ARONIA MEDIK. IN THE NETHERLANDS II. ECOLOGY OF A. × PRUNIFOLIA (MARSH) REHD. IN THE DUTCH HAF DISTRICT

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SUMMARY

Aronia × prunifolia has run wild in a number of reed marsh nature reserves in the western part of The Netherlands. Both in open Sphagnum-dominated communities and below the canopy of woodland the bushes can maintain themselves and reproduce, although performance in open vegetation seems to be better. On gaining dominance in the vegetation both the herb and the bryophyte layer become strongly reduced.

From laboratory experiments environmental circumstances as encountered in reed marshes do not seem to affect the germination of Aronia adversely. No significant relations could be detected between the composition of the vegetation and the amounts of nutrients available in the ground water at sites where Aronia was present. Only high cover percentages of Aronia were correlated with elevated amounts of NH4+. The species may be found over a wide range from more or less oligotrophic conditions to slightly brackish and moderately eutrophic conditions.

Factor analysis of the vegetation data produced no obvious relations with abiotic conditions. The density of Aronia and the structure of the vegetation dominated the first two factors, accounting for 47% of the variance in the data.

1. INTRODUCTION

Species from the North American genus Aronia (Rosaceae) were recorded in The Netherlands from 1875 on. In the first decades of the present century they spread to a number of nature reserves in the western part of the country (Vlieger 1947). In 1911 Thuisse (1911) welcomed Aronia as an addition to the flora of the Naardermeer (N.-Holland), but in the second half of this century it turned out to be a serious pest in several nature reserves (Frenken 1975, Van der Velde & Brand 1974, Werkgroepen K.N.N.V. Afd. Amsterdam 1973). Problems in the management of nature reserves suffering from fast growing Aronia-populations led to investigation of the presence of Aronia in The Netherlands and some aspects of its ecology (Beentjes 1979), especially in reed marshes where rapidly expanding shrubs were suppressing the reed marsh vegetation.

A first result of the inventory of Aronia-populations in the Haf District was, that the plants cannot be treated as belonging to one or more “true” species, but that they belong to a hybrid complex for which the name Aronia × prunifolia (Marsh.) Rehd. is appropriate (Wiegers 1983).

The present paper deals with the types of vegetation invaded by Aronia in nine reed marsh nature reserves in the Dutch Haf District, changes in the vegeta-
tion following this invasion, some aspects of the ecology of this hybrid complex and a brief survey of the ecological position of *Aronia* in North America.

2. MATERIALS AND METHODS

Relevés were made in nine areas where *Aronia* was present, according to the methods of the French-Swiss tradition (BRAUN-BLANQUET 1964), using the cover/abundance scale of LONDO (1976). Relevés were made both in stands with *Aronia* and in adjacent stands of the same vegetation lacking this species. The relevés were ordered by hand into a structured table. Here only the relevés with *Aronia* will be presented.

Nomenclature of higher plants follows HEUKELS-VAN OOSTSTROOM (1977), of bryophytes MARGADANT & DURING (1982), and of syntaxa WESTHOFF & DEN HELD (1969).

The areas of investigation are marked in *fig. 1*. Samples of the ground water were taken at a depth of c. 25 cm at 28 sites of relevés with *Aronia* and at 18 sites adjacent to these sampling sites in the same plant community but lacking *Aronia*. These water samples were taken in the first half of June 1977. The results of their analysis hence only illustrate differences or similarities between the sites...
at the moment of sampling. The substrate at all sites was peat (80–95% organic matter).

The water samples were filtrated (filter pore diameter 0.45μ) and subsequently the following measurements were carried out. Electric Conductivity was assessed with an electrode coupled to a Philips PW9505 conductivity meter; pH and concentration of NH₄⁺ were measured with specific electrodes coupled to an Orion 701 meter. Alkalinity was determined by titration to pH 4.6 with 0.01N HCl. Concentrations of PO₄³⁻, NO₃⁻, NO₂⁻ and SO₄²⁻ were measured with a Beckman Acta V spectrophotometer. Cl⁻ concentration was assessed potentiometrically by means of an AgNO₃ solution. Concentration of Na⁺ and K⁺ were determined using an Eppendorf flame-photometer, and those of Mg²⁺ and Ca²⁺ with a Perkin Elmer Absorption Spectrophotometer 290 B.

