LEIDSE GEOLOGISCHE MEDEDELINGEN, Deel 49, Aflevering 1, pp. 85–123, 1-3-1973

CARBONIFEROUS FUSULINIDS OF THE SAMA FORMATION (ASTURIA, SPAIN) (I. HEMIFUSULINA)

BY

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ABSTRACT

Deposition of the Sama Formation in the northeastern part of the Central Asturian Coal Basin most probably started in late Lower or early Upper Moscovian time and continued into the Myachkovian; a conclusion based wholly on investigation of the genus *Hemifusulina.* The *Hemifusulina* specimens occur all in siltstones and shales with a varying amount of lime, which apparently are the type of sediments laid down in conditions in which this genus could thrive. In the Sama Formation three *Hemifusulina* zones have been distinguished. A lower zone with *H.* ex gr. *moelleri* Raus. at the very base of this formation, a middle zone containing *H.* ex gr. *communis* Raus. and *H.* ex gr. *dutkevichi* (Putrya) and an upper zone with *H.* ex gr. *graciosa* (Lee). The lower zone contains *H. hispanica* (Gübler) (= *Fusulina cylindrica* var. *hispanica* Gübler, 1943); the upper zone contains the new species *H. mosquiterensis.*

INTRODUCTION

This paper deals with the occurrence of the fusulinid genus *Hemifusulina* in the Sama Formation in the northeastern part of the Central Carboniferous Coal Basin of Asturia (northwestern Spain) (Fig. 1). It is the intention of the author to follow with two papers on the Schubertellinae and Ozawainellinae respectively from the same formation and area.

A systematic investigation of the development of cyclothems in the northeastern part of the Central Coal Basin of Asturia has been carried out by Dr. M. J. M. Bless. He supplied evidence that these rhythmic units are very useful for regional correlations when closely examined (Bless, 1967; van Amerom, Bless and Winkler Prins, 1970). Fossil faunas have been collected by Bless** which could confirm his correlations and moreover could provide precise information with regard to the relative age of the Sama Formation. These fossil faunas have been investigated by Winkler Prins (brachiopods), van Amerom (pelecypods and plantfloras) and Bless (ostracods) (van Amerom et al., 1970). The present study completes the investigation of the different fossil groups which have been collected by Bless from this formation and in this area. Results with regard to fusulinid fauna and the relative age inferred from this – *Hemifusulina* – fauna are shown in Figure 2.

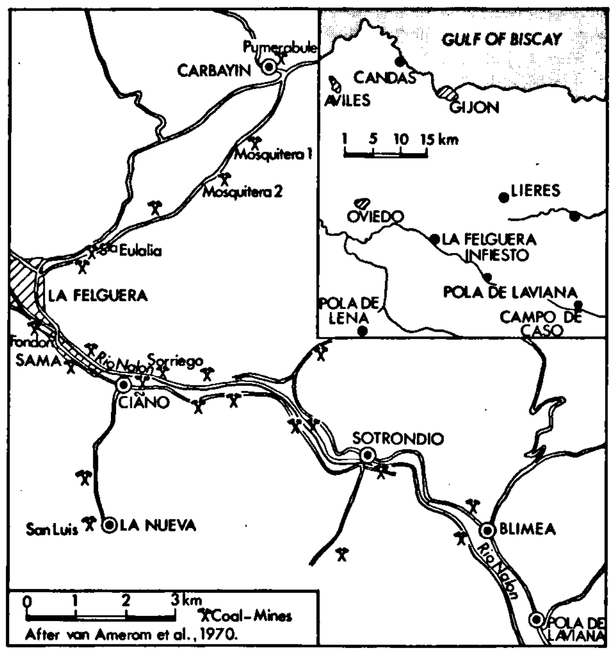

Fig. 1.

Hemifusulina, diagnosis and systematic position. – The diagnosis of a genus is a variable which includes the characteristics of the type-species but is otherwise dependent on the characteristics of the species we *select* to be congeneric. Our choice is often subjective and more or less arbitrary but if our decision does not contradict modern taxonomic principles it remains valid until new evidence, also judged according to these principles, shows that a different classification should be preferred. In consequence not only diagnosis but also other attributes such as systematic position, relative age, geographical extension or environment of deposition are influenced by what we consider to be congeneric. Stabilization may be finally achieved by a better knowledge of

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** Locality numbers in Figure 2 correspond to those of Bless in van Amerom et al., 1970 with exception of the first character.

Rock-Stratigraphic Subdivision *		Position of Samples in Rock-Stratigraphic Subdivision *			Species Content (Hemifusulina)			Relative Age **
Formation	Member	Sample Number	Coal Mine	Geographic Situation	Species	Group	Most similar species	
SAMA	SORPRESA							
SAMA	OSCURA	A1080	Mosquitera 2	Carbayin, La Felguera	*H. mosquiterensis* n.sp.	*H. ex gr. graciosa*	*H. implicata* Bogush.	Myachkovian or Upper Podolskian
SAMA	MODESTA	A1130	Sorriego	Ciaño, Sotrondio	*H.* sp. 11	?	Possibly macrospheric generation of *H.* sp. 10	Myachkovian or Upper Podolskian
					H. sp. 10	*H.* ex gr. *graciosa*	*H. mosquiterensis* (probably conspecific)	
		A1093	Mosquitera 2	Carbayin, La Felguera	*H.* sp. 9	?	?	
					H. sp. 8	?	Possibly macrospheric generation of *H.* sp. 7	
					H. sp. 7	*H.* ex gr. *graciosa*	*H. mosquiterensis* (probably conspecific)	
SAMA	SORRIEGO	A1028	Pumerabule	Carbayin	*H.* sp. 6	*H.* ex gr. *dutkevichi*	*H. dutkevichi* (Putrya) *pechorica* Raus.	Podolskian or Upper Kashirian
SAMA	ENTRERREGUERAS	A1101	Fondon	Sama	*H.* sp. 5	*H.* ex gr. *communis*	*H. pulchella* Raus.	
SAMA	SOTON							
SAMA	MARIA LUISA							
SAMA	SAN ANTONIO	A1056			*H.* sp. 4	?	?	
		A1055	Sta. Eulalia	La Felguera, Carbayin	*H.* sp. 3	*H.* ex gr. *communis*	*H. communis* Raus. *acuta* Raus.	
					H. sp. 2	*H.* ex gr. *dutkevichi*	*H. dutkevichi* (Putrya) *pechorica* Raus.	
SAMA	GENERALAS	A1110	Fondon	Sama	*H.* sp. 1	*H.* ex gr. *communis*	*H. pulchella* Raus.	
SAMA	"CALIZAS SUPERIORES"	A9	formerly mine of "Comp. Solvay"	Lieres	*H. hispanica* (Gübler)	*H.* ex gr. *moelleri*	*H. pseudobocki* Putr. et Leont. *vjatkensis* Raus.	Lower Podolskian or Upper Kashirian
LENA	"CALIZAS INFERIORES"							

* After M.J.M. Bless in van Amerom, Bless and Winkler Prins, 1970.

** The relative age given results only from comparison of Spanish Hemifusulina with those occurring in the U.S.S.R. Neither other fossils nor the relative position of samples in the column were taken into consideration.

Fig. 2.

phylogenetic relations and by the principle of conservatism in taxonomy. The latter demands that the longer a classification exists and the more radical the proposed modifications are, the more convincing should be the evidence to justify a different classification. The relevancy of these considerations becomes clear when the question is put whether *H.* ex gr. *moelleri* Raus., *H.*? ex gr. *splendida* Saf., *H.* ex gr. *djartassensis* Rumj. and the Hemifusulinas described by Chang in 1963 and 1964 from the Upper Carboniferous of China should be included in this genus. Diagnosis, systematic position, range etc. have been discussed in detail by Rauser-Chernoussova et al., 1951, p. 242, 243. This discussion was based upon the about thirty species and subspecies described in this publication assigned to *Hemifusulina*. An elevation to generic rank of many of the groups of species distinguished by Rauser-Chernoussova et al. (1951) is a possibility which would at present no less than in 1951 seriously disturb the internal balance of fusulinid classification. Yet Putrya (1956) decided to raise one of these groups i. e. *H.* ex gr. *moelleri* to generic level and introduced the genus *Dutkevichella*. The main reason for it was apparently the difference in wall structure between *H.* ex gr. *moelleri* Raus. and the type-species of *Hemifusulina* (= *H. bocki* Moeller). The morphological gap between *Dutkevichella* and the most similar *Hemifusulina* species groups is not significantly larger than the average gap between the species groups of *Hemifusulina*. A logical but not very meritorious procedure would have been therefore the introduction of new generic names for *H.* ex gr. *dutkevichi*, *H.* ? ex gr. *stabilus* etc., groups which differ as much from the type-species as *H.* ex gr. *moelleri*. In 1962 Rumjanceva described as new four species from the Lower Kashirian which are very close to each other morphologically. She points to the weak folding confined to the extreme polar areas in outer whorls and to the absence of folding in the inner whorls in which respect these species are close to *Aljutovella*. Other characteristics however, especially the two-layered wall with fine mural pores indicate a closer relation with species of *Hemifusulina*. The photographed specimens show that the differences with several species assigned to *Aljutovella* are very slight indeed. It is obviously an arbitrary decision whether these species should be assigned to *Hemifusulina** or to *Aljutovella*.

The genus *Hemifusulina* as delimited by Rauser-Chernoussova et al. (1951) descended from *Aljutovella*. This transformation apparently took place along several phylogenetic lines. One of the intermediary group of species is *Hemifusulina* ex gr. *djartassensis* Rumj., 1962, discussed above. The group *H.*? ex gr. *splendida* Saf. may be considered having developed from *Aljutovella* along another phylogenetic line. According to Rauser-Chernoussova et al. (1951) *Hemifusulina* constitutes a dead-end branch of the phylogenetic tree which terminated in the Upper Myachkovian. Yet Chang (1963, 1964) described a number of species from the Upper Carboniferous of China. It would be desirable to know whether the Chinese rock-successions provide evolutionary series of species to support the derivation of these Upper Carboniferous species from Middle Carboniferous *Hemifusulina*.

We may conclude that at present there are no decisive arguments to alter the concept of Rauser-Chernoussova et al. (1951) with regard to this genus. The diagnosis given in that paper is as follows. "Shell small, nearly spherical to subcylindrical; continuous but slow change of shape during growth; spire tightly coiled, especially in inner whorls; wall generally consisting of tectum and protheca only, and commonly pierced by simple pores: these pores are coarser in the species from the Myachkovian; the Kashirian species show in the upper part of the protheca a not very translucent diaphanotheca and occasionally a variable inner tectorium; folding of septa moderate to strong, more or less regular; the shape of chomata is very constant during growth, half spherical; septa may be thickened along and near the axis of coiling."

Table IV of the present paper shows a possible way of grouping the known species, which is largely based on similar groups as distinguished by Rauser-Chernoussova et al. (1951) and has served to facilitate classification of the Spanish fauna. To what measure the grouping presented is true to phylogenetic relations remains to be investigated.

Hemifusulina and its occurrence in relation to type of sediment. – Generally the best chance of finding fusulinids is in limestone. There are a number of genera, however, which could survive in an environment characterized by deposition of non-carbonate sediments such as clay, silt and sand (e. g. *Ozawainella, Pseudostaffella, Fusiella, Schubertella)*. There are now many data available which suggest that *Hemifusulina* not merely held out in a non-carbonate depositional environment but apparently was well adapted or perhaps even best adapted to such an environment. Shales and sandstones with a varying amount of calcareous material are often crowded with specimens of this genus. The *Hemifusulina* specimens of the Central Asturian Coal Basin were all found in shales and siltstones (Bless, pers. comm.)**. It is worthwhile to list the *Hemifusulina*-bearing rock-types in other areas of the Cantabrian Mountains. Up to the present we have found *Hemifusulina* in 1. a slightly argillaceous dense limestone (Panda Limestone Member – Loc. L 426); 2. an argillaceous grey-blackish coloured dense limestone (Mesao Limestone Member – Loc. L 11); 3. several generally calcareous sandstone beds (Pando and Prioro Formations); 4. two calcareous mudstone beds (near top of the Sierra Corisa Limestone

* Rumjanceva (1962) proposed *Hemifusulinella*, a new subgenus of *Hemifusulina* containing the four new species described, of which *H. djartassensis* was designated as the type-species.

** Bless (1970) distinguished several facies types in the Central Asturian Coal Basin. These are the Carbonita facies, Geisina facies, Lingula facies, Lamellibranch facies, Biostrome facies and Productoid/Lamellibranch facies. According to this author *Hemifusulina* has been found only in his Biostrome facies.

Member). In addition the impression is gained that outside Spain *Hemifusulina* is more often found in argillaceous or sandy sediments than in the pure limestone rock-types. When Moeller in 1878 introduced the genus *Hemifusulina,* he reported the type-species *Hemifusulina bocki* from "dem oberen Kohlenkalk untergeordnete Thonzwischenlage". Bogush (1963) in his study of the Alaj Mountains encountered "the Hemifusulina complex everywhere associated with calcareous aleurolites and sandstones". To my knowledge *Hemifusulina* has never been reported to occur in the U.S.A. Yet there are three species which according to descriptions and illustrations might very well be classified as *Hemifusulina.* Two of these – *Fusulina? arenaria* Thompson and *Fusulina? rickerensis* Thompson – do occur in calcareous sandstone and arenaceous limestone respectively; the third – *Fusulina inconspicua* Girty – in light-coloured limestone.

Hemifusulina and stratigraphic range. – The genus *Hemifusulina* ranges from Lower Kashirian to Upper Myachkovian. The genus in the U.S.S.R. flourished towards the end of the Kashirian and again at the end of the Myachkovian (Rauser-Chernoussova et al., 1951, p. 242). In 1961 Chernova reports a species from Lower Vereyan strata which she questionably assigned to *Hemifusulina.* This species – *Hemifusulina? concepta* Chernova – might have a closer affinity to *Aljutovella,* a genus akin to *Hemifusulina* and a regular constituent of Vereyan fusulinid faunas. To my knowledge there are five species assigned to *Hemifusulina* which were reported from strata younger than the Myachkovian i. e. *Hemifusulina shengi* Chang, *H. ovata* Chang – homonym of *H. ovata* Kireeva –, *H. parashengi* Chang, *H. bella* (Chen) and *H. contracta* (Schellwien). These species described from the Upper Carboniferous of south-western Sinkiang and north-western Scechuan (China) by Chang (1963, 1964), are judging from the descriptions and illustrations presented, quite distantly related to the type-species of *Hemifusulina* and the other Middle Carboniferous species of this genus. It is doubted if they should be included in *Hemifusulina.* It seems likely that the opinion of Rauser-Chernoussova et al. (1951) with respect to the range of this genus still holds today.

DESCRIPTION OF SPECIES

Hemifusulina hispanica (Gübler)
Pl. I, Figs. 1–7

Synonymy: *Fusulina cylindrica* var. *hispanica* Gübler, 1943
Fusulina cylindrica var. *hispanica* Gübler – Lys et Serre, 1958
Hemifusulina moelleri hispanica (Gübler) – F. and G. Kahler, 1969

Locality: A 9

Description: From 1st to 6th whorl test changes from oval (1st wh.), fusiform or short fusiform to fusiform (2nd wh.), fusiform or fusiform to elongate fusiform (3–4th wh.) to elongate fusiform (5–6th wh.); lateral sides in the median area of outer whorls (5–6 th wh.) parallel to axis of coiling or only slightly arched; poles pointed or bluntly pointed.

Septal folding extends up to the tunnel margins; although relative height of folds decreases towards the median area, this has not yet resulted in a notable retreat of folds towards the poles in outer whorls; folding is high in polar areas and moderate in the median area (Fig. 11); two measurements of the relative wave length provided values of 21.5 (3.5 wh., specimen 2(1)) and 13 (5th wh., specimen 4); septal pores present.

Chomata asymmetric in inner 1.5–2 whorls, subsymmetric or symmetric in subsequent whorls; relatively narrow and on an average about as high as wide; they persist in outer whorls (5–6th wh.) but their relative height is considerably reduced.

Tunnel path symmetric or almost symmetric.

Axis of coiling straight or almost straight, maintaining its original position throughout growth.

Wall not over 20 μ in thickness; in inner four whorls a diaphanotheca and a very thin lower tectorium is usually discernable; in outer whorls mural pores have been observed on occasion; the presence of an upper tectorium is doubtful, in inner whorls and below the tunnel a secondary deposit may be present above the protheca.

Measurements: See Table I

Chronostratigraphic level: Upper part of Kashirian or lower part of Podolskian (viz. Remarks).

