geven, blijkt dat de lengten der organen vrijwel gelijk zijn op het tijdstip van rooien. Een uitzondering vormt 1936; de verschillende organen zijn hier duidelijk grooter dan bijv. in 1935, toen ongeveer op denzelfden datum gerooid werd. Toch zien we uit tabel 9, dat de bloei in 1936 slechts enkele dagen eerder begon. De bloemen zijn, zooals te verwachten was (HUISMAN en HARTSEMA), bijna geheel gevormd, alleen de bijkroon moest bij een deel der bloemen (stad. VIII$^+$ tot IX) nog afgemaakt worden. In de ontwikkeling op het oogenblik van rooien hebben wij bij de narcis dus geen maatstaf voor het meer of minder vroeg bloeien. De lange trektijd voor 1932 en 1933 kunnen wij dus hieruit niet aflezen. Dat de weersgesteldheid van de laatste weken voor het rooien mogelijk hierop van invloed kan zijn, zullen wij aan het einde van het 2de gedeelte nader bespreken. Daar vindt men ook onze conclusies voor de practijk.

Wageningen, April 1938.

A summary will be given at the end of the second part in the next number.

Botany. — *Protoplasmic streaming in relation to spiral growth of Phycomyces.* By L. J. JOS. POP. (Communicated by Prof. L. G. M. BAAS BECKING).

(Communicated at the meeting of May 28, 1938.)

After the publication by OORT: "The spiral growth of Phycomyces" protoplasmic streaming was measured by me in Febr. 1932 both in young and in old sporangiophores. This was done because a connection might be expected between the direction of the protoplasmic streaming and the spiral growth of the cell wall, according to a hypothesis of H. J. DENHAM in extension of the work of CRÜGER and DIPPEL (cf. VAN ITERSON, 1927).

Material and method.

Phycomyces Blakesleeanus was cultivated in another way as was done by BLAAUW, DE BOER, OORT, a.o., viz. on malt-agar in glass-boxes, 6 cm high (cf. BURGEFF). On this sterilized culture medium (500 cc malt extract + 1000 cc aq. dest. + 30 gr. agar) Phycomyces, both the "+" and "—" strain grew equally well. After sufficient growth of the sporangiophores had taken place cubes of agar ($\pm$ ½ cc) with only one sporangiophore were cut out from the culture medium, the cube was cut off obliquely so that the sporangiophore assumed a horizontal position on the object-glass. According to TRZEBINSKI the lesion by cutting through the mycelium with a Gillette blade at a distance of a few millimetres from the sporangiophore does not greatly affect the activity of Phycomyces, as the injured spot closes immediately. The sporangiophores remained turgid, as might be expected. The abnormal horizontal position of the sporangiophore could be avoided similarly as was done by OORT by placing the sporangiophores during a part of the growth horizontally, but due to geotropical response a double curve in a sporangiophore ensues which creates an undesirable condition for measuring the protoplasmic streaming. It would be better to measure the protoplasmic streaming with a horizontal microscope, the sporangiophore remaining vertical, afterwards turning the microscope into a vertical position. In this way the influence of gravity upon protoplasmic streaming might be tested.

Results and preliminary discussion.

Some hundred sporangiophores (with and without sporangia) were measured at that time and in most cases (with an enlargement of $\pm$ 1600 $\times$

under darkfield illumination) streaming of the protoplasm in a spiral could not be found (a few cases excepted, just before the stopping of the streaming or locally in a few sporangiophores). As a matter of fact the streaming proved to be nearly always parallel to the long axis of the sporangiophore.

Another phenomenon that was found at that time, was the peculiar way the protoplasm streams. After my investigation in 1932 and again by my experiments during the summer of last year I came to the conclusion that the protoplasm streams in two concentric tubes. This result is in agreement with the work of KIRCHHEIMER (1933), although I cannot agree with KIRCHHEIMER as to the directions of the streaming: this discrepancy may be due to the inversion of the image in the microscope.

