO GENERA.

Under surface of thallus without cyphellæ.....XXXVIII *Lobaria*
Under surface of thallus with cyphellæ.....XXXIX *Sticta*

XXXVIII. *Lobaria* (Schreb.) Hue.

Lobaria Schreber, Gen. Pl. Ed. VIII, 2: p. 768. 1791.

Lobaria Hue, Nouv. Archiv d. Mus. Ser. IV, 3: 1901.

Thallus large, leaf-like, the lobes expanded; under surface villous or fleecy, interspersed with large, naked, pale spots. Spores colorless or brown, 2-10 locular, spindle or needle-shaped.

A large genus, best represented in the rainy tropics, living on bark, moss and rocks.

KEY TO SPECIES.

- A. Under side of thallus with large convex spots, more or less brown veined between them.....1. *pulmonaria*
 AA. Spots small, white or pale, flat or sunken, scattered through the dense dark nap 2. *scrobiculata*

1. *LOBARIA PULMONARIA* (L.) Hoffm.

Lichen pulmonarius Linné, Fl. Suec. Prodr. 1087. 1755.

Lobaria pulmonaria Hoffm. Deutsch. Fl. 2: 146. 1795.

Sticta pulmonaria Tuck. Syn. N. Am. Lich. I. 96. 1882.

Sticta pulmonaria Herre, Proc. Wash. Acad. Sci. 7: 368. 1906.

Thallus leathery, medium to very large, irregularly and loosely lobed, the surface reticulate and deeply pitted; lobes narrow, deeply and sinuously crenate, the margins and reticulations often sorediose or isidiose; color varying from bright green to olivaceous and yellowish brown; under surface pale or dark brown villous veined, between large, pale, naked, bullate spots.

Apothecia infrequent, marginal, small, the disk red-brown; spores colorless, 2-4 locular, $\frac{6.1 - 8.5}{22 - 29.5} \mu$.

Common on trunks of trees in the mountains above 1500 feet; reaching its best development in the redwoods at about 2000 feet altitude, the immense lax lobes sometimes having a spread of nearly two feet. Occurring also on shaded mossy sandstone in Devils Cañon, at 2300 feet.

A cosmopolitan lichen.

2. LOBARIA SCROBICULATA (Scop.) DC.

Lichen scrobiculatus Scopoli, Flor. Carn. 2: 384. 1760.

Sticta scrobiculata Ach. Lich. Univ. 453. 1810.

Sticta scrobiculata Tuck. Syn. N. Am. Lich. I: 102. 1882.

Sticta scrobiculata Herre, Proc. Wash. Acad. Sci. 7: 369. 1906.

Lobaria scrobiculata DC. Fl. Fr. 2: 402. 1805.

Thallus of medium size, rounded or sub-orbicular, leathery, short-lobed; surface more or less pitted or wrinkled; thickly sprinkled with gray soredia; lobes rounded, imbricate, but little incised, more or less crenate; color of herbarium specimens dull yellowish green or gray; in the field often a dark liver-green; beneath densely villous, buff to dark brown or dingy black; more or less interspersed with naked white or pale spots.

Sterile. Apparently without apothecia in America, but occurring fertile in Europe.

Common on trees and rocks in the mountains above 1500 feet. Also very abundant on a sandstone cliff in Pilarcitos Creek Cañon, two miles from the Pacific, at from 200 to 300 feet altitude.

A common plant of the temperate and sub-arctic regions of both hemispheres.

XXXIX. *Sticta* Schreb.

Sticta Schreber, in L. Gen. Pl. ed. 8: 2: 768. 1791.

Thallus foliaceous, usually conspicuous, often more or less ascendant, the upper surface often sorediose or isidiöse; cortex of the under surface more or less broken, the white medulla showing as white specks or heaps, known as cyphellæ; more or less covered beneath by rhizoids, passing into a fleecy nap.

Apothecia scattered or marginal, in some species apparently never present; spores colorless to brown, long-ellipsoid, spindle or needle-like, 2-8 locular.

About 150 species, dwelling on bark, earth, and rocks, best developed in the moist tropics and warm temperate regions.

KEY TO THE SPECIES.

A. Apothecia abundant; thallus lacunose-reticulate, the ridges often with confluent gray soredia. 1. *anthraspis*

AA. Always sterile.

B. Upper surface covered with dense black isidia. 2. *fuliginosa*

BB. Surface smooth; marginally sorediate. 3. *limbata*

1. STICTA ANTHRASPIS Ach.

Sticta anthraspis Ach. Meth. Lich. 280. 1803.

Sticta anthraspis Tuck. Syn. N. Am. Lich. I: 101. 1882.

Sticta anthraspis Herre, Proc. Wash. Acad. Sci. 7: 369. 1906.

Thallus medium to large, rounded or irregular, usually conspicuously pitted and reticulate; texture leathery or parchment-like; short and wide-lobed, margin sinuous, rounded and crenate, or often more narrowly and deeply cut, even becoming lacerate; ridges of surface often covered with gray confluent soredia; color usually brown, but varying from green to russet or chocolate, or even darker; beneath covered with a dense pale fleece, which becomes darker toward the centre or sometimes is entirely dark or dingy black; thickly sprinkled with small white convex cyphels.

Apothecia medium to large, scattered, becoming very abundant, the disk red-brown, or darkening and finally black; flat, finally convex and excluding the prominent, entire or denticulate margin;

spores straight, colorless, 2-5 locular, $\frac{7.5 - 10}{24 - 34.25}$ μ .

On trees, roots, and occasionally on old fences; rarely on earth or sandstone. Very common in the mountains at all elevations and extending downward in the foothills to about 200 feet. Usually sterile at the lower elevations, but in deepshady cañons luxuriant and fertile at not more than 200 feet. Often attaining a diameter of 10 or 12 inches.

Confined to the west coast of the United States.

2. STICTA FULIGINOSA (Dicks.) Ach.

Lichen fuliginosus Dickson, Brit. Crypt. 1: 13. 1785.

Sticta fuliginosa Ach. Meth. Lich. 281. 1803.

Sticta fuliginosa Tuck. Syn. N. Am. Lich. I: 99. 1882.

Sticta fuliginosa Herre, Proc. Wash. Acad. Sci. 7: 368. 1906.

Thallus leathery, more or less round-lobed; lobes short, wrinkled and pitted, the margin entire, sinuous or somewhat crenate; color

a dark brownish or lurid gray, this obscured by the dense covering of black isidia, so that the surface appears black; beneath pale brown, tomentose; more or less sprinkled with white, concave cyphels.

Sterile in America and rarely found fertile in Europe.

On rocks, trees, dead wood, old fences, moss, and earth. Common at all elevations. A plant of world-wide distribution.

3. STICTA LIMBATA (Sm.) Ach.

Lichen limbatus Smith, in Eng. Bot. 16: pl. 1104, 1802.

Sticta limbatus Ach. Meth. Lich. 280. 1803.

Sticta limbatus Tuck. Syn. N. Am. Lich. I: 100. 1882.

Sticta limbatus Herre, Proc. Wash. Acad. Sci. 7: 368. 1906.

Thallus small, usually one-leaved; lobes smooth, rounded, broad, the margin crenate or sinuous; confluent gray soredia abundant along or near the margin; color in the field usually a glaucous green; herbarium specimens vary from bluish or greenish drab or gray to dull rufous brown; beneath covered with a pale brown fleece which becomes darker centrally; white concave cyphels rather sparingly present.

Apothecia unknown.

Not uncommon along the higher ranges, at an altitude of 2400 feet and above. A European species recorded in this country only from Oregon and the Santa Cruz peninsula, and by Eckfeldt recorded from Labrador.

PELTIGERACEÆ.

Thallus expanded foliaceous, or reduced to stellate lobes surrounding the apothecia; cortex on both sides or only above, the thallus attached by rhizoids, these sometimes greatly developed, and the under side tomentose; alga *Palmella* or *Nostoc*.

Apothecia without margin, adnate to the thallus by their whole under surface; upon the under surface as well as the upper surface of the plant; hypothecium clear; paraphyses simple; asci 2-8 sporous or multisporous; spores colorless to brown, ellipsoid, spindle or needle-shaped, 2-8 locular.

dusky velvety brown usually, but varying from greenish brown to almost chestnut.

Apothecia large, numerous, reddish brown; spores pale brown to colorless, broadly spindle-shaped or oblong, 4-locular, $\frac{6.5 - 8.5}{17 - 22}$ μ .

On trees and shrubs, most frequent on *Rhus diversiloba*. Apparently confined to damp undergrowth in oak woods about the summit of the range. Abundant on Black Mountain, Page Mill road, at 2000 feet.

A lichen of arctic and temperate Europe and America.

2. NEPHROMA HELVETICA Ach.

Nephroma helvetica Acharius, Lich. Univ. 523. 1810.

Nephroma helveticum Tuck. Syn. N. Am. Lich. I: 104. 1882.

Nephroma helveticum Herre, Proc. Wash. Acad. Sci. 7: 371. 1906.

Thallus small or medium, expanded, intricately and sinuously complicate-lobed; lobes rounded, more or less crisped, their margins crenate, typically fringed with small or minute tooth-like lobules; surface smooth or minutely granular, but occasionally sprinkled with pustules or lobulate outgrowths, and sometimes deeply pitted; medullary layer white, KOH-; beneath pale brown to dusky, covered with a dense concolorous nap; thallus brown, of varying shades.

Apothecia abundant, very dark red; spores 4-locular, faint brown, ellipsoidal to spindle-shaped, $\frac{5 - 8.5}{17 - 23}$ μ .

On trees and shrubs in the mountains, above 1700 feet. Apparently confined to dense damp woods near the summit of the range; widely distributed but not very abundant in any one locality. Generally distributed over North America and the mountains of Central Europe.

3. NEPHROMA LUSITANICUM Schaer.

Nephroma lusitanicum Schaerer, Enum. Crit. Lich. Europ. 323. 1850.

Nephromium lusitanicum Tuck. Syn. N. Am. Lich. I: 105. 1882.

Nephromium lusitanicum Herre, Proc. Wash. Acad. Sci. 7:371. 1906.

Thallus expanded, rounded; of medium size but becoming rather large by the coalescence of adjacent plants; deeply and sinuately imbricate-lobed; lobes crenate at tip, their margins sometimes minutely crenate or notched, when they simulate the denticulate margins of *Nephroma helvetica*. Surface smooth, becoming more or less wrinkled; color varying from drab and pale brown to dark chestnut; beneath smooth, more or less wrinkled; pale brown, becoming dusky and finally black; medullary layer yellow, becoming purple-red with KOH.

Apothecia numerous, medium to large; spores 3-4 locular, pale brown or colorless, $\frac{6 - 7\frac{1}{3}}{16 - 24}$ μ.

Very abundant on mossy sandstone and trunks of oaks in Devils Cañon, altitude 2300 feet. Not found as yet elsewhere, but to be looked for in similar situations.

Recorded from Portugal, Spain, Italy, Switzerland, British Isles, Canary Islands, Java, Oregon, and California.

XLI. *Peltigera* Willd.

Peltigera Willdenow, Fl. Berol. 47. 1787.

Thallus leafy and large-lobed, rarely reduced, horizontally expanded or marginally ascendant, attached by tufted rhizoids; upper side naked or finely pubescent; under side without cortex, beset with more or less anastomosing netted veins.

Apothecia circular, marginal, adnate on the upper side of the more or less extended and narrowed fertile lobes, flat or laterally recurved, without margin; disk covered with a veil, the rest of the upper cortex under which the apothecium rises, which later splits, the fragments margining the fruit; hypothecium clear to brownish; paraphyses simple, septate, thickened at the tips; asci 6-8 spored; spores colorless or brownish, elongate-ellipsoid, spindle or needle-shaped, 4-8 locular, thin walled.

KEY TO THE SPECIES.

- A. Thallus more or less marginally sorediate. I. *scutata*
- AA. Thallus never sorediate.

- B. Tips of lobes smooth or barely tomentose; thallus thick, rather rigid.....2. *rufescens*
 BB. Tips of lobes more or less visibly tomentose.
 C. Thallus medium to large, thin.....3. *canina*
 CC. Very thin and papery, expanded....4. *canina membranacea*

1. PELTIGERA SCUTATA (Dicks.) Leight.

Lichen scutatus Dickson, Pl. Crypt. Brit. 3: 18. 1793, excl. syn.
Peltigera scutata Leighton, Lich. Fl. Grt. Brit. ed. 1: 210. 1871.
Peltigera scutata Tuck. Syn. N. Am. Lich. I: 107. 1882.
Peltigera scutata Herre, Proc. Wash. Acad. Sci. 7: 372. 1906.

Thallus comparatively thick, small or of medium size, much and irregularly lobed; lobes undulately crenate, their edges confluent gray soresiate; surface smooth, occasionally soresiate; the lobes sometimes finally converted into a powdery soresiate heap, losing all semblance of the original thalline form except marginally; color greenish ashy or gray, or more seldom reddish brown; beneath white, with broad, tomentose, anastomosing, brown veins; these dark brown or blackening centrally and finally coalescing so as to obscure the under surface, which appears only as small white or pale brown spots in the dark area. More or less fibrillose near the margins.

Apothecia dark reddish-brown to black; spores needle or spindle-shaped, straight or bowed, $\frac{3.5 - 5}{40 - 61} \mu$.

On mossy sandstone, tree trunks, and earth.

Common at all altitudes above 300 feet; reaching its greatest vegetative development on perpendicular mossy sandstone cliffs, where it forms extensive mats, but is usually sterile. Occasionally abundantly fertile, especially on trees, but as a rule apothecia are rare and scattered. A lichen of Europe and North America, nowhere abundant according to published records.

2. PELTIGERA RUFESCENS (Neck.) Hoffm.

Lichen rufescens Necker, Meth. Musc. 79. 1771.
Peltigera rufescens Hoffmann, Deutsch. Fl. 2: 107. 1795.
Peltigera rufescens Tuck. Syn. N. Am. Lich. I: 108. 1882.
Peltigera rufescens Herre, Proc. Wash. Acad. Sci. 7: 373. 1906.

Thallus small or medium, rather rigid and thick, smooth or marginally minutely tomentose, rounded, irregularly laciniate; lobes more or less imbricate, becoming narrowed, crowded, and somewhat crisped marginally; color varying from pale greenish gray to reddish, finally russet or dark brown; pale brown beneath, reticulate with thick brown veins; these thinly sprinkled with coarse brown fibrils.

Apothecia often clustered, comparatively large; terminal on long narrow lobes; disk reddish brown and darkening; spores spindle-shaped, straight or curved, 4-7 locular, $\frac{4\frac{3}{4} - 6\frac{1}{8}}{41.5 - 61\frac{1}{4}}$ μ .

On earth, moss, and rocks, in the foothills; a cosmopolitan lichen.

3. PELTIGERA CANINA (L.) Hoffm.

Lichen caninus Linné, Syst. Nat. ed. X. 1342. 1753; Fl. Suec. 1109. 1755.

Peltigera canina Hoffmann, Deutsch. Fl. 2: 106. 1795.

Peltigera canina Tuck. Syn. N. Am. Lich. I: 109. 1882.

Peltigera canina Herre, Proc. Wash. Acad. Sci. 7: 373. 1906.

Thallus thin, orbicular, becoming expanded, irregular, and very large; lobes large, broad, imbricate, intricately cut; tips rounded or often more pointed, more or less deeply crenate; surface smooth, or minutely pubescent, this more evident along margin of terminal lobes. Color greenish gray or drab, varying to reddish or brown; beneath very pale, netted with pale prominent veins of the same color, these sometimes darkening centrally; long conspicuous concolorous or darkening fibrils present.

Apothecia marginal, numerous; circular, becoming elongate; disk red-brown; spores colorless, 4-8 locular, needle-shaped or elongate spindle-shaped, straight or curved, $\frac{4\frac{3}{4} - 6\frac{1}{8}}{45 - 73\frac{1}{3}}$ μ .

On earth and moss throughout. A common lichen of world-wide distribution.

4. PELTIGERA CANINA MEMBRANACEA (Ach.) Nyl.

Peltidea canina membranacea Ach. Lich. Univ. 518. 1810.

Peltigera canina membranacea Nyl. Syn. Meth. Lich. 1: 324. 1860.

Peltigera canina membranacea Tuck. Syn. N. Am. Lich. I: 109. 1882.

Peltigera canina membranacea Herre, Proc. Wash. Acad. Sci. 7: 374.

1906.

Thallus very thin and papery, becoming greatly expanded, the surface smooth and more or less pitted and furrowed; lobes large, dilated, rounded, irregularly crenate and lacinate, more or less imbricate, often forming mats several layers in thickness; tips of lobes visibly tomentose; color and under surface as in typical form.

Apothecia numerous, marginal or terminal on somewhat narrowed and extended lobules; spores 4–8 locular, needle-like,

$$\frac{3.5 - 5}{40 - 73\frac{1}{3}} \mu.$$

Occurring throughout, on mossy tree trunks, rotting logs, and on earth and stones. A European lichen occurring also on the Pacific coast of America and in Mexico.

PERTUSARIACEÆ.

Thallus uniform crustaceous, attached by the hyphæ of the medulla or of the hypothallus, cortex present or absent on the upper side; alga *Pleurococcus*.

Apothecia solitary or several immersed in thalline warts, the disk usually very narrow; rarely it is broad and lecanorine in appearance, while in some forms it is pyrenocarpous in appearance; proper margin lacking; paraphyses well developed, usually branched and twining, rarely unbranched and free; spores 1–8, colorless or brownish, usually very large and thick-walled, simple or bilocular. We have the most important genus of the family, *Pertusaria*.

XLII. *Pertusaria* DC.

Pertusaria DC. Fl. Fr. 2: 139. 1805.

Thallus as above; apothecia single or more often enclosed in goni-dia-bearing fruiting warts, rarely immersed in the thallus; spores usually large to very large, colorless, rarely dusky or brown, simple, with strongly thickened walls of concentric layers, the inner spore wall smooth or with cross-markings.

A cosmopolitan genus of about 200 species, occurring on rock, bark, and moss; frequently sterile or with the apothecia degenerate, forming heaps of soredia, when the species are often difficult or impossible to determine satisfactorily.

KEY TO THE SPECIES.

- A. On rocks.....1. *pertusus*
- AA. On bark.
 - B. Thallus conspicuously sorediate and more or less marginally sorediate; sterile.
 - C. Thallus bitter to the taste, like quinine2. *amara*
 - CC. Thallus not bitter.....3. *globulifera*
 - BB. Soredia absent or inconspicuous.
 - D. Thallus usually sulfur-yellow.....4. *wulfenii*
 - DD. Thallus white or cream-colored.
 - E. Thallus milk-white; apothecial warts brownish red with CaCl_2O_25. *velata*
 - EE. Thallus cream-colored to grayish white.
 - F. Apothecial warts lecanorine; disk pruinose, pale flesh-color when moistened and rubbed.....6. *lecanina*
 - FF. Apothecial warts not lecanorine.
 - G. Thallus not affected by KOH; spores 2 or 1.
 - 7. *pustulata*
 - GG. Thallus yellow with KOH; spores 3, 4, 5, or 6; rarely 2.....8. *leioplaca*

1. PERTUSARIA PERTUSUS (L.)

Lichen pertusus Linné, Mantissa, 2: 134. 1771.

Pertusaria communis DeCandolle, Flora France, 2: 230. 1805.

Pertusaria communis Tuck. Syn. N. Am. Lich. I: 214. 1882.

Thallus thick (rarely thin), chinky, areolate and rough warty; determinate, more or less orbiculate, or often spreading extensively, the margin more or less zonate; color clear gray to dusky gray; KOH yellowish, becoming orange-red; CaCl_2O_2 -.

Apothecial warts numerous, of medium size, adnate, flattened, sub-globose or difform, usually crowded; the apothecia ordinarily five or six in each wart, but varying from one to 12 in number; ostioles black or very dark, minute, from elevated becoming depressed; epithecium violet with KOH; spores usually in twos, also

solitary, in threes, or fours; $\frac{48 - 73}{140 - 188} \mu$.

Occurring with us only on rocks, but common in the maritime region. Our plant is the form *rupestris* of authors but is not to be separated from the type. A tree and rock lichen of common occurrence throughout Europe and America.

2. PERTUSARIA AMARA (Ach.) Nyl.

Variolaria amara Acharius, Lich. Univ. 324. 1810.

Pertusaria amara Nylander, Flora, 22. 1873.

Thallus from determinate and orbicular becoming widespread and effuse; rough and chinky, more or less powdery, usually densely covered with large, often confluent soredia; color gray to almost white, marginally brown and zonate; KOH — ; the apothecial verrucæ becoming sorediate heaps with us and the plant therefore sterile; when treated with KOH + CaCl₂O₂ they give a violet reaction.

The whole plant very bitter, almost like quinine.

Abundant on trunks of trees, especially on *Æsculus* and *Quercus*.

A common lichen in Europe and recorded also from Japan, but apparently not distinguished by American authors.

3. PERTUSARIA GLOBULIFERA (Turn.) Nyl.

Variolaria globulifera Turner, Trans. Linn. Soc. 9: 139. 1808.

Pertusaria globulifera Nylander, Mem. Soc. Cherbourg, 5: 116. 1857.

Thallus sub-orbiculate but spreading extensively and then more or less indeterminate; cartilaginous; smooth at first but soon unevenly plicate and more or less fissured; sprinkled with minute white soredia; color gray to white; marginally zonate and brown, but less marked than in *P. amara*.

Apothecial warts adnate, plane, lecanoroid, sterile, degenerate, passing into white, powdery heaps, the central portion of the thallus soon almost covered with the dense confluent soredia; KOH — ; CaCl₂O₂ — .

Common on tree trunks in the mountains and widely distributed in Europe and North America.

4. PERTUSARIA WULFENII (DC.) E. Fr.

Pertusaria wulfenii DeCandolle, Fl. Fr. 2: 320. 1805.

Pertusaria wulfenii E. Fries, Lich. Europ. Reform. 244. 1831.

Pertusaria wulfenii Tuck. Syn. N. Am. Lich. I: 216. 1882.

Thallus determinate or becoming somewhat effuse, often orbiculate, sharply bounded by the black hypothallus, sometimes zonate at the circumference; originally smooth but usually thick, rough, fissured, and warty; sulfur-yellow and paler; yellow with KOH; KOH + CaCl₂O₂ orange-yellow.

Apothecial warts usually crowded, sessile, flattened globose; ostioles mostly confluent, forming a depressed black disk; the thal-line margin thick, swollen, irregularly waved or folded; epithecium violet with KOH; paraphyses and epithecium indigo with I; spores in eights, $\frac{20 - 47.5}{56 - 123} \mu$.

Occurs with us on the bark of oaks, principally *Quercus chrysolepis*, at an altitude of 2000 feet and above.

Widely distributed throughout the temperate zone, usually on bark, rarely on stone.

A very pale greenish gray to yellowish gray form occurs on *Quercus agrifolia* along the Pacific shore, at an altitude of 50-200 feet; spores very much smaller, $\frac{20 - 22}{50 - 56} \mu$.

5. PERTUSARIA VELATA (Turn.) Nyl.

Parmelia velata Turner, Trans. Linn. Soc. 9: 143, pl 12, f 1. 1808.

Pertusaria velata Nylander, Lich. Scand. 179. 1861.

Pertusaria velata Tuck. Syn. N. Am. Lich. I: 212. 1882.

Thallus thin, smooth, becoming chinky, somewhat zonate at the circumference; color milk-white; KOH yellow; CaCl₂O₂ -.

Apothecial warts small, adnate, lecanoroid, brownish red with CaCl₂O₂; disk plane or concave, concolorous to pale yellowish; spores solitary, $\frac{40 - 60}{200 - 240} \mu$.

A single specimen of this lichen has been found by me, growing on the bark of an oak at Devils Cañon, altitude 2300 feet. A common plant of Europe, Asia, and North America.

6. PERTUSARIA LECANINA Tuck.

Pertusaria lecanina Tuck. Genera Lichenum, 126, footnote. 1872.

Pertusaria lecanina Tuck. Syn. N. Am. Lich. I: 213. 1882.

Thallus sub-orbiculate, small, thin, smooth, becoming fissured and more or less thickened or roughened centrally; gray to pale yellowish; KOH pale yellow; KOH plus CaCl_2O_2 deeper or orange-yellow.

Apothecial warts numerous, small, lecanorine, sessile, pruinose, nearly concolorous to pure white; when moistened and rubbed the pale and flesh-colored disk becomes visible; margin entire; spores in

twos, $\frac{37.5 - 60}{74 - 160} \mu$.

Abundant on the bark of *Æsculus californicus* and *Populus* sp., in the foothills; occasional on oaks.

An inconspicuous species usually occurring in small to very small patches among other crustaceous lichens on bark and obscured by them. Apparently confined to California.

7. PERTUSARIA PUSTULATA (Ach.) Nyl.

Porina pustulata Ach. Lich. Univ. 309. 1810.

Pertusaria pustulata Nyl. Act. Soc. Linn. Bord. Ser. III. 441, pl. I. 1856.

Pertusaria pustulata Tuck. Syn. N. Am. Lich. I: 215. 1882.

Thallus small, smooth at first, soon chinky and more or less roughened or warty, thin, and from determinate becoming effuse; cream-colored, gray, or white; KOH—; CaCl_2O_2 —.

Apothecial warts small to minute, convex, flattened, hemispherical or irregular; ostioles dusky or black, dot-like, often confluent and becoming disk-like, or stellate; spores one or two in the asci,

$\frac{24 - 39}{73 - 98} \mu$.

Common on trunks and limbs of *Quercus agrifolia* about Santa Cruz. Occasional on other trees in the foothills. A cosmopolitan lichen.

8. PERTUSARIA LEIOPLACA (Ach.) Schaer.

Porina leioplaca Ach. Vet. Ak. Handl. 59. 1809.

- Porina leioplaca* Ach. Lich. Univ. 309, pl. 7. f. 2. 1810.
Pertusaria leioplaca Schaerer, Spicilegia, 66. 1823.
Pertusaria leioplaca Tuck. Syn. N. Am. Lich. I: 214. 1882.

Thallus determinate, cartilaginous, thin to very thin, smooth, becoming folded or undulate, and fissured; color whitish or creamy; KOH yellow.

Apothecial warts scattered, adnate, hemispherical to irregular, smooth, somewhat flattened; ostioles solitary or few, minute, punctiform, indistinct or blackening; spores varying, 3-4-5- and 6 in the asci; rarely only two; oblong ellipsoid; $\frac{27 - 35}{47 - 75} \mu$.

On trunks and limbs of trees in the foothills. A cosmopolitan lichen.

LECANORACEÆ.

Thallus crustaceous, uniform or marginally lobed, or exceptionally fruticose, branched and decumbent; without rhizoids, and with or without cortex; alga *Protococcus* or *Pleurococcus*.

Apothecia permanently innate in the thallus or sessile, circular, with a thalline margin enclosing algæ; proper margin lacking or imperfectly developed; hypothecium clear, usually upon a layer of algæ; paraphyses unbranched and free, or branched and agglutinate; asci usually 8-spored, sometimes 2-8, or 8-32 sporous; spores colorless, rarely brownish, simple, bilocular to multilocular and muriform; thin walled.

KEY TO GENERA.

- A. Spores simple.
 - B. Paraphyses unbranched, free.
 - C. Spermatia thread-like, straight or curved...XLIII. *Lecanora*
 - CC. Spermatia ellipsoid, straight; thallus egg-yellow.
 - XLVII. *Candelariella*
 - BB. Paraphyses branched and net-like.....XLIV. *Ochrolechia*
- AA. Spores not simple.
 - D. Sterigmata exobasidial; spores bilocular.
 - E. Thallus gray or brown; spermatia thread-like, straight or curved.....XLV. *Lecania*
 - EE. Thallus egg-yellow; spermatia ellipsoid, straight.
 - XLVII. *Candelariella*
 - DD. Sterigmata endobasidial; spores 2-4 locular.
 - XLVI. *Placolecania*

XLIII. *Lecanora* Ach.

Lecanora Ach. Lich. Univ. 77. 1810.

Thallus uniform crustaceous, becoming marginally lobed, or squamulose and occasionally sub-foliaceous, or very rarely fruticose and erect or decumbent; alga *Protococcus*. Apothecia permanently innate in one section, or more often sessile, circular, with thalline margin enclosing algæ; proper margin little or not at all developed; paraphyses unbranched, free; hypothecium clear or colored, not black; spores nearly always 8, rarely 16 or 32, simple, colorless, ellipsoid, ovoid, or globose, thin-walled, without halo. Spermatia thread-like, straight, bowed, or sickle-shaped.

A very large genus found all over the world and growing upon the most diversified substrata. Many of the species exceedingly variable and often difficult to determine, the varietal forms apparently intergrading.

KEY TO THE SPECIES.

- A. Thallus fruticulose.
 - I. Sect. *Cladodium* Tuck. Thallus fruticulose to decumbent and warty, without cortical layer; apothecia terminal or lateral.
 - a. Thallus erect, short, effuse, not sorediate. 1. *bolanderi*
 - aa. Thallus forming tufts or small mats; more or less sorediate
 - 2. *phryganitis*
 - AA. Thallus not fruticulose.
- B. Thallus sub-foliaceous, marginally lobed.
 - II. Sect. *Placodium* (Hill.) Th. Fr.—Thallus sub-foliaceous, marginally lobed, centrally passing from crustaceous forms to squamulose; upper cortical layer well developed; apothecia sessile.
 - b. Thallus very thick, tartareous; orange with CaCl_2O_2 .
 - 3. *pinguis*
 - bb. Thallus thin, parmelioid, with long marginal lobes; no change with CaCl_2O_2 4. *saxicola*
 - BB. Thallus uniform crustaceous, not marginally lobate.
- C. Apothecia sessile.
 - III. Section *Eulecanora* Wainio.—Thallus uniform crustaceous, areolate or warty; cortex present or more or less imperfectly developed; apothecia sessile.
 - c. On rocks.
 - d. Apothecia black within. 7. *atra*
 - dd. Apothecia pale within.
 - e. Thallus yellowish with CaCl_2O_2 15. *frustulosa*
 - ee. Thallus not affected by CaCl_2O_2 .

- f. Apothecia small, very numerous, not pruinose.
- g. Apothecia black 8. *coilocarpa*
- gg. Apothecia bright chestnut.
 - 12. *subfusca campestris*
- ff. Apothecia medium to large; pruinose.
- h. Thallus determinate, often zonate, areolate; apothecia bluish gray or whitish pruinose.
 - 9. *sordida*
- hh. Thallus effuse, warty or coarsely granular; apothecia ashy pruinose 10. *atrynea cenisia*
- cc. On bark or dead wood.
- i. Thallus not affected by or only darkened by KOH.
- j. Apothecia very small, the margin white 4. *hageni*
- jj. Apothecia biatorine, margin soon excluded, disk swollen, dark brown and blackening 17. *varia sœpincola*
- ii. Thallus colored by KOH.
- k. Thallus orange or orange-red with CaCl_2O_2 .
 - 18. *symmicta*
- kk. Thallus not affected by CaCl_2O_2 .
- l. Thallus yellow, then red or orange with KOH.
- m. Thallus thin, smooth, whitish or very pale buff-gray 5. *albella*
- mm. Thallus thick, rough or warty; dull ashy gray to dusky 6. *albella cancriformis*
- ll. Thallus only yellow or yellowish with KOH.
- n. Apothecia greenish pruinose; paraphyses agglutinate. . 13. *pacifica*
- nn. Apothecia not pruinose; paraphyses more or less distinct.
- o. Apothecia reddish brown 11. *subfusca*
- oo. Apothecia small, pale yellowish or whitish 16. *varia*
- CC. Apothecia permanently innate.
- IV. Sect. *Aspicilia* (Mass.) Th. Fr.- Thallus uniform crustaceous; apothecia permanently innate, disk concave to plane.
- p. Thallus yellow, then brick-red with KOH.
- q. Medulla blue with I. 19. *alpina*
- qq. Medulla not blue with I. 20. *cinerea*
- pp. Thallus not affected by KOH.
- r. Surface of areoles smooth; apothecia not pruinose
 - 21. *gibbosa*
- rr. Surface of areoles rough crumbly; apothecia whitish pruinose 22. *calcareæ*

SECTION CLADODIUM Tuck.

Thallus fruticulose to decumbent and warty, without cortex.

1. LECANORA BOLANDERI Tuck.

Lecanora bolanderi Tuck. Proc. Am. Acad. Arts & Sci. 6: 266. 1864.

Lecanora bolanderi Tuck. Syn. N. Am. Lich. I: 181. 1882.

Proc. Wash. Acad. Sci., May, 1910.

Lecanora bolanderi Herre. Proc. Wash. Acad. Sci. 7: 384. 1906.

Lecanora thamnitis Tuck. Lich. Calif. 20. 1866.

Lecanora thamnitis Tuck. Syn. N. Am. Lich. I: 181. 1882.

Lecanora thamnitis Herre, Proc. Wash. Acad. Sci. 7: 385. 1906,
(copied from Tuckerman).

Thallus fruticose, short, rigid, dichotomously divided, ultimately forming dense clumps, but all stages occur from diffuse, crustose forms to orbicular, fruticose clumps; branches terete, erect, blunt; color a yellowish green. Apothecia terminal, of medium size, becoming large; disk concolorous or decidedly yellowish, sometimes tawny, dusky or blackening; margin swollen, entire, or more or less crenate or denticulate; spores ovoid-ellipsoid, $\frac{5-8}{10-14}$ μ .

On granite cliffs 250-300 feet above the sea near Point San Pedro, on sandstone at Pescadero Point and near Pigeon Point Lighthouse, and on metamorphic rocks about San Francisco; not common.

After an examination of Tuckerman's material and my own material collected by Bolander as well as myself, I am unable to separate *bolanderi* and *thamnitis*.

So far as I am aware, recorded only in California, from Olima, Marin County, the Oakland Hills, the Farallone Islands, and the Santa Cruz Peninsula. In the Report of the Fur Seal Investigations, Part III, p. 383, 1896-'97 (1899) *Lecanora thamnitis* is given by W. W. Calkins in a list of lichens collected on St. Paul Island in 1891. If this is correct, the range extends to Bering Sea.

2. LECANORA PHRYGANITIS Tuck.

Lecanora phryganitis Tuck. Lich. Calif. 19: 1866.

Lecanora phryganitis Tuck. Syn. N. Am. Lich. I: 182. 1882.

Lecanora phryganitis Herre, Proc. Wash. Acad. Sci. 7: 385. 1906.

Thallus short, terete, rigid; simple or irregularly short-branched; tufted, or forming low, rounded, intertangled mat-like clumps, the branches longer and decumbent at the circumference; covered with soresiose yellowish gray-green granules or powder, or sometimes with large soredia; beneath brown, or blackening basally; apothecia very rare, only two or three fertile specimens being found; these terminal, medium to large, flexuous, the disk tawny yellowish.

Tuckerman states "apothecia middling to ample, lateral, subsessile; disk pale brick-colored, margin flexuously lobed; spores oblong, ellipsoid, $\frac{12 - 16}{5 - 7} \mu$."

Abundant on granite cliffs above the sea near Point San Pedro, altitude 300 feet; a few plants also found at Point Pescadero at an elevation of 50 feet. Still rather frequent on metamorphic rocks at Twin Peaks, San Francisco, at an altitude of 600 to 755 feet.

The type locality, Mission Dolores, is now in a thickly settled part of San Francisco and the plant is rapidly becoming extinct; material such as Bolander collected can no longer be obtained.

A very distinct lichen, always associated with *Lecanora pinguis* and *L. bolanderi* Tuck. Apparently limited in its range to the strictly maritime portions of the Santa Cruz Peninsula.

SECTION PLACODIUM (Hill.) Th. Fries.

Thallus sub-foliaceous, marginally lobed, centrally passing from crustaceous forms to squamulose; cortex present above; apothecia sessile.

3. LECANORA PINGUIS Tuck.

Lecanora pinguis Tuck. Proc. Am. Acad. Arts & Sci. 6: 268. 1864.

Lecanora pinguis Tuck. Syn. N. Am. Lich. I: 185. 1882.

Lecanora pinguis Cummings and Seymour, Decades of N. Am. Lichens, no. 130, San Mateo County, Calif.

Thallus thickened, tartareous, closely adnate, finally of wart-like, roughened areoles; centrally the areoles scarcely distinct, but radiately plicate at the circumference; color a peculiar yellowish-greenish to olive gray; sometimes dusky centrally or occasionally suggesting sulfur; medulla a very pale sulfur; thallus orange with CaCl_2O_2 ; KOH—.

Apothecia medium to very large, becoming lobate; adnate, usually numerous, strongly resembling those of *Lecanora phryganitis*; the disk yellowish flesh-color, sub-pruinose, becoming turgid and excluding the thick margin which is finally much flexed and lobed; thecium blue with I; spores oblong to narrow ellipsoid, rarely slightly bowed,

$\frac{4 - 7}{12\frac{1}{4} - 18} \mu$.

This very distinct lichen is abundant on rocks in the maritime area; so far as the author is aware it is confined to the maritime belt of central California.

4. LECANORA SAXICOLA (Poll.) Ach.

Lichen saxicola Pollich, Hist. Plant. in Palatin. Elect. 225. 1777.

Lecanora saxicola Ach. Lich. Univ. 431. 1810.

Lecanora muralis, *Lecanora muralis* a. *saxicola*, *Lecanora muralis* c. *diffracta*, and *Lecanora muralis* d. *semitensis* Tuckerman, Syn. N. Am. Lich. I: 184. 1882.

Lichen diffractus Ach. Lich. Suec. Prodr. 63. 1798.

Lecanora semitensis Tuck. Proc. Amer. Phil. Soc.

Thallus orbiculate, medium to large, closely appressed, of scales or areolae centrally, becoming radiate at the circumference; the lobes sinuate, plane or plicate, multifid, with crenate tips, parmeioid; color from glaucous green to pale yellow or brownish, the squamules sometimes black-margined; KOH—; CaCl₂O₂—.

Apothecia small to medium size, appressed, central, usually abundant, sometimes obscuring the thallus; disk plane, becoming convex, from pale yellowish passing into reddish brown; the pale margin from entire becoming crenulate and flexuose, finally excluded; spores ellipsoid, $\frac{4.9 - 7\frac{1}{3}}{8 - 15}$ μ .

Common on rocks throughout; occasional on fences and roofs of houses. A variable lichen of world-wide distribution.

var. DIFFRACTA (Ach.)

The variety *diffracta* is distinguished by (a) its much darker thallus, which passes finally into tawny yellow, brick-red, or brown; (b) the scales become reduced to separate, distinct areoles which are usually black-margined; (c) the much narrower and shorter marginal lobes. Apothecia infrequent; small to very large, and from plane and circular becoming difform or highly flexuose; from pale flesh-color passing to dark reddish; the light colored denticulate margin flexuose or sometimes excluded.

Abundant and variable on sandstone at 2000 feet and above; through the coalescence of adjacent plants often covering large areas.

Sometimes reduced to very small and sparsely scattered scales with only a trace of peripheral lobation, forming then the variety *semitensis* of Tuck., which I am unable to separate from *diffracta*, as the two forms seem to grade imperceptibly one into the other.

A lichen of Europe and North America.

SECTION EULECANORA Wainio.

Thallus uniformly crustaceous, areolate or warty, a cortical layer more or less perfectly developed; apothecia sessile.

5. LECANORA ALBELLA (Pers.) Ach.

Lichen albellus Persoon in Ust. Ann. Bot. 11: 18. 1794.

Lecanora albella Ach. Vet. Ak. Handl. 137. 1810.

Lecanora pallida Tuck. Syn. N. Am. Lich. I: 185. 1882.

Thallus thin, smooth, whitish or very pale buff-gray, determinate, from orbicular spreading and forming large diffuse patches; KOH yellow, then dark orange-red; CaCl_2O_2 —.

Apothecia usually scattered, medium, plane, pale buff or flesh-colored, naked or grayish or whitish pruinose, the entire margin finally disappearing; paraphyses hardly separate; thecium blue with

I, the color soon fading; spores $\frac{7.5 - 10}{11 - 15}$ μ .

Common on smooth barked trees in the foothills. Generally distributed throughout Europe and North America.

6. LECANORA ALBELLA CANCRIFORMIS Tuck.

Lecanora pallida b. *cancriformis* Tuck. Syn. N. Am. Lich. I: 186. 1882.

Lecanora pallida b. *cancriformis* Cummings, Williams, and Seymour, Lichens Boreali-Americana, no. 51, Berkeley, Calif.

Thallus sub-orbicular to effuse, at first thin, soon becoming thick and rough or warty; dull ashy gray to dusky; KOH yellow, changing to muddy red or orange; CaCl_2O_2 —.

Apothecia numerous, medium to large, from plane finally convex

and excluding the thick entire or crenate margin; sometimes crowded and then angular; disk flesh-colored and gray pruinose; spores broadly ellipsoid, $\frac{7-9}{12-15}$ μ ; thecium blue with I.

Common on bark of trees in the foothills and on fences in the salt marshes about San Francisco Bay. Collected by Bolander at Alameda, by Howe at Berkeley, and by Dr. Hasse in southern California; Californian specimens also in Tuck. Herb., collected by Charles Wright. A North American lichen.

7. LECANORA ATRA (Huds.) Ach.

Lichen ater Hudson, Fl. Angl. 1: 445. 1762.

Lecanora atra Ach. Lich. Univ. 334. 1810 (excluding vars. β and γ).

Lecanora atra Tuck. Syn. N. Am. Lich. I: 189. 1882.

Thallus from determinate becoming effuse and spreading extensively, bounded by the black hypothallus; from rather thin soon becoming thick, granulate, rough warty, or passing into smoothish distinct areoles, separated by black fissures; color a clear bright grayish white varying to cloudy ashy gray; KOH yellow; CaCl_2O_2 —.

Apothecia from innate soon prominent, sessile, and finally quite large; disk plane or slightly convex, dead black; margin persistent, white, entire, rarely crenulate or flexuous; black within to the naked eye; paraphyses broad, coherent, dark violet, their tips much darker; becoming reddish violet with KOH; blue or greenish blue with I;

spores ellipsoid or ovate, $\frac{5-7.5}{9.75-14}$ μ .

The smooth, areolate, brightly colored form with large to very large apothecia is abundant and conspicuous on shale along the sea coast north of Santa Cruz for 30 miles or so. Found also on rocks in the foothills and sometimes on old fences, the thallus strongly resembling that of *Lecanora coilocarpa*. Collected on metamorphic sandstone at Mission Dolores by Bolander. In the Tuckerman Herbarium is a Californian specimen collected by Charles Wright on *Quercus agrifolia*, but I have been unable to find it on trees.

Occurring all over the North Temperate Zone.

8. LECANORA COILOCARPA (Ach.) Nyl.

Lecanora subfusca β *coilocarpa* Ach. Lich. Univ. 393. 1810.

Lecanora coilocarpa Nyl. with Norrl. in Medd. Sölsk. pro Faun. et Flor. Fenn. 1: 23. 1876.

Lecanora subfusca d. *coilocarpa* Tuck. Syn. N. Am. Lich. I: 188. 1882.

Thallus determinate or effuse, at first rather thin, uneven, granulate, wrinkled, becoming thickish, fissured, and verrucose; color gray to white; KOH yellow; CaCl_2O_2 —.

Apothecia usually small and very numerous, sometimes concealing the thallus, finally of medium size; from concave and plane eventually convex and flexuous; disk black; margin entire to crenate, rarely lobate; paraphyses slender, hardly free or else coherent, the epithecium dark greenish in section; hymenium blue with I; spores

$$\frac{5 - 6}{14 - 18} \mu.$$

Abundant on rocks; closely resembling *Lecanora atra* and *Lecanora frustulosa* in some of their forms, but readily separated on examination of sections of the apothecia.

A rock lichen of Europe and North America.

9. LECANORA SORDIDA (Pers.) Th. Fr.

Lichen sordida Persoon in Ust. Ann. Bot. 7: 26. 1794.

Lecanora sordida Th. Fr. Lich. Scand. 1: 246. 1871.

Lecanora sordida Tuck. Syn. N. Am. Lich. I: 187. 1882.

Thallus determinate, medium to large, orbiculate or effuse, and spreading extensively, the circumference often zonate; fissured, or chinky and areolate, rough, the surface crumbly; whitish, glaucous white, or brownish white; KOH bright yellow; CaCl_2O_2 —.

Apothecia numerous, often crowded, of small to medium size, at first innate, plane, soon sessile and convex or globose; circular to angular and difform; disk usually black, also pale clouded-flesh-color, and dusky; densely pruinose, the apothecia appearing dull gray to bluish gray or whitish; yellow with CaCl_2O_2 ; margin thin, entire, finally disappearing; thecium blue with I; spores

$$\frac{4.9 - 8.5}{9.5 - 17.5} \mu.$$

Common on rocks throughout and widely distributed over Europe and North America.

10. LECANORA ATRYNEA CENISIA (Ach.) Nyl.

Lecanora cenisia Ach. Lich. Univ. 361. 1810.

Lecanora cenisia Tuck. Syn. N. Am. Lich. I: 186. 1882.

Lecanora atryneae cenisia Nyl. ex Lamy, Bull. Soc. Bot. Fr. 409. *pl.* 25. 1878.

Thallus of coarse crumb-like or warty granules, usually scattered, or forming a warty, areolate crust; from determinate spreading extensively and becoming indeterminate; color varying from gray to white; KOH yellow; CaCl_2O_2 —.

Apothecia usually numerous, medium to large, plane to convex, sometimes contorted from crowding; livid, yellowish brown, and blackish, the color concealed by an ashy bloom so that the apothecia appear nearly concolorous with the thallus; the thick margin crenate, persistent; epithecium brownish, granulose; thecium blue with I; spores ellipsoid, $\frac{7 - 10}{10 - 17} \mu$.

A rather variable lichen, abundant on rocks and occasional on earth along the ocean shore, occurring also on various rocks on Mt. San Bruno, at 1000 feet and above.

I also refer here a lichen from the San Bruno Hills in which the thallus is composed of closely aggregated papillate warts, with large and naked apothecia.

Distributed over Europe and North America, in maritime and alpine regions.

11. LECANORA SUBFUSCA (L.) Ach.

Lichen subfuscus Linné, Fl. Suec. 409. 1755.

Lecanora subfusca Ach. Lich. Univ. 393. 1810.

Lecanora subfusca Tuck. Syn. N. Am. Lich. I: 187. 1882, (in part.)

Thallus from orbiculate and determinate becoming effuse and widespread, smoothish and thin to uneven, wrinkled, chinky, or rough granulose; color whitish, grayish white, or ashy gray; KOH yellow; CaCl_2O_2 —.

Apothecia of small to medium size, plane or plano-convex, the disk typically of a beautiful bright clear reddish brown, but varying from light brown to a very dark brown-black; not pruinose; the persistent thalline margin entire to flexuous and slightly crenate; paraphyses slender, distinct, the epithecium brownish or yellowish; thecium bluish, then indigo with I; spores ellipsoid to ovate-ellipsoid,

$$\frac{7 - 11}{12 - 17} \mu.$$

Abundant on bark of various trees, especially in the foothills; not rare on old fences. Disk sometimes black from the numerous minute apothecia of a parasitic *Thelidium* or *Conidioclamens*.

Found throughout the world; a variable plant occurring on a great variety of substrata.

12. Var. CAMPESTRIS Schaerer.

Lecanora subfusca campestris Schaerer, Spicil. 391.

Lecanora subfusca campestris Tuck. Syn. N. Am. Lich. I: 188. 1882.

Thallus from contiguous becoming thin and scattered, rougher and granulose warty; gray to grayish white; apothecia very numerous, usually small; plano-convex or turgid, often flexuous; the disk bright chestnut to blackish brown; naked; margin entire to minutely crenate.

A rock-dwelling form of *subfusca*, occurring on sandstone throughout.

Of the many varieties of *subfusca* named by authors, we seem to have, in addition to the above described, only *argentata* and perhaps *allophana*, and these I am unable to regard as differing enough from the typical form to merit separate descriptions. In the Tuck. Herb. are specimens labelled *Lecanora subfusca* v. *chlarona* collected by Bolander on *Quercus* or *Passania densiflora*, and in Marin County on *Negundo aceroides* and also some collected by Charles Wright, botanist of the U. S. Exploring Expedition.

In some of my specimens the thallus is very near that of *Lecanora chlarona* collected by me in the Austrian Alps, but a section of the apothecium shows that they do not have the entirely clear epithecium of *chlarona* but the brownish one of *subfusca*. It is doubtful if true *chlarona* has ever been collected in this region.

13. LECANORA PACIFICA Tuck.

Lecanora pacifica Tuck. Syn. N. Am. Lich. I: 191. 1882.

Thallus thin, from smooth and uniform becoming chinky, rough, and warty; dirty white and grayish; KOH yellowish; CaCl_2O_2 —.

Apothecia small to medium, appressed, flat; disk pale to dull yellowish and tawny, or darker, usually thin greenish pruinose; the white margin crenulate, persistent, often flexuous; paraphyses slender, agglutinate; epithecium yellowish or brownish, granular; thecium indigo with I; spores ellipsoid, $\frac{6.5 - 11}{12 - 17} \mu$.

On trees, growing in small patches intermingled with *Lecanora subfusca* and *Lecanora hageni*. Recorded only from California, Oregon, and Vancouver Island. Tuckerman says "The plant is common and very observable among the bark-lichens of our Western Coast." This does not accord with the experience of either Dr. Hasse or myself; on examination of the material in the Tuckerm. Herb. it seems to me to be too close to *Lecanora subfusca* to be readily separable. Such other material as I have seen under this name elsewhere has been *Lecanora albella cancriformis*.

Separated from *subfusca* by the pruinose apothecia, the agglutinate paraphyses, and the granular epithecium.

14. LECANORA HAGENI Ach.

Lecanora hageni Ach. Lich. Univ. 367. 1810. (excluding varieties).

Lecanora hageni Tuck. Syn. N. Am. Lich. I: 188. 1882.

Thallus effuse, very thin and disappearing, or of tiny scattered warts; color white, grayish-white, ash-colored, or greenish-dusky; KOH—; CaCl_2O_2 —.

Apothecia minute to small, numerous, thin, flat, often contorted from being crowded; disk plane, pale to dark brown, and blackening, densely gray pruinose; the conspicuous white margin thin, erect, persistent, entire or denticulate; paraphyses rather slender, their tips slightly brown; said to be jointed, though I do not find them so.

Spores ellipsoid, $\frac{4.9 - 7}{10 - 14} \mu$.

On bark of trees and old fences in the foothills and mountains; most abundant on *Aesculus californicus*, associated with *Caloplaca cerina*. On leaves of *Yucca* sp., at Stanford University, with *Candelaria concolor* and *Buellia myriocarpa*. On an old leather shoe, with *Candelariella epixantha*, Fatjo Ranch, altitude 2500 feet. On shale at San Gregorio Beach; this last has a more uniform and better developed thallus than other specimens.

Found throughout Europe and North America.
(*hageni*, named for Karl Gottfried Hagen, 1749-1829, Professor of botany at Königsberg.)

