

In the diploid collections, which are self-sterile, meiosis is usually regular, with nine bivalents at metaphase I, and pollen quality is high. In four polyploids, meiosis is irregular with univalent formation up to complete asynapsis, chromatin bridges, and the occurrence of only one meiotic division in microsporogenesis. These polyploids were found to be apomictic. Characteristically they form unreduced pollen through failure of synapsis and may be detected by their poor pollen quality and ability to set seed without cross pollination. Removal of stamens and styles from florets at an early stage did not prevent production of viable seeds. The pollen grains of the polyploids are distinctly larger than those of the diploids.

Hybrid seeds were obtained from cross pollination of several diploid, self-sterile species. One hybrid plant, *T. arizonica* \times *T. florifer*, and one plant of the reciprocal were grown to maturity. Chromosome pairing was found as regular in the hybrids as in the parents, but hybrid pollen quality was low.

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BRYOPHYTA OF SANTA CATALINA ISLAND, CALIFORNIA

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Like most insular floras, that of Santa Catalina Island has attracted a large amount of botanical attention which, of course, has been stimulated by the high degree of endemism there. The comprehensive survey of the flora by Millspaugh and Nuttall (1923) covers all groups of plants, including the Bryophyta, and reviews the older literature. A more recent paper by Sayre (1940) lists the mosses collected by T. D. A. Cockerell (1938) on Santa Catalina Island, as well as on other islands off the coast of California. Some of the records cited by Millspaugh and Nuttall, as well as new collections, are included in the standard manuals of American mosses and hepatics (Grout, 1928-1940; Frye and Clark, 1937-1948) and by Koch (1950) in his check-list of the mosses of the state of California. In these several works we find eight species of Hepaticae and approximately thirty species of Musci reported definitely from Santa Catalina Island.

During the annual field meeting held jointly by the California Botani-

cal Society and the Southern California Botanists, the present author had the opportunity to visit Santa Catalina Island, May 1-3, 1953, and to collect bryophytes intensively in the vicinity of White's Landing, some five miles north of Avalon. Excellent habitats for mosses and hepatics occur on the rocky headland at the Landing, in the open, pastured valley behind it, and especially in the deep, precipitous, shaded canyons opening into the valley. About sixty species of bryophytes were brought back from this relatively small area, thereby nearly doubling the previously known bryophytic flora of the island. Of the eight species of Hepaticae reported by Millspaugh and Nuttall (1923), five were recollected, and five more can now be added as new to the island. Ten of the some thirty species of Musci reported from the island by various authors were not found again in the limited area studied, but twenty-eight other species not previously known were discovered. Since our knowledge of the bryophytes of Santa Catalina Island has been extended rather considerably through the activities of the California Botanical Society, it would seem appropriate to submit here a brief review of the previous reports and a list of the 1953 collections.

The discovery of nearly sixty species of bryophytes in a relatively small part of a large island in so short a time indicates that a careful survey of the whole island during a more favorable season would be very rewarding, and that the bryophyte flora must be much richer than realized formerly. Furthermore, there is a strong possibility that endemic species will be found. The first week in May was obviously too late in the season for the collection of bryophytes, in their best condition either in terms of morphology or of visibility. Because of the long drought, the plants in exposed habitats were completely dried out, very inconspicuous, and many of them had died. February, March, and even April would undoubtedly be better months for field studies of bryophytes, since at that season the sporophytes would be mature, yet many ephemeral species that disappear later might still be in evidence. Nevertheless, the 1953 collections not only increased substantially the known bryophyte flora of Santa Catalina Island but also resulted in the first records for California of two species, one of which is a Mexican *Riccia* previously unknown in the United States. Several of the species are so rare that the present material represents the first or second rediscovery since the original collection upon which the species was based. In their geographical distribution in California, the species fall into several categories. The largest floristic group consists of widely distributed, sometimes almost weedy species of drier habitats. More interesting elements are the species of very restricted distribution in the mountains of southern California, and those otherwise known only as far south as Marin or Monterey counties that now appear to have a very disjunct distribution in the state. Extensive collection of bryophytes on Santa Catalina Island is almost certain to result in the discovery of endemic species, and of a close correlation between the types of distribution of bryophytes and of flowering plants.