According to my opinion there exists a tubular ascent of the protoplasm around a central sap-vacuole towards the top of the sporangiophore, where the protoplasm turns back in a tubular stream towards the substratum between the ascending stream and the outer wall (cf. fig. 1). The velocity, moreover, of the stream towards the substratum was usually greater than that of the stream towards the top, as will appear from

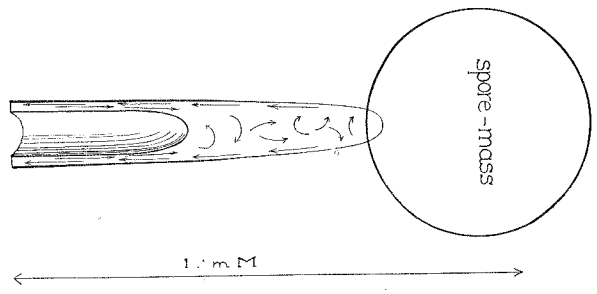

Fig. 1.

table 1, where some average velocities are given, calculated from at least five velocities measured by the speed of microsomes of about the same diameter.

Indications of the streaming in two opposite directions, as mentioned above, may also be derived from some quotations of other investigators, cf. e.g. KLEIN (1872), who writes of protoplasmic streaming in Pilobolus: "Sie fliessen in vielen Strömchen nicht bloss nach einer, sondern nach entgegengesetzten Richtungen". "Die Richtung ist vorwiegend nach oben und sich gleichbleibend; nur selten finden sich zwischen den vielen aufwärtssteigenden Strömchen auch zurückkehrende, aber einzelne sind immer vorhanden". "Sie geht selbst unter Deckglas oft Stunden lang ungestört und ungeändert vor sich", or VAN TIEGHEM (1875), who states in the case of Phycomyces nitens; "Après la maturité du sporange, ces derniers se vident progressivement, mais le protoplasme pariétal y persiste assez longtemps sous forme d'une couche très-mince, marquée de stries parallèles, verticales ou inclinées en hélice. Les granules montent le long

TABLE I.

	First layer of protoplasm (nearest to cover-glass and near the wall) Streaming from top towards substratum	Second layer of protoplasm (near the vacuole) Streaming from substratum towards top	Third layer of protoplasm (near the vacuole) Streaming towards top	Fourth layer of protoplasm (nearest to Object-glass and near the wall) Streaming towards substratum
Old sporangiophore measured $1\frac{1}{2}$ cm from top	3.4 μ/sec.	2.4 μ/sec.	2.1 μ/sec.	3.5 μ/sec.
Younger sporangiophore measured $1\frac{1}{2}$ cm from top	4.3 μ/sec.	2.8 μ/sec.	3.2 μ/sec.	4.5 μ/sec.
Young sporangiophore measured 1.3 cm from top	3.9 μ/sec.	2.6 μ/sec.	2.3 μ/sec.	3.3 μ/sec.

de certaines autres stries qui alternent quelquefois assez régulièrement avec les premières.", while OORT—ROELOFSEN (1932) also states; "Hauptsächlich bewegen Sie (z.w. die Plasmaströmchen) sich der Spitze hin, aber fast immer findet man auch wenige Fädchen, die basalwärts gehen". There are, moreover, apparently more microsomes in the ascending than in the descending stream. There is perhaps some material used in the growing region for building up the cell wall. Another possibility is the greater diameter of the descending stream that causes this apparent difference, the more so as in the ascending stream the currents of microsomes are more locally, while in the outer descending stream the microsomes are more equally divided over the whole diameter. Both the opinions of BENECKE—JOST (1923, p. 430); "Das beweist nun, dass nicht etwa der Zellsaft, sondern die peripheren Plasmamassen die Rolle, die das Substrat bei den Amöben spielt, übernehmen," and that of SIERP in "STRASBURGER's Lehrbuch der Botanik" (1931, p. 272); "Für das Zustandekommen dieser Bewegungen kommen wohl Aenderungen in der Oberflächenspannungen zwischen Protoplasma und Zellsaft im Frage," might both partially apply at the same time for Phycomyces, for the currents of microsomes in the two directions are (as seen under the microscope) not always next to each other, but certainly often enough beneath each other, so that the descending stream certainly does not come in contact with the whole surface of the cell sap, while a contact between the ascending stream and the peripheral layers of the descending stream never exists.