15. LECANORA FRUSTULOSA (Dicks.) Ach.

Lichen frustulosus Dicks. Crypt. Fasc. III: 13. pl. 8, f. 10. 1793.

Lecanora frustulosa Ach. Lich. Univ. 405. 1810.

Lecanora frustulosa Tuck. Syn. N. Am. Lich. I: 186. 1882.

Lecanora frustulosa Cummings, Williams, and Seymour, Decades of N. Am. Lichens, no. 262, San Diego, Calif.

Thallus thick, somewhat determinate, of wart-like areoles, or squamules, these distinct, becoming flattened and more or less radiately effigurate; dispersed, or crowded and nearly imbricate; color yellowish white or whitish; KOH yellow; CaCl_2O_2 yellowish.

Apothecia small to medium, sessile, plane to convex, the disk brownish black or black; margin thick, entire or somewhat crenate; paraphyses coherent, brownish, their tips darker; hymenium blue with I; spores ellipsoid or oblong, $\frac{5-8}{10-15} \mu$.

On rocks in the foothills; a lichen of northern Europe and North America.

Our specimens all seem to belong to the form with white thallus (v. *albida*), instead of the more typical form with yellowish color, and are not always easy to separate from *Lecanora coilocarpa* and *Lecanora atra* in external appearance.

16. LECANORA VARIA (Ehrh.) Ach.

Lichen varius Ehrh. Crypt. Exsicc. no. 68, 1785.

Lecanora varia Ach. Lich. Univ. 377. α and β , 1810.

Lecanora varia Tuck. Syn. N. Am. Lich. I: 191. 1882, (in part).

Thallus sub-determinate or effuse, thin, uneven, usually scanty, limited more or less by the black hypothallus; of small areoles, or distinct, unequal granules; color a pale yellowish, whitish or greenish; KOH yellow; CaCl_2O_2 —.

Apothecia small, numerous, often crowded, plane or plano-convex, concolorous or pale yellow; margin thin, entire or crenulate, finally excluded; thecium bluish then greenish-bluish with I; paraphyses slender, free or sub-conglutinate; spores ellipsoid, $\frac{4.5 - 6}{9 - 12.25} \mu$.

Common in the foothills on the bark of trees and on fences. On leaves of *Sequoia sempervirens*, Santa Cruz Mts., Farlow in Tuckerm. Herb.; on cones of *Pinus insignis*, Bolander.

A plant of very wide distribution.

17. LECANORA VARIA SÆPINCOLA E. Fries.

Lecanora varia sæpincola E. Fries, Lich. Europ. Reform. 158. 1831.

Lecanora varia sæpincola. Tuck. Syn. N. Am. Lich. I: 192. 1882.
(Not *Lecanora symmicta sæpincola* of Crombie, British Lichens, 434. 1894.)

Thallus effuse, of small, crumb-like granules or leprose-pulverulent; contiguous or more or less scattered and thin; dirty grayish, greenish, or green-gray; KOH darkens the thallus; CaCl_2O_2 —.

Apothecia very numerous, minute to small, biatorine; the pale entire margin visible only in early stages, soon excluded by the usually swollen, finally irregular disk; dark red-brown and blackening; paraphyses narrow, conglutinate to somewhat free, jointed, the brownish tips slightly thickened; epithecium brown; hypothecium clear; hymenium bluish or blue with I; spores ellipsoid,

$$\frac{4.5 - 5}{7.5 - 12.5} \mu.$$

On old fences in the foothills. A lichen of dead wood and fences, common in Europe and America.

I refer our material here with much doubt, but it is not to be placed under any other species I find described.

18. LECANORA SYMMICTA Ach.

Lecanora symmicta Ach. Synopsis, 340. 1814.

Lecanora varia d. *symmicta* Tuck. Syn. N. Am. Lich. I: 192. 1882.

Thallus thin or very thin and scanty, effuse, of minute granules, or forming a minute, rough crust; pale yellow or greenish yellow; KOH yellow; CaCl_2O_2 orange or orange-red.

Apothecia small, at first flat, with thin, entire, or denticulate margin; soon convex, the margin disappearing; often crowded and angulose, sometimes heaped, usually obscuring the thallus; color pale yellow, brownish yellow, or darkening somewhat; paraphyses slender, free, their tips slightly enlarged; thecium blue with I; spores ellipsoid or oblong, $\frac{5 - 7\frac{1}{3}}{11 - 13.5}$ μ .

Abundant on old fences about the salt marshes and in the valleys and foothills; also occurring on bark of trees. Common throughout the temperate region.

Distinguished from *Lecanora varia*, which it much resembles, by the reaction with CaCl_2O_2 , and by the biatorine apothecia.

SECTION ASPICILIA (Mass.) Th. Fr.

Thallus uniform crustaceous, upper cortical layer more or less developed; apothecia permanently innate, the disk deeply concave to plane; paraphyses mostly lax, septate.

19. LECANORA ALPINA Sommerf.

Lecanora alpina Sommerfeldt, Suppl. Fl. Lapp. 94. 1826.

Lecanora alpina Th. Fries, Lich. Scand. 1: 283. 1871.

Thallus of minute areoles with rough uneven surface, separated by deep, relatively wide fissures; from dark ashy gray merging into cream, or reddish gray at the margin; KOH yellow, then a permanent brick-red; CaCl_2O_2 — ; medulla more or less blue with I.

Apothecia numerous, small or minute, one or sometimes two or three in an areole; at first innate, with concave disk, soon emergent and plane or even elevated; color jet-black when dry; more or less reddish black when wet; thalline margin entire, at last excluded; the-

cium blue with I, the asci yellowish or reddish-yellowish; epithecium brownish; spores 8, ovoid, $\frac{3.6 - 7}{7.5 - 12.25}$ μ .

Described from a small specimen collected on the summit of Loma Prieta, altitude 3793 feet. Near *Lecanora cinerea*, from which it is markedly separated by the small spores and the rough surface of the areoles, as well as the medullary reaction with I.

A lichen of northern Europe.

20. LECANORA CINEREA (Ach.) Somm.

Lichen cinereus (?) Linné, Mantissa, I, 132. 1767.

Lichen cinereus Ach. Lich. Suec. Prodr. 32. 1798.

Lecanora cinerea Sommerfeldt, Suppl. Fl. Lapp. 99. 1826.

Lecanora cinerea Tuck. Syn. N. Am. Lich. I. 198. 1882 (in part).

Thallus effuse, or more or less determinate, of uniform smooth areoles separated by a net-work of irregular chinks or fissures, or else of separate distinct areoles; the black hypothallus not very evident; color varying from whitish to ashy or brownish gray, or in shaded situations quite dusky; KOH yellow, then blood-red or brick-red; CaCl_2O_2 —; I—.

Apothecia one to several in an areole, small to medium, at first immersed with concave disk; eventually emerging, then sessile, the disk plane, black, not pruinose; margin entire, persistent; paraphyses somewhat agglutinate, their tips brownish; hymenium bluish, then tawny with I; spores 8 or sometimes but 6 in the asci, round-ellipsoid, $\frac{11 - 14}{17 - 22}$ μ .

On rocks throughout; generally distributed over the North Temperate Zone.

With us the apothecia are not very well developed, the spermatogonia however being very numerous.

21. LECANORA GIBBOSA (Ach.) Nyl.

Lichen gibbosus Ach. Lich. Suec. Prodr. 30. 1798.

Lecanora gibbosa Nyl. Lich. Scand. 154. 1861.

Lecanora cinerea c. *gibbosa* Tuck. Syn. N. Am. Lich. I: 198. 1882.

Thallus determinate, thickish, of rounded areolae or warts, their

surface smooth, from flattish becoming tumid and irregular; color light to dark bluish-gray or ashen; KOH —; CaCl_2O_2 —; medulla I —.

Apothecia small, usually one, sometimes two or three in an areole; immersed, concave, finally protruded and sessile, the disk then plane; black, not pruinose; margin persistent, entire, finally flexuous; thecium pale blue, then greenish blue or reddish violet with I; paraphyses sub-conglutinate, their tips dark brownish; asci clavate or ventricose, in our specimens their contents usually not differentiated into spores; these when present 6 or 8, sometimes only 4, ellipsoid to sub-globose, $\frac{12 - 20}{24 - 32}$ μ . In another set of specimens tentatively placed here, with very dark greenish thallus, the spores are $\frac{11 - 13.5}{19.5 - 24.5}$ μ .

A very common rock lichen throughout our range; widely distributed in Europe and probably occurring generally over North America.

22. LECANORA CALCAREA (L.) Sommerf.

Lichen calcareus Linné, Sp. Pl. 1140. 1753.

Lecanora calcarea Sommerf. Suppl. Fl. Lapp. 102. 1826.

Lecanora calcarea Tuck. Syn. N. Am. Lich. I: 199. 1882.

Thallus determinate or becoming effuse, chinky areolate; the areoles contiguous, angular, appearing uniform to the naked eye, surface more or less rough-crumbly; at the circumference often somewhat effigurate; KOH —; CaCl_2O_2 —; medulla I —. Color from bluish and light gray to pure white; also occurring with the areoles widely scattered, rounded, convex, dull white, densely white pruinose.

Apothecia numerous, innate, sunken, finally plane, black, usually whitish pruinose; paraphyses slender, agglutinate; their apices yellowish-brownish; hymenium blue with I; asci in our specimens usually without spores; these usually 6, also 2, 7, and 8 in number, ellipsoid or globose, $\frac{14 - 22}{17 - 25}$ μ .

Well developed on limy sandstone in the mountains, above 2000

feet; the white form of dispersed areoles occurs on limestone in the foothills above Los Gatos, at 1000 feet and above.

The variety *contorta* (Hoffm.) occurs on shale along the sea coast and occasionally elsewhere. It is distinguished by the greenish-lead-colored thallus, which is more or less contiguous and thin to moderately thick; fertile areoles enlarged, elevated, irregular, with medium to large, urceolate apothecia.

Found generally over Europe, North America, and northern Africa.

XLIV. *Ochrolechia* Mass.

Ochrolechia Massalongo, Ric. Aut. Lich. Crost. 30. 1852.

Thallus uniform crustaceous, areolate, the areolæ more or less stipitate below; alga *Pleurococcus*; surface of thallus often sorediate.

Apothecia sessile, basally constricted, circular; hypothecium clear; paraphyses branched and entangled; asci 2-8 sporous; spores colorless, large, ellipsoid or ovoid, simple, with thin walls.

Species few; bark, moss, or rock lichens of the cooler portions of the earth.

KEY TO THE SPECIES.

- A. On bark; thalline warts red with CaCl_2O_21. *tartarea*
 AA. On mosses and sandstones; CaCl_2O_2 .—2. *upsaliensis*

1. OCHROLECHIA TARTAREA (L.) Mass.

Lichen tartareus Linné, Sp. Pl. 1141. 1753.

Ochrolechia tartarea Mass. Ricerch. sull' Auton. Lich. Crost. 30. 1852.

Lecanora tartarea Tuck. Syn. N. Am. Lich. I: 196. 1882, in part.

Lecanora pallescens Tuck. Syn. N. Am. Lich. I: 196. 1882, in part.

Thallus orbiculate to effuse, thick, (rarely thin), from smooth becoming rough, crumbly, granulose and chinky, or of crowded, unequal, finger-like warts; color whitish or grayish white; KOH yellow or yellowish; tops of thalline warts red with CaCl_2O_2 .

Apothecia soon large, from concave becoming plane, finally crowded, or heaped and contorted, the disk wrinkled more or less, and becoming wavy; not rarely when very large they are convex and

depressed centrally; pale brownish yellow to reddish, naked; red or reddish with CaCl_2O_2 ; margin thick, entire, becoming flexed or even lobate; spores ellipsoid, oblongo-ellipsoid, $\frac{20-30}{40-60}$ μ or sub-globose, $\frac{34}{42}$ μ ; 8, 6, 4, or even but 2 in the asci.

Abundant on trunks of trees and on shrubs in the foothills and mountains, in both forests and chaparral; also found on the roof of a house in Mayfield.

I include here the "common bark lichen of the Pacific Coast" given by Tuckerman under *L. pallescens* (see synonymy above).

A lichen of frequent occurrence in the temperate and sub-arctic realms.

2. OCHROLECHIA UPSALIENSIS (L.)

Lichen upsaliensis Linné, Sp. Pl. 1142. 1753.

Thallus sub-orbiculate and determinate, or effuse; thin and smooth to thickish and tuberculate, bluish white or yellowish white; KOH — ; CaCl_2O_2 — .

Apothecia usually small, eventually of medium size, numerous; when young deeply concave, finally plane, the disk pale yellow and granulose; margin thick, prominent, entire; spores 4 to 8 in the asci, $\frac{25-35}{40-55}$ μ .

Encrusting mosses and on sandstone among mosses at Devils Cañon, 2300 feet; Grizzly Peak, 2715 feet; and Castle Rock, 3000 feet. Also from Mt. Diablo, collected by Horace Mann, in Tuck. Herbarium. A European lichen probably occurring throughout Western North America in alpine situations.

XLV. *Lecania* (Mass.) A. Zahlbr.

Lecania Massalongo, Alc. Gen. Lich. Nuov. Limit. e Descr. 12. 1853.

Lecania A. Zahlbruckner, Ascolichenes, 204. 1907.

Thallus varying from uniform crustaceous to marginally lobate or squamulose forms, or even dwarfed fruticose; alga *Pleurococcus*.

Apothecia circular, sessile, lecanorine, a proper margin lacking or

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more or less developed; paraphyses simple, not twining; asci with 8 spores, rarely with 16 or 32; spores colorless, elongate or ellipsoid, straight or curved, 2- multilocular, thin-walled; spermatia exobasidial.

About 50 species, removed from *Lecanora* by the spores and the structure of the spermogonia.

KEY TO THE SPECIES.

- A. Thallus of discrete squamules or warts; reddish or red brown.
1. *dudleyi*
 AA. Thallus more or less continuous.
 B. Thallus areolate, pale to tawny brown and blackening.
2. *brunonis*
 BB. Thallus thin or very thin, not areolate; brownish ash-colored to white. 3. *dimera*

1. LECANIA DUDLEYI Herre, new species.

Thallus effuse, of thick, irregular, closely appressed scales, which vary in shape from crenate flattened squamules to rounded or sub-globose warts, or difform, warty clumps; always rather sparsely distributed, never forming a uniform crust; color pale to very dark reddish or red-brown; a black hypothallus more or less evident; beneath pale yellowish; KOH - ; CaCl₂O₂ - .

Apothecia of medium size, from plane soon becoming elevated, protuberant, and sub-globose, the thin, entire thalline margin excluded; the disk red-brown or reddish black, finally black granulate; epithecium reddish or reddish-brownish; paraphyses not very slender, jointed, very pale brownish; thecium deep blue or violet with I; spores bilocular, ellipsoid or ovoid, $\frac{6 - 7\frac{1}{3}}{12\frac{1}{4} - 11}$ μ .

On rocks and clay above the sea at Point Lobos, San Francisco.

A unique species unlike anything in any of the collections I have examined.

(*dudleyi*, named for Prof. William Russell Dudley, professor of systematic botany at Leland Stanford Junior University.)

2. LECANIA BRUNONIS (Tuck.) Herre.

Lecanora brunonis Tuck. Gen. Lich. 116. 1872.

Lecanora brunonis Tuck. Syn. N. Am. Lich. I: 193. 1882.

Thallus effuse, of coarse, uneven areoles separated by broad fissures, each areole made up of few to many small, crumb-like granules which become confluent or imbricated; CaCl_2O_2 - ; KOH - ; color pale to tawny brown, and blackening.

Apothecia small to medium size, solitary or clustered, sometimes confluent; disk plane to convex, or turgid, the margin entire or finely toothed, at length excluded; red-brown and blackening; paraphyses rather thick, their tips enlarged and yellow, more or less conglutinate; thecium greenish blue to blue with I; spores bilocular, ellipsoid, $\frac{4 - 7\frac{1}{3}}{12 - 18}$ μ ; also $\frac{7 - 8}{15}$ μ ; once seen 3-locular, $\frac{7}{20 - 24.5}$ μ .

Not rare on various rocks in the foothills; occurring throughout the Santa Cruz Peninsula in the maritime and foothill regions. Also recorded from the Oakland Hills and from near Santa Monica and Catalina Island.

(*brunonis*, from the San Bruno Hills, San Mateo County, where it was discovered by H. N. Bolander.)

3. LECANIA DIMERA (Nyl.) Oliv.

Lecanora dimera Nylander, Not. Sällsk. pro F. et F. Fenn. Förh. 11: 184, 1871.

Lecania dimera Olivier, Lich. l'Ouest et Nord-Ouest France, 1: 309. 1897.

Lecanora athroocarpa Tuck. Syn. N. Am. Lich. I: 194. 1882, (in part).

Thallus effuse, very thin or becoming slightly thicker and minutely verrucose or areolate, but smooth to the naked eye; sometimes disappearing; in our specimens marked by black hypothalline lines; color brownish ashen, grayish-white, or white; KOH yellow or yellowish; CaCl_2O_2 - .

Apothecia small to very small, biatorine, plane or soon becoming convex, the disk pale to dark brown or blackening, not pruinose; the thin, entire thalline margin excluded when the convex black apothecia are quite lecideine in appearance; epithecium broad, dark bluish-dusky or dusky-violaceous; paraphyses simple, free or more or less coherent, thread-like; asci narrowly clavate, $\frac{7 - 10}{45 - 50}$ μ ; thecium deep

indigo with I; spores bilocular, oblong, straight or slightly curved,
 $\frac{3-4.9}{11-19} \mu$.

Rare with us apparently, but probably only overlooked as it is inconspicuous. Growing on bark of *Umbellularia californica*, with *Lecidea tricolor* and other lichens. Widely distributed over Europe and North America.

XLVI. *Placolecania* (Steiner) A. Zahlbr.

Placolecania A. Zahlbr. *Ascolichenes*, 205. 1907.

A small genus, separated from *Lecania* by the endobasidial sterigmata, which are simple or sparingly branched, and septate; spermatia short, straight, rod-like; spores much as in the preceding genus, 2-4 locular.

We have but one species.

1. *PLACOLECANIA CRENATA* Herre, new species.

Thallus of small, orbiculate or erect-imbricate, turgid, crenate and wavy squamules; color pale yellowish-ashy, or yellowish-gray, more or less gray margined; beneath whitish, becoming dusky or blackening; KOH-; CaCl_2O_2 -.

Apothecia small to barely medium, plane, finally convex, half concealed by erect thalline lobules, or sessile; the entire thick margin becoming crenate or wavy and sometimes excluded; disk pale brownish-plum color and blackening, whitish pruinose; paraphyses free, slender, unbranched, their tips thickened and sometimes septate, colorless; epithecium reddish brown or dark; thecium permanent indigo blue with I; hypothecium colorless or slightly brown; spores simple to quadrilocular, mostly bilocular, elliptical, $\frac{4.2-5.5}{11.2-19.6} \mu$; spermatia minute, straight, endobasidial, $\frac{.25-.5}{1-2.5} \mu$.

On rocks and earth in crevices, 50 to 100 feet above the sea at Point Lobos, San Francisco. Material scanty and as yet not seen elsewhere.

Resembles in external appearance *Lecidea massata* Tuck., but the material in the Tuck. Herb. is so very scanty that I did not use any

for microscopic examination. Tuckerman's description is quite unsatisfactory, but this plant seems to be sufficiently distinct from *massata*.

XLVII. CANDELARIELLA Müll. Arg.

Candelariella Müll. Arg.,

Candelariella A. Zahlbr. Ascolichenes, 207. 1907.

Thallus crustaceous, granular, warty, areolate, or marginally lobed, bright yellow or golden; no red reaction with KOH.

Apothecia sessile, circular, lecanorine, yellow, no red reaction with KOH; paraphyses free, simple, septate or not, sometimes with the tip branched; asci with 8 to many spores; spores colorless, elongate to ellipsoid, simple or bilocular. Spermogonia very small, yellow; sterigmata exobasidial, sparingly septate, sometimes forked or branched; spermatia short, straight, more or less dumb-bell shaped. Species few, on wood, bark, and stone.

This genus seems to be close to *Caloplaca*, and is considered by Zahlbruckner to be a reduced form of it, or else to represent the forms from which *Caloplaca* originated.

1. CANDELARIELLA VITELLINA (Ehrh.) Müll. Arg.

Lichen vitellinus Ehrh. Exs. no. 155. 1785.

Candelariella vitellina Müll. Arg.

Placodium vitellinum Tuck. Syn. N. Am. Lich. I: 180. 1882.

Thallus effuse, more or less scattered, of small, rounded, crenate squamules or granules; these scattered and evanescent, or more often crowded into rounded or globose heaps; from pale yellow to bright greenish yellow.

Apothecia numerous, circular, small to medium, sessile; usually clustered and often four-sided or angular from being crowded; the disk flat, finally convex when the thalline margin is excluded; margin entire, becoming granulate or crenate; color yellow to tawny or even brown; thecium blue with I; spores simple or falsely bilocular, 12-32 in the asci, $\frac{4.75 - 7.3}{9.75 - 17.25}$ μ . Occasionally the asci have but 8 spores, when it forms the species *epixantha* of authors, which however I am unable to separate except as a variety.

Occurring throughout on rocks and the earth in their crevices; less often on old fences and on trees. Often scattered over the surface of other crustaceous lichens, when the thallus may be reduced to a few granules about the apothecia, or entirely absent. Found once (var. *epixantha*) on old leather.

Generally distributed over the Northern Hemisphere.

PARMELIACEÆ.

Thallus foliaceous, laterally expanded or more or less ascendant to sub-fruticose; in our representatives attached by rhizoids; dorsal-ventral, cortex on both sides or only above; alga *Pleurococcus*.

Apothecia circular, sessile or on very short pedicels, with thalline margin; paraphyses branched or unbranched, often imbedded in a firm jelly; asci with 6-8 (rarely 16 or more) simple, colorless spores. Spermatia endo- or rarely exobasidial.

KEY TO GENERA.

- A. Asci multisporeous.....XLVIII. *Candelaria*
- AA. Asci 6-8 sporeous
 - B. Thallus flat, usually appressed, beneath brown or dark, more or less fibrillose; apothecia scattered..... XLIX. *Parmelia*
 - BB. Thallus sub-fruticose to fruticose.
 - C. Apothecia marginal or terminal.....L. *Cetraria*
 - CC. Apothecia originating on under side of lobes, later apparently marginal or terminal by the turning of the lobes
 - LI. *Nephromopsis*

XLVIII. *Candelaria* Mass.

Candelaria Massalongo, Mon. Lich. Blast. 62. 1853.

Thallus small, laciniately dissected, yellow; no reaction with KOH.

Apothecia small, lecanorine, sessile, the disk nearly the color of the thallus; asci ventricose-clavate, with 16 or more spores; these small, ellipsoid or ovoid, simple or falsely bilocular.

Three species of wide distribution, growing on bark, wood, and mosses.

I. CANDELARIA CONCOLOR (Dicks.) Wainio.

Lichen concolor Dicks. Pl. Crypt. Brit. II, 18. pl. 9, f. 8. 1793.

Candelaria concolor Wainio, Étud. Lich. Brésil, 70. 1890.

Theloschistes concolor Tuck. Syn. N. Am. Lich. 1: 51. 1882.

Theloschistes concolor Herre, Proc. Wash. Acad. Sci. 7: 349. 1906.

Thallus foliaceous, appressed, the narrow lobes more or less dissected; quite small; color yellow, greenish-yellow, or pale; often an ashy white, pale beneath.

Apothecia small, yellow to orange; spores numerous, 20 to 60 in the asci, simple, or apparently one-septate.

On trees; also on leaves of a *Yucca*, at Stanford University, associated with *Lecanora hageni* and *Buellia myriocarpa*.

An inconspicuous lichen of wide distribution in general, but apparently rare with us.

XLIX. PARMELIA (Ach.) DeNotrs.

Parmelia Ach. Meth. Lich. 153. 1803.

Parmelia DeNotaris, Giorn. Bot. It. 189. 1847.

Thallus foliaceous, appressed, expanded laterally and often very large, variously lobed or laciniate, often imbricate; the lower surface usually black, or dark brown, often brown margined, generally more or less black fibrillose; in a few species not occurring with us fastened by a central umbilicus; upper surface often sorediate or isidiose.

Apothecia shield-like, scattered, sessile or often sub-pedicellate; paraphyses imbedded in a firm jelly, usually branched and septate; spores small, ellipsoid, ovoid, or globose, colorless.

This enormous genus of 400 species or more contains the largest and most conspicuous foliaceous lichens of our flora and is well represented both in number of species and of individuals.

KEY TO THE SPECIES.

- A. Thallus dark.
 - B. Bright shining brown to dull brown or nearly black.
 - C. Apothecia present, often abundant.
 - D. Surface smooth, often polished.
 - E. Medulla not colored by CaCl_2O_2 7. *olivacea*
 - EE. Medulla red with CaCl_2O_2 8. *glabra*
 - CC. Sterile.
 - F. Surface covered with short papillæ9. *exasperata*
 - FF. Surface covered with a concolorous scurfy growth or isidia10. *fuliginosa*
 - BB. Thallus dusky gray to dark brown; with conspicuous erumpent soredia11. *conspurcata*
 - AA. Thallus some shade of green.

- G. Thallus inflated, loosely attached; whitish to bright green.
 H. Without perforations in under surface; lobes usually with terminal soredia 16. *physodes*
 HH. With perforations in under surface; lobes longer, more inflated, without terminal soredia.
 17. *enteromorpha*
- GG. Thallus not inflated.
 I. Color pale, whitish or glaucous.
 J. Under side black, brown-margined; thallus expanded.
 K. Lobes marginally ciliate; thallus medium to very large; glaucous white..... 2. *perforata*
 KK. Margin not ciliate; thallus small to medium; pearly white; maritime;..... 1. *perlata*
 JJ. Under side not brown-margined; thallus narrowed branched.
 L. Sterile or fruiting very rarely.
 M. Thallus beset with small or dot-like white soredia 6. *borreri*
 MM. Thallus not sorediate.
 N. Thallus not reticulate above; margin ciliate; lobes very narrow, short 4. *herrei*
 NN. Surface of thallus reticulate, margin not ciliate; lobes broader, long, many-cleft..... 3. *saxatilis*
 LL. Apothecia abundant; thallus adnate, bright; lobes narrow, sinuate 5. *tiliacea*.
- II. Color yellow to yellowish green.
 O. Beneath black with chestnut or brown border.
 P. Margin of lobes not confluent sorediate.
 Q. Thallus smooth or isidiose-sorediate; on rocks..... 12. *flavicans*
 QQ. Surface wrinkled, plicate, with concolorous soredia; on stones, shrubs, fences. 13. *caperata*
 PP. Edges of lobes confluent white-sorediate; surface wrinkled, at least marginally..... 14. *soredica*
 OO. Beneath pale or dark, margin darker; with short, scattered, concolorous fibrils; surface smooth or usually more or less isidiose..... 15. *conspersa*

1. PARMELIA PERLATA (L.) Ach.

Lichen perlatus Linné, Syst. Nat. ed. 12, 712. 1767.

Parmelia perlata Acharius, Meth. Lich. 216. 1803.

Parmelia perlata Tuck. Syn. N. Am. Lich. I: 53. 1882.

Parmelia perlata Herre, Proc. Wash. Acad. Sci. 7: 351. 1906.

Thallus greenish pearl-gray, dilated, membranaceous; margin thin, smooth, rounded and irregularly lobulate; rest of thallus thick-

ened, convolute, more or less ascending; margins of inner lobes covered with confluent, concolorous soredia; under surface black, wrinkled, papillose, margin brownish; from strongly and densely black fibrillose to smooth. KOH yellow; CaCl_2O_2 —.

Sterile. On old fences and roofs along the seashore, and occasionally on trees and rocks. Not found outside the maritime region. A cosmopolitan lichen.

2. PARMELIA PERFORATA (Wulf.) Ach.

Lichen perforatus Wulfen in Jacquin Coll. 1: 116, pl. 3. 1786.

Parmelia perforata Ach. Meth. Lich. 217. 1803.

Parmelia perforata Tuck. Syn. N. Am. Lich. I: 53. 1882.

Parmelia perforata Herre, Proc. Wash. Acad. Sci. 7: 352. 1906.

Thallus large, finally greatly dilated, smooth, gray, tinged with greenish, or whitish; the ample lobes crenate, becoming marginally much dissected; margins of inner lobes often confluent gray sorediate; lobes fringed (in f. *ciliata* Nyl.) with long, black, simple or branched cilia; under side black, with a broad chestnut margin; interruptedly clothed with dense patches of black fibrils; KOH yellow; the medulla white, becoming rose-red with KOH.

Apothecia rare, medium to large; margin entire; disk chestnut, rarely perforate; spores ellipsoid, $\frac{8.5 - 11}{12 - 16}$ μ .

On trees, mossy rocks, and earth.

This large and handsome plant occurs throughout the Santa Cruz mountains, usually sterile; on shaded, moss-covered sandstone cliffs immense circular mats are formed; in many cases these coalesce into great carpets covering many square feet.

Fruiting specimens occur abundantly on *Quercus* and *Umbellularia*, about the head of Alpine Creek Cañon, at an altitude of 1000 feet, and fertile plants are occasional elsewhere. Nearly all the apothecia seen here belie the specific name, being imperforate.

Occurring generally throughout Europe and North America (including the West Indies), and also in Australasia, Ceylon, Japan, and the Isle of Mauritius.

3. PARMELIA SAXATILIS (L.) Ach.

Lichen saxatilis L. Sp. Plant. 2: 1142. 1753.

Parmelia saxatilis Ach. Meth. Lich. 204. 1803.

Parmelia saxatilis Tuck. Syn. N. Am. Lich. I: 59. 1882.

Parmelia saxatilis Herre, Proc. Wash. Acad. Sci. 7: 354. 1906.

Lichen omphalodes L. Sp. Plant. 1143. 1753.

Parmelia omphalodes Ach. Meth. Lich. 204. 1803.

Thallus narrowed, deeply cleft; lobes long, sinuous, more or less pinnately dissected, or sometimes rather simple and irregularly cut-lobed; surface reticulate, rimose, at length sculptured and lacunose; often scabrous, becoming isidiophorous; color usually ashy gray, but varying from almost white or green to even a yellow-gray; beneath black, with paler or chestnut tips to the lobes; usually densely clothed with black fibrils; KOH yellow; medulla first yellowish, soon blood-red; CaCl_2O_2 —.

Apothecia small to medium; disk pale chestnut; margin irregular, sub-crenulate or rather entire; in my specimens greenish powdery sores; spores ellipsoid, $\frac{7.5 - 9}{10 - 13} \mu$. Practically always sterile with us. Of several thousand specimens examined in the field, but one was found fruiting. This was growing in Devils Cañon on sandstone, alt. 2300 feet, the specimen having 12 apothecia.

Common on trees and rocks. Rarer in the foothills, where it descends as low as 150 feet, but becoming very abundant as the mountains are ascended. Grows indifferently on dead or live trees and rocks, but reaching its maximum size on moss-covered sandstone.

The variety *Isidiata* Anzi, distinguished by the isidiose surface of the fronds, which are reduced to an almost uniform crust, is not rare in the higher mountains, growing on sandstone.

The variety *Omphalodes* (Linné) regarded as a species by many authors, occurs rarely on sandstone along the highest peaks. It is distinguished by the dark, purplish-brown to blackish color of the thallus.

A lichen of Europe, Asia, Africa, and North America.

4. PARMELIA HERREI A. Zahlbr.

Parmelia herrei A. Zahlbr., *in litt.*

Parmelia herrei Herre, Proc. Wash. Acad. Sci. 7: 353. 1906.

Thallus narrow, lobed and deeply dissected; smooth above; the lobes sinuately pinnatifid, their tips rounded or crenate, sometimes soresiate; centrally becoming much complicate and imbricate; margin fringed with long, black, conspicuous cilia. Beneath black and densely clothed with long black fibrils. Surface a dull pearly gray, varying to a slate gray; KOH yellow; medulla red with KOH; CaCl_2O_2 —.

Apothecia not known.

This distinct *Parmelia* occurs only on earth in the crevices of sandstone in Pilarcitos Creek Cañon, about two miles from the Pacific, at an altitude of 200–300 feet, and is rather abundant at that locality.

5. PARMELIA TILIACEA (Hoffm.) Ach.

Lichen tiliaceus Hoffmann, Enum. 26, *pl.* 16, *f.* 2, 1784; (in part).

Parmelia tiliacea Ach. Meth. Lich. 215. 1803.

Parmelia tiliacea Tuck. Syn. N. Am. Lich. I.: 57. 1882.

Parmelia tiliacea Herre, Proc. Wash. Acad. Sci. 7: 353. 1906.

Thallus much narrowed, membranaceous, often suborbicular; smooth, becoming finely wrinkled; closely adherent to the substratum; lobes contiguous, often subimbricate, sinuous, deeply incised; margins crenate or rounded; color gray, varying from nearly white to green, but always of a peculiarly bright, clean appearance; beneath black; densely clothed with small black fibrils; KOH yellowish; medulla red with CaCl_2O_2 .

Apothecia abundant, mostly central; disk bright chestnut; margin entire, crenate, or crenulate, or even lobed; spores small, ellipsoid to rounded-ellipsoid, $\frac{5 - 7\frac{1}{3}}{7 - 11} \mu$.

This beautifully colored bark-dwelling lichen, found in every quarter of the globe, is very abundant with us on trees at an altitude of 2000 feet and upward, though it descends occasionally to much lower altitudes. Wherever found it is in full fruit.

6. PARMELIA BORRERI Turn.

Parmelia borreri Turner, Trans. Linn. Soc. 9: 148. *pl.* 13, *f.* 2. 1808.

Parmelia borreri Tuck. Syn. N. Am. Lich. I: 58. 1882.

Thallus sub-orbiculate, narrowed, cartilaginous-membranaceous; lobes short, broad, crenately incised, more or less reticulately rugose, and beset with small or dot-like, irregularly scattered, roughened, white soredia; upper surface glaucous gray; herbarium specimens brownish gray; beneath whitish to pale brownish and dusky, smooth, or with white, brown, or black fibrils; KOH greenish yellow to yellow; medulla and soredia red with CaCl_2O_2 .

Sterile with us.

I have found this widely distributed lichen near the mouth of Año Nuevo Creek, at an altitude of 100 feet, growing plentifully on the trunks of oaks, and also sparingly on oaks at Santa Cruz. A single specimen was also collected at Devils Cañon, growing on sandstone.

(Named for William Borrer, an eminent English lichenologist of the first half of the last century.)

7. PARMELIA OLIVACEA (L.) Ach.

Lichen olivaceus L. Sp. Plant. 2: 1143. 1753.

Parmelia olivacea Ach. Meth. Lich. 213. 1803.

Parmelia olivacea Tuck. Syn. N. Am. Lich. I: 62. 1882, (in part).

Parmelia olivacea Herre, Proc. Wash. Acad. Sci. 7: 356. 1906, (in part).

Thallus membranaceous, expanded, orbicular or becoming irregular, appressed; usually smooth and polished, but finally wrinkled and rough; lobes rounded, crenate, flat; color olive-brown to very dark brown, almost black; beneath black, with short black fibrils; KOH—; CaCl_2O_2 —.

Apothecia concolorous or chestnut; margin crenate or dentate, to entire; spores short-ellipsoid to globose, 8 in the asci, and also (variety *polyspora* Herre, new variety), are 16, 18, and 20 in the asci, $\frac{6-8}{7-10}$ μ . Apothecia very abundant on tree-growing forms but rare or wanting on those growing on rocks.

Common on trees and rocks throughout.

According to all the accessible literature this species has 8 spores, averaging $\frac{7-10}{11-19}$ μ , but the spore characters of my specimens are exceedingly different.

Var. POLYSPORA Herre, new variety.

Thallus and spores as above, the spores being from 16 to 20 in the asci and much smaller than given by authors for *olivacea*. This form is abundant on *Quercus wislizenii* on Black Mountain, at an altitude of 1600 feet.

Parmelia olivacea is generally distributed over the north temperate zone.

8. PARMELIA GLABRA Schaerer.

Parmelia glabra Schaer. Lich. Helvet. Spicilegium, 466.

Thallus membranaceous, expanded, orbicular to indeterminate; upper surface smooth or somewhat lacunose, often appearing polished and glistening or shiny; lobes rounded, crenate and irregularly cleft, from appressed often becoming centrally erect or ascendant and densely crowded or imbricate; color pale to dark olive-brown; beneath dark brown to black, with paler brown margin; short brown or black fibrils more or less abundant; medulla red with CaCl_2O_2 .

Apothecia not abundant, medium or large size, with dark chestnut disk and upturned, minutely dentate margin; spores $\frac{4.9 - 7\frac{1}{3}}{8.5 - 15}$ μ .

On rocks and moss along the summit of the range; abundant at Castle Rock. Reported also by Dr. Hasse from southern California.

A common lichen on trees in Central Europe.

9. PARMELIA EXASPERATA (Ach.) Nyl.

Collema exasperatum Ach. Lich. Univ. 645. 1810.

Parmelia exasperata Nyl. Not. Sällsk. pro F. et F. Fenn. Förrh. n. s. 5: 120 (note). 1866.

Thallus appressed, orbicular or sub-orbicular, with marginal lobes much dissected or only crenate lobulate; central portion wrinkled and folded, more or less imbricate, becoming rough and densely beset with short papillæ; dark brown in color; under side black, with many short black fibrils; no reaction with KOH or CaCl_2O_2 .

Sterile with us.

On rocks throughout, but not very conspicuous or abundant anywhere. A rock lichen of Europe and North America.

10. PARMELIA FULIGINOSA (E. Fr.) Nyl.

Parmelia olivacea var. *fuliginosa* E. Fries in Duby, Bot. Gall. 602. 1830.

Parmelia fuliginosa Nyl. Flora, 346. 1868.

Thallus orbicular, membranaceous, appressed; lobes short, rounded, broad, more or less imbricate, marginally crenate; surface more or less covered with concolorous isidia or scurfy growth; color greenish olive or brown to olive-black; beneath brown to blackish, rugose or channelled, with black fibrils. Medullared with CaCl_2O_2 .

No fertile specimens collected.

Not rare on twigs in the mountains, and also occurring on rocks throughout. Our tree form is near the variety *laetevirens* Nyl., but the typical plant is found on rocks. Common in the north temperate zone.

11. PARMELIA CONSPURCATA (Schaer.) Wainio.

Parmelia olivacea var. *conspurcata* Schaerer, Lich. Helvet. Spicil. Sect. X, 466. 1840.

Parmelia conspurcata Wainio, Med. Soc. Faun. Fl. Fenn. 14: 22. 1888.

Parmelia conspurcata Herre, Proc. Wash. Acad. Sci. 7: 357. 1906.

Thallus small to medium, orbiculate or irregular; inner lobes somewhat ascendant, their margins often confluent isidiose-sorediate; marginal lobes flatter, rounded, sub-imbricate, crenate; color brown, but varying from ashy gray to chocolate. The whole surface sprinkled with conspicuous, white, erumpent soredia, these passing into the dusky isidiose soredia on older portions of the thallus; beneath brown, varying from buff to black; thickly set with short, shaggy fibrils; both cortex and medulla yellow with KOH; medulla red when treated with KOH followed by CaCl_2O_2 .

Sterile.

Abundant on a huge sandstone rock at the summit of the range on the Bear Gulch road, altitude 1900 feet. Common on the San Bruno Hills, on rocks and earth, at an altitude of 800-1100 feet.

Not rare in Europe but not collected in North America except by Bruce Fink, who says "frequent on trees and rarely on rocks," in Lichens of the Northern Boundary.

12. PARMELIA FLAVICANS Tuck.

Parmelia perlata flavicans Tuck. Lich. Calif. 13. 1866.

Parmelia flavicans Tuck. Syn. N. Am. Lich. I: 53. 1882.

Parmelia flavicans Herre, Proc. Wash. Acad. Sci. 7: 352. 1906.

Thallus large, orbicular, becoming very large and irregular; surface smooth, or centrally more or less wrinkled and plicate; often isidiose-sorediate; lobes long, sinuous, imbricate, marginally crenate and undulate, their tips thin and rounded; color of thallus pale yellow or more often a yellowish green; beneath black with chestnut margin; smooth or wrinkled; generally naked, but also more or less interruptedly black fibrillose; thallus and medulla not affected by KOH; medulla blood-red with CaCl_2O_2 , fading to pale pink.

Apothecia not uncommon; disk chestnut in dried specimens; in the field sometimes of same color as thallus; margin entire or crenulate, often sorediate; spores ovoid or ellipsoid, often falsely bilocular, $\frac{7.5 - 12}{11 - 22} \mu$.

Common on rocks in the foothills; a well marked species, not to be confused with any other. Distribution not known; I have examined specimens collected by Baker and Nutting in northeastern California, in either Modoc or Lassen County, and now in the University of California herbarium. Probably occurring everywhere west of the Sierra Nevada watershed.

13. PARMELIA CAPERATA (L.) Ach.

Lichen caperatus Linné, Sp. Plant. 2: 1147. 1753.

Parmelia caperata Ach. Meth. Lich. 216. 1803.

Parmelia caperata Tuck. Syn. N. Am. Lich. I. 63. 1882, (in part).

Parmelia caperata Herre, Proc. W. Acad. Sci. 7: 357. 1906.

Thallus large, orbiculate to indeterminate, with smooth but wrinkled and plicate surface; marginally much dissected; lobes long, imbricate, laciniate, their margins often pointed, elevated and roughened, their tips rounded, becoming isidiose centrally or sprinkled with concolorous soredia; color pale yellowish or greenish; beneath black with narrow brown margin; more or less abundantly clothed with short black fibrils; cortex and medulla yellow with KOH; CaCl_2O_2 —.

Practically always sterile with us. But I very doubtfully refer here a densely sorediate and rather degenerate form on old fences at Santa Cruz, which has small to medium apothecia, with chestnut disks; margin entire to sub-crenulate, thick, and more or less sorediose; spores ellipsoid, $\frac{7-9}{12-16}$ μ .

Not rare on twigs and branches of trees along the summit of the range; also occurring on stones and shrubs about the entrance to San Francisco Bay; on rocks in the San Bruno Hills; rarely on old fences in the mountains.

A common bark lichen throughout both the north and the south temperate zones, but rarely fruiting.

14. PARMELIA SOREDICA Nyl.

Parmelia soredica Nylander, Flora, **68**: 605. 1885. Saskatchewan.
Parmelia soredica Herre, Proc. Wash. Acad. Sci. **7**: 358. 1906.
Parmelia caperata Tuck. Syn. N. Am. Lich. I: 64. 1882. in part.

Thallus coriaceous, large to very large, orbicular, becoming irregular, undulate, radiately plicate, closely adherent to the substratum; lobes rounded, complicate, imbricate, their margins ascendant and confluent white sorediate, except on periphery, where they are dilated, smooth or wrinkled, with crenate edges. Surface of lobes more or less sorediate; central portion of thallus finally passing into sorediate heaps which become detached and fall away, leaving the outer portions to continue their growth; color green to yellowish green; beneath black with brown margin; outer lobes sometimes with a few white or dark fibrils, otherwise naked; KOH—; medulla and soredia red with CaCl_2O_2 .

Apothecia abundant on large specimens, generally of small or medium size; disk chestnut; margin entire or lobulate, usually sorediate; spores ellipsoid, $\frac{7\frac{1}{3}-11}{12\frac{1}{4}-15.5}$ μ .

On trees, fences, and roofs; perhaps occasional on rocks. Common everywhere in the valleys and foothills and extending to the summit of the range; especially conspicuous and well grown on *Quercus lobata* on whose rough bark it seems to attain its maximum development.

This lichen probably ranges over western North America from the sub-arctic region to northern Mexico, but is only positively recorded from the Saskatchewan, British America, by Nylander, and from California by myself. An examination of the Tuckerman Herb. shows that Bolander's No. 20, being the specimen on the upper right hand corner of the sheet containing Tuckerman's material of *Parmelia caperata*, is undoubtedly *Parmelia soredica*. This is the specimen described by Tuckerman in his Synopsis, Pt. I, top of page 64, 1882.

15. PARMELIA CONSPERSA (Ehrh.) Ach.

Lichen conspersus Ehrh. in Ach. Lich. Suec. Prodr. 118. 1798.

Parmelia conspersa Ach. Meth. Lich. 205. 1803.

Parmelia conspersa Tuck. Syn. N. Am. Lich. I: 64. 1882.

Parmelia conspersa Herre, Proc. Wash. Acad. Sci. 7: 358. 1906.

Thallus dilated, membranaceous, usually orbicular, but finally irregular and greatly expanded; marginally closely appressed, smooth, often polished, much and intricately divided or lobed; the lobes usually narrowed, often complicate and intricate; the central portion wrinkled and roughened, becoming isidiose, thickened or elevated, finally forming irregular heaps detached from the substratum; color varying from pale to dark yellowish or gray-green; beneath pale to dark brown, or occasionally black, with short, scattered, concolorous fibrils, or even merely tuberculate; marginally darker, often lustrous; thallus and medulla yellow with KOH, the medulla then changing to orange or red; neither affected by CaCl_2O_2 .

Apothecia numerous; margin incurved, crenate; disk chestnut; spores short ellipsoid, $\frac{4.9 - 6.5}{8.5 - 12}$ μ .

Common on rocks throughout our range.

Like *Parmelia perforata* this species often turns a beautiful red or rose-purple when pressed while wet, and occasionally one sees similarly discolored specimens on the rocks.

A lichen of world-wide distribution.

16. PARMELIA PHYSODES (L.) Ach.

Lichen physodes Linné, Sp. Plant. 2: 1144. 1753.

Parmelia physodes Ach. Meth. Lich. 250. 1803.

Proc. Wash. Acad. Sci., May, 1910.

Parmelia physodes Bitter, Hedwigia, **40**: 218. 1901.

Parmelia physodes Herre, Proc. Wash. Acad. Sci. **7**: 354. 1906.

Parmelia physodes Tuck. Syn. N. Am. Lich. I: 59. 1882, (in part).

Thallus suborbicular, deeply cut, more or less inflated, loosely attached to the substratum; lobes numerous, sinuous, many-cleft, plane or convex; becoming crowded centrally, somewhat ascendant and complicate; ends of lobes often terminating in white soredia; surface smooth, becoming tuberculate; color varying from greenish pearl-gray, to slate-color or green; beneath dull black or dusky, naked, much wrinkled; sometimes edged with chestnut; yellow or greenish yellow with KOH, turning gradually through orange to dark red; CaCl_2O_2 —.

Apothecia more or less cup-shaped; margin crenulate; disk chestnut; spores elliptical to globose, $\frac{4.8-6}{6-8}$ μ .

This lichen occurs very sparingly throughout our range; most abundant on old fences and trees in the foothills; probably cosmopolitan in its distribution.

17. PARMELIA ENTEROMORPHA Ach.

Parmelia enteromorpha Ach. Meth. Lich. 252. 1803.

Parmelia enteromorpha Bitter, Hedwigia, **40**: 233, *pl. II. f. II, 12,* and *13.* 1901.

Parmelia enteromorpha Herre, Proc. Wash. Acad. Sci. **7**: 355. 1906.

Parmelia physodes, varieties *enteromorpha* and *vittata* Tuck. Syn. N. Am. Lich. I: 60. 1882.

Thallus sub-orbiculate, soon becoming large, expanded, and indeterminate; deeply cleft, loosely attached to the substratum; lobes very numerous, more or less inflated, elongated, lax or pendulous, irregularly divided; usually narrow but occurring in all shapes from linear or terete to broad and flat, these last usually short and marginally imbricate; surface smooth and convex, or more rarely wrinkled, sometimes papillate; often densely sprinkled with black specks, the spermogonia; color green, but varying from gray to dingy brownish or even dusky; beneath black or dark brown, wrinkled, naked; more or less beset with holes in the lower cortex; yellow or greenish yellow with KOH; CaCl_2O_2 —.

1. CETRARIA CALIFORNICA Tuck.

Cetraria californica Tuck. Am. Journ. Sci. 28: 203. 1859.

Cetraria californica Tuck. Syn. N. Am. Lich. I: 29. 1882.

Cetraria californica Herre, Proc. Wash. Acad. Sci. 7: 337. 1906.

Thallus tufted, fruticose, erect; lobes spreading, flattened or linear, much branched, their tips finely dissected; color black or very dark green; occasionally brownish green or dusky; color always dull; beneath paler, usually olive-green or brown, but varying greatly; finally white with a tinge of greenish.

Apothecia terminal, concolorous and dull, but sometimes shining and darker than the thallus; margin toothed or fringed, sometimes almost smooth; spores ellipsoid, $\frac{3 - 5}{6 - 9.75} \mu$.

On fences, shrubs, and twigs of trees. Found everywhere, from the salt marshes about San Francisco Bay to the highest elevation in the peninsula.

Found only in the western United States and British Columbia, from the Sierra Nevada Mountains to the Pacific. Originally on various coniferæ and evergreen shrubs, but migrant to fences.

2. CETRARIA JUNIPERINA (L.) Ach.

Lichen juniperinus Linné, Sp. Plant. 2: 1147. 1753.

Cetraria juniperina Ach. Meth. Lich. 298. 1803.

Cetraria juniperina Tuck. Syn. N. Am. Lich. I: 37. 1882.

Cetraria juniperina Herre, Proc. Wash. Acad. Sci. 7: 340. 1906.

Thallus foliaceous, membranaceous and expanded, or else tufted, irregularly cut-lobed and ascendant; lobes crowded, edges erose and crenate. Color bright yellow, alike on both sides; sometimes the yellow is tinged with greenish.

Apothecia submarginal, the disk chestnut; margin crenulate or tuberculate; spores ellipsoid, $\frac{3.5 - 4.9}{6 - 8.5} \mu$.

Abundant on twigs, limbs, and cones of *Pinus attenuata*, in the "chalk hills" on the western border of the Big Basin, at an altitude of 1500 feet and above; common also on *Pinus radiata*, which is found along the sea coast from Point Año Nuevo to Monterey and southward.

A lichen of the cool temperate and alpine regions of Europe and North America.

3. *CETRARIA CHLOROPHYLLA* (Humb.) Wainio.

Lichen chlorophyllus Humboldt, Fl. Fr. Spicil. 20. 1793.

Cetraria chlorophylla Wainio, Lich. Caucas. in Természtr. füzetek, 22: 278. 1899.

Cetraria chlorophylla Herre, Proc. Wash. Acad. Sci. 7: 338. 1906.

Cetraria saepincola b. *chlorophylla* Tuck. Syn. N. Am. Lich. I: 35. 1882.

Thallus foliaceous, expanded; lobes numerous, short, irregularly cut; terminally ascendant, sinuate, crenate, with white sorediate edges; color varying from olivaceous or greenish dull brown to a shining chestnut, and darker; beneath paler, wrinkled, and with occasional scattered fibrils.

Always sterile with us and rare in fruit anywhere.

On *Pseudotsuga taxifolia*, Castle Rock Ridge, altitude 2500 feet. Common on fences throughout the foothills and to the summit of the range, but originally apparently confined to the larger coniferæ of the redwood formation.

