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Effect of morphactine on differentiation and development of *Cymbidium* Sw. protocorms cultured *in vitro*

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Abstract

The morphogenetic effect of morphactine IT 3456 on meristematic tissue of *Cymbidium* Sw. was investigated within the dose range 0.01 to 10 ppm in *in vitro* culture on liquid and agar-solidified medium. In the doses applied, morphactine increased the number of protocorms differentiating from isolated meristematic tissues, and, in dependence on the dose, affected their shape and proliferation. Morphactine retards, and in large doses completely inhibits, the development of rhizoids, shoots and roots. Various developmental anomalies were observed under the influence of morphactine: leaf syncotylia, and their deformation, thickening, shortening, flattening and branching of shoots as well as formation of 2—3 shoots by one protocorm and development of secondary protocorms on the leaves.

INTRODUCTION

The different morphogenetic activity of morphactine than that of other known growth regulators (Schneider 1964, 1969, 1970; Mohr 1969) and the species specificity of the described physiological plant reactions to this substance (Ziegler et al., 1969; Pieniążek and Saniewski, 1967, 1969) prompted the authors to investigate the so far unknown influence of this growth regulator on protocorm differentiation and development in *Cymbidium* Sw. cultured in vitro. It could be expected that morphactin, active in the meristematic tissues within a wide concentration range (from 10^{-2} to 10^{-7} M) and nontoxic (Schneider 1964, 1969), may significantly affect the differentiation of protocorms from isolated meristematic tissues as well as their further development. Normal development of *Cymbidium* protocorms after their differentiation, as described by Champagnat et al. (1966) in contrast

to the development of other plants, lasts relatively long. One of the topical problems in orchid culture from meristems *in vitro* is the control of protocorm development and acceleration of stem and root morphogenesis (Kukułczanka and Sarosiek, 1971). Methodical solutions concerning meristematic tissue and *Cymbidium* Sw. protocorm culture *in vitro* (Kukułczanka, 1970; Kukułczanka and Paluch, 1971) made possible performance of the here described experiments with morphactine.

MATERIAL AND METHODS

Protocorms of two *Cymbidium* clones — Lib 67/8 from the cross *C. Alexanderi* × *C. Astrid* and the clone Lib 66/9 from the cross *C. Alexanderi* × *C. Belkis* obtained from the Botanical Garden in Liberec (Czechoslovakia) were used for the experiments. The protocorm culture conditions have been described earlier (Kukułczanka 1970; Kukułczanka and Paluch, 1971).

Morphactine IT 3456 was used. The sample was obtained from W. Merck, Darmstadt, West Germany. It is a mixture of 80 per cent 2-chloro-9-hydroxyfluoreno-(9)-carboxylic acid methyl ester with an admixture of 2,7-dichloro-9-hydroxyfluorene-(9)-carboxylic acid methyl ester. The following morphactine doses were used in the experiments: 0.01, 0.1, 1.0 and 10 ppm.

In experiment I with the Lib 67/8 clone 3—4-mm^3 meristematic tissue fragments were cultured in liquid medium for 12 weeks with various amounts of morphactine. This experiment was performed in two combinations, one in which the culture was hand shaken (once daily) and a second on a rotating apparatus (6 rpm).

Experiment II was performed with two *Cymbidium* clones. Meristematic tissue was cultured for 12 weeks in liquid medium with various morphactine doses added, then the protocorm agglomerations formed were divided into smaller part (8—10 protocorms) and transferred to uniform medium solidified with agar without morphactine and with 2 ppm naphthylacetic acid (NAA) added.

In experiment III with the clone Lib 67/8, the meristematic tissue and then the protocorms were cultured like in experiment II, only morphactine was added to the medium solidified with agar.

Each of the three combinations included 15 test tubes with meristematic tissue in liquid medium. In experiments II and III each combination was also represented by 5 Erlenmayer flasks with protocorms on solid medium.

The number of developing protocorms after 4, 8 and 12 weeks was counted in experiment I. After 12 weeks fresh and dry weight were also

determined. During the experiments the size and colour of the developing protocorms and their further development were noted. The developmental anomalies in *Cymbidium* plants were classified and photographed.

Free-hand anatomical preparations were stained with Erlich's hematoxylin (Filutowicz and Kużdowicz, 1951).

