FORAMINIFERA FROM THE CRETACEOUS OF LIMBURG, NETHERLANDS. XXXVIII.*)

THE GLIDING CHANGE IN *BOLIVINOIDES* DURING TIME.

by J. HOFKER

In a former paper on *Bolivinoides* (Natuurhist. Maandblad, vol 44, 1955, pp. 68—71) the author has pointed out that in the Upper Cretaceous of South Limburg and Belgium a series of *Bolivinoides* occurs: *Bolivinoides strigillata* — *B. decorata* — *B. australis* — *B. gigantea*. In a more recent paper the author has given some more details about that development-series, stressing attention on the number of pustules found at the suture of the last formed chamber as a continuously changing feature, easy to detect (Micropaleontology, vol. 4, 1958, pp. 329—333).

Already H i l t e r m a n n and K o c h pointed out the continuously changing characters in *Bolivinoides* (Geol. Jahrbuch, vol. 64, 1950, pp. 595—632), but the changing characters they gave are often too difficult to calculate, since they only can be obtained by elaborate manipulations. Moreover, they did not clearly distinguish between two different lines of development in the forms they studied from the neighbourhood of Hannover, Germany: the series *strigillata-decorata-australis* (which they do not considerate) *-gigantea*, and the second one: *strigilata* — *miliaris* — *draco* — *dorreeni*. In Holland and Belgium *Bolivinoides draco* is very rare, only occuring in one single layer of the boundary Lower-Upper Maestrichtian, and all other types of the second development series are lacking. Only the first series of development is found, often abundantly in all samples studied. In a recent paper B e t t e n s t a e d t (Pal. Zeitschrift, vol. 32, 1958, pp. 115—1140) once again points to the *Bolivinoides*-development, but he too gave the two series as a single one, so that his conclusions are not very satisfactory.

In order to get more precise data about the development series of *Bolivinoides strigillata-gigantea*, the author studied larger series of samples in the Belgium region, since in South Limburg of the Netherlands such continuous series are lacking, since the quarries here are too short. Two series were obtained from the North Eastern regions of Belgium, close to the Cretaceous system in the Netherlands: a drill-hole and a quarry just above near Glons, and the large quarry at Hallembaye. The samples from Glons were given to the author by Prof. L. C a l e m b e r t, Liège; the series of samples from Hallembaye were taken by the author. Many shorter series from Belgium and South Limburg were studied for comparison. Moreover, a large series of samples taken near Harmignies in South Western Belgium (Basin of Mons) in the quarry Pourbaix, gathered by the author also, could be studied as well, so that the development series of *Bolivinoides strigillata-gigantea*, as given here, must be regarded at as exhaustively analysed.

There were three easily attainable characters which were taken as base for this study: length of the test, breadth of the last formed chamber, and the number of pustules at the suture of the last formed chambers. Since these characters can be given in numbers (they are given here in cm $\times$ 80), they can be used for stratigraphic purpose without difficulty. All tests were drawn with an Abbe-mirror and the drawings were measured.

In Glons as in Hallembaye, there is a hard ground in the sedimentation series, between the Upper Campanien and the Maestrichtian, indicating a gap in sedimentation, which in Glons comprises the whole Lower Maestrichtian, in Hallembaye at least the larger lower part of that stage. But in the Mons-Basin this gap, though consisting here also, is much smaller, since here lowest Maestrichtian is covering the hard ground (Craie de Spiennes). Moreover, nearly the whole sequence of Lower Maestrichtian could be found in Holland, but only in separate parts in different quarries, and often here the facies is such that *Bolivinoides* is lacking totally. Yet all stages of development between the uppermost Upper Campanian, as found in Glons and Hallembaye, and the Lowermost Maestrichtian as found near Mons, could be analysed in the Dutch quarries, so that the whole sequence of development in the series *strigillata-gigantea* can be described here.

In the drill-hole and quarry samples near Glons from the lower part of the Upper Campanian till the hard ground at its top, in about

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35 m of white chalk the breadth of the last formed chamber increases continuously from 2,8 to 3,1 cm (× 80); than, above the hard ground, the increase continues from 3,6 to about 4,5 cm (× 80), so that at the hard ground a gap is found between 3,1 and 3,6; a simple construction reveals that about 25 m of chalk is missing here; this is in agreement with the total thickness of the sediments of the Lower Maestrichtian in adjoining localities, and the other fossils found leave no doubt as to the lacking of the total Lower Maestrichtian here (Hofker, Ann. Soc. Belgique, vol. 81, 1958, pp. B 467—B 493). See fig. 4.

The numbers given above are average numbers, in reality there is variety in each sample, due to all kinds of outer circumstances; but in most samples that variety remains between 2 cm (× 80). Moreover, slight differences also may be caused by the sampling as well as by floating conditions during sedimentation.

Since the distance between two pustules in the whole series of development remains unchanged as can be seen from fig. 1, it will be obvious that together with the increase of breadth of the last formed chamber also that number will increase. But, since there are no parts of pustules, it will also be obvious that that increase always will seem more like small leaps than like a continuous change. In *strigillata* the number is 2, than, in *decorata* it increases from 2 to 4, giving at the very end of the Campanian an average between 4 and 5 pustules; at the gap of the hard ground in Glons and otherwhere, there also is a sudden leap, from average 4—5 to 5—6 or 6. Then in *australis* there is a steady increase till 7—8, and in *gigantea* this number becomes more and more 8 or 9. During the Lower Maestrichtian (the gap at Glons) the number of pustules changes from 5 to 7, in average, just filling up the gap at Glons (fig. 3).

The increase of the length of tests is not so conspicuous, since here the variation is larger since in many cases young specimens were calculated also. Yet the average of length also is increasing continuously, as will be seen in fig. 5.

The change in these characters in the sample series taken at Hallembaye absolutely is similar to that found at Glons (fig. 7 and 8), only the gap in sedimentation is probably smaller.

In the series of the quarry Pourbaix, taken through lowermost Upper Campian upto lowermost Maestrichtian, the increase of the characters analysed is quite similar, and moreover data were found from Lower Maestrichtian as well (fig. 9 and 10).

This analysis gives us a very reliable guide for stratigraphic parallelisations in the Upper Campanian, the Maestrichtian till at the base of the Maestrichtian Chalk Tuff, in which sediment no *Bolivinoides* (but for reworked *gigantea* in Ma) is found till at the top of it, where suddenly the group reappears with *Bolivinoides polonica* (Natuurhist. Maandblad, voll. 45, 1956, pp. 28—32).

There are in the data obtained from the Glons-series some irregularities which do not change our ultimate conclusions. In the first place some samples show a slight regression in the average results; these regressions may partly be due to slight changes in the circumstances; but more likely they are due to sedimentary factors: slight sorting of tests may have occurred by floating or by streaming water. These slight irregularities do not change the total aspect of the phenomenon.

In the samples taken from the level of the hard ground itself, it always was found, that they contain two differently preserved sets of tests; moreover, the statistic results reveal that we have to do with two sets of tests, the one deriving from the uppermost Upper Campanian, the other from the Lower Maestrichtian (fig. 1, 36 m). This irregularity thus is due to the conditions of the hard ground, in which hollows are found which contain tests of the next formation; the latter fossils always show a distinctly different preservation.

In any way, we may conclude that in this *Bolivinoides*-series a continuous change in characters is obvious during time, and that that change is irreversible and rectilinear. How can we interpret that gliding change? There cannot be any question of selection, since the variation-curve of the group at the end of the development series reaches far beyond the boundary-values of the curve obtained at the beginning of this series. At about 65—70 m in the drill-hole, the variation boundaries of the breadth of the last formed chamber are 2—3,5 cm (× 80); in the quarry itself (124 m for instance) the boundaries are found between 3,5 and 6 cm (× 80). So a selection is impossible. There are no leaps other than those due to the gap of sedimentation; the change is a gliding one. So it cannot be any

normal mutation, since in real mutation sudden leaps in more than one direction always are the consequence. This gliding change, which often has been named „orthogenesis", now very well established in many other groups of Foraminifera also (*Neoflabellina, Gavelinella, Gavelinopsis, Stensiöina*) cannot be due to changes in environment, since they are found continuing in not-changing facies as well as in changing facies. In the Glons-sampling a distinct change in the facies occurs at about 12 m in the drill-hole; yet the gliding change of characters continues undisturbed.

