

# **The Journal of the Torrey Botanical Society**

**An annotated checklist of the liverworts and hornworts of the  
Delmarva Peninsula**

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McAVOY, W. A. (Delaware Natural Heritage and Endangered Species Program, Delaware Division of Fish and Wildlife, 4876 Haypoint Landing Rd., Smyrna, DE 19953), W. M. KNAPP (Wildlife and Heritage Services, Maryland Dept. of Natural Resources, PO Box 68, Wye Mills, MD 21679), AND L. BIECHELE (14011 Cooley Rd, Princess Anne, MD 21853). An annotated checklist and atlas of the liverworts and hornworts of the Delmarva Peninsula. *J. Torrey Bot. Soc.* 138: 239–251. 2011.—In order to increase the understanding of the diversity, distribution and abundance of liverworts and hornworts on the Atlantic Coastal Plain, a six year study (2004–2009) was conducted focusing on the Delmarva Peninsula (a land mass comprising portions of the states of Delaware, Maryland, and Virginia). Our previous knowledge of the liverworts and hornworts of the Delmarva were minimal. Collections were few and usually localized, and published and unpublished reports were scarce. Results from this study are presented in the format of an annotated checklist and represents the first comprehensive study on the liverworts and hornworts of the Delmarva Peninsula. A total of 65 species, subspecies, and varieties were documented during this study with 22 being reported as new to the bryoflora of the Delmarva.

Key words: bryophytes, checklist, Delmarva Peninsula, hornworts, liverworts.

Of all the land plants, bryophytes, particularly liverworts and hornworts, are one of the most understudied groups. In an effort to expand the overall knowledge of the diversity, distribution, and abundance of liverworts and hornworts of the Atlantic Coastal Plain physiographic province, research focusing on the Delmarva Peninsula was conducted from 2004 to 2009. Research involved field surveys, as well as herbaria and literature searches to document the liverwort and hornwort flora of the Delmarva. Data resulting from this

research are presented here in the format of an annotated checklist.

Prior to this study, earlier investigations and collections of liverworts and hornworts on the Delmarva Peninsula were limited and usually local in terms of the areas studied or collected. The earliest collections were made by Albert Commons in the 1890s and some of his collections, many of which are housed at the Academy of Natural Sciences (PH, herbarium acronyms follow Index Herbariorum 2010) in Philadelphia represent significant discoveries for the Peninsula, such as *Jungermannia gracillima*, *Ptilidium pulcherrimum*, and *Riccia membranacea*. All three of these species are considered historical on the Delmarva, with the only known collections being those made by Commons. Edward Uebel (2000) published an annotated list of the bryophytes collected in Maryland by Dr. Elmer Worthley. Primarily during the 1960's, Worthley collected 12 species of liverworts (10 leafy, 2 thalloid) from the Maryland Eastern Shore counties of the Delmarva, one of which includes *Blepharostoma trichophyllum* (Uebel 2000). This species is now considered to be historical on the Peninsula, with the only collection being made by Worthley. While a student at Salisbury

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University (previously Salisbury State College), B. L. Davis (1976) produced an unpublished report titled: A Survey of the Bryophytes of Wicomico County, Maryland. Davis listed 10 species of liverworts (7 leafy, 3 thalloid) based on a single season of field work within 18 acres near her home, and at "a dozen other areas of the county" where "spot checks" were done (Davis 1976). Though Davis's report was the result of an undergraduate project and unpublished, it is included in this study in order to be as thorough and comprehensive as possible and to alleviate possible questions from future researchers. In 1991, Lance Biechele began collecting liverworts and hornworts on the Delmarva, mostly in the southwest corner of the Peninsula (Somerset, Wicomico and Worcester Counties), and Lance's efforts were the impetus for this study. William McAvoy (1999) published the results of a bryophyte study of the Great Cypress Swamp Conservation Area in Sussex Co., Delaware and Worcester Co., Maryland, where he listed 12 species of liverworts (10 leafy, 2 thalloid). While doing bryological studies on Assateague Island National Seashore in Worcester Co., Maryland, Shanda King (2000) reported in an unpublished document 6 species of liverworts (5 leafy, 1 thalloid). While doing field surveys related to this paper, McAvoy, Biechele and Knapp (2006) published their discovery of *Calypogeia peruviana*, which was new to the Delmarva and a northern range extension.

Results presented here mark the first focused and comprehensive study on the liverworts and hornworts of the Delmarva Peninsula.

**The Study Area.** The Delmarva Peninsula (Fig. 1) has historically been defined as including the entire state of Delaware (both the Piedmont and Coastal Plain physiographic provinces of New Castle Co.), the entirety of the Eastern Shore of Maryland and both the Piedmont and Western Shore regions of Cecil Co., Maryland, and the Eastern Shore of Virginia (Tatnall 1946). This definition, like so many other geopolitical boundaries, is problematic from a natural history perspective because it includes very different physiographic provinces. For the purposes of this study the Delmarva Peninsula will be referred to as an area located entirely within the Atlantic Coastal Plain physiographic province, thus creating a more "natural" unit of study.

The Peninsula lies south of the fall line (a term applied to the boundary between the Appalachian Piedmont province and the Atlantic Coastal Plain) in New Castle County, Delaware and Cecil County, Maryland, and is bordered on the east by the Delaware River, Delaware Bay and the Atlantic Ocean, and on the west by the Elk River and Chesapeake Bay. It includes the Coastal Plain province of Delaware (New Castle, Kent, and Sussex Counties), the Eastern Shore of Maryland (Cecil, Kent, Queen Anne's, Caroline, Talbot, Dorchester, Wicomico, Somerset, and Worcester Counties), and the Eastern Shore of Virginia (Accomack and Northampton Counties). Its length north to south is about 200 miles (320 km), its greatest width is about 70 miles (110 km), its narrowest width is about 10 miles (16 km), and the total land area is about 5,800 mi<sup>2</sup> (15,000 km<sup>2</sup>). The climate of the Peninsula is moderated by the Delaware Bay, Chesapeake Bay, and the Atlantic Ocean and is characterized by cool winters and warm humid summers. The landscape of the Delmarva is mostly rural, on flat to gentle sloping sandy plains with slow-flowing rivers and streams that are bordered by extensive swamp forests and tidal marshes. In the coastal areas, barrier islands, salt marshes, tidal flats and inland bays are well developed. The Delmarva's Coastal Plain soils of sands, silts, clays and gravel support forests primarily composed of mixed evergreen; *Pinus taeda* L. (loblolly pine), *Ilex opaca* Aiton (American holly), and deciduous tree species; *Quercus* spp. (oaks), *Carya* spp. (hickories), *Fagus grandifolia* Ehrh. (American beech), *Nyssa sylvatica* Marsh. (black gum), *Liquidambar styraciflua* L. (sweet gum), *Acer rubrum* L. (red maple), and *Liriodendron tulipifera* L. (tulip poplar). The Delmarva Peninsula lies within the Chesapeake Bay Lowlands Ecoregion as defined by The Nature Conservancy (2002), and within the Outer Coastal Plain Mixed Forest Province as mapped by Bailey (1995).