RESULTS

The morphactine doses (experiment I) applied in all combinations, both in the hand-shaken medium and on the rotatory apparatus, enhance protocorm differentiation in *Cymbidium* Sw. (Table 1). This becomes numerically noticeable after 4 weeks of culture and is most pronounced after 8 weeks. The number of protocorms increases markedly under the effect of morphactine, and with doses of 1 and 10 ppm reaches the highest values. In all combinations the number of protocorms formed is higher in the cultures shaken on the rotating apparatus than in the hand-shaken ones. Although an enhancing effect of morphactine on the number of protocorms developed was observed, analysis of protocorm fresh and dry weight after 12 weeks of culture showed lowered values when the growth substance was applied. (Table 1).

In all experiments 8—10-day retardation of meristematic growth by 1 and 10 ppm morphactine doses was observed. The protocorms developing from meristematic tissues after 8 weeks of culture on liquid medium differed in shape under the influence of the drug in 1 and 10 ppm doses from normally growing protocorms (Table 2). With 1 ppm doses, about 30 per cent of the protocorms were elongated and some formed at the tip several smaller protocorms (Fig. 1 a, b c). Doses of 10 ppm reduced to about 20 per cent of the protocorms on the stolons, and about 10 per cent more protocorms as compared with those receiving 1 ppm of morphactine formed at the tips several minute protocorms which sometimes coalesced to form one flattened protocorm. When lower doses are applied for 12 weeks in liquid medium, some of the developmental anomalies described due to morphactine also appear (Table 2).

The stage of *Cymbidium* protocorm development characterized by the appearance of the first three leaf primordia is distinctly retarded by morphactin in 1 and 10 ppm doses. In the control combination without the drug the first primordia arose as early as after 4 weeks. After 8 weeks of culture about 20 per cent of the protocorms growing on medium with 0.01 and 0.1 ppm morphactine added formed two somewhat thickened leaf primordia, whereas in the medium without the drug about 60 per cent already had developed 3 leaf primordia. Protocorm development in both clones (Lib 67/8 and Lib 66/9) had a similar course in the presence of morphactine.

Table 1

Number of *Cymbidium* Sw. clone Lib 67/8 protocorms on liquid media with morphactine addded (experiment I)

Method of shaking medium	Morphactine — ppm				
	0	0.01	0.1	1.0	10.0
	Number of protocorms after 4 weeks of culture				
Rotation apparatus	4.8	7.0	6.4	8.0	10.3
hand shaking	4.7	5.3	5.4	6.6	8.3
	Number of protocorms after 8 weeks of culture				
Rotation apparatus	18.8	31.3	31.0	33.3	35.3
hand shaking	7.6	9.8	10.1	11.8	12.8
	Number of protocorms after 12 weeks of culture				
Rotation apparatus	32.2	44.0	42.6	48.8	51.2
hand shaking	13.2	15.4	17.6	19.8	18.8
	Fresh weight of protocorms (g) after 12 weeks of culture				
Rotation apparatus	0.3944	0.2520	0.2947	0.2257	0.3159
hand shaking	0.3494	0.2014	0.2571	0.3259	0.2312
	Dry weight of protocorms (g) after 12 weeks of culture				
Rotation apparatus	0.0339	0.0199	0.0218	0.0166	0.0222
hand shaking	0.0279	0.0134	0.0172	0.0202	0.0160
	Dry weight per cent after 12 weeks of culture				
Rotation pparatus	8.50	7.91	7.41	7.38	7.04
hand shaking	7.41	6.65	6.62	6.22	6.86

At higher doses, formation of lighter areas in the apical part of the protocorms setting leaf primordia was observed. In the medium with morphactine added no major changes in the arrangement of leaf primordia were noted.

After 4 weeks of development of the orchids on liquid medium less rhizoids were formed with 0.1, 1.0 and 10 ppm morphactine doses. After a lapse of further 4 weeks with the same doses an increase in the number of rhizoids was observed, they were, however, always less numerous than in the controls.

Four weeks after transfer of the protocorms from liquid medium without morphactine to medium solidified with agar (experiment II and III, control combination), setting of 3 or 4 leaves was observed in 15 per cent of protocorms. In experiment II in which the protocorms were transferred from liquid medium with morphactine to solid medium without the growth regulator, but with 2 ppm of NAA, remote effects of morphactine were observed. From among the protocorm plants cultured on liquid medium with 0.01 ppm morphactine, only 8 per cent

