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REDAKTOR IVAN KLÁŠTERSKÝ

JIŘÍ RŮŽIČKA:

COSMARIUM HORNAVANENSE GUTW.

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J I Ř Í R Ů Ž I Č K A :

## Cosmarium hornavanense GUTW.

(Předloženo 20. IX. 1948.)

"This species has been confused with other Cosmaria, . . . . but the truncate apices with the notch in the middle are very peculiar."

GRÖNBLAD (5., p. 9)

V roce 1909 uveřejnil GUTWINSKI nové Cosmarium, které našel ve Vysokých Tatrách. Ježto je považoval za totožné s dvěma řasami, které popsal SCHMIDLE v roce 1898 z jezera Hornavan v severním Švédsku, nazval je *Cosmarium hornavanense*.

V okolí Písku jsem v letech 1942 až 1948 nezřídka nalézal tato krásná a elegantní Cosmaria v několika formách. Další materiál ze Švýcarska mi laskavě zaslal ke studiu p. Dr. EDWIN MESSIKOMMER. Díky tomu mohu dodat některé podrobnosti k údajům v literatuře a pokusit se o jejich zhodnocení.

V následujícím článku třídím formy druhu ve tři skupiny:

### A. Skupina „typus“.

Tato skupina obsahuje statné formy blízké GUTWINSKÉHO typu. Areál (podle dosavadních údajů) alpínsko-boreální. Zdá se, že je omezena na alkalické prostředí. Radím sem tyto formy:

1. *C. hornavanense* GUTW. s. str. Fig. nostrae 1—7.

Diagnosa GUTWINSKÉHO jest vymezena příliš úzce. Jak z jeho vlastních vyobrazení (fig. nostrae 1—3), tak z kreseb ostatních autorů (fig. nostrae 4—7) je zřejmo, že i typ jest velmi variabilní.

Z typu však vylučuji dvě Cosmaria, která GUTWINSKI sám do svého druhu zahrnoval:

a) *C. subochthodes* SCHMIDLE var. *majus* SCHMIDLE (fig. nostra 25) je úplně odlišným druhem, a to jak celkovým habitem, tak v podrobnostech. S ním jest blízko příbuzné nebo dokonce totožné *C. hornava-*

nense GUTW., MESSIKOMMER, E., 16., p. 183 (fig. nostrae 23—24), a musí býti rovněž z GUTWINSKÉHO druhu vyloučeno.

b) ? *C. spec.* SCHMIDLE (fig. nostra 10) má odchylně vytvořený vrchol, a zařazují je proto s výhradou do var. *minor* ROUBAL.

2. var. *minor* ROUBAL. Fig. nostra 9.

Od typu se liší pouze vrcholem, který jest více méně rovný, bez výkrojku, charakteristického pro druh. Bylo by však třeba na početnějším materiálu zjistiti, zda redukce vrcholového zářezu není jen náhodnou modifikací.

3. var. *mirabile* RŮŽIČKA nov. var. Fig. nostrae 26—34.

Oproti všem ostatním formám má nápadně polokulovité bradavky; úpatí bradavek obklopují granulky 2. řádu, které bývají velmi silně vyvinuty.

## B. Skupina „dubovianum“.

Tato skupina obsahuje řasy o jednu pětinu až jednu polovinu menší než typ. Všechny formy této skupiny se vyskytují v nižších polohách v prostředí alkalickém nebo mírně kyselém. Byly nalezeny i v Čechách.

Řadu forem, neobyčejně variabilních v rozměrech, tvaru i skulptuře, rozdělují ve tři variace, které však přecházejí tak plynule do sebe, že lze proti jejich samostatnosti uvést vážné námítky. Jednotlivé formy byly opětovně popsány pod nejrůznějšími druhovými jmény, a jistě je mnoho dalších nálezů skryto v seznamech druhů, kde se vymykají kontrole, není-li připojeno vyobrazení.

4. var. *mesoleium* (NORDST.) RŮŽIČKA nov. comb. Fig. nostrae 16—17, 66—70.

Tato variace zahrnuje řasy užší a delší, s drobnějšími a hustšími bradavkami.

5. var. *dubovianum* (LÜTKEM.) RŮŽIČKA nov. comb. et ampl. charact. Fig. nostrae 11—14, 41—57.

Od typu se podstatně liší jen menšími rozměry a menším počtem zvlhnutí po stranách polovin. Je pravděpodobně základním nižším tvarem druhu a rozpadá se v celou řadu nesamostatných forem, z nichž jsou zajímavé:

a) forma *Lütke mülleri* (fig. nostrae 51—54) jest nejmenší dosud známou formou druhu, až o polovinu menší než typ,

b) forma *Messikommeri* (fig. nostra 14) se rozměry blíží typu,

c) forma *ochthodeiformis* (fig. nostrae 55—57) je charakterisována nadměrným vývojem sekundárních granulek (?), obklopujících úpatí bradavek. Každá bradavka se následkem toho v pohledu kolmém k její základně rozpadá ve skupinu cca 4—6 teček. Tato forma, nebo spíše jen fyziologická modifikace, bývá jistě velmi často zaměňována s *C. ochthodes* NORDST., kde však sekundární granulky se nalézají na zploštělém vrcholu bradavky a nikoliv na jejím úpatí.

6. var. *janoviense* (GUTW.) RŮŽIČKA nov. comb. Fig. nostrae 18—20, 58—65.

Od předchozí variace se odlišuje jen trapezickým tvarem polovin.

a) forma *hybrida* (fig. nostrae 64, 65) s vrcholem hlavicevitě povytaženým jest její nesamostatnou formou.

### C. Skupina „alpinum“

zahrnuje dosud málo známé alpinské formy s vyvinutými nadmutinami a se zřetelnou středovou skulpturou; jest asi o čtvrtinu menší než typ.

7. var. *alpinum* (SCHMIDLE) MESSIK. Fig. nostra 15.

Tato variace má nadmutiny jen nízké, středová skulptura sestává z malých bradavek s kruhovou základnou.

a) forma *davosiense* n. f. (fig. nostrae 35—40) je od typu vzdálenější: nadmutiny jsou užší a vyšší, pokryté bradavkami podlouhlými, srpkovitě zakřivenými. Zdá se, že jest samostatnou formou, nebo dokonce zvláštní variací.

Do uvedeného roztrídění nijak nezapadá velká forma, kterou uvádí SCHULZ ze *Sphagnet* z pomoránských nížin. SCHULZOVY kresby (fig. nostrae 21, 22) nedovolují ani její spolehlivé zařazení, ani bezpečné vyloučení, a jest jí proto nutno považovati za nejistou.

Společným znakem všech forem, které jsem měl příležitost sám pozorovati (t. j. var. *mirabile*, *mesoleium*, *dubovianum*, *janoviense*, *alpinum* f. *davosiense*), jest struktura jednotlivých bradavek. Bradavky mají v kolmém pohledu základnu více méně zaokrouhleně polygonální a jsou na úpatí obklopeny věncem as 4—8 teček (sekundárních granulek?), někdy nerozeznatelných (fig. nostra 69), jindy zřetelně vyvinutých (fig. nostrae 61, 46, 57). U var. *mirabile* jde o granulky podobné malým bradavkám; úplně mění základní kruhový půdorys bradavky v nepravidelný laločnatý útvar (fig. nostrae 32, 34). Bylo by naléhavě třeba zjistiti, zda tento rozpad bradavek v granulky 2. řádu se vyskytuje i u typu a je tedy význačný pro celý druh.

Podle mého mínění nelze však tento zjev hodnotiti taxonomicky; je asi společný několika příbuzným druhům, zejména se vyskytuje také



u *C. obtusatum* SCHMIDLE. Mám za to, že jeho výklad nutno hledati ve fyziologii.

Při posuzování popsaných forem jest nutno míti neustále na paměti neobyčejnou variabilitu druhu. Kde jsem mohl prohlédnouti větší počet exemplářů, zjistil jsem vždy, že každá variace zahrnuje celou řadu forem; ani na základě několika set pozorování jsem nebyl s to stanoviti mezi jednotlivými formami hranice a považuji je za nesamostatné. Často se ovšem v určité lokalitě rozmnoží jediná forma a činí pak nesprávný dojem samostatné variace; k témuž omylu může vésti i pozorování jen několika málo exemplářů.

*C. hornavanense* jest pro svou variabilitu a neustálenost svrchovaně zajímavým předmětem studia. Jsem přesvědčen, že není ve střední a severní Evropě nijak vzácným druhem, a že má velký okruh forem a široký areál, že však bylo dosud často přehlíženo nebo nesprávně určováno.

Proto bylo jedním z účelů článku upozorniti na toto krásné *Cosmarium*.

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### *Cosmarium hornavanense* GUTW.

In 1909 GUTWINSKI published a new *Cosmarium*, which he had found in the High Tatras. As he considered it identical with two algae described by SCHMIDLE in 1898 from the Hornavan Lake in Northern Sweden, he designated it *Cosmarium hornavanense*.

In the neighbourhood of Písek in Southern Bohemia I found in the years 1942—1948 not infrequently several forms of these beautiful and elegant *Cosmarium*. Dr. EDWIN MESSIKOMMER had the kindness to send me further material for study from Switzerland. Thus I am now able to add some details to the reports already given, as well as to attempt an evaluation of these reports.

It is my pleasant duty to thank most sincerely all those who have assisted me in my study and in the publication of my results, especially Dr. IVAN KLÁŠTERSKÝ (Czechoslovakia), Dr. EDWIN MESSIKOMMER (Switzerland), who also gave me permission to publish the Swiss material, Prof. Dr. SILVESTR PRÁT (Czechoslovakia) and Prof. KAREL ROSA (Czechoslovakia), who placed his technical library at my disposal.

## I. Classification and Description of the Forms.

### A. Group "typus".

This group comprises large forms near GUTWINSKI's type. Area alpino-boreal according to present records. It seems to be restricted to an alcalic environment.

1. *C. hornavanense* GUTW. s. str. Fig. nostrae 1—7.

*C. Hornavanense* nov. spec., GUTWIŃSKI, R., 8., p. 461 (pro parte), pl. 8, fig. 28.  
Syn.: *C. Hornavanense* (SCHMIDLE) GUTWIŃSKI, DEFLANDRE, G., 1., p. 1011, fig. 4  
in p. 1009.

*C. hornavanense* (SCHMIDLE) GUTW., INSAM, J. et KRIEGER, W., 9., p. 101,  
pl. 6, fig. 1.

*C. Hornavanense* (SCHMIDLE) GUTWIŃSKI forma *helvetica* f. nov., DUCCELLIER,  
F., 4., p. 15, fig. 3.

*C. tetraophthalmum* var. *pyramidatum* STRÖM, TAYLOR, W. R., 31., p. 269,  
pl. 52, figs. 12, 13, and 32., pl. 47, fig. 4.

?*C. subochthodes* SCHMIDLE, SCHMIDLE, W., 24., p. 75 (pro parte), fig. 26b  
(non figs. 26a, c).

Non: *C. subochthodes* SCHMIDLE var. *majus* SCHMIDLE n. var., SCHMIDLE, W., 26.,  
p. 36, pl. 1, fig. 51.

?*C. spec.*, SCHMIDLE, W., 26., p. 41, pl. 2, fig. 10.