The opinion of CASTLE and of OORT—ROELOFSEN, where these investigators state about the growth-zone; "Die Strömung ist gering und ohne bevorzugte Richtung" cannot be considered as generally valid. The

growth-zone is, according to ERRERA and OORT limited to the region of ½—2 mm below the point of attachment of the spore-mass. From OORT and ROELOFSEN's opinion conclusions may be derived against the directing effect of protoplasmic streaming in the formation of the tubular structure of the primary cell wall. Against this opinion, however, a directed streaming up towards 100 μ [1]) below the sporangium was found more than once, although the Brownian movement of the greater number of microsomes at the top of the sporangiophore makes clear observation difficult.

Other culture-methods.

In August 1937 during a short working period at the Botanical Laboratory of Leyden the observations were repeated, as it was imaginable that the difference in culture method used by me in contrast with OORT or CASTLE might be responsible for the difference in direction of the protoplasmic streaming. For this reason the "+" and "—" strains were cultured not only on sterilized malt-agar, as was done before, but also on moist bread, as was done by OORT. Furthermore other culture media were also used in relation to the work of LINDNER, viz. sterilized 2 % glucose-agar, 2 % fructose-agar, 2 % amylum solubile-agar and 3 % lindseed-agar, which was used also afterwards by DE BOER in his investigation on the metabolism of Phycomyces.

Experiments and discussion.

The cultures were placed in the dark at 19° C and at 26° C. The growth varies a good deal. At 26° C almost no growth occurred. At 19° C, however, after five days the growth, both of the "+" and of the "—" strain, was abundant on malt-agar and moist bread (the sporangia were 6 cm or longer). On linseed-agar the sporangiophores have a different appearance. They are only 2 cm long, very thick, blueish-yellow and without sporangia, or at the utmost with very small and black sporangia. On amylum-agar only a very few sporangiophores are present, which were rather thin, while on glucose and fructose-agar some mycelium was present and no sporangia ever developed.

In a second series the same results were obtained except on glucose- and fructose-agar, where at this time after five days very thin sporangiophores were present, on glucose they were without sporangia and on fructose they showed very small sporangia. No difference in growth could be stated between the "+" and "—" strain on all the culture media, which fact also applies to the type of protoplasmic streaming of both the "+" and "—" strain, as was evident from my later observations on protoplasmic

[1]) CASTLE (1936) states in his "Origin of spiral growth in Phycomyces, p. 498; "Another intrinsic difficulty is that the growth zone does not begin immediately below the sporangium but at a variable distance of 0.1 to 0.2 mm".

streaming of Phycomyces, where sporangiophores of both strains were used, often grown on different media.

During this time the protoplasmic streaming was observed with a binocular Zeiss microscope and measured nearly always with a "Kardioid Dunkelfeld" condenser and an enlargement of 630 ×. The results in general were the same, also with the sporangiophores which were cultivated on moist bread, as was stated in my earlier observation. The only difference was that the measured velocities (3 μ/sec. towards the substrate and 2 μ/sec. towards the top of the sporangiophore) were this time smaller than in Febr. 1932, but this can easily be caused by the greater distance from the spore-mass at which the streaming was measured in 1932. The velocity of protoplasmic streaming decreases when measuring more towards the spore-mass of the sporangiophore as is evident from the following table, where the times in seconds are given (an average from at least five measurements), required by microsomes to cover a distance of 29 μ at different distances from the top (the data are given in chronological sequence).

TABLE II.

Sporangiophore "—" strain, on linseed-agar Length 1.6 cm	Measured at a distance from the top of:	Velocity of the streaming over 29 μ in seconds:	
		towards the top:	towards the substrate:
	7 mm	9.7	8.2
	4.5 „	12.6	9.6
	1.5 „	15.5	12.5
	7 „	13.8	9.5
	4 „	15.5	12.7
	1 „	no streaming	no streaming
	7 „	14.4	11.4
	4 „	no streaming	14.1
	1.5 „	no streaming	no streaming

Where three times after another the streaming velocities were measured at three different distances from the spore-mass and the velocity at 7 mm from the top was always greater than the velocity, which was observed before at 4.5 mm or 1.5 mm from the top, it was evident that the differences in velocity at various distances from the top could not be caused by the slow decrease of the protoplasmic stream in the whole sporangiophore, which decrease is also evident from the above table.