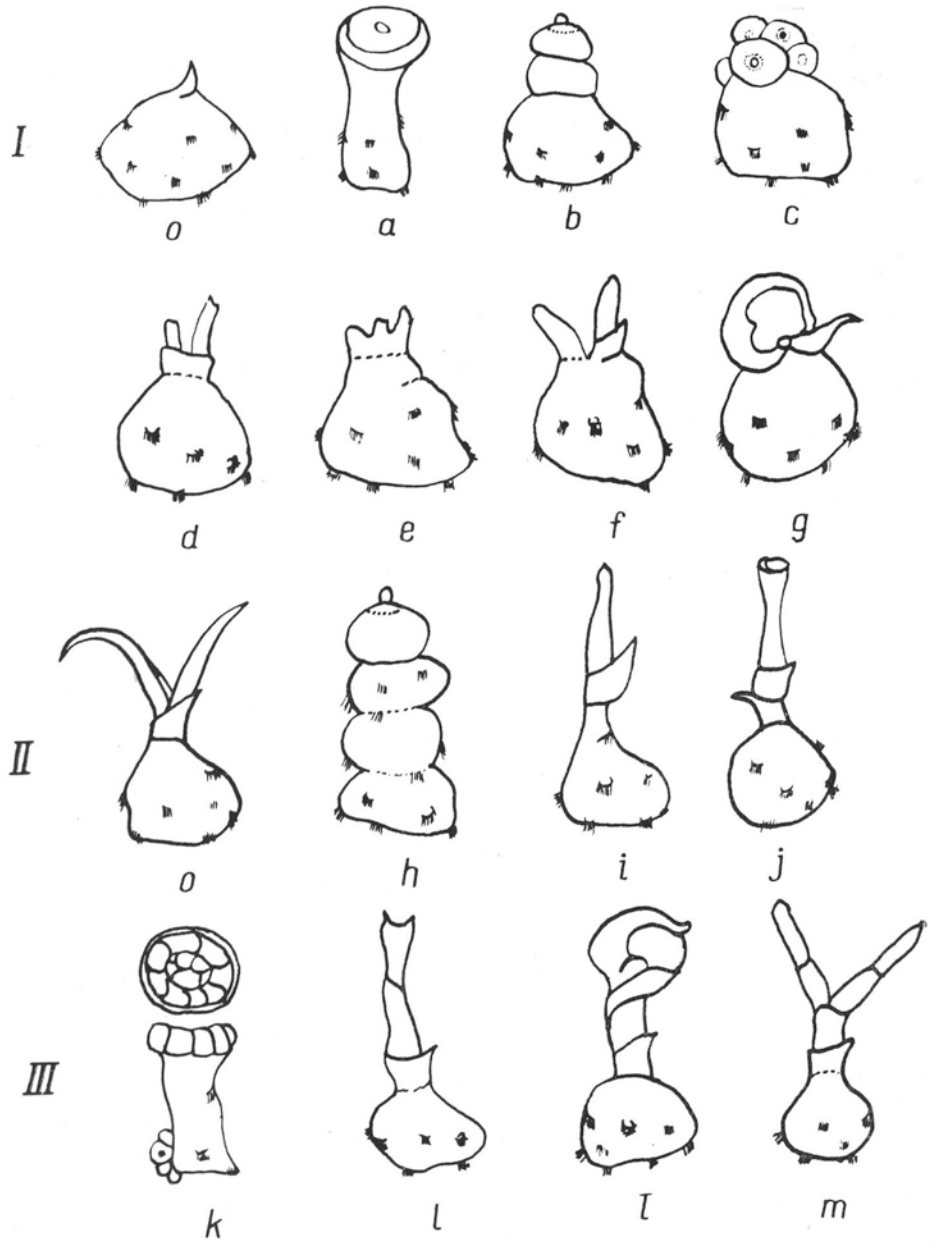

Fig. 1. Developmental anomaly in *Cymbidium* Sw. due to the influence of morphactine IT 3456

I — in liquid medium with morphactine; II — in medium solidified with agar without the growth regulator but with 2 ppm NAA added; III — on solid agar medium with morphactine: *O* — unmodified protocorm, *a* — elongated; *b* — stolon formed, *c* — protocorm proliferation, *d* — thickening of leaf primordia, *e* — tubelike growing together of leaves, *f* — development of two shoots from protocorm, *g* — deformation of shoots, *h* — modified protocorm shape, *i* — modified leaf shape, syncotylia, *j* — shoot deformation, *k* — modification of protocorm shape and additional proliferation, *l* — leaf shape modification, syncotylia, *l* — other modifications of leaf shape, *m* — development of 2 shoots from protocorm

Table 2

Development anomalies in early stages of *Cymbidium* Sw. clone Lib 67/8 growth caused by morphactine