The following list contains all Bryophyta known definitely to occur on Santa Catalina Island. With few exceptions the names follow the most recent manuals (Grout, 1928–1940; Frye and Clark, 1937–1940). Species new to the flora of the island are indicated with an asterisk (*). The specimens upon which this report is based are deposited in the Dudley Herbarium of Stanford University.

HEPATICAЕ

PORELLACEAE

**PORELLA BOLANDERI* (Aust.) Pears. On shaded rock-face above stream in deep canyon. This collection appears to represent the southernmost locality known for the species.

FRULLANIACEAE

FRULLANIA CATALINAE Evans. Not uncommon on shaded rock-faces and on the trunks of trees in canyons, at higher altitudes; with abundant perianths. This species, described by Evans (1897) from material collected Sept. 8, 1893, "on rocks in a cañon," does not seem to have been found subsequently until recollected in 1953. Recently, it has been reduced to the status of a synonym of *F. inflata* Gottsche (Clark and Svihla, 1944; Frye and Clark, 1947). On the basis of the present observations, however, *F. catalinae* appears to be adequately distinctive, even in the field, especially because of its conspicuously squarrose leaves, one of the characteristics emphasized by Evans.

FOSSOMBRONIACEAE

**FOSSOMBRONIA HISPIDISSIMA* Steph. On shaded soil, rocky headland near shore; with sporophytes. The gametophytes of this hepatic die after the onset of the dry season and become conspicuously white. The setae in these specimens had not elongated at all and the capsules remained wrapped in the pseudoperianth and the apical leaves of the plant; the spores could escape only through the wearing away of the dead leaves and the dehiscence of the capsule wall. Perhaps in unusually rainy or foggy years the seta elongates in a normal fashion. However, it is interesting that this usually mesophytic hepatic can adjust itself successfully to reproduction under xeric conditions.

FOSSOMBRONIA LONGISETA Aust. This species, not recollected in 1953, was reported by Millspaugh and Nuttall, but their report may really represent the preceding species, already the source of some confusion (Evans, 1923).

REBOULIACEAE

ASTERELLA CALIFORNICA (Hampe) Underw. This species is relatively abundant on shaded soil and rocks in many places investigated; with archegoniophores and spores. Reported by Millspaugh and Nuttall.

ASTERELLA PALMERI (Aust.) Underw. Reported from Cottonwood

Canyon by Millspaugh and Nuttall, but not found in the vicinity of White's Landing in 1953.

TARGIONIACEAE

TARGIONIA HYPOPHYLLA L. Found in all parts of the area studied, usually on steep shaded banks; with involucre. A common hepatic, widely distributed through the drier and warmer parts of the world; reported by Millspaugh and Nuttall.

RICCIACEAE

RICCIA CRYSTALLINA L. (*R. catalinae* Underw.). Reported by Millspaugh and Nuttall on the basis of *R. catalinae*, whose original description gives no details of locality; not found in 1953.

**RICCIA NIGRELLA* DC. The most common and abundant species on exposed soil on the headland at White's Landing; easily recognized in the field by the glossy, purple-black scales that become especially conspicuous as the plants dry out; identification confirmed by Dr. Ronald L. McGregor.

**RICCIA SOROCARPA* Bisch. In very small quantity on exposed soil, rocky headland at White's Landing; identified by Dr. Ronald L. McGregor.

RICCIA TRICHOCARPA Howe. Kingman's collection of this hepatic at Avalon was reported by himself (1911) and by Millspaugh and Nuttall. Abundant on the rocky headland at White's Landing, it becomes conspicuous from the long white hairs that clothe the margins of the plants as well as the upper surface of the thallus over the sunken sporophytes.