Recognized at once by the narrow but conspicuous white edge of the thallus.

A plant of northern and central Europe and western America.

4. *CETRARIA GLAUCA* (L.) Ach.

Lichen glaucus Linné, Sp. Plant. 2: 1148. 1753.

Cetraria glauca Ach. Meth. Lich. 296. 1803.

Cetraria glauca Tuck. Syn. N. Am. Lich. I: 35. 1882.

Cetraria glauca Herre, Proc. Wash. Acad. Sci. 7: 339. 1906.

Thallus membranaceous, foliaceous, sinuately or irregularly broad-lobed; the crenate or dissected edges of the lobes frequently sorediate, thickened, and prolonged into more or less conspicuous coralloid branchlets; color of plants growing on earth: greenish gray marginally, varying to olive- or brown-gray centrally, or sometimes the whole plant a glaucous gray-green; beneath wrinkled or reticulate and black, with now and then a chestnut margin; fibrils wanting, or occasionally scattered and very minute. Color of

plants on trees: pale sage-green, varying to colors as dark as those of earth-growing forms; beneath black, fading into pale brown, with broad white margins.

Rarely found in fruit anywhere, and always sterile with us.

Everywhere on trees in the mountains above 1500 feet, but at no place very abundant; usually on the limbs of *Pseudotsuga taxifolia*. This lichen also occurs on earth in rock crevices at slight elevations near the sea coast.

On sandstone in Devils Cañon, altitude 2300 feet, occurs the variety *fusca* (Flot.), which differs from the type in having the entire thallus of a dark olive brown. Rare and local.

A widespread lichen of the north temperate and sub-arctic regions.

5. CETRARIA TUCKERMANI Herre.

Cetraria glauca stenophylla Tuck. Syn. N. Am. Lich. I: 36. 1882.
name preoccupied.

Cetraria tuckermani Herre, Proc. Wash. Acad. Sci. 7: 340. 1906.

This species differs from *Cetraria glauca* in having the lobes elongated, lax, narrow or linear, and more or less channelled; margin irregularly cut and erose; beneath black or dark brown at the base, the lobes white beneath. Sterile with us.

On bark of coniferæ near King's Mountain House, altitude 1900 feet, and in the Big Basin, at an altitude of about 1200 feet.

Widely distributed but not abundant anywhere.

In the Tuckerman Herbarium are specimens labelled "Santa Cruz Mountains," collected by Dr. W. G. Farlow; on *Pinus contorta*, Tomales Bay, collected by H. N. Bolander, and from Monterey County, collected by Mrs. M. A. Booth. The plant is also recorded by Tuckerman from Oregon. In the herbarium of the University of California is a specimen from Eureka; probably generally distributed from central California northward to the western part of Washington.

Named for our most eminent student of lichens, Edward Tuckerman.

6. CETRARIA LACUNOSA STENOPHYLLA Tuck.

Cetraria lacunosa stenophylla Tuck. Syn. N. Am. Lich. I: 35. 1882.

Cetraria lacunosa stenophylla Herre, Proc. Wash. Acad. Sci. 7: 339.
1906.

Thallus becoming fruticose, deeply and irregularly lobed; lobes long, lax or sub-pendulous, narrow to linear, deeply channelled; margins laciniate, erose, and minutely tuberculate; color pale sage-green or gray-green; some times with a brownish cast; beneath white or very pale.

Apothecia terminal; disk chestnut; margin crenate or more rarely entire; spores circular or ellipsoid, $\frac{4 - 4.9}{4.9 - 8.5} \mu$.

Very common on trees in the mountains about 1500 feet. Especially abundant on the limbs of *Pseudotsuga taxifolia*, which it sometimes clothes to the exclusion of all other lichens.

Range not known, but probably occurring throughout central and northern California and to be looked for in Oregon. There is a specimen from Humboldt County in the Tuckerman Herb.

LI. *Nephromopsis* Müll. Arg.

Nephromopsis Müll. Arg.

Nephromopsis A. Zahlbr. *Ascolichenes*, 216. 1907.

Thallus similar to that of *Cetraria*. Distinguished by the terminal apothecia which originate on the under side of the lobes and are directed upward by the twisting or turning of the lobes in the same manner as the apothecia of *Nephroma* are exposed.

Species few, of the colder parts of the northern hemisphere.

KEY TO THE SPECIES.

- A. Thallus greenish to dark brown; lobes narrowed, crowded, margined with minute dark tubercles 1. *ciliaris*
- AA. Thallus dark brown; lobes broad, flat, but little ascendant.
 - 2. *platyphylla*

1. NEPHROMOPSIS CILIARIS (Ach.) Hue.

Cetraria ciliaris Ach. *Lich. Univ.* 508. 1810.

Cetraria ciliaris Tuck. *Syn. N. Am. Lich. I.* 34. 1882.

Cetraria ciliaris Herre, *Proc. Wash. Acad. Sci.* 7: 337. 1906.

Nephromopsis ciliaris Hue, *Nouv. Arch. Mus. Paris.*

Thallus foliaceous, depressed, expanded, irregularly cut and lobed; lobes expanded, leafy, or more often narrowed, crowded, ascendant, and much dissected; margin of lobes not ciliate but crenate and margined with minute black or dark tubercles; similar tubercles often

appearing on surface of lobes, or even covering them; color dusky brown, but varying from bright to dusky green, brownish, and dark brown; beneath brownish, wrinkled and pitted, and with occasional fibrils.

Apothecia terminal or marginal; disk chestnut, the margin crenulate or minutely tuberculate; spores spherical, 4.9 to 8 μ in diameter.

Abundant throughout, on trees, shrubs, and fences, from sea level to 3000 feet or more.

Examination of many hundreds of specimens has failed to show one according in character with the specific name, marginal cilia or fibrils being invariably absent.

A particularly luxuriant but aberrant form is found on fences along the ocean shore. It is distinguished by its large clumps of erect, complicate and crisped lobes, and great development of the tubercular or cephaloid growths mentioned above, the entire surface being covered with them.

A lichen of the United States and Canada; said to occur also in Northern Europe and Asia.

2. NEPHROMOPSIS PLATYPHYLLA (Tuck.) Herre.

Cetraria platyphylla Tuck. Syn. N. Am. Lich. I: 34. 1882.

Cetraria platyphylla Herre, Proc. Wash. Acad. Sci. 7: 338. 1906.

Thallus thin, compressed, rigid, foliaceous; lobes appressed, and expanded, with elevated tips, or more often ascendant, narrow at base; surface rough, covered with tubercles, the lens also often disclosing the presence of many sulfur-colored granules; color dark dull olivaceous brown; under surface paler, wrinkled, naked; medullary layer sulfur-colored or white and cottony.

Apothecia marginal; disk shining, darker than thallus; margin tuberculate; spores spherical, 4.5 to 9 μ in diameter.

On *Pseudotsuga taxifolia*, Butano Ridge, altitude 2000 feet; on *Adenostoma fasciculatum*, Loma Prieta, altitude 3793 feet.

A bark lichen ranging from the Sierras westward and from British Columbia to southern California.

USNEACEÆ.

Thallus fruticose, erect, or lax and decumbent, sometimes prostrate or pendulous and excessively elongated; attached by a holdfast

or scattering rhizoids, or growing from the earth; structure radial, sometimes dorso-ventral, with cortex on all sides, formed of hyphæ either longitudinal or running at right angles to the surface; in the genus *Ramalina* strengthened by a so-called inner cortex of distinct and solid cords. Alga *Protococcus*.

Apothecia circular, shield or dish-shaped, sessile or sub-pedicellate, with a thalline margin; spores 1 to 8, colorless, or rarely brown, simple, bilocular, or muriform, thin-walled.

KEY TO GENERA.

- A. Spores bilocular; cortex strengthened by a mechanical tissue; thallus always compressed more or less, at least basally. LV. *Ramalina*
- AA. Spores simple.
 - B. Thallus brown or black, like tangled mats of fine hair. LIV. *Alectoria*
 - BB. Thallus not black or brown.
 - C. Thallus gray or pale straw-color, rarely red; tufted or pendulous, becoming enormously elongated; apothecia concolorous or pale tan, with fibrillose margin. LVI. *Usnea*
 - CC. Apothecia not concolorous.
 - D. Thallus pendulous or erect, more or less white soredate; sterile LII. *Evernia*
 - DD. Thallus bright lemon-yellow; apothecia chestnut LIII. *Letharia*

LII. **Evernia** Ach.

Evernia Acharius, Lich. Univ. 84. 1810.

Thallus erect or pendulous, attached by a holdfast, branched; structure dorso-ventral, the lobes flattened and with a thin cortex on all sides, formed of branching and septate hyphæ arranged perpendicularly to the surface.

Apothecia lateral or terminal, sessile or sub-pedicellate, dish-like, with thalline margin, the disk of a different color from the thallus; hypothecium colorless, with an algal layer beneath; paraphyses simple, thick, septate; asci with 8 simple, colorless, small, ellipsoid spores.

We have one of the two species, widely distributed in the temperate zone.

I. EVERNIA PRUNASTRI (L.) Ach.

Lichen prunastri Linné, Sp. Plant. 2: 1147. 1753.

Evernia prunastri Ach. Lich. Univ. 442. 1810.

Evernia prunastri Tuck. Syn. N. Am. Lich. I: 39. 1882.

Evernia prunastri Herre, Proc. Wash. Acad. Sci. 7: 342. 1906.

Thallus tufted, fruticose, erect or pendulous, angular or flattened; branches numerous, narrow to linear, elongate; or (forma *soredifera* Ach.), shorter and much wider lobed, beneath lacunose or channelled; white or greenish, with mealy, lateral, and confluent soredia very abundant; these also more or less present in the typical form; color whitish, pale green, to dark green; beneath much paler, often white.

Sterile with us.

A very common lichen throughout, growing on trees, shrubs, dead wood, fences, roofs, mossy stones; often forming conspicuous whitish tufts on twigs of shrubs.

Of very wide distribution, being found in Europe, Asia, Northern Africa, and North and South America.

LIII. *Letharia* (Th. Fr.) A. Zahlbr.

Evernia sect. *Letharia* Th. Fr. Lich. Scand. 1: 32. 1871.

Letharia A. Zahlbr. Ascolichenes, 218. 1907.

Thallus tufted, erect or pendulous, attached by a holdfast, much-branched, alike on all sides, the cortex of hyphæ perpendicular to the surface; medulla cobwebby, with more or less firm medullary cords or longitudinal threads, much as in *Ramalina*. Apothecia as in *Evernia*.

Species few, of cool and temperate parts of the northern hemisphere.

I. LETHARIA VULPINA (L.) Wainio.

Lichen vulpinus Linné, Syst. Nat. ed. 10. 2: 1343. 1753.

Letharia vulpina Wainio,

Evernia vulpina Ach. Lich. Univ. 443. 1810.

Evernia vulpina Tuck. Syn. N. Am. Lich. I: 38. 1882.

Evernia vulpina Herre, Proc. Wash. Acad. Sci. 7: 341. 1906.

Thallus tufted, erect, much-branched, becoming long and pendu-

lous; branches terete, basally angular; large specimens conspicuously angular and lacunose; whole plant a bright lemon-color, often more or less sorediate; very small immature specimens sometimes of a yellowish green.

Apothecia large, in specimen from San Bernardino Mts. an inch and a half in diameter; terminal, more or less pedicellate; disk chestnut; margin often fringed with large fibrils, otherwise smooth and entire; spores (taken from specimen collected on Mt. San Bernardino, altitude 6000 feet) ellipsoid, $\frac{4 - 5.5}{7 - 11} \mu$.

On trees, old fences, and sandstone.

Occurring everywhere on the peninsula; small, inconspicuous specimens are found on old fences and roofs from the salt marshes about San Francisco Bay to the summit of the range. Common on trunks and limbs of *Sequoia sempervirens* and *Pseudotsuga taxifolia*, especially on dead or dying limbs. Common on sandstone above 2300 feet.

But one fertile specimen collected within our limits, on an old fence near Stanford University, at an altitude of 200 feet.

In the higher mountains of the state everywhere abundant, forming huge matted yellow clumps 6 inches or more in length, the large, fibrillose apothecia and brilliant thallus attracting the attention of all.

A lichen of arctic and alpine Europe and North America, and of the high mountains west of the Missouri; in this state ranging south into Lower California.

LIV. *Alectoria* Ach.

Alectoria Ach. Lich. Univ. 120. 1810.

Thallus pendulous or prostrate, attached by a holdfast, usually excessively elongated for its diameter and resembling fine hair; the cortex of longitudinal hyphæ; medulla of longitudinal hyphæ forming a cottony central cord.

Apothecia on short, crooked, lateral branchlets, sessile or sub-pedicellate, with naked or ciliate margin; disk brown or blackish; hypothecium colorless, upon an algal layer; paraphyses branched and anastomosing; asci with 4-8 spores, these simple, ellipsoid, colorless or brownish.

About 20 species growing on earth and bark, especially in alpine and sub-arctic regions.

KEY TO THE SPECIES.

- A. Thallus black, green-black, rarely brownish-black 1. *jubata*
 AA. Thallus brown, reddish brown, or pale 2. *fremontii*

1. ALECTORIA JUBATA (L.) Nyl.

Lichen jubatus Linné, Sp. Plant. 2: 1155. 1753.

Alectoria jubata Nylander, Journ. Bot. 233. 1872.

Alectoria jubata Tuck. Syn. N. Am. Lich. I: 44. 1882.

Alectoria jubata Herre, Proc. Wash. Acad. Sci. 7: 346. 1906.

Thallus tufted, pendulous, elongated, slender, terete, smooth, polished, very much branched and hair-like, forming tangled clumps and mats; small greenish, powdery, lateral soredia sometimes present; color black, green-black, or rarely brownish black.

Always sterile with us. On trees and shrubs, above 1800 feet; occurring on *Pseudotsuga taxifolia*, wherever it grows, and also on oaks and *Adenostoma*. A peculiar plant, resembling mats of much tangled fine black hair.

Occurring in the cooler parts of the earth and on high mountains of the warmer regions.

2. ALECTORIA FREMONTII Tuck.

Alectoria fremontii Tuckerman, Proc. Amer. Acad. Arts & Sci. 422. 1859.

Alectoria fremontii Tuck. Syn. N. Am. Lich. I: 45. 1882.

Thallus pendulous, elongated, forming densely tangled tufts or clumps, smooth; branches irregular, flexuous, terete, their tips becoming very long and thin and undivided; color brown, or uniform reddish brown, or sometimes paler.

Not seen in fruit by me.

Occurring on large coniferæ in the redwood forests. I have seen but two specimens from our territory; one collected by Dr. Anderson, near Santa Cruz, and the other collected by one of my students, Mr. Harold Hannibal, at Scotts Valley, some miles north of Santa Cruz.

Common on various coniferæ in the Sierra Nevada Mts., and in

the higher mountains all over California and Oregon, generally fruiting.

(Named for General John C. Frémont, distinguished explorer of the west.)

LV. **Ramalina** Ach.

Ramalina Ach. Lich. Univ. 122. 1810.

Apothecia shield-like, scattered, marginal or terminal, sub-pedicellate, concolorous; paraphyses agglutinated, simple; spores 8, oblong, ellipsoid, or spindle-shaped, colorless, bilocular, or rarely 4-locular.

Thallus fruticose, tufted, erect or pendulous, terete or more often compressed, alike on both sides; cortex usually strengthened on the inner side by a layer of hyphæ parallel to its long axis, forming a continuous ring or broken into isolated, longitudinal girders; medulla cottony, filling the inner part of the thallus, or else very small, lying in the space between the mechanical stiffening and the cortex, or attached to the inner side of the latter, so that the centre of the thallus is hollow. Soredia not rare.

A large genus, widely distributed, mostly growing on rocks and bark.

KEY TO THE SPECIES.

- A. Habitat, maritime rocks.
 - B. Thallus terete, smooth or wrinkled.
 - C. Sparingly branched, blackening at base; apothecia lateral 1. *ceruchis*
 - CC. Thallus much shorter, simple, not blackening; apothecia terminal 3. *combeoides*
 - BB. Thallus compressed, two-edged 4. *homalea*
- AA. Habitat, trees, shrubs, fences.
 - D. Thallus with conspicuous soredia.
 - E. Apothecia absent; thallus terete, thread-like, with large bluish soredia..... 2. *ceruchis cephalota*
 - EE. Apothecia rare, inconspicuous; thallus flattened, two-edged or linear, with many white powdery soredia 7. *farinacea*
 - DD. Thallus not sorediate.
 - F. Thallus a lace-like net-work, very long, pendulous, much branched and tangled..... 5. *reticulata*
 - FF. Thallus tufted, medium sized, or small, erect or pendulous, little-branched 6. *menziesii*
 - G. Thallus small to very small, erect, terete or flattened, branched, the tips filiform... 10. *rigida*
 - GG. Branches not terete, their tips not filiform.

- H.* Lobes slender, elongate-branched, channelled beneath 8. *canaliculata*
HH. Lobes short, very broad, little divided; not channelled beneath 9. *fraxinea*

1. RAMALINA CERUCHIS (Ach.) DeNot.

Parmelia ceruchis Ach. Meth. Lich. 260. 1803.

Ramalina ceruchis De Notaris, Giorn. Bot. Ital. 1: 45. 1846.

Ramalina ceruchis Tuck. Syn. N. Am. Lich. I: 21. 1882.

Ramalina ceruchis Herre, Proc. Wash. Acad. Sci. 7: 331. 1906.

Thallus tufted, terete, smooth, becoming wrinkled; sparingly branched, the tips pointed; color yellowish green, basally black or blackening. Our specimens sterile; apothecia lateral when present.

The long, cylindrical, pointed thallus of this species serves to separate it very markedly from the other Ramalinas.

I have obtained it but once, and then it was sterile; Acharius says "scutellæ rarissime."

It occurs very sparingly on the sandstone cliffs above the sea at Point Lobos, San Francisco. I have also examined specimens from San Diego, collected by Dr. Farlow, Dr. Cooper, and Miss Middlecombe.

Originally described from Peru, and probably occurring along the entire coast between Peru and Oregon.

2. RAMALINA CERUCHIS CEPHALOTA Tuck.

Ramalina ceruchis f. cephalota Tuck. Syn. N. Am. Lich. I: 21. 1882.

Ramalina ceruchis f. cephalota Herre, Proc. Wash. Acad. Sci. 7: 332. 1906.

This subspecies is known at once by the conspicuous, lateral, bluish soledia, which abound on the very slender, short, round, entangled filaments. It is always sterile, and occurs all along the Pacific coast in our territory, growing on dead or dying twigs and branches of maritime trees and shrubs, and on old fences. It extends at least as far south as San Diego, where it was collected by Dr. Farlow.

3. RAMALINA COMBEOIDES Nyl.

Ramalina combeoides Nyl. Bull. Soc. Linn. Norm. **2**: 4, p. 107.
1870.

Ramalina combeoides Tuck. Syn. N. Am. Lich. I: 21. 1882.

Ramalina combeoides Herre, Proc. Wash. Acad. Sci. **7**: 332. 1906.

Ramalina ceruchis Cummings and Seymour, Decades of N. Am.
Lich. no. 91, San Mateo County, Calif.

Thallus tufted, short, stout, terete, more or less pitted or wrinkled;
color a pale glaucous green; no part of the thallus black.

Apothecia abundant, terminal or clustered, concolorous or slightly
yellowish; spores bilocular to quadrilocular, curved or straight,

$\frac{3.6 - 4.8}{12 - 14.6} \mu$.

On maritime rocks.

This species is placed with *Ramalina ceruchis* by Tuckerman, but
there seems to be no difficulty in separating the two in the field.
They differ constantly in color, appearance of thallus, size, and in
the apothecia. The short, cylindrical thallus capped by the disk-
shaped apothecia, together with the sage-green color and the absence
of black, distinguish it from all related forms.

Very abundant about Point San Pedro, and in Pilarcitos Creek
Cañon, two miles from the ocean. In the Tuckerman Herbarium
are specimens from Mission Dolores (San Francisco), and Tomales
Bay in Marin County, collected by H. N. Bolander. It has also
been recorded from San Diego by one or two collectors. Not known
outside of California.

4. RAMALINA HOMALEA Ach.

Ramalina homalea Acharius, Lich. Univ. 598. 1810.

Ramalina homalea Tuck. Syn. N. Am. Lich. I: 21. 1882.

Ramalina homalea Cummings and Seymour, Decades of N. Am.
Lich. no. 92, San Mateo County, Calif.

Ramalina homalea Herre, Proc. Wash. Acad. Sci. **7**: 332. 1906.

Thallus tufted, compressed, two-edged, smooth or becoming
wrinkled; lobes spreading, simple or irregularly branched; color yel-
lowish green in herbarium specimens, the living plant a gray-green;
holdfast and basal portion of plant filled with red or orange coloring
matter.

Apothecia abundant, marginal or sub-terminal; concolorous or decidedly yellowish; spores straight or slightly curved, bilocular,

$$\frac{3.6 - 4.2}{9.7 - 14.5} \mu.$$

This singular looking *Ramalina* occurs on maritime rocks all along the coast of California wherever conditions are favorable. In places it covers the rocks to such an extent that at some distance they appear to be hidden from view by some kind of tufted grass. The holdfast is very strong and often brings a layer of rock away with it. It contains a remarkable amount of orange-red coloring matter and no doubt would furnish a satisfactory orchil.

I have examined specimens collected at various points along the coast, from San Francisco to Guadalupe Island, Lower California.

5. RAMALINA RETICULATA (Noehd.) Krempelh.

Lichen reticulata Noehden in Schrad. Journ. Bot. **3**: 237-238. 1801.

Ramalina reticulata Krempelhuber, Geschicht. u. Litt. d. Lich. **1**: 86. 1867.

Ramalina reticulata Tuck. Syn. N. Am. Lich. **1**: 22. 1882.

Ramalina reticulata Herre, Proc. Wash. Acad. Sci. **7**: 333. 1906.

Thallus much compressed, greatly elongated, pendulous; very much branched, forming tangled mats; the whole plant filled with holes, the result being a more or less coarse or delicate net-work; the branches giving off many lobules, also reticulated; color grayish green, alike on both sides.

Apothecia abundant, scattered over surface of plant, concolorous; spores ellipsoid or oblong, straight or curved, bilocular, $\frac{4\frac{1}{4} - 4.8}{10.8 - 15.75} \mu.$

Recorded from Lower California to British Columbia, and occurring throughout our territory; reaching its highest development in the lower foothills near the Bay and the ocean shores. It is common on trees and old fences.

In deep, dark, humid cañons, or at great elevations where influenced by the ocean fogs and winds, the thallus is exceedingly delicate and filmy, resembling the finest lace. In the dry lowlands it is often very coarse, the broad, unperforated expansions of the thallus reaching a breadth of 40 mm. or more. It sometimes reaches a length of

more than two meters and a breadth of two-thirds of a meter, and is easily our largest North American lichen.

Many specimens may be found attached by the holdfast from which they have grown, but the chief method of propagation and diffusion is by the tearing and breaking of the thallus and the dissemination of the fragments by the wind. Of course the distribution is greatest by this method during the rainy season, but it goes on at all times, even during the driest and calmest weather.

The oaks are often completely covered with festoons of this lichen so that they present an appearance identical with that of the live oaks of the Gulf States, covered with *Tillandsia usneoides*.

6. RAMALINA MENZIESII Tuck.

Ramalina menziesii Tuck. Proc. Am. Acad. Arts and Sciences, Vol. 1: p. 204. 1847.

Ramalina menziesii Tuck. Syn. N. Am. Lich. I: 24. 1882.

Ramalina menziesii Herre, Proc. Wash. Acad. Sci. 7: 334. 1906.

Ramalina menziesii Cummings and Seymour, Decades of N. Am. Lich., no. 93, Berkeley, Calif.

Thallus originally tufted, rigid, linear, canaliculate; lobes more or less twisted, irregularly branched; puberulent or smooth. With age the plant becomes more or less flaccid and pendulous, the lobes long, dilated and ribbon-like, more or less irregular in outline, the edges occasionally fringed with lobules; surface furrowed or channelled; color sage-green, gray-green, or bright green.

Apothecia abundant, at first marginal or sub-terminal, later scattered; small to large, sub-pedicellate, margin usually incurved; spores

bilocular, straight or curved, $\frac{4.8 - 6}{10 - 14.5} \mu$.

Habitat trees, shrubs, old fences. A specimen in the Tuck. Herb., collected in Alameda County by H. N. Bolander, is labelled "on the earth." It is apparently not found in the higher mountains but is exceedingly abundant throughout the plains and foothills. While its habitat is given as "California" by Tuckerman, its exact range is not known. It is recorded by Hasse from southern California, while in the Tuck. Herb. is a specimen collected in Oregon by E. Hall, and labelled by Tuckerman "*R. menziesii* f. *sorediata*." Its

Proc. Wash. Acad. Sci., May, 1910.

range is thus at least 1000 miles from north to south and may be much greater.

(Named for Archibald Menzies, Scotch botanist and explorer, who collected the plant, probably at Monterey, sometime before 1800 and who gave Tuckerman his first specimens.)

7. RAMALINA FARINACEA (L.) Ach.

Lichen farinaceus Linné, Sp. Plant. 2: 1146. 1753.

Ramalina farinaceus Ach. Lich. Univ. 606. 1810.

Ramalina farinaceus Herre, Proc. Wash. Acad. Sci. 7: 335. 1906.

Ramalina calicaris d. farinacea Tuck. Syn. N. Am. Lich. I: 25. 1882.

Thallus tufted, erect or pendulous; compressed and two-edged, or attenuate and thread-like, channelled; color pale green to white or nearly white; lateral white powdery soredia very abundant on lobes.

Apothecia lateral, rare and inconspicuous, concolorous; spores curved, bilocular, $\frac{4 - 5}{13 - 15} \mu$.

Distribution well nigh cosmopolitan, occurring with us in the foothills and mountains, on trees and shrubs. A few fruiting specimens were obtained in the mountains above Searsville, altitude 1500 feet, growing upon oaks. This plant is likely to be confused with *Evernia prunastri*, with which it is commonly associated.

In deep, dark cañons the thallus often darkens and is now and then of a pure black, only recognizable because of the intermediate forms between the typical plant and the nigricant variety.

8. RAMALINA CANALICULATA Fr.

Ramalina canaliculata E. Fries, Lich. Eur. 30. 1831.

Ramalina calicaris c. canaliculata Tuck. Syn. N. Am. Lich. I: 25. 1882.

Thallus tufted, elongate, rather rigid, erect or sub-pendulous; lobes slender, irregularly branched, channelled and more or less reticulate beneath; not sorediate; color pale gray-green or glaucous.

Apothecia abundant, marginal or terminal, sub-pedicellate, small or medium size, concolorous; spores straight or slightly curved, sometimes falsely tri- or quadri-ocular, $\frac{4.75 - 6.25}{10 - 17.25} \mu$.

Abundant on *Quercus agrifolia* near Santa Cruz, and occasional on trees at Los Gatos.

A widespread and variable lichen.

9. RAMALINA FRAXINEA Ach.

Lichen fraxineus Linné, Sp. Plantarum, 2: 1146. 1753.

Ramalina fraxinea Ach. Lich. Univ. 602. 1810.

Ramalina calicaris a. fraxinea Tuck. Syn. N. Am. Lich. I: 25. 1882.

Thallus tufted, rigid, short, stout, the surface irregularly lacunose or rugose; not soresiate; lobes short, broad, but little divided, sometimes with marginal lobules; dull gray-green.

Apothecia medium, lateral or marginal, the receptacle rugose; disk concave, very pale tan; spores curved or sometimes straight,

$\frac{5 - 7}{11 - 17} \mu$.

Our plant is small, not more than an inch in height, and reaching but a small fraction of the size I have observed it to attain in the Alps.

Abundant on trees about Los Gatos and elsewhere in the foothills; occurring in every quarter of the globe.

10. RAMALINA RIGIDA Ach.

Ramalina rigida Ach. Syn. Meth. Lich. 294. 1814.

Ramalina rigida Tuck. Syn. N. Am. Lich. I: 22. 1882.

Ramalina rigida Herre, Proc. Wash. Acad. Sci. 7: 335. 1906.

Thallus small, tufted, erect, irregularly much-branched, terete, or flattened and sometimes channelled; the branches slender, their tips thin, filiform; color white to greenish white.

Apothecia small, lateral, the disk greener than the thallus; spores

bilocular, ellipsoid, $\frac{6 - 7}{12 - 16} \mu$.

This pretty little *Ramalina* has been collected on the trunks of alders along Los Gatos Creek, near Wrights, at about 800 feet, in Austrian Gulch, at 1500 feet, and near Long Bridge, at about 800 feet. It is found very sparingly, growing with *Ramalina farinacea* and *Evernia prunastri*, with young stages of which it is likely to be confused.

It probably occurs beside all perennial streams in deep and shady cañons. Found in both North and South America.

LVI. *Usnea* (Dill.) Pers.

Usnea Dillenius, Hist. Musc. 56. 1741, in part.

Usnea Persoon in Ust. Ann. Bot. 21. 1794.

Thallus erect and shrub-like or excessively elongated and pendulous, more or less thread-like, often forming intricately branching and entangled mats, without rhizoids but attached by a holdfast; structure radial, alike on all sides, naked, or usually beset with fibrils, smooth or rough; cortex horny, of irregular or nearly perpendicular hyphæ; outer medulla cottony; inner medulla a solid, cartilaginous, central cord of longitudinal, thick-walled hyphæ; soredia often abundant.

Apothecia circular, usually large and conspicuous, lateral or terminal, shield-like, with pale, often pruinose apothecia, usually fringed with long fibrils; paraphyses branched, capitate, septate; spores 8, small, colorless, ellipsoid to globose.

A large genus, many of the species really but variable conditions of polymorphic species; found all over the world, usually on bark, rarely on rocks.

KEY TO SPECIES.

- A. Plants small, erect, shrub-like.
 - B. Color gray-green.
 - C. Without soredia. 1. *florida*
 - CC. Soredia more or less abundant. 2. *hirta*
 - BB. Color rusty red. 3. *rubiginea*
- AA. Plants more or less pendulous.
 - D. Sub-erect or short pendulous. 4. *ceratina*
 - DD. Pendulous, tangled, long to very long.
 - E. Fibrils numerous.
 - F. Thickly set with short spreading fibrils. 5. *dasypoga*
 - FF. Fibrils nearly straight, horizontal. 8. *longissima*
 - EE. Fibrils very few or wanting.
 - G. Thallus broken into distinct joints. 7. *articulata*
 - GG. Thallus not articulate.
 - H. Without spreading fibrils 6. *plicata*
 - HH. Smooth or with very few fibrils. 9. *californica*

1. USNEA FLORIDA (L.) Hoffm.

Lichen floridus Linné, Sp. Plant. 2 : 1154. 1753.

Usnea florida Hoffmann, Deutsch. Fl. 133. 1791.

Usnea florida Herre, Proc. Wash. Acad. Sci. 7 : 343. 1906.

Usnea barbata a. florida Tuck. Syn. N. Am. Lich. I: 41. 1882.

Thallus terete, tufted, erect, stout, rather rigid, shrub-like, spreading branched, beset with stiff straight fibrils; epidermis smooth or more or less roughened with minute papillæ or tubercles; color gray-green.

Apothecia medium to very large, numerous, terminal; color a pale tan, very pale flesh-color, or sometimes whitish; spores $\frac{4.8 - 6.25}{7.33 - 9.75} \mu$.

On trees and fences throughout; dwarfed and usually sterile near sea-level; larger and fruiting profusely above 1000 feet. An exceedingly variable plant of world-wide distribution.

2. USNEA HIRTA (L.) Hoffm.

Lichen hirtus Linné, Sp. Plant. 2: 1155. 1753.

Usnea hirta Hoffmann, Deutsch. Fl. 2: 133. 1791.

Usnea hirta Herre, Proc. Wash. Acad. Sci. 7: 343. 1906.

Usnea barbata a. florida hirta* Tuck. Syn. N. Am. Lich. I: 41. 1882.

Thallus small, tufted, shrub-like, erect, rigid; branches wide-spread, curving, thickly clad with short fibrils; the whole plant densely beset with soredia.

Apothecia small, rare; spores $\frac{4.5 - 7.5}{7 - 10} \mu$.

On trees and fences throughout but most frequent in the foothills at moderate elevations. Occasional on rocks, Alameda County, Bolander, in Tuckerman Herbarium.

A common lichen of the northern hemisphere.

3. USNEA RUBIGINEA (Michx.)

Usnea florida rubiginea Michaux, Fl. Bor. Am. 2: 332. 1803.

Usnea rubiginea Herre, Proc. Wash. Acad. Sci. 7: 343. 1906.

Usnea barbata a. florida hirta** rubiginea* Tuck. Syn. N. Am. Lich. I: 41. 1882.

Thallus much like that of *Usnea hirta*; epidermis smooth to papillate-scabrous; color varies from bright to dark rusty red or brick-red. Apothecia (not seen) concolorous.

Along the coast from Santa Cruz northward, on trees. Occasional in the mountains, Big Basin, and near the head of Alpine Creek. On dwarfed shrubs on San Bruno Mt., alt. 1100 feet. Very abundant and conspicuous on *Pinus radiata* at Pacific Grove.

A very handsome lichen, generally distributed over North America and also found in South America, parts of Europe, and South Africa.

4. USNEA CERATINA Ach.

Usnea ceratina Acharius, Lich. Univ. 619. 1810.

Usnea ceratina Herre, Proc. Wash. Acad. Sci. 7: 344. 1906.

Usnea barbata b. *ceratina* Tuck. Syn. N. Am. Lich. I: 41. 1882.

Thallus fruticose, much branched, at first erect but becoming pendulous; reaching a length of 6 to 8 inches, or perhaps more; thickly covered with long slender curling fibrils; epidermis smooth to warty or papillose.

Apothecia abundant, medium to large; concolorous, tan, or very pale flesh-color; spores circular to short ellipsoid, $\frac{5 - 7\frac{1}{2}}{7\frac{1}{2} - 9.75} \mu$.

On trees and dead wood; abundant at 2000 feet and above. Found in all temperate and tropical regions but absent from the arctic and sub-arctic realms.

5. USNEA DASYPOGA (Ach.) Nyl.

Usnea plicata dasypoga Ach. Meth. Lich. 312. 1803.

Usnea dasypoga Nyl. St. Gall. Nat. Ges. 202. 1876.

Usnea dasypoga Herre, Proc. Wash. Acad. Sci. 7: 344. 1906.

Usnea barbata c. *dasypoga* Tuck. Syn. N. Am. Lich. I: 41. 1882.

Thallus greatly elongated and pendulous, slender, terete; thickly beset with short spreading fibrils; epidermis usually smooth or minutely roughened; color gray or yellowish green (straw-color); the principal branches often blackening basally.

Apothecia small, infrequent, rather pale; spores $\frac{4.5 - 7}{7.5 - 10} \mu$.

Common on trees and shrubs above 600 feet; best developed in the

redwood formation, often reaching a length of four feet. Native to Europe, North and South America, the East Indies, and Madagascar.

We have the typical form as well as the following variety.

6. var. *PLICATA* (Hoffm.) Hue.

Usnea plicata Hoffmann, Deutsch. Fl. 132. 1791.

Usnea dasypoga plicata Hue, Nouv. Arch. Mus. Paris. Ser. 4^a, 1: 1899.

Usnea barbata d. plicata Tuck. Syn. N. Am. Lich. I: 41. 1882.

Usnea plicata Herre, Proc. Wash. Acad. Sci. 7: 344. 1906.

Thallus greatly elongated and pendulous, rather coarser than in the type; sub-dichotomously divided, the branches without spreading fibrils; varying from gray-green to straw-color. Apothecia very small and rare.

Frequent on trees and shrubs above 600 feet; often growing in inextricable confusion with the type.

7. *USNEA ARTICULATA* (L.) Hoffm.

Lichen articulatus Linn. Sp. Plant. 2: 1156. 1753.

Usnea articulata Hoffmann, Deutsch. Fl. 2: 35. 1791.

Usnea barbata e. articulata Tuck. Syn. N. Am. Lich. I: 41. 1882.

Thallus moderately elongate, pendulous, much branched, more or less dichotomous, smooth or minutely solediose-tuberculate; broken into joints, these more or less inflated basally; my Californian specimens without fibrils, though material collected in Europe has them present on the entangled secondary branchlets. The articulations are sometimes so distinct and numerous as to suggest beads strung on the medullary axis.

Sterile with us.

A distinct and not very abundant plant of the mountain forests. Widely distributed over the earth, absent only from the frigid zones, but not well marked in North America except on the Pacific coast.

8. *USNEA LONGISSIMA* Ach.

Usnea longissima Ach. Lich. Univ. 626. 1810.

Usnea longissima Tuck. Syn. N. Am. Lich. I: 43. 1882.

Usnea longissima Herre, Proc. Wash. Acad. Sci. 7: 345. 1906.

Thallus pendulous, finally excessively elongated, terete, basally slightly compressed, sparingly branched; thickly clothed with simple, nearly straight, horizontal, comparatively short fibrils.

Apothecia small or very small, lateral or terminal; concolorous or pale tan; spores short ellipsoid, $\frac{4.75 - 7\frac{1}{3}}{7\frac{1}{3} - 10}$ μ .

Color of thallus a soft but bright silvery or gray-green; herbarium specimens fading badly, becoming finally a yellowish green.

On trees above 1500 feet, in the redwood formation.

About the head of Purissima Creek, altitude 1900 feet, the long swaying silver-gray fronds of this lichen form a conspicuous feature of the landscape. Here it attains a length of eight or nine feet, but owing to its inaccessible situation only fragments are obtainable.

Widely distributed over the cooler portions of the northern hemisphere and on mountains in the tropics. Said to reach a length of 6 meters (Hungary, according to Zahlbruckner), or 10 meters (Java, Nylander).

9. USNEA CALIFORNICA Herre.

Usnea californica Herre, Proc. Wash. Acad. Sci. 7: 345. 1906.

Thallus large, stout, terete, much elongated and pendulous, smooth; the coarse branches irregularly divided and wide-spread, readily traceable nearly to the extremity of the plant; secondary branches long and sub-divided; sparsely clothed with fibrils; branchlets and fibrils occasionally soresiate; color gray-green to yellowish green.

Fruiting specimens rare; apothecia borne on secondary branches, terminal or lateral, small to medium size; concolorous or tan; spores nearly circular to broadly ellipsoid, $\frac{4.9 - 7\frac{1}{3}}{7 - 11}$ μ .

On trees; as yet seen only about the head of Alpine Creek at an altitude of 1000 feet, where it is locally quite abundant. A similar plant, collected in Mexico, is in the Museum at Vienna.

A robust, conspicuous plant, reaching a length ordinarily of 2-3 feet and probably the bulkiest of our *Usneas*. Quite different in habit and general appearance from all our other species.

CALOPLACACEÆ.

Thallus crustaceous and uniform or marginally lobed, or rarely podetia-form or fruticose; without rhizoids, usually without cortex; alga *Pleurococcus*.

Apothecia circular, innate or sessile, with a thalline margin, or a proper margin which does not enclose algæ; epithecium granular, usually containing chrysophanic acid and becoming purple or violet with KOH. Paraphyses simple, septate, usually with enlarged tips; spores usually 8, colorless, rarely tri- or quadrilocular, mostly polar-bilocular, the cells connected by a narrow tube or isthmus; rarely the spores are simple; these species are separated from *Lecidea* or *Lecanora* by the endobasidial sterigmata.

KEY TO THE GENERA.

- A. Apothecia with proper margin, not containing algæ,
biatorine or lecideine..... LVII. *Blastenia*
- A.A. Apothecia with thalline margin enclosing algæ,
lecanorine..... LVIII. *Caloplaca*

LVII. Blastenia (Mass.) Th. Fr.

Blastenia Massalongo, Monog. Lich. Blast. 101. 1853, in part.
Blastenia Th. Fries, Gen. Heterol. Europ. 87. 1861.

Thallus crustaceous, uniform to powdery, granular, or areolate, without cortex.

Apothecia circular, innate or sessile, light colored or dark with proper margin which does not enclose algæ; asci 4-16 spored; spores polar-bilocular, ellipsoid or oblong, colorless.

A widely distributed genus of about 60 species, occurring on bark, wood, mosses, and rocks. But one species certainly occurring with us.

1. BLASTENIA FERRUGINEA (Huds.) Arn.

Lichen ferrugineus Hudson, Flora Anglica, 444. 1762.

Blastenia ferruginea Arn.

Placodium ferruginea Tuck. Syn. N. Am. Lich. I: 177. 1882.

Thallus at first uniform but soon rough, chinky or fissured, granular to warty; determinate and sub-orbicular to effuse; from ashy gray to whitish.

Apothecia small to medium, plane to convex, rust-colored to red;

proper margin thin, more or less undulate, usually persistent; thalline margin obsolete; spores ellipsoid to broadly-ellipsoid,

$$\frac{6.25 - 10}{12.25 - 22} \mu.$$

This well-nigh cosmopolitan lichen occurs with us on the bark of oaks in the mountains and on rocks, especially along the seashore.

A variable plant with a number of rock-dwelling forms.

One of these, *Blastenia ferruginea bolanderi* (Tuck.), is distinguished by its having no thallus and the apothecia being usually of a bright vermilion. It is abundant on maritime rocks.

LVIII. *Caloplaca* Th. Fr.

Caloplaca Th. Fries, Gen. Heterol. Europ. 70. 1861.

Thallus crustaceous to fruticose, usually yellow, becoming purplish red with KOH.

Apothecia lecanorine, with a thalline margin; hypothecium clear, upon an algal layer; asci with 8 spores.

Species numerous, often quite variable and very difficult to define; scattered over the whole earth and growing upon a great variety of substrata.

KEY TO THE SPECIES.

- A. Thallus fruticose, of terete, nodulose branches... 1. *coralloides*
- AA. Thallus crustaceous to sub-foliaceous.
 - B. Apothecia dark brown to black 4. *variabilis*
 - BB. Apothecia some shade of orange or yellow.
 - C. Thallus marginally lobed or sub-foliaceous.
 - D. Lobes linear to cylindrical, much branched.... 2. *elegans*
 - DD. Lobes marginally plicate or imbricate, broad . 3. *murorum*
 - CC. Thallus not lobate or sub-foliaceous.
 - E. Thallus gray, ashy or dusky.
 - F. Hypothallus concolorous; thallus faint reddish with KOH 5. *cerina*
 - FF. Hypothallus blue black; thallus crimson with KOH 6. *gilva*
 - EE. Thallus yellow, orange or red.
 - G. Thallus granulose, lemon-yellow to greenish or grayish..... 7. *citrinum*
 - GG. Thallus not granulose.
 - H. Thallus of turgid, crenate squamules, pale or tawny yellow 8. *bolacinum*
 - HH. Thallus of minute areoles, fissured; orange-red..... 9. *cinnabarina*

1. CALOPLACA CORALLOIDES (Tuck.) A. Zahlbs.

Caloplaca coralloides A. Zahlbs. Ann. K. K. Natur. Hofmus.

22: 116. 1907., and Kryptog. exs ic. No. 1558.

Placodium coralloides Tuck. Proc. Am. Acad. 6: 287. 1864.

Placodium coralloides Tuck. Syn. N. Am. Lich. I: 169. 1882.

Placodium coralloides Herre, Proc. Wash. Acad. Sci. 7: 385. 1906.

Thallus slender, solid, cartilaginous, decumbent, forming orbiculate, eventually indeterminate patches; branches terete, nodulose, blunt, sub-dichotomously divided, much intertwined; color bright yellow or orange, finally dark orange; underneath and basally grayish or blackening.

Apothecia small to medium, lateral or terminal, sub-pedicellate; the rough, dark-orange disk somewhat concave, becoming finally convex and excluding the thin, entire, elevated margin; spores oblong or ellipsoid, the sporoblasts usually approximate, the isthmus generally lacking, $\frac{5-7}{10-15}$ μ .

Very abundant on rocks above the sea at Point Lobos, San Francisco, and from Pescadero Point southward along the coast to Franklin Point. It grows usually within a few feet of the water, barely above ordinary high tide, and must be submerged at every storm or unusual tide.

A beautiful and unique lichen.

2. CALOPLACA ELEGANS (Link) Th. Fr.

Lichen elegans Link, Ann. Bot. 1: 37. 1794.

Caloplaca elegans Th. Fries, Lich. Scand. 168. 1871.

Placodium elegans Tuck. Syn. N. Am. Lich. I: 170. 1882.

Thallus orbicular or stellate, appressed, radiate, thick; many-cleft, the linear, convex or round and knotted, much branched lobules more or less curved, twisted and knotted, but distinct; upper surface smooth; color deep orange or vermilion.

Apothecia numerous, small, concolorous; the concave disk becoming plane or even convex, at last excluding the thin, somewhat paler, entire thalline margin; spores ellipsoid or ovoid, $\frac{6-9}{9.75-15}$ μ .

" $\frac{5-9}{9-18}$ μ ." in Tuck. Syn.

Here described from specimens from San Jacinto Mountain (Dr. Hasse coll.), altitude 7500 feet, and from Mt. Eddy in northern California, collected by Dr. E. B. Copeland, altitude 8500 feet.

I have collected at Devils Cañon, altitude 2300 feet, a sterile lichen which is unmistakably referable here, but which differs from the above in the sub-crustaceous, dwarfed thallus, with much shorter lacineæ, more irregularly dispersed and with a rougher surface. The typical form may well occur with us.

The color variation in this plant is considerable; specimens collected by me in the Alps range from dingy orange to bright vermilion.

Widely distributed in both northern and austral regions.

3. CALOPLACA MURORUM (Hoffm.) Th. Fr.

Lichen murorum Hoffmann, Enum. Lich. 63. 1784.

Caloplaca murorum Th. Fries, Lich. Scand. 170. 1871.

Placodium murorum Tuck. Syn. N. Am. Lich. I: 170. 1882.

Thallus orbicular, closely adherent to the substratum, sometimes forming an effuse crust by the fusing of adjacent plants; centrally areolate or warted, gradually passing into lobes which are plicate or imbricate, convex or plane, with crenate tips; upper surface more or less minutely granulate scabrous; usually thickish or swollen, but in a maritime form the lobules are often quite thin; KOH purple; color varying from pale to bright yellow.

Apothecia medium, convex, plane or sometimes turgid, circular, becoming irregular when crowded; concolorous to dark orange, the disk naked; margin paler, entire to finely crenate; spores

$$\frac{4.9 - 8.5}{10 - 18} \mu.$$

Common throughout, especially on limestone and calcareous shale.

This cosmopolitan lichen has a number of well marked forms, of which the following occur with us:-

4. CALOPLACA MURORUM MINIATUM (Tuck.)

Tuck., l. c. 171. 1882.

This variety agrees with the type in all respects except that the thallus is a flaming orange-red or dark red. There is every gradation in color between it and the type.

It occurs very finely developed on dry perpendicular rock walls and also on boulders in dry places.

5. CALOPLACA MURORUM DECIPIENS (Nyl.)

Lecanora murorum decipiens Nyl. Flora, 8 (note) 1869; p. 106. 1883.

Lecanora murorum decipiens Crombie, Brit. Lich. 1: 359. 1894.

Distinguished by the reduced, crowded, verrucose thallus, with concolorous soredia; lobules very short; apothecia concolorous, scattered.

Rare; on rocks in the foothills.

4. CALOPLACA VARIABILIS (Pers.) Th. Fr.

Lichen variabilis Persoon in Ust. Ann. 26. 1794.

Caloplaca variabilis Th. Fr. Lich. Scand. I: 172. 1871.

Placodium variabile Nyl. Lich. Scand. 138. 1861.

Placodium variabile Tuck. Syn. N. Am. Lich. I: 172. 1882.

Thallus of minute, rather thin areoles, forming a chinky crust, without effigurate margin in our specimens; ashy gray to grayish brown in color; faint reddish or violet with KOH; CaCl_2O_2 -.

Apothecia numerous, obscuring the thallus, of moderate size, appressed, flat or plano-convex; the disk very dark brown to black, bordered by an entire, at length flexuous margin, which passes from white powdery or paler conditions into concolorous; thecium deep blue with I; in our specimens the contents of the asci generally degenerate, not often formed into spores, these also generally imperfect, broadly ellipsoid, $\frac{7 - 8.5}{14.5 - 17.1}$ μ .

On igneous rocks in the foothills near Stanford University; too easily passed by, bearing no resemblance to our other representatives of the genus. Found in Europe and western North America.

5. CALOPLACA CERINA (Ehrh.) A. Zahlbr.

Lichen cerinus Ehrhart, Pl. Crypt. Dec. 22, no. 216. 1785.

Caloplaca cerina A. Zahlbr. Ascolichenes, 228. 1907.

Placodium cerinum c. *pyracea* Tuck. Syn. N. Am. Lich. I: 175. 1882.

Thallus thin, effuse, granular and contiguous, or becoming chinky

and scurfy, or occasionally obsolete; whitish, ashen, to dusky gray; hypothallus not different in color; KOH faint reddish.

Apothecia small, sessile, plane or convex; thalline margin soon disappearing; the thin entire, proper margin prominent, paler than the orange-yellow disk; KOH crimson; spores ellipsoid,

$$\frac{4.9 - 8}{9.75 - 15.75} \mu.$$

Abundant on trees, especially on *Æsculus californicus*.

A common lichen in Europe and North America, on bark, dead wood, and stones.

6. CALOPLACA GILVA (Hoffm.) A. Zahlbr.

Verrucaria gilva Hoffmann, Deutsch. Flor. 2. 1795.

Caloplaca gilva A. Zahlbr. Ascolichenes, 228. 1907.

Placodium cerinum Tuck. Syn. N. Am. Lich. I: 175. 1882.

Thallus thin, usually definite, soon chinky, granular or warted, areolate or scattered; often disappearing; hypothallus evident, bluish black; color gray, ashy, or dusky; KOH crimson.

Apothecia small to medium, sessile; disk pale yellow to reddish or brownish; plane; thalline margin thin, entire, paler or concolorous; thecium rose-red with KOH; spores ellipsoid to broadly ellipsoid,

$$\frac{4.9 - 9.75}{10 - 15.75} \mu.$$

A common and variable lichen, occurring everywhere in the foothills on trees and old boards, and also on rocks. Found generally over Europe and North America.

7. CALOPLACA CITRINUM (Hoffm.) Th. Fr.

Verrucaria citrina Hoffmann, Deutsch. Fl. 2: 198. 1795.

Caloplaca citrinum Th. Fries, Lich. Scand. 1: 176. 1871.

Placodium citrinum Leighton, Lich. Flor. Grt. Brit. ed. 3, 163. 1879.

Placodium citrinum Tuck. Syn. N. Am. Lich. I: 174. 1882.

Thallus effuse, granulose, sub-areolate, lemon-yellow, varying from grayish to greenish.

Apothecia small, numerous, appressed, the disk yellow or pale orange, plane, the pale margin entire; spores ellipsoid, $\frac{6 - 7.5}{12.5 - 15} \mu$; KOH purple.

Not common; on bark of pepper (*Schinus molle*) and cypress trees, at Mayfield.