Developmental anomalies	after 4 weeks					after 8 weekds					after 12 weeks				
	Morphactine ppm					Morphactine ppm					Morphactine ppm				
	0	0.01	0.1	1.0	10.0	0	0.01	0.1	1.0	10.0	0	0.01	0.1	1.0	10.0
	Liquid medium (experiments I, II, III)														
Elongated protocorms (fig. 1a)	—	—	—	—	+	—	—	—	+	++	—	—	—	+	+
Stolon formation (fig. 1b)	—	—	—	—	+	—	—	—	—	++	—	—	—	+	+
Protocorm proliferation (fig. 1c)	—	—	—	—	+	—	—	—	+	++	—	+	+	++	++
Thickened leaf primordia (fig. 1d)	—	—	—	—	+	—	—	+	++	++	—	+	+	+	++
Coalescence of leaves forming tubes (fig. 1e)	—	—	—	—	—	—	—	—	+	+	—	+	+	+	+
Development of 2 shoots (fig. 1f)	—	—	—	—	—	—	—	—	—	+	—	—	+	+	++
Deformation of shoots and leaves (fig. 1g)	—	—	—	—	—	—	—	—	—	—	—	±	—	—	+
	Medium solidified with agar without morphactine, 2 ppm NAA added (experiment II*)														
Protocorm shape modification (fig. 1h)	—	—	—	+	+	—	—	+	+	+					
Modification of leaf shape (fig. 1i)	—	+	+	+	+	—	+	+	+	+					
Other deformations of shoots (fig. 1j)	—	—	—	—	—	—	—	—	—	+					
	Medium solidified with agar with morphactine added (experiment III*)														
Protocorm shape modification (fig. 1k)	—	—	—	+	+	—	+	+	+	++	—	+	+	++	++
Leaf shape modification (fig. 1l)	—	+	+	+	+	—	+	+	+	++	—	—	+	++	++
Other modifications of leaf and shoot shape (fig. 1m)	—	—	—	—	—	—	—	—	+	+	—	+	++	++	++
Development of 2-3 shoots with protocorm (1m)	—	—	—	—	—	—	—	—	—	—	—	—	+	+	++

Note: Incidence of symptoms: — none, ± sporadic, + rather common, ++ frequent

* Protocorms cultured for 12 weeks on liquid medium were transferred to medium solidified with agar