GUTWINSKI's original description (8., p. 461) runs as follows:

"*C. Hornavanense* nov. spec., tab. nostr. VIII, fig. 28. [= *C. subochthodes* SCHMIDLE var. *maius* SCHMIDLE, Pite Lappmarks... Süßwasseralg. pag. 36, tab. I, fig. 51\*) et *C. spec.* SCHMIDLE, l. c. pag. 41, tab. II, fig. 10.]\*\*\*)

Cosmarium permagnum, profunde sinu lineari angustissimo constrictum. Semicellulae subtrapezicae, angulis inferioribus rotundatis, lateribus subconvexis, apice truncato et media in parte evidenter leniter emarginato. Membrana ad marginem apice laevi excepto verrucis conicis in series obliquas ordinatis ornata et inter verrucas punctato-scrobiculata. Verrucae ad mediam semicellulam diminutae et evanescentes ibique membrana scrobiculata. Semicellulae e vertice visae ellipticae, utrimque late tumidae, ibique plerumque et ad angulos semper verrucosae, medio in apice laeves et media in area laevi punctatae, e latere circulares. Pyrenoides bini.

Long = 92  $\mu$ —99  $\mu$ —101  $\mu$ . Lat. = 72,6  $\mu$ —74,8  $\mu$ —88  $\mu$ —92,4  $\mu$ —96,8  $\mu$ . Isth. = 22  $\mu$ —24  $\mu$ —26,8  $\mu$ —28,6  $\mu$ . Apex. = 22  $\mu$ —28,6  $\mu$ .

Speciei huius primum ex lacu Hornavan ad Arjeplong in Pite Lappmark l. s. c. indicatae multa legi specimina in lacu Zielony staw Gasienicowy (22. VII. 1899) et locis mucosis aquis defluentibus irroratis in declivitate Toporowa Cyrhla (11. VIII. 1899)."

GUTWINSKI took over his description, certainly intentionally, with some changes from the diagnosis of *C. spec.* SCHMIDLE (26, p. 41). (Cf. further on Section I/2).

GUTWINSKI's figures are re-drawn in fig. nostrae 1—3. Already from them it is possible to supplement the description by the following observations:

1. The shape of the semicells is very variable; "semicellulae subtrapezicae" represent only one shape of the continuous series of forms from subcircular semicells (fig. 2) via semi-elliptic (fig. 1) to subtrapezoid ones (fig. 3). Cf. also fig. nostrae 4—7.

\*) cf. Section II/1.

\*\*) cf. Section I/2.

2. Apex either a little convex (fig. 1) or plane (figs. 2, 3) in outline.  
3. Incision at the apex, very characteristic of the species, can be either pointed (fig. 2) or roundedly incised (fig. 1, 3), and is either simple (fig. 3) or has on each side a shallow emargination (fig. 1). The number of the incisions is therefore always odd.

4. The series of verrucae above the isthmus, also characteristic for the species, may be reduced or lacks completely (fig. 3, cf. also fig. nostrae 4—7).

5. The verrucae narrow from a broad base, so that they assume a sinusoid profile; thus the margin of the cell is undulated and not crenated. There are approximately 11 to 14 undulations on each side of the semicell. The verrucae are not always only "conicae" (cf. figs. 4 and 7 with relatively flat verrucae).

We meet these characteristics not only in the typical forms, as cited, but usually also in all varieties; thus they are generally valid for the whole species (cf. Section III).

#### Remarks on the Forms Described in Literature.

a) INSAM et KRIEGER (l. c., fig. nostra 4) show typical *C. hornavanense* with flatter verrucae and reduced inner series of verrucae. In a vertical view (l. c. fig. 1) it seems too thin (cf. table of dimensions on p. 22).

b) *Forma helvetica* DUCELLIER (l. c.) has according to DUCELLIER's drawing (l. c. fig. 3, not reproduced in the present paper) semicircular semicells very reminiscent of GUTWINSKI's figuring reproduced in fig. nostram 2; the series of verrucae above the isthmus are lacking. The independence of the form is not founded, and cannot be accepted considering the variability of the species.

c) DEFLANDRE (l. c., fig. nostra 7) draws attention to the fact that his specimen has the shape of rather subtrapezoid semicells, but identifies it with *f. helvetica* DUCELL.

d) TAYLOR (l. c., fig. nostrae 5, 6) brings under the name of *C. tetraophthalmum* var. *pyramidatum* STRÖM beautiful drawings of GUTWINSKI's species. By the shape of the apex it is somewhat reminiscent of the alga recorded sub e). In a vertical view (l. c. fig. 12, fig. nostra 6) the cell is strikingly thin and subangular; sometimes we can observe similar shapes in empty semicells which have lost their inner turgor. From the typical *C. tetraophthalmum* BRÉB. TAYLOR's alga differs so completely that it cannot be considered even a variety of this species (cf. f. inst. WEST, W. et G. S., 33, pl. 95, figs. 5—6). From *C. tetraophthalmum* var. *pyramidatum* STRÖM (30., p. 484, pl. 13, fig. 9) it differs especially by the shape of its verrucae and the undulate margin of its cell; the author, it must be added, accepted STRÖM's designation only "tentatively" (l. c., p. 269).

e) *C. subochthodes* SCHMIDLE (l. c., fig. nostra 8). The author's fig. 26b is very similar to the species *C. hornavanense*. But SCHMIDLE does not distinguish it at all from his other drawings (l. c., figs. 26a, c), which are different from GUTWINSKI's species. Without

a knowledge of the original material and of its variability the position of this form cannot be decided safely. SCHMIDLE gives the dimensions only for the whole species: long. = 80—86—90  $\mu$ , lat. = 68—72—77  $\mu$ ; of these only long. = 86  $\mu$ , lat. = 72  $\mu$  correspond to fig. 26b.

**Localities:** Poland, High Tatras, 1675 m. above sea level (GUTWINSKI); France, the Pyrenees (DEFLANDRE); Switzerland, Valais (DUCCELLIER); Southern Tyrol, 1600—1800 m. (INSAM et KRIEGER); Newfoundland (TAYLOR).

a) **F o r m a.**

It differs from the type only in a side view, where the semicells show themselves to be not "circulares" but broadly ovoid with flattened apex; cell wall in the middle of the semicells thickened (and pressed inward?). Dimension cf. the table on p. 22.

From the remarks in literature it cannot be decided whether the forms cited above do not show the same features.

**Localities:** Southern Bohemia, Písek (pond Horní Nový, 375 m. above sea level, half flooded *Hypnaceae* on the margin of the pond, pH 6,5—6,7; hitherto in one specimen only, probably a chance find); Switzerland, Kt. St. Gallen, Ragaz, "Graue Hörner" [lake Rundhöckersee, 2350 m., pH 6,7],\*) very rare.

2. var. **minor** ROUBAL. Fig. nostrae 9—10.

*C. Hornavanense* GUTW. var. *minor* nova, ROUBAL, J., 23., p. 54, pl. 6, fig. 8.  
Syn.: ?*C. spec.*, SCHMIDLE, W., 26., p. 41, pl. 2, fig. 10.

Cells on an average slightly smaller than in the type. Apex more or less plane, without incision at the apex or with incision only indicated.

ROUBAL's variety (l. c., fig. nostra 9) differs from the type only by the complete reduction of the incision at the apex. According to the author's report in litt. the greatest importance has to be attached to this characteristic. The variety is perhaps related to some forms of *C. botrytis* var. *mediolaeve* W. WEST (cf. further on, Section IV/1). For the dimensions see the table on p. 22.

*C. spec.* SCHMIDLE (l. c., fig. nostra 10) differs again from the type by the reduction of the incision at the apex. SCHMIDLE does not speak of this incision even in his diagnosis (l. c., p. 41). For the rest the difference from the type (and perhaps also from ROUBAL's form) is given in two sentences of the diagnosis, which GUTWINSKI did not take over, though he considered *C. spec.* SCHMIDLE identical with his species: "membrana scrobiculata (scrobiculis magnis in series obliquas et rectas ordinatis) et media in semicellula verrucis e 3 majoribus ornata"; but in SCHMIDLE's drawing the regularly arranged "scrobiculae" seem to be somewhat stylized, and the described central sculpture from a front view is not figured at all.

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\*) quoted from MESSIKOMMER, E., 20., pp. 237—239, in which also further details are given.

By these features, which may be compared by referring to the drawings, ROUBAL's variety corresponds on the whole to SCHMIDLE's *C. spec.* [compare fig. nostram 10 with the drawing in the ROUBAL's fig. 8 (l. c.) not reproduced in the present paper]; though it is a little narrower and has lower verrucae, yet these two features are very variable in the species. The diagnoses of the two forms agree also in the main characteristics.

As neither ROUBAL's nor SCHMIDLE's drawings permit a more certain decision, the placing of both forms remains uncertain. For the placing it would also be necessary to ascertain by reference to more numerous material whether the reduction of the incision at the apex is not a chance modification.

*Localities*: Bulgaria, Pirin planina (region of the Vlahina Lake, 2230—2290 m. above sea level, and of the Papas Gjó1) (ROUBAL); Northern Sweden, Pite Lappmark (Hornavan Lake), 425 m. above sea level (SCHMIDLE).

3. var. *mirabile* RŮŽIČKA nov. var. Fig. nostrae 26—34.

Verrucae strikingly semiglobular, surrounded at their base by several secondary granules; in a view perpendicular to its base each verruca seems to break up into a group of some 4—8 coarse punctae situated in the angles of an irregular polygon. The punctulation of the cell wall between the verrucae, in the middle of the semicells and on the apex is also strikingly coarse. Semicells elliptic in a vertical view, angularly rounded in a side view. For the dimensions see the table on p. 22.

In specimens where the secondary granules are but little developed (fig. nostra 29) the structure of the verrucae does not differ at all from that of some of the forms of var. *dubovianum* (cf. Section I/5). It is easy to overlook the series of flat verrucae above the isthmus in the closely punctulated cell wall. The cell wall is in the basal angles of the semicell and at the apex usually a little thickened.

Compare also fig. nostram 33 with the drawing in SCHULZ, P., 28., p. 130, fig. 22a (fig. nostra 22).

*Localities*: Switzerland, Kt. St. Gallen, Ragaz, „Graue Hörner“ (lake Rundhöckersee, 2350 m. above sea level, pH. 6, 7),\*) rare.

B. Group “*dubovianum*”.

This group includes a number of forms unusually variable in shape, dimensions and sculpture. I divide it into three varieties, which, however, merge so gradually into each other that serious objections can be raised against their independence from each other.

The forms of this group seem to be distributed at lower altitudes, in an alcalic as well as in a moderately acidic environment.

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\*) quoted from MESSIKOMMER, E., 20., pp. 237—239, which see also for further data.

4. var. *mesoleium* (NORDST.) RŮŽIČKA nov. comb. Fig. nostrae 16—17, 66—70.

Syn.: *C. Botrytis* (BORY) MENECH.  $\beta$  *mesoleium* nov. var., NORDSTEDT, O. et WITTRÖCK, V., 22., p. 27 (pro parte), pl. 12, figs. 2a-c, 2a'.