**Methods and Materials.** The study area (the Delmarva Peninsula of the Atlantic Coastal Plain, United States) was regularly sampled from 2004–2009 (usually from April to October) resulting in surveys that captured all habitat types known from the Delmarva Peninsula. Surveys were conducted in all habitat types (natural and anthropogenic) to capture the full diversity of Liverworts and

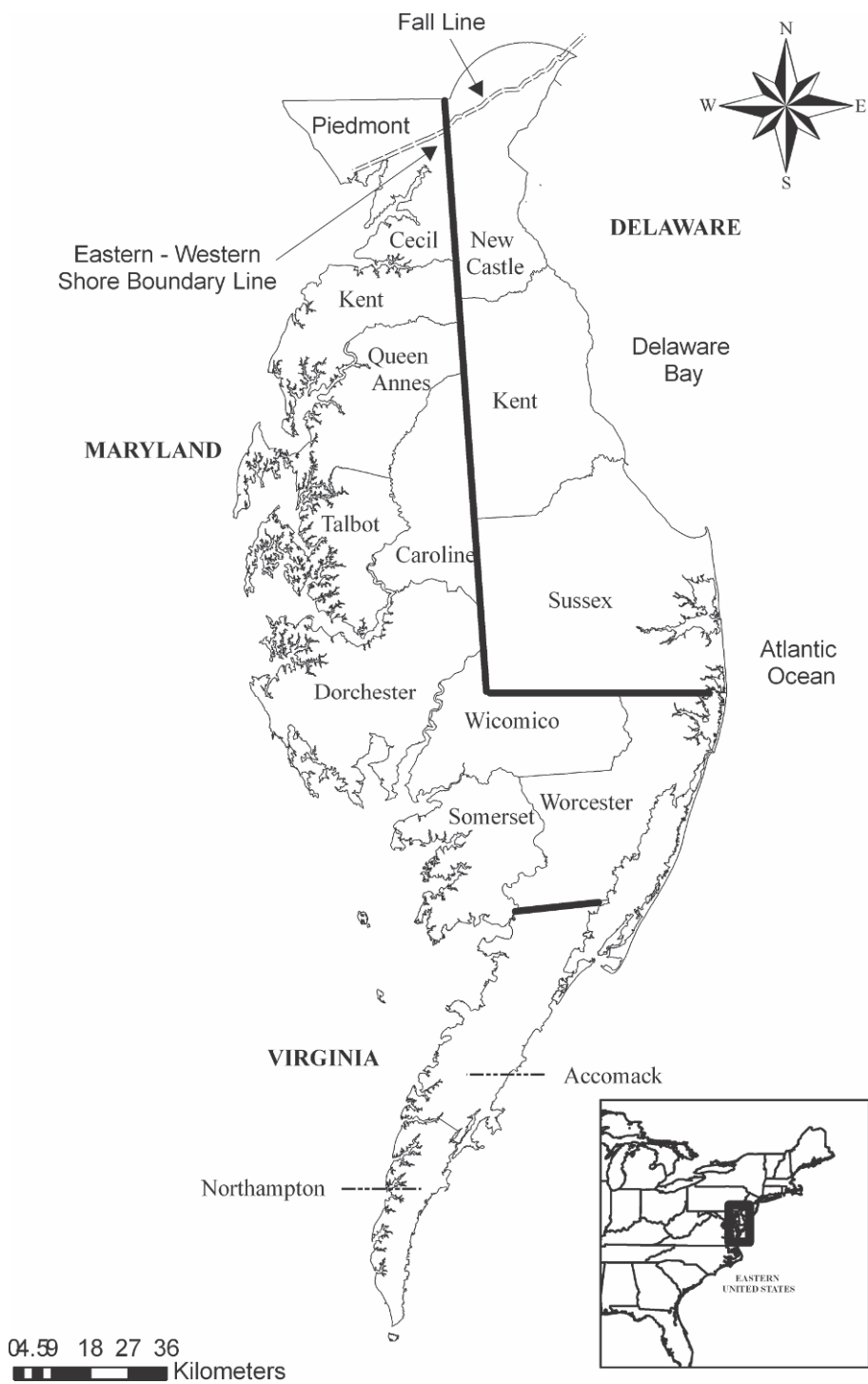


FIG. 1. Location map, Delmarva Peninsula.

Table 1. Summation of the Liverwort and Hornwort flora of the Delmarva Peninsula.

|                          | Totals |
|--------------------------|--------|
| Taxa                     | 65     |
| Species                  | 56     |
| Subspecies and Varieties | 9      |
| Native Taxa              | 64     |
| Non-native Taxa          | 1      |
| Families                 | 28     |
| Genera                   | 39     |
| Leafy Liverworts         | 45     |
| Thalloid Liverworts      | 18     |
| Hornworts                | 2      |
| Rare Taxa                | 22     |
| Southern Taxa            | 8      |
| Northern Taxa            | 1      |

Hornworts. The seasonality of some taxa required multiple surveys over the course of the study. Voucher specimens were made for all new county and Delmarva records. Collections made by the first and second authors are deposited at the Claude E. Phillips Herbarium (DOV), Delaware State University, Dover, Delaware and the third author deposited specimens at the Charles O. Wingo Jr. Herbarium, Salisbury University, Salisbury, Maryland.