There must be quite a different factor which causes the continuous rectilinear increase of the characters analysed here, as well as that of the pore-diameters in Gavelinellidae (see fig. 6) and the change in characters of *Neoflabellina* (see fig. 2) as well; that factor might be time itself, so that we could describe the change as due to genes which are function of time.

No one can trace the boundaries between the stages of development in such groups; all such distinctions as given here in the names *Bolivinoides strigillata, decorata, australis* and *gigantea*, are totally artificial; one may describe these forms such as:

Bolivinoides strigillata with 2 pustules;
Bolivinoides decorata with 3—4 pustules
Bolivinoides australis with 5—6 pustules;
Bolivinoides gigantea with 7—9 pustules;

but one has to bear in mind that such distinctions are averages, and that variability increases the uncertainty. Also the lengthening of the pustules is gliding. There only is a continously changing series of development, beginning with *B. strigillata* in the Santonian and ending with *B. gigantea* in the Upper Maestrichtian. Such changes are very important for stratigraphic parallelisation, and many of the short outcrops in South Limburg could be stratigraphied by means of such changing series, as the author has demonstrated in another paper (Natuurhist. Maandbl., vol. 45, pp. 99—110, Gavelinellidae); but just those gliding changes make distinct taxonomy impossible, though they reveal the phylogenetic succession of formerly established species belonging to such a series. Moreover these orthogenetic gliding changes reveal a phenomenon which is unknown to biologists: it seems to be caused by time and not by environmental circomstances as change in climate or chemical changes. For as well in different localities over the world as in different sediments, the gliding rectilinear change is found in all cases where the changing group is found; such a changing group has been called by V a u g h a n a „gens" (Quart. Journ. Geol. Soc. London, vol. 61, 1905). Within a „gens" no clear boundaries between the successive forms are found; here biological names cannot be applied; since trinomical signature only is given to geographic varieties, that mode of distinction also is forbidden taxonomically; we only can speak of the *Bolivinoides strigillata-gigantea*-gens.

To complete this study, I have given in fig 2 also the types of *Neoflabellina* found in the samples at Glons; moreover here are given the pore-diameters of some of the gliding Gavelinellidae which, compared with those given in my study already mentioned on that matter, will give the more exact stratigraphical level of the samples; these diameters once again show us the gap in the sedimentation as well as the same phenomenon of characters being a function of time (fig. 6).

In de large figure (fig. 1) the reader will get an idea of the total changes of the characters in this *Bolivinoides*-gens, and in fig 2 the change of *Neoflabellina* in the same series of samples.

Such gliding changes, named orthogenetic changes, especially in real gens, form the only real time-indicators for stratigraphical use; they are the base of geochronology (see: H o f k e r: Neues Jahrb. Geol. Pal., 1957, p. 338—342). Especially in Foraminifera, when they can be detected in measurable features, such phenomena will be of emense importance, since Foraminifera are found in large numbers even in small samples. That was demonstrated in the series of samples from the drill-hole at Glons, since these samples in reality were small ones, never larger than a hand full of washed material. Yet the result was very satisfactory.

S h o r t d e s c r i p t i o n o f l o c a l i t i e s s t u d i e d
(See fig. 11).

GLONS. A drill-hole driven from the base of a quarry; the quarry's bottom is found at 124 m + N.P., the top of it at 132,50 m + N.P.; the drill-hole attained a depth of 70 m below the base of the quarry.

The lowest 4 m in the drill-hole are glauconitic and seem to form the base of the Upper Campanian; at 90 + N.P. or at about 36 m of depth in the drill-hole,

the hard ground was found, dividing the Upper Campanian from the Maestrichtian. The fossils above this hard ground indicate a gap of sedimentation, covering the whole Lower Maestrichtian, at possibly the lowest part of the Upper Maestrichtian; the according gap in the orthogenesis of the fossils indicate the lack of about 25 m thickness of chalk. At about 10 m depth of the drill-hole, the upper part of the Maestrichtian begins with more tuffous chalk. At the top of the quarry the base of the Maestrichtian Tuff Chalk is not yet reached.

HALLEMBAYE. In the large quarry at Hallembaye above the Middle Campanian which consists of greyish sandy chalks (Hervian), a glauconitic white chalk layer with thickness of about 1 m is found; above that layer about 30 m of white chalk are found, with at its top the hard ground; the fauna of the white chalk indicates it as Upper Campanian. The hard ground is found here at 105 m + N.P. (see L. Calembert, Bull. Soc. géol. Belgique, vol. 81, 1958, p. 462, fig. 2); above it at some places at least a greyish chalk is found, with a thickness of about 5 m, containing fossils of the upper part of the Lower Maestrichtian. Above that layer we find the chalks of the upper Maestrichtian, with a total thickness of about 28 m. At the top of the quarry it seems that just the level is reached which was found at Glons at a depth of 10 m in the drill-hole.

POURBAIX. This large quarry at Harmignies in Southern Belgium (Basin of Mons) begins at its base with some meters of Craie d'Obourg; this seems to be lowest Upper Campanian and its fossils date it to be of the same age as the lowest glauconitic layers in Glons and Hallembaye above the Hervian. Above that basal layer with a thickness of about 3 m at the highest above the base of the quarry, about 20 m of Craie de Nouvelles is found; in it, especially at its top, bancs of flints are found; the fossils indicate the same age as the Craie blanche below the hard ground at Glons and Hallembaye, it is indeed the same formation, Lower Campanian. At its top a feeble hard ground can be detected, whereon about 4 m of a more tuffous white chalk is found, the Craie grossière de Spiennes. It is very rich in **Inoceramus**-needles and contains the fossils of the lowest Maestrichtian, so that the sedimentation-gap here must be very small. It in all characteristics is identical with the white Cr 3 b in South Limburg, Netherlands, as found above the rests of the hard ground at Beutenaken, Bovenste Bos, Crapoel, etc., where also the hard ground often is difficult to detect. This formation already has been indicated by Leriche as Lowest Maestrichtian. In North Western Belgium this Lowest Maestrichtian is totally absent, but remains of it are found in the hollows of the hard ground.

Stratigraphic results.

In the quarry Pourbaix, Harmignies, near Mons, Southern Belgium, the increase of pustules and of breadth of last formed chamber during the sedimentation of Craie d'Obourg and Craie de Nouvelles at its top, where the hard ground is found, suddenly leaps up from 4 to 4,7 resp. form 3,1 to 3,4; reconstruction of the increase gives a gap in the sedimentation of about 7 meters of chalk; since the top of the Craie de Nouvelles shows the fauna of Upper Campanian, and the fauna of the Craie de Spiennes is that of typical lowest Maestrichtian, the gap of sedimentation at the Campanian-Maestrichtian boundary is according to Bettenstaedt (Pal. Zeitschrift, vol. 32, 1958, p. 133) about 175.000—350.000 years. Quite the same leap in evolution is found in *Bolivinoides* in the Dutch quarries at Bovenste Bos and Beutenaken, and here also the identical faunae below and above the hard ground is found; so we now can identify this gap in sedimentation in Southern Limburg also, and the white Cr 3 b above the hard ground and below the cemetery of Belemnites, must be identified with the Craie de Spiennes of the Basin of Mons (identical faunae, identical leap in the evolution) and thus is of lowest Maestrichtian age.

In the drill-hole of Glons in Northern Belgium, the jump in evolution of pustulus and breadth of last formed chamber in *Bolivinoides*, as well as that of the pore-increase in *Gavelinella clementiana* and *Gavelinopsis complanata* give us a gap in sedimentation of about 25 m of chalk. That would give according to Bettenstaedt a period of 625.000—1250.000 years. Since here at the top the pustules leap from 4,7 to 6,6 and the breadth from 3,1 to 3,6, we must presume that the gap of sedimentation in Glons was much larger; this coincides with the faunae which above the hard ground are those of the lowest Upper Maestrichtian. This may give us a measure for the lenght of the Lower Maestrichtian. I have already pointed out that the total thickness of the layers in Southern Limburg in Holland is about 25 m, formed by the small gap at the hard ground and the white and yellow Cr 3 b.