The cells, on an average smaller and narrower than the type, up to one and a half times larger than broad. On each side of the semicells (not counting the apex) about 12 to 15 undulations. Verrucae smaller than in the type. Punctulation of the cell wall often very fine. Cell wall in the middle of the semicells slightly thickened and pressed inward. In a side view the semicells are ovoid with a flattened apex. In a vertical view the cells are elliptic, without protuberances or with only small protuberances (NORDSTEDT).

Within the variety occur several forms which distinguish themselves especially a) by the different shape of the incision at the apex (NORDSTEDT, l. c., fig. 2a', fig. nostra 17); b) by the different development of the protuberances (NORDSTEDT, l. c., fig. 2b, fig. nostra 16); c) by the punctulation of the cell wall.

I have to mention that there is a great discrepancy between NORDSTEDT's statements (l. c. p. 27) of the length and thickness (but not of the breadth!) and his own drawings (cf. table of dimensions on p. 22). When we complete NORDSTEDT's drawings to whole cells, the difference in their lengths compared with the statements in the text amounts to 20%. This discrepancy can be explained only by assuming that NORDSTEDT figured other, longer forms than the ones he measured; also at Písek I found both forms mixed in one locality. NORDSTEDT's shorter, measured, but not figured forms I separate from var. *mesoleium* and place them in var. *dubovianum* (cf. Section I/5), into which they fit accurately by their dimensions (cf. table of dimensions).

Localities: Southern Bohemia, about 370 m. above sea level: Písek (Šarlak Pond, pH 6,5—6,7), Ražice (Režabinec Pond), all in half flooded *Hypnaceae* in *Caricetum* at the margin of the pond, rare; Tyrol, "in rupibus ad bad Comana" (NORDSTEDT).

5. var. *dubovianum* (LÜTKEM.) RŮŽIČKA nov. comb. et ampl. charact. Fig. nostrae 11—14, 41—57.

Syn.: *C. Botrytis* (BORY) MENECH.  $\beta$  *mesoleium* nov. var., NORDSTEDT, O. et WITTRÖCK, V., 22., p. 27 (pro parte), non pl. 12, figs. 2a-c, 2a'.

*C. Botrytis* MENECH. var.?, DICK, J., 2., p. 245, pl. 14, fig. 1.

*C. Dubovianum* nov. spec., LÜTKEMÜLLER, J., 13., p. 487, pl. 2, figs. 14—16.

*C. Hornavanense* GUTW., MESSIKOMMER, E., 14., p. 343, pl. 1, fig. 4.

*C. Kjellmani* WILLE var. *grande* WILLE, GRÖNBLAD, R., 6., p. 14, pl. 2, fig. 22.

Cells on an average smaller than the type. On each side of the semicells only about 8—10 undulations. Verrucae in a view perpendicular to their base rounded or more often rounded-polygonic. Cell wall in the middle of the semicells thickened and pressed inward. In a side view the semicells are ovoid with flattened apex. In a vertical view the semicells are elliptic, without protuberances or with small protuberances.

Var. *dubovianum*, too, is composed of a number of forms. I observed forms of different dimensions (see below); forms with undeveloped or differently developed incision at the apex (fig. nostra 54, compare with fig. 17); forms with small protuberances (fig. nostra 47, compare with fig. 16); forms with low verrucae, so that the margin of the cell seems almost crenated (fig. nostra 49); forms with series of verrucae at the base curved in an arc in the direction of the isthmus or in the direction of the apex, usually, however, these series are irregular; forms with the sculpture reduced to 3—4 concentric series of verrucae, sometimes also without series at the base (fig. 49); forms with the punctulation of the cell wall little distinct (DICK?); forms with the punctulation very coarse, where at their base the verrucae are surrounded with some 4—6 more or less distinct punctae (see below). All these forms are connected with the usual forms of the variety in a gradual series, and they cannot be counted independent forms.

The dimensions are given in the table on p. 22. My data in the table are compiled on the basis of more than one hundred of measurements, and this is probably the reason for their wide amplitude. The apices of the variation curves for the most important data are at long. = 72  $\mu$ , lat. = 55  $\mu$ , long.: lat. = 1,31 $\times$ .

Var. *dubovianum* is probably considerably distributed and represents the fundamental lowland type of the species. It is connected by transitions with var. *janoviense* (fig. nostra 44) and var. *mesoleium*. With its larger forms it attaches to the type, with the structure of the cell wall to var. *mirabile*. The forms *Lütkemülleri* and *ochthodeiformis* approach *C. obtusatum* SCHMIDLE (cf. Section IV/3).

a) forma *Lütkemülleri*. Fig. nostrae 11, 51—54.

The variation curves betray the existence of a smaller and shorter form with apices of the curves at long. = 64  $\mu$ , lat. = 51  $\mu$ , long.: lat. = 1,20 $\times$ . In all other respects this form does not differ at all from the others, and thus I do not regard it as a separate variety. It is indubitably identical with *C. Dubovianum* LÜTKEM. (l. c., fig. nostra 11), but the shape and position of the verrucae are far more variable than stated in the definition of this species.

b) ? forma *Messikommeri*. Fig. nostra 14.

I think it probable that there exists still a form of dimensions above 80  $\mu \times 60 \mu$ . This is indicated in the records of MESSIKOMMER (l. c., p. 343) as well as in my observations (cf. table of dimensions); but I had no opportunity to measure more than a few specimens of this larger form.

c) forma *ochthodeiformis* n. f. Fig. nostrae 55—57.

The granules surrounding the verrucae are so enlarged that in a view perpendicular to their base the verrucae seem to break up into groups of 4—6 coarse punctae. In its sculpture it thus approaches var. *mirabile* (cf. Section I/3). This form is rare, and it may be a mere physiological modification. It is probably often mistaken for *C. ochthodes* NORDST. (cf. Section IV/2).



## Remarks to the Forms Described in Literature.

a) LÜTKEMÜLLER's species (l. c., fig. nostra 11) has almost all the characteristic features of *C. hornavanense*, especially the shape of the semicells, the undulated margin, the very distinct incision at the apex, and the sculpture. The author does not mention whether or not the wall is punctulated. The alga is the smallest form hitherto known of *C. hornavanense*, but the transitions to the type are quite gradual (cf. table of dimensions on p. 22).

b) DICK's *Cosmarium* (l. c., fig. nostra 13) has so characteristic a sculpture that it can hardly be separated from the other forms here listed, though the distinct incision at the apex and the punctulation of the cell wall were not figured by the author. DICK expressly points to the series of verrucae at the base, strikingly curved in crescent-shape against the isthmus. Such a curvature is frequent in var. *dubovianum* (cf. fig. nostrae 12, 14, 50), though not a rule.

c) GRÖNBLAD's alga (l. c., fig. nostra 12) has a somewhat reduced sculpture, the incision at the apex is, however, distinct. According to the author's report in litt. its cell wall is punctulated. *C. Kjellmani* WILLE var. *grande* WILLE (35, p. 43, pl. 12, fig. 33) is built differently (f. inst. the verrucae above the isthmus in series perpendicular to the base).

d) On NORDSTEDT's forms (l. c.) cf. Section I/4. From the ratio of breadth and thickness given by the author we can deduce that those forms of NORDSTEDT's which I place in var. *dubovianum* had probably no protuberances.

e) MESSIKOMMER's alga (l. c., fig. nostra 14) agrees with the other forms especially in sculpture and number of undulations in the margins, and belongs therefore rather to var. *dubovianum* than to the type. It is, however, relatively large (see above).

Localities: Southern Bohemia: ponds in the neighbourhood of Třeboň (LÜTKEMÜLLER); Písek, often in half flooded moss (mainly *Hypnaceae*) in *Caricetum* at the margins of eutrophic and oligotrophizing ponds at an altitude above sea level of 365—430 m., at pH 6,5—7,8 (f. inst. ponds of Šarlak, Malý Hánovec, Trubka, Horní Nový, Dolní Nový etc.); Switzerland: Kt. Zürich, Wetzikon, "Böndlerstück", *Caricetum* and ditches, 530 m. above sea level, pH 7,2—7,4; Kt. Zürich, Effretikon, "Mülizriet", between aquatic plants, 523 m., pH 7,4 etc.)\* Kt. Schaffhausen, Schaffhausen, "Eschheimertal", in filamentous algae in ditches, also forms with protuberances (fig. nostrae 47, 48), etc.; Tyrol (cf. Section I/4, NORDSTEDT); Southern Bavaria, 632 m. and 370 m. above sea level (DICK); Sweden, Öland, pH over 8,0—8,5 (GRÖNBLAD).

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\*) quoted from MESSIKOMMER, E., 14., pp. 332—333, and 19., pp. 509—511, which gives also further data.



6. var. *janoviense* (GUTW.) RŮŽIČKA nov. comb. Fig. nostrae 18—20, 58—65.

Syn.: *C. Botrytis* MENEGH. var. *janoviense* nov. var., GUTWIŃSKI, R., 7., p. 52, pl. 2, fig. 4.

*C. obtusatum* SCHMIDLE, forma, SKUJA, H., 29., p. 163, pl. 4, fig. 8.

*C. ochthodes* NORDST., typus, DICK, J., 3., p. 449, pl. 21, fig. 4.

Cells on an average smaller than the type. Semicells trapezoid, with sides from the basal angles to the apex almost straight in outline, also the apex planed in outline, not convex. On each side of the semicells about 8 to 10 undulations. Sculpture conform with var. *dubovianum*. Cell wall in the middle of the semicells slightly thickened and pressed inward. In a side view the semicells are ovoid with flattened apex. In a vertical view the cells are elliptic.

This variety is distinctly related to the var. *dubovianum*, but transition forms (fig. nostra 44) are rare. It is certainly not a mere teratological change of the cell.

Var. *janoviense* is less variable than the preceding variety, especially its dimensions are on the whole constant (cf. table of dimensions on p. 22). Divergences in sculpture described in var. *dubovianum* occur also in var. *janoviense*, especially the breaking up of the verrucae into punctae ("forma *ochthodeiformis*"). Very rarely I observed also forms with a reduced incision at the apex, so that the apex was scarcely visibly undulated (cf. GUTWIŃSKI, l. c., fig. 4, fig. nostra 18).

a) forma hybrida n. f. Fig. nostrae 64, 65.

The verrucae, at the margins of the cells close under the apex fuse, the sides of the semicells are under the apex a little concave; thus the apex is outstanding. In all other respects entirely like var. *janoviense*, with which it often occurs together and into which it gradually merges.

#### Remarks on the Forms Described in Literature:

a) GUTWIŃSKI's variety (l. c., fig. nostra 18) must be placed according to certain important characteristics in the sphere of *C. hornavansense*: margins of the cell undulated; verrucae in radiating series (figured by the author in a vertical view only); coarse punctulation of the cell wall; apex and the middle of the semicells without verrucae. The isthmus is strikingly narrow. The apex is figured straight, without incision; but this is doubtful as the author's drawing is evidently inaccurate; cf. also the var. *minor* ROUBAL (Section I/2).

b) DICK (l. c., fig. nostra 20) determines his *Cosmarium* as *C. ochthodes* NORDST. type, and appeals to WEST's drawing (34., pl. 98, fig. 2); this differs however sufficiently from DICK's figuring, and besides its belonging to *C. ochthodes* is not unconstested. The shape of the verrucae and the sculpture exclude an identification of DICK's *Cosmarium* with *C. ochthodes*; on the contrary, they place it in the sphere of *C. hornavansense*. One semicell has a distinct incision at the apex, to which, however, the apex of the second semicell does not correspond. As DICK placed his alga in *C. ochthodes*, we may conclude that he observed the breaking up of the verrucae into punctae as described in several forms in the present paper.

c) SKUJA's form (l. c., fig. nostra 19) differs essentially from DICK's *Cosmarium* only by the closer punctulation of the cell wall and by the inner series of verrucae being reduced. The incision at the apex is distinct. SKUJA regarded his form as a transition between *C. obtusatum* var. *Benanlandii* W. et G. S. WEST and *C. cymatopleurum* NORDST., so it is possible that he, too, observed the breaking up of the verrucae into punctae which occurs in some forms of *C. obtusatum* (cf. Section III/6).