From this experiment it also appears (and it was confirmed in ± 20 observations) that the streaming towards the top ceases earlier than the

streaming towards the substrate of the sporangiophores. The differences of the streaming-velocity in proportion to the distance from the top (where the velocity was measured) and the discrepancy in velocity between the ascending and the descending stream could at first view be ascribed to the influence of gravity. Though this is a factor which plays probably a part in the streaming velocity in the normal vertical position of the sporangiophores, it does not seem to hold in these measurements as all these velocities were measured in a horizontal position of the sporangiophore. In my opinion there is a better chance that these differences are caused by the thickness of the protoplasmic layers, which thickness is greater at the top where no cell sap is present and gradually diminishes in the sporangiophore towards the substratum. The objection could be made that the decrease of the protoplasmic streaming, close to the spore-mass, was a local phenomenon in an individual ridge of microsomes. This cannot, however, be accepted as an explanation as will be apparent from several sets of observations, one of which is shown in table 3. In this special case it was possible, in spite of the enlargement used (630 ×), to measure at the same time the protoplasmic stream above- and below the vacuole, because the sporangiophore was only 60 μ in diameter. Almost the same velocities were observed in the four currents, also at various distances from the spore-mass.

TABLE III.

Sporangiophore, length 6 cm, thickness 60 μ
Streaming velocity measured over a distance of 29 μ

At a distance from the spore-mass of:	Time in seconds:			
8 mm	↓ 9 →	↑11.2	↑11.8	↓ 9.8
	↓ 8.6 →	↑12.4	↑11.8	↓ 9.2
	↓ 9.6	↑13.2	↑12.8	↓ 9.8 ←
5 mm	↓13.4 →	↑16.4	↑16.6	↓13 2
	↓13.6	↑16.6	↑16.8	↓13.6 ←

In table 3, where the times necessary in covering a distance of 29 μ are shown, the vertical arrows refer to the direction of the protoplasmic stream, viz. towards the top of the sporangiophore ↑ or towards the substrate ↓, while the horizontal arrows refer to the succession in time of the recorded measurements. When the arrow points to the right the stream, which approximates most the objective of the microscope, was first measured and the contrary (viz., last measured) condition is indicated when the arrow points to the left.

Even though not attaching (like KIRCHHEIMER, CASTLE, FREY—WYSSLING a.o.) great importance to protoplasmic streaming in the determination of the spiral growth of the cell wall as was done by VAN ITERSON and OORT—ROELOFSEN, it might be possible that the varying velocity of the stream in different parts of the sporangiophore plays a secundary part in the spiral growth of the cell wall. For this variable velocity, provided that this is also present under natural conditions, may give an explanation of the great individual differences in rotation found again and again by OORT—ROELOFSEN, CASTLE a.o., supposing that the protoplasmic stream, notwithstanding its parallel direction in relation to the long axis of the sporangiophore, plays after all a part in directing the micellae or the molecules.