In the quarry Hallembaye in Northern Belgium, the jump in the evolution of pustules and breadth of the last formed chamber in *Bolivinoides* is from 4,2 to 5,7 resp. 3,2 to 3,8. This would suggest that here the gap covers the top of the Upper Campanian and a slightly smaller part of the Maestrichtian; this is comfirmed by the faunae. Here the total thickness of the missing packet of chalk is about 28 m, giving a

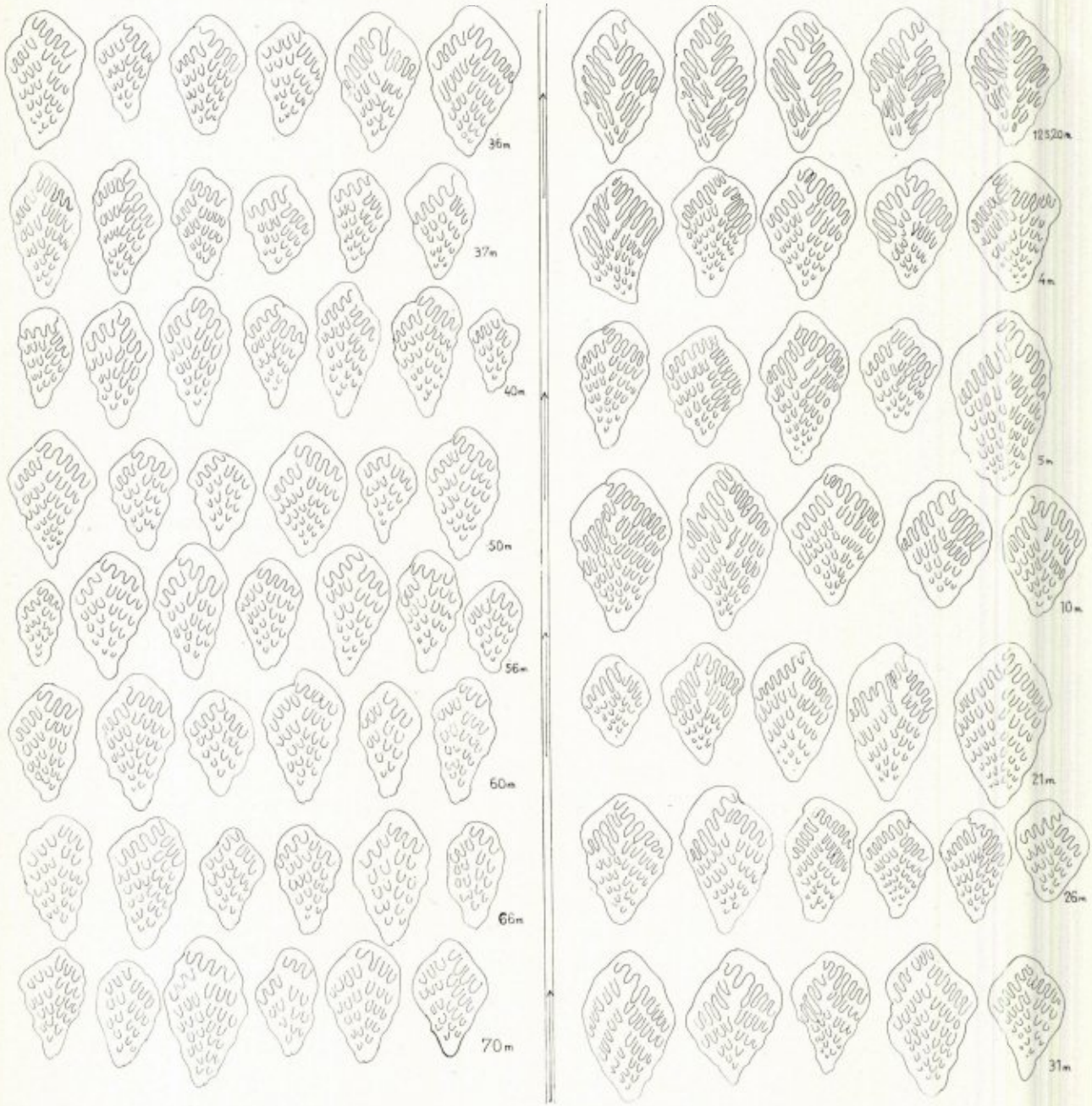

Fig. 1. The sequence of the *Bolivinoides decorata-gigantea* gens in Glons.
At the left side this sequence begins at the bottom and runs up towards the top; next comes the row at the bottom to the right and once again runs up towards the top. At the left side top, 36 m, the two different evolution-stages in the hard ground are pictured, so that the whole left side shows the group as found in the Upper Campanian; the right side shows the Upper Maestrichtian sequence. From each level 5—7 specimens are figured, chosen at random. Besides two specimens at 36 m, all specimens of the left side belong to *„Bolivinoides decorata"*; at the right side *„Bolivinoides australis"* runs up into *„Bolivinoides gigantea"* which is found at the very top (125,20 m - N.P.). Between 36 m and 31 m part of the *australis*-sequence (with 5 pustules) is missing, due to the gap in sedimentation.

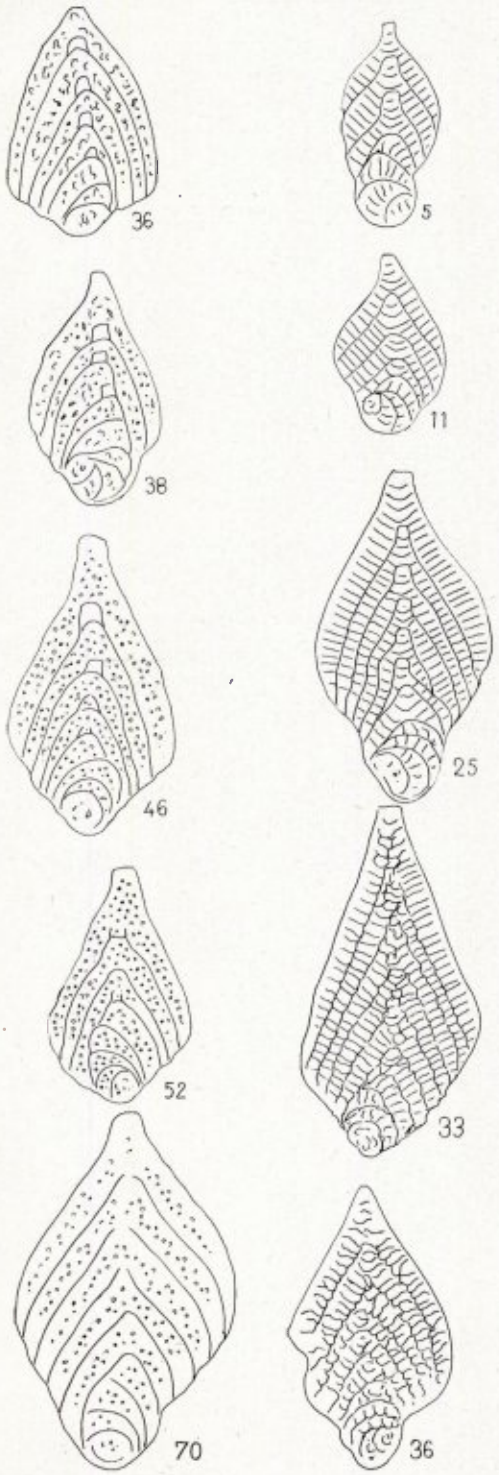

Fig. 2. The sequence of the *Neoflabellina leptodisca-postreticulata* gens in Glons is pictured. Here also the left row runs bottom to top and is continued in the right row, also from bottom to top. In the lowest samples of the drill-hole, we find *Neoflabellina pachydisca*, rapidly changing into *leptodisca* which is found till just below the hard ground; at 38 m, we find the first specimens of primitive *praereticulata*, whereas in the hard ground itself (36 m) two forms are found, *praereticulata* in primitive form and *praereticulata* in a more advanced form. Above the hard ground *reticulata* is found (33 m), but in the upper layers, especially in the Craie tuffoide (11 m, 5 m) the form *postreticulata* is typical. Here also we find a gliding change, though this cannot be given in distinct numbers.

period of 700.000—1400.000 years. The fauna just above the hard ground in Hallembaye is identical with that found in the quarry near Mesch in Holland, in which quarry 4 m of that chalk are visible, just the thickness of the difference between Glons and Hallembaye of the missing packet.