A variety of manuals were consulted for this project because no single treatment contained all the species encountered. The following manuals were referred to: Ammons (1940), Schuster (1969, 1974, 1980, 1992), Breil (1970, 1996), Crum (1991), Hicks (1993), Lincoln (2008). Questionable identifications, or difficult to determine collections were sent to Dr. Raymond Stotler (Southern Illinois University) for confirmation. A literature review was conducted in order to compile a list of materials that may have included Delmarva liverworts and hornworts. Specimen searches were done at various herbaria (PH, DOV, US, NY, DUKE) to confirm the identification of literature reports and to obtain additional county and Delmarva records.

Results. Collectively, the liverworts and hornworts of the Delmarva Peninsula consists of 65 taxa (species, subspecies and varieties), which includes 64 native taxa and one non-native taxon, and is represented by 28 families and 39 genera (Table 1). The families with the largest number of taxa are (Table 2): Cephaloziaceae (7 taxa), Lejeuneaceae (7 taxa), Ricciaceae (6 taxa), Frullaniaceae (5 taxa), Calypogeiaceae (4 taxa) and Lophocoleaceae

Table 2. Families represented on the Delmarva Peninsula with the greatest number of taxa.

| Family         | Genera | Taxa |
|----------------|--------|------|
| Cephaloziaceae | 3      | 7    |
| Lejeuneaceae   | 3      | 7    |
| Ricciaceae     | 2      | 6    |
| Lophocoleaceae | 2      | 4    |
| Frullaniaceae  | 1      | 5    |
| Calypogeiaceae | 1      | 4    |

(4 taxa). The largest genera include: Frullania and Riccia both with 5 taxa, and Calypogeia and Cephalozia both with 4. The majority of the taxa are leafy liverworts with 45, followed by thalloid liverworts with 18, and hornworts with two (Table 1). There are 22 taxa considered to be rare on the Delmarva, or 35% of the flora (Table 3), and of that total, 5 are historical (not documented for 20 or more years, Table 3). The Delmarva county supporting the highest number of taxa is Worcester, with 46 (Table 4). The Delmarva county supporting the lowest number of taxa is Cecil, with 13 (Table 4). Four species were documented from all 14 Delmarva counties: Lophocolea heterophylla, Odontoschisma prostratum, Pallavicinia lyellii, and Scapania nemorea. Eight taxa occurring on the Delmarva are more southern in their geographic distri-

Table 3. Taxa considered to be rare (known from 10 or fewer populations) on the Delmarva Peninsula. Those marked with an \* are considered to be historical (not documented for 20 or more years).

| Taxon                                  |
|----------------------------------------|
| Blepharostoma trichophyllum*           |
| Cephalozia macrostachya                |
| Chiloscyphus polyanthus var. rivularis |
| Cololejeunea cardiocarpa*              |
| Conocepalum conicum                    |
| Gymnocolea inflata                     |
| Jungermannia gracillima*               |
| Lejeunea maxonii                       |
| Leucolejeunea conchifolia              |
| Leucolejeunea uncioloba                |
| Lophocolea bidentata                   |
| Lophocolea minor                       |
| Lophozia bicrenata                     |
| Lophozia capitata                      |
| Porella platyphylla                    |
| Ptilidium pulcherrimum*                |
| Radula complanata                      |
| Radula obconica                        |
| Reboulia hemisphaerica                 |
| Riccia membranacea*                    |
| Ricciocarpos natans                    |
| Trichocolea tomentella                 |

Table 4. Total number of taxa documented by county on the Delmarva Peninsula (highest to lowest).

| County       | Taxa |
|--------------|------|
| Worcester    | 46   |
| Sussex       | 45   |
| Wicomico     | 32   |
| Accomack     | 27   |
| Queen Anne's | 26   |
| New Castle   | 27   |
| Caroline     | 26   |
| Northampton  | 25   |
| Dorchester   | 24   |
| Kent (DE)    | 23   |
| Somerset     | 22   |
| Talbot       | 20   |
| Kent (MD)    | 17   |
| Cecil        | 13   |

bution and are at or near the northern limits of their range on the Peninsula (Table 5). Only one species has a more northern distribution and is at or near the southern limits of its range on the Delmarva (*Lophocolea minor*). Twenty-two taxa documented during this study are reported here for the first time (Table 6).

Excluded Species. The following species have been excluded from the liverwort and hornwort flora of the Delmarva Peninsula.

*Blasia pusilla* L. (*Blasiaceae*). This species was cited for Wicomico Co., Maryland by Davis (Davis 1976), but no specimens for this species from Wicomico Co. could be found at MO (pers. comm., Carl Darigo, Missouri Botanical Garden, 3 April 2008). Though *Blasia pusilla* is not improbable for the Delmarva, the literature (Breil 1996, Hicks 1992, Lincoln 2008, Manville 2001, Plitt 1908, Schuster 1992) suggests that it may be more northern in its range and more frequent in the Piedmont and Mountain provinces than on the Coastal Plain.

Table 5. Taxa documented from the Delmarva Peninsula with a more southern distribution that are at or near their northern limits of natural distribution.

| Taxon                                                     |
|-----------------------------------------------------------|
| <i>Calypogeia peruviana</i>                               |
| <i>Cololejeunea cardiocarpa</i>                           |
| <i>Cololejeunea minutissima</i> subsp. <i>minutissima</i> |
| <i>Lejeunea maxonii</i>                                   |
| <i>Leucolejeunea conchifolia</i>                          |
| <i>Leucolejeunea uncioloba</i>                            |
| <i>Sphaerocarpos texanus</i>                              |
| <i>Telaranea nematodes</i>                                |

Table 6. Taxa documented and reported as new to the Liverwort and Hornwort flora of the Delmarva Peninsula.