A subset of 28 relevés was submitted to factor analysis using a BMDP4M-routine available at the Botanical Institute of the University of Rome. A cluster analysis using a routine from ORLOCI & BOWLES (1982) was carried out on the results from the water analysis for evaluation of the resemblances in ecological conditions between the different sites.

From the investigated sites samples were taken of Aronia stems at 25 cm above soil level to determine relations between age, stem density and stem diameter in five Aronia-populations. In September 1978 sites were visited to collect branches with ripe fruit from plants growing scattered in reed marsh vegetation, from closed scrub in woodland margins, and from plants growing under a tree canopy to measure the diameter of the fruit produced under these different ecological conditions.

Using seeds harvested from a population at Nieuwkoop germination experiments were carried out at the laboratory to test the influence of pH of the substrate on the germination percentage and to assess the rate of germination at an optimum level of pH. The seeds used in these experiments were stored at 10°C after being harvested. In a first experiment a pretreatment to break dormancy (14 days at 4°C under moist conditions) was applied to one half of the seed lot and the influence of different levels of pH was tested. The seeds were put onto filter paper in Petri dishes wetted with distilled water brought to pH 3, 4, 5, 6 or 7 by means of an acetic acid resp. sodium phosphate buffer solution. Each combination of cold pretreatment and pH was tested for two batches of ten seeds. The filter paper was wetted twice per week and pH was checked and, if necessary, adjusted. The experiment was terminated after 15 weeks. In a second experiment only pH 4 was used and all seeds received a cold pretreatment as described above. Ten Petri dishes each containing 20 seeds were used. For 15 weeks the number of germinated seeds was counted weekly. The germinated seeds were removed from the Petri dishes.

In both experiments the Petri dishes were placed in a growth chamber. During the light period (16 hours per day, ± 6,000 lux) the temperature was kept at 25°C, whereas during the dark period (8 hours/day) this was lowered to 15°C.
3. RESULTS

3.1. Germination experiments
The results of the first experiment are presented in table 1. The positive effect of the cold pretreatment is obvious throughout the pH range tested. Differences in pH of the medium seem to be of no importance between pH 3 and 7, levels of pH met with by Aronia at the investigated sites, and in most reed marshes in The Netherlands.

The results of the second experiment are given in table 2. Within 6 ± 2 weeks 70% of the seeds germinated. The total germination percentage after 15 weeks was 44%, which does not differ significantly from the 46% attained in the previous experiment.

3.2. Relations between stem density, age, and stem diameter
The results of the measurements and the counting of year rings in five populations are graphically presented in fig. 2. In the dense populations (stem densities 50–200 stems/m²) sampled at the sites Delft, Buitenliede, and Weerribben no shoots older than 8 years were found. At the other sites (stem densities < 50 stems/m²) individual shoots with an age of 13 years could be sampled. The regression lines for the five populations sampled indicate a lower increment rate in the dense populations and higher variation of this feature, indicated by lower correlation coefficients for the regression lines.

3.3. Diameter of the fruit in relation to the site
The diameter of fruits from different site types is summarized in fig. 3. Site conditions clearly influence fruit size. Under a tree canopy fruit size is distinctly smaller (8.7 ± 1.0 mm) than in plants from open habitats (10.2 ± 1.0 mm). Plants growing in woodland margins exhibit a fruit size that is intermediate (9.6 ± 1.0 mm).

Table 1. Germination of Aronia × prunifolia at different levels of pH, with or without a cold pretreatment of 14 days at 4°C. Each sample contained 20 seeds.

<table>
<thead>
<tr>
<th>pH</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
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<th>4</th>
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<tr>
<td>cold pretreatment</td>
<td>no</td>
<td>no</td>
<td>no</td>
<td>no</td>
<td>yes</td>
<td>no</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>number of seeds germinated</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>10</td>
<td>8</td>
<td>9</td>
<td>8</td>
<td>11</td>
<td></td>
</tr>
</tbody>
</table>

Table 2. Germination rate of Aronia × prunifolia at pH 4, following a cold pretreatment (14 days at 4°C). In this experiment 10 Petri dishes each containing 20 seeds were used.

<table>
<thead>
<tr>
<th>week number</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>11</th>
<th>12</th>
<th>13</th>
<th>14</th>
<th>15</th>
</tr>
</thead>
<tbody>
<tr>
<td>number of seeds germinated</td>
<td>5</td>
<td>9</td>
<td>8</td>
<td>16</td>
<td>15</td>
<td>16</td>
<td>4</td>
<td>6</td>
<td>4</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>
3.4. Vegetation analysis

In the structured table (table 3) six groups of relevés are delineated on the basis of differential species groups in five groups. The sixth group has no differential species.