Comparing both quarries Glons and Hallembaye we find that at the top of Hallembaye the averages of pustules and breadths are 6,4 resp. 4,3; in Glons they are at the very top 7,5 and 4,5. This difference is due to the lack in Hallembaye of the upper part of sediment as found in Glons. The difference calculated gives for Glons about 20 m more of sediment than in Hallembaye; that would give a depth in the drill-hole in Glons of 10—12 m; since the tuffoid chalk in that drill-hole begins with a depth of 15 m in the drill-hole, and since just at the top at Hallembaye the tuffoid chalk has a thickness of about 3 m, these two values agree.

Comparing the hard grounds between the Upper Campanian and the Maestrichtian in Holland, North Eastern Belgium and the Basin of Mons, we find that the hard grounds in North Eastern Belgium are distinct, with distinct holes („racines"), while those in Holland and the Basin of Mons are indistinct without holes; this may point to a much longer uphaeval of the locality in question; the longer the hard ground has been exposed, the more it is distinct.

The results of these studies in chronology may be found in fig. 11, where the three localities discussed are compared with what we know about comparable or even identical sediments in Holland.

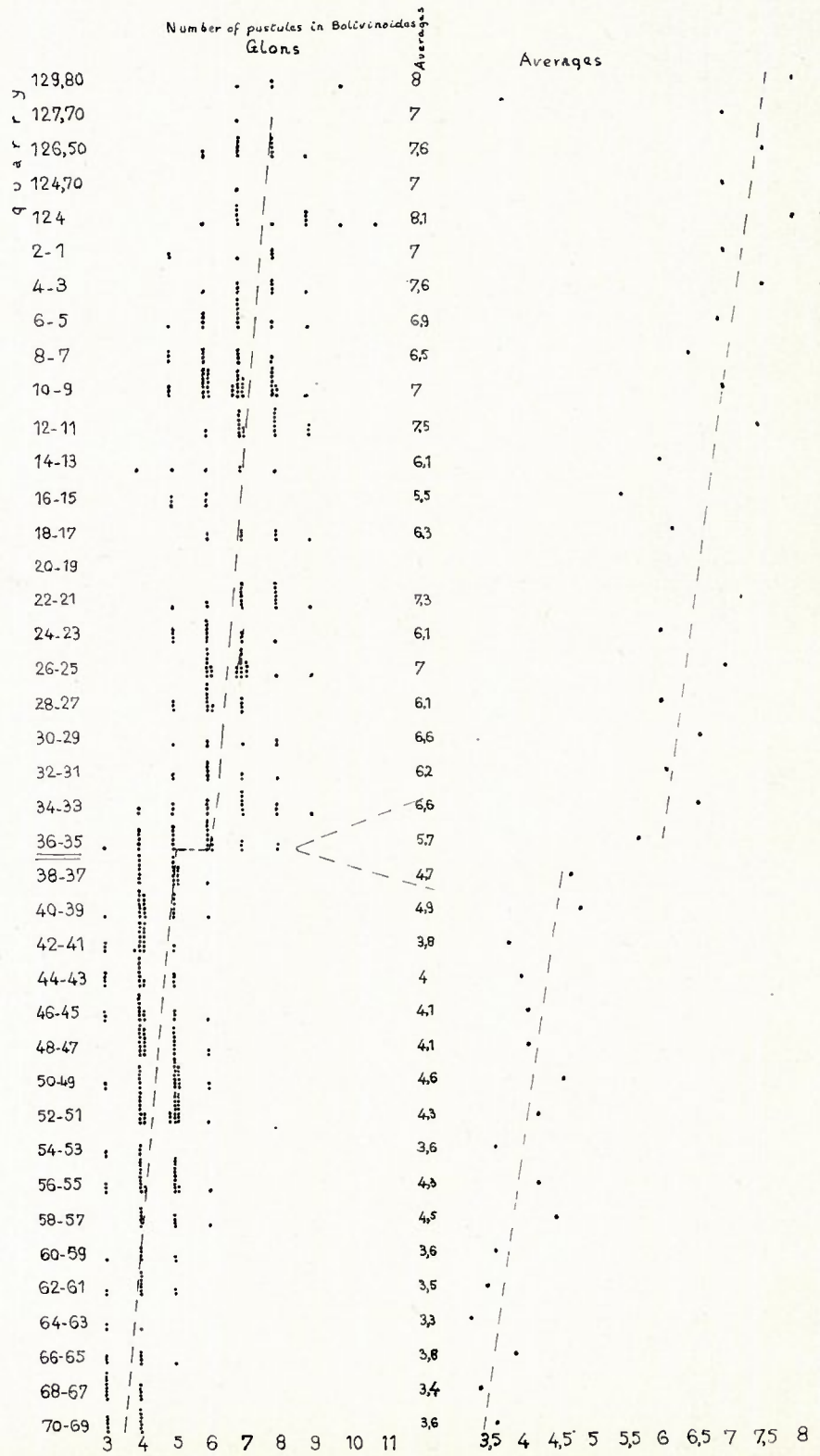

Fig. 3. Diagram of the increase in the number of pustules along the suture of the last formed chamber in the *Bolivinoides decorata-gigantea* gens. The orthogenetic change is very typical, but shows a sudden jump at 35—36 m, where the hard ground is found and part of the Maestrichtian is lacking. Each point indicates an individual. The breadth of variation as found in the lower levels is surpassed greatly in the upper levels, but always towards one side; this cannot be due to selection and also cannot be explained by mutation; it has to be explained by the change of time itself.