| Taxon                                                        |
|--------------------------------------------------------------|
| <i>Calypogeia fissa</i> subsp. <i>neogaea</i>                |
| <i>Calypogeia peruviana</i> (McAvoy, Biechle and Knapp 2006) |
| <i>Cephaloziella byssacea</i> var. <i>byssacea</i>           |
| <i>Cephaloziella rubella</i> var. <i>rubella</i>             |
| <i>Conocephalum conicum</i>                                  |
| <i>Frullania eboracensis</i> subsp. <i>virginica</i>         |
| <i>Frullania ericoides</i>                                   |
| <i>Gymnocolea inflata</i>                                    |
| <i>Kurzia sylvatica</i>                                      |
| <i>Lejeunea maxonii</i>                                      |
| <i>Leucolejeunea conchifolia</i>                             |
| <i>Lophocolea bidentata</i>                                  |
| <i>Lophozia bicrenata</i>                                    |
| <i>Lophozia capitata</i>                                     |
| <i>Lunularia cruciata</i>                                    |
| <i>Metzgeria furcata</i>                                     |
| <i>Notothylas orbicularis</i>                                |
| <i>Radula complanata</i>                                     |
| <i>Radula obconica</i>                                       |
| <i>Riccia bifurca</i>                                        |
| <i>Riccia hirta</i>                                          |
| <i>Ricciocarpos natans</i>                                   |

*Calypogeia trichomanis* (L.) Corda (*Calypogeiaceae*). *Calypogeia trichomanis* is a northern species (Canada and New England), and was cited for Worcester Co., Maryland by Worthley (Uebel 2000) and for Wicomico Co., Maryland by Davis (1976). The Worthley collection (1967, MO) has been annotated as *Calypogeia muelleriana* (pers. comm., Carl Darigo, Missouri Botanical Garden, 3 April 2008). Concerning the Wicomico Co. collection, if Davis made a specimen, it would have been deposited at MO (pers. comm., Dr. Ronald A. Pursell, Penn State University, 9 July 2004). The collection at MO has been searched and no specimens of this species from Wicomico Co., Maryland could be found (pers. comm., Carl Darigo, Missouri Botanical Garden, 3 April 2008). The Davis citation is likely *C. muelleriana*.

*Cephalozia bicuspidata* (L.) Dumort. (*Cephaloziaceae*). According to Schuster's Vol. III (1974), this species is essentially northern in its distribution, becoming rare farther south. This species was cited for Wicomico Co., Maryland by Davis (Davis 1976), but no specimens for this species from Wicomico Co. could be found at MO (pers. comm., Carl Darigo, Missouri Botanical Garden, 3 April 2008).

*Lophozia laxa* (Lindb.) Grolle [syn. *L. marchica* (Nees) Steph., (*Scapaniaceae*)]. This

species was cited for Delaware [unknown if Piedmont or Coastal Plain (i.e., Delmarva)] by Evans and Nichols (1908). Shuster in Vol. II (1969) makes note of this citation and points out that this species was "Reported from Delaware and West Virginia (Evans & Nichols 1908). It is highly unlikely that either of these reports represents this northern species, which is almost strictly confined to areas which underwent Pleistocene glaciation." No specimen can be found which supports the claim of Evans and Nichols (1908).

**Checklist Format and Arrangement.** For the most part, nomenclature follows Stotler & Crandall-Stotler (1977). The checklist begins with Phylum Marchantiophyta, the liverworts and concludes with Phylum Anthocerotophyta, the hornworts. Within each Phylum, arrangement is by Class and then alphabetically by Family, Genus, and Species. The scientific name for each species includes author(s), followed by synonyms where appropriate. Author abbreviations follow Brummitt and Powell (1992). In addition, for each taxon listed the following attributes are also provided.

**STATUS.** The status of a taxon refers to its relative rarity on the Delmarva Peninsula and is based on the collection record, the literature, and the field experience of the authors. However, the level of rarity is applied with a certain level of uncertainty. Continued field studies in the future will undoubtedly provide new data that will add to our overall knowledge of the distribution and abundance of liverworts and hornworts on the Delmarva. The following terms are used to describe the status of a taxon on the Delmarva: Rare (known from only 10 or fewer populations, or habitat is limited), Historical (has not been reported for 20 or more years), Uncommon (evenly distributed, but not plentiful), Common (plentiful throughout).

**DISTRIBUTION.** Listed first by state [Del. (Delaware), Md. (Maryland), and Va. (Virginia)], then by the counties within each state going from north to south (e.g., Delmarva Status and Distribution: Del.: New Castle; Kent; Sussex. Md.: Cecil; Kent; Queen Anne's; Caroline; Talbot; Dorchester; Wicomico; Somerset; Worcester. Va.: Accomack; Northampton). For some entries, it is useful to provide the overall North American distribution and in those cases, distributional data are

based on Schuster (1969, 1974, 1980, and 1992) and Hicks (1992).

**DELMARVA HABITAT.** Brief habitat descriptions refer to the habitat preferences of a taxon on the Delmarva Peninsula, and are based on the collection record, the literature, and the field experience of the authors.

**ADDITIONAL INFORMATION.** Comments are varied and are meant to provide useful information related to a taxon.

If a taxon is listed for a state and county, then it has been vouchered with a modern day (within the last 20 years) collection by the authors, unless otherwise noted [e.g., A. Commons (collector's name), ### (collection number), 1892 (year of collection), PH (herbarium where deposited)]. A county record has been vouchered by at least one collection, but in most cases several collections exist, both modern day and historical. Since the majority of county voucher specimens were collected by the authors, collection data (year, number and herbarium) are not listed in order to save space. Collections made by the first two authors are deposited at the Claude E. Phillips Herbarium (DOV), Delaware State University, Dover, Delaware. Collections made by the third author are deposited at the Charles O. Wingo Jr. Herbarium, Salisbury University, Salisbury, Maryland. Specimens pertaining to a specific county of occurrence that were collected by the third author are distinguished as (SUHC), following the county name. If a taxon has been reported from a county based on the literature and no voucher specimen has been seen by the authors, then the literature citation is given (e.g., Davis 1976), followed by nss, (no specimen seen). For example, Md.: Wicomico, (Davis 1976, nss).

#### An Annotated Checklist of the Liverworts and Hornworts of the Delmarva Peninsula

##### Phylum Marchantiophyta (Liverworts) Class

##### Marchantiopsida (Complex Thalloid Liverworts)

##### Aytoniaceae

##### *Reboulia hemisphaerica* (L.) Raddi

Delmarva Status and Distribution: Rare. Md.: Kent.

Delmarva Habitat: Calcareous marl and shell-bearing soils.

## Conocephalaceae

*Conocephalum conicum* (L.) Dumort.

Delmarva Status and Distribution: Rare. Md.: Queen Anne's.

Delmarva Habitat: Forms dense patches on organic substrates and gravel in groundwater seepage slope wetlands.