Group A (rel. 1–28) shows a good resemblance with the Sphagnetum palustri-papillosi, in this table characterized by the differential species Eriophorum angustifolium, Oxycoccus palustris, and Vaccinium vitis-idaea, the presence of Calypo-
Fig. 3. Diameter of the fruit of *Aronia × prunifolia* from three different site types. a. under a tree canopy in woodland, b. in dense scrub in woodland margins, c. in tall herb vegetation.
<table>
<thead>
<tr>
<th>Species</th>
<th>Area</th>
<th>Height</th>
<th>Herb</th>
<th>Shrub</th>
<th>Year</th>
<th>Cover</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Opogona macrocarpa</td>
<td>400</td>
<td>3</td>
<td>2</td>
<td>0</td>
<td>1940</td>
<td>0.03</td>
<td>0.02</td>
</tr>
<tr>
<td>Eriophorum angustifolium</td>
<td>200</td>
<td>2</td>
<td>2</td>
<td>0</td>
<td>1930</td>
<td>0.02</td>
<td>0.01</td>
</tr>
<tr>
<td>Calluna vulgaris</td>
<td>100</td>
<td>2</td>
<td>2</td>
<td>0</td>
<td>1920</td>
<td>0.01</td>
<td>0.01</td>
</tr>
<tr>
<td>Vaccinium vitis-idaea</td>
<td>500</td>
<td>5</td>
<td>2</td>
<td>2</td>
<td>1910</td>
<td>0.05</td>
<td>0.02</td>
</tr>
<tr>
<td>Orontium aquaticum</td>
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<td>2</td>
<td>2</td>
<td>0</td>
<td>1900</td>
<td>0.01</td>
<td>0.01</td>
</tr>
<tr>
<td>Potentilla erecta</td>
<td>500</td>
<td>5</td>
<td>2</td>
<td>2</td>
<td>1890</td>
<td>0.05</td>
<td>0.02</td>
</tr>
<tr>
<td>Calamagrostis canescens</td>
<td>200</td>
<td>2</td>
<td>2</td>
<td>0</td>
<td>1880</td>
<td>0.02</td>
<td>0.01</td>
</tr>
<tr>
<td>Betula pendula</td>
<td>100</td>
<td>2</td>
<td>2</td>
<td>0</td>
<td>1870</td>
<td>0.01</td>
<td>0.01</td>
</tr>
<tr>
<td>Crataegus monogyna</td>
<td>500</td>
<td>5</td>
<td>2</td>
<td>2</td>
<td>1860</td>
<td>0.05</td>
<td>0.02</td>
</tr>
<tr>
<td>Malus sylvestris</td>
<td>100</td>
<td>2</td>
<td>2</td>
<td>0</td>
<td>1850</td>
<td>0.01</td>
<td>0.01</td>
</tr>
<tr>
<td>Quercus robur</td>
<td>500</td>
<td>5</td>
<td>2</td>
<td>2</td>
<td>1840</td>
<td>0.05</td>
<td>0.02</td>
</tr>
</tbody>
</table>
Table 3. Relevés with Aronia × prunifolia, made at the following sites: B = Buitenliede, L = Binnenliede, O = Oostenderpoel, P = Amstelveense Poel, N = Nieuwkoop, I = Iperveld, D = Delft (Tweemolentjesvaart), U = Ursem, W = Weerribben.