Another question, according to GREHN, is the problem whether protoplasmic streaming is an autonomous phenomenon or a phenomenon that might be explained "durch eine osmotisch erklärbare Druckströmung und die Transpirationssaugung". There exist several arguments for the first-mentioned opinion. Primo; in a sporangiophore, which is surrounded by water under a cover glass, the evaporation cannot be the cause of a directed current and a fortiori not of a current in two opposite directions, as is the case in Phycomyces. In the second place the osmotic pressure from the mycelium in the substrate cannot be the only reason of the protoplasmic stream as this pressure can be released by cutting off the sporangiophore from the substrate without much influencing the velocity of streaming in the two opposite directions. For this purpose a series of velocity-measurements were performed both with sporangiophores which were still connected with the substrate and also with the same sporangiophore but now cut off from the substrate; even with cuttings from the middle of the sporangiophore, which were at times only 2 mm long and of which the protoplasmic stream persisted during several hours in the two directions. From these observations some may be cited here, which perhaps allow a conclusion e.g. that a streaming in the cell sap does not always influence the velocity of the protoplasmic layer, even not of the protoplasmic layer which borders directly to the cell sap. The velocity was measured in a sporangiophore, still connected with the mycelium, at 9.2 sec. (over 29 μ) towards the substrate and 11.1 sec. towards the spore-mass. Separated from the substrate the protoplasmic velocity was measured after five minutes at 9.4 sec. towards the substrate and 11.3 sec. towards the top notwithstanding the fact that protoplasmic contents of the sporangiophore were emptying through the cell sap. The passing of spherical masses of protoplasm throughout the cell sap was found frequently, as also stated by KIRCHHEIMER; and although these masses had apparently the same diameter as the vacuole no disturbance of the velocity could be seen in the protoplasmic layers. I should like to mention briefly a series of measurements, taken from a larger set of observations. From these measurements two facts become apparent; 1) that in the stream towards the substrate irregularities appear later than in the stream towards the spore-mass, viz.

the irregular acceleration of the microsomes over a distance of 2—5 μ, and 2) that a zigzag streaming of the microsomes, which runs towards the substrate, is caused by a honeycomb-pattern of the protoplasm, which appears first in the current towards the top, a phenomenon perhaps indicated by KIRCHHEIMER (p. 581).

TABLE IV.

Sporangiophore with a spore-mass, 3.8 cm long, 140 μ thick
All measurements were done 4 mm underneath the spore-mass

	Streaming velocity (time in sec./29 μ)		
	towards the substrate	towards the spore-mass	
2.05 p.m.			A piece of 9 mm was cut from the sporangiophore, measured from the top of the sporangium
2.10 p.m.	9.0	12.7	
2.25 „	8.9	13.1	
2.40 „	12.0	14.8	
2.55 „	13.5	16.0	
3.10 „	12.4	15.3	Many irregularities towards top, each leap 2—5 μ
3.25 „	11.9	15.4	Many irregularities towards top
3.40 „	12.5	14.2	Many irregularities towards top. Streaming towards top in a honeycomb-pattern
3.55 „	8.9	12.1	Many irregularities towards top. Towards the substrate also more zigzag streaming following the honeycomb-pattern of the stream towards the top
4.10 „	11.0	15.1	Towards top almost only irregularities
4.25 „	11.6	15.8	Towards top only one measurement
4.40 „	12.4	?	Towards top no measurement. Only „directed" Brownian movement towards top
4.55 „	13.5	14.0?	Towards top almost only Brownian movement
5.10 „	12.2	?	Towards top only Brownian movement

It is possible that the two facts, mentioned above, indicate a more important influence of the current towards the top, compared to the current towards the substrate. The question arises (in the supposition that the protoplasmic stream plays after all a part in directing the micellae) whether it is not possible that a change in the viscosity, as the sporangiophores grow older, causes a zigzag streaming of the protoplasm, which could partly explain the greater inclination of the micellae, which

according to OORT—ROELOFSEN occurs in the third layer of the cell wall. The asymmetry, moreover, of the acetyl-glucosamin molecules, by which the centre of gravity also has an asymmetric position in the molecule, could be perhaps another factor in the spiral growth of the cell wall, notwithstanding the fact that the current of the protoplasm runs usually parallel to the long axis of the cell. In the cited series of observations with a sporangiophore, which was removed from the substrate, it struck me that the current towards the top of the sporangiophore stopped earlier than that towards the substrate. In connection with the supposed autonomous character of the protoplasmic streaming the suggestion seemed obvious that a lack of material at the open end was the reason that the current towards the top stopped first, while the normal path of the microsomes into the outer stream at the top supplied more material in this outer stream, so that this streaming remained for a longer time. For testing this suggestion five series of observations were made, but now with pieces of sporangiophores which were cut from the middle of the sporangiophore (lengt 6 cm, diameter 60—70 μ) at a distance of 3—1½ cm from the top of the sporangiophore. The pieces had a length respectively of 1.3; 0.5; 0.25; 0.225 cm. Five minutes after the cutting the velocities were measured ± in the middle of the piece with interval of ten minutes, until the streaming stopped in both directions .From these data were calculated the mean times, mentioned below, necessary to cover a distance of 29 μ. The distance covered was calculated from the time which passed until the current stopped in the two directions, supposing that the velocity towards the top of the sporangiophore diminishes as much as this increases towards the substrate, a supposition which is certainly not true at the end of the series of observations, when the velocity at the top is much smaller than towards the substrate.