**RICCIA VIOLACEA* Howe. Found only in small quantity on the rocky headland at White's Landing, on exposed soil. This essentially tropical species (cf. Howe, 1923), not reported earlier from the United States, is not included in "The Hepaticae of North America" (Frye and Clark, 1937-1948). It was recognized, however, because of some collections made the preceding year in Baja California, Mexico: on the mainland in a deep arroyo several miles south of Puerto de Bahía de los Muertos (Steere 17562, April 2, 1952) and on Cerralbo Island, in the Gulf of California, in a large arroyo on the west side (Steere 17563, 17567, April 4, 1952). Dr. Ronald L. McGregor very kindly identified the Mexican collections and confirmed the present one.

ANTHOCEROTACEAE

ANTHOCEROS PEARSONI Howe. Reported without locality data by Kingman (1911) and by Millspaugh and Nuttall. Small fragments of some species of *Anthoceros*, collected on the steep bank of a deep canyon in 1953, were inadequate for identification.

MUSCI

FISSIDENTACEAE

FISSIDENS LIMBATUS Sull. Very common and abundant in moist shaded

habitats from sea level upwards; with sporophytes. Previously reported by Millspaugh and Nuttall.

DITRICHACEAE

CERATODON PURPUREUS (Hedw.) Brid. On soil over rock, steep bank; with sporophytes. A cosmopolitan weed whose absence from the island would be more noticeable than its presence; reported by Sayre.

DICRANACEAE

ANISOTHECIUM VARIUM (Hedw.) Mitt. Not uncommon on moist silt banks near small stream in deep canyon; with sporophytes. Reported (as *Dicranella varia*) by Millspaugh and Nuttall.

ENCALYPTACEAE

*ENCALYPTA VULGARIS Hedw. var. MUTICA Brid. This moss, common and widely distributed elsewhere in California, was collected in small quantity and in sterile condition on moist silt near the stream in a deep canyon.

POTTIACEAE

ALOINA AMBIGUA (BSG). Limpr. Abundant on rather exposed silt banks in deep canyon; with sporophytes. Previously reported from the same area by Millspaugh and Nuttall.

*ALOINA RIGIDA (Hedw.) Kindb. var. PILIFERA (BSG.) Limpr. On exposed soil, summit of rocky headland at White's Landing; rather abundant and with sporophytes.

*ANOECTANGIUM OBTUSIFOLIUM (Broth. & Paris) Grout. On vertical silt bank near small stream, upper reaches of canyon at perhaps 1000 feet altitude; sterile. This species is new not only to Santa Catalina Island but also to California. Its previously known geographical range comprises Texas, Arizona, and Mexico.

*BARBULA BRACHYPHYLLA Sull. On soil, steep bank in deep canyon; with sporophytes. This is a Californian species of restricted distribution.

*BARBULA CONVOLUTA Hedw. On moist soil near water, in deep shaded canyon; one small collection without sporophytes.

BARBULA CYLINDRICA (Tayl.) Tayl. On moist soil, steep bank in canyon; not rare but less abundant than the following species; with sporophytes. Reported (as *B. subfallax*) by Millspaugh and Nuttall.

BARBULA VINEALIS Brid. A common and almost weedy species in all the places visited (and in most of California); with sporophytes in several stages of development. Reported by Millspaugh and Nuttall from a Kingman collection, without locality. Probably most of the collections of *B. artocarpa* reported by the same authors belong here (Steere, 1939), although some of the collections may possibly represent *B. brachyphylla*.

DESMATODON CONVOLUTUS (Brid.) Grout. Abundant on soil, rocky headland at White's Landing; with sporophytes. Reported by Millspaugh and Nuttall (as *Tortula atrovirens*).

DESMATODON GUEPINI BSG. Reported by Millspaugh and Nuttall, but not found in 1953.