Remarks: The gallery of the former Solvay coal mine in Lieres which yielded to Delépine the fusulinid-bearing rock sample with *Fusulina cylindrica* var. *hispanica* new var. (Delépine, 1943) is no longer accessible. This unfortunate circumstance was compensated in a way by the find of a fusulinid-brachiopod containing argillaceous limestone in 1970 in the mine's rock collection. Apparently this sample is from the same locality as the

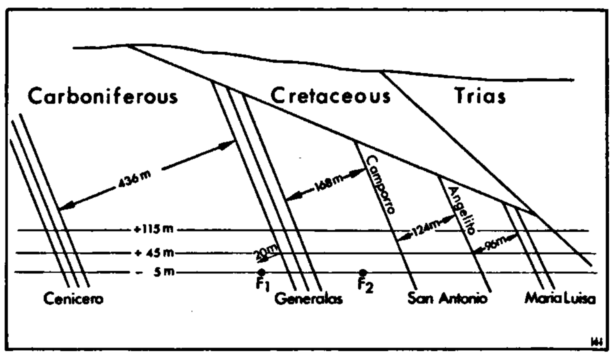


Fig. 3. Position of the fusulinid-bearing localities F_1 and F_2 according to data supplied by the managing directors of the Lieres Coal Mine, formerly belonging to the 'Compagnie Solvay'. F_1 (= A9 in the present paper) is the locality which provided the sample present in the mine's collection and which is in all probability the type-locality of *Hemifusulina hispanica* (Gübler).

sample collected by Delépine and investigated by Gübler. Their identical original location follows from Gübler's statement with regard to the stratigraphic level of Delépine's sample i. e. 20 m below the lowest (= 4th) coal bed from the top of the Lena Formation, and the locality of the mine's rock specimen as indicated on a map of this mining company (Fig. 3). Subsequent preparation of the mine's sample yielded only two almost axial sections and a single sagittal section. Most specimens in the thin sections were crushed in the median area above the tunnel. It is noteworthy that specimens of *Hemifusulina* from other localities in Asturia are often similarly damaged. When we compare Gübler's description with the data presented in Table I, a conspicuous difference is observed in the length-diameter ratio. According to Gübler this ratio does not exceed 2.6 whereas in our material it may reach a value of 3.5. Gübler's data in this respect are rather dubious since the L/D ratio of one of Gübler's illustrated specimens i. e. the lectotype (Pl. I, Fig. 1) is about 3.0. An important result of the present reinvestigation of Gübler's variety is the verification of a diaphanotheca in the inner four whorls. This implies that we are dealing with a representative of a group of species once assembled in *Dutkevichella* on this very criterium; a group of species restricted to Kashirian and – mostly lower – Podolskian strata in the U.S.S.R. For this reason and on fusulinid evidence only, I disagree with Lys and Serre (1958) who concluded upon a Myachkovian age for this fusulinid-brachiopod containing horizon. With respect to the age of this locality at Lieres, F. and G. Kahler are apparently of the same opinion as the present author (F. and G. Kahler, 1969, p. 45). It is agreed with F. and G. Kahler that there can be no doubt that Gübler's population should be assigned to the genus *Hemifusulina*, provided that the independent generic rank of species close to *Hemifusulina bocki* Moeller is accepted and the genus *Dutkevichella* is rejected. A comparison of *Hemifusulina hispanica* (Gübler) with other species of this genus shows that it is close to a number of species assembled in *H.* ex gr. *moelleri*, *H.* ex gr. *communis* and *H.* ex gr. *vozhgalica*. Although specimens of *H. hispanica* (Gübler) are more loosely coiled especially in the inner three whorls and thickening of the septa along the axial region is only indistinctly expressed, it is nevertheless considered to be more closely related to species of the group of *H. moelleri* Raus. than to the other two groups mentioned above. However, and this contrary to F. and G. Kahler's opinion, I do not consider *H. hispanica* (Gübler) a very typical representative of the group of *H. moelleri* Raus. As well as the reasons given above one could add the condition of the septal folds in *H.* ex gr. *moelleri* which in outer whorls generally recede towards the poles, a characteristic hardly developed in *H. hispanica* (Gübler). If we take into account also the pointed or bluntly pointed poles of *H. hispanica* which gives this species an elongate fusiform shape, *H. pseudobocki vjatkensis* Raus. provides a better fit than *H. moelleri* Raus. Elevation to species rank of Gübler's variety is here proposed to accommodate classification of the Spanish fusulinid fauna with the narrow delimitation of species in fusulinid classification as advocated in the U.S.S.R.

Hemifusulina mosquiterensis sp. nov.

Pl. VII, Figs. 8–19
Pl. VIII, Figs. 1–12
Pl. IX, Figs. 1–6
Pl. X, Figs. 1–8

Type specimen: Specimen 15 (Pl. X, Fig. 3) is designated as the holotype.

Locality: A 1080

Description: Radius vector: 340–600μ
Form ratio: 2.05–3.00
Number of whorls: 5–6.5

From 1st to 6th whorl test changes from spherical to oval, nautiloid (1st wh.) oval, short fusiform, fusiform or rhomboidal (2nd wh.) short fusiform to fusiform, fusiform, fusiform or rhomboidal or fusiform to elongate fusiform (3rd wh.) to fusiform or elongate fusiform (4–6th wh.).

Septal folding starts in the 1.5–2.5 whorl; clear septal loops appear in the 2–3rd whorl and folding has progressed from the poles on to the lateral sides occupying part of the median region; in the adult stage one may observe sometimes a slight retreat of folds towards the poles; in sagittal sections septal loops are absent; the folding is regular and not very intense; the cellular network at the poles is rather coarse; relative wave length in outer whorls (5–6.5 wh.) is on an average about 13 to 21; relative height of septal loops in outer whorls (5–6.5 wh.) is on an average about 60–65% in the median area and 70–75% in the polar area although single values may rise to 100% in the polar as well as in the median area on occasion; at the poles the folding is too irregular to measure the height of individual septal loops but it clearly extends from bottom to roof of chambers. Septal pores have not been observed.

Chomata are present generally throughout growth; subsymmetrical or symmetrical chomata appear in the 1–3rd whorl whereas beyond the 2.5–4.5 whorl no asymmetrical chomata are observed; in the first whorl chomata may extend to the poles; their width gradually decreases to 1/10–1/4th of their maximum possible extension in outer whorls (5–6.5 wh.); average values of relative height increase from about 20–35% in inner two whorls to a maximum of about 40–45% in the 2.5–4.5 whorl and decrease to 25–35% in outer whorls; the maximum and minimum values recorded are 75% (3rd wh.) and 0% (5.5–6th wh.).

The tunnel path is symmetrical or asymmetrical; average and range of maximum deviation of symmetry are respectively 14.5° and 4–27° (N = 20); average values of relative height range from about 30–40% in inner two whorls and from about 45–60% in subsequent whorls; the ratio of height to width (Th/Tw) of the tunnel shows average values of 40 to 60% in inner two whorls and 35 to 40% in subsequent whorls; average values of relative width (Tw/L) range from 10 to 12% in inner two whorls and from 9 to 10% in subsequent whorls; the tunnel angle in outer whorls may attain a value of 50–55°.

Axis generally maintains original position throughout growth; more rarely first half whorl at an angle to subsequent whorls. Straight.

The wall consists of a protheca only; thickness of wall in outer whorls (5–6.5 wh.) varies from 15 to 22μ which is 1.5–3.8% of the diameter in outer (5–6.5) whorls; mural pores generally inconspicuous, their presence is indicated by weakly defined striations perpendicular to the wall; they may be observed locally and from the 2.5 whorl onwards.

Measurements: See Table II

Chronostratigraphic level: Upper Moscovian; upper part Podolskian-Myachkovian; probably Myachkovian (viz. Remarks).

Remarks: H. mosquiterensis n. sp. is close to species of the group *H. graciosa* and most similar to *H. implicata* Bogush. The properties of *H. mosquiterensis* n. sp. point also to a relationship with species of the group *H. communis* Raus. The presence of chomata even in the outermost whorl and septal folding which does not recede towards the poles in the final growth stage are characteristics which rather resemble those of species of *H.* ex gr. *communis.* The main differences between both groups of species are the relatively thicker walls i. e. thicker relative to diameter of shell, the absence of a diaphanotheca and the appearance of mural pores in an earlier stage of growth in *H.* ex gr. *graciosa* Lee. In these respects *H. mosquiterensis* n. sp. is definitely closely allied to species of the group of *H. graciosa* Lee. *H. mosquiterensis* differs from *H. implicata* in the larger proloculum and the larger diameter for corresponding whorls, the larger L/D proportion and the retreat of septal folds in outer whorls of *H. implicata.* Both species are similar with respect to relative thickness of wall and its structure, shape of spiral curve, regularity of septal folding, shape of chomata and general outline of the test. *H. implicata* Bogush is reported to occur in the Džilanda beds (Alaj Mountains and E. Ferghana). Examination of the correlation table of Bogush (Bogush, 1963, p. 7, 8) shows that the lower and upper boundary of the Džilanda beds coincide respectively with the lower boundary of the C_2^md Zone and the upper boundary of the C_2^me Zone of the zonal division scheme of Brazhnikova and Potievskaja (1959). Following the majority of Russian stratigraphers, this would imply that sedimentation of the Džilanda beds started in the Upper Podolskian and continued up to the end of the Myachkovian. A similar range of the possible relative age may be inferred for *H. mosquiterensis* n. sp. (viz. Chronostratigraphic level).

Open nomenclature has been used for classification of the species to follow. The short descriptions of these species are based on a few specimens only. Measurements are presented in Table III which offers mean, range and number of observations for several parameters.

Hemifusulina sp. 1 and sp. 5

Hemifusulina sp. 1. – Material: 2 axial sections (Pl. II, Figs. 1, 2). Loc. A 1110. The present species is close to species of the group of *H. communis* Rauser-Chernoussova. Outside Spain the most similar species is *H. pulchella* Rauser-Chernoussova which species apparently differs only very slightly from our Spanish specimens. *Hemifusulina* sp. 1 might differ in having somewhat less volutions on an average, a somewhat smaller diameter for corresponding whorls and a slightly greater L/D ratio.

Hemifusulina sp. 5. – Material: 6 axial sections (Pl. IV, Figs. 6–11). Loc. A 1101. The absence of a diaphanotheca in all whorls indicates a relation of *Hemifusulina* sp. 5 with species of the group of *H. graciosa* (Lee) rather than with *H.* ex gr. *communis* Raus. Yet the species most similar to *H.* sp. 5 is *H. pulchella* Raus. which is from the latter group. Moreover a single specimen (specimen 4) shows an indistinct diaphanotheca at some places in the 4th whorl. *H.* sp. 5 differs from *H. pulchella* in having less volutions, a slightly smaller diameter for corresponding volutions and a somewhat greater L/D ratio.

H. pulchella occurs in strata of Kashirian and Podolskian age in the Moscow basin (Rauser-Chernoussova et al., 1951).

Hemifusulina sp. 3

Hemifusulina sp. 3. – Material: 4 axial sections (Pl. II, Figs. 5–7; Pl. IV, Fig. 5). Locs. A 1055, A 1056. The present species is best compared with species of the group of *H. graciosa* (Lee) and species of the group of *H. communis* Raus. With respect to the wall which on occasion shows a diaphanotheca (e.g. specimen 3, loc. A 1056), *Hemifusulina* sp. 3 is closer to *H.* ex gr. *communis.* Also the spiral coil which shows relatively loose inner volutions, points to the latter group of species. Although our specimens have a larger form ratio, they are in general outline not unlike *H. communis* Raus. *acuta* Raus. This subspecies has been reported to occur in the Kashirian and Podolskian of the Moscow basin and the Samara bend (U.S.S.R.) (Rauser-Chernoussova et al., 1951).

Hemifusulina sp. 2 and sp. 6

Hemifusulina sp. 2. – Material: 3 axial sections (Pl. II, Figs. 3, 4, 10). Loc. A 1056. These exceedingly small specimens are most probably closer to species of the group of *H. dutkevichi* (Putrya) than to any other species of *Hemifusulina*. They somewhat resemble *H. dutkevichi* (Putrya) *pechorica* Raus., though the latter subspecies has larger dimensions.

Hemifusulina sp. 6. – Material: 5 axial sections (Pl. V, Figs. 1–5). Loc. A 1028. The present species belongs to a group of species similar to *H. dutkevichi* (Putrya) *pechorica* Raus. It differs from species of the group of *H. dutkevichi* in having a slightly tighter spire especially in inner whorls, less volutions and a slightly larger diameter of the proloculum.

H. dutkevichi (Putrya) *pechorica* Raus. has been described from Lower Moscovian (Kashirian?) strata of the Pechora river region (U.S.S.R.). Species of the group of *H. dutkevichi* have been reported also from Lower Podolskian strata. They probably disappear in the Upper Podolskian.

Hemifusulina sp. 7 and sp. 10
Hemifusulina sp. 7. – Material: 3 axial sections (Pl. VI, Figs. 1–3). Loc. A 1093. This species is very close to and possibly conspecific with *H. mosquiterensis* n. sp. Outside Spain the most similar species are *H. implicata* Bogush and *H. graciosa* (Lee). The latter species differs from *H.* sp. 7 and *H.* sp. 10 in having a thicker wall absolute as well as relative to diameter of shell.

Hemifusulina sp. 10. – Material: 7 axial sections (Pl. VI, Figs. 6–10, 12, 13). Loc. A 1130. *H.* sp. 10 is possibly also conspecific with *H. mosquiterensis* n. sp. Outside Spain it is most similar to *H. leviplicata* Bogush, *H. graciosa* (Lee) and *H. ovata* Kireeva, all included in the group of *H. graciosa* (Lee). Less similar are *H. nataliae* Raus. (= *H.* ex gr. *dutkevichi*) and *H. communis* Raus. *acuta* Raus. (= *H.* ex gr. *communis*). These latter species, moreover, differ markedly in the structure of the wall since in *H.* sp. 10 as in *H.* sp. 7 a diaphanotheca is absent.

Hemifusulina sp. 10 ? . – Material: 2 axial sections (Pl. VI, Figs. 11, 14). These specimens from Loc. A 1130 are considered to represent a microspheric generation. Both specimens have a proloculum radius of 12μ and count 5–5.5 whorls. In the megalospheric generation this is respectively 25–41μ and 4.5–5 whorls. Both microspheres show the first whorl at an angle to subsequent whorls.

H. leviplicata Bogush and *H. implicata* Bogush are reported from the Džilanda Formation of the Alaj Mountains (U.S.S.R.) deposited in the Upper Podolskian and Myachkovian (Bogush, 1963). *H. ovata* Kireeva and *H. graciosa* (Lee) occur in the N_1 Limestone of the Donetz basin (U.S.S.R.) which is of Upper Myachkovian age (Kireeva, 1949) (Lee, 1937).

Hemifusulina sp. 8 and sp. 11
Hemifusulina sp. 8. – Material: 2 axial sections (Pl. VI, Figs. 4, 5). Loc. A 1093. The few (2–2.5) volutions and the large-sized proloculum (radius 77μ and 87μ) suggest that *H.* sp. 8 represents merely the macrospheric generation of *H.* sp. 7.

Hemifusulina sp. 11. – Material: 4 axial sections (Pl. VII, Figs. 1–4). Loc. A 1130. These rhomboidal-shaped specimens with a radius vector of 300–500μ and a form ratio of 1.65–1.80 in the outer (3–4th) whorls, resemble primitive species of *Beedeina*. Since the spindle-shaped fusulinid faunas of the argillaceous deposits of the Central Coal Basin apparently contain only *Hemifusulina* – besides some *Schubertella* and *Fusiella* – it seems more probable that these specimens must be classified as *Hemifusulina*. They are not closely similar, however, to any of the hitherto described species of this genus. Considering the few (3–4) volutions and the large-sized proloculum (radius 49–72μ) it seems possible that *H.* sp. 11 represents the macrospheric generation of *H.* sp. 10.