TABLE V.

Length of the piece	Average time in sec/29 μ		Time of streaming in minutes	Calculated distance in cm	
	Towards the substrate	Towards the spore-mass		Towards the substrate	Towards the spore-mass
1.3 cm	8.8	12.6	140	2.8	1.9
0.5 „	12.1	16.1	60	0.88	0.62
0.25 „	13.8	17.1	50	0.63	0.52
0.25 „	12.6	16.1	45	0.62	0.48
0.225 „	13.8	17.1	65	0.82	0.66

Though the distances covered by both currents, calculated in this way, are much longer than the length of the pieces used, I do not believe that a transition of microsomes occurred from the inner layer of the protoplasm

into the outer one, for such a transition of microsomes was never observed at the end of the experiment, except in the last series with the piece of 0.225 cm, wherein perhaps such a transport was seen on the side where the spore-mass had been. This, however, could also be explained by the often-observed direct transition in undamaged sporangiophores. In my opinion it is most evident that one must look for the cause of the protoplasmic streaming in the protoplasm itself, and not in a boundary-surface phenomenon e.g. a) between protoplasm and outer wall, for then it is difficult to understand why the inner stream persists in pieces of a sporangiophore or b) between protoplasm and cell sap, for how would it be possible then that 1) big masses of protoplasm, which pass through the cell sap, have no influence on the inner streaming and 2) that the outer streaming persists in cut sections of the sporangiophores.

Possible explanation.

In relation to the supposed connection between protoplasmic streaming and spiral growth of the cell wall, some suggestions may be proposed here, keeping, however, in mind the purely hypothetical character of these suggestions.

Because no spirally-streaming protoplasm was ever observed in the material used, first of all the spiral growth of the material was tested. For this purpose several sporangiophores, both of the "+" and "—" strain, were fitted in diffuse light with moist grains of "Norit" on one side of the spore-mass and after this treatment placed in the dark. Though this experiment was too superficial to measure definite angles of rotation, in both strains a rotation of the spore-mass could be observed. A nutation as suggested by CASTLE seemed to me less probable, where an angle of rotation of 160° (or 160° + 360°) was found after 2½ hours. So spiral growth of the cell wall occurred in the material used, notwithstanding the fact that never spirally streaming protoplasm was observed. I should like to suggest a hypothesis in relation to the work of VAN ITERSON about the structure of the cell wall of Valonia; for the elastic forces — to which CASTLE ascribes a possible rôle in effecting the spiral structure of the primary wall of Phycomyces, — cannot be the only reason of spiral growth (whereat CASTLE hints himself in a footnote), when a left-hand spiral (defined as spiralling in the direction of the thread on a left-hand screw) occurs more times than a right-hand spiral. The hypothesis would be that three factors cooperate; a) the plastic- and elastic properties of the cell wall, b) the asymmetry of the acetyl-glucosamin molecule and c) the changing velocity of protoplasmic streaming caused by the difference in thickness of the protoplasmic layer at different height in the sporangiophore and by the age of the cell.

One could imagine [1]) that the acetyl-glucosamin molecule is flat and moreover longer than broad, while the acetyl-unit, placed at one side, would make the molecule biased on that side. In this way one would obtain a modification of the suggestion made by FREY—WYSSLING, p. 131 [2]), in which, however, the fluctuation of the angles of spiralling becomes more plausible. This hypothesis might give at the same time an explanation, opposed to the one given by VAN ITERSON, of the periodical change in direction of the crystallites in two subsequent lamellae, by the assumption that the asymmetric units of one and the same layer form together submicroscopic ridges, along which the molecules of the subsequent layer glide in such a way that the asymmetric units of the subsequent layer repeat this process in the opposite direction.