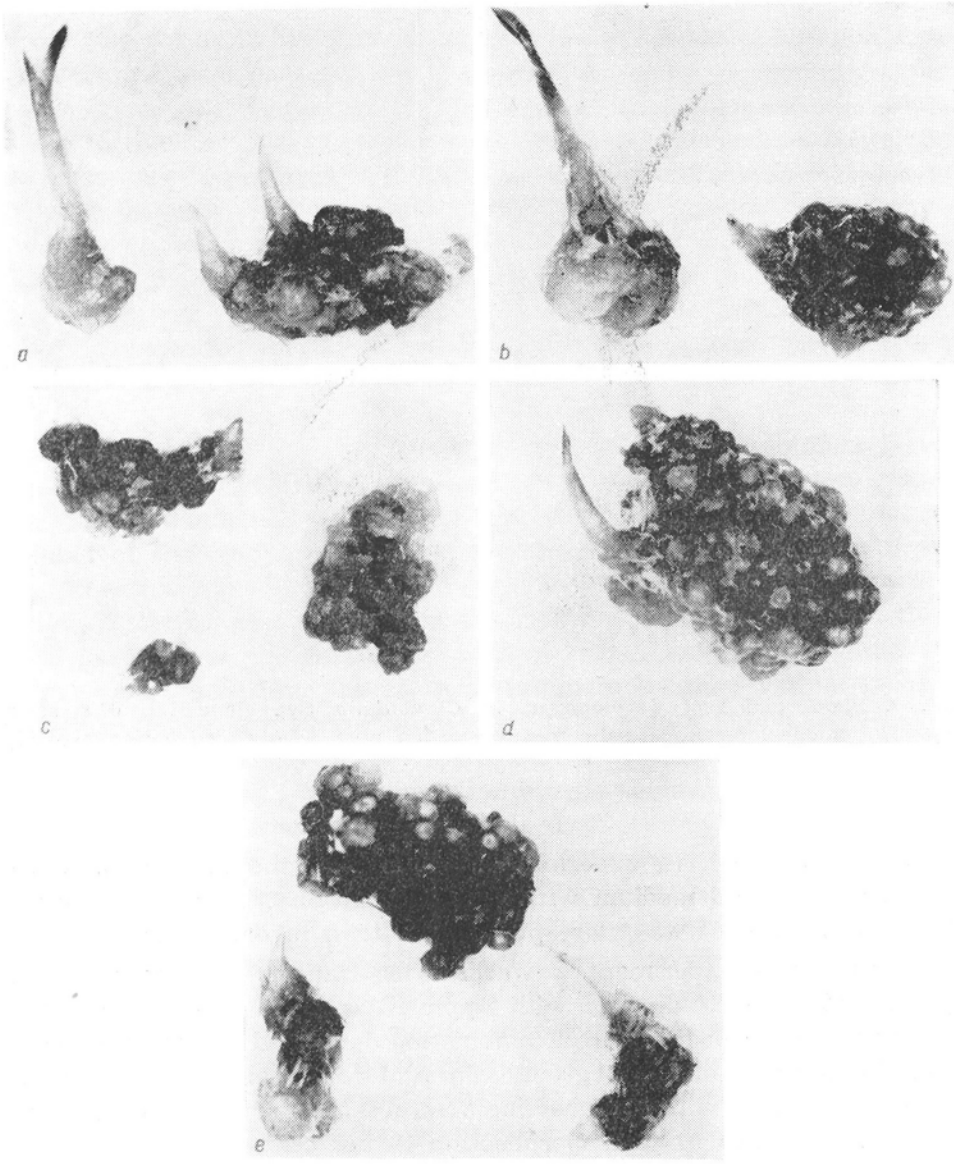

Fig. 2. Remote effect of morphactine IT 3456 on *Cymbidium* Sw. clone Lib 67/8 protocorm development on solid medium with addition of 2 ppm NAA after 8 weeks of culture (experiment II, magn. × 6).

Morphactine amount in liquid media: a — 0, b — 0.01, c — 0.1, d — 1.0, e — 10.0 ppm

formed 2 or 3 leaves after transfer to solid medium. Protocorms multiplied in liquid medium with 0.1, 1.0 and 10 ppm morphactine formed in the same time period 1 or 2 leaves. Thus 0.1 ppm, 1.0 ppm and 10 ppm doses resulted in 2, 1 and 0.5 per cent of protocorms forming

Fig. 3. Shoot and root development in *Cymbidium* Sw. clone Lib 67/8 after 10 weeks of development on solid medium with 2 ppm NAA added (experiment II, magn. × 6).

leaves, respectively. In experiment III in which the protocorms were transferred to solid medium with the same morphactine doses, retardation of development was more pronounced than in experiment II.

In the latter experiment, 8 weeks after transfer of the protocorm agglomerates to solid medium with 2 ppm NAA added, about 25 per cent of the protocorms of the control combination developed shoots 3.5—4.5 cm long. Retardation of shoot growth on protocorms previously cultured in liquid medium with morphactine was observed (Fig. 2 a—d). In the combination with 0.01 ppm morphactine 10 per cent of the protocorms formed shoots 3—4 cm long, with a 0.1 ppm dose 5 per cent of the protocorms formed shoots reaching a length of 2—2.5 cm, with a dose of 1 ppm only 3 per cent of the protocorms formed shoots 1—1.5 cm long and only 1 per cent of protocorms multiplied in liquid medium with 10 ppm of the growth regulator formed 2-cm shoots. On the shoots of *Cymbidium* in the control combination and that with the lowest morphactine dose (0.01 ppm) the first roots appeared (Fig. 3 a, b). The number of rhizoids decreases with morphactine concentration in the culture on fluid medium.

In experiment III, 12 weeks after transfer of the protocorms to

medium solidified with agar, 40—60 per cent of the protocorms formed 6 cm long shoots in the control combination. On these shoots numerous rhizoids and roots sprouted. At the lowest morphactine dose (0.01 ppm) about 30 per cent of the protocorms formed 1.2—2.5 cm shoots showing disturbed phototropism. Rhizoids are scarse here. On medium containing 0.1 ppm only 15 per cent of protocorms developed shoots of 0.5—1.5 cm length. Rhizoids were very scarse. A 1 ppm morphactine dose strongly inhibited shoot formation. Frequently 2—3 shoots formed on one protocorm. The phototropism of these shoots was greatly disturbed, rhizoids were absent. At the highest morphactine dose (10 ppm) only 2—3 per cent of the protocorms forms shoots with a highly disturbed phototropism. Further intensive proliferation of young green protocorms is observed (fig. 5a—d).