I also refer here a depauperate plant growing on various maritime shrubs at Santa Cruz; the spores of this are $\frac{4 - 6.75}{8.5 - 12.25}$ μ .

Occurring over Europe and North America, more often on mortar or rocks, rarely on old trees.

8. CALOPLACA BOLACINUM (Tuck.) Herre.

Placodium bolacinum Tuckerman, Lich. Calif. 18. 1866.

Placodium bolacinum Tuck. Syn. N. Am. Lich. I: 173. 1882.

Thallus of rounded, turgid, crenate squamules, or centrally of warty areoles; often contiguous but usually scattered, when the scales are sometimes much reduced; color a pale yellow to tawny yellow.

Apothecia medium to large, sessile, becoming convex; often crenate or difform; the disk bright to dark orange, finely granulate; proper margin pale, often prominent; thalline margin becoming obsolete; thecium purplish red with KOH; blue with I; spores ellipsoid, $\frac{6 - 9.75}{9.75 - 17}$ μ .

On rocks; perhaps occurring throughout our range, but not often seen outside the maritime belt, where it occurs on cliffs above the sea; nowhere very abundant.

A Californian lichen.

9. CALOPLACA CINNABARINA (Ach.) A. Zahlbr.

Lecanora cinnabarina Ach. Lich. Univ. 402. 1810; Island of St. Bartholomew, West Indies.

Caloplaca cinnabarina A. Zahlbr. Ascolichenes, 228. 1907.

Placodium cinnabarrinum Tuck. Syn. N. Am. Lich. I: 173. 1882.

Thallus areolate, fissured or chinky, or the areoles more often scattered and minute or almost disappearing; sometimes large and passing into flattened and crenate scales; on a black hypothallus; color of thallus, orange-red.

Apothecia very small or minute, appressed; disk plane to moderately convex, orange-red; margin pale, entire; spores $\frac{6 - 8.5}{11 - 15}$ μ .

1. XANTHORIA PARIETINA (L.) Th. Fr.

Lichen parietinus Linné, Sp. Plant. 2: 1143. 1753.

Xanthoria parietina Th. Fries, Lich. Arctoi. 67. 1860, in part.

Xanthoria parietina Th. Fries, Lich. Scand. 1: 145. 1871.

Theloschistes parietinus Norm. Nyt. Mag. Naturvid. 7: 229. 1853.

Theloschistes parietinus Tuck. Syn. N. Am. Lich. I: 49. 1882.

Theloschistes parietinus Herre, Proc. Wash. Acad. Sci. 7: 348. 1906.

Thallus foliaceous, more or less orbicular, appressed; lobes broad, entire, crenate, often plaited; sometimes short, thick, and somewhat pruinose; sometimes forming a thick, effuse crust; color yellow to orange.

Apothecia small to medium size, concolorous; margin thick, prominent, entire, becoming flexuous; finally disappearing; spores

$$\frac{5 - 9}{12.25 - 17} \mu.$$

On trees, rocks, roofs, and fences. A wide spread lichen, with most abundant in the lowlands and foothills about San Francisco Bay.

2. XANTHORIA POLYCARPUS (Ehrh.)

Lichen polycarpus Ehrhart, Plant. Crypt. Exsic. no. 136. 1785.

Theloschistes polycarpus Tuck. Syn. N. Am. Lich. I: 50. 1882.

Theloschistes polycarpus Herre, Proc. Wash. Acad. Sci. 7: 348. 1906.

Thallus very small, sub-orbicular, stellate or more often effuse, closely appressed, yellow; lobes much cleft, narrow.

Apothecia small and very numerous, sometimes concealing the thallus; disk concolorous or orange; spores $\frac{5 - 8.5}{11 - 16.9} \mu.$

On trees. Common in the valleys and lower foothills. Widely distributed over the northern hemisphere.

3. XANTHORIA LYCHNEA LACINIOSA (Schaer.)

Parmelia parietina laciniosa Schaerer, Lich. Helvet. Spicil. 477. 1840.

Theloschistes lichneus laciniosa Tuck. Syn. N. Am. Lich. I: 51. 1882.

Theloschistes lichneus laciniosa Herre, Proc. Wash. Acad. Sci. 7: 349. 1906.

Proc. Wash. Acad. Sci., May, 1910.

Thallus foliaceous, appressed, expanded, orbicular or stellate; lobes much and intricately dissected, their tips ascendant and more or less fibrillose; lobes either smooth or with granulose powdery margins; color yellow to orange, rarely greenish to whitish; beneath white or greenish white, with scattered fibrils of the same color.

Apothecia abundant, medium to large, their disks dark orange; margin entire or minutely crenulate.

Very abundant in the valleys and foothills on trees and dead wood; especially noticeable on *Æsculus californicus*.

Passing into states not distinct from *polycarpus*, but when well developed a very well marked form.

4. XANTHORIA LYCHNEA PYGMÆA (Bory).

Borrera pygmæa Bory, in Fries, Lich. Europ. Reform. 73. 1831.

Theloschistes lychneus b. *pygmæus* Tuck. Syn. N. Am. Lich. I: 51. 1882.

Thallus small, sub-orbiculate and pulvinate, or effuse; the lobes much narrowed or minute, irregular, becoming more or less rounded and erect, the tips and margins finally granulose-powdery; color orange or orange-yellow.

Apothecia small, dark orange, not numerous, the entire margin becoming flexuous and granulose. Spores $\frac{5-6}{11-16}$ μ .

On rocks in the maritime belt, San Bruno Mt., 1000 to 1300 feet elevation. In the Tuck. Herbarium are specimens from the Oakland Hills, elevation 2000 feet, and from Olima, Marin County; these are labelled *Theloschistes parietinus* var. *finmarkicus* Ach. Dr. Hasse has also collected it on the ocean bluffs at Newport, Los Angeles County.

5. XANTHORIA RAMULOSUS (Tuck.) Herre.

Theloschistes ramulosus Tuck. Syn. N. Am. Lich. I: 51. 1882.

Theloschistes ramulosus Herre, Proc. Wash. Acad. Sci. 7: 349. 1906.

Thallus small, effuse, closely appressed; the minute and scattered lobules but little divided; color pale yellow to greenish yellow.

Apothecia very small, entire, concolorous, or at length orange; spores $\frac{5-6}{14-16}$ μ .

On trees and shrubs in the maritime region and in the lower foothills.

In the Tuckerman Herb. are specimens found on bushes at Mare Island, collected by Charles Wright, and others simply marked "California," growing on *Æsculus*, with *Placodium gilva*.

This insignificant little plant is too readily overlooked. It resembles *Candelaria concolor*, from which it may be best distinguished by the difference in spores.

LX. *Theloschistes* Norm.

Theloschistes Norman, Con. Gen. Lich. 16. 1852.

Thallus fruticose, erect or decumbent, branched; structure radial, alike on all sides, without rhizoids.

Apothecia circular, sessile, plate-shaped, with thalline margin; spores colorless, polar-bilocular to 4-locular.

A small genus of wide distribution, usually living on bark.

KEY TO THE SPECIES.

- A. Thallus sub-terete; apothecial margin sub-crenulate. . . 1. *flavicans*
- AA. Thallus compressed; apothecia with marginal radiate fibrils. 2. *chrysophthalmus*

1. THELOSCHISTES FLAVICANS (Sw.) Norm.

Lichen flavicans Swartz, Fl. Ind. Occid. 3: 1908. 1788.

Theloschistes flavicans Norman, Gen. Lich. 17. 1852.

Theloschistes flavicans Herre, Proc. Wash. Acad. Sci. 7: 348. 1906.

Theloschistes chrysophthalmus b. *flavicans* Tuck. Syn. N. Am. Lich. 1: 49. 1882.

Thallus tufted, elongated, erect and spreading, becoming decumbent, sub-terete; branches numerous, narrow to linear, more or less twisted and pitted or channelled; margins with numerous small concolorous soredia; color a bright orange-yellow.

Apothecia rare, without marginal radial fibrils; disk a very dark orange; margin sub-crenulate; my specimens do not yield me spores but examples from Santa Barbara have spores, $\frac{6.75 - 9.75}{12 - 14.75} \mu$.

On rocks, earth, and shrubs. Rather abundant on a sandstone cliff in Pilarcitos Creek Cañon, altitude about 200 feet. It also occurs sparingly on the twigs of dwarf *Baccharis* and *Vaccinium* on

the foggy, wind-swept summit of San Bruno mountain, at an altitude of about 1300 feet; here it is sometimes paler basally, or, when shaded, is greenish.

Abundant in the coast ranges from San Luis Obispo County southward, on the twigs of various trees and shrubs; here the lichen is darker colored, usually lacks soredia, and the apothecia are numerous. A wide-spread tropical or sub-tropical lichen of maritime regions.

2. THELOSCHISTES CHRYSOPHTHALMUS (L.) Th. Fr.

Lichen chrysophthalmus Linné, Mantissa, 2: 311. 1771.

Theloschistes chrysophthalmus Th. Fries, Gen. Heterol. Europ. 51. 1861.

Theloschistes chrysophthalmus Tuck. Syn. N. Am. Lich. I: 48. 1882.

Thallus small, rigid, somewhat erect, much compressed, divaricately lobed, the multifid tips becoming more or less beset with fibrillose or spinose branches; yellow or yellowish white; beneath whitish; smooth.

Apothecia medium to large, with orange disk, the margin with radiate fibrils; spores polar-bilocular, the cells often connected by a faint tube, $\frac{6-7}{14-17} \mu$.

On *Quercus agrifolia* at Santa Cruz. Rare in the Santa Cruz peninsula, the herbarium specimens I have seen under this name from this region being all *Xanthoria lychneus laciniosa*.

A common lichen in some parts of the state and widely distributed in general.

BUELLIACEÆ.

Thallus crustaceous to squamulose, uniform or marginally lobed, without rhizoids, usually without cortex; alga *Protococcus*.

Apothecia circular, innate or sessile, with only a proper margin or with a thalline margin; paraphyses simple; asci with 8 spores, rarely with 16-24 spores; these smoky gray to brown, 2-4 locular, or also muriform, usually with very thick walls.

KEY TO GENERA.

- Apothecia lecideine.....LXI. *Buellia*
 Apothecia lecanorine.....LXII. *Rinodina*

LXI. *Buellia* DeNot.

Buellia DeNotaris, Giorn. Bot. It. an. 2: t. 1: 195. 1846.

Thallus as above; apothecia innate, appressed, or sessile, lecideine, not containing algæ; hypothecium usually dark or black; paraphyses simple, the tips generally dark and thickened; asci 8-spored, rarely with 16-24 spores; spores brown to blackish, oblong or ellipsoid, 2-4 locular, becoming muriform, the septa thick, without a halo.

A large genus, the species often very difficult; on bark, rocks, and wood, occurring in all parts of the world.

KEY TO THE SPECIES.

- A. Thallus dark.
 - B. Thallus more or less squamulose. 1. *badia*
 - BB. Thallus more or less compactly crustose or minutely areolate.
 - C. Brown-gray or umber 2. *pullata*
 - CC. Greenish or brownish ash colored and darker. 3. *myriocarpa*
 - AA. Thallus pale.
 - D. Thallus more or less yellowish.
 - E. Yellow with CaCl_2O_2 ; on trees.. . . . 4. *oidalea*
 - EE. Orange-red with CaCl_2O_2 5. *halonia*
 - DD. Thallus more or less whitish or ashen.
 - F. Little or no reaction with KOH.
 - G. Areoles small, rough-surfaced, angulose; KOH— or brownish; on rocks. 8. *spuria*
 - GG. Thallus uniform or sub-areolate; clear white, often silvery; KOH faintly yellowish or — ; on rocks. 6. *albo-atra*
 - FF. Yellow with KOH.
 - H. On bark.
 - I. Thallus of smooth, rounded, contiguous areoles, occasionally sub-lobate; whitish to dark gray. 7. *parasema*
 - HH. On rocks.
 - J. Without evident hypothallus.
 - K. Areoles distinct, putty-colored; more or less sub-lobate or crenate at circumference.
 - 9. *lepidastræ*
 - JJ. Hypothallus present.
 - L. Areoles and apothecia minute to very minute; apothecia innate-sessile, between the areoles 10. *stellulata*
 - LL. Areoles and apothecia minute to small; apothecia adnate upon the areoles.
 - 11. *retrovertens*

1. BUELLIA BADIA (E. Fr.) Körb.

Lecidea badia E. Fr. Lich. Europ. Reform. 289. 1831.

Buellia badia Körber, Sys. Lich. Germ. 226. 1855.

Buellia badia Tuck. Syn. N. Am. Lich. II: p. 88. 1888.

Thallus effuse, indeterminate, of minute, crumb-like granules or these becoming larger, crenate-incised, or lobate and more or less crowded and imbricate; often passing into a fissured crust of small or medium-sized, flattened, sometimes sub-lobulate squamules; a black hypothallus very little evident; color gray-brown, olive-brown, and nearly chestnut; KOH; CaCl₂O₂.

Apothecia minute or small, closely adnate, black; disk at first flat, with an evident entire or irregular margin, becoming moderately convex and the margin finally excluded; hypothecium umber to blackish brown; paraphyses free, simple, rather stout, the outer half of their moderately enlarged, sub-globose or rounded tips dusky or brown; asci ventricose clavate, thecium blue with I; spores bilocular, dark brown, ellipsoid, $\frac{6.5 - 8}{9 - 17} \mu$.

Not rare on rocks in the foothills, occurring in small patches among other lichens.

A European lichen found also in western America.

2. BUELLIA PULLATA Tuck.

Buellia pullata Tuck. Lich. Calif. 26. 1866.

Buellia pullata Tuck. Syn. N. Am. Lich. II: 96. 1888.

Thallus effuse, of very minute angular areoles, flat or concave, finally somewhat rugose or warty, separated by very small fissures, forming a contiguous, brown-gray or pale umber crust; KOH or brown; CaCl₂O₂.

Apothecia numerous, small, sessile, circular or finally angular and irregular; the black naked disk flat and surrounded by a thin, erect, entire margin, or becoming convex, and the margin disappearing; paraphyses simple, thread-like, more or less sub-coherent, their tips sometimes capitate and darkened; epithecium broad, blackish brown; hypothecium pale to dark brown; asci short and broadly clavate or cylindrical-clavate, the spores variously arranged; thecium

deep blue with I; spores short ellipsoid, rather blunt, bilocular, $\frac{5 - 8.5}{10 - 15} \mu$. A specimen collected by Bolander yields me spores $\frac{6.5 - 9}{13 - 19} \mu$.

On rocks above the sea and also in the foothills. Known only from the coast region of California.

A specimen in the Tuck. Herb., collected by Bolander, No. 150, at San Bruno, has the thallus obsolete.

3. BUELLIA MYRIOCARPA (DC.) Mudd.

Patellaria myriocarpa DC. Fl. Fr., Vol. II: 346. 1805.

Buellia myriocarpa Mudd, Manual Brit. Lich. 217. 1861.

Buellia myriocarpa Tuck. Syn. N. Am. Lich. II: 97. 1888.

Thallus small, thin, indeterminate, scurfy or forming a compact minutely fissured crust which may pass into minutely rough-warty conditions; greenish or brownish ash-colored and darker; KOH⁻; CaCl₂O₂.

Apothecia numerous, very small, sessile, black; the disk flat, with a thin, erect, paler margin; soon moderately convex and the margin disappearing; epithecium granulose, brown; paraphyses free, rather slender, their enlarged tips more or less ellipsoid or oblong, the extreme apex often dark; hypothecium dark brown; asci clavate, thecium blue with I; spores bilocular, ellipsoid, $\frac{5 - 7}{9.5 - 14.7} \mu$; according to Tuckerman, $\frac{4 - 8}{7 - 16} \mu$.

Abundant on the bark of *Cupressus* and other trees and also occurring on stones, in the foothills. Found all over the world.

4. BUELLIA OIDALEA Tuck.

Lecidea oidalea Tuck. Proc. Am. Acad. Arts & Sci., Vol. , p. 383. 1860.

Buellia oidalea Tuck. Lich. Calif. 26. 1866.

Buellia oidalea Tuck. Gen. Lich. 189. 1872.

Buellia oidalea Tuck. Syn. N. Am. Lich. II: 99. 1888.

Thallus suborbiculate to effuse, more or less limited by the black

or dusky hypothallus, uniform, from thin and rather smooth becoming thick, minutely fissured and rough-warty or uneven; color a yellowish-green or whitish-greenish; KOH greenish yellow; CaCl_2O_2 yellow.

Apothecia small to medium, finally large, scattered, sessile, dull black; the disk at first concave, then plane, at last convex, the entire margin finally excluded; epithecium granulose, brown to dark brown; hypothecium brownish black; paraphyses simple, threadlike, lax, their tips very slightly enlarged and brown-margined; asci with 1, 2, 3 and 4 spores; thecium blue with I; spores very diverse, at first bilocular, then quadrilocular, finally becoming muriform multilocular, $\frac{14 - 18}{29 - 45}$ μ in a specimen from *Pinus radiata*, $\frac{15 - 22}{40 - 60}$ μ in a specimen from an old fence near San Francisco Bay.

On the bark of *Pinus radiata* at the mouth of Año Nuevo Creek and southward along the coast on old fences and various trees; also on an old fence on the salt marsh near Mountainview Landing. Recorded by Tuckerman as occurring on the bark of various trees, in a number of localities, from San Diego and Yosemite to the state of Washington.

According to Tuckerman the spores occur solitary, $\frac{18 - 24}{46 - 88}$ μ and also in twos, threes, fours, fives, sixes and eights, averaging 16 by 30 μ . As Tuckerman well says "This instructive lichen beautifully exhibits the history of the muriform spore."

5. BUELLIA HALONIA (Ach.) Tuck.

Lecidea halonia Ach. Meth. Lich. 47. 1803.

Buellia halonia Tuck. Lich. Calif. 26. 1866.

Buellia halonia Tuck. Gen. Lich. 186. 1872.

Buellia halonia Tuck. Syn. N. Am. Lich. II: 95. 1888.

Thallus determinate and more or less orbiculate, or even subeffigurate, upon a black, limiting hypothallus; made up of tiny, angular areoles separated by minute to medium-sized chinks or fissures, at first smooth but soon wavy or variously rugose; color a pale yellow-green to bright greenish yellow; KOH —; bright orange-red with CaCl_2O_2 .

Apothecia numerous, of medium size, innate, sessile, black, the disk at first flat or plano-convex, bordered by a thin, erect entire margin; soon convex or swollen and the margin disappearing; more or less greenish- or pale-pruinose; epithecium dark brown; paraphyses thread-like, sub-coherent, their tips hardly enlarged; thecium blue with I; hypothecium very broad, reddish brown to blackish brown; spores bilocular, ellipsoid, $\frac{7-10}{11-18}$ μ .

On rocks all along the ocean shore and in the foothills bordering the Bay. Oakland Hills, Bolander, in Tuck. Herb. Recorded by Hasse from the islands off the coast of southern California. Originally described from the coast of South Africa, at the Cape of Good Hope.

6. BUELLIA ALBO-ATRA (Hoffm.) Th. Fr.

Lichen albo-ater Hoffmann, Enum. Lich. 30. 1784.

Buellia albo-atra Th. Fr. Lich. Scand. 2: 607. 1874.

Buellia albo-atra Tuck. Syn. N. Am. Lich. II: 92. 1888.

Thallus small, effuse, thin to moderately thick, from uniform becoming fissured and sub-areolate, with an irregularly roughened surface; color clear white, often with a silvery lustre; KOH faintly yellowish or —; CaCl_2O_2 —.

Apothecia numerous, small, sub-innate to adnate and sessile, black; disk from plane soon strongly convex, naked or gray pruinose, the proper margin not apparent but often bordered by a false white or darkening thalline margin; epithecium slightly granulose, yellowish brown; hypothecium deep brown; paraphyses becoming free, moderately stout, their slightly enlarged and sometimes bluish dusky and dark brown tips cut off by a septum; asci clavate; thecium permanent deep blue with I; spores brown, ellipsoid or bowed or bean-shaped, from quadrilocular becoming muriform, irregularly disposed in the asci, $\frac{7\frac{1}{3}-9.75}{13-22}$ μ , and $\frac{12-14.6}{20-28}$ μ .

On the bark of oaks in the foothills and on *Pseudotsuga taxifolia* at the summit of the range.

The variety *saxicola* is common in the foothills on rocks, and occurs also under overhanging sandstone walls at Devils Cañon. It is distinguished by the sub-orbiculate to effuse thallus of minute

areoles, occurring generally in small, more or less determinate patches, sometimes bounded by a black hypothallus. The apothecia are smaller and more crowded.

A common and variable lichen, dwelling on bark and rocks in the cold and temperate regions of the northern hemisphere.

7. BUELLIA PARASEMA (Ach.) Th. Fr.

Lichen parasemus Ach. Lich. Suec. Prodr. 64. 1798.

Lecidea parasema Ach. Meth. Lich. 35. 1803.

Buellia parasema Th. Fr. Lich. Scand. 2: 589. 1874.

Buellia parasema Tuck. Syn. N. Am. Lich. II: 92. 1888.

Thallus of small, smooth, rounded, contiguous areoles, or much fissured and the areoles often sublobate; passing also into very thin, almost obsolete states; or the areoles becoming thicker, rough, and corrugated; color whitish gray, to dark ashy gray, the limiting, pale or blackening hypothallus usually but little evident in our specimens, or even entirely obsolete; KOH yellow; CaCl_2O_2 —.

Apothecia numerous, small to medium, closely sessile or adnate, black and also brownish black; the disk at first flat, with a thin, entire margin which is irregular as the disk becomes flexuous; or the disk convex almost from the beginning, and soon tumid, the margin disappearing; epithecium yellowish brown; paraphyses very slender, coherent, thecium blue with I; hypothecium very broad, brownish black; spores brown, ellipsoid, bilocular, not constricted, $\frac{7.5 - 12}{16 - 29} \mu$; according to Tuck. $\frac{5 - 11}{10 - 24} \mu$.

Common throughout on old fences, decorticated dead wood, and the bark of trees; a variable species probably distributed over the whole earth.

8. BUELLIA SPURIA (Schaer.) Körb.

Lecidea spuria Schaerer, Lich. Helvet. Spicilegium, 127.

Lecidea spuria Schaerer, Enum. Crit. Lich. Europ. 114. 1850.

Buellia spuria Körber, Parerga Lich. 183. 1865.

Buellia spuria Tuck. Syn. N. Am. Lich. II: 91. 1888.

Thallus of small, flattish or plano-convex, rough-surfaced, angulose areoles crowded together into a rimose or chinky dark ashy gray crust, or else of more or less dispersed, slightly convex,

angular, smooth areoles, upon a black hypothallus; KOH— or brownish; CaCl_2O_2 —.

Apothecia small or minute, innate-sessile or closely appressed, black; the flat disk surrounded by a thin but prominent and entire margin; more rarely the disk is roughened or papillate, moderately convex, the margin disappearing; epithecium thick, black; hypothecium brownish black; asci clavate or ventricose; thecium blue with I; paraphyses sub-coherent at their tips, becoming free, slender, the apices but little enlarged, umber to blackish brown; spores ellipsoid, bilocular, not constricted at the middle, $\frac{6 - 8.5}{12 - 17}$ μ .

On rocks in the foothills at slight elevations; common in Europe and the eastern United States.

9. BUELLIA LEPIDASTRA Tuck.

Lecidea lepidastr Tuck. Amer. Journ. Arts. & Sci. 25: 429. 1858.

Buellia lepidastr Tuck. Gen. Lich. 186. 1872.

Buellia lepidastr Tuck. Syn. N. Am. Lich. II: 90. 1888.

Buellia lepidastr Hasse, Lich. South. Calif. ed. 2, 15. 1898.

Thallus of distinct, thickish, flat or plano-convex areoles forming a fissured crust, passing at the circumference into sub-lobate and crenulate or more dilate areoles or squamules, which often form a limiting, sub-orbiculate border; no hypothallus to be made out; color of a putty-like whiteness; KOH yellow; CaCl_2O_2 —.

Apothecia numerous, often crowded, circular to angulose, small, adnate or sessile, black; the naked disk at first flat, with a thin entire margin, becoming plano-convex or moderately rounded, the margin more or less obsolete; paraphyses moderately stout, septate, from agglutinate becoming free, their slightly enlarged and dusky tips brown to black at the very apex; asci clavate, thecium deep blue with I; hypothecium blackish brown; spores bilocular, blunt-ellipsoid or pointed, not constricted at the middle, $\frac{6 - 7.5}{10 - 13.5}$ μ ; Tuck.,

“ $\frac{6 - 8}{10 - 20}$ ” μ .

On stones in the foothills, at elevations of a few hundred feet, forming small, sub-effigurate patches among other lichens. A North American lichen originally described from Vermont.

10. BUELLIA STELLULATA (Tayl.) Mudd.

Lecidea stellulata Taylor, in Mackay, Fl. Hibern. II: 118. 1836.

Buellia stellulata Mudd, Man. Brit. Lich. 216. 1861.

Buellia stellulata Tuck. Syn. N. Am. Lich. II: 91. 1888.

Thallus from small and more or less orbiculate becoming effuse and spreading extensively, but bounded by a thin black hypothallus; thin, of minute to very minute, flat or plano-convex areoles, finely rimose; color white, ashy gray, and dusky ashen; KOH yellow; CaCl_2O_2 —.

Apothecia numerous, minute to very minute, innate-sessile between the areoles, becoming crowded and confluent, black; the disk plane with a thin erect black or occasionally gray margin which finally disappears; epithecium and hypothecium blackish brown or umber; paraphyses simple, thread-like, sub-coherent, their tips enlarged, blunt, rounded; thecium blue with I; spores bilocular, blunt-ellipsoid, $\frac{6-8}{10-15}$ μ .

Common on various rocks in the maritime area and in the foothills. A cosmopolitan lichen.

The minute white areoles thickly studded with the black apothecia often give it a "pepper and salt" or "Milky Way" appearance.

11. BUELLIA RETROVERTENS Tuck.

Buellia retrovertens Tuck. Syn. N. Am. Lich. II: 89. 1888.

Thallus of small or minute, separate or contiguous, smooth, plano-convex, rounded, angulose, or sub-lobate whitish-gray squamules on a more or less evident black hypothallus; KOH yellow; CaCl_2O_2 —.

Apothecia adnate, minute to small, disk at first flat, dull black, with an entire, slightly elevated, brown-black margin; becoming convex when the margin is obsolete; epithecium a narrow brown-black line; hypothecium dark brownish black; paraphyses coherent, with abrupt globular pale violaceous heads; thecium pallid, blue with I; asci spatulate, nearly as high as thecium; spores long-ellipsoid, dark brown, little or not at all constricted at the middle, apparently with a narrow and little evident halo, $\frac{5-8}{10-17}$ μ .

On rocks near Mayfield, at an altitude of 200 feet, and on jasper at Twin Peaks, San Francisco, altitude about 550 feet.

This species seems to be almost as near *Rhizocarpon* as to *Buellia*.

LXII. **Rinodina** (Mass.) Stiz.

Rinodina Mass. Ric. Lich. Crost. 14. 1852.

Rinodina Stizenberger, Beitrag zur Flechtensystematik, 45. 1862.

Thallus crustaceous, rarely squamulose, uniform or marginally lobed, without rhizoids, a cortex present in some species; alga *Prolococcus*.

Apothecia circular, innate or sessile, lecanorine, with thalline margin enclosing algæ which in some species soon die; proper margin very thin or lacking; disk dusky or black, naked or pruinose; epithecium granular or powdery, usually purple or violet with KOH; hypothecium colorless, rarely dark; paraphyses simple or rarely forked, thread-like, more or less clavate, often thickened at the tips; spores usually 8, rarely as many as 24, smoky gray, brown, or blackish, 2-4 celled, with (usually) strongly thickened walls, the cell contents united by an isthmus.

A large genus of rock and bark lichens, found all over the world.

KEY TO THE SPECIES.

- A. Thallus obsolete or nearly so, on limestone; apothecia immersed in pits in the rock3. *bischoffi immersa*
- AA. Thallus well developed.
- B. Thallus with margin radiately lobate.
- C. Thallus white to dusky gray.....1. *radiata*
- CC. Thallus greenish yellow or straw-color.....2. *oreina*
- BB. Thallus not marginally lobate.
- D. On rocks.
- E. Thallus dark brownish to olive black; KOH—...4. *tephraspis*
- EE. Thallus whitish to brown-gray; KOH bright yellow
5. *confragosa*
- DD. On bark.
- F. Thallus brown or gray.
- G. Color umber or dark brown; apothecia often pruinose.....6. *hallii*
- GG. Color olive-brown or gray-brown; apothecia never pruinose.....7. *sophodes*
- FF. Thallus whitish or gray.
- H. Thallus reddish with CaCl₂O₂ 8. *atrocinerea*
- HH. Thallus not affected by CaCl₂O₂.

- I. Thallus faint yellow with KOH; paraphyses agglutinate9. *roboris*
 II. Thallus not affected by KOH; paraphyses free; spores smaller than in *roboris*.
 10. *exigua*

1. RINODINA RADIATA Tuck.

Buellia radiata Tuck. Lich. Calif. 25. 1866.

Rinodina radiata Tuck. Proc. Am. Acad. Arts. & Sci. new series, 4: 173. 1877.

Rinodina radiata Tuck. Syn. N. Am. Lich. I: 205. 1882.

Lecanora radiata Hasse, Lich. So. Calif. ed. 2. 11. 1898.

Thallus more or less orbicular, adnate, rather thin, small or medium, or spreading through the coalescence of several plants; the rather broad marginal region radiately lobed, irregularly crenate and cleft, the lobules convex or flattened; remainder of thallus of small, irregular, flattish areoles, forming a uniform fissured crust. Margin white to gray; central portion dusky gray to blackish; a black fringing hypothallus often visible; KOH—; CaCl_2O_2 —.

Apothecia from small and innate emerging and becoming sessile and sub-globose; disk plane, at last strongly convex, black; naked, or more often white pruinose, with entire or irregular whitish thal-line margin which rarely disappears; epithecium thin, granulose, brown; paraphyses short, free, simple, their tips somewhat enlarged, pale yellowish brown; hypothecium dusky or blackish brown; asci short, cylindrical-clavate or ventricose; thecium deep blue with I; spores short ellipsoid, $\frac{4.9 - 8.5}{8 - 12.25} \mu$.

Abundant on rocks in the maritime area; usually closely associated with *Buellia stellulata*. Probably confined to the coast ranges of California.

Under unfavorable conditions the thallus is poorly developed, without the radiately lobed margin, but remains uniform, being then the variety *fimbriata* of Tuckerman.

2. RINODINA OREINA (Ach.) Mass.

Lecanora straminea β *oreina* Ach. Lich. Univ. 433. 1810.

Rinodina oreina Mass. Ric. Lich. Crost. 16. 1852.

Rinodina oreina Tuck. Syn. N. Am. Lich. I: 206. 1882.

Thallus of medium size or large, rarely small with us, closely appressed, with a radiately lobed circumference, the crenate lobules long and distinct; remainder of plant thicker, crustaceous, fissured, of variously shaped areoles, plane or convex, smooth, or roughened; color greenish yellow or straw-color, the margin much lighter than the inner portion, which is often dusky; lobes of circumference black-margined, as are sometimes all the areoles; KOH faintly darker yellowish; CaCl_2O_2 —.

Apothecia small, innate, soon emergent and sessile, from plane, becoming strongly convex; color of disk brown, brownish-black and black; the entire thalline margin finally disappearing; paraphyses agglutinate, their pale yellow tips enlarged; epithecium granular, brownish; hypothecium clear; thecium blue with I; spores short, blunt ellipsoid, $4.9 - 7\frac{1}{2}$
 $9.75 - 12.5$ μ .

Found but once within our limits, lining a "pot-hole" on the top of a huge sandstone crag, on the summit of the range near Devils Cañon, altitude about 2500 feet. Very abundant and finely developed in the Inner Coast Range, occurring at Alum Rock Park as low as 300 feet, covering large areas of igneous rock.

Occasionally the marginal lobes are absent and the central portion is degenerate.

Widely distributed over the temperate zone.

3. RINODINA BISCHOFFII IMMERSA Körber.

Rinodina bischoffii immersa Körber, Parerga Lich. 75. 1865.

Rinodina bischoffii immersa Jatta, Syll. Lich. Ital. 272. 1900.

Lecanora bischoffii immersa Leighton, Lich. Fl. Grt. Brit. ed. 3, 221. 1879.

Thallus endolithic, of minute granules visible only with a good lens, imparting a gray or bluish cast to the stone, or else entirely absent; KOH—; CaCl_2O_2 —.

Apothecia minute, numerous, immersed in tiny pits in the rock, black, usually plane and below the surface; a thin paler or concolorous margin more or less evident; paraphyses simple, their tips coherent, broadly capitate, sometimes forked, umber-colored; epithecium, broad, blackish brown; hypothecium dark brown; spores blunt

ellipsoid, from colorless becoming dark brown, bilocular, the septum broad, $\frac{7.5 - 12.25}{14 - 19.5} \mu$.

Abundant on limestone near the summit of Black Mountain, altitude 2700 feet.

A European lichen which I fail to find recorded from this country.

4. RINODINA TEPHRASPIS Tuck.

Lecanora tephraaspis Tuck. Proc. Am. Acad. Arts & Sci.,———
p. 425, ——.

Rinodina sophodes c. *tephraaspis* Tuck. Syn. N. Am. Lich. I: 208.
1882.

Thallus of thick, swollen, uneven, densely crowded and variously shaped areoles; from dark brownish ashen becoming very dark, finally olive black; hypothallus hardly perceptible; KOH—; $\text{CaCl}_2\text{O}_2^-$.

Apothecia numerous, at first innate and very small, emerging and sessile, finally of medium size; the disk black or very dark; the entire, persistent margin at first paler but soon blackening; epithecium dark brown; paraphyses thread-like, free, the tips becoming much enlarged, yellow to brownish; thecium blue with I; spores with thick walls, blunt and broadly ellipsoid, $\frac{8.5 - 13.5}{14.5 - 22} \mu$.

Abundant on serpentine and occurring also on other rocks in the foothills.

A North American plant, separated from *sophodes* by the different thallus, the free paraphyses, and the broader spores, as well as the different habitat.

5. RINODINA CONFRAGOSA (Ach.) Körb.

Parmelia confragosa Ach. Meth. Lich. Supplem. 33. 1803.

Rinodina confragosa Körber, Syst. Lich. Germ. 125. 1855.

Rinodina sophodes d. *confragosa* Tuck. Syn. N. Am. Lich. I: 208.
1882.

Thallus of rather thick, lobulate or warty, conglomerate areoles, from whitish becoming brown-gray; KOH bright yellow; $\text{CaCl}_2\text{O}_2^-$; the hypothallus not observable in my specimens.

Apothecia from innate soon sessile, small or medium size, plane, the persistent thalline margin thick, entire, sometimes wavy, often inflexed; brownish black to black; paraphyses coherent, their tips not much enlarged; epithecium dark blackish brown; thecium blue with I; spores thick-walled, blunt, ellipsoid, $\frac{9 - 13}{18 - 22} \mu$.

On sandstone in the mountains, apparently not very abundant. Widespread throughout the north temperate zone.

6. RINODINA HALLII Tuck.

Rinodina hallii Tuck. Syn. N. Am. Lich. I: 208. 1882.

Thallus determinate, bounded by a conspicuous, broad, black hypothallus, uniform, but soon chinky areolate, rather thin; color varying from pale green-brown to umber, the dark forms most common; KOH—; CaCl_2O_2 —.

Apothecia numerous but not crowded, closely appressed but hardly innate even when very young, from small to rather more than medium size; the disk plane when very small, but soon convex, at length strongly so, bordered by a thin, entire, concolorous proper margin which is usually persistent, though sometimes excluded; brownish black to black, occasionally partially covered with a thin white bloom; paraphyses coherent, their enlarged tips yellow or yellowish brown; epithecium brown; hypothecium clear; thecium deep blue with I; spores thin-walled, ellipsoid to irregular, $\frac{8 - 12.5}{16 - 23} \mu$.

On the bark of various trees, but abundant and conspicuous on oaks; in the mountains at 1500 feet and above, and also in deep, dark cañons beside perennial streams as low as 600 feet.

The more or less orbiculate thallus often spreads extensively and becomes effuse by the union of several plants.

There seem to be no published records of its occurrence outside California and Oregon.

Named for Elihu Hall, an Illinois botanist and collector who also collected extensively in the west and sent Tuckerman his type specimens.

Proc. Wash. Acad. Sci., May, 1910.

7. RINODINA SOPHODES (Ach.) Th. Fr.

Lichen sophodes Ach. Lich. Suec. Prodr. 67. 1798.

Rinodina sophodes Th. Fr. Lich. Scand. I: 199. 1871.

Rinodina sophodes Tuck. Syn. N. Am. Lich. I: 207. 1882, in part.

Thallus more or less determinate, thin or of moderate thickness, bordered by a black hypothallus; uniform granular or of uneven granulose areoles; color olive-brown or gray-brown; KOH—; CaCl₂O₂—.

Apothecia small, appressed, the disk at first plane, then convex, color varying from dark brown to brownish-black; the thin entire margin usually paler, rarely blackening; epithecium dark brown; paraphyses slender, confluent, or hardly free, their tips enlarged, yellow and darker; hypothecium colorless; hymenium deep beautiful blue with I; spores ellipsoid or sub-ellipsoid, often with one side nearly straight, the other one strongly arched, $\frac{7 - 12}{16 - 22} \mu$.

Common on bark throughout, and distributed over the entire earth.

8. RINODINA ATRO-CINEREA (Dicks.) Körber.

Lichen atro-cinerea Dickson, Plant. Crypt. Brit., Fasc. III: 14. 1793.

Rinodina atro-cinerea Körber, Syst. Lich. Germ. 125. 1855.

Rinodina sophodes b. *atro-cinerea* Tuck. Syn. N. Am. Lich. I: 207. 1882.

Thallus of small, sub-lobulate granules or areoles, scattered, or subcontiguous and forming a chinky, areolate, unequal crust, of a whitish or light ashy gray color; hypothallus not perceptible; KOH yellow; CaCl₂O₂ reddish.

Apothecia small to very small, adnate, sessile, the red-brown disk darkening, from brown to black; at first plane but soon convex; the entire, whitish thalline margin very soon disappearing and the apothecia then purely lecideine, with a thin, entire, proper margin which may also disappear; paraphyses simple, free, thread-like, their tips hardly enlarged; epithecium umber or blackish; thecium deep blue with I; spores ellipsoid, oblong, or bowed, $\frac{8.5 - 12.5}{17 - 27} \mu$.

On charred stems of *Manzanita* in the mountains near Los Gatos, at about 2000 feet altitude.

9. RINODINA ROBORIS (Duf.) Th. Fr.

Lecanora roboris Dufour, Pr. L. Gall. 93.

Rinodina roboris Jatta, Syll. Lich. Ital. 273. 1900.

Thallus thin, determinate to sub-effuse, of rather uniform small areoles; color whitish to gray; hypothallus broad, black, but often obsolete; KOH faint yellow; CaCl_2O_2 —.

Apothecia medium to large, sessile, soon convex, the gray, entire margin becoming crenulate, rarely entirely disappearing; the disk blackish brown; paraphyses agglutinate, their tips enlarged and pale yellow; epithecium brownish; hypothecium clear; thecium a beautiful dark blue with I; spores long ellipsoid, thin-walled, $\frac{9.5 - 12.25}{19 - 27} \mu$.

On bark of *Acer macrophyllum* and of oaks, along the summit of the range.

Found in western Europe and on the Pacific coast of the United States.

Differs from *sophodes* in the color of the thallus, the larger apothecia with crenulate margin, and the larger spores, as well as the thal-line reaction with KOH.

10. RINODINA EXIGUA (Ach.) Th. Fr.

Lichen exigua Ach. Lich. Suec. Prodr., 69. 1798.

Rinodina exigua Th. Fr. Lich. Scand. I: 201. 1871.

Rinodina exigua Tuck. Syn. N. Am. Lich. I: 208. 1882, in part.

Thallus effuse, thin, uneven, granulose, or merely scurfy, and often scattered and very thin; varying in color from whitish and pale gray to very dark grayish brown and blackish olive; KOH—; CaCl_2O_2 —.

Apothecia small to minute, numerous, plane or finally convex, disk brownish black to black; thal-line margin pale or whitish, from entire becoming crenulate, and finally excluded; epithecium blackish brown, granulose; paraphyses thread-like, free, their tips enlarged, yellowish brown; hypothecium clear; thecium blue with I; spores

$\frac{6 - 11}{11.5 - 20} \mu$.

On various trees in the foothills and also on rocks and old fences. Of world wide distribution.

Differs from *sophodes* in the reduced, effuse thallus and smaller spores, while the hypothallus is indistinct or absent.

PHYSCIACEÆ.

Thallus usually foliaceous, stellate, or orbicular, appressed, laciniately branched or lobed; rarely fruticose or ascendant; beneath fibrillose, or more seldom naked; cortical layer present; alga *Protococcus*.

Apothecia usually abundant, shield-shaped, lecideine or lecanorine; the disk dark or blackish, often pruinose; paraphyses simple; asci with 8 brown, ellipsoid, in our species, bilocular and thick-walled spores.

KEY TO THE GENERA.

- A. Upper cortical layer of pseudoparenchyma, formed of hyphæ perpendicular to the surface LXIII. *Physcia*
 AA. Upper cortical layer of longitudinal hyphæ, not forming pseudoparenchyma LXIV. *Anaptychia*

LXIII. *Physcia* (Schreb.) Wainio.

Physcia Schreber, Genera Plant. 2: 767. 1791, in part.

Physcia Wainio, Étud. Lich. Brésil, 1: 138. 1890.

Thallus foliaceous, stellate or orbicular, appressed or ascendant, usually attached by rhizoids, laciniately branched or lobed; lobes dorsi-ventral, both sides with cortical layer; medulla cottony, white, saffron, sulfur-colored, or red.

Apothecia shield-shaped, sessile, with thalline margin; disk dark to black, often pruinose; paraphyses simple, septate, rarely unseptate; epithecium not affected by KOH; hypothecium colorless or dark; spores 8, brown, ellipsoid, thick-walled, bilocular, rarely quadrilocular or muriform through the interpolation of longitudinal septa.

This widely distributed genus is well represented with us.

KEY TO THE SPECIES.

- A. Thallus more or less pruinose.
 B. Thallus silvery white 2. *pulverulenta argyphæa*.
 BB. Thallus more or less brown.

- C. Surface not isidiose.
 D. Apothecial margin not fringed with thalline lobules.
 1. *pulverulenta*
 DD. Apothecial margin fringed with thalline lobules.
 4. *venusta*
- CC. Surface isidiose.
 E. Medulla white. 3. *pulverulenta isidiigera*
 EE. Medulla greenish yellow or sulfur. 5. *muscigena*
- AA. Thallus not pruinose.
 F. Thallus brownish gray to olive and dark brown.
 G. Thin and very closely appressed, not sorediate.
 10. *adglutinata*
 GG. Thallus thicker, sorediate, marginally hispid. . . . 11. *obscura*
- FF. Thallus white, gray, or ashy.
 H. Thickly sprinkled with small white, sub-epidermal spots.
 I. Under surface with simple white fibrils. 6. *stellaris*
 II. Under surface with hispid black fibrils. 7. *aipolia*
 HH. Thallus without sub-epidermal white spots.
 J. Lobes flat; marginally sorediate 8. *tribacia*
 JJ. Lobes ascendant, with vaulted inflated tips; not
 sorediate 9. *tenella*

1. PHYSCIA PULVERULENTA (Schreb.) Nyl.

Lichen pulverulentus Schreber, Spicil. 128. 1771.

Physcia pulverulenta Nyl. Act. Soc. Linn. Bord. sér. 3. 1: 308.
1856.

Physcia pulverulenta Tuck. Syn. N. Am. Lich. I: 72. 1882.

Physcia pulverulenta Herre, Proc. Wash. Acad. Sci. 7: 361. 1906.

Thallus orbicular or stellate; the numerous lobes usually long and broad, laciniate, crenate, their margins sometimes dissected, tips rounded; central lobes sometimes short, rounded, imbricate, with retuse tips; color greenish to brownish, the upper surface more or less white pruinose; beneath black, or marginally white, densely black fibrillose; medullary layer white or greenish white.

Apothecia wanting or imperfectly developed.

On stones in the foothills. Recorded by Hue from nearly all over the world.

2. PHYSCIA PULVERULENTA ARGYPHÆA Nyl.

Physcia pulverulenta argyphæa Nyl. Lich. Scand. 104. 1861.

Physcia pulverulenta argyphæa Herre, Proc. Wash. Acad. Sci. 7: 361.
1906.

Thallus orbicular or stellate, appressed; lobes discrete, narrow, elongate, many-cleft; their margins crenate or entire; usually up-turned and confluent sorediate; thallus often becoming powdery sorediate or crustose at the centre, and now disappearing, leaving only the marginal lobes.

Varies from the type in having the thallus of a silvery white color; rarely darker or dingy. Medullary layer white or greenish white.

Apothecia rare, the disk pruinose; margin thick, sorediate, entire, or sometimes slightly dentate; spores $\frac{15 - 17}{25 - 32.5} \mu$.

Common on trees in the foothills and mountains.

3. PHYSCIA PULVERULENTA ISIDIIGERA A. Zahlbr.

Physcia pulverulenta isidiigera A. Zahlbruckner, *in litt.*

Physcia pulverulenta isidiigera Herre, Proc. Wash. Acad. Sci. **7**: 362. 1906.

Physcia pulverulenta isidiigera Hasse, Bull. So. Calif. Acad. Sci. **5**: 39. 1906; Ventura County and Mt. San Jacinto.

Thallus orbicular, marginally closely appressed and thin; becoming thick, heaped, and isidiose powdery or granular in the central portion, all trace of lobes being lost; marginal lobes short, crenate, imbricate; color brownish or dingy black; often bluish pruinose, the plant then of a pale, bluish-slate color; beneath black, the margin pale; covered with short black fibrils; medulla greenish white.

Apothecia small, the disk black, occasionally pruinose; margin thick, tumid, elevated, sorediate; spores $\frac{15 - 20}{32 - 37.5} \mu$.

On trees, roofs, and fences. Very common in the lowlands about San Francisco Bay and back to the foothills, growing in great abundance in the shade or where exposed to the moist bay winds.

4. PHYSCIA VENUSTA (Ach.) Nyl.

Parmelia venusta Ach. Meth. Lich. 211. 1803.

Physcia venusta Nyl. Bull. Soc. Bot. Fr. **25**: 383, *pl.* 25. 1878.

Physcia venusta Herre, Proc. Wash. Acad. Sci. **7**: 363. 1906.

Thallus expanded, or bicular, appressed; lobes many-cleft, narrow, lacinate or crenate, the tips usually rounded; inner lobes often

marked with small tooth-like lobules; color varying from green through buff to tawny brown; gray pruinose at least on tips of lobes, but usually otherwise naked; beneath black and densely black fibrillose, usually pale at margin; medullary layer white.

Apothecia pruinose, sessile; disk flat, black, or reddish-black; often gray or bluish pruinose; margin thick, entire, fringed with small thalline lobules; spores $\frac{15 - 17}{27 - 32} \mu$.

This species grows luxuriantly on oaks, principally *Quercus chrysolepis*, along the summit of the range at an altitude of 2200 feet and above.

5. PHYSCIA MUSCIGENA (Ach.) Nyl.

Parmelia muscigena Ach. Lich. Univ. 472. 1810.

Physcia muscigena Nyl. Syn. Meth. Lich. 1: 418. 1860.

Physcia muscigena Herre, Proc. Wash. Acad. Sci. 7: 363. 1906.

Thallus diffuse, spreading, irregular; the lacinate, numerous lobes short, narrow, distinct, often upturned at the tip; margins more or less soresdiate or powdery with confluent, sulfur-colored soresdia; surface often with isidiose or cephaloid outgrowths; medullary layer usually greenish yellow or sulfur-colored; color of thallus brown, finally a very dark dull brown; rarely greenish; usually only tips of lobes pruinose; beneath white, becoming very dark; densely clothed with more or less hispid black fibrils.

Apothecia rare, scattered; margin thick, becoming soresdiate; spores $\frac{13.75 - 17.5}{27.5 - 37.5} \mu$.

Common in the foothills on mossy sandstone and the trunks of oaks.

6. PHYSCIA STELLARIS (L.) Nyl.

Lichen stellaris L. Sp. Plant. 2: 1144. 1753.

Physcia stellaris Nyl. Syn. Meth. Lich. 1: 424. 1860.

Physcia stellaris Tuck. Syn. N. Am. Lich. 1: 73. 1882.

Physcia stellaris Herre, Proc. Wash. Acad. Sci. 7: 363. 1906.

Thallus smooth, appressed, stellate or irregular; lobes many cleft, sinuate, very close together; thickly sprinkled with small white sub-epidermal spots; neither pruinose nor soresdiate; color white; beneath

white or pale, clothed more or less with simple white fibrils. KOH yellow; medulla not colored yellow by KOH.

Apothecia black, usually pruinose; margin entire; spores
 $\frac{5 - 8.5}{14.5 - 19.5} \mu.$

On stones and twigs; abundant along the highest peaks of the range and one of the commonest and most widespread of lichens.

7. PHYSCIA AIPOLIA (Ach.) Nyl.

Lichen aipolius Ach. Lich. Suec. Prodr. 112. 1798.

Physcia aipolia Nyl. Flora, 53: 38. 1870.

Physcia aipolia Tuck. Syn. N. Am. Lich. I: 73. 1882.

Physcia aipolia Herre, Proc. Wash. Acad. Sci. 7: 363. 1906.

Thallus orbicular, expanded, appressed; lobes much cleft, sinuous, separate and distinct, or coalescent and imbricate; very thickly sprinkled with small white sub-epidermal spots; surface smooth, without soredia; color white or bluish white; beneath dark or black, usually densely clothed with black hispid fibrils; medulla yellow with KOH.

Apothecia numerous, usually bluish pruinose; disk brownish black; margin thick, prominent, more or less crenate; spores

$\frac{5 - 10}{15 - 25} \mu.$

Common on twigs and trunks throughout our range; particularly well developed on *Æsculus californicus* above 2000 feet. Abundant on rocks along the summit of the range. A very common and widespread lichen.

8. PHYSCIA TRIBACIA (Ach.) Tuck.

Lecanora tribacia Ach. Lich. Univ. 415. 1810.

Physcia tribacia Tuck Lich. Am. Sept. No. 85.

Physcia tribacia Tuck. Syn. N. Am. Lich. I: 75. 1882.

Physcia tribacia Herre, Proc. Wash. Acad. Sci. 7: 364. 1906.

Thallus more or less orbicular, usually rather small, much lobed; lobes short, intricately laciniate; their margins upturned, much-dissected, granulate, becoming lined with confluent soredia; center of thallus sometimes converted into a granulate or sorediate crust; color

bluish white, gray, or ashy; beneath white, becoming buff centrally; sparingly covered with short white fibrils.