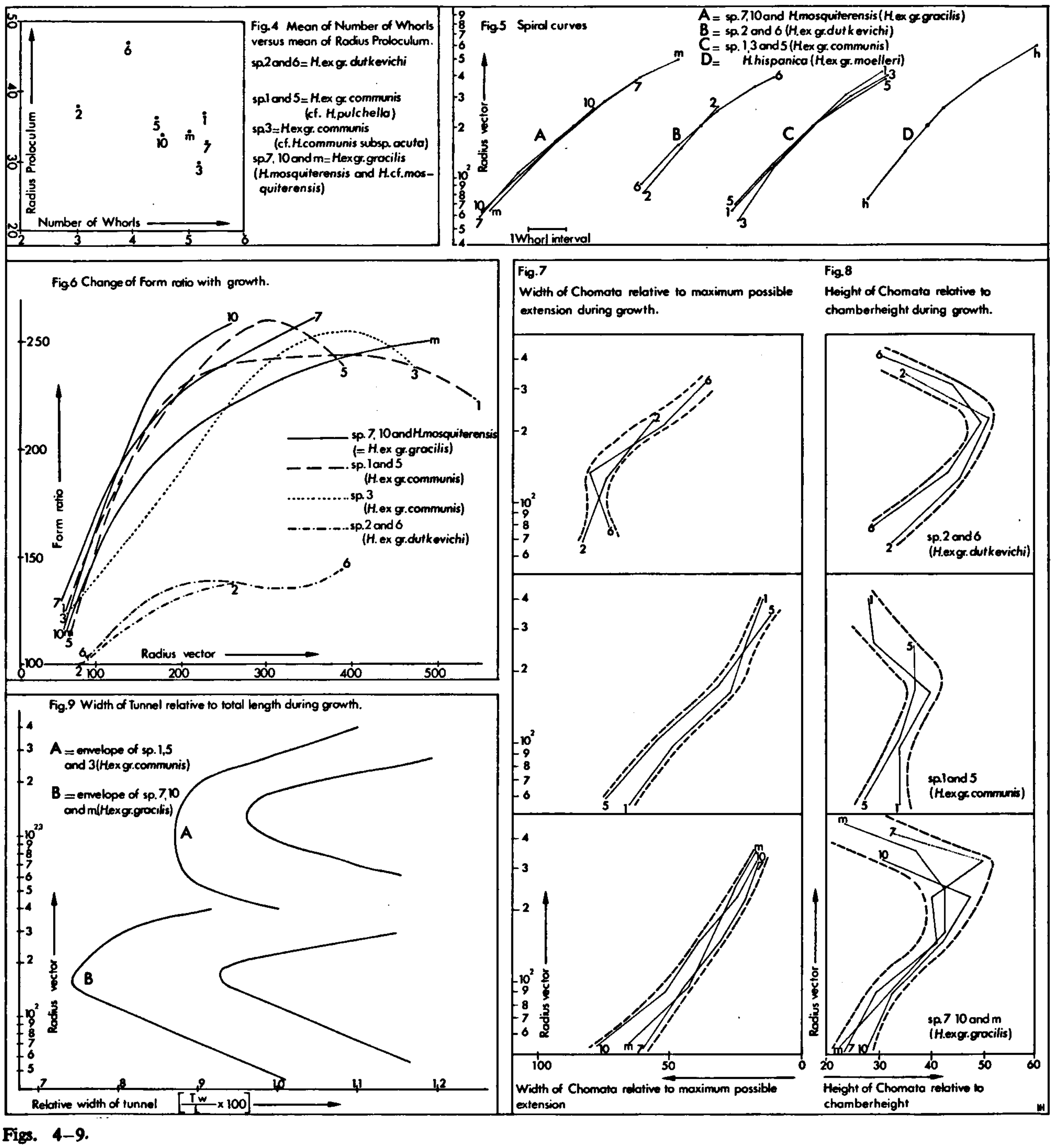
Hemifusulina sp. 4 and sp. 9
Hemifusulina sp. 4. – Material: 15 axial sections (Pl. II, Figs. 8, 9; Pl. III, Figs. 1–9; Pl. IV, Figs. 1–4). Loc. A 1055. Specimens are sometimes slightly recrystallized and are often crushed above the tunnel by forces parallel to the axis of coiling. It is not clear if all specimens indeed belong to a single species as is suggested here. One might divide the material in six groups – each containing one or more conspecific specimens – as follows. 1. Figs. 8, 9 (Pl. II), Fig. 1 (Pl. III); 2. Figs. 2, 3 (Pl. III); 3. Figs. 4–9 (Pl. III); 4. Fig. 1 (Pl. IV); 5. Figs. 2, 3 (Pl. IV); 6. Fig. 4 (Pl. IV).

The sample is too small and the material too poorly preserved to prove the morphological gaps which possibly exist. The groups 4, 5 and 6 (Pl. IV, Figs. 1–4) are quite aberrant forms as compared with typical *Hemifusulina*.

Hemifusulina? sp. 9. – Material: 6 axial sections (Pl. V, Figs. 6–11). Loc. A 1093. This species presents similar difficulties with regard to recrystallization, abrasion and crushing as discussed for *H.* sp. 4. They are quite aberrant forms as compared with typical *Hemifusulina*. To what measure these differences are original or caused by later alterations is not clear.

DISCUSSION ON HEMIFUSULINA OF THE SAMA FORMATION

It follows from the previous remarks with respect to the *Hemifusulina* fauna occurring in the Central Asturian Coal Basin that this fauna is considered to belong to at least four of the thirteen groups distinguished in Table IV. These are 1. *H.* ex gr. *graciosa* with *H. mosquiterensis* n. sp., *H.* sp. 7 and *H.* sp. 10; 2. *H.* ex gr. *communis* with *H.* sp. 1 and *H.* sp. 5 both compared with *H. pulchella* Raus., and *H.* sp. 3 compared with *H. communis acuta* Raus.; 3. *H.* ex gr. *dutkevichi* with *H.* sp. 2 and *H.* sp. 6; 4. *H.* ex gr. *moelleri* with *H. hispanica* (Gübler). The assignment of the Spanish fauna to more

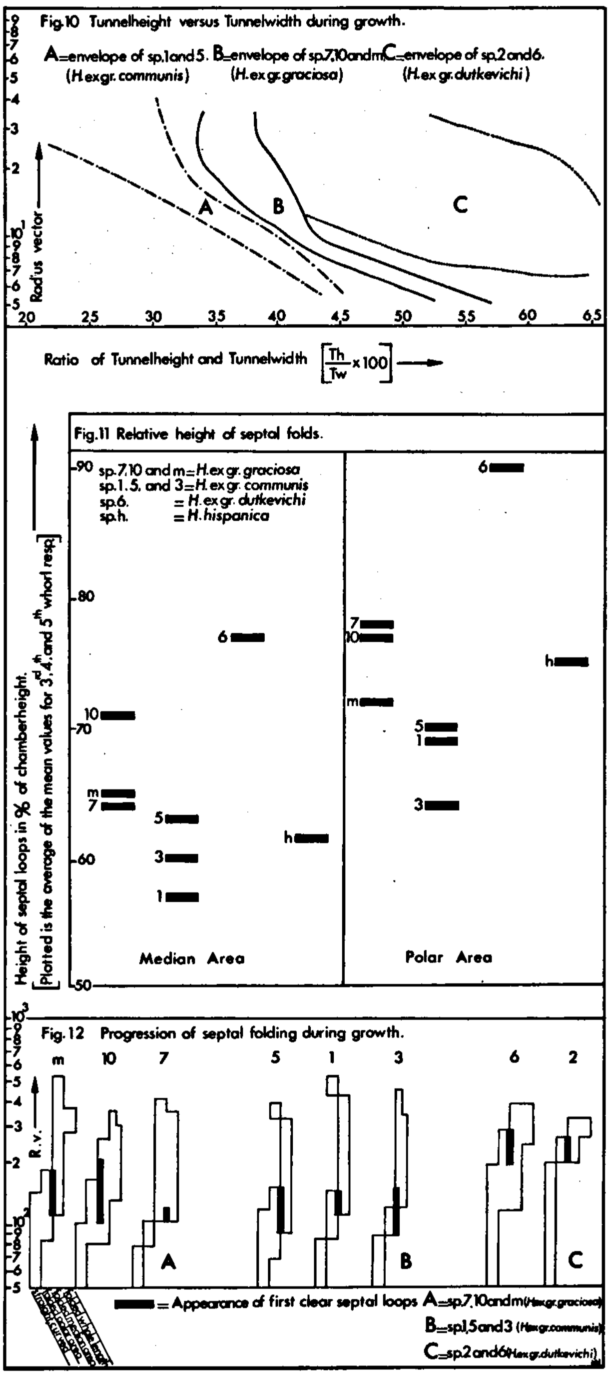


Figs. 4–9.

or less established groups of related species was preceded by a comparison of the corresponding characteristics in our material. As shown in the Figures 4–12 and measurements of Table III which supplied the data for these graphs, we may indeed distinguish three groups of related species as follows.

1. *H. mosquiterensis*, *H.* sp. 7, *H.* sp. 10
2. *H.* sp. 1, *H.* sp. 5 and *H.* sp. 3
3. *H.* sp. 2 and *H.* sp. 6.

A fourth group with *H. hispanica* (Gübler) has generally not been included for mutual comparison because of the paucity of our data regarding this species. It is, however, easily distinguishable from species of the groups 1–3. It is of interest to examine to what measure intergroup differences of the Asturian *Hemifusulina* correspond to differences between the *moelleri-*, *dutkevichi-*, *communis-* and *graciosa* groups. However, many characteristics used here for description of the Asturian



Figs. 10–12.

Hemifusulina fauna are mostly dealt with in a rather loose descriptive way and therefore cannot serve our purpose. The following characteristics or parameters will be considered. Wall structure, thickness of wall, number of whorls in relation to proloculum radius (Fig. 4), form ratio (Fig. 6) and tightness of coiling (Fig. 5).

Wall structure. – A clear diaphanotheca may be observed in *H. hispanica* (Gübler); such differentiation of the protheca is often indistinct in *H.* sp. 1, 3 and 5 and also in *H.* sp. 2 and 6, whereas in *H. mosquiterensis* n. sp. and *H.* sp. 7 and 10 a differentiation of the protheca is not observed at all. More detailed observations with regard to the wall structure of these Asturian *Hemifusulina* are presented at p. 94.

These observations in the order given (1 to 4) concur respectively with data on wall structure of species assigned to the groups of *H. graciosa*, *H. communis*, *H. dutkevichi* and *H. moelleri*.

It might be of interest to note that of the three Asturian species assigned to *H.* ex gr. *communis*, the oldest species i. e. *H.* sp. 1 shows a wall structure typical of *H.* ex gr. *communis*, the youngest species i. e. *H.* sp. 5 a wall structure typical of *H.* ex gr. *graciosa* whereas *H.* sp. 3 is intermediate in this respect. This suggests a phylogenetic trend towards simple undifferentiated walls. By taking into consideration also that not only *H.* ex gr. *graciosa* but all other groups of *Hemifusulina* of Upper Podolskian-Myachkovian age are reported to have walls without diaphanotheca or tectoria, it seems possible that there has been a parallel evolutionary development towards simple one-layered walls. This is in accord with earlier remarks on the evolution of *Hemifusulina* (Rauser-Chernoussova et al. p. 242).

Wall thickness. – According to Rauser Chernoussova et al. (1951, p. 242) the wall thickness increases from up to 25μ in outer whorls of Kashirian species to about 40μ in outer whorls of Myachkovian species. This tendency towards thicker whorls could not be affirmed for Asturian *Hemifusulina*. There is no significant difference neither in absolute nor relative sense (e.g. with respect to diameter, radius vector or chamber lumen) between the different groups of species in our Spanish material. However, the small sample of Spanish material as compared with known Russian material with respect to number of specimens, species, groups of species and areal extent has to be taken into consideration. Wall thickness in outer whorls of *H. mosquiterensis* n. sp., *H.* sp. 10 and *H.* sp. 7 is on an average about 2.6–2.7% of the diameter of outer whorls. In *H.* ex gr. *graciosa* this is normally higher and on an average slightly over 3% but it corresponds approximately to the relative wall thickness of *H. implicata* Bogush, which may be estimated to be on an average about 2.4% with a range of 1.8–3.0%. Relative wall thickness in outer whorls of *H.* sp. 1 and *H.* sp. 5 is on an average about 2.2–2.3% and 2.6–2.8% respectively. For *H.* sp. 3 this value is about 2.8–2.9%. The average value for species of the group of *H. communis* may be calculated to be about 2.0–2.1%. This clearly shows that not only for wall structure but also with respect to wall thickness *H.* sp. 1 fits better in *H.* ex gr. *communis* than do *H.* sp. 3 and *H.* sp. 5. Both *H.* sp. 1 and *H.* sp. 5, however, seem to correspond to *H. pulchella* Raus. in relative wall thickness since for the latter species an average value of 2.5% and a probable range of 2.1–3.0% may be calculated. *H.* sp. 3 has on an average a greater relative wall thickness than *H. communis acuta*

1. *H. mosquiterensis* n. sp. *H.* sp. 10 *H.* sp. 7	No differentiation of protheca; tectoria absent. Mural pores rarely seen, generally inconspicuous.
2. *H.* sp. 3 *H.* sp. 5 *H.* sp. 1	Protheca occasionally differentiated in a tectum and an indistinct diaphanotheca (*H.* sp. 1 and a single specimen of *H.* sp. 3). No differentiation of protheca in *H.* sp. 5. Mural pores well expressed (*H.* sp. 1 and 5) or rarely observed (*H.* sp. 3).
3. *H.* sp. 6 *H.* sp. 2	Protheca consists of tectum and a thick but not very transparent diaphanotheca; lower tectorium may be present locally. Mural pores fairly coarse in outer (3–3.5wh.) whorls (*H.* sp. 2) or rarely observed (*H.* sp. 6).
4. *H. hispanica* (Gübler)	Inner four whorls show a rather clear diaphanotheca and a very thin lower tectorium; presence of upper tectorium doubtful. Mural pores have been observed only in outer whorls.

Raus. which latter subspecies provides an average value of slightly below 2%. With respect to *H.* sp. 2 and *H.* sp. 6 or *H. hispanica* (Gübler) data are insufficient to give comparisons, though it seems that *H.* sp. 2 and *H.* sp. 6 have somewhat greater relative wall thickness as compared with the average value for *H.* ex gr. *dutkevichi* which is slightly below 2%.

Size of proloculum and number of whorls. – It is well known that measurements of fusulinid populations often suggest a negative correlation between number of whorls and size of proloculum. The impression is gained moreover, that a large proloculum is comparable to a smaller proloculum and a certain number (n) of initial whorls. This may be inferred by the appearance of a particular characteristic or parameter value in the n^{th} whorl of a macrospherical specimen and the appearance of the same characteristic in the n + x whorl of a microspherical specimen. Some examples to support this hypothesis are the spiral curve of *Schwagerina anderssoni* (Cutbill and Forbes, 1967, figs. 1,5) or the thickness of spirotheca in *Fusulinella* (van Ginkel, 1965, p. 176, 177). The latter example suggests moreover, that changes affecting the juvenarium leading either to more whorls and a smaller-sized proloculum or to the reverse situation could possibly play a role in the evolution of fusulinids. It seems proper therefore to consider proloculum size and number of whorls in relation to each other (Fig. 4). Species of *H.* ex gr. *graciosa* have on an average less whorls and a larger proloculum than species of *H.* ex gr. *communis*. *H. mosquiterensis* n. sp., *H.* sp. 10 and *H.* sp. 7 are close to *H.* ex gr. *graciosa* in this respect. This holds however also for *H.* sp. 1, *H.* sp. 3 and especially *H.* sp. 5 which implies that the latter group of Spanish species assigned to *H.* ex gr. *communis* in some of its characteristics is in fact closer to species of *H.* ex gr. *graciosa*. The species *H.* sp. 6 and *H.* sp. 2 have less whorls and a larger proloculum than *H. mosquiterensis* n. sp., *H.* sp. 10, *H.* sp. 7 as well as *H.* sp. 1, *H.* sp. 5 and *H.* sp. 3 (Fig. 4). Both species are closer to *H.* ex gr. *dutkevichi* than to *H.* ex gr. *graciosa* or *H.* ex gr. *communis*. Yet species of *H.* ex gr. *dutkevichi* differ in having a smaller proloculum and more volutions.

Form ratio. – Species of *H.* ex gr. *graciosa* have a larger form ratio in outer whorls than species of *H.* ex gr. *communis*. This difference holds also when form ratio is plotted against radius vector. Not only *H. mosquiterensis*, *H.* sp. 10 and *H.* sp. 7, but also *H.* sp. 5 and *H.* sp. 3 conform in this respect with species of the group of *H. graciosa* (Lee) whereas *H.* sp. 1 takes a position intermediate between *H.* ex gr. *graciosa* and *H.* ex gr. *communis*. *H.* sp. 2 and *H.* sp. 6 have a somewhat smaller form ratio than species of *H.* ex gr. *dutkevichi* in outer whorls but there is close similarity when plotted against radius vector. Figure 6 shows the form ratio to decrease in the final growth stage of *H.* sp. 1, *H.* sp. 5 and *H.* sp. 3. These species differ in this respect from *H. mosquiterensis*, *H.* sp. 10 and *H.* sp. 7.

