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Autor(en): **Masters, Bruce A.**

Objektyp: **Article**

Zeitschrift: **Eclogae Geologicae Helvetiae**

Band (Jahr): **73 (1980)**

Heft 1

PDF erstellt am: **21.09.2024**

Persistenter Link: <https://doi.org/10.5169/seals-164945>

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Reevaluation of selected types of EHRENBERG'S Cretaceous planktonic foraminifera

By BRUCE A. MASTERS¹⁾

ABSTRACT

A few of the many Cretaceous planktonic foraminifera named by EHRENBERG are still used by modern workers. The true nature of their surface morphology has never been clarified because EHRENBERG illustrated his taxa by transmitted light. The primary types of *Phanerostomum asperum*, *Textularia americana*, *Textularia globulosa* and *Textularia striata* are reevaluated herein and some are illustrated by topotypes. A neotype is selected for *T. striata*.

RÉSUMÉ

Quelques-uns des nombreux foraminifères crétacés et planctoniques nommés par EHRENBERG sont toujours employés par les spécialistes modernes. La vraie nature de la morphologie de leur surfaces n'a jamais été clarifiée parce que EHRENBERG a illustré ses taxa par la lumière transmise. Les types primaires des *Phanerostomum asperum*, *Textularia americana*, *Textularia globulosa* et *Textularia striata* sont évalués et quelques-uns sont illustrés par les topotypes. Un néotype est choisi pour le *T. striata*.

Introduction

CHRISTIAN GOTTFRIED EHRENBERG was one of Europe's most prominent micropaleontologists. He authored many new taxa of foraminifera and other microfossils. Unfortunately, EHRENBERG studied and illustrated the foraminifera by way of transmitted light. As a result most of his taxa cannot be related to modern species concepts and have been ignored, subsequently becoming nomina oblita. However, a few of his Cretaceous species have been used continually as senior synonyms.

Because of uncertainties regarding morphologies due to his method of illustration, a reevaluation of selected type specimens was undertaken in 1974. The EHRENBERG collections are housed in the Humboldt Museum in East Berlin under the curatorial care of Dr. Sigurd Locher.

The types are remarkably well preserved considering EHRENBERG'S preparation techniques. To process his material, EHRENBERG took a small piece of rock sample, crushed it, mixed the powder with water and made a strew preparation on a mica disc. After drying, he covered the strew with Canada Balsam. The muscovite discs measure 10-11 mm in diameter. These in turn are mounted on muscovite strip

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measuring about 80 mm long by 2–3 mm wide. Usually there are five discs per strip. Each described species is encircled by a colored paper ring. The strips are catalogued and carefully boxed so as to be retrievable. During the more or less 130 years of handling, a number of the discs have separated from the strips and have become mixed. In addition to the types, EHRENBURG'S notes and original drawings, many unpublished, are at the Museum.

The specimens illustrated herein have been extracted from the remaining bulk samples used by EHRENBURG. They are then precise topotypes. These specimens, along with those from Mississippi, are deposited in the collections of the U.S. National Museum, Washington, D.C.

Systematic descriptions

Order *Foraminiferida* ZBORZEWSKI, 1834

Superfamily *Globigerinacea* CARPENTER, PARKER & JONES, 1862

Family *Planomaliniidae* BOLLI, LOEBLICH & TAPPAN, 1957

Genus *Globigerinelloides* CUSHMAN & TEN DAM, 1948

Globigerinelloides asper (EHRENBURG)

(Fig. 1; Pl. 1, Fig. 1–5)

1854 *Phanerostomum asperum* EHRENBURG, p. 23, Pl. 30, Fig. 26b (? 26a; Pl. 32, group 1, Fig. 24; Pl. 32, group 2, Fig. 42).

1865 *Nonionina escheri* KAUFMANN, p. 198, Text-Fig. 110a–e.

Lectotype description. – Test planispiral, involute, consisting of 5½ to 6 chambers in the final whorl. Aperture appears to be an equatorial, moderately high arch bordered by a narrow lip. Surface strongly rugose. Maximum diameter: 0.11 mm, maximum thickness: 0.067 mm.

Remarks. – PESSAGNO (1967, p. 274, 275) hoped to stabilize the taxonomy of *Phanerostomum asperum* by selecting a lectotype. He chose the specimen represented by EHRENBURG'S Figures 26a, b. However, the Figures 26a and 26b represent two different specimens. The former is on Slide 9dbl (blue circle), and the latter is on Slide 1er (red circle). These are stored in Box 37, Book 11, and are represented by Drawing 2957.