ADDITIONAL SPECIES: Acer pseudoplatanus 25; rl; Agrostis stolonifera 25: pl, 52; pl; Amelanchier lamarkii 25: rl; 88: rl; Bryum pseudotriquetrum 27: ml; Calliergon stramineum 18: al; Calypogeia trichomanis 6: al; Carex curta 42: m4; C. elongata 62: rl; C. hudsonii 87: rl; C. lasiocarpa 56: pl; C. nigra 40:1; C. paniculata 36: pl; Chamaenerion angustifolium 1: pl, 81: rl; Chilo- scyphus polyanthus 2: pl, 61: pl; Dicranella cerviculata 90: pl; Dicranum longifolium 12: ml; D. scoparium 40: rl; Drepanoclados fluitans 45: +; Empetrum nigrum 28: 6; Epilobium palustre 1: rl; Erica tetralix 8: 1", 9: pl; Eupatorium cannabinum 39: rl, 73: rl; Euphorbia palustris 66: rl; Funaria hygrometra 27: al; Galium palustre 57: al, 61: al; Hypochaeris radicata 36: rl; Lepidium pyrojense 27: ml2; Lonicer periclymenum 38: rl, 55: rl; Lophocolea heterophylla 26: al, 27: ml; Myosotis palustris 41: rl; Orchis praetermissa 4: pl; Oxalis europaea 70: a2; Pedicularis palustris 61: a2; Pellia epiphylla 11: al; Phalaris arundinacea 61: pl; Poa palustris 50: pl; P. trivialis 61: al; Polytrichum longisetum 52: pl; Potentilla anglica 52: rl; P. palustris 56: rl; Prunus serotina 64: rl; Ranunculus repens 19: +; Ribes nigrum 68: rl, 70: 70; Rumex hydrolapathum 58: rl; Salix aurita 88: p2; Scirpus maritimus 18: al, 19: +; Sparganium nemorum 9: 5", 12: m4; S. papillosum 11: 1", 12: m2; The- lypterus palustris 32: pl; Typha latifolia 19: +; Urtica dioica 63: rl, 80: pl.
gea fissa, Drosera rotundifolia and Pallavicinia lyellii, and the abundance of Polytrichum commune and Sphagnum flexuosum. Mean cover percentage of Aronia in this group is c. 10%.

Group B (rel. 29–42) cannot be assigned to any single syntaxon on the basis of its differential species group (Juncus subnodulosus, Molinia caerulea, and Potentilla erecta). From the species group shared with the relevé groups A and C it might be named a poorly developed and relatively dry variant of the Thelypterido-Phragmitetum. Mean cover of Aronia is slightly over 10%.

Group C (rel. 43–54) has no differential species but is characterized by the combination of species that are also present in the relevé groups A and B, or more optimally represented in relevé group D. It shows both characteristics of the Thelypterido-Phragmitetum and the Valeriano-Filipenduletum. Mean cover of Aronia is almost 20%.

Group D (rel. 55–66) represents the Valeriano-Filipenduletum. Its characteristic species Lychnis flos-cuculi, Lysimachia vulgaris, and Lythrum salicaria have their optimum in this group. With the remaining relevé groups it shares the presence of Eurhynchium praelongum and Mnium hornum, species very common on a raw litter layer. This group is considerably richer in species (56) than the relevé groups A, B, C, and E (41–46 species). Aronia is often limited to scattered shoots (mean cover percentage less than 5%).

Group E (rel. 67–81) unites woodland and shrub communities, generally with a well-developed shrub layer of Aronia. It can be judged to belong partly to the Carici elongatae-Alnetum by the presence of Betula pubescens, Cirsium palustre, Solanum dulcamara, and Sphagnum palustre and partly to the Salicion cinareae (the shrub communities in this relevé group). Transitions to communities belonging to the Alno-Padion are visible from the presence of Crataegus monogyna, Melandrium rubrum, Poa trivialis, and Sambucus nigra. Mean cover percentage of Aronia in this relevé group is over 25%.

Group F (rel. 82–90) is very poor in species (18), which may be partly related to the dominance of Aronia (mean cover percentage over 50%). From the, sometimes sparse, presence of Betula pubescens, Frangula alnus, Salix cinerea, Sphagnum palustre, and S. squarrosum a weak affinity to the Franguletea can be concluded.

Factor analysis carried out on a subset of 28 relevés, considered as fairly good representatives for the six relevé groups, indicated the same separation into groups as presented in table 3. It revealed a major separation into two groups, one with positive loadings on the second axis (A, B, and C) and one with negative loadings on this axis (D, E, and F) (fig. 4). Within both groups there is a strong correlation between the loading on the first axis and the cover percentage of Aronia, relevés with high quantities of this species receiving high positive values. The second factor is closely related to the structure in the vegetation. Relevés with only a herb layer generally have high positive loadings on this factor whereas woodland communities receive high negative loadings. These two factors account for 47% of the variance in the data.
3.5. Ecological factors
The results of the water analyses from sites with *Aronia* and comparable sites lacking this species are given in table 4. For relevé group F no equivalent of this vegetation type lacking *Aronia* could be sampled. No differences in the ground water properties measured could be found between sites with *Aronia* and sites lacking this species. Alkalinity could only be measured in several samples from group C and D and NO₃⁻ was detectable in only five samples. These two factors are not included in table 4.