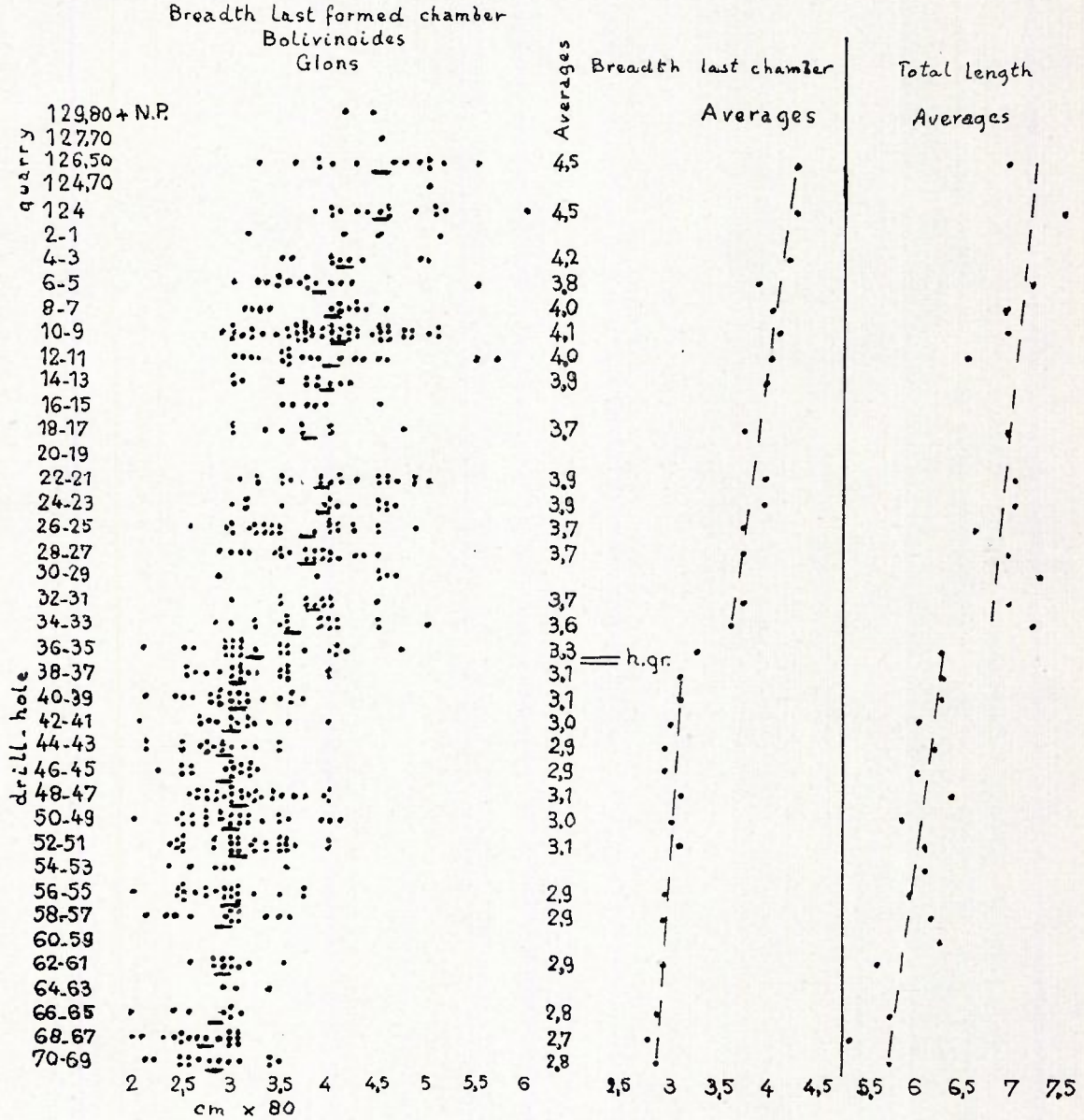

Fig. 4. Diagram of the change in the breadth of the last formed chamber in the *Bolivinoides decorata-gigantea* gens at Glons. Here once again the jump at the hard ground is distinct. This also is shown in the total lengths of the tests which also gradually increase. Here again the breadths of variation are greatly surpassed in the upper levels.

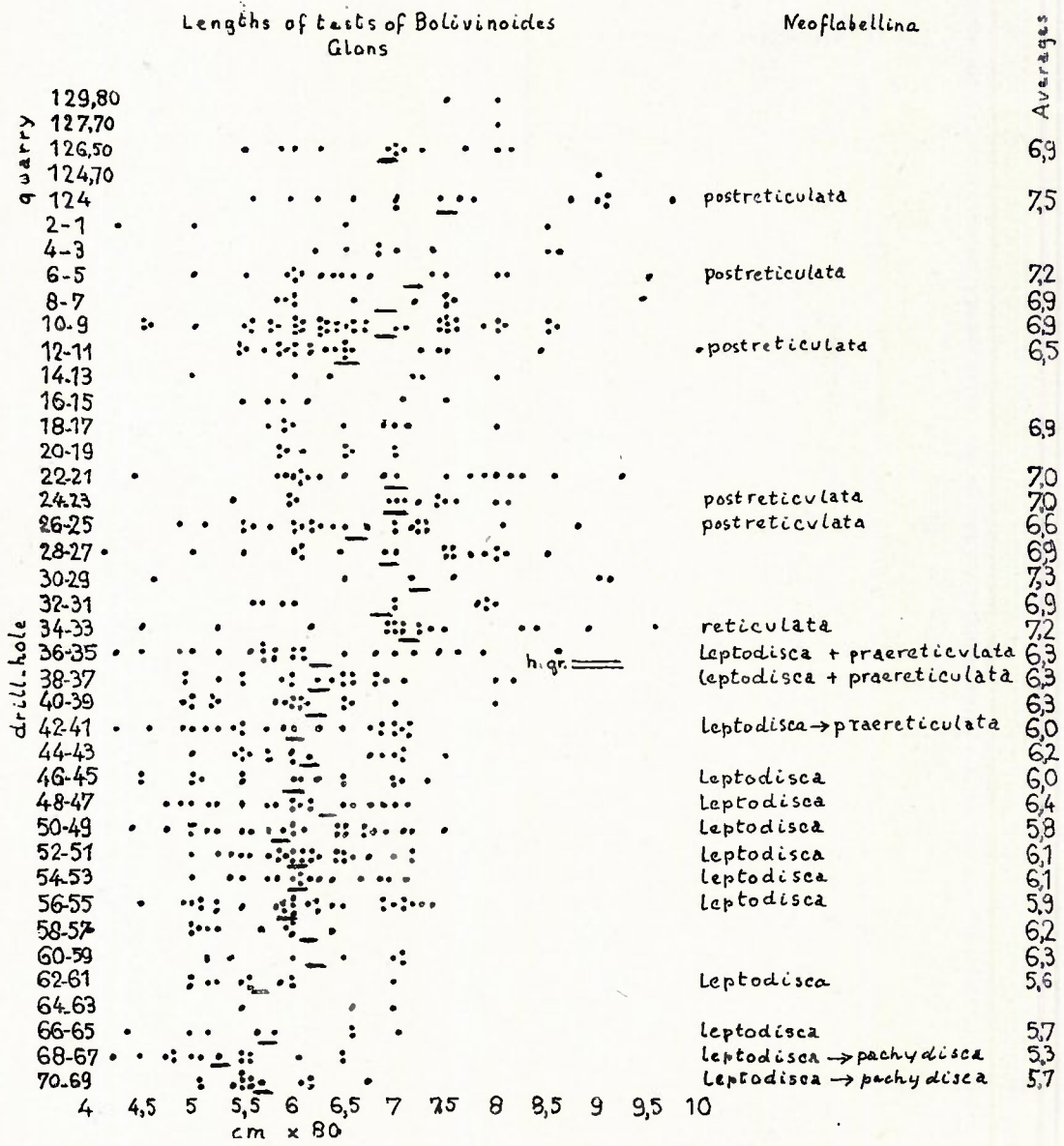

Fig. 5. Diagram of the change in the total length of *Bolivinoides* in Glons. The spreading especially in the upper part of the sediment, due to the fact that also younger specimens are incalculated, makes this diagram not so conspicuous; yet the averages given here increase more and more; sudden decrease of average, such as at 50—49 and 12—11 must be explained by circumstances in sedimentation (picking out of smaller individuals by means of currents, etc.) rather than that such differences resulted from variations or mutations in the specimens when living. The species of *Neoflabellina* found in the samples are given here also.