Apothecia rare, small to medium, sessile; disk brown to black; margin thick, entire or somewhat rugose; spores $\frac{8.75 - 15}{17.5 - 25} \mu$.

Common in the foothills on trees and rocks. A common lichen of Europe and North America.

9. PHYSCIA TENELLA (Scop.) Nyl.

Lichen tenellus Scopoli, Flor. Car. ed. 2, 2: 394. 1772.

Physcia tenella Nyl. Flora, 57: 306. 1874.

Physcia hispida Tuck. Syn. N. Am. Lich. I: 75. 1882.

Physcia hispida Herre, Proc. Wash. Acad. Sci. 7: 364. 1906.

Thallus quite small; sub-stellate and appressed. or more commonly forming small, loose, diffuse clumps; the short ascendant lobes irregularly and deeply cleft, their tips inflated and vaulted, forming a very characteristic feature; margins of lobes beset with long, concolorous, or occasionally darkening, fibrils; color white or bluish ashy-gray; beneath white, with few short white fibrils.

Sterile with us.

Sometimes covering considerable areas, and dwarfed so as to be scarcely recognizable.

Frequent on trees and shrubs throughout. Occurs in the university arboretum on stems of the giant cactus of Arizona, *Cereus giganteus*.

Common throughout the colder portions of the northern hemisphere.

10. PHYSCIA ADGLUTINATA (Flk.) Nyl.

Lecanora adglutinata Floerke, Deutsch. Lich. 4: 7. 1815.

Physcia adglutinata Nyl. Syn. Meth. Lich. 1: 428. 1860.

Physcia adglutinata Tuck. Syn. N. Am. Lich. 1: 77. 1882.

Physcia adglutinata Herre, Proc. Wash. Acad. Sci. 7: 365. 1906.

Thallus small, inconspicuous; very closely appressed so that it appears to be a part of the substratum; lobes thin, flat, coalescent; center of the thallus often crustose; color "glaucous becoming cinerous and brown, pale and scarcely fibrillose beneath; apothecia

cia small and very small; disk blackish brown; margin entire, scarcely ciliate; "spores $\frac{8 - 11}{14 - 22} \mu$ ", Tuckerman.

Occurring very rarely with us, on trees. A wide spread but not very common lichen.

11. PHYSCIA OBSCURA (Ehrh.) Nyl.

Lichen obscurus Ehrhart, Pl. Crypt. no. 177. 1785.

Physcia obscura Nyl. Act. Soc. Linn. Bordeaux, series 3, I: 309. 1856.

Physcia obscura Tuck. Syn. N. Am. Lich. I: 76. 1882.

Thallus sub-orbicular or sub-stellate, appressed, smooth, not pruinose; lobes narrow, many-cleft, flat or slightly convex, sorediate; marginally hispid or pseudo-ciliate; centrally it may pass into small, overlapping lobules, or become crustaceous and disappearing, leaving the marginal lobes only; brownish-gray mouse-color to dark brown; beneath black, more or less clothed with black fibrils.

No fruiting specimens have yet been collected here.

Not abundant or conspicuous with us; best developed on bark, but occurring likewise on rocks, usually with stellate and much reduced thallus.

A variable and cosmopolitan lichen.

LXIV. *Anaptychia* Körber.

Anaptychia Körber, Sys. Lich. Germ. 49. 1855.

Thallus foliaceous or fruticose, much lobed or branched, prostrate, ascendant, or erect, usually with rhizoids on the lower side; lobes broad to linear, smooth or channelled, often fibrillose; dorsi-ventral or radial, both sides or only the upper with an almost cartilaginous cortex of longitudinal, agglutinated hyphæ, not forming pseudoparenchyma; the algæ lie either under the upper cortex or also next the under cortex.

Apothecia circular, sessile or terminal, lecanorine; disk dark, pruinose or naked; hypothecium clear, the paraphyses simple; spores brown, ellipsoid to elongate, bilocular, with thick walls.

Species few, of wide distribution, occurring on earth, rocks, moss, and bark.

KEY TO TO THE SPECIES.

- A. Apothecia abundant; thallus small, matted or tufted, KOH-.
1. *erinacea*
- AA. Sterile with us.
- B. Thallus elongate, fruticose; KOH-; on earth. 2. *leucomela*
- BB. Lobes shorter and wider than No. 2; KOH yellow; on
 trees and shrubs. 3. *ciliaris*

1. ANAPTYCHIA ERINACEA (Ach.) Herre.

Borrera erinacea Ach. Lich. Univ. 499. 1810.
Physcia erinacea Tuck. Proc. Am. Acad. 1: 224. 1847.
Physcia erinacea Tuck. Syn. N. Am. Lich. I: 67. 1882.
Physcia erinacea Herre, Proc. Wash. Acad. Sci. 7: 360. 1906.

Thallus small, matted or loosely tufted; naked, white or greenish white; beneath very white and often covered with a greenish powder; the ascendant lobes more or less flat, sinuous, and irregularly notched; contracting and dilating so as to be knobbed; marginally ciliate with many long fibrils, so that the whole plant has a fuzzy appearance; cilia white, brown, or blackening; KOH-.

Apothecia usually abundant, small, scattered; pedicellate; the convex disk black or brownish black; more or less bluish-white pruinose, becoming later naked; margin entire or minutely crenulate; spores

$$\frac{7.5 - 11}{15 - 23} \mu.$$

Occurring in both Lower and upper California on shrubs near the seashore. A few specimens were also found on sandstone at Point Lobos, San Francisco, and near Pigeon Point lighthouse. Southward it is both abundant and luxuriant, but in our territory it is rare and rather depauperate.

2. ANAPTYCHIA LEUCOMELA (L.)

Lichen leucomelas L. Sp. Plant. ed. 12, 2: 1613. 1763.
Physcia leucomela Michaux, Fl. Bor. Amer. 2: 306. 1803.
Physcia leucomela Tuck. Syn. N. Am. Lich. I: 69. 1882.
Physcia leucomela Herre, Proc. Wash. Acad. Sci. 7: 361. 1906.

Thallus fruticose, ascendant, elongated, forming diffuse clumps or mats; the lobes but little divided, narrow to linear, very much intertwined; margins with numerous stout, branched, black or dark

fibrils; color above varying from greenish or pearly gray to pale dingy brown; under surface channelled, very white; white powdery; KOH—.

Sterile with us and rarely fruiting anywhere.

Found in some abundance in Pilarcitos Creek Cañon, growing on high clay banks and on earth in crevices of sandstone cliffs. On earth at Santa Cruz, herbarium of Dr. C. L. Anderson; on clay banks on San Juan Hill, elevation about 1000 feet; on *Quercus agrifolia*, Oakland Cañon, Bolander in Tuckerman Herbarium. Recorded by Dr. Hasse from Catalina Island, southern California. A cosmopolitan lichen.

3. ANAPTYCHIA CILIARIS (L.) Mass.

Lichen ciliaris Linné, Sp. Plant. 2: 1144. 1753.

Anaptychia ciliaris Massalongo, Mem. Lichenograf. 35. 1853.

Physcia ciliaris Tuck. Syn. N. Am. Lich. I: 71. 1882.

Thallus loosely tufted, orbiculate or more often in diffuse clumps; spreading and decumbent, or slightly ascendant; gray to green-gray; rarely darkening to brownish; yellow with KOH.

The narrow and elongate lobes wider and shorter than those of *A. leucomela*, intricately intertangled, many-cleft; their margins beset with brownish or blackening fibrils, mostly simple, but becoming branched; beneath channelled, white to greenish, usually covered with a greenish powder.

Sterile with us.

Abundant on *Quercus agrifolia* in the hills immediately back of Santa Cruz.

A common and variable lichen of the temperate regions of the northern hemisphere, usually on bark, more rarely on rocks.

ANAPTYCHIA COMOSA (Esch.) Trevis., has been collected once by Dr. Hasse in the Santa Monica Range and may be expected here. It is near *leucomela* and *ciliaris*, but may be distinguished by the much shorter lobes, thickly beset along their margins and upper surface with long white or concolorous fibrils, which give the plant a fuzzy, cottony appearance.

ADDENDA

LECIDEA QUERNEA (Dicks.) Ach.

Lichen querneus Dickson, Plant. Crypt. Brit. Fasc. I: 9. and T. II: f. 3. 1785.

Lecidea querneia Acharius, Meth. Lich. 63. 1803.

Biatora querneia Tuck. Genera Lich. 159. 1872.

Biatora querneia Syn. N. Am. Lich. Part II: 28. 1888.

Thallus effuse, spreading widely, of minute, sorediose, greenish-yellow granules which form a pale or bright but thin leprose crust, which is rarely thickish; usually without an evident hypothallus but sometimes a white or whitish hypothallus is present; dark reddish brown with KOH; CaCl_2O_2 —.

Apothecia minute to small, immersed, circular, at first plane, but soon becoming convex and finally sub-globose and emergent; without margin; disk reddish, reddish-brown, and dull brown to brownish-black; epithecium broad, dark or reddish, granulose; thecium pale, the paraphyses slender, embedded in the hymenial gelatine; blue with I; hypothecium yellowish to brown, with brown or violet granules scattered through it; becoming reddish with

KOH; asci broadly clavate, $\frac{14}{26.5 - 38} \mu$; spores ellipsoid or ovoid,

colorless, or more rarely brown, in specimens from bark measuring

$\frac{5.85 - 7.3}{8.8 - 11.7} \mu$; specimens from fences have spores $\frac{5.5 - 6.5}{9.75 - 12.25} \mu$.

Forming powdery, indeterminate patches on the bark of *Pinus radiata* along Año Nuevo Creek, altitude 100 feet, and also spreading extensively over old fences along the sea coast between Pigeon Point and Scott Creek. On old fences at Santa Cruz and all about Monterey Bay and southward along the coast of Monterey peninsula; on trunks of *Cupressus macrocarpa* along the coast south of Monterey.

The form on tree trunks is a much paler and brighter yellow than the plant usually is on fences, while the latter has darker and duller colored apothecia. The lichen often grows intermingled with *Lecanora albella cancriformis*.

Collected by Bolander on *Pinus (insignis) radiata*, near Pescadero, and on *Myrica* near San Francisco, and by Dr. Farlow at Santa Cruz.

Not certainly known in North America outside the Santa Cruz and Monterey peninsulas, the plant recorded by Dr. Hasse from Santa Monica under this name being something else. Widely distributed in Europe.

LECIDEA PACIFICA Herre, new species.

Lecidea pacifica Herre, Ex. Lich. Santa Cruz Pen. Calif. no. 635.

Thallus thin to very thin, from determinate soon effuse, sometimes bordered by a scarcely evident black hypothalline line; from contiguous becoming minutely fissured and areolate, the surface smooth or minutely roughened; appearing to the eye as a uniform brownish gray film; KOH light yellow; CaCl_2O_2 —.

Apothecia medium to rather large, sessile, scattered, dark red-brown to blackish-brown and reddish black; disk at first plane or flattish with an evident, thick, entire, sometimes flexuous margin; becoming convex, the margin finally disappearing; epithecium yellowish brown; paraphyses simple, free, thread-like, their blackish brown tips subcoherent; hypothecium colorless; thecium blue with I; spores variously disposed in the clavate asci, ellipsoid to short

ellipsoid, $\frac{7. - 8.5}{12 - 16} \mu$.

Rare; forming pale spots or blotches on granite rocks in the bed of Peters Creek, altitude about 1100 feet.

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THE POLYTRICHACEÆ OF WESTERN NORTH
AMERICA

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INTRODUCTORY NOTE.

There is great confusion in the taxonomy of our western mosses on account of the duplication of names and the naming of species from sterile specimens or single collections. Systematic work on them is much needed. To show the way, a single family, the Polytrichaceæ, was studied from type material and accessible collections. In the keys in this paper the characters separating the genera or species are given for all, thus making a comparison. So often one wants a comparison rather than a description, that it is hoped this will prove of value to those using this paper.

Acknowledgments are due to Mrs. Elizabeth G. Britton for kindly permitting the writer to examine type material in the herbarium of the New York Botanical Gardens.

The illustrations in this paper are mostly from drawings by Elsie K. Waddingham.

POLYTRICHACEÆ.

Name derived from poly = many, and tricho = hair; referring to the hairiness of the calyptra in many genera.

Plants usually of large size, growing on soil. Stems simple or slightly branched, springing from a subterranean shoot.

Leaves usually narrow. Lamellæ present on their inner surface and sometimes on the back as well, each usually a few cells high and

1 cell thick, wanting in *Racelopus*; marginal cells often of a different form from the others. Vein one, extending at least nearly to the tip. Inflorescence nearly always dioicous; sex organs terminal; antheridia in a rather large cup or disk through which the plant generally again grows.

Calyptra narrow, often covered with a dense mat of branched hairs which are directed away from the point and end freely; if not with densely matted hairs, the apex of the calyptra is spinulose, or has few to many hairs, or is quite smooth.

Capsule large, cylindric, or prismatic with 2–6 angles. Peristome present (except in *Lyellia*, *Bartramiopsis* and some species of *Psilopilum*), single; teeth 32 or 64, rarely 16, unbarred, ligulate, triangular in cross section. Columella expanded at the apex into a shield-shaped membrane (epiphragm) covering the mouth of the capsule and uniting with the tips of the teeth. Lid present. Pedicel long, smooth (except in *Racelopus*). Spores .008–.021 mm., rarely larger, smooth or nearly so.

Total number of genera, 10; number represented in western North America, 7. Total number species, about 320; number in western North America, 27.

SYNOPSIS AND COMPARISON OF THE WORLD'S GENERA OF POLYTRICHACEÆ.

1. Calyptra with few or no hairs.
 2. Lamellæ on upper side 18 or fewer.
 3. Lamina of 1 layer of cells.
 4. Leaves bordered.
 5. Peristome present.
 6. Stomates wanting on capsules.
 7. Capsule terete. **Catharinea.**
 4. Leaves not bordered.
 5. Peristome present; calyptra with few hairs; lamellæ on vein at back of leaves in nearly all cases.
 6. Stomates present on capsule.
 7. Capsule terete **Oligotrichum.**
 5. Peristome wanting; or if present, calyptra without hairs; without lamellæ on back of leaves.
 6. Stomates present on capsule.
 7. Capsule somewhat flattened, elliptical in cross section.

Psilopilum.
3. Lamina composed of 2 layers of cells.
 4. Leaves not bordered.

- 5. Peristome wanting.
 - 6. Stomates present on capsule.
 - 7. Capsule terete **Bartramiopsis.**
 - 5. Peristome present.
 - 6. Stomates present on capsule.
 - 7. Capsule terete..... **Dendroligotrichum.**
- 2. Lamellæ on upper side 20 or more.
 - 3. Lamina of 1 layer of cells.
 - 4. Leaves not bordered.
 - 5. Peristome wanting.
 - 6. Stomates present on capsule.
 - 7. Capsule 2-4 angled..... **Polytrichadelphus.**
 - 3. Lamina of 2 layers of cells.
 - 4. Leaves not bordered.
 - 5. Peristome wanting.
 - 6. Stomates present on capsule.
 - 7. Capsule keeled on one side, somewhat oval in cross section..... **Lyellia.**
- 1. Calyptra densely covered with hairs.
 - 2. Lamellæ wanting.
 - 3. Lamina of 1 layer of cells.
 - 4. Leaves not bordered.
 - 5. Peristome present.
 - 6. Stomates wanting on capsule.
 - 7. Capsule terete..... **Racelopus.**
 - 2. Lamellæ on upper side 20 or more.
 - 3. Lamina of 1 layer of cells.
 - 4. Leaves not bordered.
 - 5. Peristome present.
 - 6. Stomates either present or wanting on the capsule.
 - 7. Capsule terete **Pogonatum.**
 - 6. Stomates present on capsule.
 - 7. Capsule 4-6 angled¹..... **Polytrichum.**

¹The writer has followed the classification of Brotherus in Engler & Prantl: "Die natürlichen Pflanzenfamilien," Teil 1, Abt. 3, s. 669-698 (1904) except in the separation of *Pogonatum* from *Polytrichum*. The chief question here arising is where to put *Pogonatum alpinum*. Excepting this plant the *Pogonatum*s have capsules terete, teeth 32, stomates wanting; the *Polytrichum*s have capsules angular, teeth 64, stomates present; *Pogonatum alpinum* is a fine gradation form between the two genera, having the terete capsule of the *Pogonatum*s, the stomates of the *Polytrichum*s, and standing between the two genera in its 32 or 64 teeth depending upon how one counts the doubling. Whether one classes it a *Pogonatum* or a *Polytrichum* depends upon whether one emphasizes the form of the capsule or the presence of the stomates. When there is nothing to be gained by using a microscopic character in the separation of genera, why not use one which can be seen with the naked eye? In this paper *Pogonatum alpinum* is therefore classed as a *Pogonatum*.

KEY TO THE WEST NORTH AMERICAN GENERA.

1. Lamellæ on upper side of leaf 18 or fewer.....2.
1. Lamellæ on upper side of leaf 20 or more.....8.
2. Leaves bordered.....**Catharinea**, p. 275
2. Leaves not bordered.....3.
3. Leaf margin with long hairs where sheath grades into blade; lamina of two layers of cells; peristome wanting.
Bartramiopsis, p. 289
3. Leaf margin without hairs; lamina of 1 layer of cells; peristome present.....4.
4. Capsule distinctly cernuous.....**Psilopilum**, p. 288
4. Capsule straight or very nearly so.....**Oligotrichum**, p. 281
4. Capsule wanting (for sterile specimens).....5.
5. Lamellæ straight; plant much crisped when dry.
Oligotrichum parallelum, p. 282
5. Lamellæ wavy from side to side; plants not or very little crisped when dry.....6.
6. Lamellæ on back conspicuous, about equal in number and size to those on the upper side; leaf margin plane or erect.
Oligotrichum aligerum, p. 284
6. Lamellæ on back inconspicuous or none; leaf margin incurved.7.
7. Leaf margin abruptly incurved above the sheath; lamellæ on back inconspicuous or none..**Oligotrichum incurvum**, p. 285
7. Leaf margin gradually incurved from base; lamellæ on back wanting.....**Psilopilum**, p. 298
8. Capsules 4-6 angled; teeth 64; calyptra densely hairy.
Polytrichum, p. 304
8. Capsules 2-4 angled; two of the angles nearer together than the others; teeth 64, calyptra with few hairs.
Polytrichadelphus, p. 291
8. Capsules terete; teeth 32, or 64 in *Pogonatum alpinum*; calyptra densely hairy.....**Pogonatum**, p. 294
8. Capsules wanting (for sterile specimens).....9.
9. Leaf margin entire, inflexed over the lamellæ in most species.
Polytrichum, p. 304
9. Leaf margin serrate.....10.
10. Leaves very much crisped when dry.
Pogonatum contortum, p. 295
10. Leaves little or not at all crisped when dry.....11.
11. Marginal cells of lamellæ smooth or merely grooved.
Polytrichum, p. 304
11. Marginal cells of lamellæ rough or papillose.....12.

12. Plants erect; marginal cells of lamellæ not higher than wide,
 except in *P. alpinum* *Pogonatum*, p. 294
 12. Plants decumbent; marginal cells higher than wide.
 *Polytrichadelphus*, p. 291

CATHARINEA Ehrh.

Atrichum Beauv.

Named after the Empress Catharine II of Russia.

Plants not very tall. Stems with abundant rhizoids at base.

Leaves without sheath, more or less transversely undulate, generally with diagonal rows of teeth on the back, mostly crisped when dry. Margin plane, bordered except in young leaves, singly or doubly serrate with coarse sharp teeth. Lamellæ 1-10, restricted to the vein, composed of similar smooth cells, margin entire. Vein $\frac{1}{3}$ the leaf-width or less, percurrent or vanishing, without lamellæ on the back, often toothed on back near apex. Cells all smooth, chlorophyllose, mostly quadratic, upper ones hexagonal or elliptic-hexagonal.

Calyptra naked, or with a few hairs or teeth at the tip.

Capsule somewhat inclined, curved, never angular, smooth, without stomates. Peristome present; teeth 32, pale, with yellow or brown middle line. Lid long-beaked. Pedicel smooth, solitary or sometimes 1-3 from a stem-tip.

Number species in western North America, 4; total number species, about 33.

THE WEST NORTH AMERICAN SPECIES,—A COMPARISON AND KEY.

1. Capsule as 1:4; leaves not wavy along the margin when moist.
 2. Vein constituting $\frac{1}{3}$ - $\frac{1}{5}$ of the leaf-width.
 3. Lamellæ 1-2 cells high.
 4. Cells .025-.045 mm.
 5. Lamina without teeth at back 1. *C. crispa*.
1. Capsule as 1: 6-8; leaves slightly to distinctly wavy along margins when moist.
 2. Vein constituting $\frac{1}{3}$ - $\frac{1}{4}$ of the leaf-width.
 3. Lamellæ 5-8 cells high.
 4. Cells .010-.020 mm.
 5. Lamina mostly with teeth at back 2. *C. angustata*.
2. Vein constituting $\frac{1}{5}$ - $\frac{1}{3}$ of leaf-width.
 3. Lamellæ 3-5 cells high.

- 4. Cells .010-.020 mm.
- 5. Lamina mostly with teeth at back. 3. *C. undulata*.
- 3. Lamellæ 9-13 cells high.
- 4. Cells .025-.050 mm.
- 5. Lamina mostly with teeth at back. 4. *C. selwyni*.

1. *Catharinea crispa* James, in Proc. of Amer. Acad., 1855, p. 445. *Atrichum crispum* Sull., in Mos. of U. S., p. 41 (1856).

Name probably derived from the crisping of the leaves in drying, a characteristic however, not restricted to this species, nor even this genus.

Plants dioicous, 2.5-10 cm. high, in soft tufts. Stems erect, simple.

Leaves distant, oval-oblong to oblong-lanceolate, not papillose, patent, crisped when dry, obtusely acuminate, hardly at all undulate, width to length about as 1:2-3, the lower shorter and broader; lamina smooth at back. Margin reddish, toothed from near the base, bordered. Lamellæ 1-4, 1-3 cells high, vanishing in the lower half of the leaf. Vein strong, reddish/brown, vanishing in the apex, with few or no teeth at back, about $\frac{1}{8}$ - $\frac{1}{10}$ the leaf-width. Cells .025-.045 mm., quadrate-hexagonal or rounded, the lower elongate.

Calyptra smooth except at tip, which is roughened with very short hairs.

Capsule erect or nearly so, slightly curved, width to length about as 1:4, narrowly obconic, wide-mouthed. Teeth narrow, unequal; basal membrane very narrow. Lid conic, with subulate beak. Pedicels slender, 1-3 at a stem-tip, somewhat flexuose.—On clayey soil.—Revelstoke, British Columbia; Atlantic Coast of United States; England.

2. *Catharinea angustata* Brid., in Mant. Musc. p. 204 (1819), *Atrichum angustatum* B. & S., in Bryol. Eur. t. 411, (1844.)

Name derived from augustus = narrow; referring to the narrow leaves.

Plants dioicous. Stems 2-5 cm. high.

Leaves narrower than in *C. undulata*, undulate when moist, width to length about as 1:7-10, not papillose; lamina smooth at back. Margin serrate only above middle, bordered. Lamellæ 4-7, 5-8 cells high. Vein toothed at back, $\frac{1}{3}$ - $\frac{1}{4}$ the width of leaf. Cells .010-.014 mm.

Calyptra cucullate, about half covering the capsule, rough at tip.

Capsule purple, narrower and more erect than in *C. undulata*, width to length about as 1:7-8. Teeth shorter than in *C. undulata*. Lid dark purple, about half as long as the capsule.—On clayey soil.—McLeod's Lake, British Columbia; Santa Cruz Mountains, California; Atlantic states; Eastern Canada; Europe.

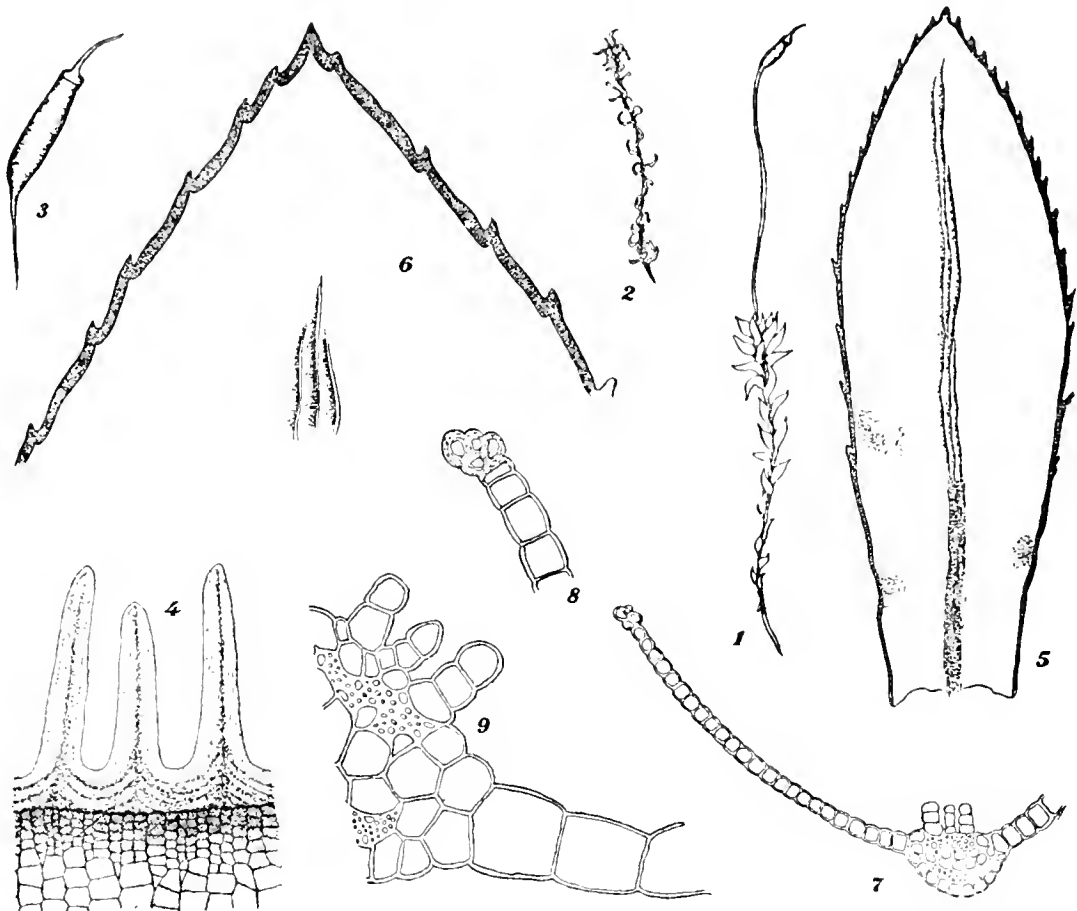


Fig. 1. *Catharinea crispa*.

1 = Plant moist, with capsule, $\times 1$. 2 = Plant dry, showing crisping of leaves $\times 1$. 3 = Capsule with lid, $\times 5$. 4 = Peristome $\times 150$. 5 = Leaf showing lamellae on upper side, $\times 15$. 6 = Leaf-tip, $\times 65$. 7 = Cross section of leaf, showing lamellae, $\times 65$. 8 = Cross section of leaf margin showing thickened border cells, $\times 250$. 9 = Cross section of a few lamellae, $\times 250$.

3. *Catharinea undulata* Web. & Mohr, in Ind. pl. crypt. (1803).
Atrichum undulatum Beauv. Prodr. p. 42 (1805).

So named on account of its wavy or undulate leaves.

Plants in loose patches, dull green. Stems erect, 2.5-5 cm. high, simple or much branched, from a subterranean shoot. Inflorescence autoicous.

Lower leaves very small, scale-like; upper leaves ligulate, width to length about as 1:5-6, 4-6 cm. long, strongly transversely undulate, much crisped and incurved when dry, spreading when moist, lamina with transverse rows of teeth on back. Margin bordered with 2-3 rows of very narrow brownish cells, sharply spinose for the greater part of its length with strong and usually paired teeth. Lamellæ 2-6, straight, 3-5 cells high, occasionally as much as 7

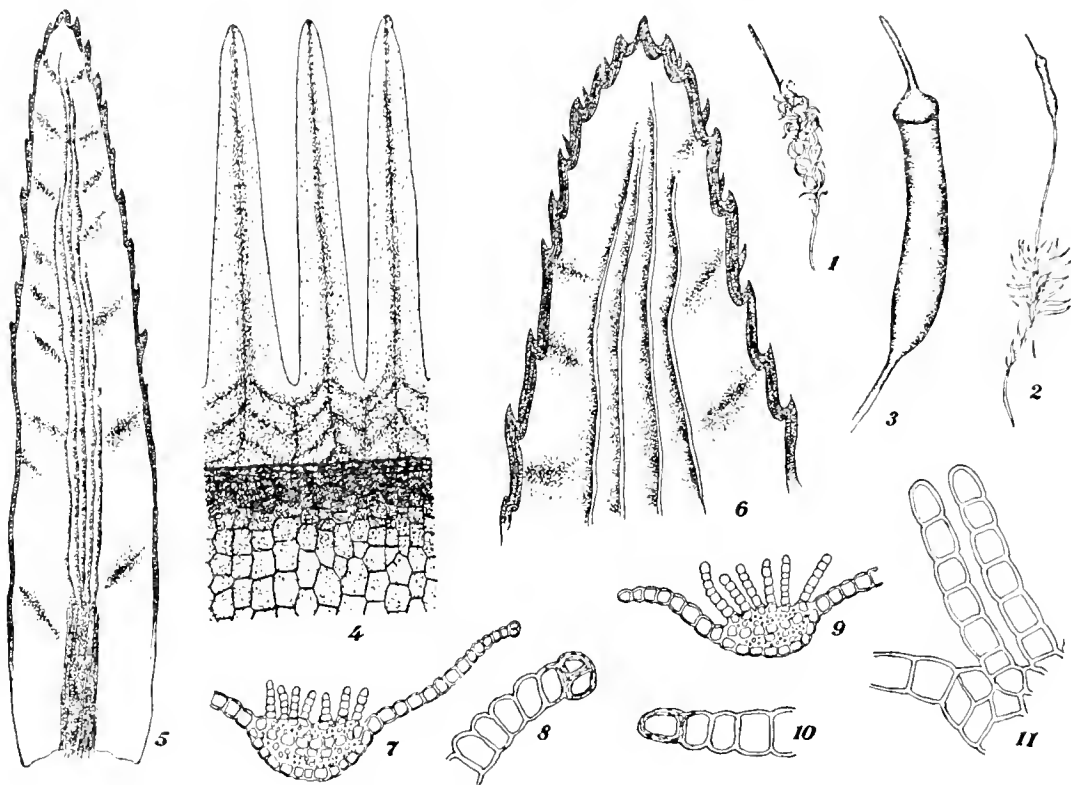


Fig. 2. *Catharinea angustata*.

1 = Plant dry, $\times 1$. 2 = Moist plant, with capsule, $\times 1$. 3 = Capsule, $\times 5$. 4 = Peristome, $\times 150$. 5 = Leaf showing lamellæ on upper side, $\times 15$. 6 = Leaf tip, $\times 65$. 7 = Cross section of leaf in lower portion, $\times 65$. 8 = Cross section of margin in lower portion, $\times 250$. 9 = Cross section of leaf in upper portion, $\times 65$. 10 = Cross section of margin in upper portion, $\times 250$. 11 = Cross section of a few lamellæ, $\times 250$.

Cells high. Vein vanishing in the apex, sharply spinose at the back, $\frac{1}{8}$ - $\frac{1}{16}$ the leaf width. Cells above hexagonal or elliptic-hexagonal with the longer axis transverse, .018-.020 mm.; basal elongate-rectangular.

Calyptra pale, rough at apex, covering about $\frac{1}{3}$ of the capsule.

Capsule cylindric, width to length about as 1:6-8, strongly arcu-

ate, brown. Teeth long, lanceolate, obtuse, median line orange. Lid subulate, curved, one-half to once length of capsule. Pedicels terminal, erect, flexuose, reddish-brown, 2.5-6 cm. long, 1-3 from

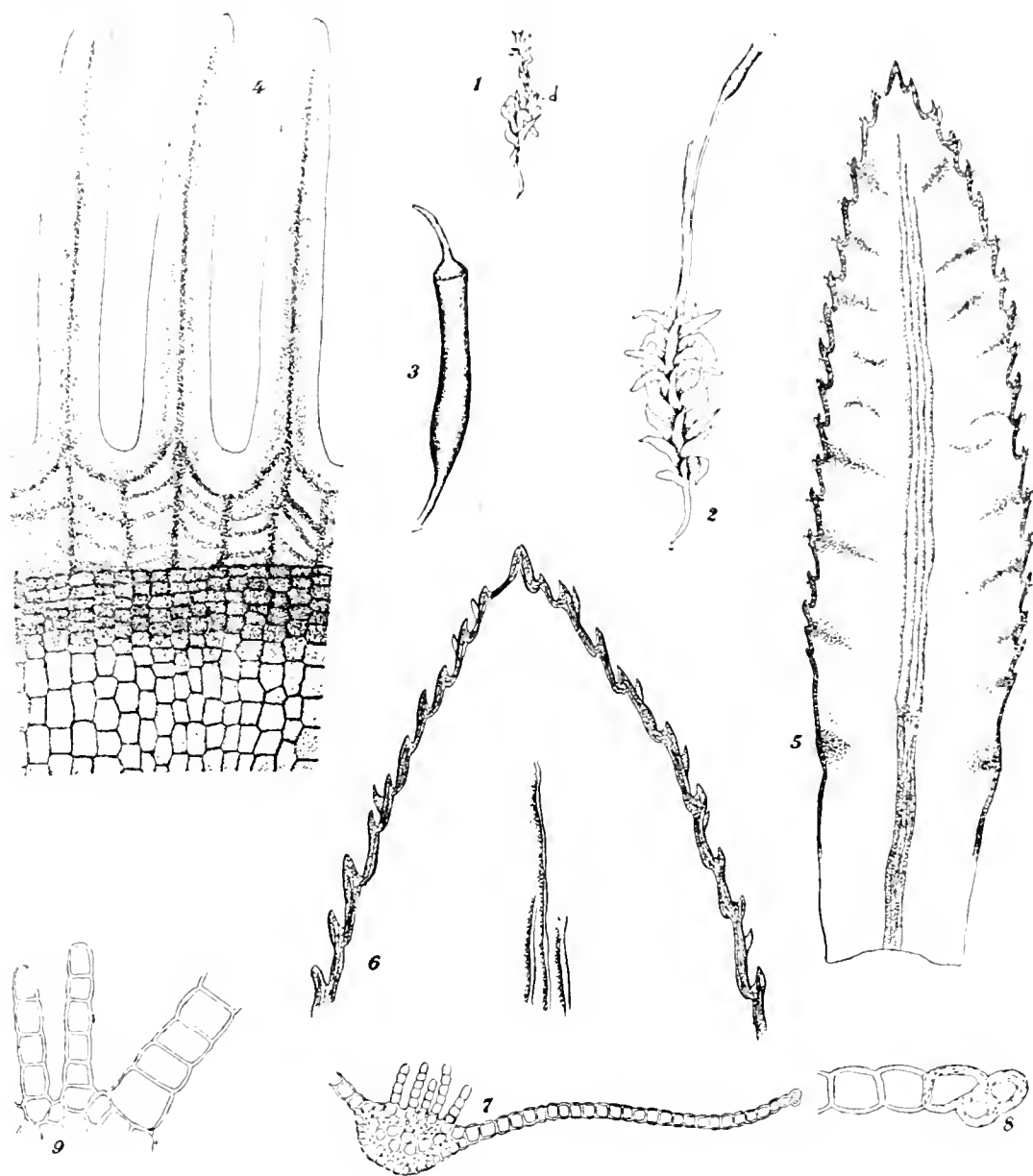


Fig. 3. *Catharinea undulata*.

1 = Dry antheridial plant; d = antheridial disk through which stem has continued, $\times 1$. 2 = Moist plant with capsule, $\times 1$. 3 = Capsule, $\times 5$. 4 = Peristome, $\times 150$. 5 = Leaf, showing paired serræ, and lamellæ on upper side, $\times 15$. 6 = Leaf-tip, $\times 65$. 7 = Cross section of leaf, $\times 65$. 8 = Cross section of leaf-margin showing thickened border cells, $\times 250$. 9 = A few lamellæ in cross section, $\times 250$.

the same stem-tip.—On clayey soil.—Juneau, Alaska, and south to California, eastward across the continent in Canada and northern United States; Europe; Asia.

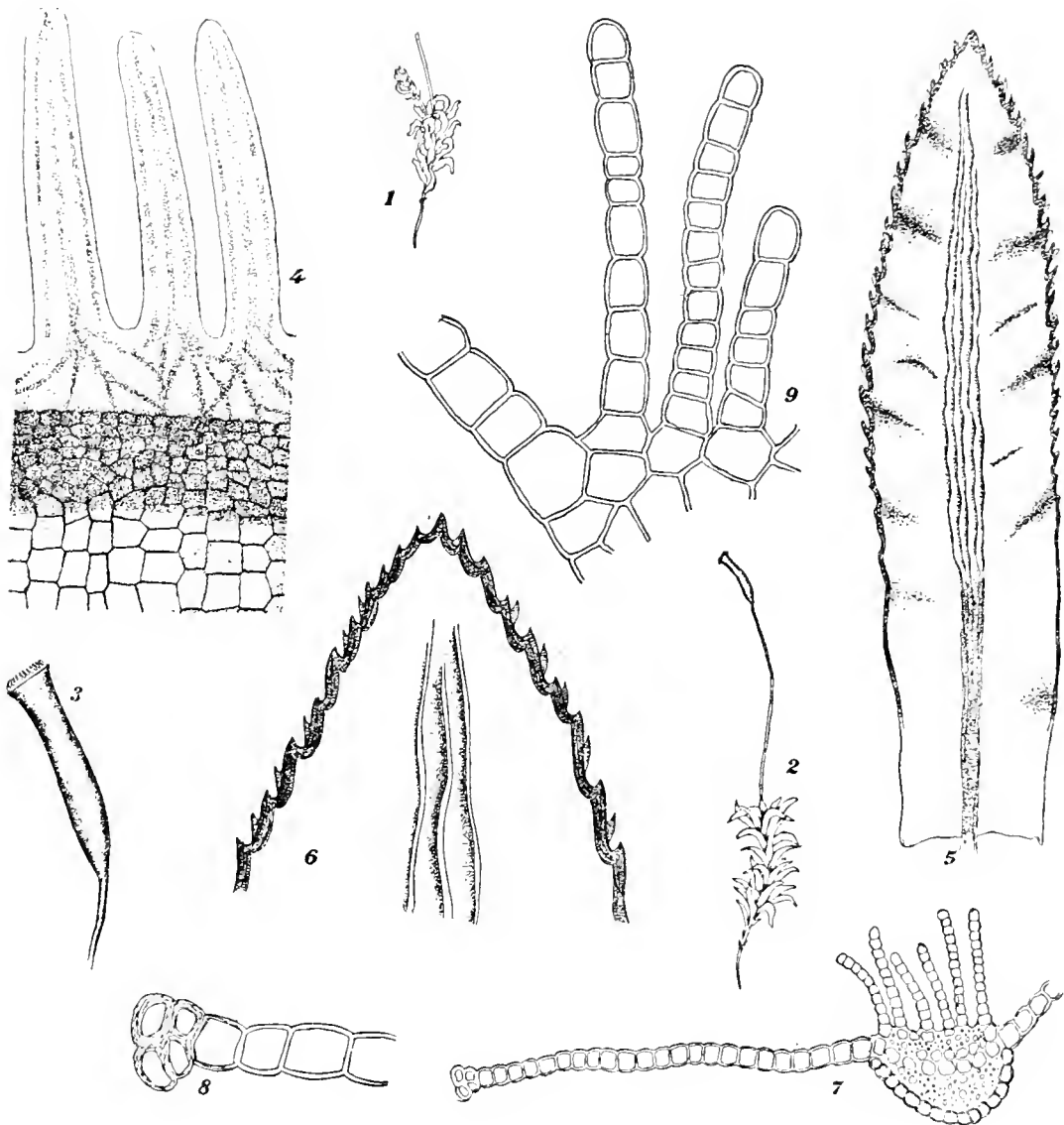


Fig. 4. *Catharinea selwyni*.

1 = Dry plant, showing innovation, $\times 1$. 2 = Moist plant with capsule, $\times 1$.
 3 = Capsule, $\times 5$. 4 = Peristome, $\times 150$. 5 = Leaf showing lamellæ on upper
 side and paired serræ at margin, $\times 15$. 6 = Leaf-tip, $\times 65$. 7 = Cross section of
 leaf, $\times 65$. 8 = Cross section of leaf margin showing thickened border cells, $\times 250$.
 9 = Cross section of a few lamellæ, $\times 250$.

4. *Catharinea selwyni* (Aust.) E. G. Brit., in Bull. Torr. Bot. Club.
 16: 110 (1889).

Atrichum selwyni Aust., in Bot. Gazette, 2: 95 (1877).

*Catharinea rosulata*² Kindb., in Eur. and N. Amer. Bryin. p. 154
 (1897).

² For the reasons for including *C. rosulata* under *C. undulata*, see Bryologist, 10:
 53 (1907).

Named after Selwyn.³

Plants dioicous. Stems more slender than in *C. undulata*.

Leaves undulate when moist, with transverse rows of teeth on the back, broader in proportion than in *C. angustata*, subspatulate, generally obtuse, excavated at base. Margin bordered, serrate to middle or below. Lamellæ 4–6, 9–13 cells high. Vein vanishing in apex, toothed at back. Cells .025–.050 mm.

Calyptra quite smooth.

Capsule nearly erect or subarcuate, narrowly cylindrical, dark purple, shining, width to length about as 1:6–8. Teeth shorter than in *Cundulata*. Lid shorter rostrate than in *C. undulata*.—On clayey soil and in crevices of rock.—Revelstoke, British Columbia; Rogers Pass and Beaver Creek in Selkirk Mountains, British Columbia; Lesser Slave Lake, Athabasca, Canada; Kootenai County, Idaho.

OLIGOTRICHUM Lam. & DC.

Name derived from oligo = few, and tricho = hair; referring to the almost naked calyptra.

Plants dioicous. Stems simple, 1–3 cm. tall, with rhizoids at base.

Leaves not undulate, 1 cell thick; upper leaves lanceolate to ligulate, when dry incurved-hooked and rarely crisped, when moist patent to squarrose from an indistinct sheath-like base, usually with lamellæ on back toward apex; lamina on back not toothed (except sometimes in *O. parallelum*). Margin not bordered, sometimes inflexed. Lamellæ on upper side 3–13 (in our species), wavy from side to side (except in *O. parallelum*), with crenulate margins (except in *O. parallelum*), composed of similar smooth cells.

Calyptra with a few erect hairs, rarely smooth.

Capsule erect or inclined, symmetric, terete, oval or ovate, usually straight, smooth, with very large 2-celled stomates. Peristome present; teeth 32 (at least in ours), usually equal, pale throughout. Lid readily dropping off, thinly rostrate from a conic base.

Number species in western North America, 3; total number species, about 10.

³ Alfred Richard Cecil Selwyn, Director of the Canadian Geological Survey from 1869 to 1895; editor of the Geological and Natural History Survey of Canada, and a large contributor to the same.

THE WEST NORTH AMERICAN SPECIES,—A COMPARISON AND KEY.

1. Lamellæ straight; capsule with few stomates.
 2. Leaf margin plane.
 3. Lamellæ on upper side 4-7; 3-6 cells high.
 4. Lamellæ on back low or wanting.....1. *O. parallelum*.
1. Lamellæ wavy from side to side; capsule with numerous stomates.
 2. Leaf margin plane.
 3. Lamellæ on upper side 5-7; 3-7 cells high.
 4. Lamellæ on back high.....2. *O. aligerum*.
 2. Leaf margin incurved.
 3. Lamellæ on upper side 10-13; 6-12 cells high.
 4. Lamellæ on back low or wanting.....3. *O. incurvum*.

1. **Oligotrichum parallelum** (Mitt.) Kindb., in Eur. and N. Amer. Bryin., p. 156, (1897).

Atrichum parallelum Mitt., in Journ. of Linn. Soc., 1864, p. 48, t. 8.
*Atrichum leiophyllum*⁴ Kindb., in Bull. Torr. Bot. Club. **17**: 275, (1890).

Oligotrichum leiophyllum Kindb., in Eur. and N. Amer. Bryin., p. 156 (1897).

Probably so named because there are often tooth-like processes parallel to the vein on the backs of the leaves.

Plants dioicous, loosely cæspitose, dark green; antheridial plants more slender, the antheridial disks cupshaped. Stems simple, erect, 1-3 cm. tall.

Upper leaves half open, incurved when moist, slightly undulate, ligulate-lanceolate, often marked on the back by small thin tooth-like processes parallel to the vein; lower leaves shorter, oblong, more obtuse. Margin plane, sharply dentate from the middle or below. Lamellæ on upper side 4-7, straight. Vein percurrent, sometimes with 1-3 longitudinal dentate lamellæ on back. Cells round-hexagonal, basal cells narrow. Perichætil leaves oblong, convolute at base, gradually narrowed, lanceolate.

Capsule as 1:3-4, subcylindric, slightly arcuate, contracted under the mouth, with few stomates.—On soil.—Kodiak Island, Port Etches, and Douglas Island, Alaska; Vancouver Island, and Rocky Mountain region of British Columbia; Washington.

⁴ See Proc. Wash. Acad. Sci., **4**: 326, (1902).

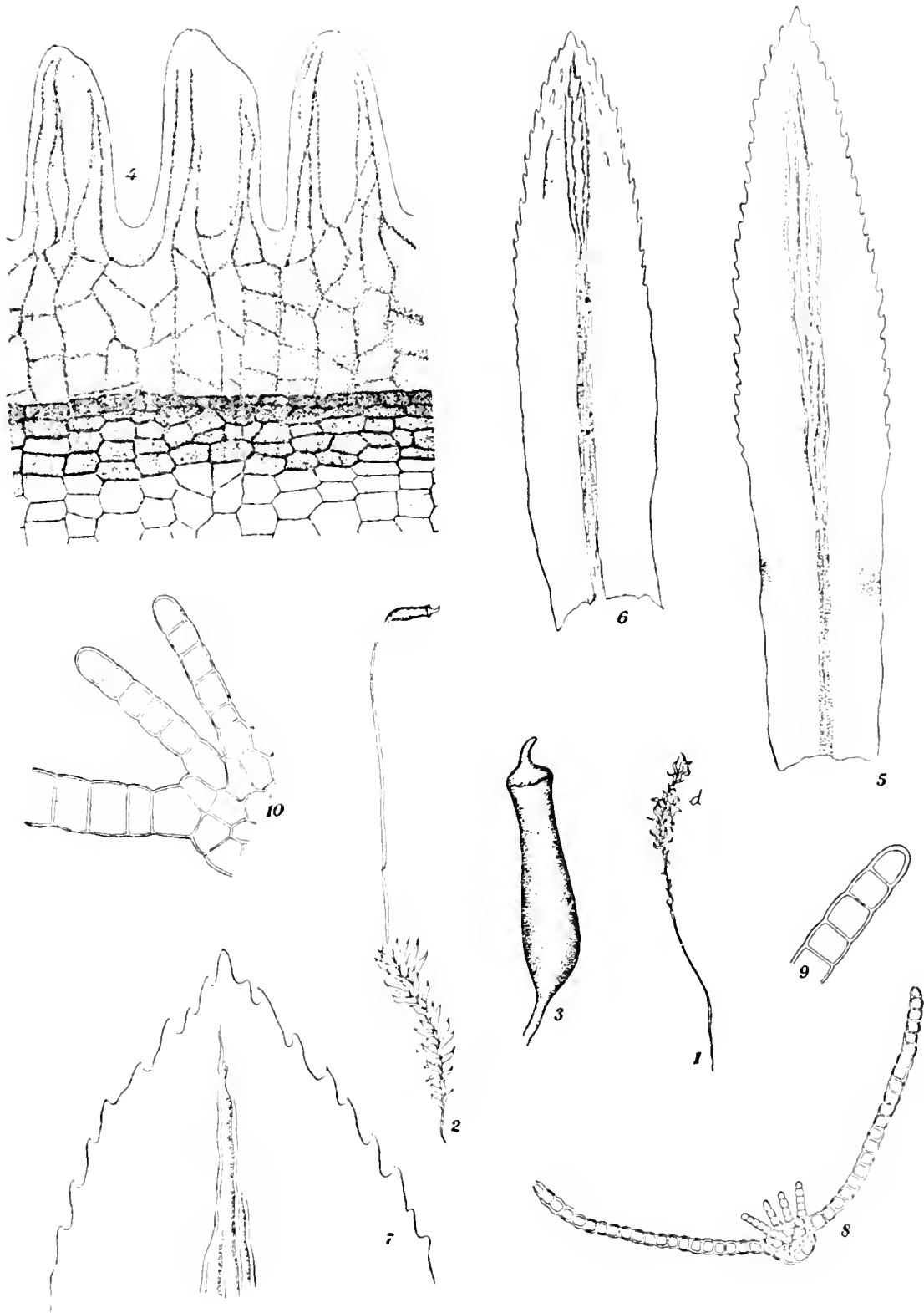


Fig. 5. *Oligotrichum parallelum*.

1 = Antheridial plant dry; d = antheridial disk, termination of a year's growth, $\times 1$. 2 = Moist plant with capsule, $\times 1$. 3 = Capsule with lid, $\times 5$. 4 = Peristome showing wide membrane and doubling of teeth, $\times 150$. 5 = Leaf showing lamellae on upper surface, $\times 15$. 6 = Leaf showing teeth and lamellae on back, $\times 15$. 7 = Leaf-tip. $\times 65$. 8 = Cross section of leaf showing lamellae, $\times 65$. 9 = Cross section of leaf margin, $\times 250$. 10 = Cross section of a few lamellae showing smooth and unthickened marginal cells, $\times 250$.

2. *Oligotrichum aligerum* Mitt., in Journ. of Linn. Soc., 1864, p. 48, t. 8.

Name derived from aliger = wing; referring to the conspicuous lamellæ on the back.

Plants dioicous, loosely cæspitose, gregarious; male plants shorter, proliferous from the center of the antheridial disk. Stems 1–3 cm. tall, slender, radiculose at base.