## Lunulariaceae

*Lunularia cruciata* (L.) Dumort.

Delmarva Status and Distribution: Non-native, a native of Europe. Currently vouchered only from Accomack Co., Va. (SUHC), but widespread throughout North America and is probably found in most greenhouses on the Delmarva.

Delmarva Habitat: Not naturalized, but forms patches on soil in pots and trays in nurseries and greenhouses.

## Marchantiaceae

*Marchantia polymorpha* L.

Delmarva Status and Distribution: Uncommon. Del.: New Castle. Md.: Dorchester, Wicomico (SUHC).

Delmarva Habitat: Forms patches on bare mineral soil, on stream banks and rivers, both tidal and non-tidal, and on disturbed ground.

## Ricciaceae

*Riccia bifurca* Hoffm.

Delmarva Status and Distribution: Uncommon. Del.: New Castle. Md.: Queen Anne's; Caroline; Worcester.

Delmarva Habitat: Develops rosettes on bare mineral soils in moist to poorly drained corners of agricultural fields, and also appears in Coastal Plain seasonal ponds after draw-down.

Additional Information: This species, as well as *R. hirta*, and *R. huebeneriana* subsp. *sullivantii* are characteristically found in summer on soils that have been flooded in the spring. Plants are seasonal and appear to grow annually from water-borne or soil-borne spores.

*Riccia fluitans* L.

Delmarva Status and Distribution: Common. Del.: New Castle; Kent; Sussex. Md.: Cecil; Kent; Queen Anne's; Dorchester; Wicomico (SUHC); Worcester. Va.: Northampton.

Delmarva Habitat: Aquatic, floating and stranded in Coastal Plain seasonal ponds,

wetland depressions, sandpits and fresh water impoundments.

Additional Information: The aquatic *Riccia fluitans* is nearly always sterile, but plants stranded on mud may produce fertile capsules. These fertile populations are possibly a distinct species, *Riccia canaliculata* Hoffm. (Ammons 1940, Breil 1970, Crum 1991).

*Riccia hirta* (Aust.) Underw.

Delmarva Status and Distribution: Uncommon. Del.: New Castle; Sussex. Md.: Somerset.

Delmarva Habitat: Develops rosettes on bare mineral soils in moist poorly drained corners of agricultural fields.

*Riccia huebeneriana* Lindenb. subsp. *sullivantii* (Austin) R.M. Schust. *Riccia sullivantii* Austin

Delmarva Status and Distribution: Common. Del.: New Castle; Kent, Sussex. Md.: Kent; Dorchester; Somerset; Worcester.

Delmarva Habitat: Develops rosettes on bare mineral soils in poorly drained corners of agricultural fields, and also appears in Coastal Plain seasonal ponds after draw-down.

*Riccia membranacea* Gottsche et. Lindb.

Delmarva Status and Distribution: Species is historical on the Delmarva, known only from the two collections cited. Del.: Sussex (A. Commons, s.n., 1892, PH). Va.: Northampton (E. Wherry, s.n., 1925, PH).

Delmarva Habitat: Bare, poorly drained mineral soils.

*Ricciocarpos natans* (L.) Corda

Delmarva Status and Distribution: Rare. Del.: New Castle.

Delmarva Habitat: Coastal Plain seasonal ponds.

Additional Information: This species takes on two forms: aquatic and terrestrial. The aquatic form is a heart or fan-shaped thallus with long, purplish-black scales on the underside. The thallus floats on the surface of the water in spring when flooding occurs, in habitats such as seasonally flooded wetland depressions (known as Coastal Plain seasonal ponds). The aquatic form produces sex organs, and spores mature by mid-summer. As the season progresses and water levels fall and sites become dry, thalli will become stranded on exposed bottoms and take on a terrestrial form of a 1-sided rosette with narrow, forked segments. The terrestrial form will overwinter and when wetland sites become flooded once again in winter/early spring, the tips of the

thalli become detached, float to the surface, then grow into the floating aquatic form.

### Sphaerocarpaceae

#### *Sphaerocarpos texanus* Austin

Delmarva Status and Distribution: Uncommon. The species occurs from Texas, east to Florida and north to the Delmarva Peninsula, its northern limit. Md.: Wicomico, (Davis 1976, nss); Worcester. Va.: Accomack.

Delmarva Habitat: Bare, moist mineral soils of agricultural fields, usually on the perimeter in unplanted strips adjacent to woodlands and thickets. Spores germinate and gametophytes develop in early spring.

### Class Jungermanniopsida (Simple Thaloid and Leafy Liverworts)

#### Aneuraceae

#### *Aneura pinguis* (L.) Dumort.

Delmarva Status and Distribution: Uncommon. Del.: New Castle; Sussex. Md.: Queen Anne's; Talbot; Dorchester; Wicomico; Worcester.

Delmarva Habitat: Forming patches on organic substrates in wet places. *Riccardia latifrons* (Lindb.) Lindb.

Delmarva Status and Distribution: Common. Del.: Sussex. Md.: Queen Anne's; Caroline; Dorchester; Wicomico; Somerset; Worcester (SUHC). Va.: Accomack; Northampton.

Delmarva Habitat: Forms crowded, tiered patches that are irregularly branched on decorticated branches and logs in shady, cool swamps.

#### *Riccardia multifida* (L.) Gray

Delmarva Status and Distribution: Uncommon. Del.: New Castle; Kent (B. Allen, 7756, 1989, NY); Sussex. Md.: Caroline; Dorchester; Worcester. Va.: Northampton.

Delmarva Habitat: Forming crowded patches that are regularly branched (ultimate segments are parallel sided) on organic substrates in swamps.

### Calypogeiaceae

#### *Calypogeia fissa* (L.) Raddi subsp. *neogaea* R.M. Schust.

Delmarva Status and Distribution: Common. Del.: New Castle; Sussex. Md.: Cecil; Kent; Queen Anne's; Caroline; Talbot; Dorchester; Wicomico; Somerset; Worcester Va.: Accomack; Northampton.

Delmarva Habitat: Usually on moist mineral soil on banks, wooded slopes and along streams, infrequently on humus.