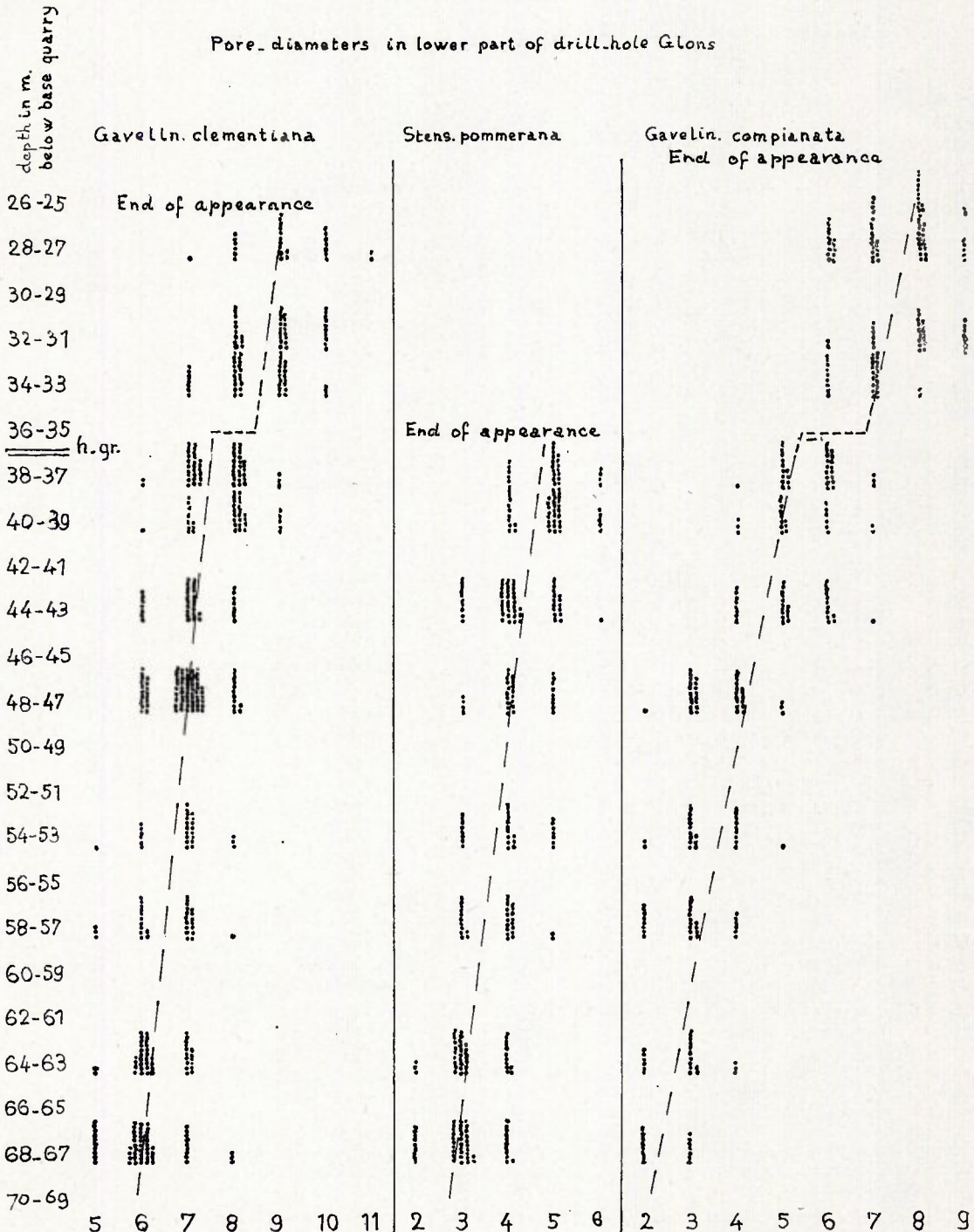

Fig. 6.

Diagram of the increase of pore-diameter of *Gavelinella clementiana* which is found above the hard ground till at 27 m (typical jump at hard ground), *Stensiöina pommerana* (which does not continue in the Upper Maestrichtian), and *Gavelinopsis complanata*, which is found till at 25 m above the hard ground (once again distinct jump at the hard ground). Here once again during the continuous change the breadth of variation strongly is surpassed, always at one side, so that mutation or selection cannot form the cause of the change. Each point is the average of the diameter of pores in the second last chamber of an individual. The pore-diameters are those found in other localities (North Western Germany) in the Upper Campanian for the levels below the hard ground; those found above the hard ground are typical for the lowest Upper Maestrichtian.

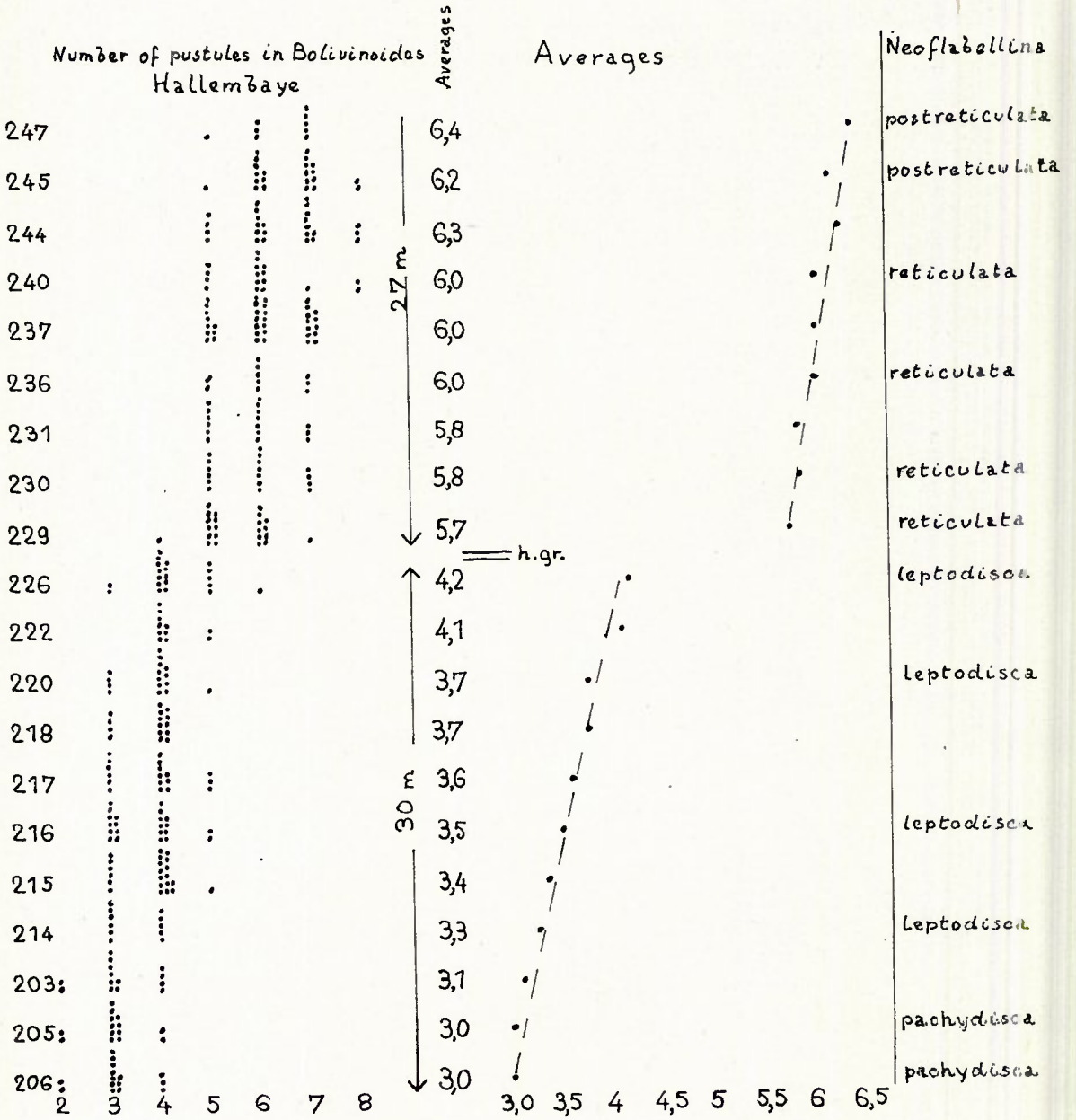

Fig. 7. Diagram of the number of pustules along the suture of the last formed chamber of the *Bolivinoides decorata-gigantea* gens in the quarry at Hallembaye, Belgium. The sample-numbers show that not always *Bolivinoides* occurs. The jump at the hardground is seen especially in the averages. The forms of the *Neoflabellina*-gens found in the samples also have been given.