Tightness of coiling. – The increase of radius vector (or diameter) during growth may be shown by plotting radius vector on a logarithmic scale (cf. Burma, 1942) against volution number. This is the spiral curve and differences in amount of procentual increase are reflected by the slope of the spiral curve. These differences are presented as percentage-increase values (G.r.) in Table III. One could also choose the set of angles as a measure for the rate of increase, each single value representing the slope of the curve at consecutive volution intervals. Different specimens, species or higher categories should be compared by plotting the radius vector or its rate of increase against volution interval starting from an arbitrary origin (Cutbill and Forbes, 1967, p. 325).

Comparison of the spiral curves of the Spanish *Hemifusulina* with species of the group of *H. graciosa* (Lee) and *H. communis* Raus. shows that *H. mosquiterensis* n. sp., *H.* sp. 10 and *H.* sp. 7 are closer to species of the group *H. graciosa* whereas *H.* sp. 1, *H.* sp. 5 and *H.* sp. 3 correspond to *H.* ex gr. *communis*. The difference between *H.* ex gr. *graciosa* and *H.* ex gr. *communis* is apparently that the latter group on an average starts with a steeper spiral curve (= looser coiled inner whorls). Afterwards the rate of increase slows down in both groups but less so in *H.* ex gr. *graciosa*. The spiral curves in *H.* ex gr. *communis* are therefore more negative as compared to those in *H.* ex gr. *graciosa*. The latter are better described as normal-negative (see Cutbill and Forbes, 1967, fig. 4, for types of spiral curve). It is shown in Figure 5 that the spiral curves of C (= *H.* sp. 1, 3 and 5) are negative as compared with those of A (= *H. Mosquiterensis, H.* sp. 10 and 7) which are rather normal-negative. Species of the groups of *H. communis* and *H. dutkevichi* have closely similar spiral curves. *H.* sp. 2 and *H.* sp. 6, which also show negative spiral curves (Fig. 5-B), are closer to species of the latter groups than to species of *H.* ex gr. *graciosa.* A negative spiral curve is moreover seen in Figure 5-D of *H. hispanica* (Gübler).

THE RELATIVE AGE OF THE SAMA FORMATION IN THE CENTRAL COAL BASIN (ASTURIA)

We distinguished three *Hemifusulina*-containing intervals in the Sama Formation, each of which has a bearing on the age of this formation as follows. A lower interval with *H.* ex gr. *moelleri* near the boundary of the Lena and Sama formations, a middle interval with *H.* ex gr. *communis* and *H.* ex gr. *dutkevichi* comprising the major part of the Sama Formation and including at least the San Antonio, Maria Luisa, Soton and Entrerregueras Members and finally an upper interval with *H.* ex gr. *graciosa* including the Modesta and Oscura Members (Fig. 2). Comparison with similar faunas in the U.S.S.R. leads to an Upper Kashirian or Lower Podolskian age, an Upper Kashirian or Podolskian age and an Upper Podolskian or Myachkovian age for the lower, middle, and upper interval respectively (Fig. 2). The middle interval contains the species *H.* sp. 1 and *H.* sp. 5 which are fairly similar to *H. pulchella* Raus. besides *H.* sp. 3 compared with *H. communis acuta* Raus., both Russian species of the group of *H. communis* Raus. In the discussion dealing with these species it has been demonstrated however, that *H.* sp. 1, *H.* sp. 5 and *H.* sp. 3 in certain characteristics or parameter values are intermediate between *H.* ex gr. *communis* and *H.* ex gr. *graciosa* or perhaps even closer to the latter group of species. This holds notably for *H.* sp. 5 and *H.* sp. 3. As a consequence, an age near the upper limit of the range Upper Kashirian-Podolskian seems to be more probable for the middle interval. We may conclude therefore that although an Upper Kashirian age for the lower part of the Sama Formation cannot definitely be excluded, it is more likely that this part of the stratigraphic column is younger and that the boundary between the Sama and the underlying Lena Formation approximately coincides with the Kashirian/Podolskian boundary. Sedimentation of the Modesta and Oscura Members near the top of the Sama Formation (= upper interval) probably took place in Myachkovian time although an Upper Podolskian age is also possible.

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TABLES

Abbreviations used in tables I, II and III

R.v.	=	radius vector
G.r.	=	ratio of radius of n^{th} to $n-1^{th}$ whorl
F.r.	=	ratio of half length to radius vector
W.Th.	=	wall thickness
T.a.	=	tunnel angle
T.h/H	=	ratio of heights of tunnel and chamber
T.h/T.w.	=	ratio of height to width of tunnel
T.w/L	=	ratio of width of tunnel to length of shell
M.d.s.	=	maximum deviation of symmetry of tunnel path
Ch.h/H	=	ratio of heights of chomata and chamber
Ch.w/ls.	=	ratio of width of chomata to maximum possible extension along lateral slope
Sl.h/H	=	ratio of heights of septal loops and chamber
Y/hL	=	ratio of septal wave length to half length
S.c.	=	number of septa

All ratios with exception of the form ratio are expressed in percentage values.
Values of radius vector and wall thickness are given in microns.

Table I

Measurements of <u>Hemifusulina hispanica</u> (Gübler)

Wh.n.	0		1		2		3		4		5		6	
Specimen: 2(1)	33		71		131		246		369	—				
4	42		76		139		246		377		500	599		R.v.
3	33		76		151		267		—		—			
				84		88		50						
				83		77		53		33				G.r.
				100		77								
2(1)			1.35		1.75		2.0		2.25	2.5				
4			—		2.0		2.6		2.6		3.3	3.2	3.5	F.r.
2(1)			7.5		13		17		16					
4			—		17		19		17	19				W.th.
3			9.5		17		15							
2(1)			—	46	46	57	52	45	52					Ch.h./H
4		33	29	41	39	48	43	46	28		30			
			20		31		30		42					T.a.
			12		30		43		48		53			
		25	36	23	53	40	45	48						Th/H
		—	22	27	29	—	36	41	41					
		66	72	38	80	43	44	37						Th/Tw
			33	36	30	44	29	26	21	24				
		9	9	10	9	11	11	11						Tw/L
		13	11	10	10	11	10	13	11	11				
3			7		10		13		—		—			S.c.

Table II

Measurements of Hemifusulina mosquiterensis

Axial sections

	Specimen: Wh.n.	21	19	16	25	36	13	30	9	29	5	4	3	12	18	24	7	14	11	8	15	Range	Av.
R.v.	0	30	34	39	34	27	41	32	23	37	42	40	33	31	39	39	31	29	43	31	—	23– 43	34.5
	1	52	71	64	61	56	73	58	56	67	81	82	60	63	63	69	56	52	77	68	60	52– 82	64.5
	2	82	144	110	105	95	120	99	101	129	165	129	107	105	95	116	95	86	125	111	111	82–165	111.5
	3	138	211	198	185	172	210	163	163	217	265	193	185	172	153	191	155	142	211	176	171	138–265	184
	4	215	271*	299	274	243	327	262	256	318	360	291	291	273	234	291	258	236	316	277	274	215–360	279
	5					325*	400*	342*	342	410*	420*	—	427	—*	353	410	363	314	462	—	410	314–462	385
	6												479*		—		496	428		—	547	428–547	490
	7																	598*					
G.r.	1																						
	2	58	103	72	72	70	64	71	80	93	104	57	78	67	51	68	70	65	62	63	85	51–104	73
	3	68	47	80	76	81	75	65	61	68	61	50	73	64	61	65	63	65	69	59	54	47– 81	65
	4	56		51	48	41	56	61	57	47	36	51	57	59	53	52	66	66	50	57	60	36– 66	54
	5								34				47		51	41	41	33	46		50	33– 51	43
	6																37	36			33	33– 37	35
F.r.	1	0.92	1.09	1.35	1.37	0.96	1.37	1.22	0.88	1.32	1.53	1.18	1.11	0.78	1.22	1.28	1.04	0.96	1.25	0.99	1.36	0.78–1.53	1.16
	2	1.16	1.61	1.92	2.10	1.64	2.03	1.88	1.34	1.72	1.61	1.73	1.64	1.37	1.74	1.93	1.41	1.40	1.66	1.35	1.69	1.16–2.10	1.65
	3	1.63	1.71	2.43	2.56	1.85	2.23	2.53	1.76	2.18	1.96	2.04	1.95	1.79	2.31	2.25	2.14	1.85	2.12	1.65	1.93	1.63–2.56	2.04
	4	1.96	1.78*	2.29	2.63	2.32	2.35	2.72	1.93	2.40	2.30	2.18	2.18	1.93	2.39	2.63	2.25	1.89	2.35	1.89	2.13	1.89–2.72	2.25
	5					2.08*	—*	2.60*	2.50	2.29*	2.45*	(2.5)	2.36	2.06	2.44	3.02	2.46	2.11	2.46	—	2.50	2.06–3.02	2.43
	6												2.39*		—		2.55	2.40		(2.5)	2.59	2.40–2.59	2.51
W.th.	1	4	8	4	8	6	4	5	4	8	6	6	5	4	6	8	4	4	-	6	5	4– 8	5.5
	2	9	9	10	12	—	9	6	9	10	11	9	9	9	-	9	5	9	9	6	9	5–12	8.5
	3	12	—	13	13	12	13	13	10	13	14	13	17	11	10	19	12	—	13	10	11	10–19	12.5
	4			—	—	—	—	20	15	—	—	15	15	14	17	17	13	13	15	14	17	13–20	15.5
	5								—			—	19	—	22	—	15	15	—	15	20	15–22	17.5
	6																17	—		—	—		
Tunnel T.a.	1	14	27	13	31	—	15	25	16	21	15	20	—	—	—	23	16	—	19	16	22	13–31	19.5
	2	22	22	26	32	—	27	27	23	32	25	19	26	21	24	32	22	16	26	24	27	16–32	25
	3	29	32	37	40	—	30	40	23	41	32	28	26	24	38	36	30	26	30	25	31	23–41	31.5
	4					35	33	—	28	38	33	27	31	25	35	39	30	26	37	27	39	25–39	32
	5								36				36	42	—		37	25		34	34	25–42	35
	6																53	31		52			
M.d.s.		11	21	22	10	4	12	15	12	13	12	17	24	9	13	17	8	24	11	27	10	4–27	14.5

Measurements of Hemifusulina mosquiterensis

	Specimen: Wh.n.	21	19	16	25	36	13	30	9	29	5	4	3	12	18	24	7	14	11	8	15	Range	Average
Th/H	0.5	22	35	23	33			50		45	25		28		20				40			20–50	32
	1	22	33	17	35	24	50	60		39	25					35	55	42	45	45	21	17–60	37
		18	33	37	36	42		46	43	44	26	70	36		31	15	45	35	44		50	18–70	38
	2	32	20	39	50		47	53	57	26	33	33	22	50	50	33	46	38	45	42	50	20–57	40
		31	29	58	47	38		40	61	64		41	45	30	35	42	44	75	48	35	43	29–75	45
	3	33	69	37	44		53	52	42	30	33	45	54	46	43		39	36	33	42	42	30–69	43
		60		50	87			83	36	40	52			47	45	45	56	42	46	50	41	36–87	52
	4	47				61	45	58		42	49	35	50	50		44		39		50	40	35–61	47
									91				40	71	64		82	38	56	34	40	34–91	57
	5														54			94		53			
																		42					
	6																						
Th/Tw	0.5	57	58	50	55			57		75	50		83		33				57			33–83	57
	1	40	40	33	30	36	69	67		54	33					40	58	53	53	75	33	30–75	48
		40	48	42	36	59		46	52	42	32	70	40		32	22	47	44	44		55	22–70	44
	2	35	38	37	42		42	50	57	30	40	43	30	50	43	32	43	45	47	36	42	30–57	41
		26	33	58	40	27		33	58	64		39	48	30	29	41	44	75	39	44	47	26–75	43
	3	32	47	27	33		50	30	50	24	30	30	54	55	36		35	38	26	42	33	24–55	37
		36		32	29			57	37	28	40			50	25	32	46	46	32	50	39	25–57	39
	4	33				33	34	34		25	30	26	50	47		24		39		45	26	24–50	34
									58				30	42	41		49	40	31	32	30	30–58	39
	5														25			56		26			–
																		31					
	6																						
Tw/L	0.5	13	10	12	12			14		10	12		6		11				10			6–13	11
	1	12	14	8	16	12	11	14		11	7					13	16	16	11	12	11	7–16	12
		9	8	9	11	10		10	11	10	11	8	10		11	6	12	12	10		10	6–12	10
	2	11	8	10	10		9	10	11	10	8	7	9	10	9	10	11	9	10	11	10	7–11	10
		10	9	8	8	11		9	10	8		8	8	11	9	9	9	9	9	10	8	8–11	9
	3	11	11	10	10		8	10	8	11	10	9	8	8	8		9	9	9	10	10	8–11	9
		11		9	13			9	9	10	10			9	9	8	10	9	9	10	8	8–13	10
	4	12				10	9	9		10	10	8	7	8		9		9		8	11	7–12	9
									9				9	11	11	12	11	9	10	9	9	9–12	10
	5														7			9		10			
																		9					
	6																					10					

Measurements of Hemifusulina mosquiterensis

	Specimen: Wh.n.	21	19	16	25	36	13	30	9	29	5	4	3	12	18	24	7	14	11	8	15	Range	Average
Chomata																							
	0.5		26	15	17	12		19		15	28	33	17		26		30	14				12–33	21
	1	15	32	27	27	24	33	27		22	30	32	25	25	20	33	17	18			32	15–33	24
		27	33	32	29	24	36	31		37	27	33	43		30	28	30	26	37	22	36	22–43	31
	2	25	50	50	38	28	45	34	33	43	43	47	42	31	36	43	20	25		30	30	20–50	36
		28	48	49		44	47	47	37	42	43	40	44	42	39		34	32	52	39	45	28–52	42
	3	41	51	52	40		74	43	38	45	39	55	42	45	36	39	39	32	46	40	38	32–74	43
Ch.h/H		62	43		52	48	51	45			45	44	45	33	35	44	46	47	39	41	43	33–62	45
	4	58		21	43		47	42	42		34	39	50	38	27		40	50	42	41	31	21–58	40
						27				48		54	34	42	39		34		42	41	31	27–54	39
	5								40				37	42	18		38		28	37	38	18–42	35
															0		20				34		
	6														0		40	48					
																		43					
	7																						
	0.5		71	44	86			66		73	100	85		57	67							44–100	72
	1		41	68	46		48	68	82	66	54	45	80		50	55	66	90	62	50	58	41–90	61
		60	51	50		39	29	52	59	57	54	37	42	44	51	39	44	44	55	43	73	29–73	49
	2	25	36	46	38	39	35	43	39	33	34		30	27	31	27	42	31	35	55	34	25–55	36
		34	55	38	37	45	35	36	37	30	34	45	36	25	46	35	36	40	46	33	38	25–55	38
	3	48	30	51	19		29	26	22	23	22	37	28	24	32	22	37	35	24	23	26	19–51	29
Ch.w/ ls.		36	51	26	23	41	27	17	22	17	17	37	29	20	31	34	22	31	17	22	40	17–51	28
	4	19		18		28	17	17	29	17	14	22	20	17	24	24	26	23	23	18	33	14–33	22
						14		10	26	24	13	16	15	12		27	14	36	16	13	18	10–36	18
	5								14				14		11		19	23	17	17	20	11–23	17
															9		13	19			17		
	6																17	17					
Septa	3				62	56	73	80	67	74	72	74	69	63	60	68		66		63	69	56–80	68
Sl.h/H	4			60	55		61	70	58	82	61	60	74	59	62	63	68	66	66	62	66	55–82	64
(median	5								65				66	86	40		46	64		76	58	46–86	63
region)	6																	68			54		
	3	68	65	65	68	67	85	76	75	68		74	76	76	71	67	55			74		55–85	71
Sl.h/H	4	63		74	69	70	86	80	75	86	82	63	66	90	76	73	81	69	71	77		63–90	75
(polar	5								77				76		71		58	77		68	68	58–77	71
region)	6																	77			80		

Measurements of Hemifusulina mosquiterensis

	Specimen: Wh.n.	21	19	16	25	36	13	30	9	29	5	4	3	12	18	24	7	14	11	8	15	Range	Average
	2.5				28.5						32.5												
	3	32.5			21	33	27.5	25		26	25	24		36	24.5	28		38	25	28	23	21–36	28
					20		19	24.5	28.5	23	23	22	24.5		24	22	26	30.5	19.5	24		19–31	24
y/hL	4	24.5		22	16.5		18	22.5	24	19.5	16	21	20.5	22.5	19.5	21	24	30	17.5	24		16–30	21
								19	20.5			19	16.5	22		18	22.5	23	17	17.5	22.5	16–23	20
	5								18.5				15.5		17		18.5	21		18.5	20	15–21	18
													13.5		13			17		13	16	13–17	14.5
	6																	16			14.5		
																		19					
	7																						