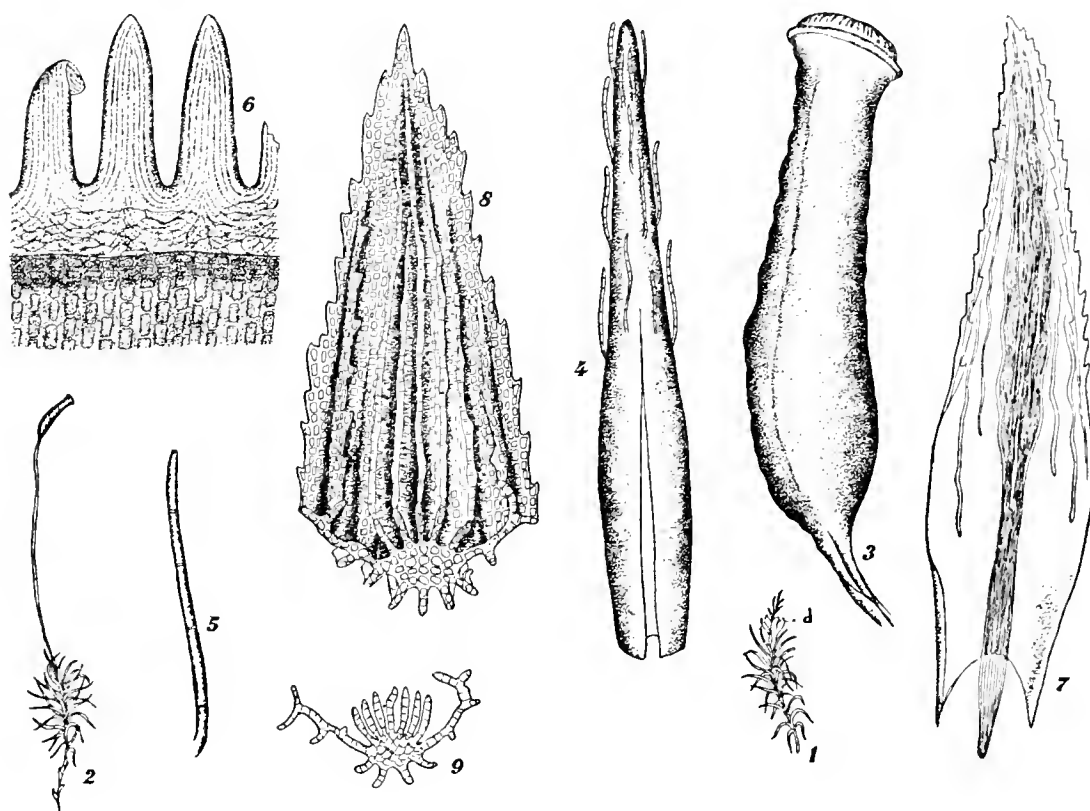


Fig. 6. *Oligotrichum aligerum*.

1 = Antheridial plant; d = antheridial disk through which the stem has grown. 2 = Plant with capsule. 3 = Capsule. 4 = Calyptra, with its few hairs. 5 = Hair of calyptra. 6 = Peristome. 7 = Leaf, showing lamellæ on upper surface. 8 = Leaf-tip. 9 = Cross section of leaf showing lamellæ. (After Sullivant).

Leaves open or spreading, oblong-lanceolate, smooth, blunt, pointed, with lamellæ on both sides. Margin plane, entire at base—short-dentate above middle. Lamellæ on upper side 5–7,⁵ wavy from side to side; lamellæ on back 6–8, high, dentate. Vein per-

⁵ Brotherus, in Engler & Prantl: Die natürlichen Pflanzenfamilien, Teil. 1, Abt. 3 s. 674, shows 11 in a figure.

current or vanishing, keeled. Cells round-quadrangle, distinct. Perichæcial leaves ovate, sheathing at base, erect, narrower, subulate to apex, their cells round and pellucid.

Calyptra with a few hairs above.

Capsule long, subcylindric, slightly arcuate, contracted under the mouth, ventricose below, with numerous stomates.— On wet clay banks.— Rocky Mountains and coast of British Columbia; Washington; Oregon.

3. *Oligotrichum incurvum* (Huds.) Lindb., in Hartm. Skand. Fl. 9 ed. 2: p. 45 (1864).

Oligotrichum hercynicum Lam. & DC. Fl. Fr. 3 ed., 2: 492 (1805).

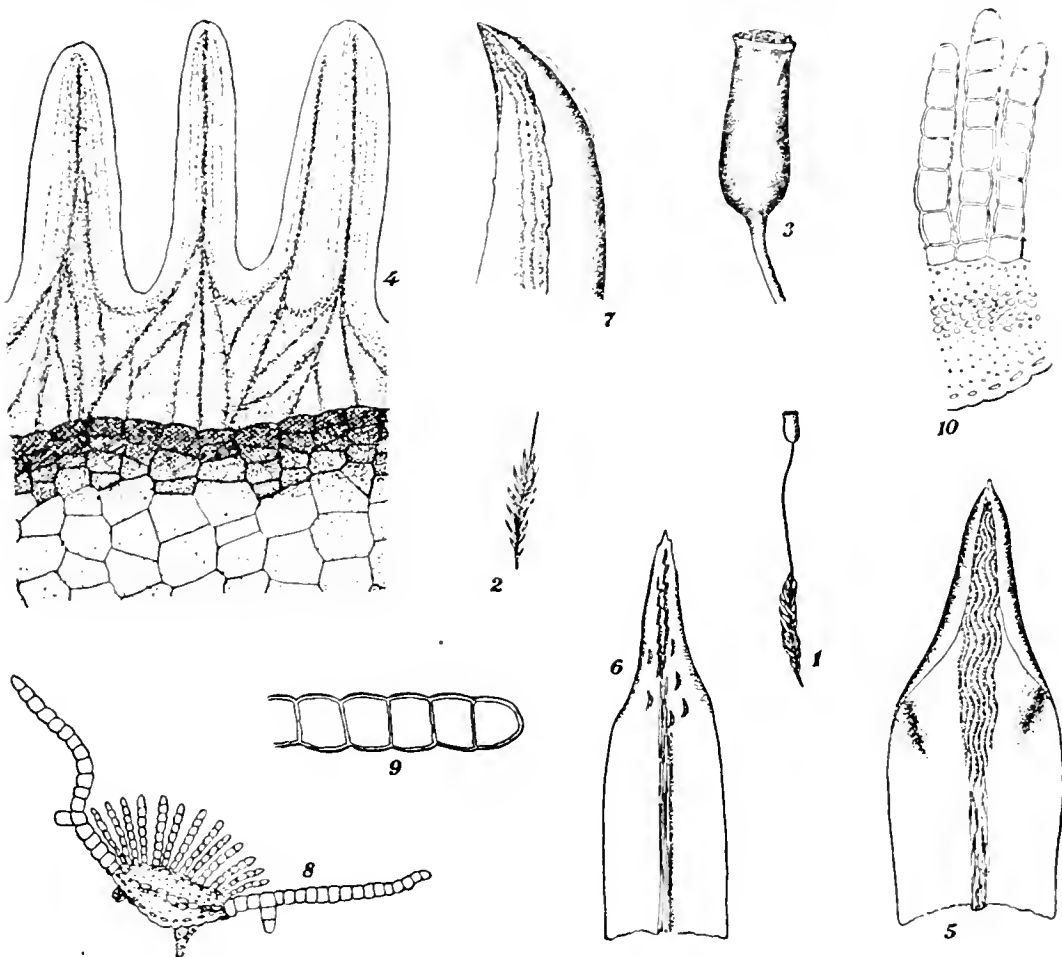


Fig. 7. *Oligotrichum incurvum*.

1 = Plant with capsule, dry, $\times 1$. 2 = Moist plant, $\times 1$. 3 = Capsule, $\times 5$. 4 = Peristome, $\times 150$. 5 = Leaf showing upper side with lamellæ and incurved margin, $\times 15$. 6 = Leaf from back showing ridges, those on vein toothed, $\times 15$. 7 = Leaf-tip showing serration of margin, $\times 65$. 8 = Cross section of leaf showing lamellæ on upper side and ridges on back, $\times 65$. 9 = Cross section of leaf margin $\times 250$. 10 = A few lamellæ in cross section, $\times 250$.

So named because the leaves are strongly incurved or twisted when dry.

Plants dioicous, loosely caespitose, glaucous green, reddish-brown when old. Stems 1–3 cm. high, erect, rigid, simple.

Leaves erect or spreading, lanceolate from an oblong base, more or less acute; when dry strongly incurved and twisted but less crisped and undulate than in *Catharinea*. Margin not bordered, incurved at least above thus making leaves somewhat tubular near tip, remotely and minutely dentate at apex but sometimes entire. Lamellæ on upper side 10–13, wavy from side to side, 6–12 cells high, their margins variously notched and crested. Vein with 2–3 lamellæ on back; back lamellæ short, blunt, low, serrate, rather ridges than lamellæ, sometimes wanting. Cells hexagonal, rectangular at base; cell-walls meeting margin of leaf perpendicularly.

Calyptra with a few scattered hairs.

Capsule ovate-cylindric, erect or somewhat inclined, somewhat irregularly plicate when dry, contracted below the mouth, with numerous stomates. Teeth short, unequal. Lid shortly rostrate, oblique, often falling off with the calyptra. Pedicel smooth, rather thick, 2–4 cm. long.—On soil.—Rogers Pass, Selkirk Mountain, British Columbia; Greenland; Europe.

COMPARISON OF VARIETY WITH TYPE.

3. *O. incurvum*, typical.

1. Cells wall in upper half of leaf approaching leaf margin perpendicularly.
2. Cells about midway between base and tip .010–.015 mm. in their longer diameter.
3. Leaves usually remotely dentate, but sometimes entire.
4. Vein usually with 1–3 low serrate ridges or lamellæ on back, but sometimes smooth.
5. Capsule somewhat irregularly plicate.

3a. *O. incurvum* var. *latifolium*⁶ (C. M. & Kindb).

Oligotrichum hercynicum var. *latifolium* C. M. & Kindb., Mac. Cat. VI, p. 149, (1892).

Oligotrichum integrifolium Kindb., in Revue Bryol. 1894, p. 40.

⁶Name derived from *latum* = broad, and *folium* = leaf; referring to the leaves being broader than in the type.

1. Cell walls in upper half of leaf approaching leaf margin diagonally.
2. Cells about midway between base and tip 0.20-0.30 mm. in their longer diameter.
3. Leaves entire or nearly so.
4. Vein smooth at back.
5. Capsule distinctly plicate.

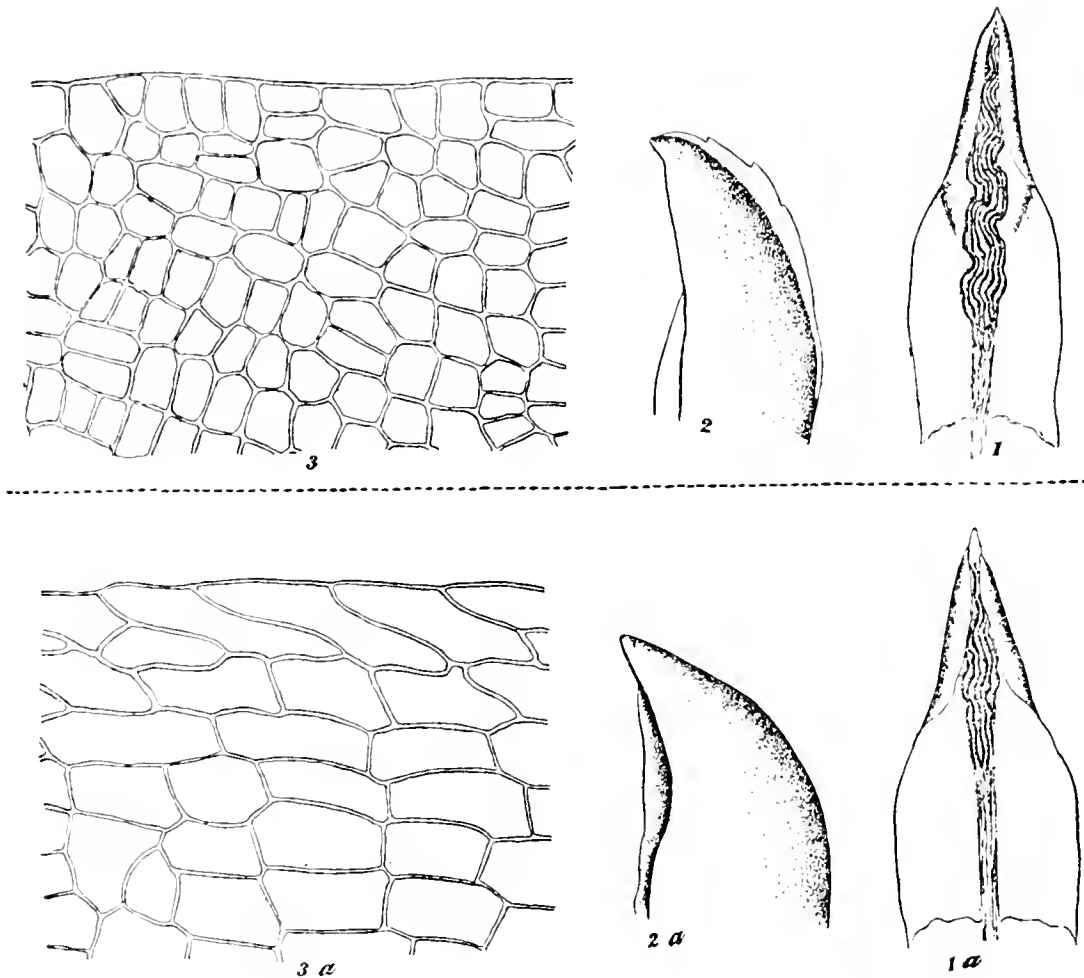


Fig. 8. Comparison of *Oligotrichum incurvum* (upper figure) with *Oligotrichum incurvum* var. *latifolium* (lower figure).

1 and 1a = Leaves, upper side, one narrower than the other. In 1 the margin is usually serrate where it is rolled in, $\times 15$. 2 and 2a = Leaf-tips, one usually with serrate lamellæ on the back, the other not, $\times 65$. 3 and 3a = Portions of leaves showing difference in size of leaf cells; also the cell walls meeting the margin perpendicularly in 3 and diagonally in 3a, $\times 500$.

On Soil—St. Lawrence Island, Bering Sea.⁷

⁷ Kindberg reports this from Rogers Pass, Selkirk Mountains, B. C., but an examination of this material shows that in areolation, direction of marginal cell walls, and size of leaves it is nearer to the type than to the variety. The leaf margin of *O. incurvum* sometimes approaches entirety, and the back smoothness. *O. incurvum* var. *latifolium* is therefore known only from St. Lawrence Island.

PSILOPILUM Brid.

Name derived from *psilos* = bare, and *pilos* = felt; referring to the absence of felted or matted hairs on the calyptra.

Plants dioicous. Stems simple, from subterranean shoots.

Leaves keeled or incurved, lanceolate or ligulate, not undulate, never toothed at back, 1 cell thick, when moist more or less patent from an indistinct sheath, when dry appressed or the tips incurved. Margin not bordered. Lamellæ on upper side only, wavy from side to side, with crenulate edges; marginal cells similar to the others. Cells quadratic or round-hexagonal, rectangular at base.

Calyptra cucullate, naked, or at tip papillose.

Capsule usually inclined, more or less distinctly obliquely ovate, with small mouth, laterally compressed, smooth, with large 2-celled stomates. Peristome present (in North American species); teeth usually unequal in size. Lid easily falling off, pointed to long and thinly rostrate from a conic base. Pedicels single.

Number of species in western North America, 1; total number species, about 13.

1. *Psilopilum glabratum* (Wahl.) Holz., in *Bryologist*, **5**: p. 80 (1902).

Oligotrichum glabratum (Wahl.) Lindb., in *Musc. Scand.* p. 12 (1879).

*Psilopilum tschutschicum*⁸ (C. M.) Par., in *Index*, ed. 1, p. 1040. (1897).

Psilopilum arcticum Brid., in *Bryol. Univ.* Vol. 2, p. 96 (1827).

Name from *glabrare* = to deprive of hair; referring to the smooth calyptra.

Stem 1–3 cm. high.

Leaves very concave, muticous. Margin irregularly crenulate above. Lamellæ 7–10, disappearing toward the base. Vein vanishing in the apex, smooth on the back. Cells small, long-rectangular at the base.

Calyptra very narrow, smooth.

Capsule ferruginous, black when old, ovate-gibbous. Teeth long, some of them 2-parted, thin. Lid short, convex-conic, with short incurved beak. Pedicel terminal, erect, brownish, .5–1.5 cm. long.

⁸ Cardot & Theriot in *Proc. Wash. Acad. Sci.* **4**, p. 327 (1902).

—On soil.—Port Clarence, and near Nome, Alaska; St. Paul and St. Matthew islands in Bering Sea, Alaska; Klondike River in Yukon Territory; Labrador; Greenland; Scandinavian Peninsula; Siberia.

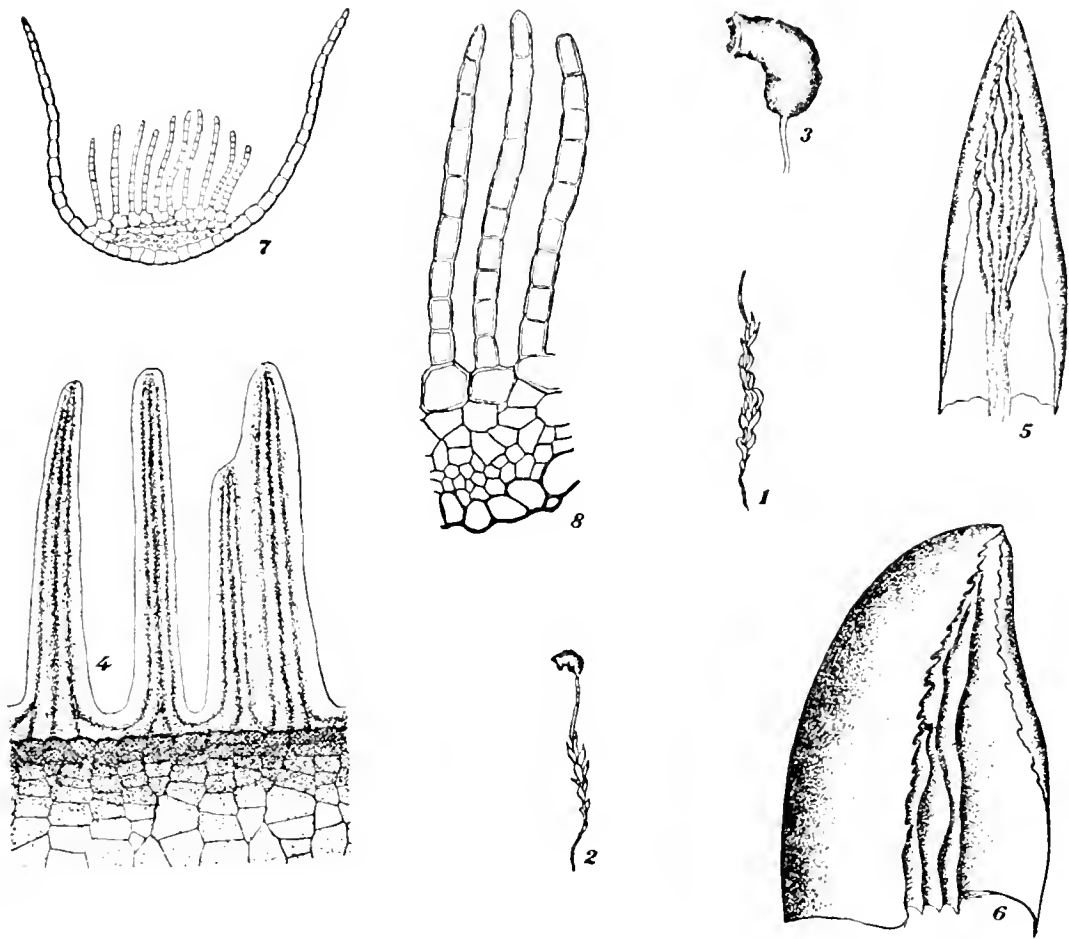


Fig. 9. *Psilopilum glabratum*.

1 = Dry plant, $\times 1$. 2 = Moist plant with capsule, $\times 1$. 3 = Capsule, $\times 5$. 4 = Peristome, $\times 150$. 5 = Leaf showing incurved margins and lamellæ on upper side, $\times 15$. 6 = Leaf-tip, mucous, keeled, $\times 65$. 7 = Cross section of leaf, $\times 65$. 8 = Cross section of a few lamellæ, $\times 250$.

BARTRAMIOPSIS Kindb.

Bartramia is another genus of mosses, *opsis* = looking like; hence looking like Bartramia.

Plants dioicous, blackish-green to brown. Stems slender, 2–8 cm. high, simple or dichotomous above, with rhizoids at base.

Leaves distant, squarrose, more or less crisped when dry, linear-lanceolate from a hyaline sheath-like base whose edges bear each 3–5 long hairs, not transversely undulate, not toothed at back; lamina 2 cells thick. Margin not bordered, densely and sharply serrate. Lamellæ 5–8, not wavy from side to side, on upper side only, 6–8 cells high, toothed. Vein strong, percurrent. Cells round-hexagonal, thick-walled, .008 mm.; sheath-cells elongated-rectangular, thin-walled.

Calyptra cucullate, naked, covering only the lid.

Capsule erect, symmetric, terete, wide mouthed, smooth, with large 2-celled stomates. Peristome wanting. Lid conic, with long beak. Pedicels single, 8–12 mm. long, reddish, flexuose when dry.

Number of species in western North America, 1; total number species, 1.

1. *Bartramiopsis lescurii* (James) Kindb., in *Rev. Bryol.* 1894, p. 35.

Atrichum lescurii James, in *Bull. Torr. Bot. Club.* 6: 33 (1879).

Bartramiopsis sitkana Kindb.,⁹ in *Rev. Bryol.*, 1894, p. 35.

Named after Lesquereux¹⁰

Plants laxly caespitose. Stems filiform, flexuous, laxly foliose, long naked below.

Leaves 4 mm. long, subvaginate at base, acuminate, 2 cells thick except near the margin where they are 1 cell thick, when dry very much crisped, when moist arcuate-spreading. Margin plane, at sheath-like base entire, with 3–5 hairs at edge where sheath joins blade, further up the hairs shorten into strong teeth. Vein broad, smooth at base. Cells of sheath hyaline, width to length about as 1:4–6.

Calyptra glabrous, shortly acuminate.

Capsule at first slightly ovate-cylindrical, turbinate when old, lid long conic, long acuminate, almost equaling the capsule. Spores

⁹ *Proc. Wash. Acad. Sci.* 4: 326 (1902).

¹⁰ Leo Lesquereux, 1806–1889. A noted worker in American fossil plants and in the mosses. With W. S. Sullivant he published “*Icones Muscorum*,” and with T. P. James, “*Manual of the Mosses of North America*.” These are today two of our best books on North American mosses.

ovate or somewhat spherical, .012—.016 mm.—On soil.—Virgin Bay, Orca, Douglas Island, and Wrangel, Alaska; Japan; Kamchatka.

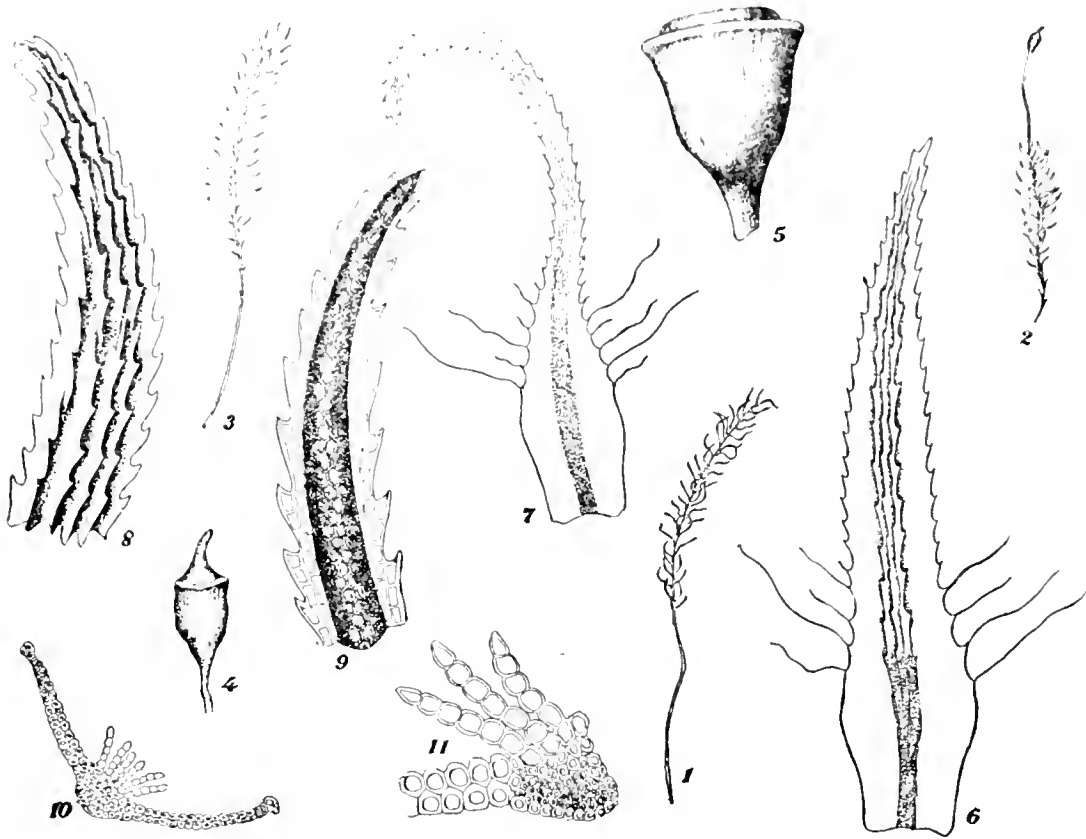


Fig. 10. *Bartramiopsis lescurii*.

1 = Plant dry, $\times 1$. 2 = Moist plant, with capsule, $\times 1$. 3 = Moist plant, without capsule, $\times 1$. 4 = Capsule with lid, not quite mature and therefore slightly shrunken, $\times 5$. 5 = Mature capsule without lid, $\times 8$. 6 = Leaf showing hairs at margin and lamellæ on upper side, $\times 15$. 7 = Leaf showing narrower blade and more curved tip, $\times 12$. 8 = Leaf tip, upper side, showing lamellæ, $\times 100$. 9 = Leaf tip, under side, $\times 100$. 10 = Cross section of leaf showing 2 layers of cells except near the margin, $\times 65$. 11 = Cross section of a few lamellæ, $\times 250$. (Numbers 5, 7, 8, 9, after Engler & Prantl.)

POLYTRICHADELPHUS Mitt.

Polytrichum is another genus of mosses, adelphos = brother; hence a brother to *Polytrichum*.

Plants dioicous, more or less robust, rigid, loosely caespitose. Stems from subterranean rhizomes, erect or inclined, usually quite long, densely leafy, simple or forked or tufted.

Upper leaves erect to patent, when dry more or less closely applied to the stem, narrowly lanceolate to awl-shaped from a thin sheath-like base, smooth at back; lamina 1 cell thick, but narrow. Margin not bordered, slightly if at all incurved, mostly sharply toothed to hairy above (not hairy in North American species). Lamellæ on upper side only, numerous, not wavy from side to side, entire, marginal cells mostly somewhat enlarged and somewhat oval. Vein broad outside of sheath, excurrent as a red point. Cells of sheath without chlorophyll, elongated-rectangular to linear, narrower toward the margin; cells of limb iso-diametric, thick walled.

Calyptra cucullate, usually with short hairs at tip, sometimes smooth.

Capsule inclined, oblong or ovate, 2-4 angled, smooth, often semilunar in cross section, with numerous 2-celled stomates. Peristome present; teeth pale, with yellowish axis. Lid conic, more or less beaked. Pedicels single or two on a tip, elongated, thick.

Number of species in western North America, 1; total number of species, about 18.

1. *Polytrichadelphus lyallii* Mitt., in Journ. Linn. Soc. 1864, p. 49.
Oligotrichum lyallii Lindb., in Act. Soc. pr. Fauna et Fl. Fenn, 1868,
p. 102.

Polytrichum angustidens Lindb.¹¹ in Bot. Centralb. Vol. 84.

Named after Lyall.¹²

Plants robust, dirty yellow to brownish green. Stems fastigiately branching from the middle, sometimes simple, naked at the base, densely foliate above.

¹¹ Prof. J. M. Holzinger, of Winona, Minnesota, kindly sent some *Polytrichum angustidens* Lindb., co-type material, No. 1121 of the collection by Sandberg in northern Idaho. A comparison of this with *Polytrichadelphus lyallii* Mitt. indicates that they are the same. The leaf characteristics even down to the marginal cells of the lamellæ agree. The number of lamellæ is 35-45. The capsules sent were young and shrunken; the angles cannot therefore be made out with certainty. Lindberg says, "capsules acutely 4-angled," but if his material was likewise young and shrunken, one could easily surmise an error here. The other capsule characteristics agree with *Polytrichadelphus lyallii*. The calyptra would at once distinguish *Polytrichum* from *Polytrichadelphus*, but it is wanting in the writer's material; since Lindberg omits it in his description, one surmises it was wanting in his as well. More evidence is necessary to convince the writer that *Polytrichum angustidens* is not *Polytrichadelphus lyallii*.

¹² David Lyall, surgeon and botanist attached to international survey.

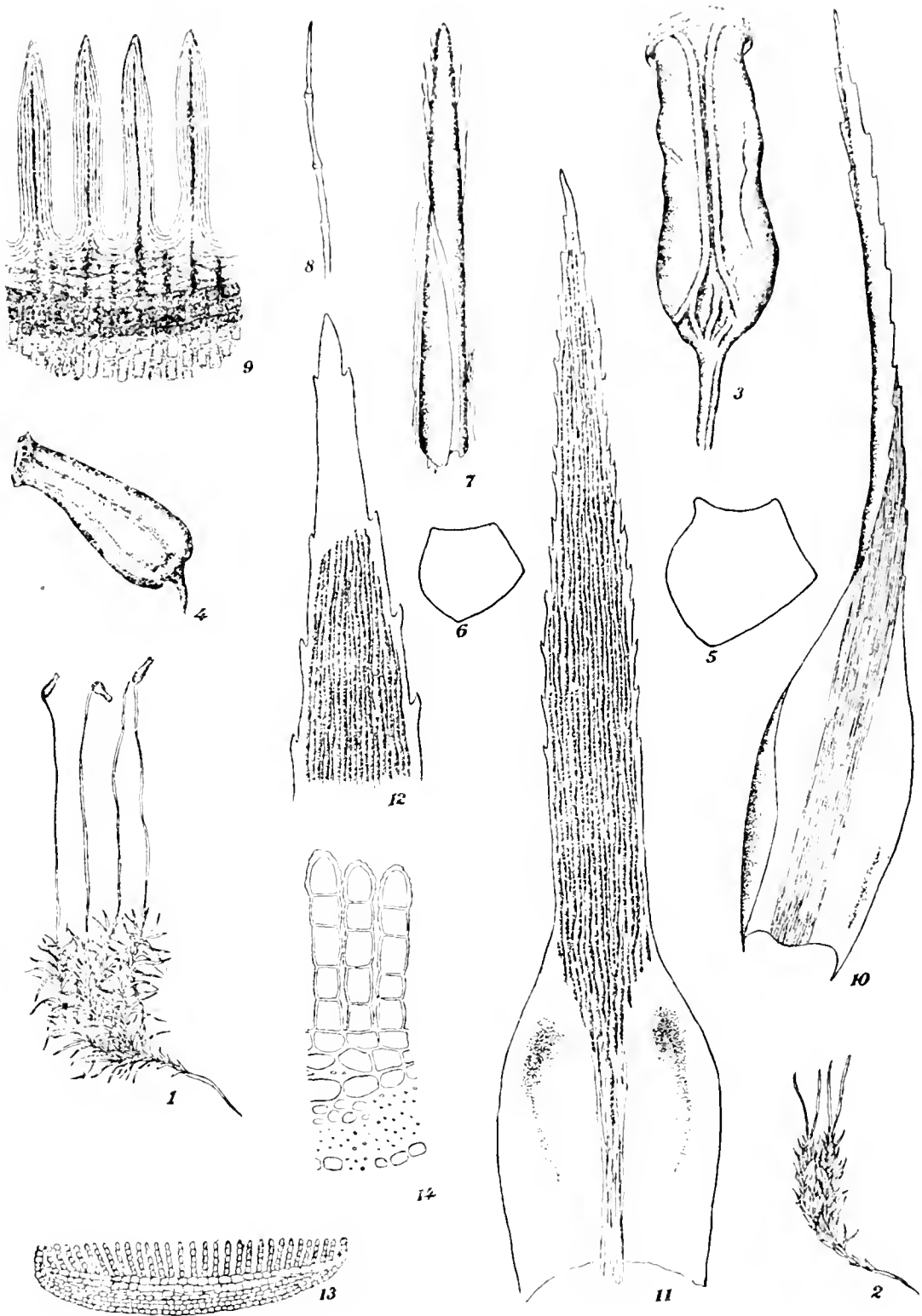


Fig. 11. *Polytrichadelphus lyallii*.

1 = Plant moist, with capsules, $\times 1$. 2 = Plant dry, $\times 1$. 3 = Capsule, showing double fold. 4 = Capsule, $\times 5$. 5 = Cross section of capsule near base, $\times 10$. 6 = Cross section of capsule near mouth, $\times 10$. 7 = Calyptra. 8 = Hair of calyptra. 9 = Peristome. 10 = Leaf. 11 = Leaf, $\times 15$. 12 = Leaf tip, $\times 65$. 13 = Cross section of leaf. 14 = Cross section of a few lamellæ, $\times 250$. (Nos. 3, 7, 8, 9, 10, 13, after Sullivant.)

Leaves oblong, clasping at base, narrowly lanceolate above, convex and smooth on back. Margin incurved, distantly serrate from the middle up. Lamellæ 35–45, 3–7 cells high; marginal cells rough, oval, higher than wide. Inner perichæatial leaves with long convolute base and short acumen.

Calyptra fugacious, with few appressed hairs, split on one side, not curved, slightly twisted.

Capsule slightly inclined, cylindrical-oblong, ventricose below, bluntly 2–4 angled,¹³ plicate-rugose at base when empty. Teeth 64. Lid broadly conic, subulate-rostrate. Pedicel long, flexuous.—On soil.—In mountains from British Columbia southward to Colorado, Nevada, and California.

POGONATUM P. Beauv.

Name derived from pogon = beard; referring to the hairy calyptra.

Plants dioicous (in species included), loosely cæspitose, olive to dark green. Stems erect, simple or branched above.

Leaves when dry crisped, appressed or spreading more or less, lanceolate to linear-lanceolate, usually with a sheath-like base, sheath and lamina 1 cell thick; lamina smooth at back. Margin not incurved, usually sharply serrate, not bordered. Lamellæ mostly very numerous (at least 35 in the included species), not at all or very little wavy from side to side, entire, rarely few to wanting. Vein toothed at back toward apex, sometimes smooth, wide, many cells thick. Cells of lamina small, thick walled, round-hexagonal; cells of sheath rectangular to linear.

Calyptra with long smooth hairs at tip which usually form a felted mat covering the whole surface.

Capsule erect or inclined, straight, sometimes slightly curved, terete, sometimes slightly ribbed, cells of epidermis usually mamilllose; without stomates, except in *P. alpinum*; hypophysis wanting or

¹³ This species is described in Lesquereux & James' Manual as having the capsule biplicate and semilunar in cross section. There are however two other faint angles extending part way up from the base, making it 4-angled at least below. Brotherus' description of the capsule of the genus (Engler & Prantl. Nat. Pflanzenf. Teil 1, Abt. 3, s. 682) as "2-kantig, in Querschnitt halbmondförmig" does not hold as shown by the cross sections of the capsule in the plate.

indistinct; Peristome present; teeth 32 (in the included species), in *P. alpinum* doubled so one might count 64. Lid hemispheric, more or less long-beaked. Pedicels single, rarely several at one tip, more or less elongated, purple.

Number of species in western North America, 4; total number species, about 133.

THE WEST NORTH AMERICAN SPECIES. —A COMPARISON AND KEY.

1. Leaves very much crisped when dry.
 2. Marginal cells of lamellæ smooth, not thickened.
 3. Teeth 32.
 4. Capsule without stomates.
 5. Capsule papillose.
 6. Marginal cells of lamellæ differing little in size and form from the others. 1. *P. contortum*.
1. Leaves hardly or not at all crisped when dry.
 2. Marginal cells of lamellæ papillose or rough, thickened.
 3. Teeth 64, or 32 double ones.
 4. Capsule with stomates.
 5. Capsule not papillose.
 6. Marginal cells of lamellæ ovate, width to length as 1: $\frac{1}{2}$ -2, larger than the others. 4. *P. alpinum*.
 3. Teeth 32.
 4. Capsule without stomates.
 5. Capsule papillose.
 6. Marginal cells of lamellæ oval or flat-topped, width to length as 1 $\frac{1}{2}$ -2:1, larger than the others.
 2. *P. capillare*.
 6. Marginal cells of lamellæ round, about the same size as the others. 3. *P. urnigerum*.

1. **Pogonatum contortum** (Menz.) Lesq., in Mem. Calif. Acad. 1, p. 27.

Pogonatum erythrodontium Kindb., in Mac. Cat. p. 150 (1892).

Pogonatum atrovirens Mitt.,¹⁴ in Journ. Linn. Soc. 1864, p. 49.

¹⁴ An examination of *P. atrovirens* Mitt. shows it to be *P. contortum*. Type material from the Mitten Herbarium, now owned by the New York Botanical Garden, and also material collected by Macoun at Hastings, Burrard Inlet, near Vancouver, British Columbia, was compared with authentic *P. contortum*. The capsules are papillose as in *P. contortum*. The basilar areolation is the same in leaves taken from corresponding parts of the stem. The leaves in both vary in the size of the sheath, those near the base of the stem having larger sheaths than those near the tip. Since these constitute the characteristics upon which *P. atrovirens* Mitt. is founded, it reduces to *P. contortum*.

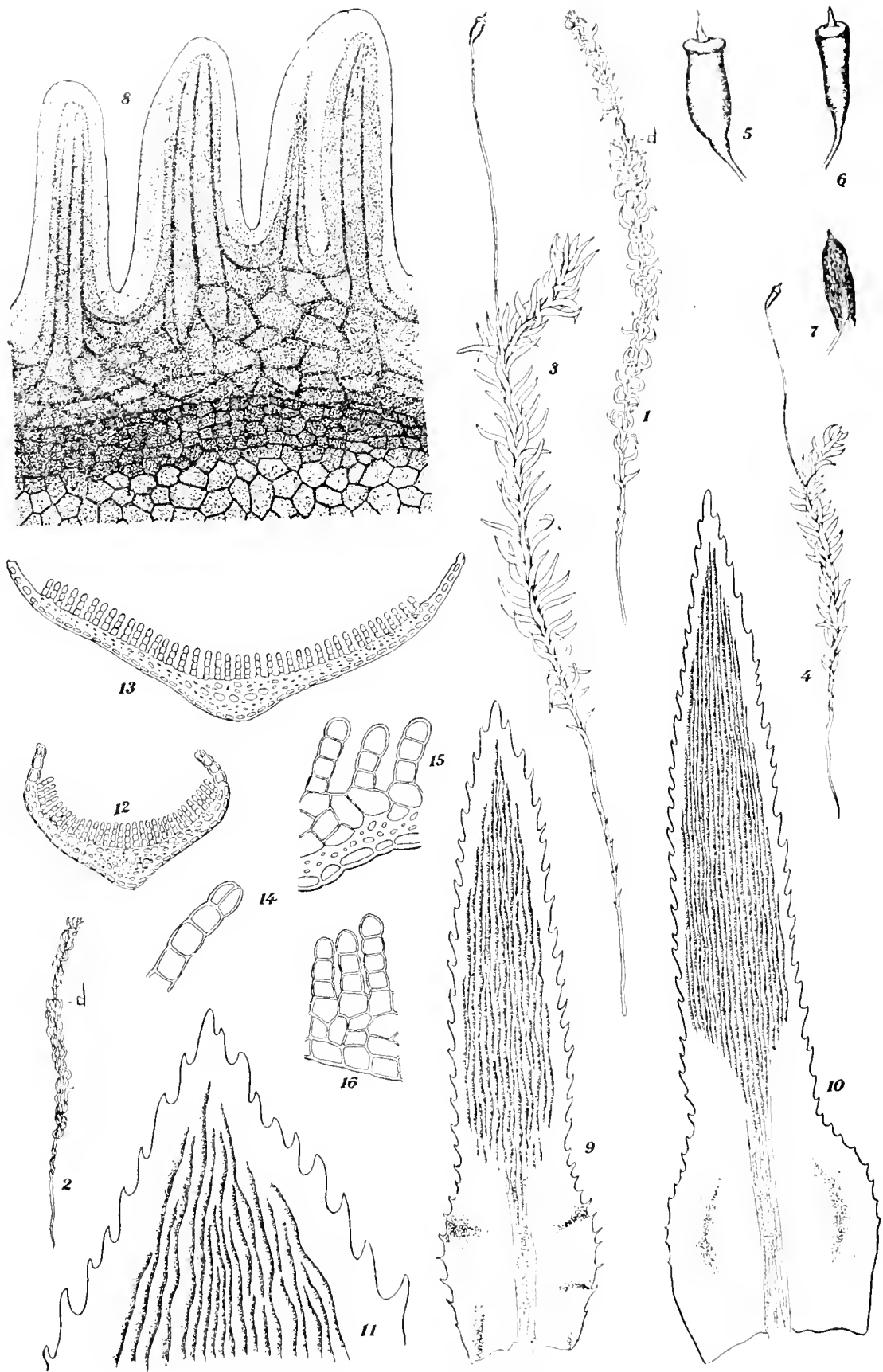


Fig. 12. *Pogonatum contortum*.

1 and 2 = Dry antheridial plants; d = antheridial disks through which stems have grown, $\times 1$. 3 and 4 = Moist plants with capsules; stems have continued beyond point where pedicel arises, $\times 1$. 5 and 6 = Capsules, $\times 5$. 7 = Immature capsule covered by calyptra, $\times 5$. 8 = Peristome, $\times 150$. 9 and 10 = Leaves, showing lamellae on upper side, $\times 15$. 11 = Leaf tip, $\times 65$. 12 and 13 = Cross sections of leaves, $\times 65$. 14 = Cross section of leaf margin, $\times 250$. 15 and 16 = Cross sections of lamellae, $\times 250$.

So named because the leaves are strongly twisted or contorted when dry.

Plants large, gregarious or loosely cæspitose, glaucous green above, brown below. Stems simple, or with an innovation from under the perichetium, loosely and irregularly foliate its whole length.

Leaves erect, open, twisted and crisped when dry, linear-lanceolate, usually longer upwards on the stem, acute, sheath scarcely broader than blade. Margin sharply serrate to the base. Lamellæ 20—40. Marginal cells of the lamellæ oval, smooth, not very much larger than the others. Vein percurrent, sparingly dentate on the back. Perichætial leaves similar to the foliage leaves.

Calyptra covering the whole capsule.

Capsule ovate to obovate or cylindric, erect or somewhat curved, papillose, when dry slightly constricted under the mouth, without stomates. Teeth 32. Lid convex, rostellate. Pedicel long, flexuous.—On soil, usually clay.—Along the coast from the Alaska Peninsula to California; Rocky Mountains, at least of British Columbia.

2. *Pogonatum capillare* (Rich.) Brid., in Bryol. Univ. II, p. 127, (1827).

Pogonatum dentatum Brid., in Bryol. Univ. II, pp. 122 and 744, (1827).

Pogonatum capillare var. *dentatum* Lindb.,¹⁵ in Act. Soc. sc. Fenn. 1872, p. 266.

Name derived from *capillaris* = hairy; probably referring to the hairy calyptra, so common in this family.

Plants 2.5 cm. high or less, gregarious or loosely cæspitose, glaucous green; male plants smaller. Stems slender, mostly simple, loosely foliate, with rhizoids at base.

¹⁵ Cardot and Thériot, in "Mosses of Alaska," Proc. Wash. Acad. Sci. 4: 327 (1902) say "*Pogonatum dentatum* (Menz.) Brid. is but a western race of *P. capillare*, characterized by having slenderer stems than those of the type, and by its pedicel which is usually not so flexuous." This hardly seems sufficient difference for a variety. Cloudy weather and wet soil cause stems to grow longer and more slender. The northwest coast of North America is characteristically damp and cloudy. Potatoes growing in a dark damp cellar are not called new varieties. Further the difference is not constant. The marginal cells of the lamellæ vary a great deal, so this distinction, shown in the figures in Sullivant's *Icones Muscorum*, does not hold.

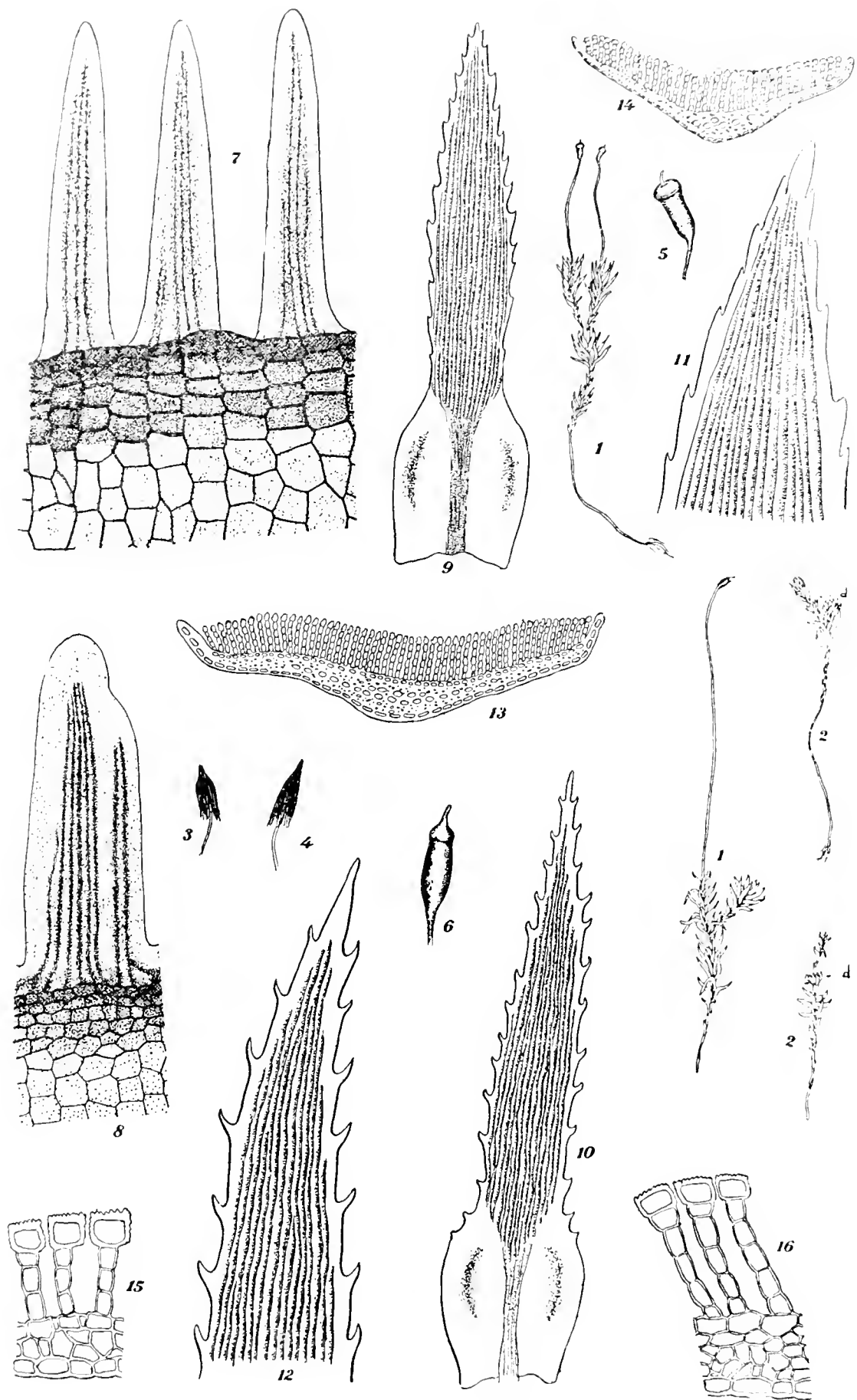


Fig. 13. *Pogonatum capillare*.

1 = Moist plants, with capsules, $\times 1$. 2 = Dry antheridial plant; d = antheridial disks, $\times 1$. 3 and 4 = Immature capsules covered by calyptras, $\times 5$. 5 and 6 = Capsules with lid, $\times 5$. 7 = Peristome, $\times 150$. 8 = Double tooth of peristome, $\times 150$. 9 and 10 = Leaves showing sheath at base and lamellæ on upperside, $\times 15$. 11 and 12 = Leaf tip, $\times 65$. 13 and 14 = Cross sections showing lamellæ and leaf margins, $\times 65$. 15 and 16 = Cross sections of a few lamellæ, $\times 250$.

Leaves not crisped when dry, gradually longer upwards; lower leaves distant, small, appressed; upper leaves large, linear from a short sheathing base. Margin sharply serrate. Lamellæ 45–55; marginal cells of lamellæ much larger, papillose, rectangular or oval, wider than long as $1\frac{1}{2} - 2:1$.

Calyptra hairy, hardly covering capsule to base.

Capsule oblong-cylindric, erect, papillose, thin, without stomates. Teeth 32. Lid hemispheric, abruptly straight-beaked. Pedicel slender, flexuous, long.—On soil.—St. Paul Island, Bering Sea; from the Alaska Peninsula along the coast to southern Alaska; Rocky Mountains of British Columbia and the United States; Portland, Oregon; Adirondack Mountains; White Mountains; Newfoundland; Miquelon Island; Greenland; Scandinavian Peninsula; Siberia.

3. Pogonatum urnigerum (L.) Beauv., in Prodr. p. 84 (1805).

Polytrichum urnigerum L., in Sp. Pl. II, p. 1109. n. 3 (1753).

Name derived from urna = urn, and gerere = to bear; probably referring to its erect, wide-mouthed capsule.

Plants erect, 2.5–7.5 cm. high, dark green, brown below. Stems rigid, sometimes forked at tip.

Upper leaves lanceolate from a pale sheathing base, crowded, at apex acute to acuminate; when moist patulose; when dry rigid, not crisped, appressed, erect. Margin plane or erect, sharply toothed nearly to sheath. Lamellæ 40–50, 4–6 cells high; marginal cells not much larger, rounded, thickened, papillose, yellowish-green. Vein slightly excurrent or vanishing, sharply spinose at back. Cells quadrate-hexagonal or rounded.

Calyptra longer than the capsule.

Capsule erect or nearly so, symmetric, wide-mouthed, yellowish-brown to brown, without stomates, very papillose. Teeth 32, reddish. Beak of lid almost straight, subulate. Pedicel 2.5–4 cm. long, slender, pale reddish.—On soil and soil-covered rocks.—Coast of Alaska from Disenchantment Bay near mouth of Yukon River to the vicinity of Juneau; Rogers Pass, Selkirk Mountains, British Columbia; Cathlamet, Washington; Portland, Oregon; Europe; Asia.