Localities: Southern Bohemia, Písek: quite frequently together with var. *dubovianum* in the same localities (cf. Section I/5); U. S. S. R., vicinity of Lvov (GUTWIŃSKI); Latvia (SKUJA); Germany: Southern Bavaria, about 800 m. above sea level (DICK).

### C. Group "alpinum".

This group comprises the Alpine forms with developed protuberances and characteristic central sculpture.

7. var. *alpinum* (SCHMIDLE) MESSIK. Fig. nostra 15.

Syn.: *C. quasillus* LUND. var. *alpinum* n. var., SCHMIDLE, W., 25., p. 459, pl. 16, figs. 1a, b.

Cells smaller than the type. On each side of the semicells about 9—10 undulations; verrucae flatter, incision at the apex little distinct. Above the isthmus is a sculpture composed of a group of verrucae, irregularly grouped on a circular plane; the individual verrucae have a rounded base. Cell wall in the middle of the semicell slightly thickened. In a vertical view low, but distinct, protuberances.

The dimensions are given in the table on p. 22.

In SCHMIDLE's drawing some main characteristics of *C. hornavanense* can be seen, especially the incision at the apex; the apex without verrucae; the radiating series of verrucae of the shape characteristic of the species; the punctulated cell wall. According to the text (l. c., p. 459) also "formae rotundatae" occur in addition to the trapezoid forms; the shape of the semicells is thus just as variable as in the type. Therefore we have to accept without reservation MESSIKOMMER's (17, p. 125) placing this *Cosmarium* in the sphere of *C. hornavanense*.

From SCHMIDLE's drawing (l. c., pl. 16, fig. 1a) neither the side view nor the shape of base and sinus can be ascertained. SCHMIDLE (l. c., p. 459) writes in his text: "ceterum ut in forma apud LUNDELL". According to this the characteristics listed do not differ either from *C. quasillus* LUNDELL or from the following forms from Davos. SCHMIDLE does not mention the structure of the sculpture.

Locality: Tyrol, Ötztal Alps, 1900 m. and 2200 m. above sea level (SCHMIDLE).

a) forma *davosiense* n. f. Fig. nostrae 34—40.

Sculpture above the isthmus composed of elongated, curved verrucae. The other minute verrucae are surrounded by coarse punctae, and have in a view perpendicular to their base a more or less angular shape. In

a side view the semicells are almost rounded, with moderate protuberances on the underside. In a vertical view the cells are elliptic with relatively high protuberances.

Dimensions cf. table on p. 22.

In the Swiss material I found only specimens with roughly semi-circular semicells (SCHMIDLE's "formae rotundatae"?). In the structure of the verrucae this form corresponds to var. *dubovianum* f. *ochthodeiformis* (cf. Section I/5c), but the verrucae are more minute, and in a vertical view more angular (fig. nostra 39).

It is not excluded that this form is so independent that it should be defined as a new variety. But because of the rarity of its occurrence I had no opportunity to observe more than ten specimens, so that I have not sufficient material for judging of the variability.

Locality: Switzerland, Kt. Graubünden, Frauenkirch—Davos, "Wildboden", 1550 m. above sea level, pH 7,2—7,3.\*)

#### D. Uncertain Form.

C. Hornavanense GUTW. sec. SCHULZ. Fig. nostrae 21, 22.

*C. Hornavanense* GUTW., SCHULZ, P., 28., p. 130, figs. 22a-c, 22a'.

The inaccuracy of the drawings makes it difficult to judge of the author's forms. The drawings figure two very different algae, whose divergence SCHULZ does not explain.

SCHULZ's fig. 22a—c (fig. nostra 22) differs from *C. hornavanense* type especially by the different apex and by the sculpture formed by semiglobular verrucae; judging from the drawing this form is reminiscent in many respects of var. *mirabile* (Section I/3; compare fig. nostram 22 with fig. 33). In a vertical and in a lateral view are figured extensive protuberances with unusually large verrucae. In a vertical view the semicells have very broad poles.

Fig. 22a' (fig. nostra 21) differs again in quite different characteristics from GUTWIŃSKI's species, especially by the reniform base with the broadly rounded basal angles; from the text (l. c., p. 131) we have to assume that this form too has striking protuberances. The punctuation of the middle of the semicells is unusually coarse. When we take into account the inaccuracy of the drawing, this form is reminiscent of var. *dubovianum* (Section I/5), but it is considerably larger (cf. p. 22).

It is a great pity that it is not possible either to place SCHULZ's form in the species or to exclude it from it with certainty. On the one hand it gives us an interesting record from the Pomeranian lowland, from Sphagneta and therefore presumably from a strongly acidic environment, and on the other hand it is possible that it represents a form connecting the type and var. *mirabile* with the groups *dubovianum* and *alpinum*.

The dimensions are given in the table on p. 22.

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\*) quoted from MESSIKOMMER, E., 17., p. 70, where there are more data.

## II. Excluded Forms.

1. *C. subochthodes* SCHMIDLE var. *majus* SCHMIDLE. Fig. nostra 25.

*C. subochthodes* SCHMIDLE var. *majus* SCHMIDLE, n. var., SCHMIDLE, W., 26., p. 36, pl. 1, fig. 51.

GUTWIŃSKI regarded this *Cosmarium* as conform with his species (cf. Section I/1). I cannot share his opinion. The differences between the two *Cosmaria* are very important (compare fig. nostram 25 with figs. 1—3). SCHMIDLE's form has the semicells broadly ovoid with broadly rounded basal angles, so that the greatest breadth of the semicells is in about one third of their length; the shorter form of this *Cosmarium* (l. c., p. 36) has even "semicellulae late ovaes"; the base is reniform; the apex is narrow and without incision; the verrucae are semiglobular, minute, and fairly far apart from each other; there are 19 verrucae on each side of the semicell; the cell wall is "colorata"; in a vertical view the cell is relatively broader ( $1,50\times$  against about  $1,85\times$ , cf. p. 22) and the poles are broadly rounded.

In my opinion there is only one possible conclusion from a comparison of these characteristics with the description of *C. hornavanense* (cf. Section I/1): the two *Cosmaria* are two entirely different species.

2. *C. Hornavanense* GUTW. sec. MESSIKOMMER. Fig. nostrae 23, 24.

*C. Hornavanense* GUTW., MESSIKOMMER, E., 16., p. 183, text fig. 1, pl. 7, figs. 87—89.

MESSIKOMMER (l. c. p. 184) lists in detail the differences of his forms from GUTWIŃSKI's drawings (among others also the coarse, crater-shaped pores) and ascertains that these forms agree perfectly with *C. subochthodes* var. *majus* SCHMIDLE. There is nothing to add to the author's detailed conclusions. MESSIKOMMER's fig. 87 is reproduced in fig. nostram 23.

In the Swiss material I could convince myself that also the details of the sculpture are quite different (fig. nostra 24): the secondary punctae are quite independent of the verrucae, do not border their base, and in a vertical view they do not form groups (cf. Section III/6).

Therefore also these forms of MESSIKOMMER have to be excluded from the sphere of *C. hornavanense* GUTW.

The dimensions of the forms of MESSIKOMMER and SCHMIDLE are given in the table on p. 22.

## III. General Remarks.

### 1. Dimensions.

When we compare the dimensions given in the table on p. 22 we arrive at the following conclusions: The typical forms are on an average larger, approximately  $80\text{--}100\ \mu \times 70\text{--}90\ \mu$ , var. *alpinum* and the low-

land forms of the group *dubovianum* are about one fourth smaller. A final judgement would be premature, partly because we do not possess a sufficient number of reliable measurements of some forms, and partly because the division is disturbed by the uncertain large form of SCHULZ from the Pomeranian lowland.

More important than the absolute dimensions are their ratios, i. e. the ratio of the length to the breadth and of the breadth to the thickness. The typical large forms are relatively wider and thinner; but the data given in the literature on the subject vary too much and for a final judgement a greater number of reliable measurements would be needed, especially of the thickness (chiefly the measuring of empty semicells gives often too low figures).

In the same way as the absolute dimensions of the different forms merge gradually into each other so also do their ratios. Therefore the description of new forms or varieties distinguished only by their different dimensions is possible only on the basis of the statistics of variation.

## 2. Shape of the Semicells.

From Section I. the unusual variability of the shape of the semicells from semicircular via subtrapezoid to trapezoid with outstanding apex is sufficiently clear. It is also important to keep in mind the characteristics which are preserved without change in all forms: the sinus is always linear, deeply incised; the basal angles are but moderately rounded, not too broadly, so that the broadest place of the semicells is near the base; the apex is always developed, but does not always fall within the general outline, and is never too narrow.

The incision at the apex is very characteristic of the species, and it is always more or less distinct. Where the apex is figured entirely without any incision (cf. fig. nostrae 9 and 18) in the literature, the records are not quite dependable. The shape of the incision at the apex is very variable; as however the incision is not developed in one plane (it is formed by elevations at the apex), its apparent form depends also on the optics used and on the focussing.

## 3. Vertical View.

In a vertical view the cells are elliptic, i. e. with the poles not too broadly rounded and with curved sides. It is not clear whether GUTWIŃSKI (8., p. 461) with the expression "semicellulae . . . late tumidae" meant real protuberances or only the convex sides of the semicells. INSAM et KRIEGER (9., pl. 6, fig. 1) and TAYLOR (31., pl. 52, fig. 12, fig. nostra 6) did not figure protuberances in the type. Among the forms of the group *dubovianum* occur rarely also specimens without protuberances (fig. nostra 42 and others) and more rarely also with traces of protuberances (fig. nostrae 16, 48). In var. *alpinum* the protuberances form a permanent characteristic (fig. nostrae 15, 38).

In all varieties of the group *dubovianum* the cell wall is in the middle of the semicells slightly thickened and pressed inward. LÜTKE-

MÜLLER (13., p. 487) described this feature as follows: "E vertice... membrana in medio marginis utriusque fovea praedita". This feature is rather variable and seems to depend on the turgor of the cell as it is marked chiefly in empty semicells. It has not yet been described in the typical *C. hornavanense* (cf. however the form recorded in Section I/1a). Similar "foveae" occur also in other species, though they are rarely mentioned in literature. The taxonomic value of this feature is probably not great.

#### 4. Side View.

GUTWIŃSKI (8., p. 461) informs us only generally of the shape of the type in a side view: "semicellulae... circulares". In var. *mirabile*, near the type, we have really one approximately rounded shape of the semicells (fig. nostra 28). Also var. *alpinum* f. *davosiense* (fig. nostra 37) has rounded semicells with protuberances. In forms of the group *dubovianum* the semicells are more oval or ovoid with flattened apex (fig. nostra 45 etc., cf. also fig. 16).