Sagittal sections

	Specimen: Wh.n.	S37	S38	S39	S40	S41	S42	S43	S44	S45	S46	S47	Range	Average
	0	27	30	31	31	32	34	34	34	35	37	45	27–45	34
	1	64	65	65	73	69	82	73	77	76	86	88	64–88	74
	2	106	108	107	120	120	142	119	135	118	140	148	106–148	124
R.v.	3	168	174	172	189	211	228	196	215	202	219	254	168–254	203
	4	252	295	274	308	314	342	282	331	316	325	368	252–368	310
	5	376	—	—	—	436	—	—	462	462	—	479*		
	6	—								—				
	1													
		65	67	67	65	75	74	73	75	55	63	73	55–75	67
	2													
		58	62	60	57	75	61	64	59	71	57	71	57–75	63
G.r.	3													
		50	69	59	63	49	50	44	54	56	48	45	44–69	53
	4													
		49				39			40	46				
	5													
	1	7	8	9	9	9	7	8	7	8	7	6	6–9	8
	2	11	12	14	14	12	12	11	12	11	13	11	11–14	12
S.o.	3	13	15	14	15	16	16	13	14	17	12	13	12–17	14
	4	16	20	16	22	18	17	17	—	17	16	17	16–22	17.5
	5	—		23	—	—	—	20	—	21	18	22	18–23	21

	Wh.n.	1		2		3		4		5		6	
Pr.	m	1.16	0.78-1.53 (20)	1.65	1.16-2.10 (20)	2.04	1.63-2.56 (20)	2.25	1.89-2.72 (19)	2.43	2.06-3.02 (9)	2.51	2.40-2.59 (3)
	10	1,16	0.90-1.50 (7)	1.70	1.17-2.12 (7)	2.31	1.38-2.95 (7)	2.60	1.72-3.02 (7)	2.18*	1.72-2.65*(2)		
	7	1.29	1.25-1.32 (3)	1.75	1.66-1.81 (3)	2.15	1.91-2.40 (3)	2.38	2.15-2.57 (3)	2.61	2.30-2.79 (3)		
	6	1.03	0.65-1.33 (5)	1.30	1.02-1.71 (5)	1.38	1.21-1.50 (5)	1.33	1.31-1.34 (2)	1.44*	1.33-1.55*(2)		
	2	1.00	0.98-1.00 (3)	1.20	1.16-1.27 (3)	1.38	1.29-1.46 (2)						
	3	1.23	1.02-1.40 (4)	1.62	1.35-2.00 (4)	1.87	1.59-2.24 (4)	2.38	2.06-2.71 (4)	2.57	2.33-2.89 (4)		
	5	1.13	0.96-1.27 (6)	1.78	1.54-2.05 (6)	2.20	2.00-2.55 (6)	2.61	2.31-3.01 (6)	2.41*	2.21-2.62*(2)		
	1	1.25	1.23-1.27 (2)	1.81	1.81 (2) (2)	2.26	2.21-2.31 (2)	2.42	2.41-2.43 (2)	2.43	2.42-2.44 (2)		

		0		1		2		3		4		5		6	
Rv.	m	34.5	23-43 (19)	64.5	52-82 (20)	111.5	82-165 (20)	184	138-265 (20)	279	215-360 (19)	385	314-462 (8)	490	428-547 (3)
	10	34	25-41 (7)	62	52-80 (7)	103	84-145 (7)	165	133-220 (7)	261	215-325 (7)	303*	260-365*(3)		
	7	33	28-40 (3)	59	51-73 (3)	105	95-125 (3)	163	146-193 (3)	252	231-291 (3)	355	312-393 (3)		
	6	47	30-56 (5)	91	56-110(5)	153	97-181 (5)	243	172-286 (5)	338	286-370 (3)	384*	342-425*(2)		
	2	38	36-40 (3)	80	69-90 (3)	148	135-168 (3)	260	239-282 (2)						
	3	30	26-35 (3)	65.5	52-75 (4)	119	97-138 (4)	198	163-225 (4)	289	231-330 (4)	395	325-440 (4)		
	5	36.5	28-47 (6)	68.5	58-88 (6)	118	101-159 (6)	195	166-243 (6)	278	215-338 (6)				
	1	37	34-40 (2)	64.5	64-65 (2)	112	112 (2) (2)	186	183-189 (2)	303	291-316 (2)	436	410-462 (2)		

Table III

		Rv2/Rv1		Rv3/Rv2		Rv4/Rv3		Rv5/Rv4		Rv6/Rv5	
Gr.	m	73	51-104 (20)	65	47-81 (20)	54	36-66 (19)	43	33-51 (8)	35	33-37 (3)
	10	66	56-81 (7)	61	52-69 (7)	59	48-66 (7)	41	35-53 (3)		
	7	80	71-86 (3)	56	55-58 (3)	55	51-58 (3)				
	6	69	57-76 (5)	60	50-78 (5)	53	43-66 (3)				
	2	86	75-96 (3)	72	68-77 (2)						
	3	82	77-87 (4)	67	61-73 (4)	47	35-63 (4)	37	33-41 (4)		
	5	72	67-80 (6)	66	53-76 (6)	42	30-55 (6)				
	1	74	73-75 (2)	66	63-69 (2)	63	59-67 (2)	43.5	41-46 (2)		

	Wh.n	0.5-1		1.5-2		2.5-3		3.5-4		4.5-5	
T.w./L	m	11.5	6-16 (25)	10	6-12 (36)	9	8-11 (36)	9.5	7-13 (28)	10	7-12 (13)
	10	10	6-14 (9)	9	7-13 (13)	8.5	6-12 (14)	9.5	9-11 (10)	11.5	9-15 (4)
	7	10	9-12 (5)	10	8-12 (6)	7.5	6-9 (6)	8	7-9 (4)	8.5	8-10 (5)
	6	11	8-14 (7)	9	6-13 (8)	9	5-11 (7)	10	7-13 (5)		
	2	12	11-13 (2)	12	11-13 (3)	12	7-16 (3)				
	3	10	9-11 (2)	9	7-11 (4)	9	7-11 (6)	11	9-14 (5)	11	6-14 (5)
	5	11.5	8-15 (8)	9.5	8-15 (12)	9.5	8-11 (12)	11.5	9-16 (12)	12	11-14 (3)
	1	9	8-10 (2)	9	6-12 (4)	9	8-11 (4)	11	10-12 (4)	11	9-14 (2)

T.mds.	m	14.5	4-27 (20)
	10	17	7-27 (7)
	7	21	8-32 (3)
	6	16	7-28 (5)
	2	—	—
	3	23	5-33 (4)
	5	14	4-26 (6)
	1	17.5	15-20 (2)

Septa

		median area						polar area					
	Wh.n	2.5-3		3.5-4		4.5-5		2.5-3		3.5-4		4.5-5	
Sl.h./H	m	68	56-80 (15)	64	55-82 (17)	63	40-86 (8)	71	55-85 (16)	75	63-90 (18)	71	58-77 (7)
	10	66	42-81 (9)	66.5	43-85 (12)	80	64-100(6)	84	74-95 (4)	75	59-87 (10)	73	44-100(7)
	7	68	48-91 (5)	68	50-81 (6)	57	47-63 (5)	84	77-89 (3)	73	68-82 (4)	76	72-83 (5)
	6	73	69-76 (4)	76	56-93 (8)	84	71-100(4)	90	80-100(2)	90	81-100(6)	89	81-97 (2)
	2	65.5	56-73 (4)					75	66-86 (5)				
	3	60	55-70 (5)	54.5	47-62 (8)	65.5	50-75 (7)	62	55-71 (6)	63	43-75 (8)	67	50-78 (6)
	5	60	38-73 (4)	55	32-83 (10)	74	66-82 (2)	72	60-83 (5)	71	60-84 (10)	68	57-83 (4)
	1	62	44-72 (3)	58	41-72 (5)	52	40-63 (2)	68	54-78 (3)	73	61-100(6)	66	56-80 (3)

Septal pores

m	absent
10	absent
7	absent
6	absent
2	absent
3	present
5	present
1	present
h	present

	Wh.n	2.5-3		3.5-4		4.5-5		5.5-6	
V/hL.	m	28	21-38 (17)	22	16-31 (31)	19	15-23 (18)	15	13-17 (7)
	10	24	19-28 (6)	21	13-27 (12)	23	15-31 (4)		
	7	27	21-33 (4)	20	16-23 (2)	18	12-26 (6)		
	6	33	(1)	37	34-40 (2)				
	2	42	37-47 (3)	37	(1)				
	3	27	23-34 (3)	22.5	15-[illegible] (6)	17.5	16-19 (4)		
	5	28	21-38 (8)	22	15-28 (11)	19	14-23 (3)		
	1	23	(1)	18.5	15-21 (3)	16	14-18 (2)		

	Wh.n.	1	2	3	4	5	6
	m	5.5 4–8 (19)	8.5 5–12 (18)	12.5 10–19 (18)	15.5 13–20 (12)	17.5 15–22 (6)	17 (1)
	10	6 4–10 (7)	9 6–14 (6)	12 10–15 (7)	14 11–17 (6)	18° (1)	
	7	6 5–7 (3)	7 6–9 (3)	10 9–10 (3)	12 11–13 (3)	16 15–17 (2)	
	6	7 5–10 (5)	10 8–12 (3)	14 11–18 (5)	13 (2)	17° (1)	
W.th.	2	8 6–10 (3)	12 10–17 (3)	16 13–21 (3)			
	3	7 5–9 (4)	9 8–10 (4)	16 11–21 (4)	18 15–23 (4)	20 17–23 (3)	17° (1)
	5	5 4–6 (6)	10 8–13 (6)	11 9–15 (6)	16 13–19 (3)	21° (1)	
	1	8.5 8–9 (2)	11 9–13 (2)	11.5 9–14 (2)	16 15–17 (2)	18.5 13–24 (2)	16° (1)

Chomata

	Wh.n.	0.5–1	1.5–2	2.5–3	3.5–4	4.5–5	5.5–6
	m	23 12–33 (29)	33.5 20–50 (37)	42.5 28–74 (37)	42.5 21–62 (33)	37 18–54 (18)	23.5 0–48 (6)
	10	28 14–45 (11)	32.5 12–45 (14)	42 32–56 (14)	47.5 31–62 (13)	31 11–52 (7)	
	7	23.5 17–33 (5)	29.5 23–35 (6)	41 28–58 (6)	40 33–48 (6)	50 47–58 (5)	33 (1)
	6	30 17–42 (7)	44 34–56 (10)	50 38–63 (9)	44.5 0–59 (6)	31.5 24–39 (2)	
Ch.h./H	2	33.5 30–37 (2)	46 41–56 (5)	51.5 43–60 (5)	36 (1)		
	3	22 17–33 (4)	35 20–46 (8)	37 20–50 (6)	46 31–73 (6)	45.5 17–73 (5)	
	5	27.5 17–38 (12)	34 17–41 (12)	37 27–46 (12)	36.5 30–41 (9)	18 (1)	
	1	34 30–40 (3)	34 33–36 (3)	40 34–46 (4)	29 17–46 (4)	28 18–42 (3)	

		0.5–1	1.5–2	2.5–3	3.5–4	4.5–5	5.5–6
	m	65 41–100 (26)	42.5 25–73 (38)	33.5 19–55 (39)	25 14–51 (38)	17.5 10–36 (22)	
	10	77 36–100 (12)	52 30–93 (13)	39 21–57 (13)	24 13–44 (13)	17 12–28 (4)	
	7	60 40–76 (4)	45 37–52 (6)	31 21–48 (6)	21 15–28 (6)	16 13–20 (5)	
	6	73 37–100 (7)	80 54–100 (10)	51 38–74 (9)	37 21–55 (6)	28 (1)	
Ch.W./ls.	2	83 79–85 (4)	74 45–100 (5)	56 41–79 (5)	17 (1)		
	3	66 (1)	38 21–73 (6)	34.5 21–70 (7)	18 17–20 (7)	16 12–28 (6)	11 (1)
	5	74 41–95 (7)	55 29–100 (11)	32 17–57 (11)	21 12–33 (12)	12 8–18 (3)	
	1	65 60–70 (4)	49 36–66 (4)	27 18–35 (4)	21 13–30 (4)	15 10–20 (3)	

Tunnel

	Wh.n	1	2	3	4	5
	m	19.5 13–31 (15)	25 16–32 (19)	31.5 23–41 (19)	32 25–39 (15)	35 25–42 (7)
	10	23 14–29 (4)	24 16–30 (6)	31 20–44 (7)	40 26–54 (7)	
	7	16 13–19 (3)	24 23–24 (3)	27 25–30 (3)	28 26–29 (3)	36 31–41 (2)
	6	20 12–27 (4)	17 16–19 (5)	17 11–22 (5)	16.5 13–20 (2)	
T.n.	2	17 14–20 (2)	21 18–25 (3)	26 14–35 (3)		
	3	19.5 10–29 (2)	24 21–27 (3)	26 22–30 (3)	37 25–47 (3)	40.5 39–42 (2)
	5	23 19–29 (5)	30 24–37 (6)	37.5 33–44 (6)	46 31–65 (6)	
	1	19.5 14–25 (2)	34 32–36 (2)	34.5 33–36 (2)	40.5 40–41 (2)	

	Wh.n	0.5–1	1.5–2	2.5–3	3.5–4	4.5–5
	m	35 17–60 (25)	39 15–70 (36)	44 29–75 (36)	50 35–87 (28)	59.5 34–94 (12)
	10	34 17–59 (9)	39 10–58 (13)	39 31–45 (13)	47 31–74 (10)	76 59–100 (3)
	7	40 28–57 (5)	40 25–50 (6)	47 33–59 (6)	48 43–50 (3)	58 27–85 (4)
	6	35 16–50 (7)	42 25–59 (8)	50 33–75 (7)	43 29–69 (5)	
T.h./H	2	28.5 28–29 (2)	27 17–48 (3)	32 31–33 (2)		
	3	52 42–58 (4)	34 27–43 (4)	44 40–48 (4)	57 43–77 (4)	43 40–46 (2)
	5	48 33–62 (7)	41 24–50 (12)	43 25–64 (11)	49 37–67 (8)	
	1	32 31–33 (2)	42 25–60 (4)	41 28–52 (4)	49 39–64 (4)	57 45–70 (2)

	Wh.n	0.5–1	1.5–2	2.5–3	3.5–4	4.5–5
	m	52 30–83 (25)	42 22–70 (36)	40 24–75 (36)	37 24–57 (28)	38 25–58 (12)
	10	52 20–87 (9)	43 11–57 (13)	37 22–52 (12)	34 22–44 (10)	36 27–43 (3)
	7	56 36–89 (5)	42 29–50 (6)	41 30–54 (6)	39 31–44 (3)	34 21–42 (4)
	6	52 27–75 (7)	65 33–100 (8)	62 34–83 (7)	53 28–83 (5)	
T.h./T.w.	2	64 57–71 (2)	42 21–80 (3)	52 33–71 (2)		
	3	70 66–75 (2)	46 37–54 (4)	49 39–56 (6)	35 33–38 (2)	25 21–29 (2)
	5	43 29–55 (7)	36 24–57 (12)	29 15–45 (11)	22 12–33 (8)	
	1	45 31–60 (2)	40 25–50 (4)	33 24–40 (4)	31 28–37 (4)	30 26–35 (2)

Table IV

I H. ex gr. djartassensis Rumjanoeva Kashirian	H. djartassensis Rumjanoeva rotundata Rumjanoeva marnica Rumjanoeva kysylkumensis Rumjanoeva
II H. ex gr. moelleri Rauser-Chernoussova Upper Kashirian-Lower Podolskian	H. moelleri Raus. pseudobocki (Putrya et Leontovich) pseudobocki vjatkensis Raus. kashirica Bolkhovitina truncatula Raus. hispanica (Gübler) arenaria (Thompson)
III H. ex gr. communis Rauser-Chernoussova A Kashirian-Podolskian	H. communis Raus. communis acuta Raus. communis borealis Raus. paraelliptica Raus. pulchella Raus. pseudominima Putrya
B H. ex gr. voshgalica Safonova Kashirian-Lower Podolskian	H. voshgalica Safonova rjasanensis Raus.
C H. ex gr. elegantula Rauser-Chernoussova Upper Kashirian- Lower Podolskian	H. elegantula Raus. proelegantula Raus. subrhomboïdes Raus. rhomboïdales Raus. (= H? splendida rhomboidales firma Raus.
IV H. ex gr. dutkevichi (Putrya) A Kashirian-Lower Podolskian	H. dutkevichi (Putrya) dutkevichi samarensis Raus. dutkevichi pechorica Raus. nataliae Raus.
B H. ex gr. volgensis(Putrya et Leontovich) Kashirian- Lower Podolskian	H. volgensis (Putrya et Leontovich) volgensis intermedia Safonova volgensis syzranica Raus. polasnensis Safonova consobrina Raus.
V H.? ex gr. splendida Safonova Kashirian- Podolskian	H.? splendida Safonova H.? splendida globosa Safonova H.? sphaerica Manukalova
VI H. ex gr. bocki Moeller A Podolskian-Myachkovian	H. bocki Moeller bocki mosquensis Raus. elliptica (Lee) stabilis Raus.
B H. ex gr. graciosa (Lee) Upper Podolskian- Myachkovian	H. graciosa (Lee) ovata Kireeva ovata decurta Kireeva implicata Bogush leviplicata Bogush mosquiterensis n.sp.
VII H. ex gr. plana Manukalova Upper Podolskian- Myachkovian	H. plana Manukalova bilitschevae Bogush subcylindrica Man. (= graciosa subcylindrica Man.)
VIII H. ex gr. djilandyensis Bogush Myachkovian	H. djilandyensis Bogush fusiformis Kireeva lissitsynae Bogush
IX H. ex gr. inconspicua (Girty) Upper Desmoinesian	H. inconspicua (Girty) rickerensis (Thompson)

PLATES

Plate explanation

The scale of the microphotographs* in the plates is indicated by a bat representing 500 μ.
Different enlargements in a single plare are indicated by insertion of extra bars.
The specimen numbers quoted correspond to those of the slides in which the specimens have been found.

t.sp.	=	type specimen
s.s.	=	sagittal section

* The microphotographs have been prepared by Mr. W. C. Laurijssen of the Geological Institute of Leiden.