Because the specimen in Figure 26a (Fig. 1a) cannot be oriented so as to prove that it is planispiral, it is recommended that the specimen illustrated by EHRENBURG'S Figure 26b (Fig. 1b) be treated as the lectotype. Figure 26a probably should not even be regarded as a paralectotype because of the uncertainty of its coiling. This side view does exhibit the characteristic outline, and it does *appear* to be planispiral. EHRENBURG'S original drawing of 26a is a more accurate representation than the published one which over-emphasized the rugosity.

The lectotype (Fig. 26b) is from Rügen, DDR. It is refigured here (Fig. 1c). The lectotype appears to have a strictly equatorial aperture. This is believed to be due to orientation only. Typical *Globigerinelloides* possess an umbilical-equatorial aper-

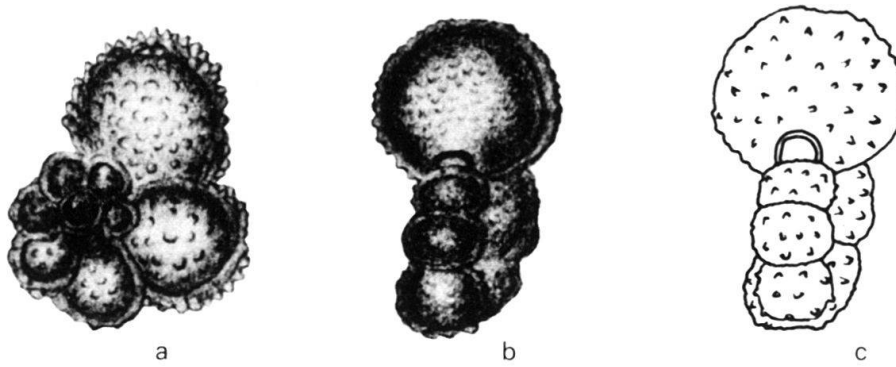


Fig. 1. *Phanerostomum asperum* EHRENBERG 1854 (= *Globigerinelloides asper*).

a-b = EHRENBERG'S original Figures 26a, b, respectively. *c* = Lectotype refigured: showing a higher aperture than originally figured; debris adhering to the right side of the penultimate and antipenultimate chambers has been omitted from the figure. $\times 175$.

ture. As with most other *Globigerinelloides*, *G. asper* has a late ontogenetic stage which develops paired supplementary apertures (Pl. 1, Fig. 2, 4).

Globigerinelloides escheri (*Nonionina escheri* KAUFMANN) is now regarded as a junior synonym of *G. asper*. For a more complete synonymy refer to MASTERS (1977, p. 409–412).

The topotypes from Rügen are associated with a nannoplankton assemblage of late Campanian to early Maastrichtian age.

Family *Heterohelicidae* CUSHMAN, 1927

Genus *Heterohelix* EHRENBERG, 1843

Heterohelix americana (EHRENBERG)

(Fig. 2; Pl. 1, Fig. 12; Pl. 2, Fig. 1–3, 6, 7)

1843 *Textilaria americana* EHRENBERG, p. 366, 398, 429.

1844 non *Spiroplecta americana* EHRENBERG, p. 75.

1854 *Textilaria americana* EHRENBERG, p. 24, Pl. 32 (group 1), Fig. 4a. [First illustration.]

1854 *Textilaria missouriensis* EHRENBERG, p. 24, Pl. 32 (group 1), Fig. 5.

1854 *Spiroplecta americana* EHRENBERG, p. 24, Pl. 32 (group 1), Fig. 13, 14 (non group 2, Fig. 25). [First illustration.]

1927b non *Spiroplecta americana* EHRENBERG. CUSHMAN, p. 190. [Designated genotype (= type species) of *Heterohelix*.]

Holotype description. – Test finely costate with an initial coil of three chambers followed by nine biserially arranged chambers. The two preceding the broken ultimate chamber are angular, with the penultimate appearing to have a laterally projecting short spine. A wide apertural flap is present. Maximum length: 0.189 mm, maximum width: 0.147 mm.