#### 5. Colouring of the Cell Wall.

In no form, which I have had the opportunity to see, was the cell wall coloured. With nitrogenic ferro-cyanide and hydrochloric acid it coloured only slightly and uniformly.

#### 6. Sculpture.

The sculpture is formed by verrucae which narrow from the broad base and assume the profile of a higher or lower sinusoid. In some forms they are elongated into a roundedly conical shape (fig. nostrae 1—3, 63), in var. *mirabile* they are strikingly semiglobularly convex (fig. 26, 30, 33), in other cases they may be quite low and flat (fig. 4, 14, 49). But their apex is never abruptly flattened.

At the margins the verrucae are so close together that the margin of the cell appears undulatingly incised. When the verrucae are flatter, the margin appears sometimes almost crenated, especially with inaccurate focussing or incorrect position of the cell under the microscope.

The verrucae form characteristic radiating series, which, however, below the upper angles sometimes lose their regularity; at the margins of the cell one sees here the tendency to form verrucae outside the series, so that the marginal undulation is sometimes doubled (fig. 2, 44, 70).

A characteristic feature is also given by the series of verrucae above the isthmus, parallel with the base (fig. 2, 52), or curved in an arc in the direction towards the apex (fig. 1, 44) or towards the isthmus (fig. 12—14, 50, 70); but most frequently the series are very irregular. In all varieties specimens occur in which these series are reduced or completely disappear (fig. 3, 4—7, 49, 65). Under strong optics and still better in an oblique view we can, however, usually ascertain also in such cases unsuspected further series of verrucae. The verrucae in the

series above the isthmus have rarely an elongated shape (fig. 11—13, 62). Sometimes the verrucae cover also the whole middle of the semicells.

Below the middle of the semicells may sometimes be observed a group of indistinct, flat verrucae (fig. nostra 44, cf. also DEFLANDRE, 1., fig. 4). In var. *alpinum* this indication sometimes turns into a distinct sculpture, which suppresses or completely replaces the series of verrucae parallel to the base (fig. nostrae 15, 35).

The whole cell wall is always covered with punctae, sometimes hardly discernible under immersion (var. *mesoleium*), in other cases they are very coarse and striking (var. *mirabile*). The nature of these punctae has not so far as I know hitherto been examined by accurate methods. From the specimens with specially well developed sculpture I conclude that they are granules or an elevated pore-apparatus, and that between them the cell wall is still covered with dense and very fine punctae (pores?; fig. nostra 50).

In a view perpendicular to the base of the verrucae (best in a side view of the cell) their optical cross section appears as an indistinctly delimited inscribed circle, in low and flat verrucae only as a lighter or darker spot; often only the different refraction betrays the exact place of a verruca, which is so flat that otherwise it disappears completely in the punctulation of the cell wall. This optical cross section is most frequently 4—6 sided with broadly rounded angles. This is the appearance of the verrucae under strong magnification especially in var. *mesoleium* (fig. nostra 69), often also in var. *dubovianum* and var. *janoviense*.

When the sculpture of the cell wall is more distinctly developed, the base of each verruca is surrounded by several secondary granules situated in the angles of the 4—6 sided spots mentioned. I often observed such a sculpture in var. *dubovianum* (fig. nostra 46), *janoviense* (fig. 61) and *alpinum* f. *davosiense* (fig. 39). When the secondary granules are especially strongly developed, the verrucae divide completely in a view perpendicular to their base into a group of 4—6 punctae, and disappear themselves completely to the eye; only the refraction of the light betrays their outlines (fig. 57). I call such forms f. *ochthodeiformis*.

The extreme development of the secondary granules is current in var. *mirabile*; here the granules already resemble small verrucae. The large, semiglobular primary verrucae change in a perpendicular view into groups of small secondary verrucae, which, with the use of immersion, seem to merge into lobate formations (fig. 29, 32, 34).

In literature there is no remark on the details of the structure of the cell wall in the type, from which we may conclude that its verrucae in a cursory examination did not break up markedly into punctae. It is urgently needed to make similar observations also in the type to find out whether the structure described can be regarded as characteristic of the whole species.

In my opinion, however, the phenomenon described cannot be evaluated taxonomically; it is probably common to several related species,



especially to *C. obtusatum* SCHMIDLE (cf. *C. obtusatum* SCHMIDLE, formae: DICK, J., 3., p. 449, pl. 20, fig. 15, MESSIKOMMER, E., 15., p. 123, pl. 2, fig. 12, and 18., pl. 11, fig. 11). The explanation of this phenomenon may be sought in physiology.

#### IV. Relations to Other Species.

A so uncommonly variable species as *C. hornavanense* necessarily approaches in its extreme forms other species. I list here some of these.

1. The typical *C. botrytis* MENECH. differs completely from *C. hornavanense* by its general aspect, sculpture, and minute granules situated far from each other; the margin of the cell is entire (cf. f. inst. W. et G. S. WEST, 34., pl. 96, fig. 1). But there exist several forms of this species with an undulatingly incised margin and with radiating series of verrucae. Of these some forms of *C. botrytis* var. *mediolaeve* W. WEST are perhaps related to GUTWIŃSKI's species. Cf. *C. botrytis* var. *mediolaeve* W. WEST, TAYLOR, W., 31., p. 251, pl. 52, fig. 7, and *C. subochthodes* SCHMIDLE, SCHRÖDER, B., 27., p. 35 pl. 1, fig. 11, which WEST (34., p. 6) placed also in var. *mediolaeve*.

2. *C. ochthodes* NORDST. differs from the typical *C. hornavanense* in a whole number of features, but by cursory inspection it appears very similar to the var. *dubovianum*. As main differences we may list: in *C. hornavanense* punctae of second order are never found at the apex of the verrucae, but only at their base; the verrucae are smaller and farther from each other; even when the verrucae are sometimes very low, they are never abruptly flattened (the verrucae of *C. ochthodes* are described by LÜTKEMÜLLER, 11., p. 557, cf. also 12., p. 68: "Verrucarum vertex planus, granulis ternis-senis subregulariter dispositis ornatus"); margin of the cell cut out in *C. hornavanense* more or less undulatingly, in *C. ochthodes* more or less crenated; in the literature on *C. ochthodes* the incision at the apex and the series of verrucae above the isthmus are but rarely described, and forms of this kind are not indubitable. The two species thus differ essentially in the details, but they are certainly related, and some forms of both seem to be built according to the same plan.

3. *C. obtusatum* SCHMIDLE. Certain reduced and shortened forms of *C. hornavanense* var. *dubovianum* are very reminiscent of this species and transition forms also occur. For the closest possible relation argues also the ability to form secondary punctae at the base of the verrucae, which shows itself in some forms of each of the two species (cf. Section III/6). The two species can generally be distinguished from each other in a vertical view, where *C. obtusatum* has a very characteristic shape; sides only little curved, poles more broadly rounded (cf. f. inst. the drawing by LAPORTE, L.—J., 10., pl. 1, fig. 12).

4. *C. subochthodes* SCHMIDLE (non var. *majus* SCHMIDLE) seems also to be related to *C. hornavanense*. The connection is perhaps mediated by the form SCHMIDLE, 24., p. 75, fig. 26b, fig. nostra 8 (non



figs. 26a, c). Without the knowledge of the details of the sculpture it is not possible to decide this question from the drawings only.

## V. Conclusion.

In judging of the forms described we have constantly to bear in mind the unusual variability of the species. Where I was able to examine a greater number of specimens, I always found that each variety comprises a whole series of forms; even on the basis of several hundred observations I was unable to determine the limits between the different forms, and I regard them as not independent. Often of course one form only multiplies in a given locality and gives then wrongly the impression of an independent variety; also observations of only a few specimens can lead to this mistake.

*C. hornavanense* is because of its variability and fluidity a most interesting object for studying. I am convinced that it is by no means a rare species and that it has a wide range of forms and a wide area, but that hitherto it has often been overlooked or wrongly determined.

It was therefore one of the aims of the present paper to draw attention to this beautiful *Cosmarium*.

Písek, November 1948.

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Table of Dimensions.

Author	long. $\mu$	lat. $\mu$	crass. $\mu$	isthm. $\mu$	long. : lat.	lat. : crass.
<i>C. hornavanense</i> :						
1. Typus						
TAYLOR, 31. . . . .	94-109	71-84	37-44	19-24	1,22x <sup>1)</sup>	1,95x <sup>1)</sup>
GUTWIŃSKI, 8. . . . .	92-101	72,6-96,8	?	22-28,6	1,13-1,25x <sup>1)</sup>	?
DUCELLIER, 4. . . . .	90,4-102	73,5-90,4	?	23,2-29	1,13-1,23x	?
INSAM et KRIEGER, 9.	87-91	73-75	39-39,6	24-23	1,21x <sup>1)</sup>	1,89x <sup>1)</sup>
DEFLANDRE, 1. . . . .	87 <sup>1)</sup>	72 <sup>1)</sup>	?	26,4 <sup>1)</sup>	1,21x <sup>1)</sup>	?
?SCHMIDLE, 24. . . . .	? 86	? 72	?	? 30	1,20x <sup>1)</sup>	?
a. Forma						
RŮŽIČKA . . . . .	86-88,5	67,5-71	38,8-41	24,5	1,24-1,28x	1,73-1,75x
2. var. <i>minor</i>						
ROUBAL, 23. . . . .	78,2-87	63,25-71,3	?	23	1,21-1,27x	?
SCHMIDLE, 26. . . . .	83	74	48,6 <sup>1)</sup> 3)	29 <sup>1)</sup>	1,12x	1,52x <sup>1)</sup> 3)
3. var. <i>mirabile</i>						
RŮŽIČKA . . . . .	95-108	75-82	45-47	25-28	1,21-1,35x	1,66-1,80x
4. var. <i>mesoleium</i>						
NORDSTEDT, 22. . . . .	75-85 <sup>1)</sup>	50-56 <sup>1)</sup>	35 <sup>1)</sup> 3)	20-23 <sup>1)</sup>	1,50x <sup>1)</sup>	1,57x <sup>1)</sup> 3)
RŮŽIČKA . . . . .	76-88,5	55-65	34,5-37	20-22	1,36-1,45x	1,60-1,67x
5. var. <i>dubovianum</i>						
a. f. <i>Messikommeri</i>						
MESSIKOMMER, 14. . . . .	81,6	62	34,8 <sup>1)</sup>	21,4	1,32x	1,78x <sup>1)</sup>
RŮŽIČKA . . . . .	80-82	61-65	?	22-23	1,24-1,28x	?
b. f. <i>genuina</i>						
RŮŽIČKA . . . . .	67-78	53-60	32-37,7	18-21	1,22-1,36x	1,57-1,72x
GRÖNBLAD, 6. . . . .	72	57	32	19 <sup>1)</sup>	1,26x	1,78x
DICK, 2. . . . .	64-72	52,5-55	?	15,5!	1,27x <sup>1)</sup>	?
NORDSTEDT, 22. . . . .	60-68	48-54	28-30	22-24	1,26x <sup>2)</sup>	1,76x <sup>2)</sup>
c. f. <i>Lütkemülleri</i>						
RŮŽIČKA . . . . .	55-68	46-55	29-32,7	18-21	1,19-1,30x	1,62-1,72x
LÜTKEMÜLLER, 13. . . . .	52-62	43-50	26-28	16-18	1,24x <sup>2)</sup>	1,75x <sup>1)</sup>
6. var. <i>janoviense</i>						
DICK, 3. . . . .	78 <sup>1)</sup>	56 <sup>1)</sup>	?	16! <sup>1)</sup>	1,39x <sup>1)</sup>	?
SKUJA, 29. . . . .	68-71	52-54	?	20-22	1,32x <sup>1)</sup>	?
GUTWIŃSKI, 7. . . . .	70	53	34	12!	1,32x	1,56x
RŮŽIČKA . . . . .	69,5-75,5	54-61	33-35	19-22,5	1,20-1,33x	1,64-1,72x
7. var. <i>alpinum</i>						
SCHMIDLE, 25. . . . .	65-64	52-53	34 <sup>3)</sup>	?	1,23x <sup>2)</sup>	1,54x <sup>3)</sup>
a. f. <i>davosiense</i>						
RŮŽIČKA . . . . .	67-69,5	52-56,5	35-37 <sup>3)</sup>	18,5-20	1,24-1,30x	1,44-1,54x <sup>3)</sup>
8. forma incerta						
SCHULZ, 23. . . . .	84-108	70-75	? 48 <sup>1)</sup> 3)	25	1,32x <sup>2)</sup>	1,46x <sup>1)</sup> 3)
<i>C. subochthodes</i>						
var. <i>majus</i>						
SCHMIDLE, 26. . . . .	112	80	53,3 <sup>1)</sup>	?	1,40x	1,50x <sup>1)</sup>
MESSIKOMMER, 16. . . . .	82-87	56-63	36,5-39,5 <sup>1)</sup>	20-21	1,42x <sup>2)</sup>	1,54-1,60x <sup>1)</sup>