Noteworthy are the developmental anomalies in Cymbidium leaves and shoots caused by morphactine. After 4 weeks of protocorm growth on solid medium, in experiments II and III, syncotylia was noted, i.e. joining of the leaf edges to form a tube, moreover, the shape of the protocorms was modified (only at 1 and 10 ppm doses, table 2) The first scalelike leaf generally did not joins edges whereas the second and third ones form a tube (fig. 1i). In the present experiments with *Cymbidium* a 0.01 ppm dose of morphactine was sufficient to cause various degrees of syncotylia: a low degree with incomplete joining of leaf edges into a tube, and a higher degree with complete tube formation. Syncotylia of leaves developing from Cymbidium protocorms is shown in fig. 1e, i, l. In experiment II when the protocorms develop on solid medium with morphactine doses of 0.01 and 0.1 ppm the developmental anomalies involve only the first leaves while the further ones develop normally beginning with the fourth. After 10 ppm morphactine addition to the solid medium (experiment III) the protocorms develop in the shape of a mineglass in the concavity of which smaller protocorms grow (fig. 1 k).

After 8 weeks of culture on solid medium the developmental anomalies of the protocorms become more pronounced, particularly in experiment III. Further deformation of leaves and shoots occurs. In experiment II the protocorms previously developing on liquid medium with 10 ppm of morphactine, and in experiment III, when also 1 ppm of this substance is added, the leaves exhibit deformations other than syncotylia (Fig. 1 j, ł). These anomalously developing leaves have the shape of shells with folded and inward rolled edges (Fig. 1 ł). Sporadically, secondary protocorm formation on the developing leaves was observed. It was found that these secondary protocorms form from leaf epidermal cells (Fig. 4).

After 12 weeks of culture on solid medium in experiment III, marked disturbance of phototropism in shoots appeared at 0.1 to 10 ppm doses, not noted in experiment II. Further teratological symptoms were

observed in leaf development. Rolling up in tubes, incisions in lower or upper part, funnel- — or cup-shaped leaves with rolled up edges, sporadically also leaves with blades dissected into two to four parts. The development of 2—3 shoots from one protocorm is also one of the teratological symptoms. Besides, deformation of shoots such as flattening, bending, shortening and thickening may be observed. The number of protocorms forming shoots decreases to 2—3 per cent.

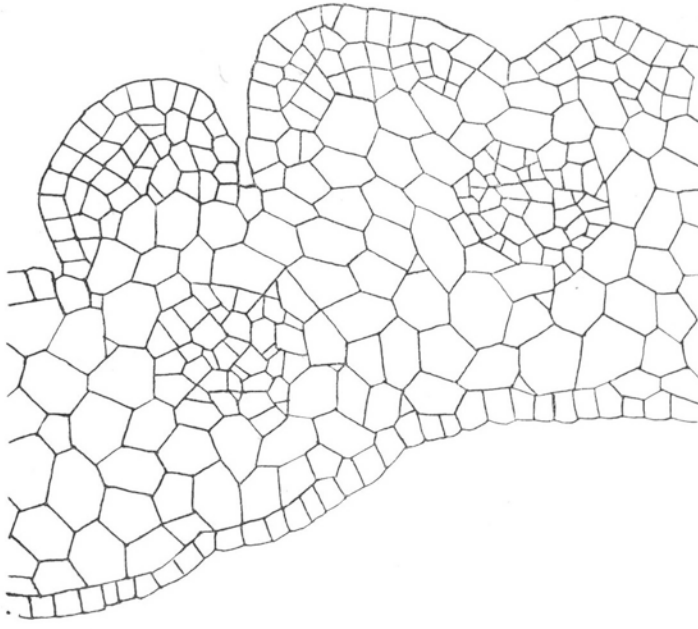

Fig. 4. Protocorm initiation in *Cymbidium* Sw. clone Lib 67/8 leaves due to morphactine (leaf crossection, magn. × 50).

After four months of culture on solid medium, the phototropism of shoots is visibly disturbed by morphactine in experiment III. Further deformation of the shoots is noted. They develop with shortened scale--like leaves, and subsequent leaves have to break through the tubular one. Sometimes above several of the latter, in the upper part, a dichotomically branched shoot develops. Frequently on one shoot variously modified tubular leaves develop, sometimes additionally frayed at the top, shell- or funnel-shaped or separated into two or three parts. Characteristic is further progressive proliferation of the protocorms. A great deal of them is formed, they are minute with symptoms of starvation, associated mainly with the lack of roots and small number of rhizoids.