Remarks. – The holotype is housed in Box 23, Book 4, Slide 7d (white circle), and is represented by Drawing 2439. LOEBLICH & TAPPAN (1962, p. 353, 354) reviewed what was known of the type locality of *Textilaria americana*. Notes written in English which accompanied EHRENBERG'S drawing are as follows: "Calcareous

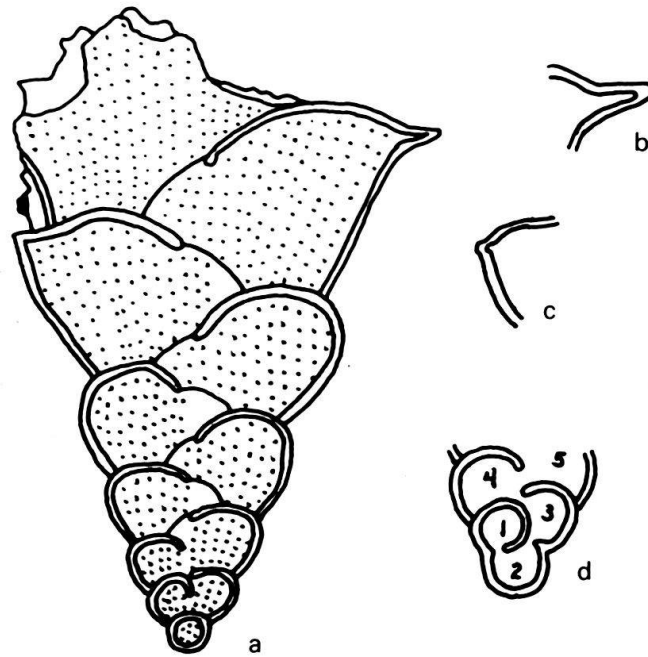


Fig. 2. *Textilaria americana* EHRENBERG 1843 (= *Heterohelix americana*).

a = Sketch of an unpublished EHRENBERG version of the holotype showing a larger imperforate area for some of the apertural flaps than in the published version (1854). *b-c* = Details of the shape of the penultimate and antipenultimate chambers, respectively, as observed on the holotype. *d* = An initial three-chambered coil occurs in the holotype. $\times 250$.

Marl with Polythalamia from a vast Cretaceous formation extending from near the mouth of the Sioux River (Upper Missouri) to near the Rocky Mountains, North America (Light gray material)", and then: "Received by EHRENBERG from BAILEY; missionaries collected the material, p. 187, Monatsberichte 1842 (1843)." This of course would have been J.W. Bailey of the U.S. Military Academy who supplied EHRENBERG with a number of samples. No more precise a location was given.

The holotype exhibits an initial planispiral coil (Fig. 2d) which EHRENBERG overlooked. Aside from that, his original (unpublished) drawing (Fig. 2a) is an accurate representation. This drawing is nearly identical to the published version (1854). The main difference being in the area of the imperforate apertural flap.

CUSHMAN (1927a, p. 215; 1938, p. 5) used the name *Textilaria americana* and reprinted EHRENBERG's later figures to bring them to the attention of the profession rather than as new applications of the name. In fact, CUSHMAN (1938, p. 3) had difficulty with some of EHRENBERG's species, including *T. americana*, in knowing exactly how to treat them in the taxonomy of his (CUSHMAN's) day. For this reason and because the taxon had not been treated elsewhere in modern literature as a senior synonym, I recommended (1977, p. 338, 339) that *T. americana* be regarded as a nomen oblitum. This has not been submitted formally to the Commission of Zoological Nomenclature. Such action now seems inappropriate because the name has been applied recently by FRERICHS & GASKILL (1978, p. 144) to specimens from South Dakota.

As a result of the resurrection of the species name *Textilaria americana* by FRERICHS & GASKILL (1978), and correctly noted by them, *Spiroplecta americana*

becomes a junior secondary homonym inasmuch as both forms are now treated as *Heterohelix*. CUSHMAN (1927b, p. 190) designated Figure 25 (EHRENBERG 1854) of *S. americana* as representing the "genotype" of *Heterohelix*. In turn, this must also then represent the lectotype of the species. As a junior homonym, the name *S. americana* must be rejected, and the first available name is *Heterohelix navarroensis* LOEBLICH.