DESMATODON HENDERSONI (Ren. & Card.) Williams. Abundant on moist to wet soil on vertical banks near small stream, in deep canyon; only rarely with a few sporophytes. The complete description and excellent illustration of this species by Williams in the comprehensive work of Millspaugh and Nuttall, escaped the notice of bryologists almost completely and were overlooked even by Grout (1939) in the latest monograph of the American species of *Desmatodon*. A careful study of the present collections has led to the conclusion that much of the material from the southwestern United States identified as *Didymodon tophaceus* really belongs to the present species. For several years it has been realized that much of the so-called *Didymodon tophaceus* of California does not agree with European or with eastern North American material, and that, moreover, it differs markedly in the structure of the leaf midrib, in its darker color, the more revolute leaf margins, and in the smaller amount of carbonate deposition. The problem has been complicated by the statement of Conard (1945) to the effect that *Didymodon tophaceus* is the only one of several very similar and commonly confused species that possesses hyaline and decurrent alar cells. Since *Desmatodon hendersoni* presents the same condition, as well as other features of resemblance, some confusion has very naturally resulted between the two species. A careful reexamination of a series of specimens from the Southwest now identified as *Didymodon tophaceus* is expected to result in a very considerable extension of the geographic range of the present species, at the moment known with certainty only from the Pacific Coast states.

DIDYMODON TOPHACEUS (Brid.) Jur. Kingman's collection of this species, "Near a calcareous spring," was reported by himself (1912) and by Millspaugh and Nuttall. Several collections made in 1953 were so identified in the field, but on careful study later they all turned out to be *Desmatodon hendersoni* as indicated in the discussion of that species. An investigation of the whole problem is now under way.

*EUCLADIUM VERTICILLATUM (Brid.) BSG. Locally abundant on rock and thin soil over rocks in cascades of a small stream, in a deep shaded canyon. Common in wet calcareous habitats in California.

*PHASCUM HYALINOTRICHUM Card. & Thér. A few plants with sporophytes of this distinctive and interesting moss which is nearly microscopic in size were collected with specimens of *Fossombronina hispidissima* quite by accident as they had been confused in the field with *Bryum argenteum*. This appears to be only the third known collection of a species restricted so far to southern California. Of course, the minute size prevents its discovery, but careful search specifically for this moss during its growing season would undoubtedly result in the finding of many populations over a much wider area.

*POTTIA ARIZONICA Wareham. Very abundant in pastured valley bottom behind White's Landing; not in good condition as the capsules had

dried up before full maturation and were still mostly operculate.

**POTTIA BRYOIDES* (Dicks.) Mitt. A few scattered plants of this distinctive species were found on bare soil on top of the rocky headland at White's Landing; with sporophytes.

TIMMIELLA VANCOUVERIENSIS Broth. Not uncommon on steep, shaded slopes and on the pastured valley bottom in full sun; sterile. Previously reported by Sayre (1940) as *T. anomala*, a species that may not occur in California (cf. Koch, 1950).

**TORTULA BOLANDERI* (Lesq.) Broth. Abundant on moist shaded vertical soil banks near the stream in a deep canyon, at middle altitudes; with sporophytes. These specimens and a collection from San Diego (Steere 17503, March 24, 1952) extend the known range of the species considerably southward, from Monterey County.

**TORTULA BREVIPES* (Lesq.) Broth. Common and abundant on rocky headland at White's Landing and in pastured valley bottom; with sporophytes.

**TORTULA CALIFORNICA* Bartram. This collection represents the first rediscovery of a handsome and well-marked species since the collection of the type specimen in Riverside County (Bartram, 1945). It grew in small quantity on a moist vertical silt bank above the stream, in a deep canyon; with sporophytes.

TORTULA INTERMEDIA (Brid.) Brid. Rather abundant on shaded rock faces in deep canyon; with sporophytes. Reported by Millspaugh and Nuttall, as *T. montana*.