<sup>1)</sup> computed from the drawing and from the magnification stated

<sup>2)</sup> computed from the averages of the dimensions recorded

<sup>3)</sup> the cell has low protuberances

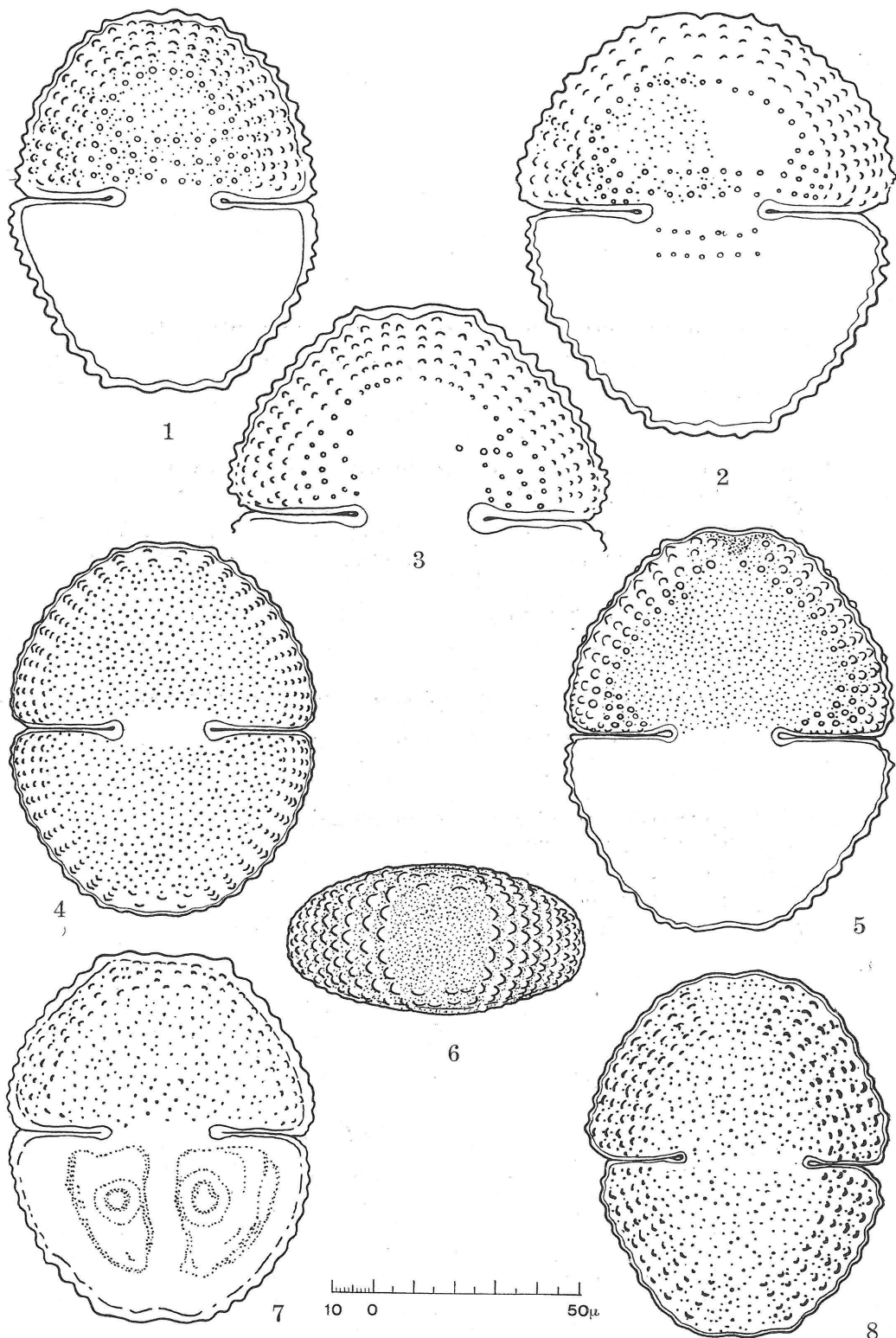
Tab. I.

1—7. *Cosmarium hornavanense* GUTW.

- 1—3. *C. Hornavanense* nov. spec., GUTWIŃSKI, R., 8., t. 8, fig. 28.
4. *C. hornavanense* (SCHMIDLE) GUTW., INSAM, J. et KRIEGER, W., 9., t. 6, fig. 1.
- 5—6. *C. tetraophthalmum* var. *pyramidatum* STRÖM, TAYLOR, W. R., 31., t. 52, fig. 12, 13.
7. *C. Hornavanense* (SCHMIDLE) GUTWINSKI, DEFLANDRE, G., 1., p. 1009, fig. 4.

8. ? *C. subochthodes* SCHMIDLE.

8. *C. subochthodes* SCHMIDLE, W., 24., p. 75, fig. 26b.



Tab. II.

9—10. *Cosmarium hornavanense* GUTW. var. *minor* ROUBAL.

9. *C. Hornavanense* GUTW. var. *minor nova*, ROUBAL, J., 23., t. 6, fig. 8.
10. *C. spec.*, SCHMIDLE, W., 26., t. 2, fig. 10.

11—14. *C. hornavanense* GUTW. var. *dubovianum* (LÜTKEM.)  
RŮŽIČKA nov. comb.

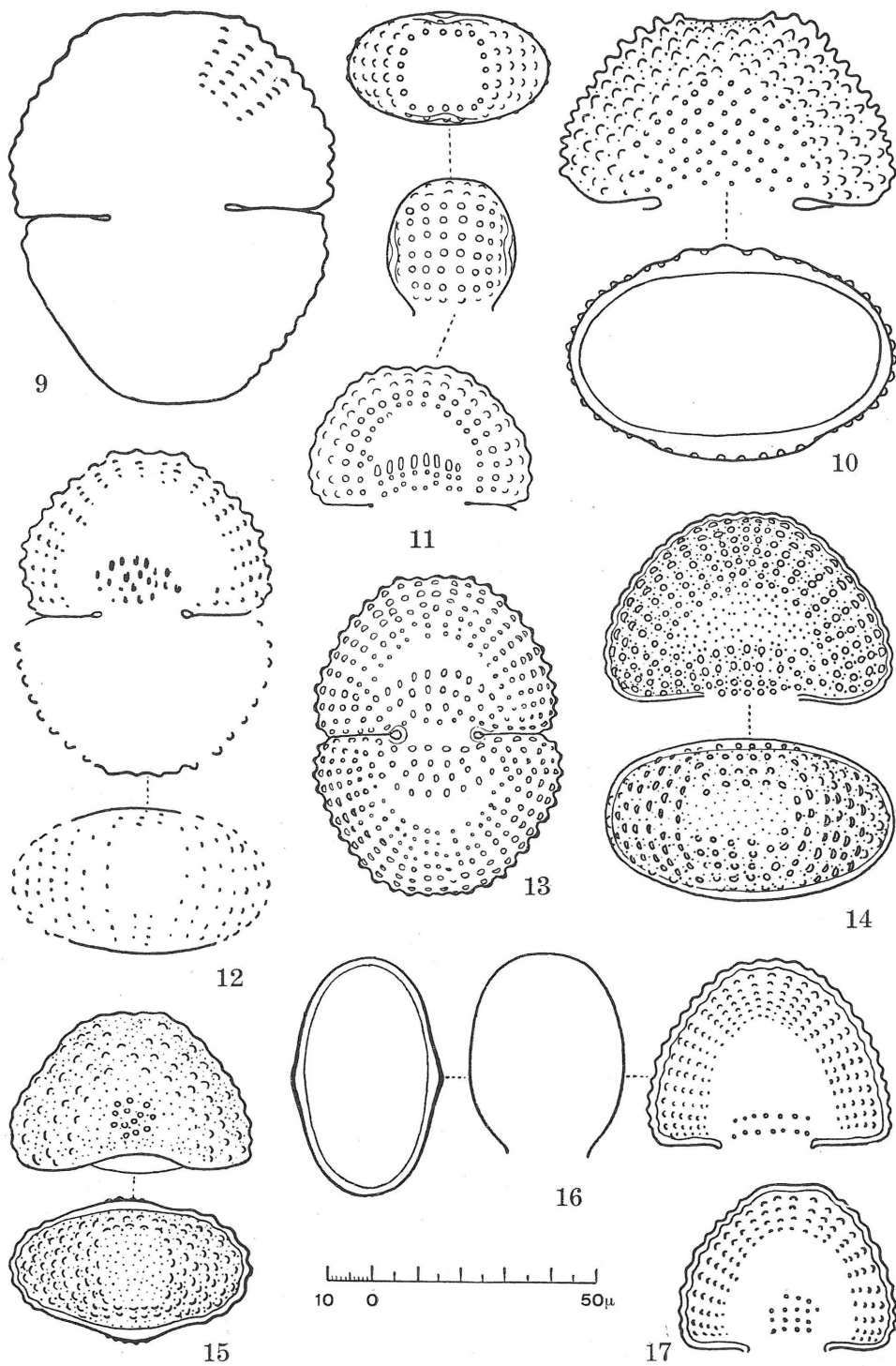
11. *C. Dubovianum* nov. spec., LÜTKEMÜLLER, J., 13., t. 2, fig. 14—16.
12. *C. Kjellmani* WILLE var. *grande* WILLE, GRÖNBLAD, R., 6., t. 2, fig. 22.
13. *C. Botrytis* MENECH. var.?, DICK, J., 2., t. 14, fig. 1.
14. *C. Hornavanense* GUTW., MESSIKOMMER, E., 14., t. 1, fig. 4.