In all relevé groups ground water levels varied between -10 and -15 cm. Electric Conductivity varied between 132 µS/cm and 950 µS/cm. Mean values for the six relevé groups varied slightly, but ranges for all groups showed considerable overlap. There were no obvious differences in pH of the ground water of all the samples. The values ranged between 3.3 and 6.3, low values being more frequent in relevé groups A and F and high values being more frequent in relevé groups D and C.

Fig. 4. Projection of a subset of 28 relevés on the first two axes determined by factor analysis. These two axes account for 47% of the variation in the data. The first factor is correlated with the density of *Aronia* in the vegetation, the second with the structure of the vegetation.
Table 4. Results of water analysis from sites belonging to the six vegetation types from table 3, with (+) or without (−) Aronia. n = number of samples, n.d. = not detectable. Ion concentrations in mg/l.

<table>
<thead>
<tr>
<th>Relevé group</th>
<th>n</th>
<th>pH</th>
<th>Cl⁻</th>
<th>PO₄³⁻</th>
<th>NO₂⁻</th>
<th>SO₄²⁻</th>
<th>NH₄⁺</th>
<th>Ca²⁺</th>
<th>Mg²⁺</th>
<th>Na⁺</th>
<th>K⁺</th>
</tr>
</thead>
<tbody>
<tr>
<td>A +</td>
<td>7</td>
<td>3.4–3.5</td>
<td>71.0±25.9</td>
<td>.53±.26</td>
<td>.03±.02</td>
<td>12.0±1.6</td>
<td>.78±.12</td>
<td>9.0±.4</td>
<td>4.0±1.4</td>
<td>32.8±10.4</td>
<td>6.3±1.5</td>
</tr>
<tr>
<td>B +</td>
<td>4</td>
<td>4.5–4.9</td>
<td>58.3±24.5</td>
<td>.40±.22</td>
<td>.03±.02</td>
<td>32.0±25.5</td>
<td>.44±.27</td>
<td>11.3±7.1</td>
<td>4.7±2.3</td>
<td>29.0±11.4</td>
<td>3.7±2.9</td>
</tr>
<tr>
<td>C +</td>
<td>3</td>
<td>5.4–5.6</td>
<td>93.3±5.8</td>
<td>.83±.12</td>
<td>.03±.02</td>
<td>51.0±10.2</td>
<td>1.23±.15</td>
<td>16.3±4.0</td>
<td>8.0±4.1</td>
<td>39.0±16.8</td>
<td>13.0±2.8</td>
</tr>
<tr>
<td>D +</td>
<td>5</td>
<td>3.7–4.8</td>
<td>34.7±9.1</td>
<td>.35±.07</td>
<td>.09±.02</td>
<td>53.0±19.5</td>
<td>.79±.31</td>
<td>13.7±5.9</td>
<td>5.7±2.1</td>
<td>21.3±5.0</td>
<td>9.0±2.8</td>
</tr>
<tr>
<td>E +</td>
<td>5</td>
<td>3.4–4.07</td>
<td>83.8±42.3</td>
<td>.67±.29</td>
<td>.03±.02</td>
<td>43.3±8.6</td>
<td>2.72±.41</td>
<td>23.0±4.8</td>
<td>6.6±3.8</td>
<td>42.0±22.0</td>
<td>8.0±4.9</td>
</tr>
<tr>
<td>F +</td>
<td>3</td>
<td>4.0–5.0</td>
<td>65.3±16.2</td>
<td>.78±.30</td>
<td>.08±.05</td>
<td>55.7±14.5</td>
<td>1.31±.69</td>
<td>13.0±1.0</td>
<td>7.0±3.5</td>
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<td>3.0±1.0</td>
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<tr>
<td></td>
<td>4</td>
<td>3.6–4.3</td>
<td>111.0±55.2</td>
<td>.60±.41</td>
<td>.06±.04</td>
<td>29.3±15.5</td>
<td>2.73±1.46</td>
<td>20.7±3.1</td>
<td>7.5±3.7</td>
<td>62.3±15.3</td>
<td>12.0±2.2</td>
</tr>
</tbody>
</table>
The interpretation of the main discriminating factor is indicated:

<table>
<thead>
<tr>
<th>group</th>
<th>relevé numbers</th>
<th>interpretation</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>8, 14, 15, 23, 28, 29, 56, 65, 77, 79</td>
<td>Cl(^-) &lt; 55 mg/l</td>
</tr>
<tr>
<td>II</td>
<td>3, 24, 36, 41, 45, 48, 51, 58, 60, 61, 74, 90</td>
<td>Cl(^-) 55–100 mg/l</td>
</tr>
<tr>
<td>III</td>
<td>32, 69, 73, 83, 85, 87</td>
<td>Cl(^-) &gt; 100 mg/l</td>
</tr>
</tbody>
</table>