PLATE I

Sagittal sections x 50
Axial sections x 40

Loc. A 9 (Type locality of *H. hispanica* (Gübler))

Figs. 1–5 *Hemifusulina hispanica* (Gübler)

1, one of Gübler's syntypes shown in his plate 2 as figure 8 (Gübler, 1943) and designated as the lectotype by F. and G. Kahler in 1969.
2, a specimen of Gübler's collection according to M. Lys and B. Serre (Lys and Serre, 1958, Pl. XI).
3, specimen 4
4, 3, s.s.
5, 2

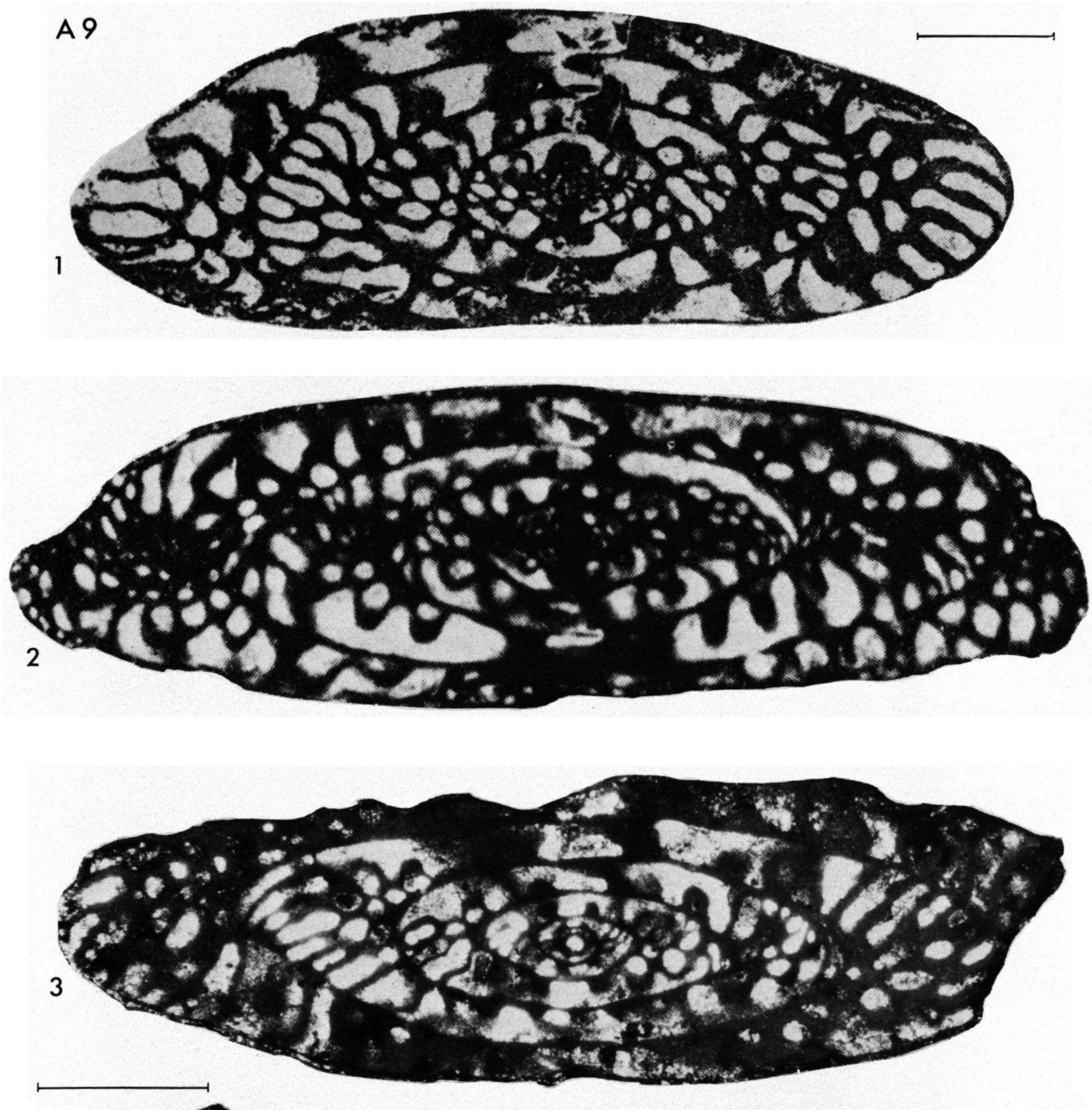

A 9
1
2
3
4
5

PLATE II

All x 40

Loc. A 1110

Figs. 1, 2 Hemifusulina sp. 1 (cf. *H. pulchella* Raus.)

1, specimen	1	
2,	2	

Locs. A 1055 and A 1056

Figs. 3, 4, 10 *Hemifusulina* sp. 2 (*H.* ex gr. *dutkevichi*)

3, specimen	2	(A 1056)
4,	1	(A 1056)
10,	1	(A 1055)

Figs. 5–7 *Hemifusulina* sp. 3 (See also Pl. IV, Fig. 5)

5, specimen	12	(A 1055)
6,	6	(A 1055)
7,	9	(A 1055)

Figs. 8, 9 *Hemifusulina* sp. 4 (See also Pl. III and IV)

9, specimen	8	(A 1055)

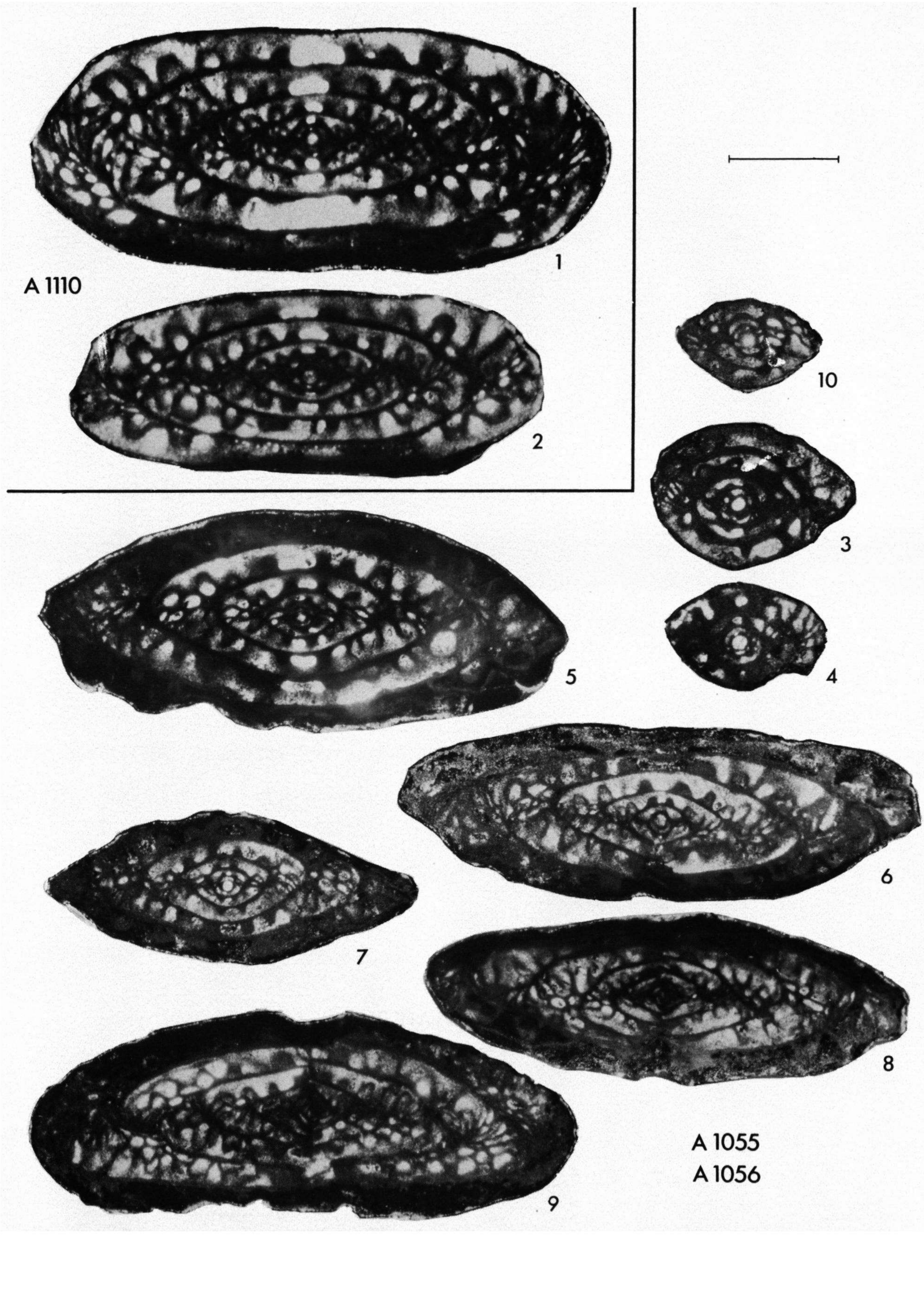

A 1110
1
2
10
3
4
5
6
7
8
9
A 1055
A 1056

PLATE III

All x 40

Locs. A 1055 and A 1056

Figs. 1–9 *Hemifusulina* sp. 4 (See also Pl. II and IV)

1,	specimen	3	(A 1055)
6,		10	(A 1055)
7,		13	(A 1055)
9,		2	(A 1055)

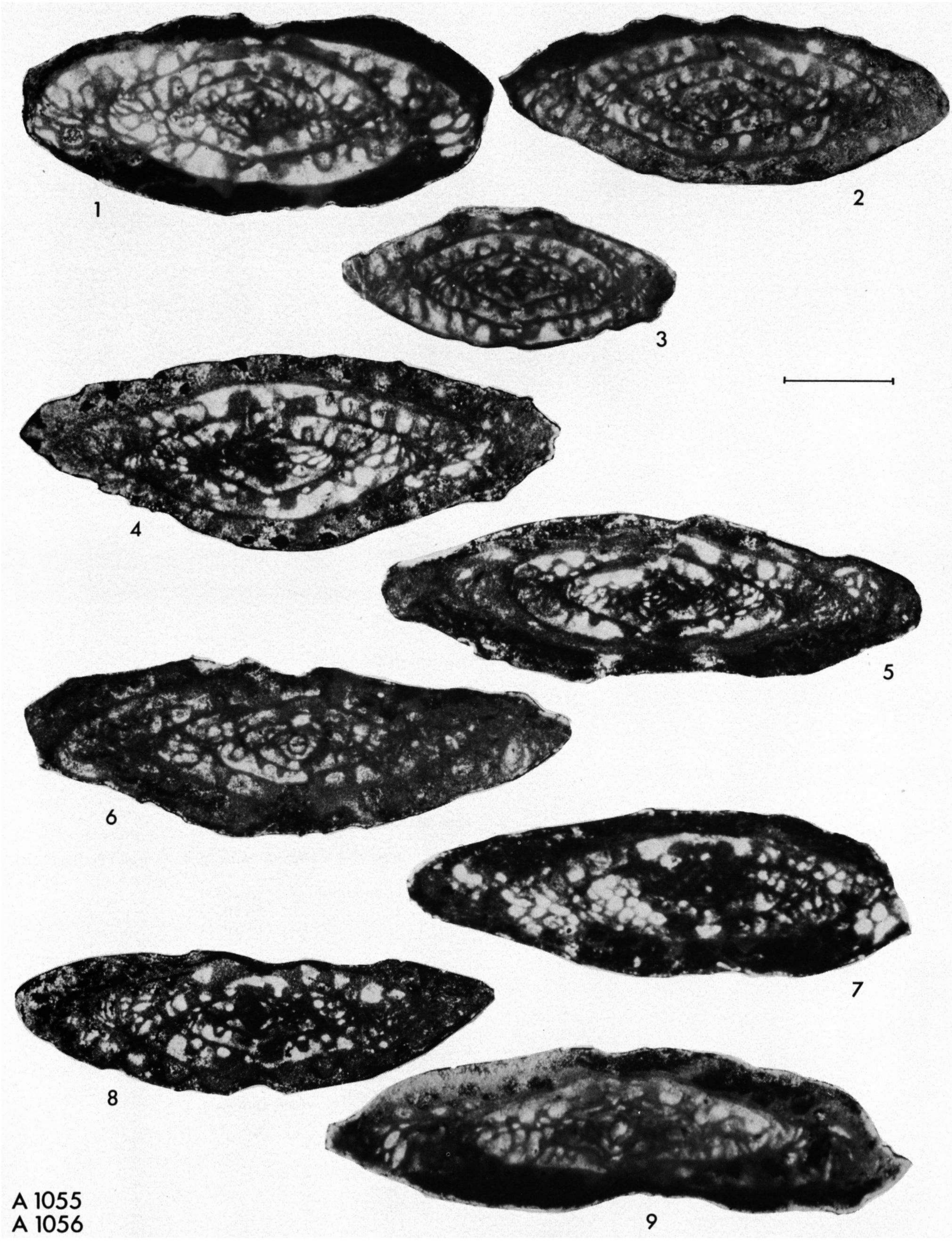

1
2
3
4
5
6
7
8
9
A 1055
A 1056

PLATE IV

All x 40

Locs. A 1055 and A 1056

Figs. 1–4 *Hemifusulina* sp. 4 (See also Pl. II and III)

1, specimen	4	(A 1055)
2,	7	(A 1055)
4,	11	(A 1055)