15. *C. hornavanense* GUTW. var. *alpinum* (SMIDLE) MESSIK.

15. *C. quasillus* LUND. var. *alpinum n. var.*, SCHMIDLE, W., 25., t. 16, fig. 1a, b.

6—17. *G. hornavanense* GUTW. var. *mesoleium* (NORDST.)  
RŮŽIČKA nov. comb.

16. *C. Botrytis* (BORY) MENECH.  $\beta$  *mesoleium* nov. var., NORDSTEDT, O., et WITTRÖCK, V., 22., t. 12, fig. 2a—c.
17. dtto, *ibid.*, fig. 2a'.



Tab. III.

**18—20. *Cosmarium hornavanense* GUTW. var. *janoviense* (GUTW.)  
RŮŽIČKA nov. comb.**

- 18. *C. Botrytis* MENEGH., var. *janoviense* nov. var., GUTWIŃSKI, R., 7., t. 2, fig. 4.
- 19. *C. obtusatum* SCHMIDLE, forma, SKUJA, H., 29., t. 4, fig. 8.
- 20. *C. ochthodes* NORDST., typus, DICK, J., 3., t. 21, fig. 4.

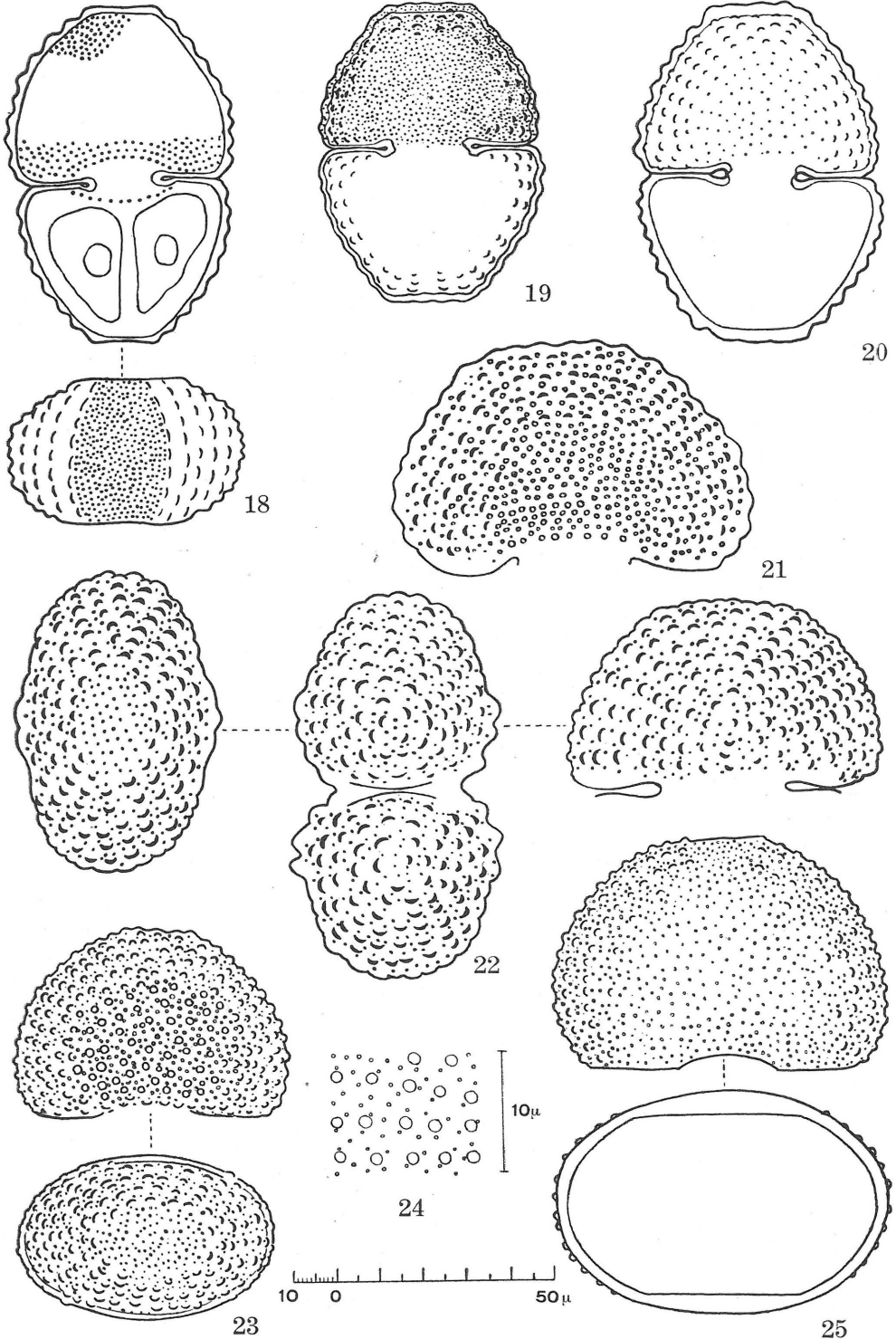
**21—22 ? *C. hornavanense* GUTW. sec. SCHULZ.**

- 21. *C. Hornavanense* GUTW., SCHULZ, P., 28., p. 130, fig. 22a'.
- 22. dtto, *ibid.*, fig. 22a—c.

**23—25. ? *C. subochthodes* SCHMIDLE var. *majus* SCHMIDLE.**

- 23. *C. Hornavanense* GUTW., MESSIKOMMER, E., 16., t. 7, fig. 87.
- 24. dtto, detail skulpturae, orig. aut.
- 25. *C. subochthodes* SCHMIDLE var. *majus* SCHMIDLE, n. var., SCHMIDLE, W., 26., t. 1, fig. 51.





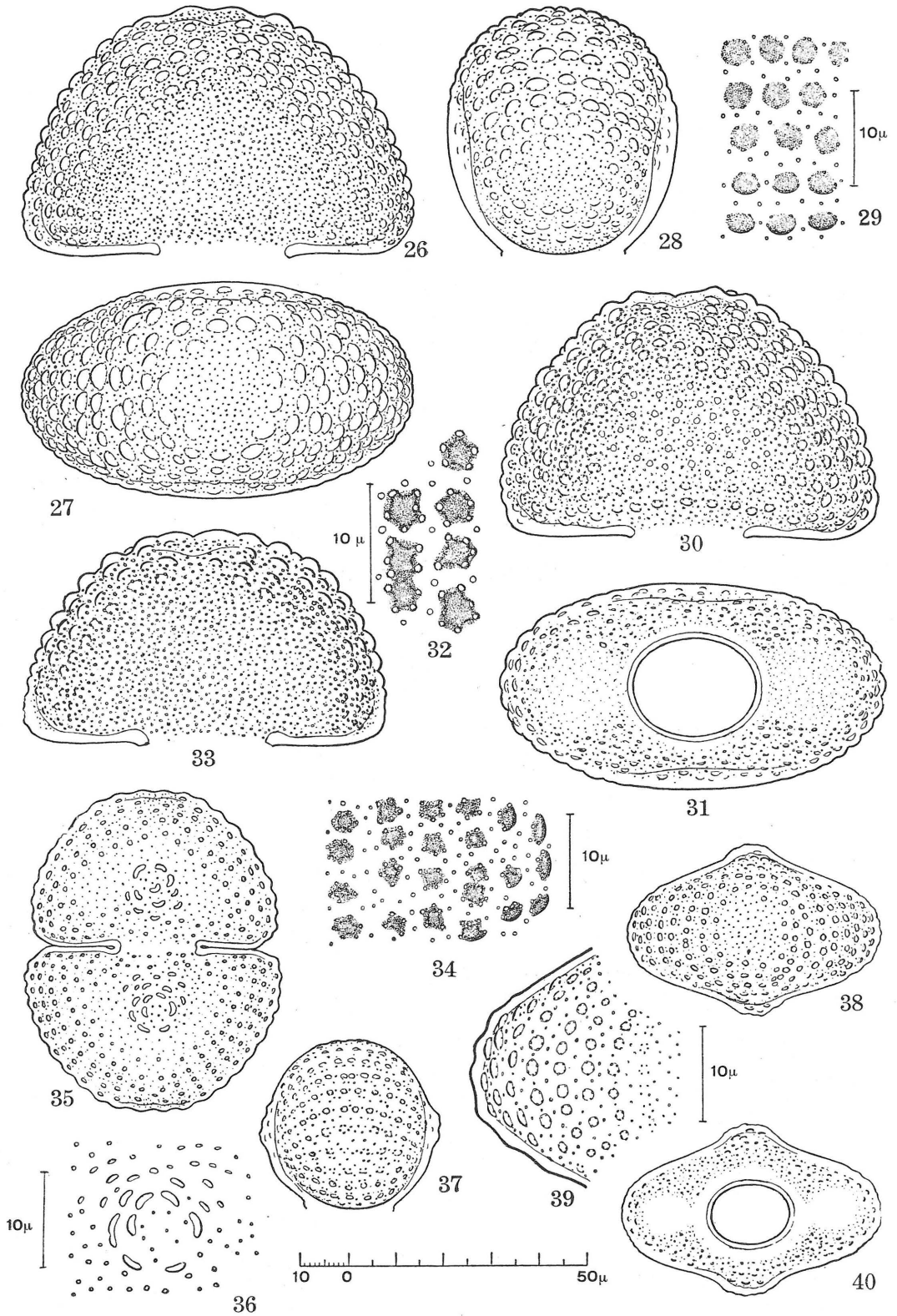
Tab. IV.

**26—34. *Cosmarium hornavanense* GUTW. var. *mirabile* RŮŽIČKA nov. var.**

26. Helvetia, Ragaz, Graue Hörner, Rundhöckersee; e fronte.
27. dtto; e vertice.
28. dtto; e latere.
29. dtto; detail sculpturae (e latere).
30. Helvetia, Ragaz, Graue Hörner, Rundhöckersee; e fronte.
31. dtto; e basi.
32. dtto; detail sculpturae (e latere).
33. Helvetia, Ragaz, Graue Hörner, Rundhöckersee; e fronte.
34. dtto; detail sculpturae (e vertice).

**35—40. *hornavanense* GUTW., var. *alpinum* (SCHMIDLE) MESSIK.  
f. *davosiense* n. f.**

35. Helvetia, Frauenkirch-Davos, Wildboden; e fronte.
36. dtto; detail sculpturae (e fronte).
37. dtto; e latere.
38. dtto; e vertice.
39. dtto; detail (e vertice).
40. dtto; e basi.



Tab. V.