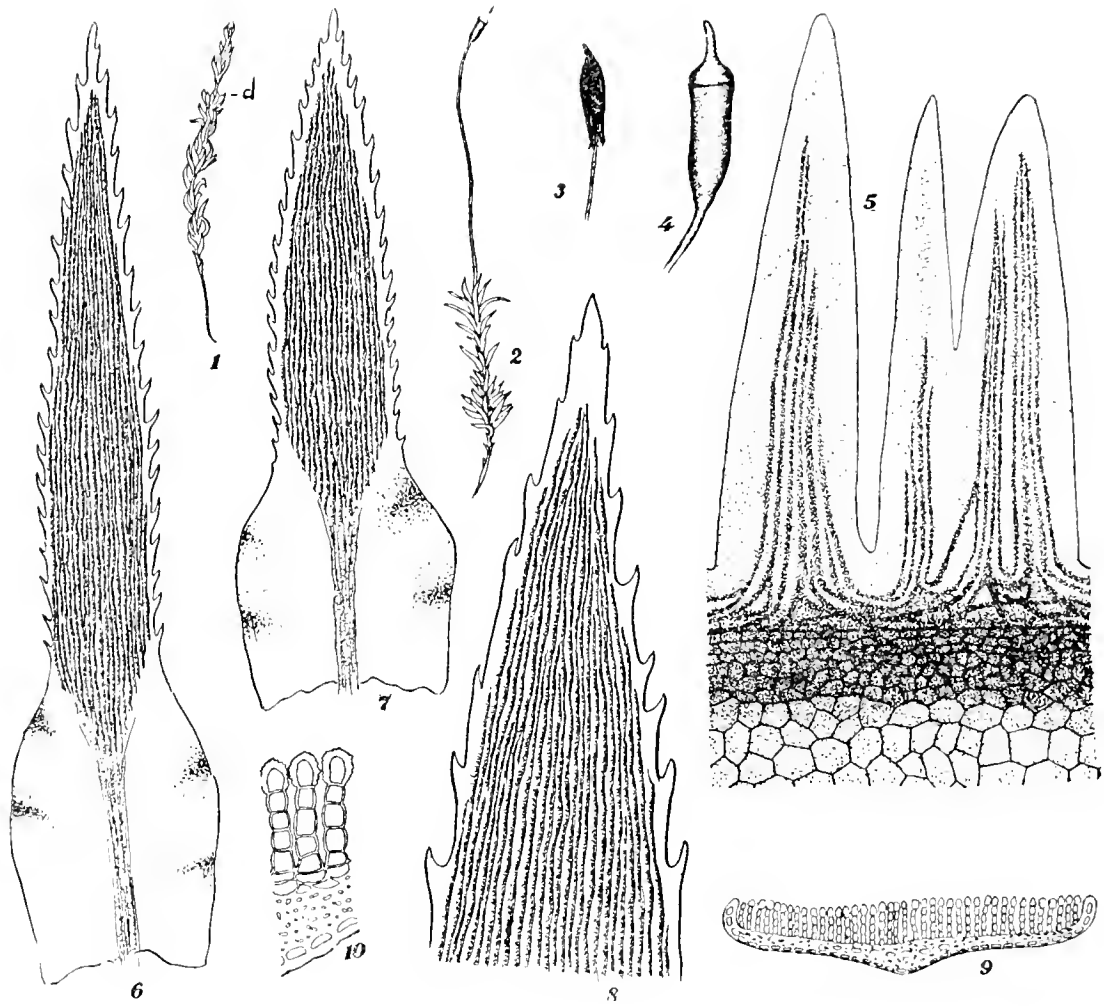


Fig. 14. *Pogonatum urnigerum*.

1 = Dry antheridial plant; d = old antheridial disk through which young shoot has grown, $\times 1$. 2 = Moist plant with capsule, $\times 1$. 3 = Calyptra covering capsule, immature, $\times 1$. 4 = Capsule, $\times 5$. 5 = Peristome, $\times 150$. 6 and 7 = Leaves showing lamellæ on upper side, $\times 15$. 8 = Leaf tip, $\times 65$. 9 = Cross section of leaf, $\times 65$. 10 = Cross section of a few lamellæ, showing rounded, thick-walled papillose, marginal cells, $\times 250$.

4. *Pogonatum alpinum* (L.) Roehl., in Ann. Wett. Gesells. III, p. 226 (1812).

Polytrichum alpinum L., in Sp. pl. II, p. 1109, n. 2 (1753).

Probably so named because it is found in mountain (alpine) regions in Europe.

Plants loosely or densely tufted, tall, decumbent at base. Stems much branched, rarely simple.

Leaves dull green, narrowly acuminate, not crisped when dry. Margin serrate. Lamellæ 30-40, 5-8 cells high; marginal cells slightly larger than the others, ovate to ovate-conic, longer than wide, thickened, papillose or rough, yellowish.

Calyptra shorter than the capsule.

Capsule inclined, arcuate, subglobose to elongate-cylindric and curved, terete, narrower at mouth than below, smooth, with stomates, greenish-brown, black and rugose when old; hypophysis indistinct or wanting. Peristome present; teeth 64, or 32 double ones, short, irregular. Beak of lid curved, long, subulate. Pedicel long, flexuous.—On soil.—From Kotzebue Sound north of Bering Strait in Alaska southward to Washington and Idaho; White Mountains of New Hampshire; Europe; Asia; Australia.

COMPARISON OF VARIETIES WITH TYPE.

4a. *P. alpinum* var. *simplex*¹⁶ Sch., in Coroll. p. 91, (1856).

1. Leaves about 5 mm. long.¹⁷
2. Leaf-sheath to blade about as 1:2½.
3. Plant about 2 cm. tall or shorter.
4. Capsule 1.8-2.3 mm. long.
5. Width of capsule to length as 1:1½-2½
6. Stems simple.
7. Pedicel 1½-2 cm. long.

On soil and rocks.—Port Clarence, Alaska; Colorado; Copper Mountains and Gold range in British America.¹⁸

¹⁶ So named on account of its unbranched stems.

¹⁷ It should be borne in mind that varietal differences are not so constant as those characterizing species; varieties grade into each other more. Therefore, while these numbered statements constitute a description and comparison of the varieties, considerable latitude must be permitted for variations.

¹⁸ An examination of Macoun's No. 427 leads to the conclusion that this is var. *simplex* instead of var. *septentrionale*.

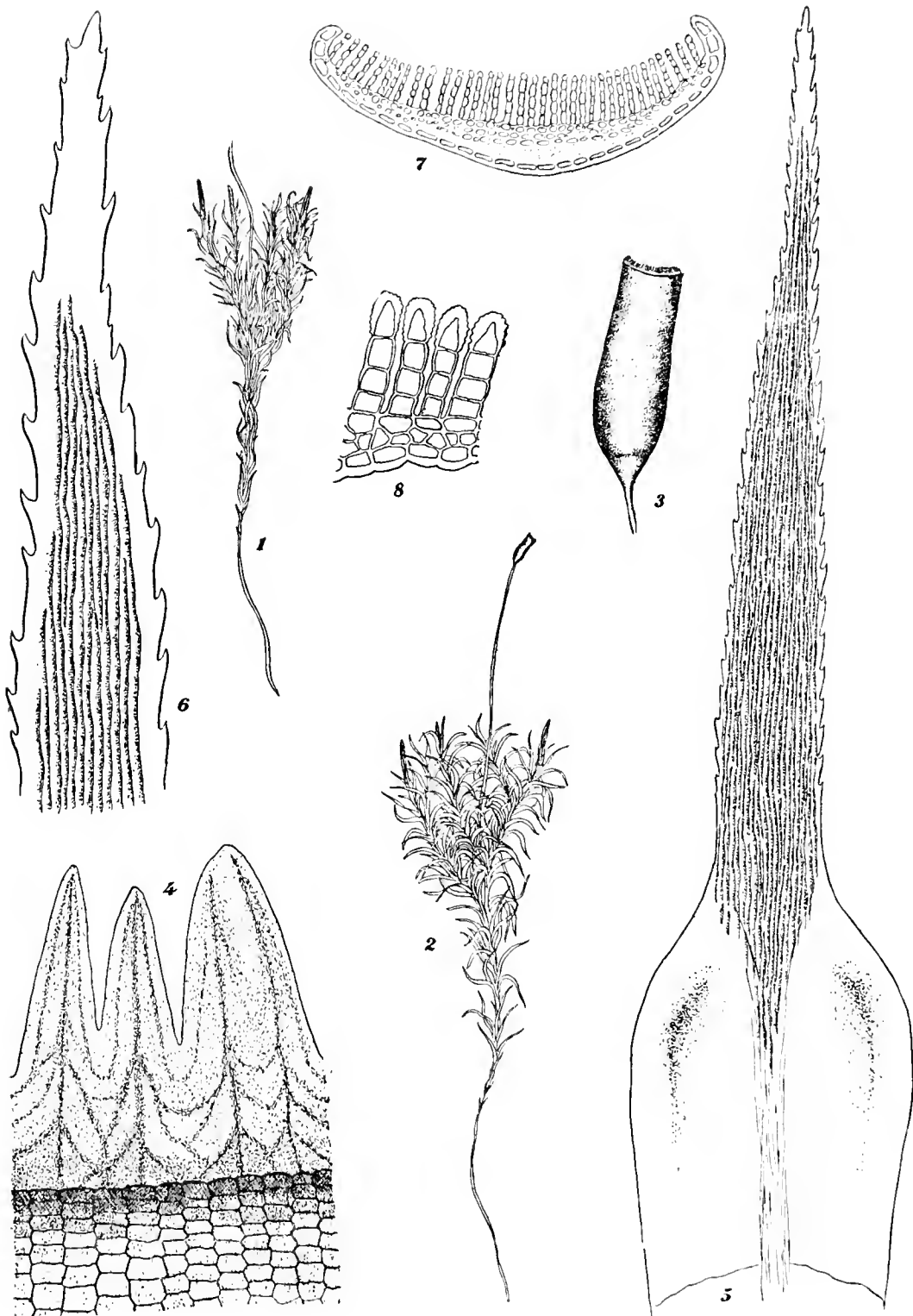


Fig. 15. *Pogonatum alpinum*.

1 = Plant dry, $\times 1$. 2 = Moist plant with capsule, $\times 1$. 3 = Capsule, $\times 5$
 4 = Peristome, $\times 150$. 5 = Leaf with sheathing base and lamellae on upper side,
 $\times 15$. 6 = Leaf tip, $\times 65$. 7 = Cross section of leaf showing lamellae and margin,
 $\times 65$. 8 = Cross section of a few lamellae showing thickened and papillose marginal
 cells, $\times 250$.

4b. *P. alpinum* var. *brevifolium*¹⁹ Brid., in Sch. Syn. I. ed. p. 441, (1860).

Polytrichum alpinum var. *brevifolium* Muell., in Syn. I, p. 210, (1849).

1. Leaves about 7-8 mm. long.
2. Leaf-sheath to blade about as 1:3-3½.
3. Plant about 4 cm. tall or shorter.
4. Capsule 3-4 mm. long.
5. Width of capsule to length as 1:1½-2½.
6. Stems with few and short branches.
7. Pedicel 2½-3½ cm. long.
 - a. Capsule with distinct neck.

On rocks.—Islands of Bering Sea; Mt. Dana, California; Hudson Strait; Greenland; mountains of Europe; Siberia.

4c. *P. alpinum* var. *septentrionale*²⁰ (Sw.) Brid., in Sch. Syn., 1 ed., p. 441 (1860).

P. alpinum var. *microdontium*²¹ Kindb., in Mac. Cat. Vol. 6, p. 152, (1892).

1. Leaves about 7-8 mm. long.
2. Leaf-sheath to blade about as 1:3-3½.
3. Plants about 5 cm. tall or shorter.
4. Capsule 3-4 mm. long.
5. Width of capsule to length as 1:1½-2½.
6. Stems simple.
7. Pedicel 1½-2 cm. long.
 - a. Capsule without distinct neck.

On soil and rocks.—Islands of Bering Sea; Kodiak Island, Alaska; mouth of Skeena River and Rocky Mountains, British Columbia; Europe.

4d. *P. alpinum* var. *arcticum*²² (Sw.) Brid., in Sch. Syn. 1 ed. p. 441 (1860).

Polytrichum sylvaticum Menz., in Trans. Linn. Soc. 4. p. 83, n. 19 (1798).

Polytrichum alpinum var. *arcticum* Wahl., in Fl. Lapp., p. 346 (1812).

¹⁹ Breve = short, folium = leaf; because its leaves are shorter than those of nearly all other varieties.

²⁰ Septentrionale = pertaining to the north; referring to the northern habitat of this variety.

²¹ Examination of Alaskan collections leads to the conclusion that Cardot and Thèriot are right in concluding that var. *microdontium* does not separate from var. *septentrionale*.

²² So named on account of its arctic habitat.

1. Leaves about 7-8 mm. long.
2. Leaf-sheath to blade about as 1:3-4.
3. Plants about 5 cm. tall or shorter.
4. Capsule 4-5 mm. long.
5. Width of capsule to length as 1:3-5.
6. Stems simple or with few branches.
7. Pedicel 2-3 cm. long.

On soil and rocks.—Egg Island, Disenchantment Bay, Alaska; Stewart Island and Mt. Rainier, Washington; northern Europe.

4. **P. alpinum**, typical.

1. Leaves about 9-11 mm. long.
2. Leaf-sheath to blades about as 1:3-5.
3. Plants about 10 cm. tall or shorter.
4. Capsule 4-5 mm. long.
5. Width of capsule to length as 1:2-3.
6. Stem much branched.
7. Pedicel $2\frac{1}{2}$ - $3\frac{1}{2}$ cm. long.

4e. **P. alpinum** var. **macounii**²³ (Kindb.) C. & Ther. in Proc. Wash. Acad. Sci. **4**, p. 328 (1902).

P. macounii Kindb., in Bull. Torr. Bot. Club, **16**, p. 96 (1889).

1. Leaves about 12-14 mm. long.
2. Leaf-sheath to blade about as 1:3-5.
3. Plants about 15 cm. tall or shorter.
4. Capsule 5-6 mm. long.
5. Width of capsule to length as 1:3-4.
6. Stems simple, rarely branched.
7. Pedicel 4-7 cm. long.

On soil.—From the Alaska Peninsula southward along the coast to Washington, and eastward across British Columbia to the Rocky Mountains.

POLYTRICHUM Dill

Name derived from poly = many, and tricho = hair; referring to the hairiness of the calyptra.

Plants dioicous, loosely to densely caespitose. Stems rigid, from subterranean rhizomes, erect or nearly so, densely leafy, simple, rarely forked or much branched at the tip.

Leaves erect when dry, from a sheath-like base, lanceolate to awl-shaped, more than 1 cell thick except at margins, sheath 1 cell

²³ Named after John Macoun, naturalist of the Canadian Geological Survey.

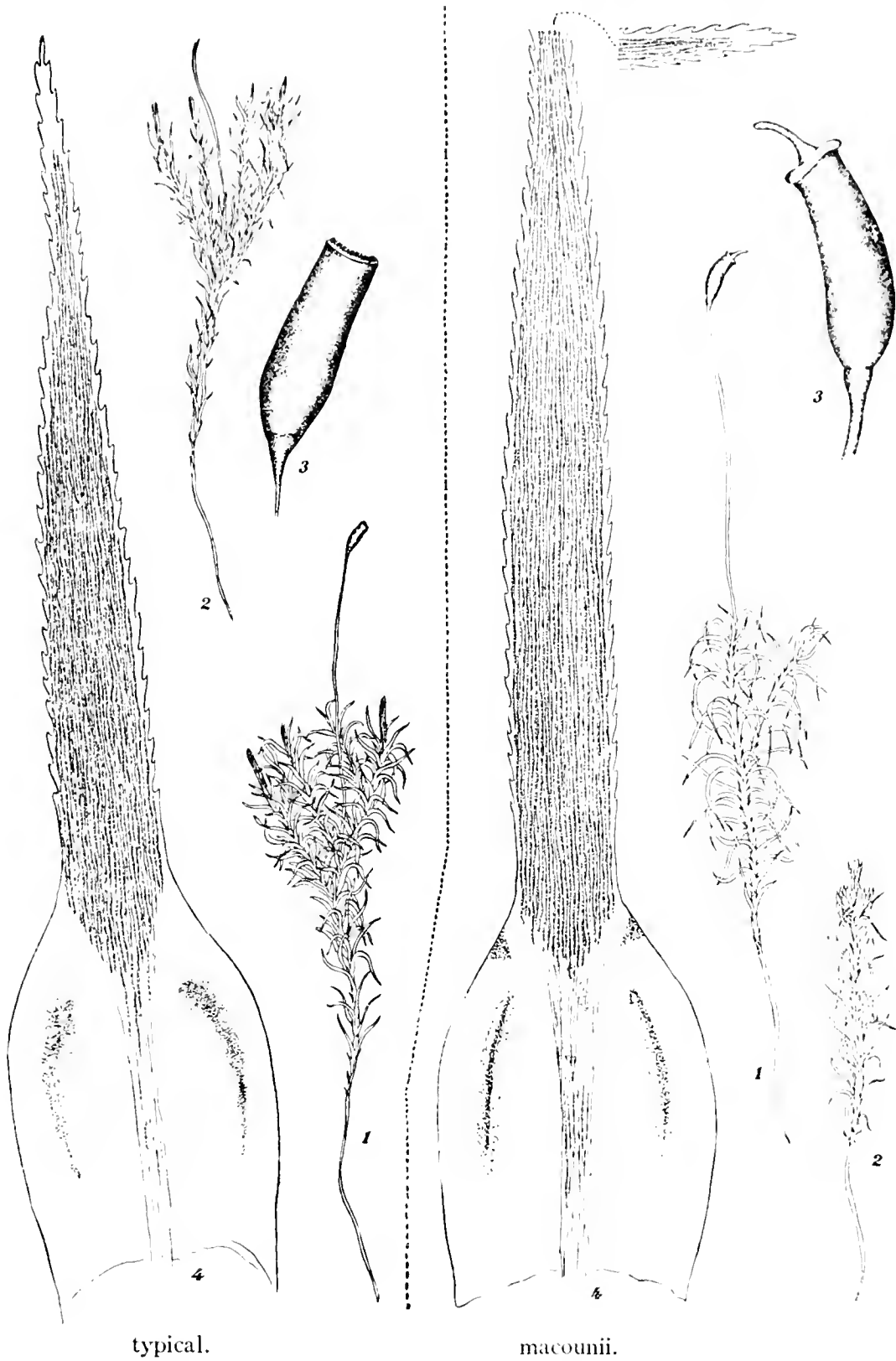


Fig. 16. *Pogonatum alpinum*, and variety.

1 = Plants moist, $\times 1$. 2 = Dry plants, $\times 1$. 3 = Capsules, $\times 5$. 4 = Leaves, $\times 15$.

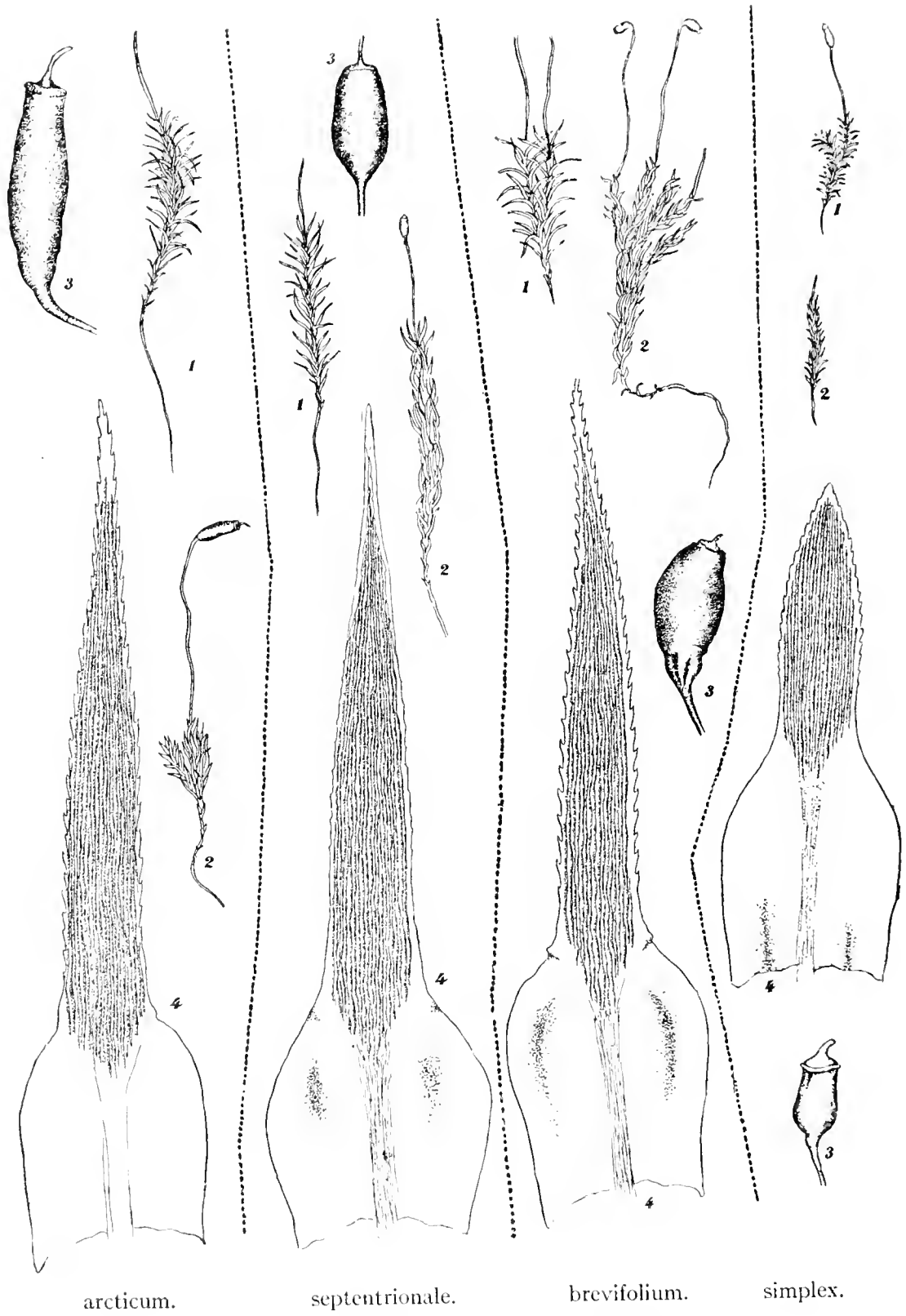


Fig. 17. *Pogonatum alpinum*, varieties.

1 = Plants moist, $\times 1$. 2 = Plants dry, $\times 1$. 3 = Capsules, $\times 5$. 4 = Leaves, $\times 15$.

thick; lamina smooth at back. Margin plane or broadly incurved, not bordered, usually with large teeth. Lamellæ on upper side only, very numerous, erect, high, not wavy from side to side, entire or nearly so. Vein often toothed at back near apex. Cells of sheath without chlorophyll, elongated-rectangular to linear, toward the edge longer than along the vein; cells of lamina small, thick walled, quadratic or hexagonal, at base often broader than long, often in rows at the margin.

Calyptra matted with very long white to brown hairs which cover the whole capsule.

Capsule erect when young, later inclined, finally often horizontal, 4-6 angled or terete, cubical to oblong; hypophysis hemispheric and grading into capsule, or discoid and deeply constricted from capsule, with large 1-celled stomates. Peristome present; teeth 64. Lid large, plane to conic, beaked. Pedicels single, long, rigid, yellowish-red to purple, twisted to the right above when dry.

Number of species in western North America, 12; total number species, about 104.

THE WEST NORTH AMERICAN SPECIES,—A COMPARISON AND KEY.

1. Leaf margin serrate to sheath or nearly so.
 2. Margin plane or erect.
 3. Leaves sharply pointed, the point composed mostly of the ex-current vein.
 4. Leaf point red, dentate, about 1 mm. long.
 5. Marginal cells of lamellæ like the rest, sometimes slightly flattened or elongated, not thickened, width to height about as 1:1.
 6. Capsule about as 1:1½, obscurely 5-6 angled.
 7. Plants 2½-10 cm. long.
 - a. Cells near middle of sheath and ¾ distance from margin to vein about 3-4 times as long as wide; leaf blade about middle 1 cell thick for 4-8 cells from margin1. *P. gracile*.
 6. Capsule about as 1:1¾, sharply 4-6 angled.
 7. Plants 7-20 cm. high.
 - a. Cells near middle of sheath and ¾ distance from margin to vein about 6-10 times as long as wide; leaf blade about middle 1 cell thick for 2-3 cells from margin2. *P. attenuatum*.
5. Marginal cells of lamellæ oval or flattened, thickened, width to height about as 1½-2:1.
 6. Capsule about as 1:2-2½, sharply 4-6 angled.
 7. Plants 3-6 cm. high3. *P. ohioense*.

5. Marginal cells of lamellæ notched in cross section.
 6. Capsule about as $1:1\frac{1}{4}-1\frac{1}{2}$, sharply 4-angled.
 7. Plants 5-45 cm. high.....5. *P. commune*.
4. Leaf point red, smooth, $\frac{1}{2}$ mm. or shorter.
 5. Marginal cells of lamellæ oval or flattened in cross section, not thickened, width to height about as 2:1.
 6. Capsule unknown.
 7. Plants 4-8 cm. high4. *P. inconstans*.
1. Leaf margin serrate from the middle up.
 2. Margin plane below, erect or somewhat incurved above.
 3. Leaves sharply pointed, the point composed mostly of the excurrent vein.
 4. Leaf point red, dentate, 1 mm. long or shorter.
 5. Marginal cells of lamellæ notched in cross section.
 6. Capsule unknown.
 7. Plant 4-8 cm. high6. *P. jensenii*.
1. Leaf margin entire.
 2. Margin plane or erect.
 3. Leaves sharply pointed, the vein excurrent as an arista.
 4. Arista red, smooth, 1 mm. long or shorter.
 5. Marginal cells of lamellæ notched in cross section.
 6. Capsule unknown.
 7. Plants 5-8 cm. high7. *P. yukonense*.
 2. Margin plainly incurved.
 3. Leaves blunt, cucullate.
 4. Arista or sharp point none.
 5. Marginal cells of lamellæ ovate, thickened, width to height about as 1:2.
 6. Capsule about as $1:1\frac{1}{2}$, bluntly 6-angled.
 7. Plants 2.5-10 cm. high8. *P. sexangulare*.
 3. Leaves sharply pointed, the vein excurrent as an arista.
 4. Arista red, rarely somewhat colorless at tip, rough, $\frac{1}{2}-1\frac{1}{2}$ mm. long.
 5. Marginal cells of lamellæ ovate or flask-shaped.
 6. Capsule as $1:1\frac{1}{2}-1\frac{3}{4}$, sharply 4-angled, 3-5 mm. long.
 7. Plants 2-10 cm. high.
 - b. Stem without dense covering of rhizoids.
 9. *P. juniperinum*.
 6. Capsule about as $1:1\frac{1}{4}$, sharply 4-angled, 2-3mm. long.
 7. Stems mostly with dense covering of rhizoids.
 10. *P. strictum*.

- 4. Arista hyaline, rough, 1½ mm. or shorter.
- 5. Marginal cells of lamellæ ovate or flask-shaped, thickened, width to height about as 1:1½-2.
- 6. Capsule about as 1:1-1¼, sharply 4-angled.
- 7. Plants 3-12 cm. high.
 - c. Stems mostly branched.....11. *P. hyperboreum*.
- 4. Arista hyaline, rough, 3 mm. or shorter.
- 5. Marginal cells of lamellæ ovate or flask-shaped, thickened, width to height about as 1:1½-2.
- 6. Capsule about as 1:1¼-1½, sharply 4-angled.
- 7. Plants 2.5-4 cm. high.
 - c. Stems simple.....12. *P. piliferum*.

1. Polytrichum gracile Dicks., in MSS.

Name derived from gracilis = slender; probably referring to the rather tall stem, naked below.

Plants tufted, dark green 2.5-10 cm. high. Stems matted together below with whitish tomentum, simple or slightly divided, leafless below.

Leaves erecto-patent, somewhat flexuous or patent when dry, 8-10 mm. long, the limb lanceolate, gradually narrowed to a short acumen, limb usually about 4-6 cells wide in the middle of the leaf. Margin erect, sharply serrate, variable in width. Lamellæ about 40, 4-6 cells high; marginal cells about equalling the others, not papillose, rounded or a little higher than wide; vein toothed above at back, excurrent; point short, red, dentate. Cells of limb .015-.018 mm., round-quadrate to transversely elliptical; cells of sheathing base thin, rectangular, in middle of wing length to width about as 1:3-4. Perichaetial leaves long-sheathing.

Calyptra hardly covering the capsule.

Capsule short, broadly ovate, inflated, erect, horizontal when dry, with 5-6 obtuse and often obscure angles, smooth, narrowed at mouth; hypophysis rather indistinct, hardly constricted above. Teeth often confluent and unequal. Lid large with a rather long beak. Spores .018-.022 mm. Pedicel 4-5 cm. long, thin, flexuous.—On soil.—Kotzebue Sound north of Bering Strait, and Kodiak Island, Alaska; below White Horse Rapids, Yukon region, western British America; Rocky Mountain region of British Columbia; Eastern United States and British America.

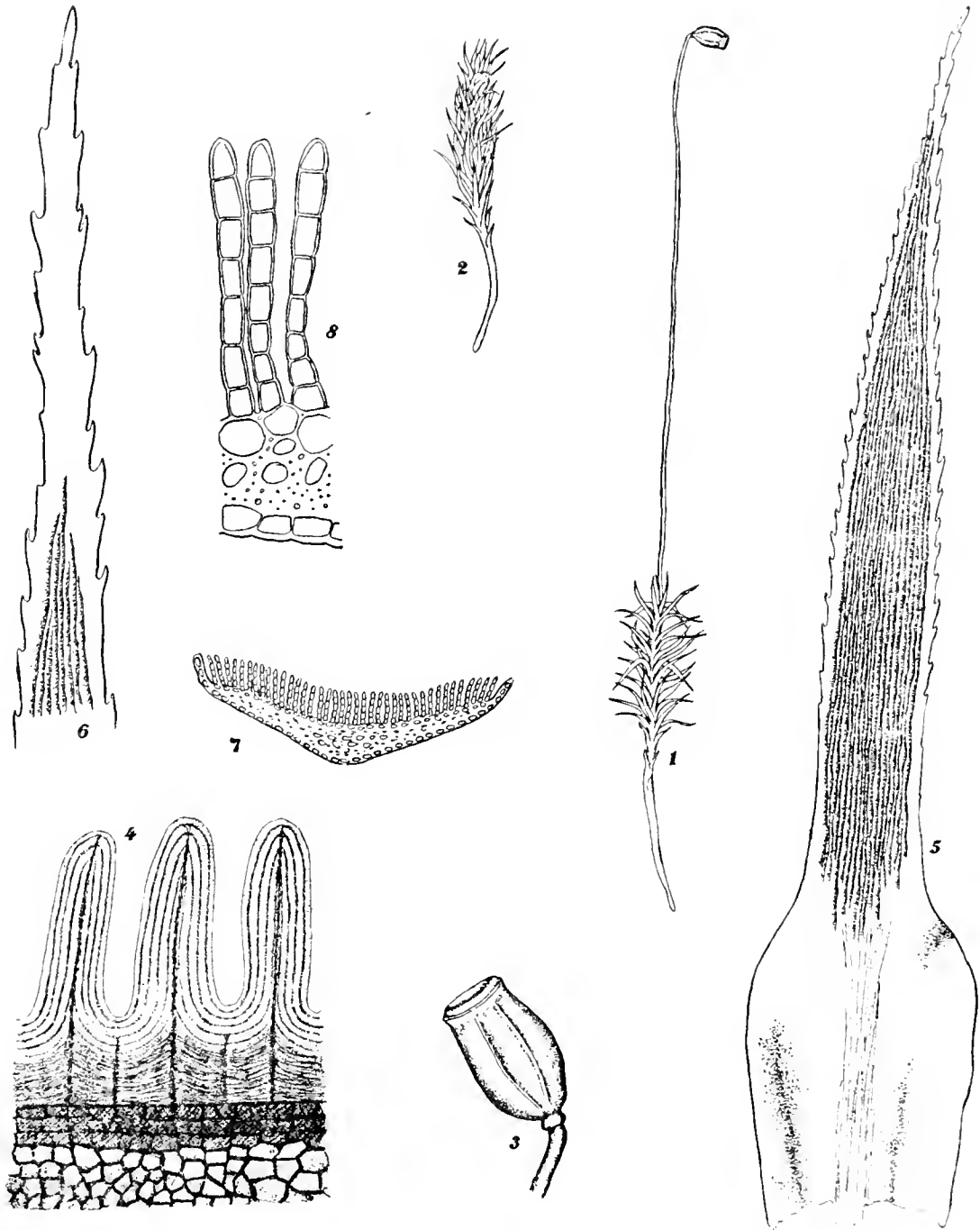


Fig. 18. *Polytrichum gracile*.

1 = Moist plant with capsule, $\times 1$. 2 = Dry plant, $\times 1$. 3 = Capsule, $\times 5$.
 4 = Peristome, $\times 150$. 5 = Leaf showing lamellæ on upper side, $\times 15$. 6 = Leaf
 tip, $\times 65$. 7 = Cross section of leaf showing lamellæ, $\times 65$. 8 = Cross section of
 a few lamellæ showing smooth marginal cells, $\times 250$.

2. *Polytrichum attenuatum* Menz., in Trans. Linn. Soc. (1798), p. 72.

Polytrichum conorhynchum Kindb., in Mac. Cat., p. 164 (1892).

Polytrichum formosum Hedw., in Sp. M., p. 92 (1801).

Name derived from *attenuatus* = drawn out; referring to the long narrow, simple form of the plant often found.

Plants loosely tufted, dark green, 7-20 cm. high. Stems erect or ascending, tomentose at base, simple or forked.

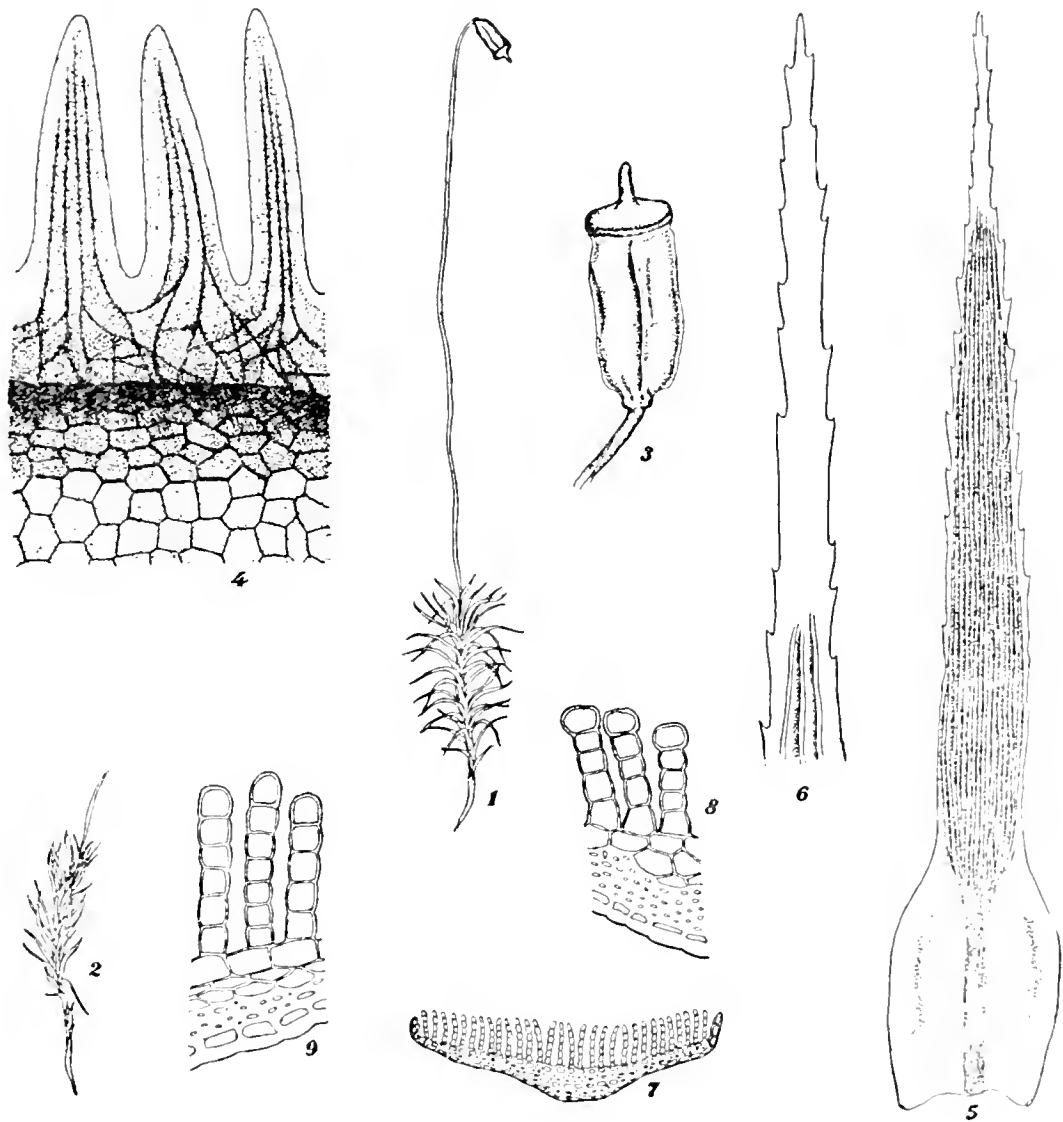


Fig. 19. *Polytrichum attenuatum*.

1 = Moist plant with capsule, $\times 1$. 2 = Dry plant, $\times 1$. 3 = Capsule, $\times 5$. 4 = Peristome, $\times 150$. 5 = Leaf showing lamellæ on upper side, $\times 15$. 6 = Leaf tip, $\times 65$. 7 = Cross section of leaf showing lamellæ, $\times 65$. 8 and 9 = Cross sections of a few lamellæ showing height and the marginal cells, $\times 250$.

Upper leaves spreading, loosely incumbent when dry, similar to those of *P. gracile* but larger, 10–15 mm. long. Margin erect, sharply serrate, very narrow, of 2–3 rows of smaller cells (.010–.012 mm.). Lamellæ about 50–70, very low, 3–5 cells high; marginal cells smooth, round, equal or slightly larger than the others and sometimes a little longer than broad. Vein excurrent; point red, short, dentate. Cells of leaf-base longer and narrower than in *P. gracile*, very narrow at margin, near middle toward vein width to length about as 1:6–10. Perichætil leaves with long sheaths. longly acuminate.

Calyptra covering capsule.

Capsule erect or inclined, cernuous when dry, oblong, with 5–6 (rarely 4) acute angles, yellow-green, fawn-colored when ripe, wide-mouthed, cells of surface turgidly mamilllose, smooth; hypophysis small, distinct, constricted above. Lid large, with rather long beak. Spores .010 – .014 mm. Pedicel 5–6 cm. long, stout, rigid, orange below and paler above.—On soil and rocks.—From Alaska Peninsula southward along the coast, Ravelstoke and Selkirk Mountains in British Columbia; Oregon; Pelee Point on Lake Erie in eastern Canada; Miquelon Island; Europe; Japan.

3. *Polytrichum ohioense* R. & C., in Rev. Bryol., 1885,

p. 11.

Name derived from Ohio in which state it was first found.

Plants erect, 3–6 cm. high. Stems simple or bipartite.

Leaves spreading when moist, erect-flexuous when dry, cuspidate, linear-acuminate from a sheathing base. Margin plane or erect, serrate. Lamellæ about 50, 5–7 cells high; marginal cells much larger than the others, broader than long as $1\frac{1}{2}$ –2 : 1, slightly convex or plane. Vein excurrent in a red dentate point. Perichætil leaves longer, with a longer hyaline base.

Capsule erect, finally horizontal, acutely 4–5 angled, rarely 6 angled, smooth, rather narrow towards the base, 2 – $2\frac{1}{2}$ mm. wide, 5–7 mm. long; hypophysis very small or indistinct. Lid conic-acuminate, red at margin. Pedicel 4–6 cm. long, reddish below, pale above.²⁴—On soil.—Ravelstoke, British Columbia; eastern British Columbia; northeastern United States.

²⁴ Examination of material from Alaska, eastern United States and Europe shows that *P. ohioense* cannot be distinguished from *P. attenuatum* by the form of the capsule

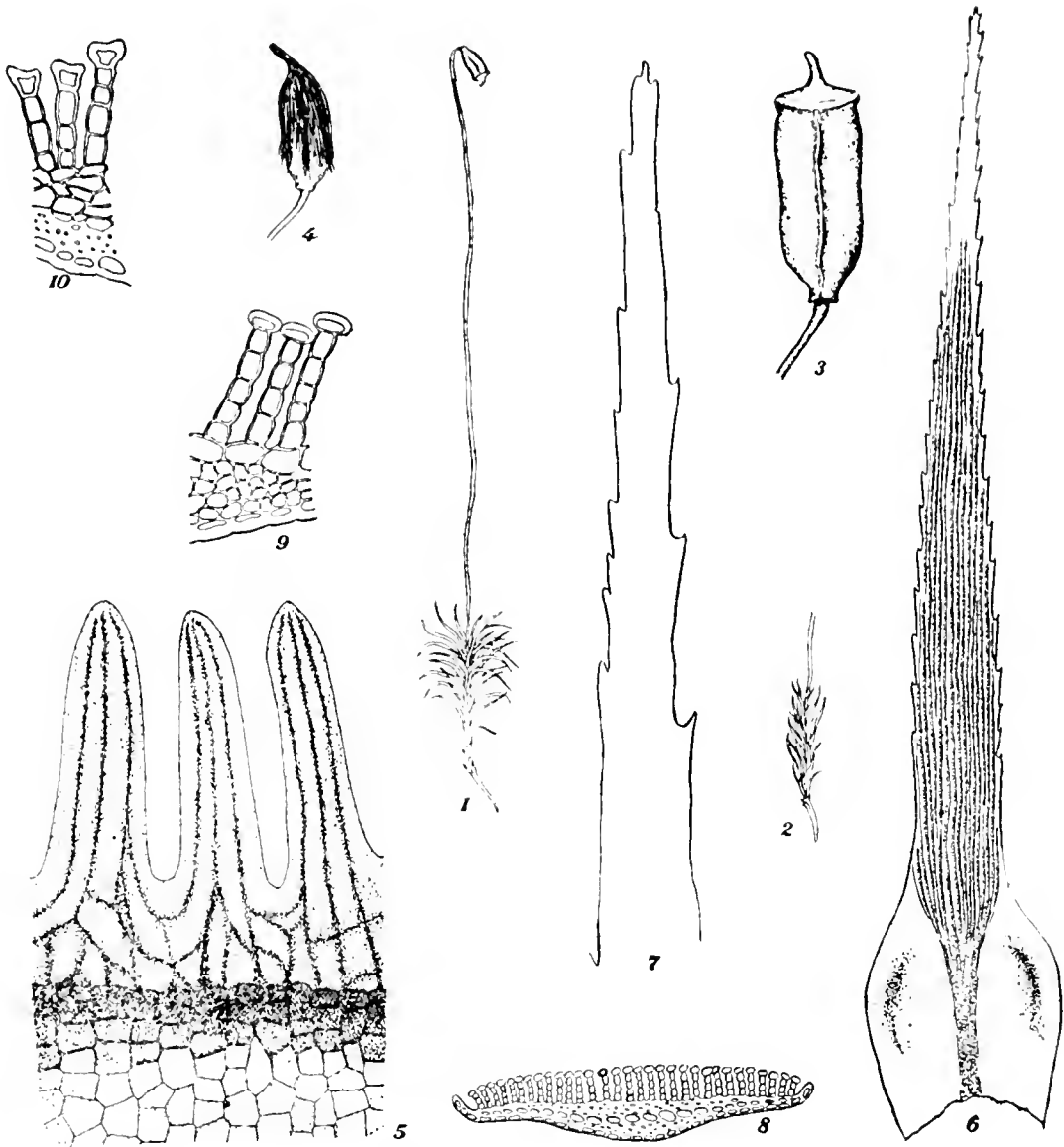


Fig. 20. *Polytrichum ohioense*.

1 = Moist plant with capsule, $\times 1$. 2 = Dry plant, $\times 1$. 3 = Capsule, $\times 5$. 4 = Immature capsule with calyptra, $\times 5$. 5 = Peristome, $\times 150$. 6 = Leaf showing lamellæ on upper side, $\times 15$. 7 = Leaf tip, $\times 65$. 8 = Cross section of leaf showing lamellæ, $\times 65$. 9 = Cross section of a few lamellæ showing usual form of marginal cells, $\times 250$. 10 = Cross section of a few lamellæ just above sheath, $\times 250$.

and distinctness of the hypophysis. However, all the specimens examined could at once be distinguished by the marginal cells of the lamellæ. Occasionally in *P. ohioense* they are somewhat depressed in the center approaching forms of *P. Commune* but the elongated capsule clearly separates it from the last. *P. ohioense* tends to have fewer lamellæ than *P. attenuatum*; of the specimens examined none of the former had over 45, while none of the latter had less than 45.

4. *Polytrichum inconstans* Hagen, in *Nyt. Mag. Naturvid.* 1900, p. 339.

Inconstans = inconstant; just how this applies to this species the writer does not know.

Plants 8 cm. or less. Stems rather uniformly leaved above, with a felt of dark red rhizoids below.

Leaves somewhat distant, irregularly spreading, 6 mm. long or less, lanceolate; lamina under lamellæ 2 cells thick, between lamellæ

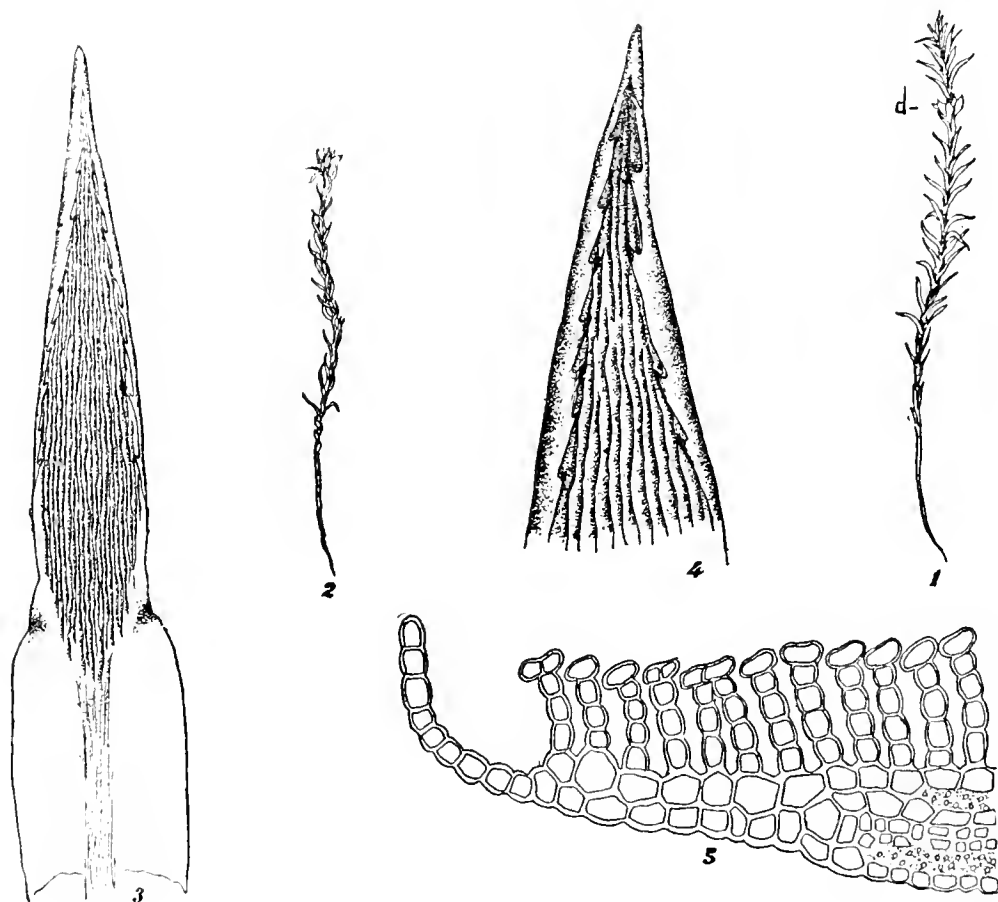


Fig. 21. *Polytrichum inconstans*.

1 = Moist antheridial plant; d = antheridial disk, $\times 1$. 2 = Dry plant, $\times 1$. 3 = Leaf showing lamellæ on upper side, $\times 15$. 4 = Leaf tip, $\times 65$. 5 = Cross section of part of leaf showing margin, height of lamellæ, and form of marginal cells. (No. 5 after Williams).

and margin 1 cell thick. Margins plane below, erect or somewhat incurved above, minutely serrulate. Lamellæ 2.4 or less, the median ones 5-9 cells high; marginal cells sometimes 2 side by side, not papillose, oblong, wider than long (about as 2 : 1), scarcely or not

grooved. Vein scarcely or shortly excurrent, the point smooth. Cells in limb between lamellæ and margin mostly .012 by .016 mm. to .016 by .020 mm.; cell walls on back of leaf not thickened. Otherwise unknown.—Lake Lindeman, Yukon region of British America; Norway; Iceland.

5. *Polytrichum commune* L., in Sp. Pl. II, p. 1109, (1753).

Commune = common. It is quite common in Europe where Linnæus found it.

Plants very tall, 5–45 cm. high, in large loose cushions, deep green tomentose at base; male plants shorter, with longer leaves, repeatedly proliferous from the center of the antheridial disk or cup. Stems simple, rarely forked, flexuose, wiry.

Upper leaves very long, squarrose or recurved when moist, erect and appressed when dry, with the apex flexuose, rather laxly arranged, very long, suddenly narrowed from an oblong sheathing base; limb lanceolate, gradually narrowing from its base upward to a sharp dentate acumen. Margin densely and sharply serrate to the base of the limb, very narrow, of about 1 row of small cells. Lamellæ about 60, low, thickened at the upper border and channelled, 4–6 cells high; marginal cells broader than the others, depressed in the center and bicuspidate in section. Cells of leaf-base and of margin similar to those of *P. attenuatum*. Perichæial leaves more distinct than in *P. attenuatum*, long-sheathing membranous, without lamellæ, ending in an arista formed by the excurrent vein.

Calyptra large, golden-brown, descending below the capsule.

Capsule at first erect, when ripe reddish-brown and horizontal, 4-angled, with the two lateral angles usually larger and more prominent than the upper and lower, slightly flattened, shortly rectangular or almost cubic; hypophysis discoid, very distinct, narrowly constricted above; surface cells each with a high conical papilla bearing a small narrowly-elliptical or slit-shaped pore at the apex. Lid with short rostellate beak. Pedicel 6–10 cm. long, stout.—On soil.—Between Cook Inlet and Tanana River, Kodiak Island, and Sitka, Alaska; Dawson and Lake Lindeman in Yukon region of British America; Washington; Oregon; Eastern United States and British America; Europe; Asia; Australia; South America.