In experiment III after 6 months of protocorm culture and their transfer to solid medium, 60 per cent of the plants in the control

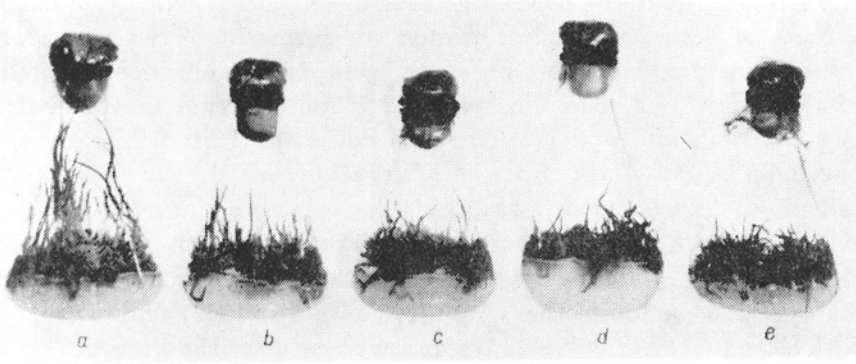

Fig. 5. Development of *Cymbidium* Sw. clone Lib 67/8 plants on medium with morphactine

a — 0, *b* — 0.01, *c* — 0.1, *d* — 1.0, *e* — 10.0 ppm (experiment III, after 12 weeks of culture on solid medium)

combination formed about 8 cm long strong shoots with 8—10 leaves, roots and a large number of rhizoids. With a dose of 0.01 morphactine, 30 per cent of the plants developed normally about 7.5 cm long shoots with 5—8 leaves. Some leaves of these plants coalesced in various degree. The remaining plants were dwarfed and protocorm proliferation occurred. The dwarfed plants had leaves of various shapes. Sometimes 1—2 young lateral shoots developed with 0.1 ppm morphactine doses the 1.5—3.0 cm long shoots showed disturbed phototropism and all leaves were anomalous. The scarse shoots at 1 ppm doses reached a length of 1.5 cm and formed 2—3 anomalous leaves. In this combination extremely profuse proliferation of minute yellow-green protocorms occurred, showing symptoms of starvation. Roots and rhizoids were lacking. A 10 ppm morphactine dose enhances the disturbances. Only few shoots reach a length of 0.5—1.5 cm and the leaves show deformation and syncotylia of second grade.

DISCUSSION

Morphactine in doses of 0.01 to 10 ppm exerts a strong morphogenetic growth-regulating influence on the meristematic tissue of *Cymbidium* Sw. It increases the number of protocorms differentiating from it, and in dependence on the dose, affects their shape and proliferation. The retardation of further protocorm development, and at higher doses, complete inhibition seems to indicate that morphactine maintains a juvenile state of the protocorms. Evidence of this may be found in the fact that protocorms subjected to the action of morphactine show

a higher regenerative potential. Many of them exhibit anomalous symptoms of secondary apical protocorm formation even as a remote effect of morphactine. The observed retardation of shoot growth in *Cymbidium* Sw. is a common reaction to morphactine in various plant species (Schneider 1969). The retardation of leaf development also observed in *Cymbidium* Sw. is a reaction which has been earlier described in *Rhoeo spathacea* by Lorenzen and Weisbrich (1969). Inhibition of root development in *Cymbidium* plants growing from protocorms is analogical to the reaction to morphactine of various plants described among others by Allevedt (1969) and Denffer, Fricke and Ringe (1969). When lower doses of the growth regulator are applied, the forming *Cymbidium* roots did not show anomalies, and no disturbances of geotropism were noted such as Lorenzen and Weisbrich (1969) described in *Rhoeo spathacea* and *Cardamine chenopodifolia* the roots of which grow in various directions in culture. This inhibition of root and rhizoid growth at lower morphactine doses in liquid medium is abolished in the second step of culture on solid medium without morphactine by the addition of alpha-naphthylacetic acid. This could be expected on the basis of the investigations of Ziegler et al. (1969) which demonstrated that morphactine lowers the auxin level of plants.

In the present study the developmental anomalies on *Cymbidium* Sw. leaves induced by morphactine are similar to those earlier described in various species (Haccius 1969; Lorenzen and Weisbrich 1969; Boeker 1969). This confirms the view that such an anomaly as syncotylia is a specific reaction to morphactine. The anomalous production of secondary protocorms on leaves is, on the other hand, the specific reaction of *Cymbidium*. This is consistent with the enhanced ability of regeneration observed in *Cymbidium* and produced by morphactine. Young *Cattleya* seedlings have been described to form protocorms at the base of isolated leaves under the influence of a certain sequence of growth regulators applied to cultures *in vitro* (Champagnat, Morel and Mounetou, 1970).