**41—50. *Cosmarium hornavanense* GUTW. var. *dubovianum* (LÜTK.)  
RŮŽIČKA nov. comb.**

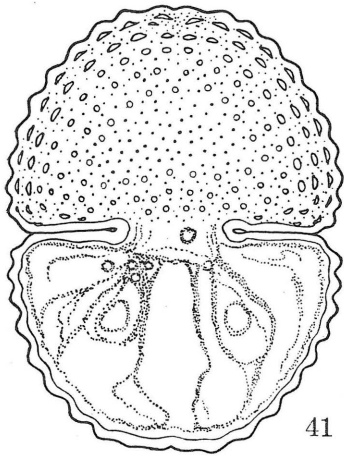
41. Bohemia, Písek, Šarlak; e fronte.
42. dtto; e vertice.
43. dtto; e basi.
44. Forma transitoria. Bohemia, Písek, Šarlak; e fronte.
45. dtto; e latere.
46. dtto; detail sculpturae (e latere).
47. Forma. Helvetia, Schaffhausen, Eschheimertal; e fronte.
48. dtto; e vertice.
49. Forma. Helvetia, Schaffhausen, Eschheimertal; e fronte.
50. Bohemia, Písek, Šarlak; e fronte.

**51—54. dtto, forma *Lütkemülleri*.**

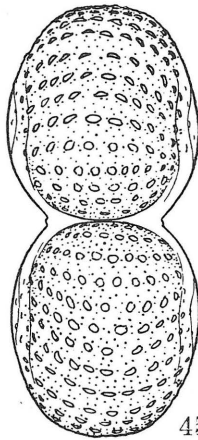
51. Bohemia, Písek, Horní Nový; e fronte.
52. Bohemia, Písek, Horní Nový; e fronte.
53. dtto; e latere.
54. Forma. Bohemia, Písek, Horní Nový; e fronte.

**55—57. dtto, forma *ochthodeiformis*.**

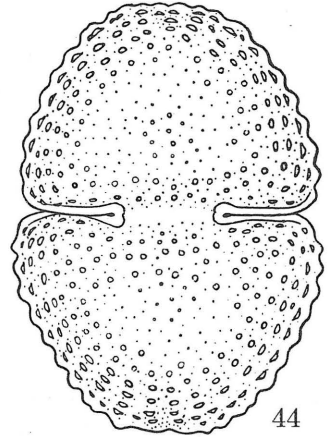
55. Bohemia, Písek, Šarlak; e fronte.
56. dtto; e latere.
57. dtto; detail sculpturae (e latere).



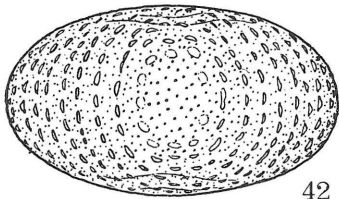
41



45



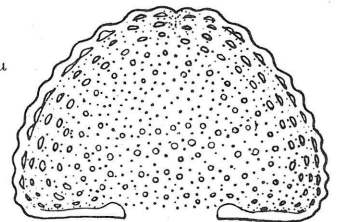
44



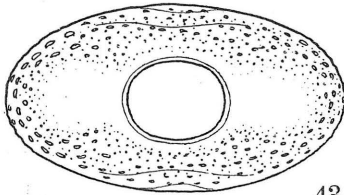
42



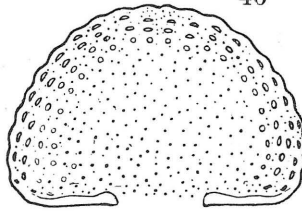
46



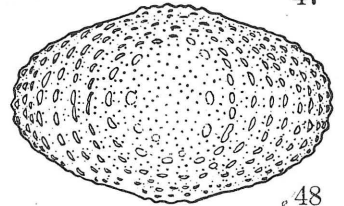
47



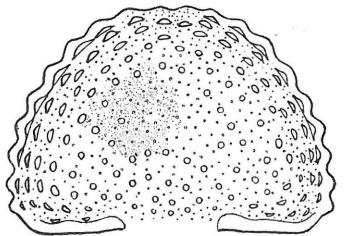
43



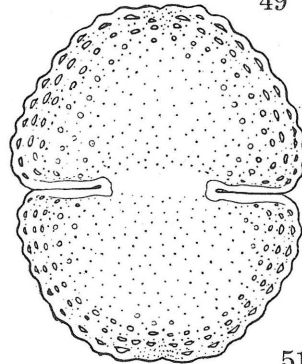
49



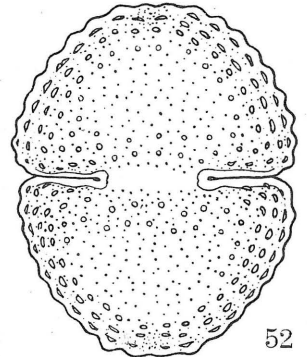
48



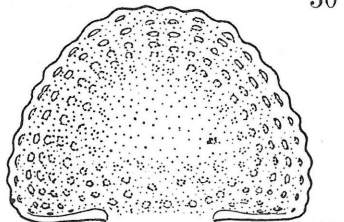
50



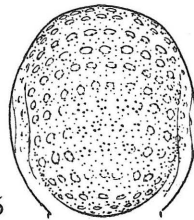
51



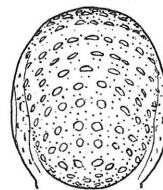
52



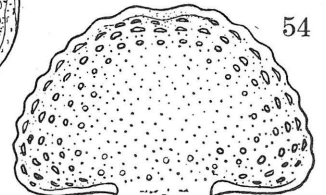
55



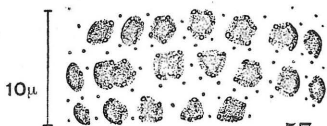
56



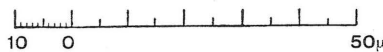
53



54



57



10

0

50μ

Tab. VI.

**58—63. *Cosmarium hornavanense* GUTW. var. *janoviense* (GUTW.)  
RŮŽIČKA nov. comb.**

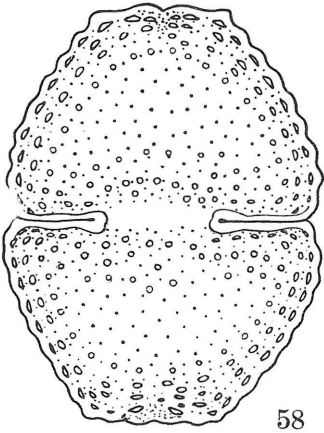
- 58. Bohemia, Písek, Malý Hánovec; e fronte.
- 59. dtto; e vertice.
- 60. dtto; e latere.
- 61. dtto; detail sculpturae (e latere).
- 62. Bohemia, Písek, Horní Nový; e fronte.
- 63. Bohemia, Písek, Šarlak; e fronte.

**64—65. dtto, forma hybrida.**

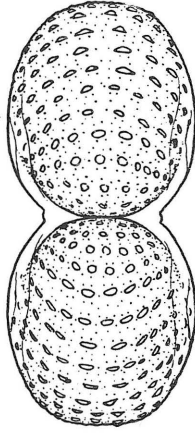
- 64. Bohemia, Písek, Šarlak; e fronte.
- 65. Bohemia, Písek, Malý Hánovec; e fronte.

**66—70. *C. hornavanense* GUTW. var. *mesoleium* (NORDST.)  
RŮŽIČKA nov. comb.**

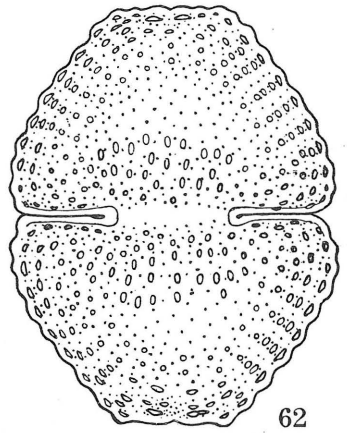
- 66. Bohemia, Písek, Šarlak; e fronte.
- 67. dtto; e vertice.
- 68. dtto; e latere.
- 69. dtto; detail sculpturae (e latere).
- 70. Bohemia, Písek, Šarlak; e fronte.



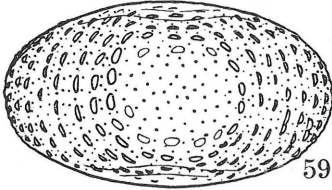
58



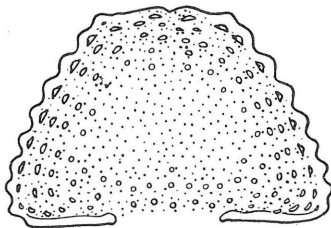
60



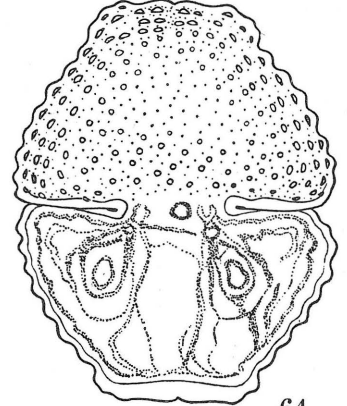
62



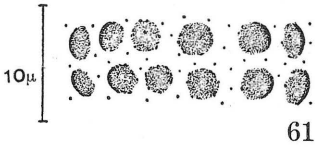
59



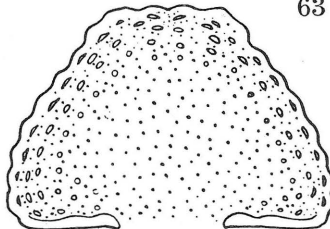
63



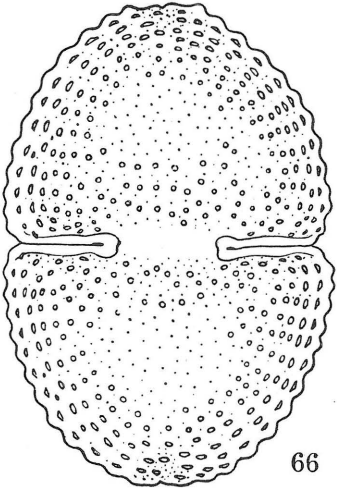
64



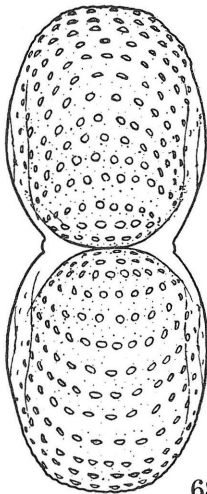
61



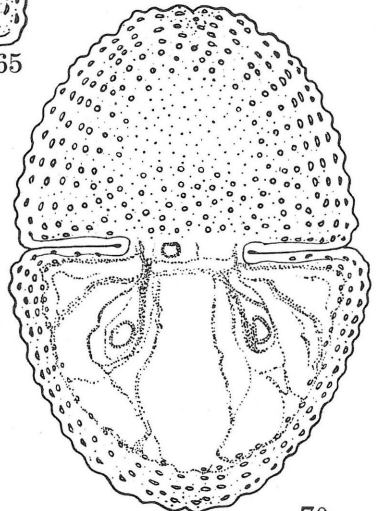
65



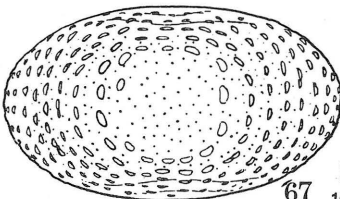
66



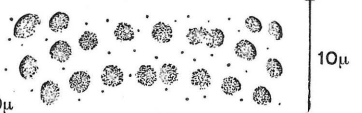
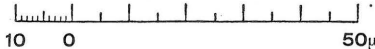
68



70



67



69

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