SHORT COMMUNICATIONS

CONTROL OF GROWTH IN CALLITRICHÉ SHOOTS BY GROWTH RETARDANTS AND GIBBERELLIC ACID*

By C. H. Wong†‡ and A. J. McComb†

Shoots of the aquatic, Callitircé, form floating rosettes of leaves, the internodes of which elongate if the shoot is submerged, or treated at the water surface with gibberellic acid (McComb 1965; Wong and McComb 1967). It may therefore be tentatively proposed that submerged shoots synthesize more gibberellin than do floating shoots. To obtain further information concerning this hypothesis, investigations have been carried out with the growth retardants Amel1618 and CCC, compounds which characteristically bring about dwarfing in higher plants, an effect reversed by gibberellin (e.g. McComb and McComb 1970), and which have been shown to inhibit gibberellin biosynthesis in certain systems (e.g. Baldev, Lang, and Agatep 1965; Dennis, Upper, and West 1965; Zeevaart 1966).

Materials and Methods

Plants of Callitriche stagnalis Scop. were obtained and treated essentially as described by Wong and McComb (1967). Rosettes were selected at random, excised immediately below the basal leaves, and placed in the experimental solutions. Gibberellic acid (GA3; British Drug Houses, Poole, England, or Sigma Chemical Co., St. Louis, U.S.A.) was applied as a pretreatment by floating rosettes for 12 hr on an aqueous solution, blotting them dry, and transferring them to tap water for the remainder of the experimental period. Previous experiments (McComb 1965) showed that with 5 p.p.m. GA3, a treatment time of 12 hr (or more) gave a maximum growth response. When growth retardants were used, plants were grown throughout the experimental period in aqueous solutions of Amo 1618 (2-isopropyl-4-dimethylamino-3-methylphenyl-1-piperidine carboxylate; Nutritional Biochemical Corporation, Cleveland, Ohio) or CCC [(2-chloroethyl)trimethylammonium chloride; Cyanimid International, Wayne, New Jersey]. When submerged plants were required, rosettes (where appropriate pretreated with gibberellin) were attached to glass rods by thin, stainless-steel wire, and submerged about 25 cm below the water surface. Throughout the experimental period the plants were under constant light of about 100 f.c. from "warm-white" fluorescent tubes (Philips, Holland) 50 cm above the water surface. Experiments were carried out in an air-conditioned room at about 20°C.

Results and Discussion

As seen in Tables 1 and 2, treatment with growth retardants brought about a marked reduction in internode growth in both floating and submerged shoots. The treated plants also showed somewhat darker green coloration of leaves, and rather swollen nodes. (In preliminary work, 500 p.p.m. CCC proved toxic in 7 days.) The retarding effects of the chemicals were largely overcome by pretreatment with GA3.

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This reversal of the effects of Amo 1618 and CCC is consistent with the view that the retardants interfere with gibberellin synthesis in the plant, but do not affect gibberellin action. It is concluded that the growth of the shoots is dependent on the presence of gibberellin.

### Table 1

**Effect of Amo 1618 and Gibberellin Acid (GA$_3$) on the Lengths of Callitriche Shoots**

<table>
<thead>
<tr>
<th>Concentration of Amo 1618 (p.p.m.)</th>
<th>Mean length of floating shoots (mm)</th>
<th>Mean length of submerged shoots (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No GA$_3$ + GA$_3$ (5 p.p.m.)</td>
<td>No GA$_3$ + GA$_3$ (5 p.p.m.)</td>
</tr>
<tr>
<td>0</td>
<td>7.4 (2.8) 57.5 (2.5)</td>
<td>110.6 (37.6) 122.4 (7.0)</td>
</tr>
<tr>
<td>5</td>
<td>3.7 (0.3) 79.2 (6.8)</td>
<td>19.9 (1.6) 112.9 (14.0)</td>
</tr>
<tr>
<td>10</td>
<td>3.1 (0.4) 58.7 (5.5)</td>
<td>8.7 (1.5) 126.6 (8.5)</td>
</tr>
<tr>
<td>50</td>
<td>2.6 (0.2) 60.9 (5.5)</td>
<td>5.4 (0.7) 93.9 (3.0)</td>
</tr>
<tr>
<td>100</td>
<td>2.2 (0.1) 49.3 (7.6)</td>
<td>4.5 (0.5) 88.7 (2.1)</td>
</tr>
</tbody>
</table>