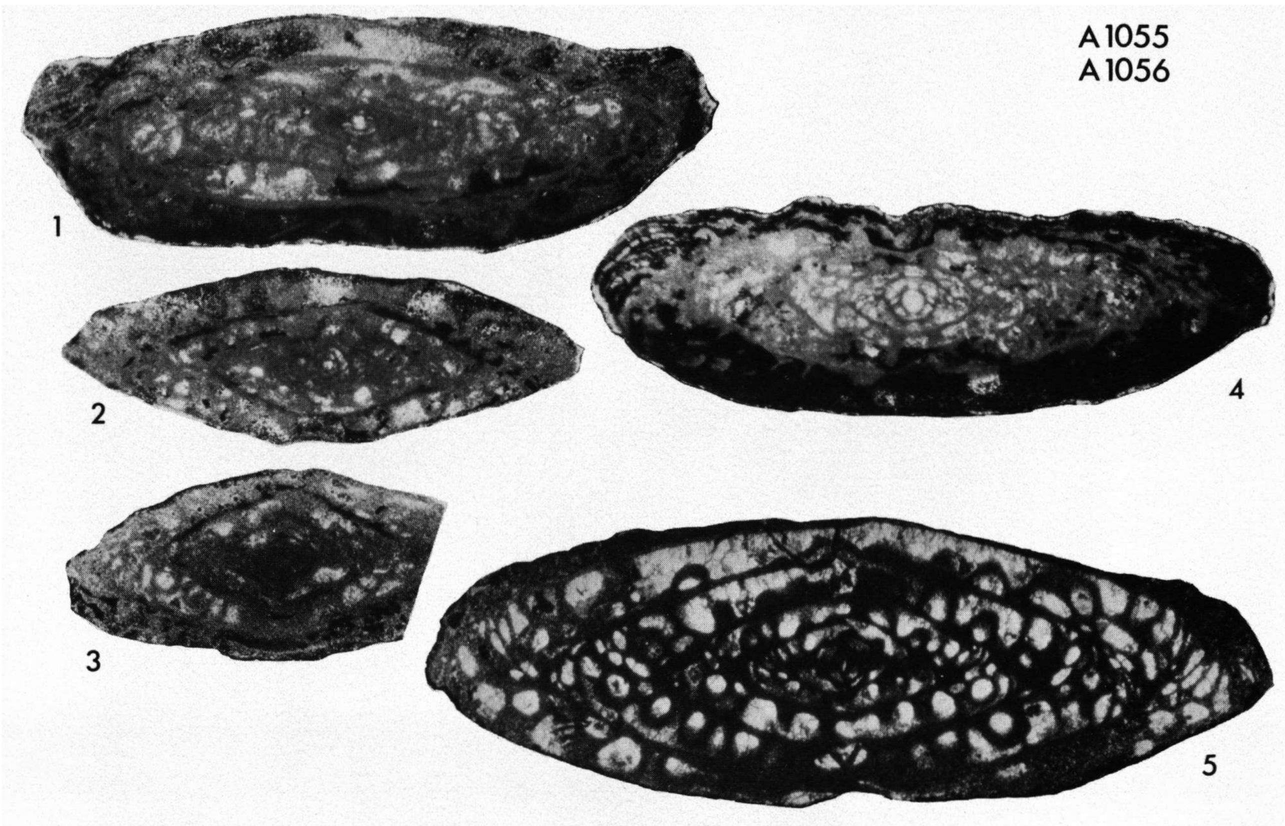
Fig. 5 *Hemifusulina* sp. 3 (See also Pl. II)

5, specimen 3 (A 1056)

Loc. A 1101

Figs. 6–11 *Hemifusulina* sp. 5

6, specimen	6
7,	5
8,	4
9,	1
10,	2
11,	3


A1055
A1056
1
2
3
4
5

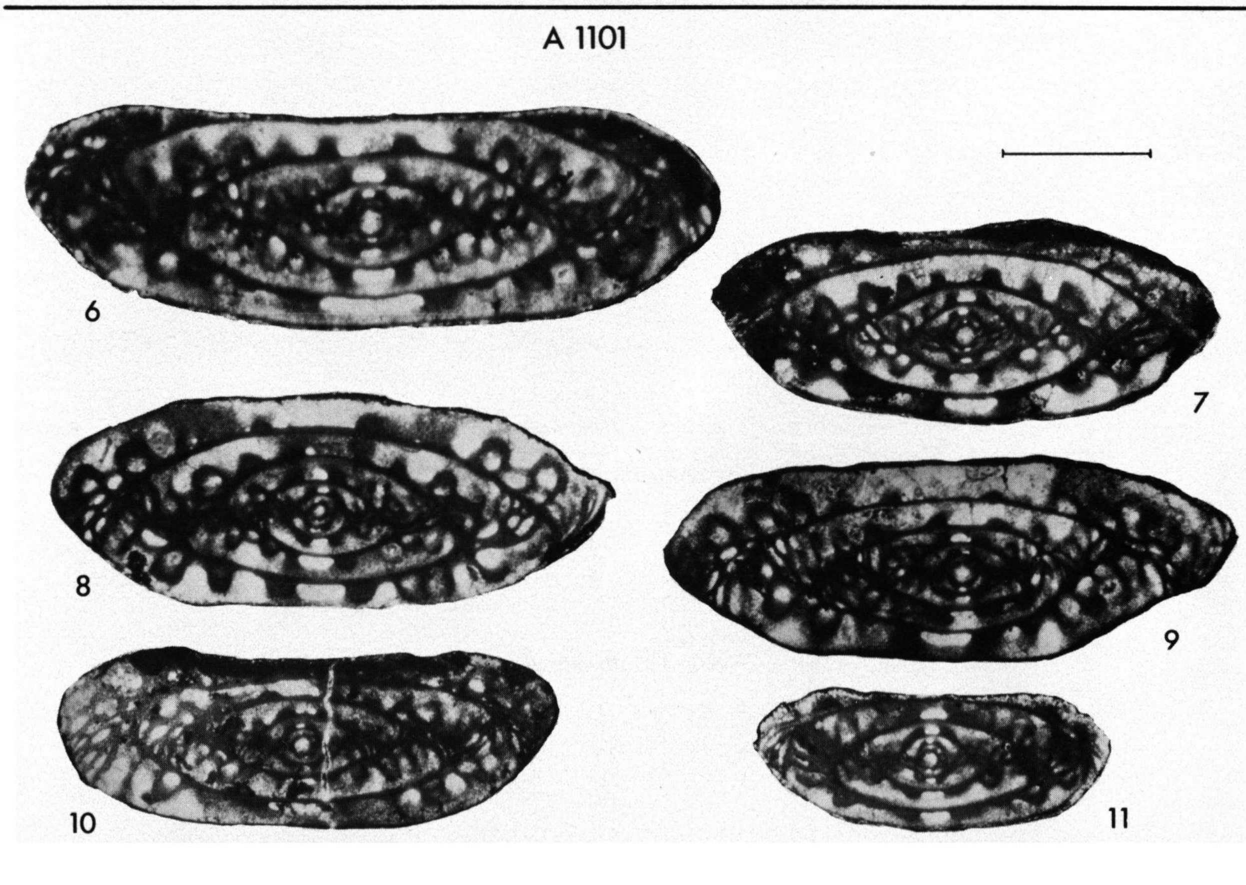

A 1101
6
7
8
9
10
11

PLATE V

All x 40

Loc. A 1028

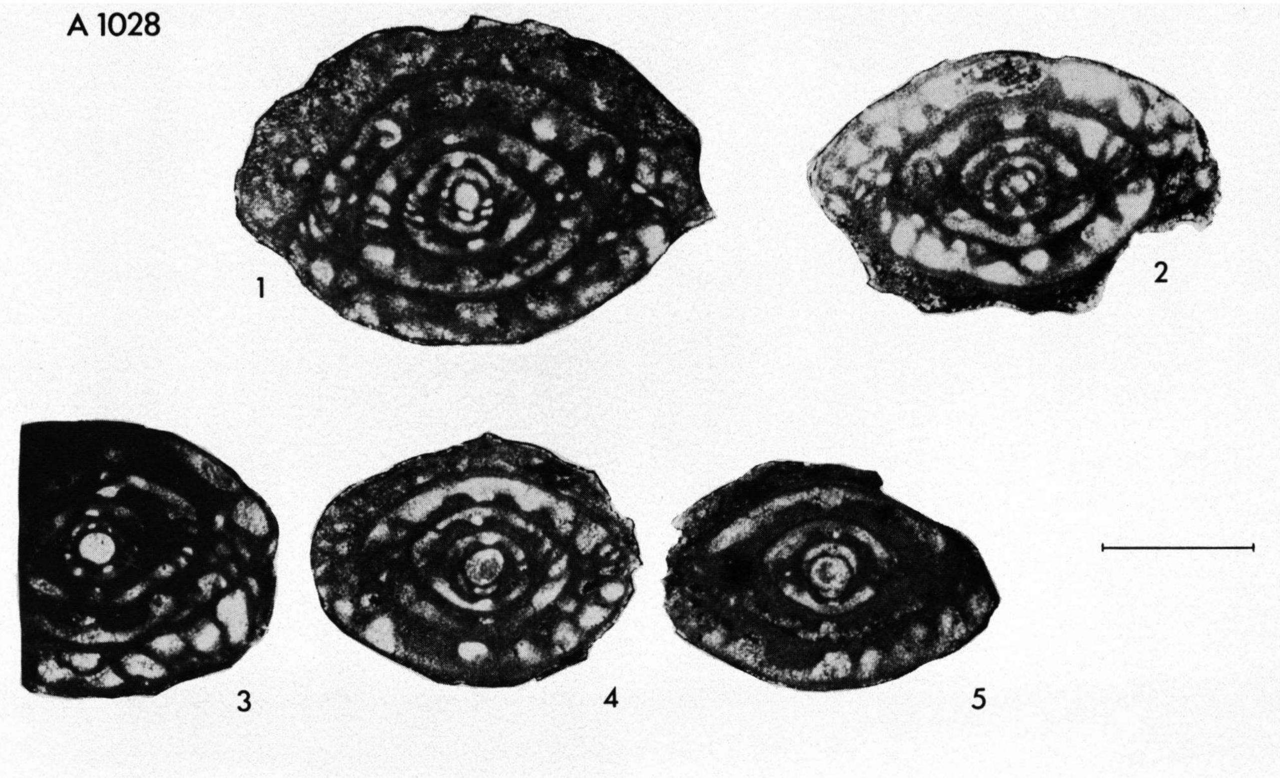
Figs. 1–5 *Hemifusulina* sp. 6 (cf. *H. dutkevichi* (Putrya) *pechorica* Rauser)

1, specimen	7
2,	17
3,	2
4,	1
5,	3

Loc. A 1093

Figs. 6–11 *Hemifusulina?* sp. 9

6, specimen	2
7,	21
8,	20
9,	18
10,	17
11,	19


A 1028
1
2
3
4
5


A 1093
6
7
8
9
10
11

PLATE VI

All x 40

Loc. A 1093

Figs. 1–3 *Hemifusulina* sp. 7 (cf. *H. mosquiterensis* n. sp.)

1,	specimen	1
2,		3
3,		22

Figs. 4, 5 *Hemifusulina* sp. 8 (probably the macrospheric generation of *H.* sp. 7)

4,	specimen	5
5,		4

Loc. A 1130

Figs. 6–14 *Hemifusulina* sp. 10 (cf. *H. Mosquiterensis* n. sp.)

6,	specimen	1
7,		4
8,		2
9,		3
10,		8
11,		16
12,		18
13,		11
14,		14

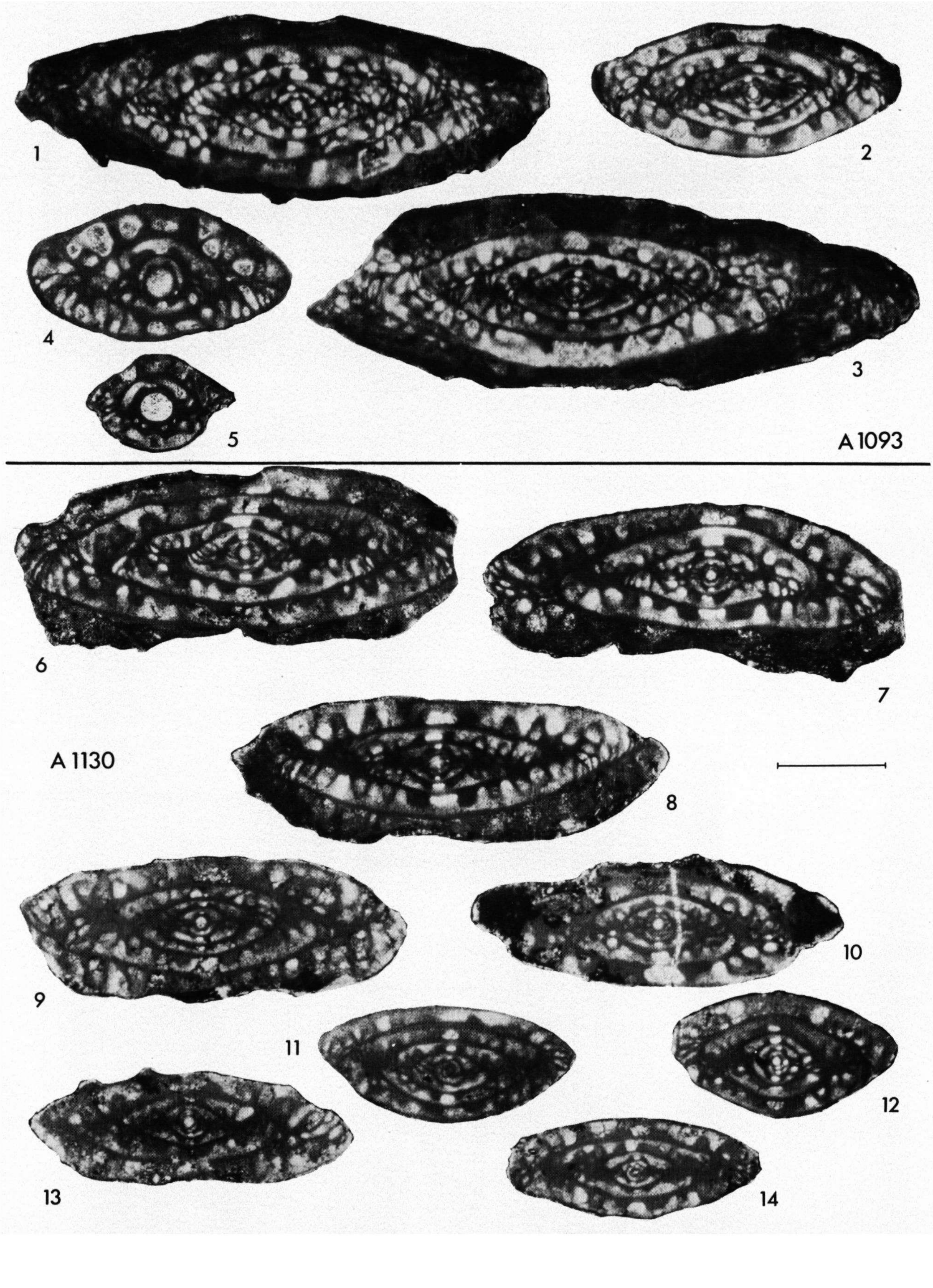

1
2
4
3
5
A 1093
6
7
A 1130
8
9
10
11
12
13
14

PLATE VII

All x 40

Loc. A 1130

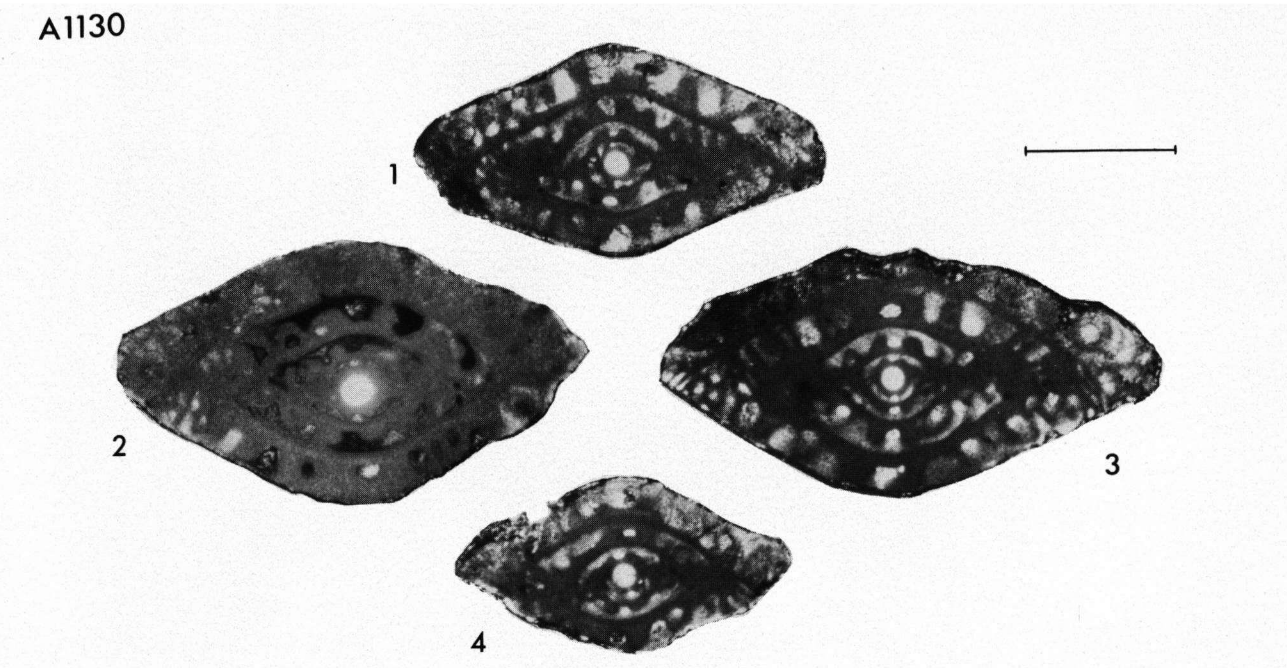
Figs. 1–4 *Hemifusulina* sp. 11 (possibly the macrospheric generation of *H.* sp. 10)