*Calypogeia muelleriana* (Schiffn.) Mull. Frib. subsp. *muelleriana*

Delmarva Status and Distribution: Common. Del.: New Castle; Sussex. Md.: Cecil; Kent; Queen Anne's; Talbot; Dorchester; Worcester. Va.: Accomack; Northampton.

Delmarva Habitat: Usually on peaty humus in swamps, infrequently on mineral soil.

*Calypogeia peruviana* Nees et Mont.

Delmarva Status and Distribution: Uncommon. The species extends north on the Coastal Plain (from South and Central America, Mexico, and the Gulf Coastal Plain) to the Delmarva Peninsula (McAvoy, Biechle and Knapp 2006), where it reaches its northern limit. Del.: Sussex. Md.: Dorchester; Wicomico; Somerset; Worcester. Va.: Accomack; Northampton.

Delmarva Habitat: Forming creeping patches on humus in swamps, often in Atlantic white cedar swamps.

*Calypogeia sullivantii* Austin

Delmarva Status and Distribution: Uncommon. Md.: Queen Anne's; Dorchester (SUHC); Worcester.

Delmarva Habitat: On mineral soil of banks and wooded slopes.

### Cephaloziaceae

#### *Cephalozia catenulata* (Huebener) Lindb.

Delmarva Status and Distribution: Uncommon. Del.: Kent; Sussex. Md.: Wicomico (SUHC); Worcester. Va.: Accomack; Northampton.

Delmarva Habitat: All of Delmarva's species of *Cephalozia* form dense patches on humus, decorticated logs and other organic substrates in swamps, and they are often mixed with other bryophytes.

*Cephalozia connivens* (Dicks.) Linb.

Delmarva Status and Distribution: Common. Del.: New Castle; Kent (B. Allen, 7756, 1989, NY); Sussex. Md.: Talbot; Wicomico (SUHC); Worcester. Va.: Accomack.

*Cephalozia lunulifolia* (Dumort.) Dumort.

Delmarva Status and Distribution: Common. Del.: Sussex. Md.: Kent; Queen Anne's; Caroline; Talbot; Dorchester; Wicomico; Somerset; Worcester. Va.: Accomack; Northampton.

*Cephalozia macrostachya* Kaal.

Delmarva Status and Distribution: Rare.  
Md.: Worcester (SUHC).

*Nowellia curvifolia* (Dicks.) Mitt.

Delmarva Status and Distribution: Common.  
Del.: New Castle; Kent; Sussex. Md.: Cecil;  
Queen Anne's; Caroline; Talbot; Wicomico;  
Somerset; Worcester. Va.: Accomack.

Delmarva Habitat: On decorticated logs in  
swamps, often forming wide mats or carpets.  
*Odontoschisma denudatum* (Mart.) Dumort.

Delmarva Status and Distribution: Common.  
Del.: Kent; Sussex. Md.: Caroline; Talbot;  
Wicomico; Worcester. Va.: Accomack.

Delmarva Habitat: Forming creeping patch-  
es on humus and other organic substrates.  
*Odontoschisma prostratum* (Sw.) Trevis.

Delmarva Status and Distribution: Common  
in all counties of the Delmarva.

Delmarva Habitat: Forming creeping patch-  
es on mineral soil, humus, decorticated logs and  
other organic substrates.

#### Cephaloziellaceae

*Cephaloziella byssacea* (Roth.) Warnst. var.  
*byssacea*

Delmarva Status and Distribution: Uncom-  
mon. Del.: Sussex. Md.: Queen Anne's;  
Caroline; Talbot; Dorchester; Wicomico.

Delmarva Habitat: Forming patches on  
bare, sandy soil on slopes and banks.

*Cephaloziella rubella* (Nees) Warnst. var. *ru-  
bella*

Delmarva Status and Distribution: Uncom-  
mon. Del.: Kent; Sussex. Md.: Queen Annes;  
Talbot; Somerset; Worcester. Va.: Accomack.

Delmarva Habitat: On moist, peaty sand  
and decorticated logs, or as strands among  
other bryophytes.

#### Fossombroniaceae

*Fossombronia cristula* Austin

Delmarva Status and Distribution: Uncom-  
mon. Del.: New Castle; Sussex. Md.: Kent;  
Queen Anne's; Caroline; Wicomico; Somerset;  
Worcester.

Delmarva Habitat: Forming seasonal patch-  
es on moist, often disturbed mineral soil; ditch  
banks, tire ruts, puddles, Coastal Plain sea-  
sonal ponds, and moist swales within the inner  
dunes along the coast.

Additional Information: Species resembles a  
leafy liverwort, but dorsal sex organs place it  
in the simple thalloid lineage. Pale-green,  
ruffle-lobed thalli and red-violet rhizoids are  
distinctive for the species.

#### Frullaniaceae

*Frullania asagrayana* Mont. *Frullania tamarisci*  
(L.) Dumort. subsp. *asagrayana* (Mont.) S. Hatt.

Delmarva Status and Distribution: Common.  
Del.: Sussex. Md.: Cecil; Caroline; Talbot;  
Wicomico; Somerset; Worcester. Va.: Accom-  
ack; Northampton.

Delmarva Habitat: Epiphytic, forming  
creeping patches on the bark of trees in woods  
and swamps.

*Frullania eboracensis* Lehm. subsp. *eboracensis*

Delmarva Status and Distribution: Common.  
Del.: New Castle; Kent; Sussex. Md.: Cecil;  
Kent; Caroline; Queen Anne's; Dorchester;  
Worcester.

Delmarva Habitat: Epiphytic, forming  
creeping patches on the bark of trees in woods  
and swamps.

*Frullania eboracensis* Lehm. subsp. *virginica*  
(Gottsche) Schust.

Delmarva Status and Distribution: Common.  
Del.: Sussex. Md.: Talbot; Dorchester; Wico-  
mico (SUHC). Va.: Northampton.

Delmarva Habitat: Epiphytic, forming  
creeping patches on the bark of trees in woods  
and swamps.

*Frullania ericoides* (Nees) Nees. *Frullania*  
*squarrosa* (Reinw; Blume & Nees) Dumort.

Delmarva Status and Distribution: Common.  
Del.: Sussex. Md.: Caroline; Wicomico  
(SUHC); Worcester. Va.: Northampton.

Delmarva Habitat: Epiphytic, forming  
creeping patches on the bark of trees in woods  
and swamps.