At first sight these observations may appear to offer support for the hypothesis that submerged shoots synthesize more gibberellin than do floating shoots. However, there remains the possibility that the submerged shoots are in some way rendered more “sensitive” to endogenous gibberellin than are the floating shoots, but that there is no difference in gibberellin synthesis; when growth retardants are used, the absence of endogenous gibberellin would preclude growth. If this were so, one might expect

### Table 2

**Effect of CCC and Gibberellin Acid (GA$_3$) on the Lengths of Callitriche Shoots**

<table>
<thead>
<tr>
<th>Concentration of CCC (p.p.m.)</th>
<th>Mean length of floating shoots (mm)</th>
<th>Mean length of submerged shoots (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No GA$_3$ + GA$_3$ (5 p.p.m.)</td>
<td>No GA$_3$ + GA$_3$ (5 p.p.m.)</td>
</tr>
<tr>
<td>0</td>
<td>15.0 (1.7) 61.6 (9.3)</td>
<td>87.9 (8.8) 131.4 (9.4)</td>
</tr>
<tr>
<td>5</td>
<td>4.5 (0.5) 94.2 (9.8)</td>
<td>25.0 (5.7) 107.2 (7.9)</td>
</tr>
<tr>
<td>10</td>
<td>4.8 (0.6) 85.4 (5.9)</td>
<td>7.6 (1.2) 109.7 (13.8)</td>
</tr>
<tr>
<td>50</td>
<td>3.4 (0.5) 79.2 (4.7)</td>
<td>4.0 (0.6) 53.1 (14.1)</td>
</tr>
<tr>
<td>100</td>
<td>3.1 (0.3) 36.5 (7.6)</td>
<td>4.0 (0.7) 64.0 (19.4)</td>
</tr>
</tbody>
</table>

submerged shoots, in the presence of retardants, to be more sensitive to exogenous gibberellin than floating rosettes. This suggestion is born out by the data in Table 1. In 10 p.p.m. Amo 1618 the growth of submerged plants was comparable with that of untreated floating shoots; however, after pretreatment with gibberellin the shoots submerged in Amo 1618 expanded more than twice as rapidly as the floating shoots.
A similar effect can be seen in Table 2 for CCC. Even at the highest Amo 1618 concentration used, the growth of GA$_3$-treated, submerged plants exceeded that of GA$_3$-treated, floating shoots in the absence of retardant.

As the 5 p.p.m. GA$_3$ solution was apparently not "saturating" the growth response of Callitriche in these experiments, a dose–response curve was obtained for different concentrations of GA$_3$, in the presence or absence of 10 p.p.m. Amo 1618 (Fig. 1). Maximum growth rates were achieved by plants treated with GA$_3$, whether or not they were submerged or floating, or treated with Amo 1618. At non-saturating levels of GA$_3$ the growth response of floating rosettes treated with Amo 1618 was greater than that of floating rosettes treated with the same concentration of GA$_3$. The response of floating shoots to GA$_3$ was also somewhat enhanced by the presence of Amo 1618, an effect noted with certain pea varieties (McComb and McComb 1970).

The suggestion that submerged shoots produce more gibberellin than floating shoots is tentatively discarded in favour of the hypothesis that floating shoots are less sensitive to endogenous gibberellin than are submerged shoots. It is useful to compare this suggestion with information available for the control of stem growth in pea plants, which are more readily available for extraction experiments. For that species, evidence is accumulating that the inhibitory effect of light on stem growth, and the genetic control of stem growth, are mediated through a control over the response of the tissue to gibberellin, rather than a control operating in the pathway of gibberellin synthesis (see, for example, Kende and Lang 1964; Jones and Lang 1968; McComb and McComb 1970).

Acknowledgments

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References