Under the effect of morphactine not only the leaves of *Cymbidium* show diverse anomalies, but also the shoots. They may be dichotomically branched or two to three shoots may start from one protocorm. Similar developmental anomalies were induced by Haccius (1969) in *Eranthis* by the action of 2,4-dichlorophenoxyacetic acid (2,4-D) and 2-methyl--4-chlorophenoxyacetic acid (MCPA) on the primordia.

The present investigations on *Cymbidium* confirm that disturbances of phototropism are the typical reaction to morphactine (Khan 1967; Pieniążek and Saniewski, 1967; Krelle and Libbert 1968).

CONCLUSIONS

1. Morphactine IT 3456 in 0.1 to 10 ppm doses causes strong morphogenetic reactions in *Cymbidium* Sw. in early stages of *in vitro* culture:

a) it increases the number of protocorms differentiating from meristematic tissue, and, in dependence on the dose applied, affects their shape and proliferation;

b) it retards, and in larger doses completely inhibits, development of rhizoids, shoots and roots;

c) in larger doses it causes disturbances of shoot phototropism.

2. Morphactine produces in *Cymbidium* Sw. in culture *in vitro* diverse developmental anomalies:

a) syncotylia of various degree and deformation of leaves;

b) shortening, thickening, flattening and branching of shoots;

c) formation of 2—3 shoots from one protocorm;

d) formation of secondary protocorms on the leaves.

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Wpływ morfaktyny na różnicowanie się i rozwój protokormów Cymbidium Sw. w kulturze in vitro

Streszczenie

Celem podjętych doświadczeń było zbadanie morfogenetycznego działania morfaktyny IT 3456 na rozwój izolowanych tkanek merystematycznych 2 klonów *Cymbidium* Sw. w kulturze *in vitro*. Morfaktynę w dawkach 0,01, 0,1, 1,0 i 10 mg/l dodawano do pożywek płynnych i zestalonych agarem. Hodowlę prowadzono przez pierwszych 12 tygodni w pożywce płynnej, a następnie na pożywkach zestalonych agarem. W doświadczeniu I zanalizowano liczbę wykształcających się protokormów po upływie 4, 8 i 12 tygodni. Po upływie 12 tygodni zbadano również świeżą i suchą masę (Tabela 1). Podczas przebiegu wszystkich 3 doświadczeń obserwowano wielkość i barwę wykształcających się protokormów oraz ich dalszy rozwój. Pojawiające się pod wpływem morfaktyny anomalie rozwojowe protokormów i roślin *Cymbidium* Sw. sklasyfikowano i zilustrowano (Tabela 2, ryc. 1).

Morfaktyna w dawkach od 0,01 do 10 mg/l pożywki wywołuje silne reakcje morfogenetyczne *Cymbidium* Sw. w jego wczesnych stadiach rozwojowych w kulturze *in vitro*, podobne u obu klonów. Stwierdzono, iż morfaktyna zwiększa liczbę wyróżniających się protokormów z izolowanej tkanki merystematycznej, a w zależności od dawki wpływa na ich kształt i proliferację (Tabela 1, 2). Morfaktyna opóźnia, a w większych dawkach całkowicie hamuje rozwój chwytników, pędów i korzeni. We wszystkich doświadczeniach, w kombinacjach z morfaktyną obserwowano anomalie rozwojowe protokormów i roślin. Za typową reakcję morfogenetyczną wywołaną morfaktyną należy uznać różnego stopnia synkotylię liści *Cymbidium* Sw., tym większą im wyższa dawka morfaktyny (Tabela 2, ryc. 1 i, l). Przezwyciężenie synkotylii w dalszym rozwoju pędów *Cymbidium* Sw. osiągano po przeniesieniu protokormów na pożywkę stałą bez morfaktyny i to tylko tych, które hodowano w niższych dawkach morfaktyny w pożywce płynnej. Częstym objawem wywołanym morfaktyną są deformacje liści. Pod wpływem morfaktyny *Cymbidium* Sw. wytwarza skrócone, zgrubiałe, spłaszczone i rzadziej rozgałęzione pędy. Specyficzną reakcją *Cymbidium* Sw. na morfaktynę jest wytwarzanie 2—3 pędów z jednego protokormu, oraz wykształcanie się wtórnych protokormów na liściach (Tabela 2, ryc. 1 f, m, 4).