*Frullania inflata* Gottsche

Delmarva Status and Distribution: Common.  
Del.: New Castle; Kent. Md.: Cecil; Kent;  
Queen Anne's; Caroline; Talbot; Wicomico  
(Davis 1976, nss); Somerset. Va.: Accomack.

Delmarva Habitat: Epiphytic, forming  
creeping patches on the bark of trees in woods  
and swamps.

#### Jamesoniellaceae

*Jamesoniella autumnalis* (DC.) Steph. Delmarva  
Status and Distribution: Uncom-  
mon. Del.: New Castle; Kent; Sussex. Md.:  
Somerset (SUHC); Worcester (SUHC).

Delmarva Habitat: Decorticated logs in  
swamps.

#### Jungermanniaceae

*Jungermannia gracillima* Sm. *Solenostoma*  
*gracillimum* (Sm.) Schust.

Delmarva Status and Distribution: Species is historical on the Delmarva, known only from the two collections cited. Del.: New Castle (A. Commons, s.n., 1894, NY; A. Commons, s.n., 1895, PH).

Delmarva Habitat: Forming patches on moist to dry mineral soil on banks and slopes.

#### Lejeuneaceae

*Cololejeunea biddlecomiae* (Austin) A. Evans

Delmarva Status and Distribution: Common. Del.: New Castle; Kent; Sussex. Md.: Cecil; Caroline; Talbot; Wicomico; Somerset; Worcester Va.: Accomack; Northampton.

Delmarva Habitat: Epiphytic on the bark of trees in woods and swamps, usually forming minute patches in bark furrows and intermingled with other species.

*Cololejeunea cardiocarpa* (Mont.) R. M. Schust.

Delmarva Status and Distribution: Species is historical on the Delmarva, known only from a single collection from Accomack Co., Virginia. The species is cited here based on Schuster (1980): Vol. IV, page 1281, "at the northern most American station on Assateague Island, Virginia (R.M.S 78-301). Species occurs in the tropics and Florida, north on the Coastal Plain to the Delmarva Peninsula, its northern limit.

Delmarva Habitat: Epiphytic on the bark of trees.

*Cololejeunea minutissima* (Sm.) Schiffn. subsp. *minutissima*

Delmarva Status and Distribution: Uncommon. Species is found from Alabama and Florida, north to the Delmarva Peninsula, its northern limit. Del.: Sussex. Md.: Worcester. Va.: Accomack; Northampton.

Delmarva Habitat: Epiphytic on the bark of trees in woods and swamps, usually forming minute patches in bark furrows and intermingled with other species.

*Lejeunea maxonii* (Evans) X.-L. He *Rectolejeunea maxonii* A. Evans

Delmarva Status and Distribution: Rare. Species is tropical, being found in Puerto Rico, Jamaica and Florida, then north along the Atlantic coast to the Delmarva Peninsula, its northern limit. Del.: Sussex. Md.: Worcester. Va.: Northampton.

Delmarva Habitat: Epiphytic on the bark of trees in swamps, often mixed with other bryophytes.

*Leucolejeunea clypeata* (Schwein.) A. Evans

Delmarva Status and Distribution: Common. Del.: Kent; Sussex. Md.: Kent; Caroline; Dorchester; Wicomico; Somerset; Worcester. Va.: Accomack; Northampton.

Delmarva Habitat: Epiphytic, forming large, flat solid patches on tree trunks in woods and swamps, often found on American holly (*Ilex opaca*).

*Leucolejeunea conchifolia* (A. Evans) A. Evans

Delmarva Status and Distribution: Rare. Species occurs from Texas, east to Florida, then north to the Delmarva Peninsula, its northern limit. Md.: Dorchester.

Delmarva Habitat: Epiphytic on the bark of trees in woods.

*Leucolejeunea uncioloba* (Lindenb.) A. Evans

Delmarva Status and Distribution: Rare. Species is found in Texas and Mexico, east to Florida, then north to the Delmarva Peninsula, its northern limit. Del.: Sussex (A. Commons, s.n., 1893, NY). Md.: Wicomico. Va.: Accomack (E. Mears, s.n. 1891, NY).

Delmarva Habitat: Epiphytic on the bark of trees in swamp.

#### Lepidoziaceae

*Bazzania trilobata* (L.) Gray

Delmarva Status and Distribution: Common. Del.: New Castle; Kent; Sussex. Md.: Caroline; Talbot; Dorchester; Wicomico; Worcester. Va.: Accomack.

Delmarva Habitat: Forming patches on humus in deep swamps and less frequently on mineral soil of steep wooded slopes.

*Kurzia sylvatica* (Evans) Grolle

Delmarva Status and Distribution: Uncommon. Del.: Kent; Sussex. Md.: Kent; Caroline; Talbot; Dorchester; Worcester. Va.: Accomack; Northampton.

Delmarva Habitat: Typically on moist mineral soil of steep wooded slopes and less frequently on humus and other organic substrates in swamps.

*Telaranea nematodes* (Gottsche ex Austin) M. Howe

Delmarva Status and Distribution: Common. This species is near its northern limit on the Delmarva; it is found from Central America and the Caribbean, north along the Coastal Plain to Long Island, New York. Del.: Sussex. Md.: Kent; Queen Anne's; Dorchester (Biechele); Wicomico; Somerset; Worcester (Biechele). Va.: Accomack; Northampton.

Delmarva Habitat: Intermingled with other bryophytes on humus and other organic substrates in swamps; easily overlooked.

#### Lophocoleaceae

*Chiloscyphus polyanthus* (L.) Corda var. *rivularis* (Schrad.) Nees *C. rivularis* (Schrad.) Loeske

Delmarva Status and Distribution: Rare. Del.: New Castle. Md.: Queen Anne's; Worcester.

Delmarva Habitat: Developing patches on gravel, humus and soft soil in cool, hillside seepage wetlands, and submersed in shallow streams that originate from hillside seeps.

*Lophocolea bidentata* (L.) Dumort. *Chiloscyphus chlorophyllus* (Hook. f. & Taylor) Mitt.

Delmarva Status and Distribution: Rare. Md.: Queen Anne's.

Delmarva Habitat: On gravel, humus and other organic substrates in cool, hillside seepage wetland.