By means of our hypothesis which connects protoplasmic streaming with asymmetric structure of the molecule, one could explain the difference in structure of the primary, secondary and tertiary wall of Phycomyces (in the sense of OORT—ROELOFSEN) as follows:

1. In the growth-zone [3]) the molecules, in forming the primary wall, should move forward on their flat side, but much deviated from the direction parallel to the long axis by the asymmetry of the acetyl-unit. The orientation of the chitin molecule will not be, however, perpendicular to the direction of the streaming because the acetyl-unit is not fastened to the chitin in its centre.

2. At a greater distance from the spore-mass, where the secondary wall is formed, the protoplasmic streaming itself is more parallel to the long axis of the cell, while the much greater streaming velocity produces a far better orientation of the molecules with their long axes almost parallel to the direction of the stream. A perfect parallelism should not occur on account of the asymmetry of the molecule. The difference in velocity of the protoplasmic streaming caused by individual differences of the sporangiophores (by difference in age of the same sporangiophore or by the difference in thickness of the protoplasmic layer according to a different distance from the top in the same sporangiophore) could in

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[1]) Provided that this possibility is not already excluded by the results of MEYER–PANKOW and ITERSON–MEYER–LOTMAR, as e.g. MEYER–PANKOW write on p. 594; "Nous sommes donc en droit de considérer le groupe constitué par les deux restes d'acétyle-glucosamine, que nous appellerons chitobiose, comme unité de structure", because in that case the asymmetry of the acetyl-glucosamin molecule is already balanced out in his model of chitin (of Palinurus vulg. just as in the second publication of Phycomyces). My ignorance of röntgenographic methods does not allow me to form a clear opinion in this matter.

[1]) "Ein weiteres Problem bilden die Beziehungen zwischen Protoplasmaströmung und Schraubenstruktur. Es gibt in der Natur viel organische Stoffe, die von sich aus zu schraubigen Kristallaggregaten heranwachsen".

[3]) In the growth-zone the streaming velocity of the protoplasm is very small and moreover the direction parallel to the long axis of the cell is much disturbed by the greater number of microsomes and by the Brownian movement.

our supposition give a ready explanation of the difference in the angles of rotation of different sporangiophores or of the same sporangiophore at subsequent times.

3. In the formation, finally, of the tertiary wall the velocity of the streaming, much diminished by age, would result again in a decrease of the directive force of the streaming upon the molecules. Ageing also may cause, as observed above, a "honeycomb-pattern" in the protoplasm, which would be in agreement with the description of OORT—ROELOFSEN, of this tertiary layer; "Die Schicht zeigt eine ziemlich grobe netzförmige oder schachbrettartige Zeichnung."

LITERATURE.