**TORTULA LAEVIPILO* (Brid.) Schwaegr. On inclined tree-trunk, about six feet from the ground, in rather open forest, at middle altitudes; sterile.

TRICHOSTOMOPSIS BREVIFOLIA Bartram. On exposed soil, rocky headland at White's Landing; with few sporophytes. Koch (1950) reported this species from Santa Catalina Island from a Millspaugh collection (4730 in part). In the Millspaugh and Nuttall list this specimen, collected at Avalon Run, is included under *Barbula artocarpa*, a badly misunderstood species.

**TRICHOSTOMOPSIS FAYAE* Grout. Abundant on exposed silt in open pastured valley bottom behind White's Landing, and conspicuous for its perfectly black color, in contrast to the various shades of brown of the associated mosses.

**WEISSIA VIRIDULA* Hedw. Not at all common; one colony of this customarily weedy species was found on soil at the shaded face of a large boulder, associated with *Asterella californica*; sterile.

GRIMMIACEAE

**GRIMMIA PULVINATA* (Hedw.) Smith. On vertical rock, headland at White's Landing; a sterile, reduced form.

GRIMMIA TRICHOPHYLLA Grev. Not uncommon and locally abundant in several places on shaded rock-faces in deep canyons; with sporophytes. Reported from this area by Millspaugh and Nuttall; also by Sayre (1940).

FUNARIACEAE

FUNARIA HYGROMETRICA Hedw. Abundant in pastured valley bottom; with sporophytes. A truly weedy species all over the world. Reported by Millspaugh and Nuttall.

FUNARIA MUHLENBERGII Turn. On moist steep silt banks above stream in deep canyon; locally abundant, with sporophytes in several stages of development. Previously reported by Millspaugh and Nuttall.

BRYACEAE

BRYUM ARGENTEUM Hedw. var. LANATUM (Brid.) BSG. Not common, on rocky headland, White's Landing; with sporophytes. Although a truly cosmopolitan weed, this moss was not found in abundance. Reported by Millspaugh and Nuttall.

BRYUM BICOLOR Dicks. On exposed silt in pastured valley bottom; with sporophytes. Reported by Millspaugh and Nuttall as *B. californicum*.

*BRYUM CANARIENSE Brid. On moist soil, steep bank above small stream, in deep canyon; with sporophytes.

BRYUM CAPILLARE Hedw. A variable species, abundant in many forms, on soil and rock-faces; with sporophytes. Reported by Kingman (1912) under the name, *B. obconicum*, and by Millspaugh and Nuttall as *B. torquescens*.

BRYUM CUSPIDATUM (BSG.) Schimp. Common on soil, from shaded moist slopes of deep canyons to open insolated valley bottoms; with sporophytes. Reported by Millspaugh and Nuttall as *B. intermedium*.

BARTRAMIACEAE

*ANACOLIA MENZIESii (Turn.) Paris var. BAUERi (Hampe) Paris. In local abundance at White's Landing, on headland, and on shaded bank in deep canyon at some altitude; at the second locality with sporophytes. The moisture requirements of this species are such that fog must occur reasonably commonly in the places where it is found.

ORTHOTRICHACEAE

ORTHOTRICHUM CYLINDROCARPUM Lesq. Reported by Millspaugh and Nuttall from Bulrush Canyon, but not found in 1953.

ORTHOTRICHUM LYELLii Hook. & Tayl. Reported by Millspaugh and Nuttall but not found in 1953 in the White's Landing area.

*ORTHOTRICHUM TENELLUM Bruch. Common and occasionally abundant on the trunks and branches of trees in open forest in the upper reaches of a deep canyon; with sporophytes. The report of *O. cylindrocarpum* from Santa Catalina Island may be based on this species.

CRYPHAEACEAE

ALSIA CALIFORNICA (Hook. & Arn.) Sull. Reported by Millspaugh and Nuttall, but not seen in 1953.

LEUCODONTACEAE

ANTITRICHIA CALIFORNICA Sull. Reported by Millspaugh and Nuttall, but not found in 1953 in the White's Landing areas.