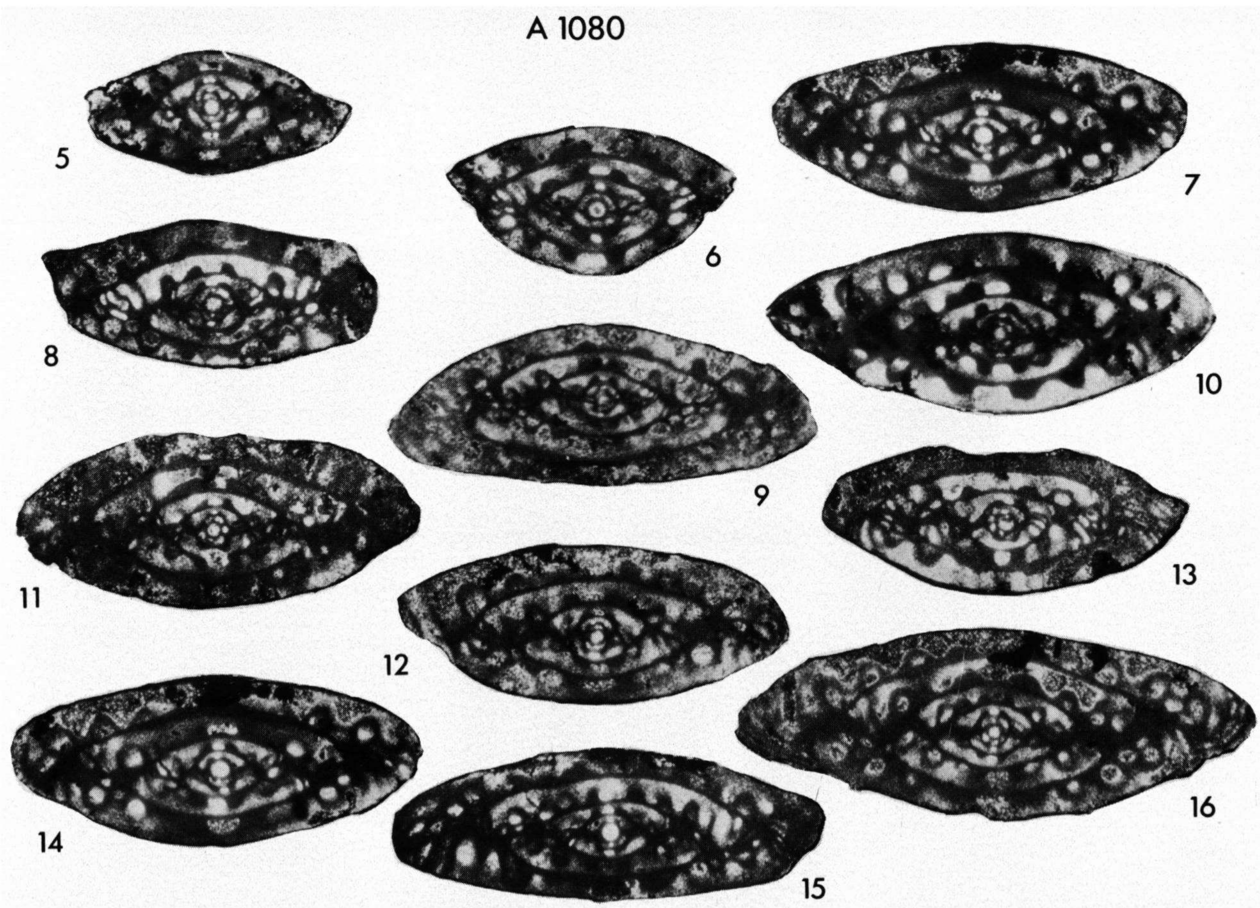
1,	specimen	6
2,		7
3,		5
4,		13

Loc. A 1080

Figs. 5–16 *Hemifusulina mosquiterensis* n. sp. (See also Pl. VIII, IX and X)

5,	specimen	21
6,		19
7,		16
8,		23
9,		35
10,		22
11,		36
12,		26
13,		31
14,		16
15,		25
16,		9


A1130
1
2
3
4


A 1080
5
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14
15
16

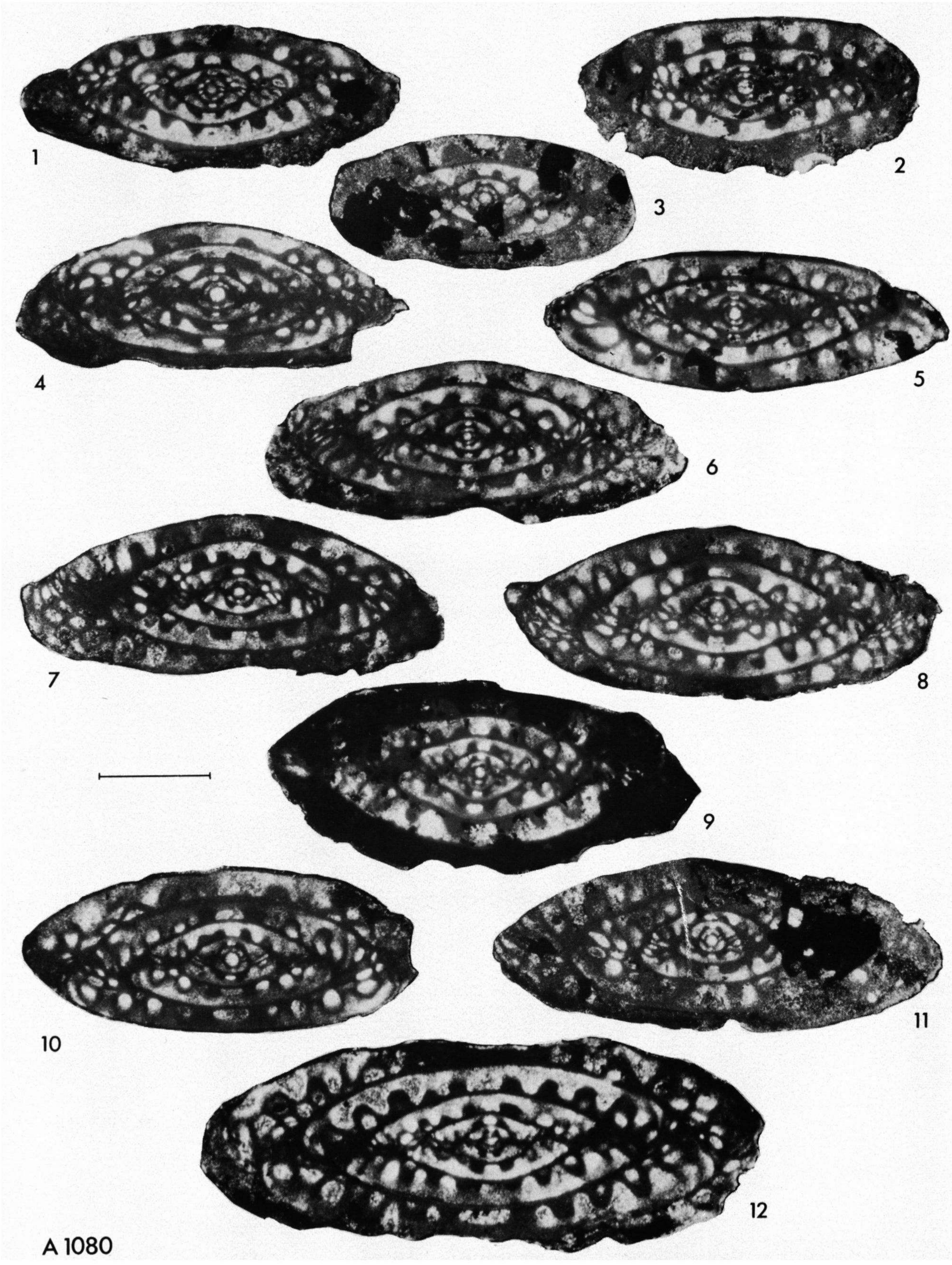
PLATE VIII

All x 40

Loc. A 1080

Figs. 1–12 *Hemifusulina mosquiterensis* n. sp. (See also Pl. VII, IX and X)

1, specimen	6
2,	13
3,	34
4,	4
5,	30
6,	27
7,	28
8,	5
9,	12
10,	29
11,	2
12,	32


1
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11
12
A 1080

PLATE IX

All x 40

Loc. A 1080

Figs. 1–6 *Hemifusulina mosquiterensis* n. sp. (See also Pl. VII, VIII and X)

1,	specimen	14
2,		18
3,		17
4,		33
5,		10
6,		8

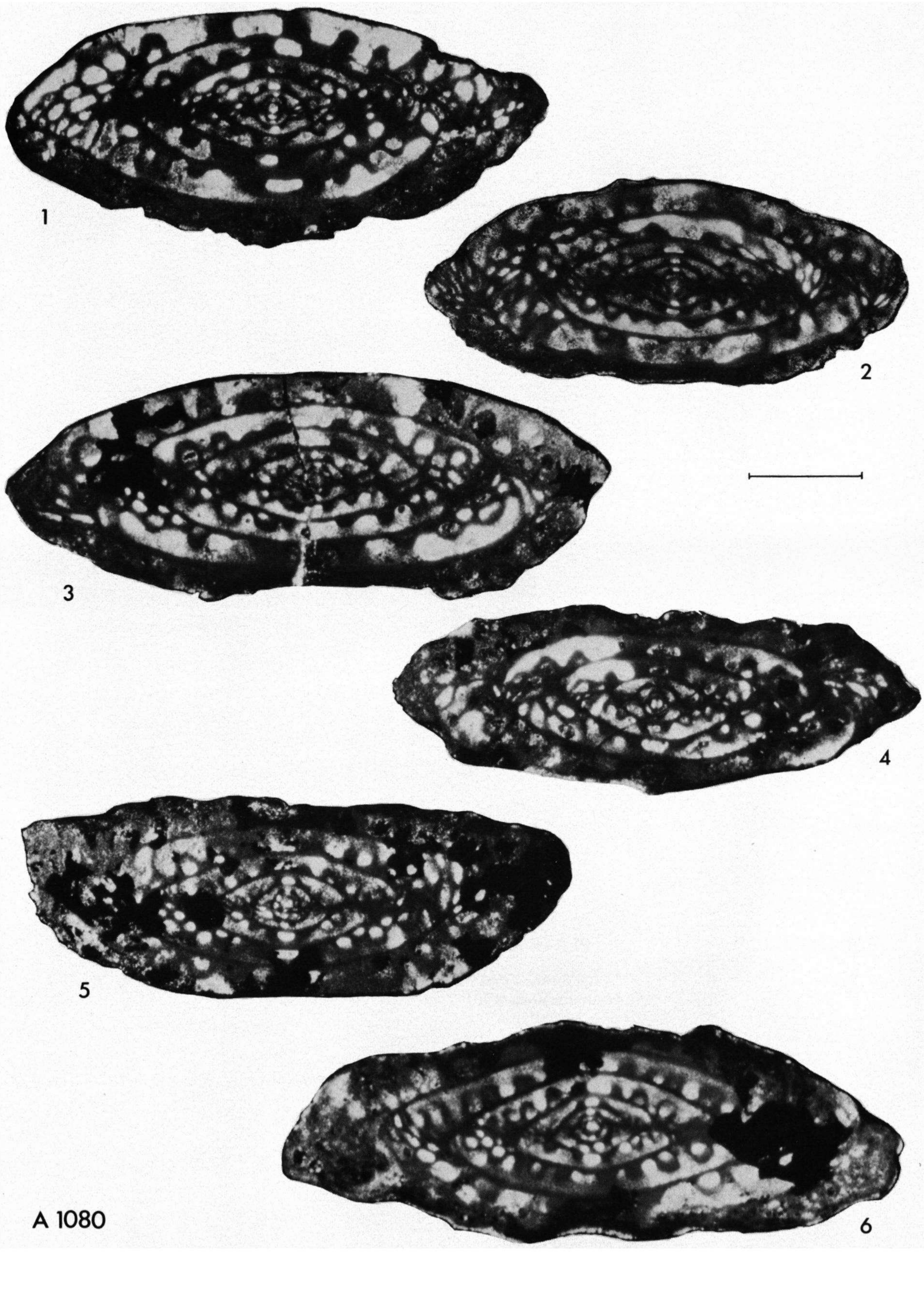

1
2
3
4
5
6
A 1080

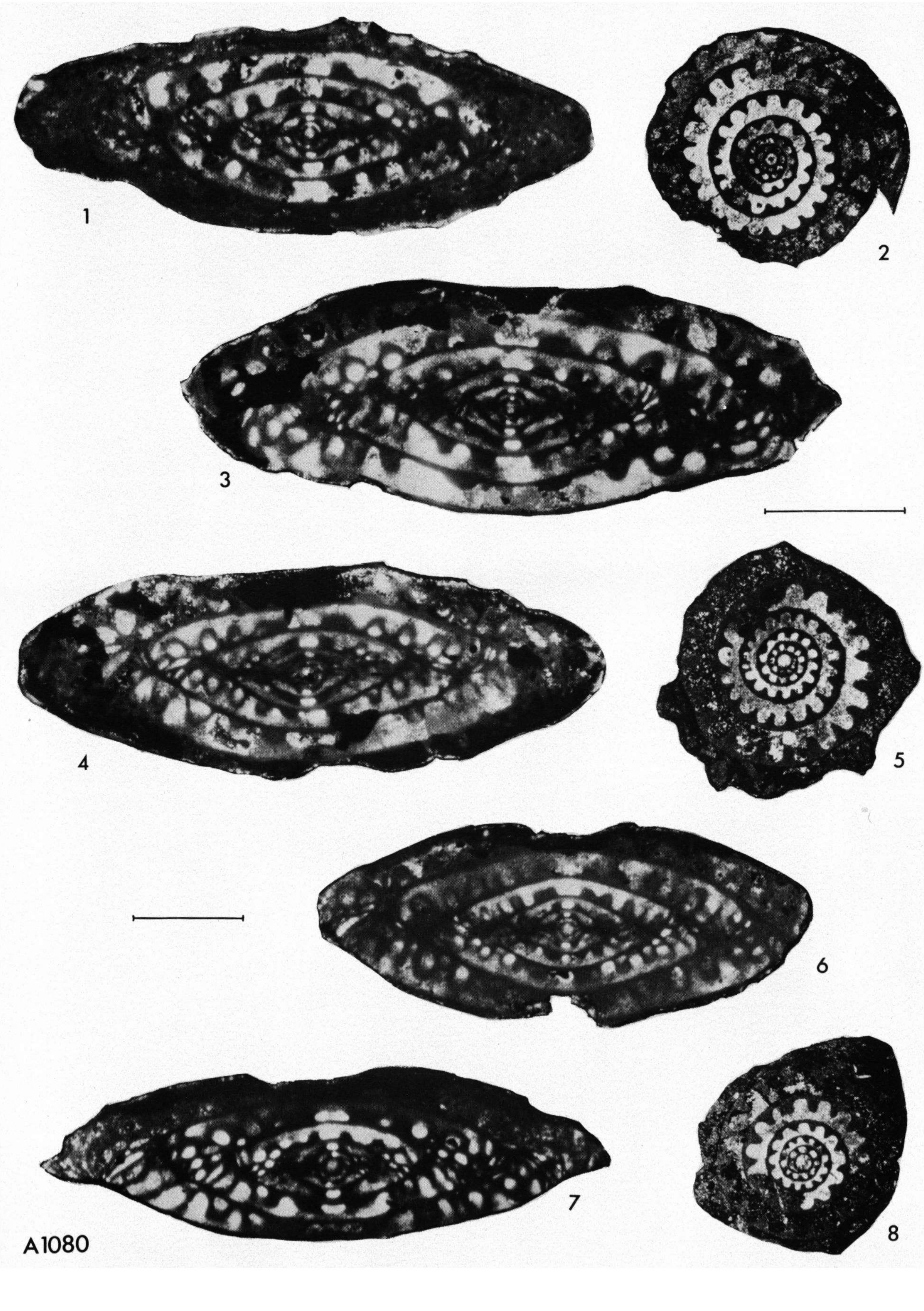
PLATE X

Axial sections x 40
Sagittal sections x 50

Loc. A 1080

Figs. 1–8 *Hemifusulina mosquiterensis* n. sp. (See also Pl. VII, VIII and IX)

	1, specimen	7
	2,	47, s.s.
t.sp.	3,	15
	4,	11
	5,	45, s.s.
	6,	3
	7,	24
	8,	46, s.s.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A1080