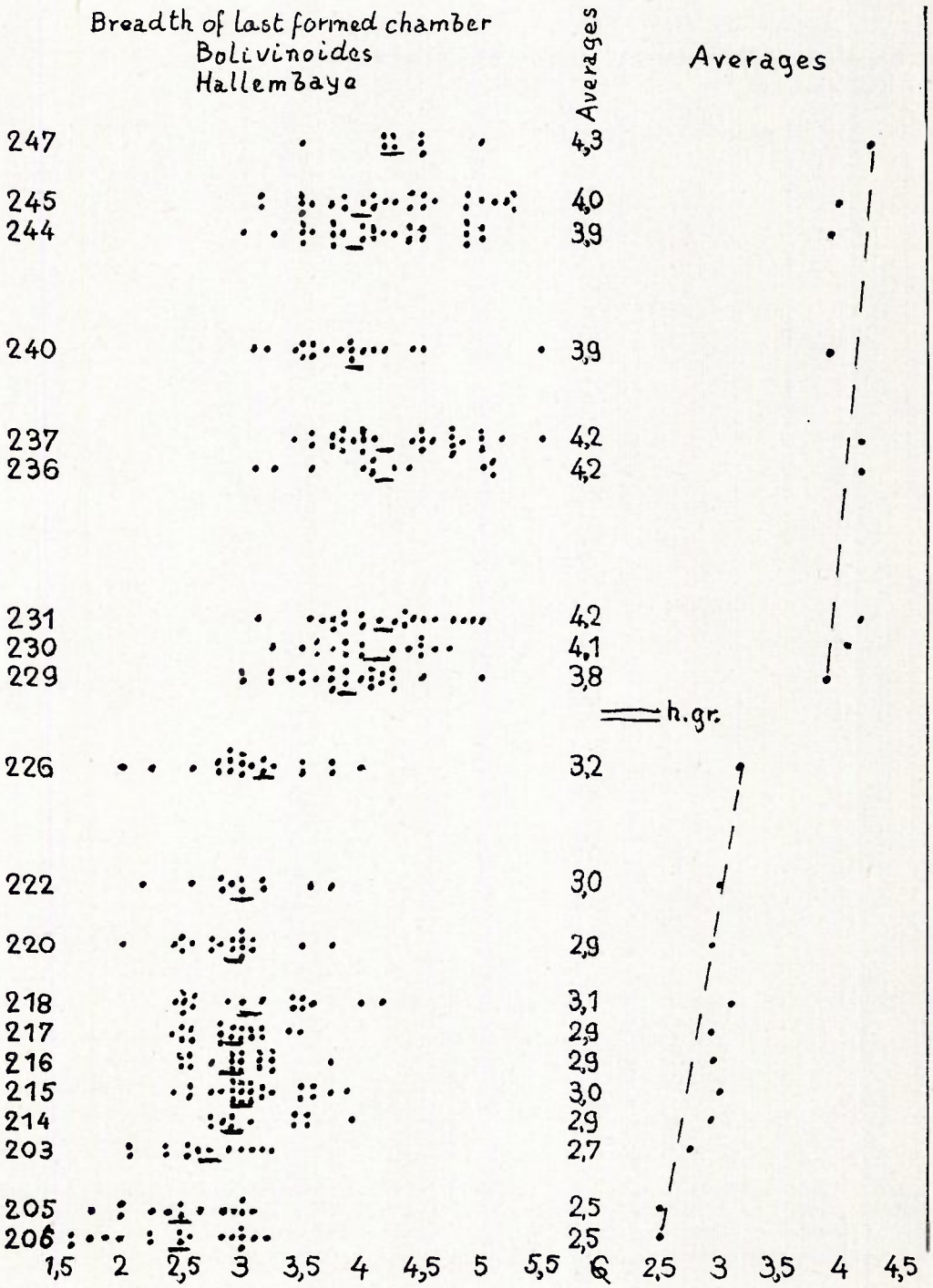

Fig. 8. Diagram of the breadths of the last formed chamber in the *Bolivinoides*-gens in Hallembaye, Belgium. The steady increase, the surpassing of the breadth of the variation towards one side only, and the sudden jump at the hard ground (gap in sedimentation) are very distinct. At the top of this quarry the sediment is reached which is found at about 12 m in the drill-hole of Glons.

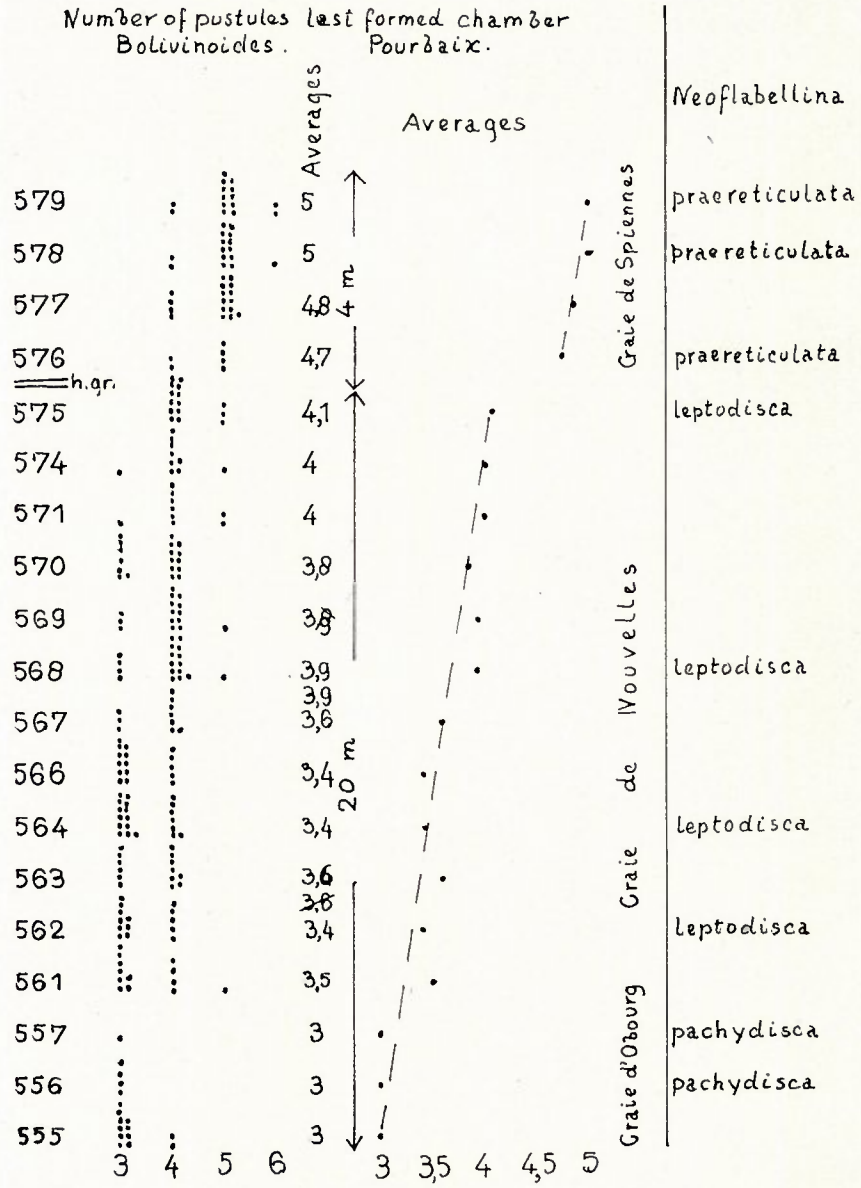

Fig. 9. Diagram of the number of pustules at the suture of the last formed chamber of the *Bolivinoides decorata-gigantea* gens in the quarry Pourbaix, Harmignies, Basin of Mons, Southern Belgium. Once again the steady increase of that number can be followed, and at the hard ground once again a jump is visible. The occurrence of *Neoflabellina* shows us that at the top only the lowest Maestrichtian is reached; this fully is in agreement with the number of pustules, which here reaches 5, in average; this part of the Maestrichtian is missing at Glons and Hallembaye, but is refound in Southern Limburg, Holland, where it forms the so-called white Cr 3 b. Near Mons it is called the Craie de Spiennes. Faunae of Craie de Spiennes and white Cr 3 b are absolutely identical.