*BESTIA BREWERIANA (Lesq.) Grout. On base of tree in shade, in deep narrow canyon. This seems to be an extension of range southward from Monterey County; sterile.

*BESTIA BREVIPES (Sull. & Lesq.) Broth. On shaded rock-face above stream, in deep canyon; sterile. This is not a common species anywhere (cf. Koch, 1950).

*PTEROGONIUM GRACILE (Hedw.) BSG. On shaded rock-face in deep canyon, in considerable quantity but sterile. A common and widely distributed species in the state.

THUIDIACEAE

CLAOPODIUM WHIPPLEANUM (Sull.) Ren. & Card. Reported by Millspaugh and Nuttall but not found in 1953, even though it is a very common species almost throughout California.

HAPLOCLADIUM MICROPHYLLUM (Hedw.) Broth. Reported by Sayre (1940), as *Thuidium microphyllum*; not represented in the 1953 collections.

AMBLYSTEGIACEAE

*AMBLYSTEGIUM COMPACTUM (C. Müll.) Grout. On moist soil below cascade of small stream in deep canyon; sterile. This collection establishes an interesting disjunction, as the species is otherwise known in California from the northern part.

BRACHYTHECIACEAE

CAMPTOTHECIUM AENEUM (Mitt.) Jaeg. & Sauerb. var. DOLOSUM (Ren. & Card.) Grout. On shaded rock-face near stream, deep canyon; with sporophytes. Reported by Millspaugh and Nuttall as *C. dolosum*.

*CAMPTOTHECIUM ALSIOIDES Kindb. On soil at base of tree in deep shaded canyon; with sporophytes. This is a considerable extension southward of the geographical range of a species described from Marin County and otherwise still known only from northern California.

*CAMPTOTHECIUM PINNATIFIDUM (Sull. & Lesq.) Jaeg. & Sauerb. On moist shaded soil in deep canyon; sterile. This is a common and widely distributed species in California, usually on rock.

CAMPTOTHECIUM ARENARIUM (Lesq.) Jaeg. & Sauerb. Reported by Millspaugh and Nuttall, but not found in 1953.

EURHYNCHIUM PULCHELLUM (Hedw.) Jenn. and R. PULCHELLUM var. SCABRISETUM Grout. These were reported by Sayre (1940) from collections made by Cockerell. In view of the generally northern and montane distribution of the species and the eastern range of the variety, it is possible that these reports are based on *Scleropodium illecebrum*, a remarkably variable species that produces forms parallel to those of *E. pulchellum*. Attempts to obtain material of these collections for further study have been unsuccessful.

**HOMALOTHECIUM NUTTALLII* (Wils.) Grout. Abundant on the base of a tree in open forest in the upper reaches of a large canyon; with sporophytes. A very common Pacific Coast species.

**SCLEROPODIUM CAESPITOSUM* (Wils.) BSG. On shaded soil in deep canyon; sterile. A common Californian species.

SCLEROPODIUM CALIFORNICUM (Lesq.) Ren. & Card. On soil over rock in deep canyon; sterile. Reported from the same area by Millspaugh and Nuttall.

**SCLEROPODIUM COLPOPHYLLUM* (Sull.) Grout. On soil, steep bank above stream, deep canyon; sterile. A variable species that may represent only an extreme form of one of the others listed here.

SCLEROPODIUM ILLECEBRUM (Schwaegr.) BSG. Very abundant on shaded vertical rock-faces in deep canyon; with sporophytes. This material is of more than casual interest because it differs from all other forms of the species known to the author through the presence of numerous spines on the back of the costa, at and near its apex, arranged in a pectinate fashion. However, it is hardly necessary to give nomenclatural recognition to this race, in view of the fundamental variability of the basic species. Reported by Millspaugh and Nuttall as "One of the commoner mosses of the island"; also listed by Sayre (1940).

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