NH\(_4^+\)-concentrations were significantly higher in E and F (ranging from 0.82 to 4.3 mg/l) than in the other groups (0.14–1.4 mg/l), both in samples with and in samples without Aronia. Ca\(^{2+}\)-concentrations varied between 5 and 42 mg/l. Mean values for the groups did not differ significantly. The same holds for Mg\(^{2+}\)-concentrations (1–14 mg/l), Na\(^+\)-concentrations (11–74 mg/l), and K\(^+\)-concentrations (1–15 mg/l).

Anion concentrations also show considerable overlap between the relevé groups. Cl\(^-\)-concentrations varied from 22 till 150 mg/l, PO\(_4^{3-}\)-concentrations from 0.2 till 1.2 mg/l, NO\(_2^-\)-concentrations from 0.01 till 0.19 mg/l, and SO\(_4^{2-}\)-concentrations from 8 till 110 mg/l. No significant differences were found between the relevé groups or between samples from sites with Aronia and sites lacking this species.

Cluster analysis of the 28 water samples from sites with Aronia rendered three groups at a fusion level of 4.0 (table 5). The division into these three groups appears to be caused mainly by the Cl\(^-\)-concentration. In the first group all values are lower than 55 mg/l and in the third group they are higher than 100 mg/l. All samples but one in the second group have intermediate Cl\(^-\)-concentrations. Sample 58 has a lower value, but has obviously been linked to sample 61 on the basis of its high SO\(_4^{2-}\)-concentration. Only in these two samples it exceeds 100 mg/l. This subdivision does not correspond with the division into six groups based on floristic composition and shows no relation with the ordination of the 28 relevés.

Ranking the relevé groups on the basis of mean ion concentrations in the water samples produces a sequence that is equal to the ranking based on mean kation concentrations. In this sequence A and B are the least minerotraphentous communities and C and F are the richest in mineral nutrients. Ranking on the basis of NH\(_4^+\)-concentrations has the highest correlation with average cover values of Aronia.

4. (SYN-)ECOLOGICAL POSITION OF ARONIA IN NORTH AMERICA

In North America Aronia is a common element of shrub communities on ombrotrophic bogs and their woodland fringes (Gauthier & Grandtner 1975, Knapp
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1965, Pollett & Bridgewater 1973, Potonié 1912), but it is also present in moderately rich fen vegetation and their corresponding woodlands (Pollett & Bridgewater 1973, Rousseau 1974, Uphof 1932). Following disturbance of a bog site, e.g. by a fire, it may exhibit an aggressive growth habit comparable to its behaviour in the Dutch Haf District.

5. DISCUSSION AND CONCLUSIONS

Information about the presence of Aronia at other sites in Europe is very scarce. Sukopp (1959/60, 1962) mentions it to be present in the woodland fringes of bogs and at slightly eutrophicated sites in ombrotrophic bogs.

In The Netherlands Aronia × prunifolia is present in a wide range of peatland ecosystems in the western part of the country. Germination seems not to be affected adversely by a closed Sphagnum layer resulting in a low pH of the substrate. Following germination the plants remain vegetative in their first growing season, flowering in the next year for the first time.

Differences in ecological conditions between sites with Aronia in a range of vegetation types were only gradual. High densities of the shrub are correlated with NH₄⁺-concentrations in the ground water between 1.0 and 4.5 mg/l.

In all relevé groups high cover values of Aronia involve a reduction of the total number of species. The communities in relevé group F could have been evolved from any of the communities in the other relevé groups. The strong dominance of Aronia, forming a dense shrub, reduced the available light at soil level apparently so strongly that the development of many species is prohibited. Bryophyte cover of the soil and litter layer, which may reach well over 50% in peatland ecosystems is also strongly reduced.

The tendency to gain dominance in widely different vegetation types presents a potential threat to quite a few nature reserves where the species is not yet present. Although fruiting of the species can effectively be suppressed by yearly mowing, expansion of existing bushes is not affected by this type of management. Just below the surface of the soil or the moss cover horizontal shoots are produced, resulting in a network of underground stems. Abandoning mowing management at sites where the species has built up a dense underground shoot system may result in rapid development of dense bushes, suppressing the original local vegetation.

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