*Lophocolea heterophylla* (Schrad.) Dumort. *Chiloscyphus profundus* (Nees ) J.J. Engel & R. M. Schust.

Delmarva Status and Distribution: Common in all counties of the Delmarva.

Delmarva Habitat: On bark on the base of trees, mineral soil, humus, and other organic substrates in woods and swamps.

*Lophocolea minor* Nees *Chiloscyphus minor* (Nees) J.J. Eng. & R.M. Schust.

Delmarva Status and Distribution: Rare. Del.: Sussex. Md.: Queen Anne's; Caroline; Worcester (S. King, 196, 2000, DOV).

Delmarva Habitat: Forming creeping patches on bark at the base of trees and rarely on mineral soil.

#### Metzgeriaceae

*Metzgeria furcata* (L.) Dumort.

Delmarva Status and Distribution: Uncommon. Del.: Kent; Sussex. Md.: Caroline; Wicomico; Worcester.

Delmarva Habitat: Epiphytic on the bark of trees in swamps, or along streams; often on smooth barked tree species, such as *Carpinus caroliniana*.

Additional Information: A form of this species with thalli that are copiously gemmiparous (treated by some authors as variety *ulvula* Nees), has been found on the Delmarva.

#### Pallaviciniaceae

*Pallavicinia lyellii* (Hook.) Carruth.

Delmarva Status and Distribution: Common in all counties of the Delmarva.

Delmarva Habitat: Forms mats on organic substrates in shady swamps.

#### Pelliaceae

*Pellia epiphylla* (L.) Corda

Delmarva Status and Distribution: Common. Del.: New Castle; Sussex. Md.: Kent; Queen Anne's; Dorchester; Somerset; Worcester. Va.: Accomack.

Delmarva Habitat: Forms patches on organic substrates in swamps, forested seeps and along streams.

#### Porellaceae

*Porella pinnata* L.

Delmarva Status and Distribution: Uncommon. Del.: Kent; Sussex. Md.: Caroline; Queen Anne's; Talbot; Worcester (SUHC). Va.: Northampton.

Delmarva Habitat: Forming dense, hanging patches on roots, bases of trees, and other organic substrates along the edges of freshwater tidal and non-tidal streams and rivers; plants are submersed at high tides and during flooding events or periods of high water.

*Porella platyphylla* (L.) Pfeiff.

Delmarva Status and Distribution: Rare. Md.: Cecil; Somerset (Biechele); Worcester.

Delmarva Habitat: Epiphytic on the bark of deciduous trees in moist woods and swamps.

#### Pseudolepicoleaceae

*Blepharostoma trichophyllum* (L.) Dumort.

Delmarva Status and Distribution: Species is historical on the Delmarva, known only from the single collection cited. Md.: Worcester (E. Worthley, 85208, 1967, MO).

Delmarva Habitat: Decorticated logs in swamps, usually mixed with other bryophytes.

#### Ptilidiaceae

*Ptilidium pulcherrimum* (Weber) Hampe

Delmarva Status and Distribution: Species is historical on the Delmarva, known only from the single collection cited. This species could be considered disjunct on the Delmarva; it occurs on the Atlantic Coastal Plain from Massachusetts south to Long Island, New York and then is scattered widely through the Piedmont and Appalachian Mountains south to North Carolina. Del.: Sussex (A. Commons, s.n., 1893, PH).

Delmarva Habitat: Bark of trees. Historical collection is on the bark of loblolly pine (*Pinus taeda*).

#### Radulaceae

*Radula complanata* (L.) Dumort.

Delmarva Status and Distribution: Rare. Del.: Kent; Sussex. Md.: Caroline; Wicomico; Worcester (SUHC).

Delmarva Habitat: Epiphytic on the bark of trees in swamps.

*Radula obconica* Sull.

Delmarva Status and Distribution: Rare. Del.: Sussex. Md.: Caroline; Wicomico (SUHC); Worcester (SUHC).

Delmarva Habitat: Epiphytic on the bark of trees in swamps.

#### Scapaniaceae

*Gymnocolea inflata* (Huds.) Dumort.

Delmarva Status and Distribution: Rare. Del.: Sussex.

Delmarva Habitat: Forming creeping patches on moist, peaty sand in wetland depressions dominated by cranberry (*Vaccinium macrocarpon*) within the inner dunes along the coast. *Lophozia bicrenata* (Schmid. ex Hoffm.) Dumort. *Jungermannia bicrenata* Schmidel

Delmarva Status and Distribution: Rare. Del.: New Castle (A. Commons, s.n., 1895, NY). Md.: Queen Anne's; Worcester.

Delmarva Habitat: Forming small creeping patches on bare, dry sandy soils; plants are closely appressed to soil.

*Lophozia capitata* (Hook.) Macoun *Jungermannia capitata* Hook.

Delmarva Status and Distribution: Rare. Md.: Worcester (SUHC).

Delmarva Habitat: Forming small creeping patches on moist sandy soils.

*Scapania nemorea* (L.) Grolle

Delmarva Status and Distribution: Common in all counties of the Delmarva.

Delmarva Habitat: On moist, bare mineral soil in woods and on slopes, and on soil and organic substrates in seepages.

#### Trichocoleaceae

*Trichocolea tomentella* (Ehrh.) Dumort.

Delmarva Status and Distribution: Rare. Del.: New Castle, Kent; Sussex. Md.: Worcester.

Delmarva Habitat: Forming patches on humus in swamps and along streams, and is perhaps Delmarva's most pulchritudinous liverwort.

#### Phylum Anthocerotophyta (Hornworts)

##### Class Anthocerotopsida

##### Anthocerotaceae

*Phaeoceros carolinianus* (Michx.) Prosk. *Anthoceros carolinianus* Michx.; *Phaeoceros laevis* (L.) Prosk. subsp. *carolinianus* (Michx.) Prosk.

Delmarva Status and Distribution: Uncommon. Md.: Wicomico; Somerset; Worcester.

Delmarva Habitat: On bare, moist mineral soils, usually disturbed soils.

##### Notothyladaceae

*Notothylas orbiculatus* (Schwein.) Sull.

Delmarva Status and Distribution: Uncommon. Del.: Kent; Sussex. Va.: Northampton.

Delmarva Habitat: On wet mineral soil, in puddles, tire tracks in fields, and ditch banks.

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