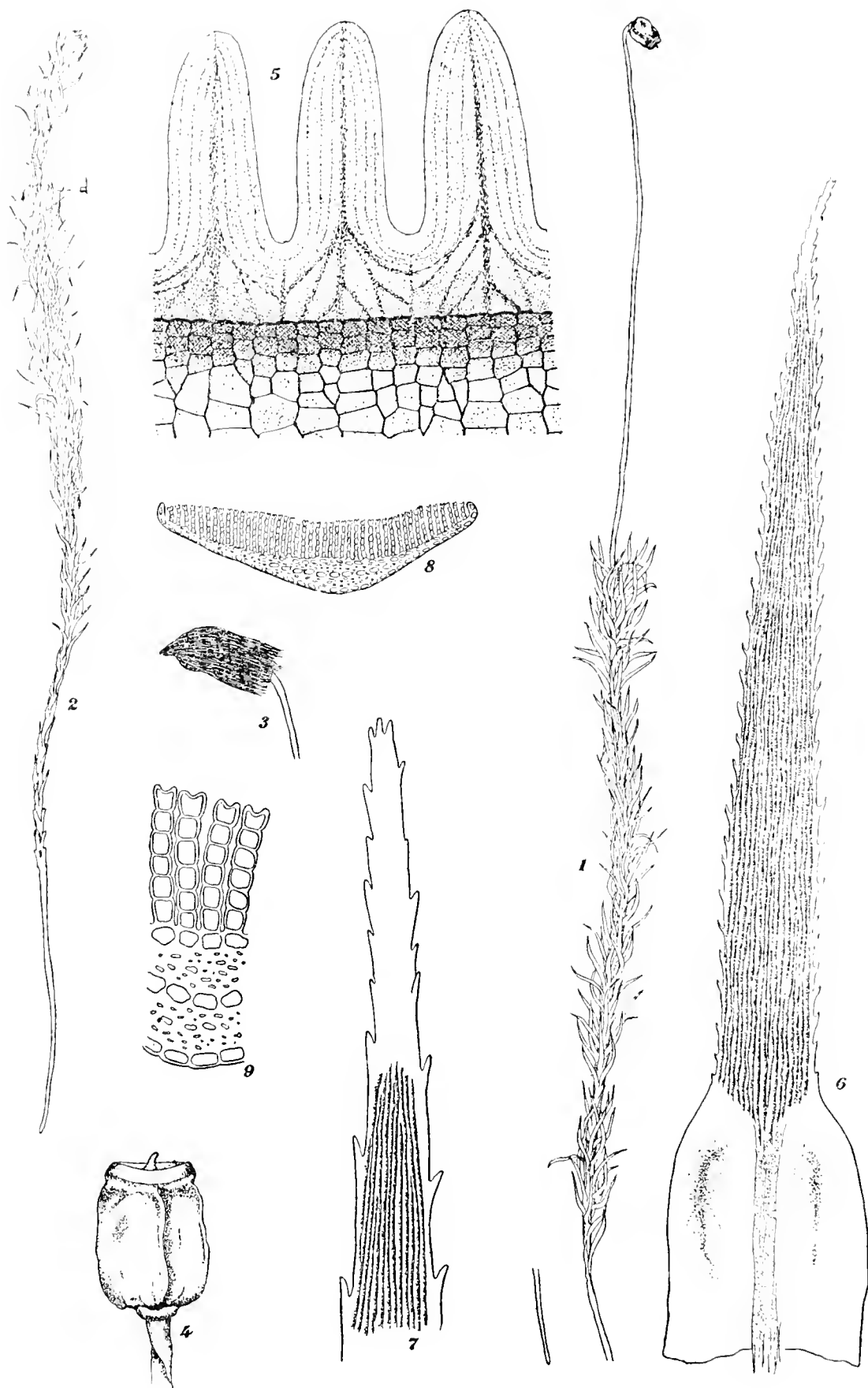


Fig. 22. Polytrichum commune.

1 = Moist plant with capsule, $\times 1$. 2 = Antheridial plant dry; d = antheridial disk, $\times 1$. 3 = Immature capsule with calyptra, $\times 5$. 4 = Capsule, $\times 5$. 5 = Peristome, $\times 150$. 6 = Leaf showing lamellae on upper side, $\times 15$. 7 = Leaf tip, $\times 65$. 8 = Cross section of leaf, $\times 65$. 9 = Cross section of a few lamellae showing notched marginal cells, $\times 250$.

COMPARISON OF VARIETIES WITH TYPE.

5. *P. commune*, typical.
1. Lamellæ 4-6 cells high.
 2. Leaves appressed when dry.
 3. Inner perichaetial leaves not exceeding the foliage leaves.
 4. Width of capsule to length about as 1:1¼-1½.
 5. Beak of lid slightly curved.
 6. Pores of papillæ of capsule wall from elliptical to slit-like.
- 5a. *P. commune* var. *uliginosum* Hueb., in Muscol. Germ. p. 535 (1833).
1. Lamellæ 4-6 cells high.
 2. Leaves spreading-recurved when dry.
 3. Inner perichaetial leaves not exceeding the foliage leaves.
 4. Width of capsule to length about as 1:1½-1¾.
 5. Beak of lid slightly curved.
 6. Pores of papillæ of capsule wall from almost rounded to slit-like.

On soil.—White Mountains, New Hampshire; Washington.

- 5b. *P. commune* var. *perigoniale*²⁵ (Michx.) B. & S., in Bryol. Eur. fasc. 21-24, iv, 1844.

1. Lamellæ 6-9 cells high.
2. Leaves appressed when dry.
3. Inner perichaetial leaves very long, exceeding the foliage leaves.
4. Width of capsule to length about as 1:1¼-1½.
5. Beak of lid straight.
6. Pores of papillæ of capsule from rounded to slit-like.

On soil.—McLeod Lake, British Columbia; Pass Creek, near Sproat, British Columbia; Ontario; Europe; Australia.

- 5c. *P. commune* var. *minus*²⁶ Weis, in Pl. Crypt. Goett. p. 171 (1770).

P. commune var. *canadense*²⁷ Kindb., in Mac. Cat. p. 156 (1892).

1. Leaves 6-9 cells high.
2. Leaves appressed when dry.
3. Inner perichaetial leaves not exceeding the foliage leaves.
4. Width of capsule to length about as 1:1-1¼.
5. Beak of lid slightly curved.
6. Pores of papillæ of capsule wall from elliptical to slit-like.

²⁵ Peri = around, gone = female plant organ; referring to the perichaetial leaves which are very long in this species.

²⁶ Minus = small. This is one of the smaller varieties of the species.

²⁷ The var. *minus* does not seem to differ from the var. *canadense* by any well defined characteristics.

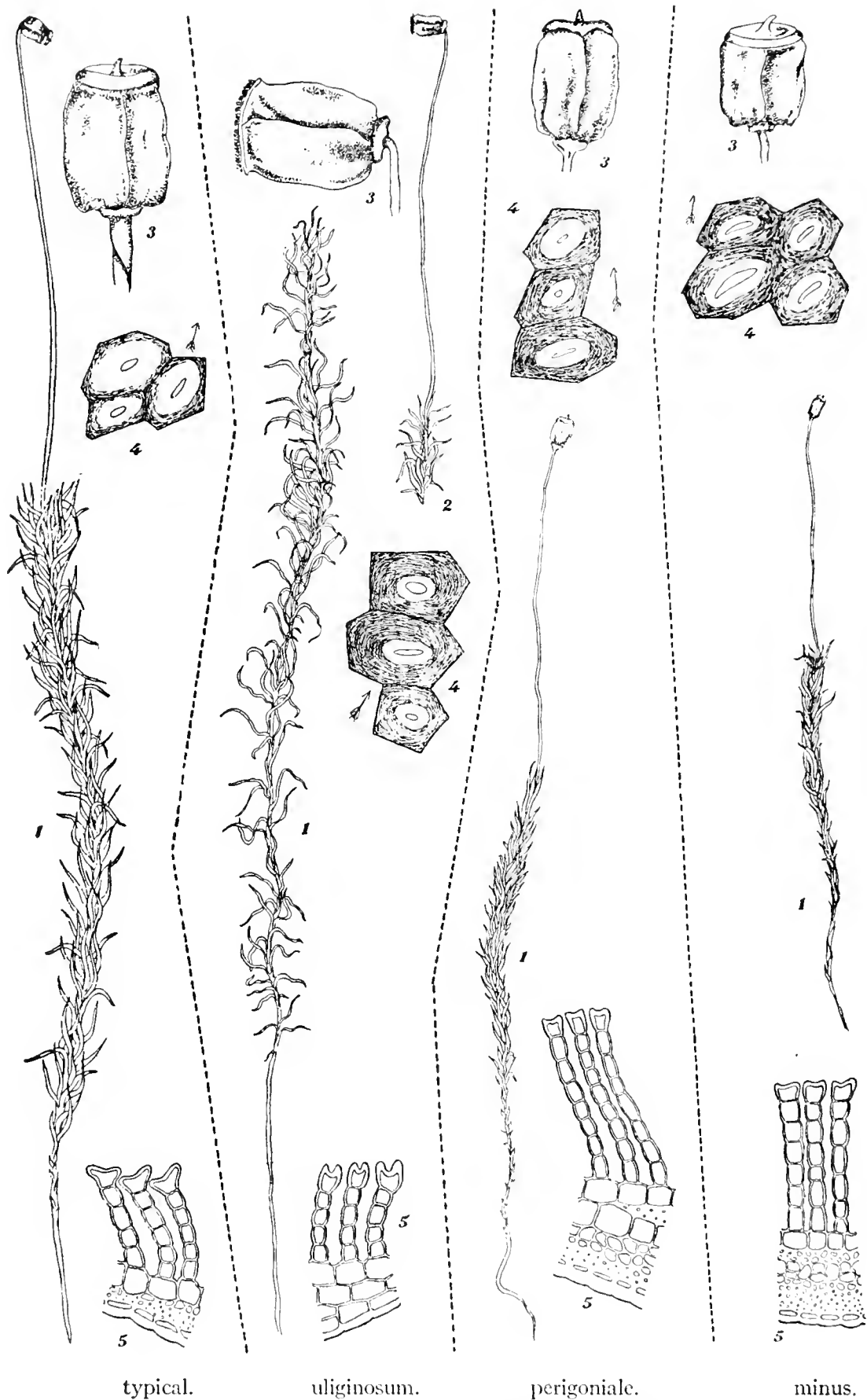


Fig. 23. *Polytrichum commune* and varieties.

1 = Dry plants, $\times 1$. (The typical plant often has more erect leaves.) **2** = Tip of plant showing perichaetial leaves and capsule, $\times 1$. **3** = Capsules, $\times 5$. **4** = Pores from surface of capsule; the arrows point up in capsule, $\times 365$. **5** = Cross sections of a few lamellae showing their height, and depth of notching of apical cell, $\times 250$.

On soil.—Unalaska, Alaska; Lake Lindeman and Dawson, Yukon; Albert Cañon, Selkirk Mountain, British Columbia; eastern British America; England.

6. *Polytrichum jensenii* Hag., in Saretryk Middel. om Groenl. 15, p. 444, (1898).

Polytrichum fragilifolium Lindb. fil., in Proc. Soc. pro Fauna et Fl. Fenn., Oct. 1900.

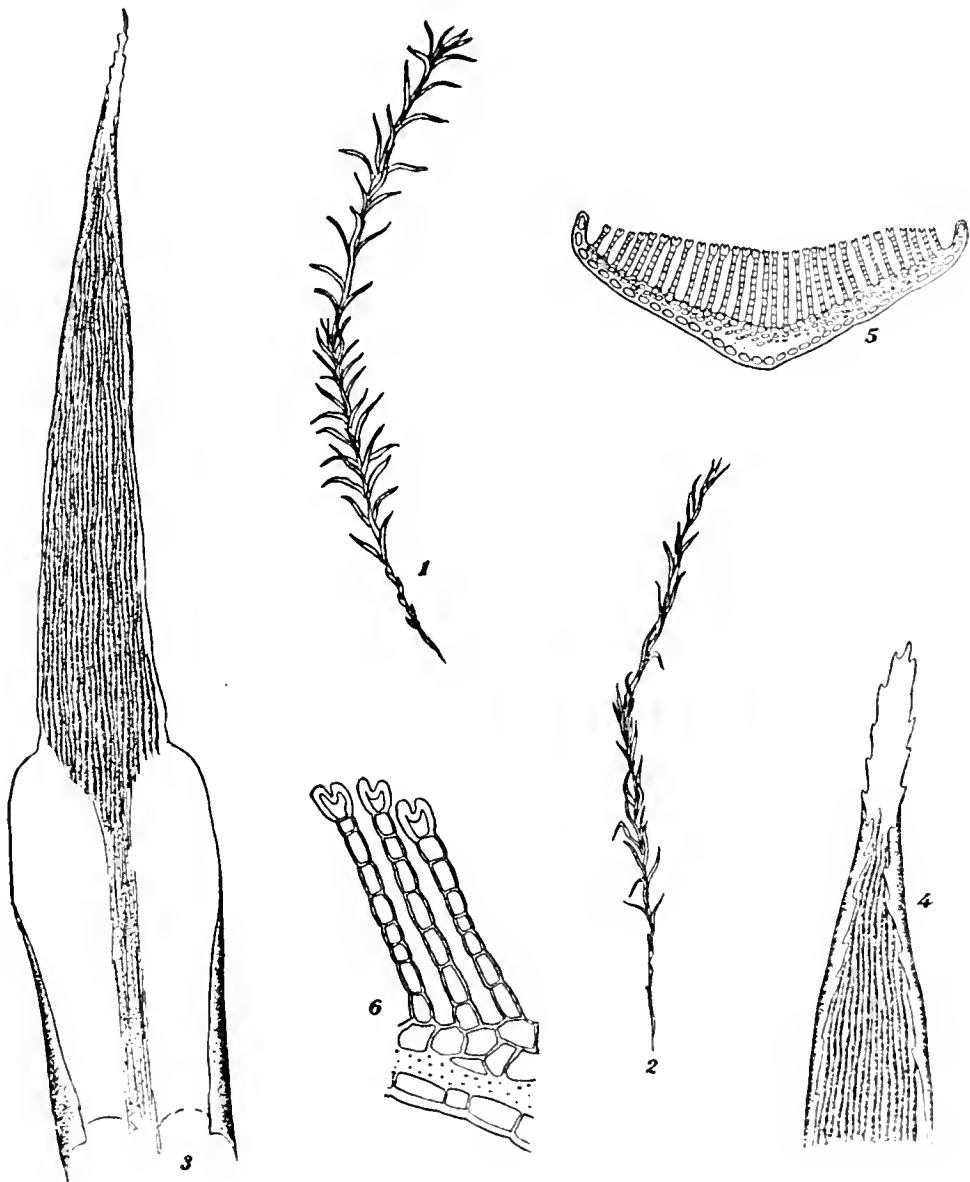


Fig. 24. *Polytrichum jensenii*.

1 = Moist plant, $\times 1$. 2 = Dry plant, $\times 1$. 3 = Leaf showing lamellæ and margin, $\times 15$. 4 = Leaf tip, $\times 65$. 5 = Cross section of leaf showing lamellæ, $\times 65$. 6 = Cross section of a few lamellæ, $\times 250$.

Proc. Wash. Acad. Sci., August, 1910.

Named after Jensen.²⁸

Plants lighter in color than *P. commune*. Stem 3–5 cm. high.

Leaves about 8 mm. long, somewhat spreading when moist, but erect when dry, sheath to blade about as 1 : 2; apex blunter than in *P. commune*, dentate; a brown spot where sheath joins blade near vein. Margin plane below, erect or slightly incurved above, entire below, somewhat serrate in the upper half. Lamellæ 30–35, 6–8 cells high; marginal cells notched in cross section, smooth, thickened.

Capsule 4-angled, width to length about as 1 : 1¼, smooth, porose. Teeth 64. Lid conic, with a short slightly crooked beak.²⁹— In Sphagnum bogs and on soil.—Nome, Alaska; Yellowstone National Park, Wyoming; Greenland; northern Europe.

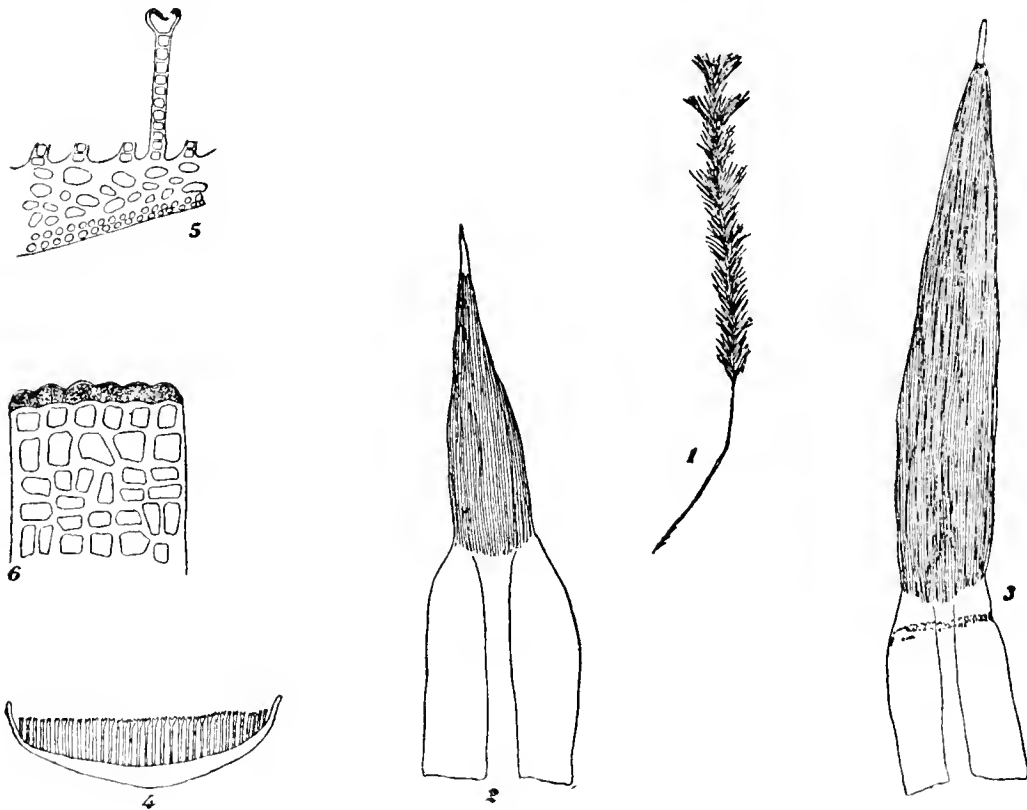


Fig. 25. *Polytrichum yukonense*.

1 = Plant, $\times 1$. 2 and 3 = Leaves, showing lamellæ on upper side, $\times 13$. 4 = Cross section of leaf, $\times 34$. 5 = Cross section of a lamella, showing notched marginal cell, $\times 135$. 6 = Portion of a lamella as seen from side showing irregularity of cell form and arrangement, $\times 270$. (After Cardot & Thériot.)

²⁸ C. O. E. Jensen is a Danish apothecary at Kirke Hvalsø, Denmark.

²⁹ This is not a description of the plant, but a noting of some of the characters from specimens and verification of points from Asa Gray Bulletin and from Bryologist, 4; p. 26. Literature containing Hagen's description was inaccessible to the writer.

7. *Polytrichum yukonense* C. & Thér. in Proc. Wash. Acad. Sci. 4: 329 (1902).

Named after its locality, the Yukon river in Alaska.

Plants 5-8 cm. high. Stems simple or nearly so, rather naked below, base covered with white tomentum.

Leaves rigid, when dry suberect, when damp erecto-patent, 4-6 mm. long, 1 mm. broad, shortly linear-acuminate from an appressed yellowish sheath. Margin erect, entire. Lamellæ about 30, margins crenulate, 8-12 cells high. Vein excurrent as an opaque red entire arista; marginal cells higher than the others, deeply grooved. Otherwise unknown.—Yukon River, Alaska.

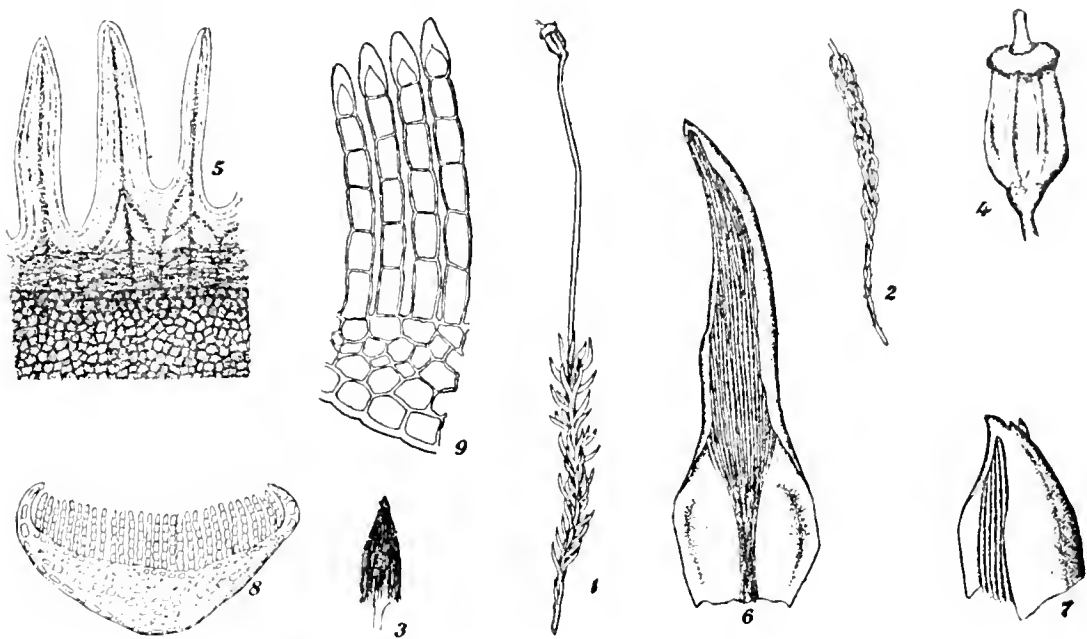


Fig. 26. *Polytrichum sexangulare*.

1 = Moist plant, $\times 1$. 2 = Dry plant, $\times 1$. 3 = Capsule with calyptra, immature, $\times 5$. 4 = Capsule, $\times 5$. 5 = Peristome, $\times 150$. 6 = Leaf showing lamellæ on upper surface, $\times 15$. 7 = Leaf tip, showing teeth at back, and involute margins making it cucullate, $\times 65$. 8 = Cross section of leaf showing lamellæ, $\times 65$. 9 = Cross section of a few lamellæ, $\times 250$. (Nos. 6 and 7 after Dixon and Jameson.)

8. *Polytrichum sexangulare* Floerke, in Hoppe Bot. Taschenb. 1799. p. 126.

Name derived from sex = six, and angularis = angled; referring to the 6-angled capsule.

Plants 2.5-10 cm. high, in tufts or loose patches. Stems erect or decumbent, simple or slightly divided, rigid, not tomentose at base.

Leaves short, rather obtuse, linear-lanceolate from a broad sheathing base, patent when moist, lower ones glossy and dark colored; dry leaves closely imbricate, rigid, curved at apex. Margin entire, incurved from near base of limb, at apex cucullate, blunt. Lamellæ 30-50, 4-6 cells high; marginal cells larger than the others, ovate-conical, smooth.

Calyptra not covering the whole of the capsule.

Capsule erect or inclined, oval, with 6 obtuse angles, reddish brown; length to width about as 1 : 1½; hypophysis obconic, not constricted above. Teeth short, unequal. Lid with rather thick beak. Pedicel 1.3-4 cm. long, short, rather thick.—On soil and rocks.—Rocky Mountain region of British Columbia; Mt. Rainier, Washington; Mt. Hood, Oregon; Greenland; Europe; Kamchatka Peninsula; Herald Island, northwest of Bering Strait.

9. *Polytrichum juniperinum* Willd., in Fl. Berol. Prodr. p. 305. (1787).

So named because its leaves resemble those of the juniper.

Plants scattered, 2-10 cm. high, glaucous green; male plants more slender, with short leaves. Stems rarely branched, sometimes slightly tomentose at base.

Leaves less crowded at top of stem than in *P. piliferum*, spreading when moist, erect when dry, long, lanceolate from an oblong base. Margin incurved but not so nearly meeting as in *P. piliferum*, entire. Lamellæ 35-40, 4-7 cells high; marginal cells longer than wide, ovate or flask-shaped, smooth. Vein excurrent in a red dentate sometimes slightly hyaline arista which is ½-1½ mm. long, strongly toothed at back of apex, and often half way down. Perichætial leaves longer than foliage leaves, with longer arista, white and membranous at edges.

Calyptra covering capsules.

Capsule larger than in *P. piliferum*, sharply 4-angled, oblong; hypophysis short, less distinct than in *P. piliferum*. Lid deep red, beak short. Pedicel 4-6 cm. long, shining, bright red.—On soil.—From Kotzebue Sound north of Bering Sea along the coast to California; Rocky Mountains; eastern North America; Greenland. Our most common moss in this family.

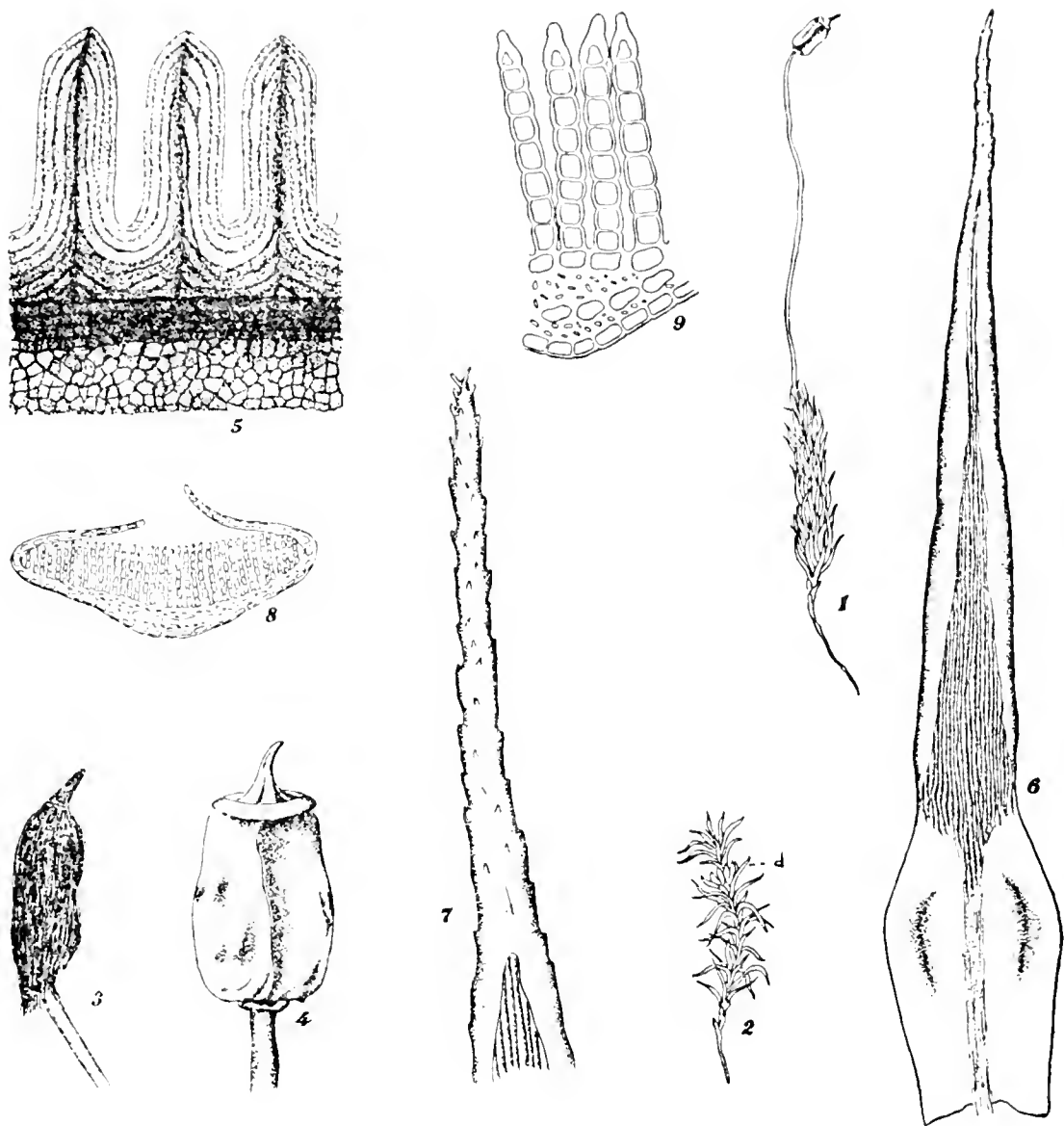


Fig. 27. *Polytrichum juniperinum*.

1 = Dry plant with capsule, $\times 1$. 2 = Moist antheridial plant; **d** = antheridial disk, $\times 1$. 3 = Immature capsule with calyptra, $\times 5$. 4 = Capsule, $\times 5$. 5 = Peristome, $\times 150$. 6 = Leaf showing incurved margin and lamellae on upper side, $\times 15$. 7 = Leaf tip, $\times 65$. 8 = Cross section of leaf, $\times 65$. 9 = Cross section of a few lamellae showing smooth flask-shaped marginal cells, $\times 250$.

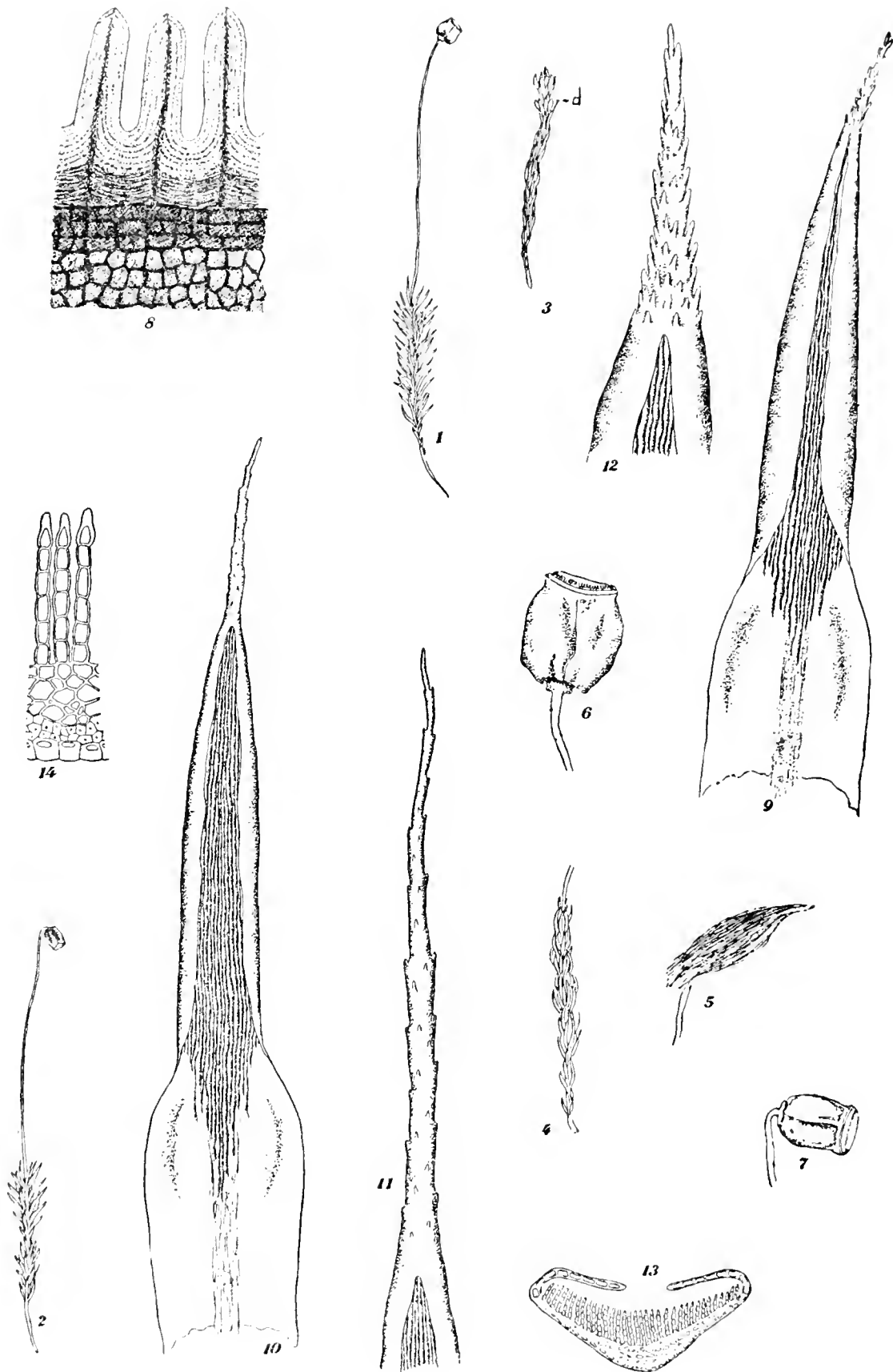


Fig. 28. *Polytrichum strictum*.

1 and 2 = Moist plants with capsules, $\times 1$. 3 = Dry antheridial plant, $\times 1$. 4 = Dry archegonial plant, $\times 1$. 5 = Immature capsule with calyptra, $\times 5$. 6 and 7 = Capsules, $\times 5$. 8 = Peristome, $\times 150$. 9 and 10 = Leaves showing lamellæ on upper side, $\times 15$. 11 and 12 = Leaf tips, $\times 65$. 13 = Cross section of leaf, $\times 65$. 14 = Cross section of a few lamellæ showing flask-shaped marginal cells, $\times 250$.

10. *Polytrichum strictum* Banks, in MSS.

Polytrichum behringianum Kindb.,³⁰ in Rev. Bryol. 1894, p. 39.

Strictum = drawn tightly; probably referring to the closely appressed leaves in the dry plant.

Plants 6–20 cm. tall, densely tufted, rigid, almost terete when dry with its closely appressed leaves. Stems more slender than in *P. juniperinum*, usually covered for the greater part of its length with dirty-white tomentum, slightly branched.

Leaves erect-patent, shorter and narrower than in *P. juniperinum*, straight, closely and regularly imbricated when dry. Margin incurved, entire. Lamellæ 25–35, 4–7 cells high; marginal cells longer than wide, ovate or flask-shaped, smooth. Vein excurrent in a red dentate arista.

Calyptra covering the capsule.

Capsule sharply 4-angled, cubic or very little longer than wide; hypophysis short. Pedicel 4–6 cm. long.—On soil.—From Kotzebue Sound north of Bering Strait southward along the coast to British Columbia; Cascade and Rocky Mountains of British Columbia; northeastern North America; Greenland; Europe; Asia; Argentine Republic.

11. *Polytrichum hyperboreum* R. Br., in Parry, Voy. Suppl. p. 294, (1824).

Polytrichum boreale Kindb., in Laubm. Schwed. U. Norw. (1883).

Name derived from hyper = beyond, and boreas = the north wind; referring to its arctic habitat.

Plants dioicous, 3–12 cm. high. Stems simple or branched, branches in tufts.

Leaves spreading when moist, appressed when dry. Margin broad, incurved, entire. Lamellæ more or less crenulate, 5–7 cells high, 25–35; marginal cells ovate or flask-shaped, higher than wide, smooth, larger than the others. Vein excurrent in a very thick, short, hyaline, slightly serrate arista.

Capsule erect or inclined, sharply 4-angled, papillose, about $1\frac{1}{4}$ times as long as wide; hypophysis flattened, deeply constricted from

³⁰ A comparison of authentic *Polytrichum behringianum* with *Polytrichum strictum* shows them to be the same.

the capsule. Lid hemispheric, with short beak. Pedicel 8-12 cm. long.—St. Paul Island, Bering Sea; Lake Lindeman, Yukon, British America; Labrador; Greenland; northern Europe and the Alps; Siberia.

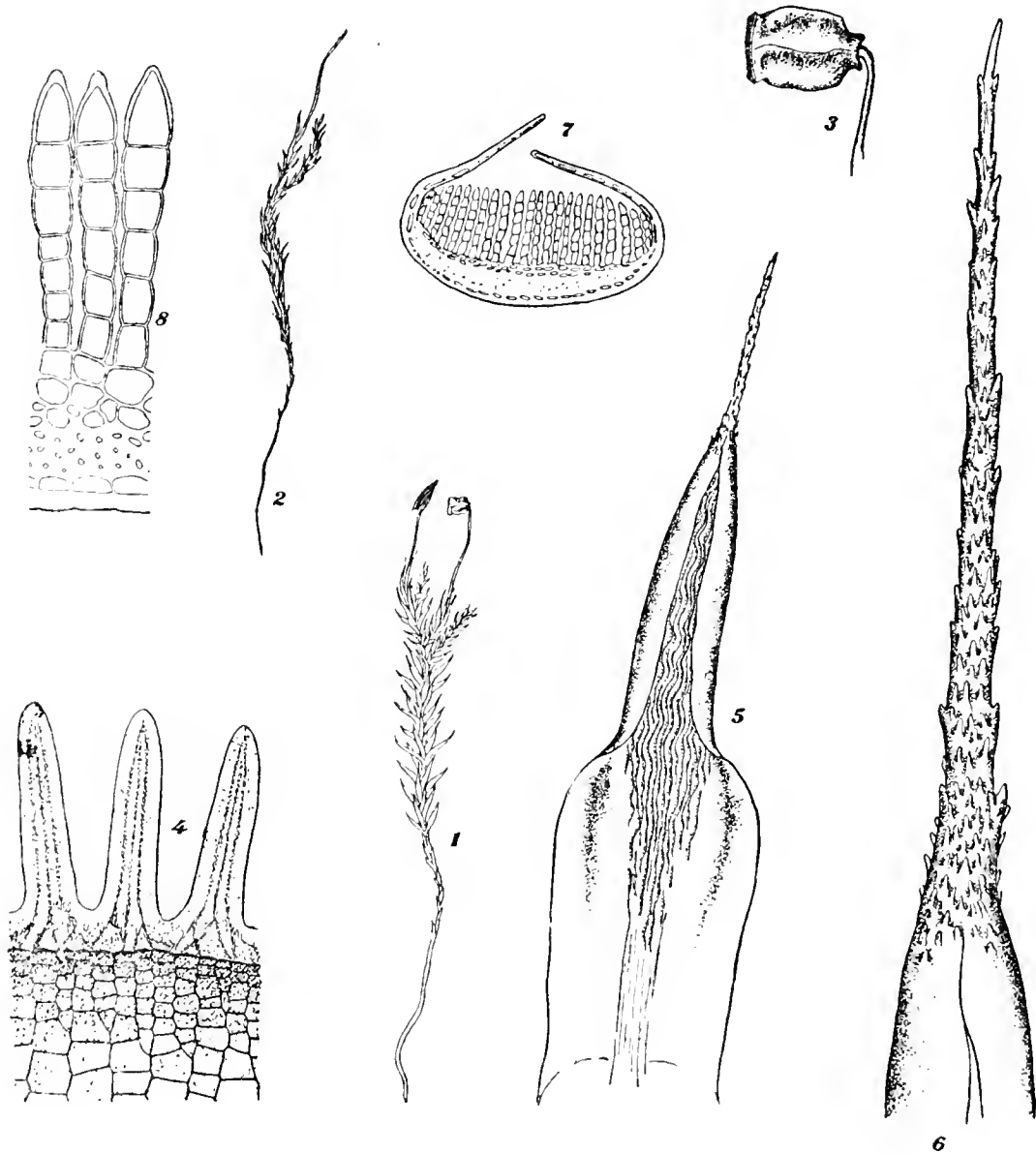


Fig. 29. *Polytrichum hyperboreum*.

1 = Moist plant, $\times 1$. 2 = Dry plant, $\times 1$. 3 = Capsule, $\times 5$. 4 = Peristome, $\times 150$. 5 = Leaf showing lamellæ and involute margin, $\times 15$. 6 = Leaf tip, $\times 65$. 7 = Cross section of leaf, $\times 65$. 8 = Cross section of a few lamellæ.

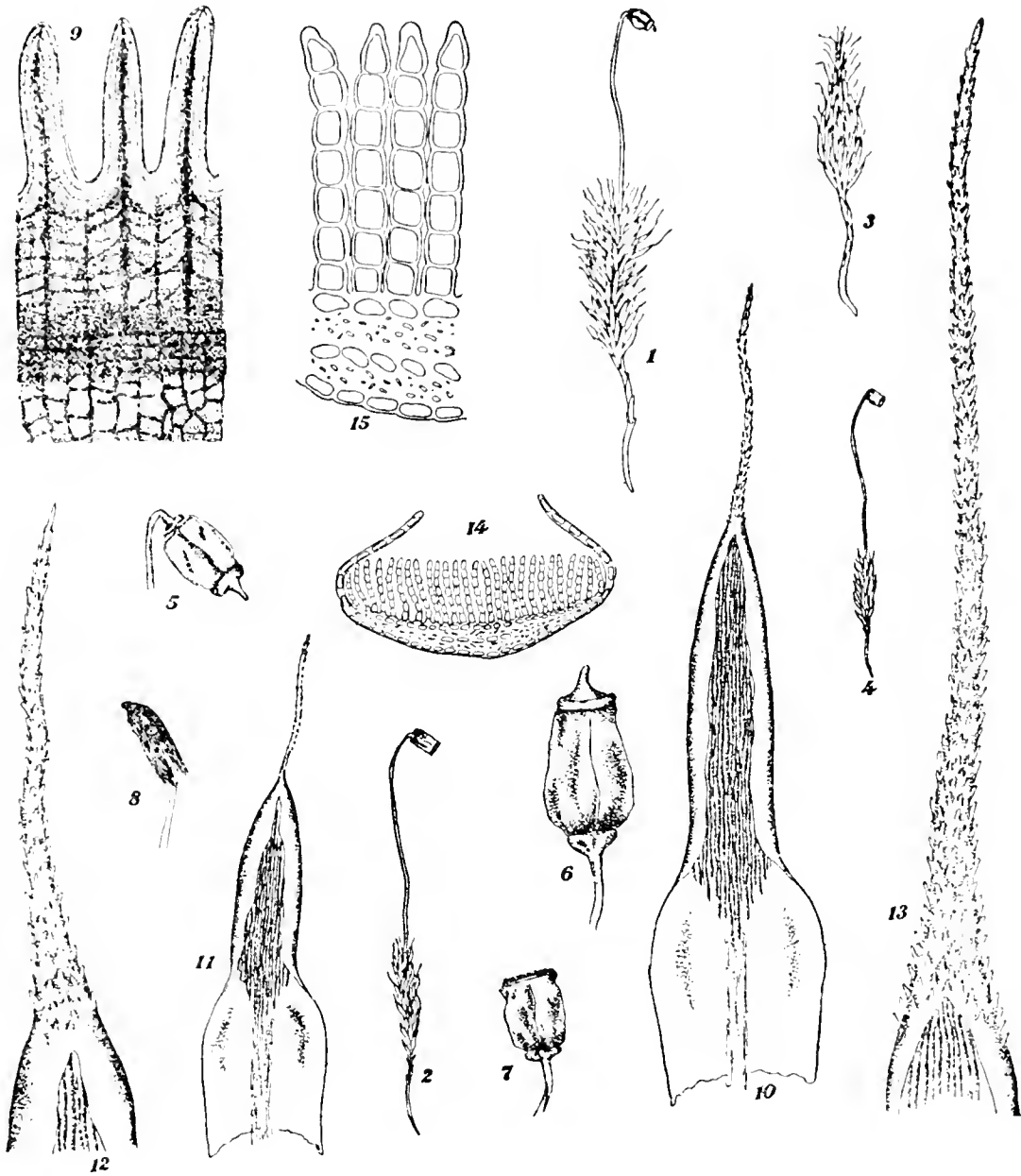


Fig. 30. *Polytrichum piliferum*.

1 = Moist plant with capsule, $\times 1$. 2, 3 and 4 = Dry plants, $\times 1$. 5, 6 and 7 = Capsules, $\times 5$. 8 = Capsule with calyptra, immature, $\times 5$. 9 = Peristome, $\times 150$. 10 and 11 = Leaves showing involute margin and lamellæ on upper side, $\times 15$. 12 and 13 = Leaf tips, $\times 65$. 14 = Cross section of leaf, $\times 65$. 15 = Cross section of a few lamellæ showing flask-shaped, somewhat thickened cells, $\times 250$.

- 12. *Polytrichum piliferum*** Schreb., in Spic. fl. Lips. p. 74, (1771).
Polytrichum pilosum Neck., in Meth, M. p. 123, (1771).
Polytrichum laevipilum Hampe, in Linn. 1859. p, 459.
Polytrichum piliferum var. *hoppei* Rab.³¹ in Deutsch. Kryptfl. II, P. III, p. 238 (1848).

Name derived from pilus = hair, and ferre = to bear; referring to the long hyaline arista at the tip of the leaf.

Plants in loose tufts, glaucous green, 2.5-4 cm. high. Stems erect, simple, rarely forked, naked at base.

Leaves when dry closely appressed and straight forming a narrow ovoid or clavate head, leaf-base longer and narrower than in *P. sexangulare*, limb narrowly lanceolate, apex below arista minutely scabrous; leaves of antheridial plants shorter and more shortly aristate. Margins broadly inflexed and almost meeting, entire, of very narrow transversely elliptical cells. Lamellæ about 30, 4-7 cells high; marginal cell larger than the others, ovate or flask-shaped, not papillose. Vein reddish, at apex suddenly becoming hyaline, excurrent as a long denticulate hyaline arista, smooth at back. Perichætil leaves longer than the foliage leaves; inner ones thin, whitish, without lamellæ, longly aristate.

Calyptra covering the capsule.

Capsule erect, small, inclined when dry, shortly oblong, with 4 sharp angles and occasionally a fainter intermediate one; hypophysis indistinct, short, constricted above where it joins the capsule. Lid red or orange, shortly and stoutly beaked. Pedicel 2.5-4 cm. long.—On rocks and soil.—Lake Lindeman, Yukon, British America; Vancouver Island and eastward in British Columbia to the Rocky Mountains; Washington; California; Uinta Mountains, Utah; eastern British America; Greenland; Europe; Asia; South America.

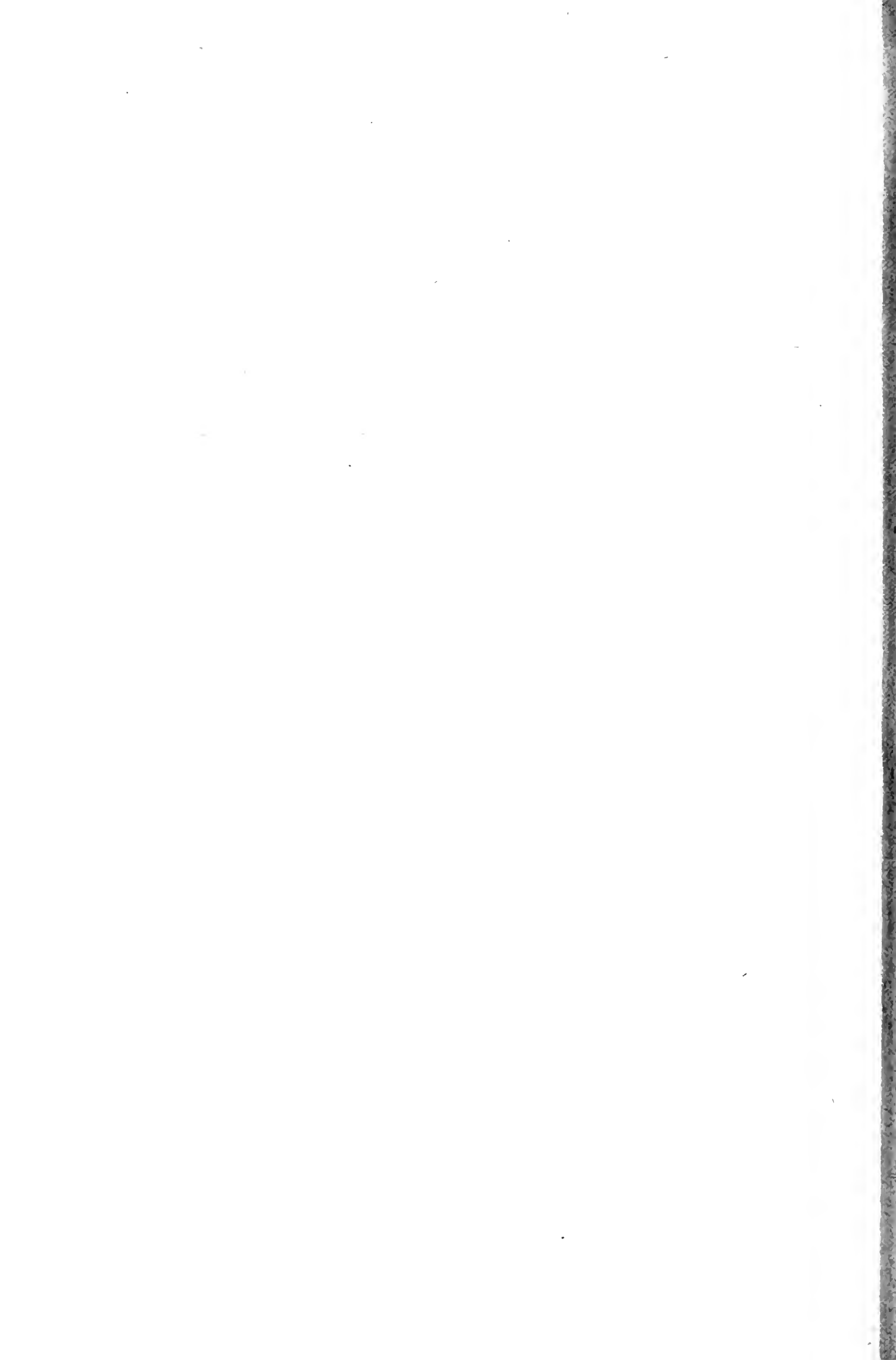
³¹ The distinctions between *P. piliferum* and its variety *hoppei* do not seem to warrant a variety. For example, in Fig. 30, Nos. 1, 2, 5, and 12, from the same plant, are variety *hoppei* in leaf tips, plant form and capsule; but the nodding capsule does not agree. Nos. 4, 6, and 13, from another package are variety *hoppei* in form of capsule and possibly in leaf arrangement, but hardly in leaf tips; also disagreeing in that many of the capsules in this material not shown are nodding. No. 7 is not variety *hoppei* in form, but the leaves in this plant were very long awned. The length of the awn does not vary constantly with the form of the capsule nor with the length of the leaf. It is believed therefore that variety *hoppei* is *P. piliferum* prematurely dried or growing under very adverse conditions, and varying sometimes in capsule, sometimes in leaf.

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