1. BENECKE, W. und JOST, L., Pflanzenphysiologie II, p. 430, Fischer, Jena (1923).
2. BOER, S. R. DE, 1927, Rec. trav. bot. néerl. **25**, 117 (1928).
3. BURGEFF, H., Flora **107**, 259 (1915).
4. CASTLE, E. S., Science **80**, 362 (1934).
5. ——— Journ. Cell. and Comp. Physiol. **7**, 3, 448 (1936).
6. ——— Journ. Cell. and Comp. Physiol. **8**, 4, 493 (1936).
7. ——— Proc. Nat. Acad. Sci. **22**, 336 (1936).
8. ——— Journ. Cell. and Comp. Physiol. **9**, 3, 477 (1937).
9. ——— Journ. Cell. and Comp. Physiol. **10**, 1, 113 (1937).
10. ERRERA, L., Bot. Zeit, **42** (1884).
11. FREY-WYSSLING, A., Die Stoffausscheidung der höheren Pflanzen, (p. 130). J. SPRINGER, Berlin (1935).
12. GREHN, J. , Jahrb. wiss. Bot. **76**, 93 (1932).
13. ITERSON, JR., G. VAN, Chem. Weekbl. **24**, 15, 166 (1927).
14. ——— Links en rechts in de levende natuur. Hand. XXIIIe Ned. Nat. en Geneesk. Congr., Delft (1931).
15. ——— Chem. Weekbl. **30**, 1, 1 (1933).
16. ———, MEYER, KURT H. und LOTMAR, W., Rec. trav. chim. **55**, 61 (1936).
17. ——— Nature **138**, 364 (1936).
18. ——— Proc. Kon. Akad. v. Wetensch., Amsterdam, **39**, 1066 (1936).
19. ——— Protoplasma **27**, 190 (1937).
20. KIRCHHEIMER, F., Planta **19**, 574 (1933).
21. KLEIN, J., Jahrb. wiss. Bot. **8**, 309 (1872).
22. LINDNER, P., Ber. d. d. Bot. Ges. **34**, 448 (1916).
23. MEYER, KURT H. et PANKOW, GEORGE W., Helv. Chim. Acta **18**, 589 (1935).
24. OORT, A. J. P., Proc. Kon. Akad. v. Wetensch., Amsterdam, **34**, 564 (1931).
25. ——— und ROELOFSEN, P. A., Proc. Kon. Akad. v. Wetensch., Amsterdam, **35**, 898 (1932).
26. STRASBURGER, E., Lehrbuch der Botanik. p. 272, Fischer, Jena (1931).
27. TIEGHEM, PH VAN, Ann. Sc. nat. **6**, 18 (1875).
28. TRZEBINSKY, M. I., Anz. d. Akad. d. Wiss. Krakau, Math. nat. Kl. (1902).

Palaeontology. — *On cretaceous Nerinea's from Cuba.* By H. KNIPSCHEER. (Communicated by Prof. L. RUTTEN.)

(Communicated at the meeting of May 28, 1938.)

In the collections, made by the Utrecht Cuba Expedition 1933 there were still some well-preserved *Nerinea*'s from Southern Santa Clara and Camaguey, which hitherto not had been studied. Equally undetermined were some *Nerinea*'s from Camaguey, collected in 1933 by Dr. TSCHOPP (of the Bataafsche Petroleum Maatschappij) in Camaguey, and presented by him to the Utrecht Geological Institute. In the following a short description will be given of four species.

Nerinea bicincta Bronn. fig. 1, 2, 3*a*, *b*, *c*.

H. G. BRONN, Neues Jahrb. 1836, p. 562, pl. VI, fig. 14; GOLDFUSS, Petref. Germ. 1844, 3, p. 46, pl. CLXXVII, fig. 5*a*, *b*.

Conical, with rather low convolutions; one row of knots with twelve knots on each winding; the knots of the different convolutions connected with each other in vertical sense. Four infoldings: two from the columella, one from the inner lip and one from the outer lip. Our specimens agree externally and internally with the species described by BRONN.

Localities: *a*. 700 m. S. from Aurora, Camaguey; *b*. Cantera Caballero, W. from Sibanicu, Camaguey.

Habana formation (Maestrichtian). The species, described by BRONN is from the Gosau-Cretaceous and from the "Upper Quader-Sandstein" (Senonian).

Nerinea (Plesioptygmatis) burckhardti Böse. fig. 4, 5.

E. BÖSE, Bol. Inst. Geol. Mexico, 24, 1906, p. 66—67, pl. XV, fig. 3—13.

Our specimens only rarely show any detail of the ornamentation, there only being visible an indistinct suture at the distal end of some of the convolutions. I did not detect a second spiral line, which BÖSE mentions from the proximal part of each winding. The deepest part of each convolution lies near the distal end. The height of the convolutions is rather variable: one specimen having 5 windings on 3.5 cm., another one of almost the same width 5 windings on 2.9 cm. There are no complete specimens. Four infoldings: two from the columella, of which the distal one is the deepest, one from the innerlip and a small one from the outer lip.

Localities: *a*. Ingenio Grande, Camaguey, SW. from Camaguey City; *b*. San José de los Jibaros, Camaguey.

Habana formation (Maestrichtian). BÖSE's specimens are from the