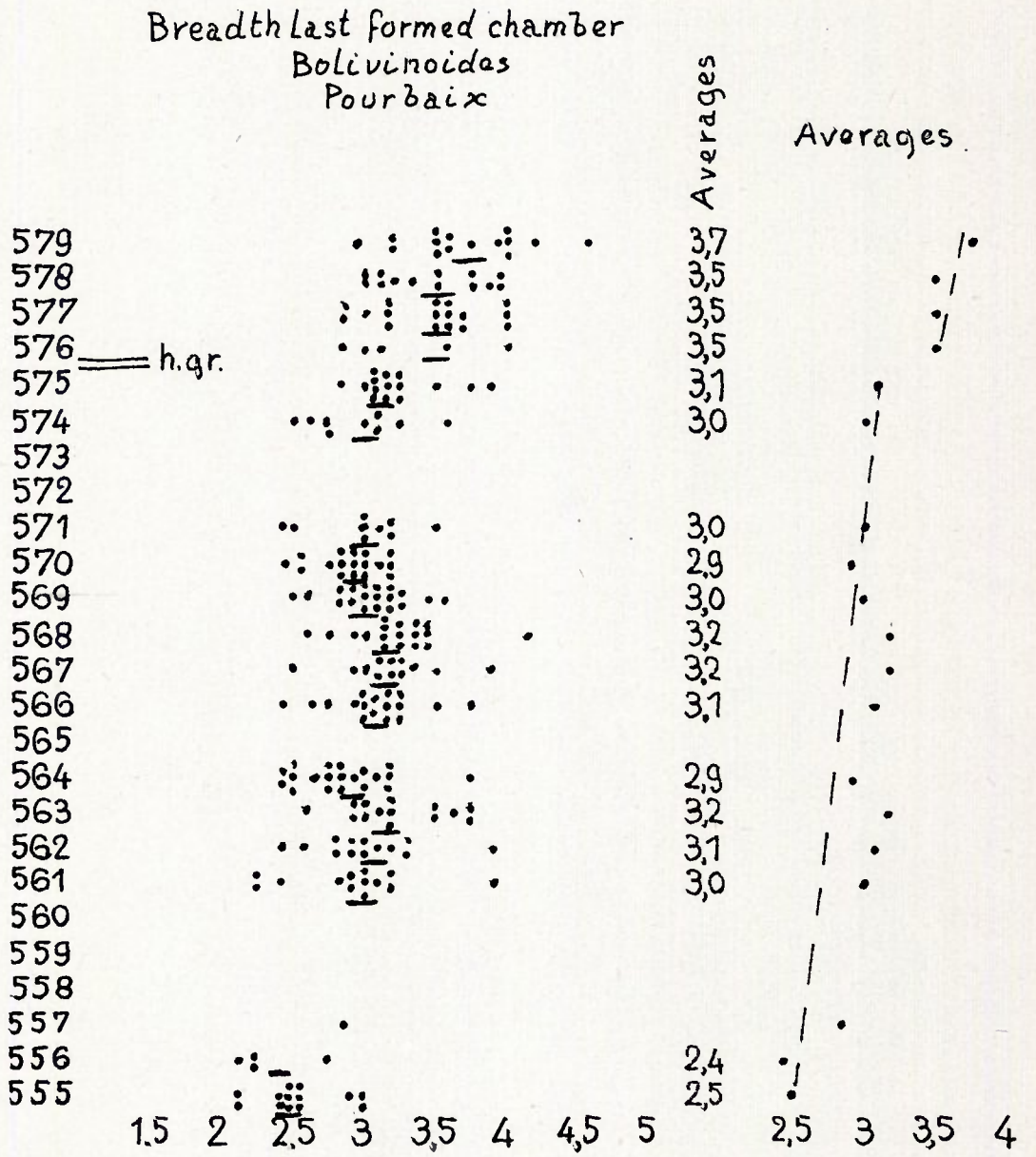

Fig. 10. Diagram of the breadth of the last formed chamber in the *Bolivinoides*-gens in the quarry Pourbaix, Harmignies, Basin of Mons, Southern Belgium. Regrettably the samples 558—560 and 572—573 (each sample taken 1 m above the former one) lack *Bolivinoides*, and are very poor in fauna. Yet the steady increase of the breadth is distinct enough, as is the jump at the hardground.

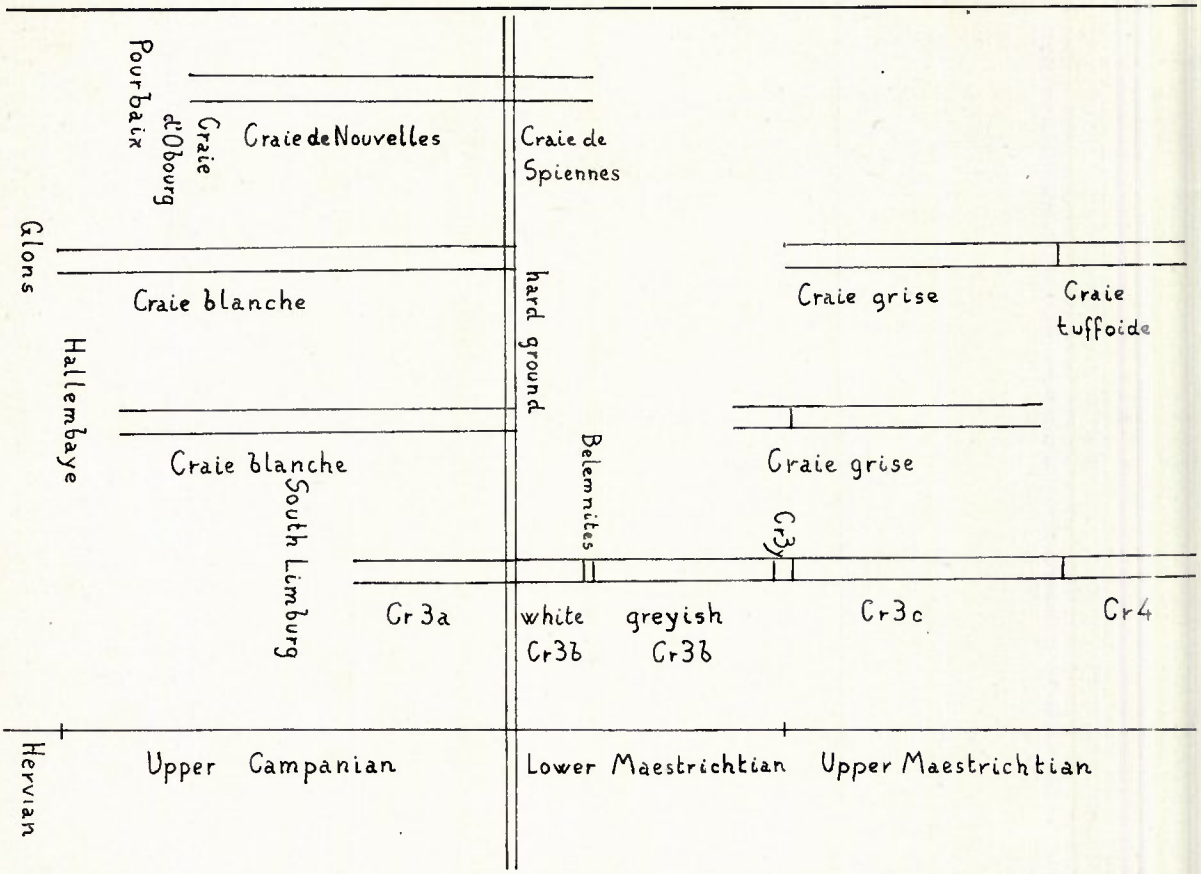

Fig. 11. Schematic figure of the sequence of sediments found in the different localities studied, the hard ground given here as one level, and compared with the formations as found in Southern Limburg, Holland, and the names of comparable stages internationally. The local names of the formations are given at the localities. In all Belgian localities studied here the upper part of the Lower Maestrichtian is missing, but for a small part at Hallembaye. In Holland (South Limburg) the Cr 3a, identical in its fauna with Craie blanche as well as Craie de Nouvelles, never reaches the thick packet of sediment as found in the Belgian localities studied. In Holland, Hallembaye and Glons the Upper Campanian rests on the Middle Campanian, Hervian; in the Basin of Mons it rests on the Craie de Trivières, also Middle Campanian, but with a different facies.

KORT VERSLAG DER PADDESTOELEN-EXCURSIE NAAR DE HEELDERPEEL OP 19 OKT. 1958.

Aan deze zeer geslaagde excursie, onder leiding van de heer en mevrouw Dr. Bels-Koning en de heer Dr. Reijnders werd deelgenomen door een 50-tal liefhebbers, zowel uit de omgeving van Roermond en Venlo, als uit die van Maastricht en Heerlen. Bovendien waren er enkele deelnemers uit Eindhoven en Utrecht. Tevens waren er enkele buitenlanders (Duitsers) te gast. Na afloop van de door schitterend weer begunstigde excursie gaf Dr. Reijnders nog een overzicht van de gedane vondsten.

Behalve de meer gewone soorten werden o.a. gevonden: *Boletinus cavipes, Xerocomus parasiticus, Boletus erythropus, Russula fragilis* var. *carminea, Russula claroflava, Omphalia viridis, Mycena pura* var. *lutea M. avenacea, M. cinerella, M. aetites, M. atrocyanea, Tephrophana palustre, Rhodophyllus staurosporus, R. turbidus* (*Cordae* ss Lge), *Cortinarius phoeniceus, C. uliginosus, C. rigidus, Flammula myosotis, Conocybe tenera* var. *subovalis* Kühn., *Galerina badipes, Nematoloma elongatum, N. polytrichi, Stropharia inuncta, Cordyceps militaris. Ms.*