The lectotype of *Spiroplecta americana* is missing from the EHRENBERG collections, but the two remaining illustrated specimens (Fig. 13, 14) were located. Both of these specimens, unlike the lectotype, are conspecific with *Textilaria americana*, and are located in Box 23, Book 4, and are represented by Drawing 2440. Figure 13, on Slide 7abl (blue circle), has five chambers in the initial coil. Its ultimate chamber is not acute as indicated by the figure; otherwise, it appears to be a less mature specimen. Figure 14, on Slide 4bbl (blue circle), has an initial coil of four chambers, and is more coarsely costate. This specimen measures 0.147 mm (max.) long by 0.112 mm (max.) wide.

The holotype of *Textilaria missouriensis* was examined also (Box 23, Book 4, Slide 8dbl [blue circle], Drawing 2439). It has nine chambers, the first three of which form a coil (Fig. 3b). The costae are very fine. Its maximum length and width are respectively: 0.140 mm and 0.133 mm.

Textilaria americana, *Spiroplecta americana* (excluding the lectotype) and *T. missouriensis* have the following features in common: (1) an initial planispiral coil, (2) laterally projecting spines on the last one to three chambers, (3) similar size, (4) apertural flaps, and (5) all come from the upper Missouri River basin. For these reasons they are regarded as conspecific.

The taxonomic history of *Heterohelix* has been presented by LOEBLICH (1951) and by FRERICHS & GASKILL (1978), but warrants review again because of necessary modifications of their conclusions. Briefly, EHRENBERG (1843) named *Textilaria americana* without illustration. Following the description of *T. americana*, he noted that some specimens possessed an initial coil for which he proposed the name *Heterohelix*. It would appear that he was restricting the totally biserial form to

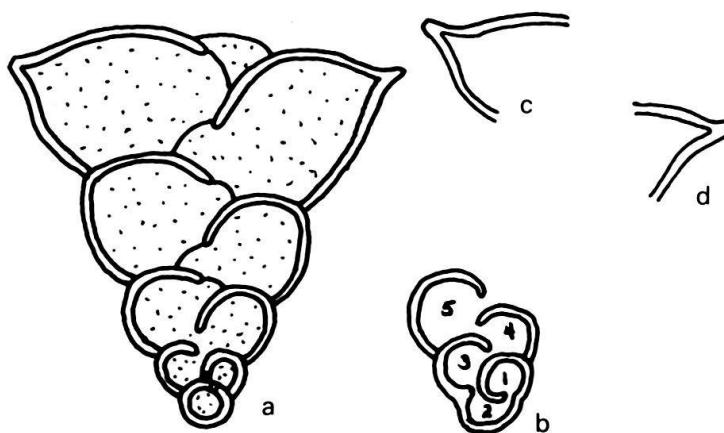


Fig. 3. *Textilaria missouriensis* EHRENBERG 1854 (= *Heterohelix americana*).

a = Type figure. *b* = The initial three-chambered coil in the holotype overlooked by EHRENBERG. *c-d* = Details of the ultimate and penultimate chambers, respectively, sketched from the holotype. $\times 250$.

T. americana and forms with a coil to some unnamed species of *Heterohelix*. This view is supported by the later published (1854) type figure of *T. americana* which was shown, although incorrectly, to be entirely biserial.

In 1844 EHRENBERG proposed the name *Spiroplecta* for those forms with an initial coil, forms which a year earlier he placed in *Heterohelix*. LOEBLICH (1951, p. 107) correctly concluded that *Spiroplecta* is a junior synonym of *Heterohelix*. EHRENBERG (1844) named *S. americana*, which was not illustrated until 1854. CUSHMAN (1927b, p. 190) selected EHRENBERG's Figure 25 of *S. americana* to be the "genotype" of *Heterohelix*.

LOEBLICH (1951, p. 107) placed the supposed fully biserial *Textularia americana* in the genus *Guembelina* and the planispiral-biserial *Spiroplecta americana* in *Heterohelix*. Now, however, *Guembelina* is regarded as a junior synonym of *Heterohelix* (MONTANARO GALLITELLI 1957, p. 137) with the resulting homonymy of *S. americana* with *T. americana*. Evidently because of this homonymy and such treatment by ELLIS & MESSINA (1940), FRERICHS & GASKILL (1978, p. 143, 144) believed that *T. americana* must then become the type species of *Heterohelix*, arguing also that it is the first species illustrated by EHRENBERG referable to this genus. This assumption is incorrect.

Spiroplecta americana is fixed as the type species of *Heterohelix* by subsequent designation (CUSHMAN 1927b) and cannot be changed. Subjective synonymies which result in homonyms, as in this case, do not alter primary designations. Otherwise the subjective interpretations of various authors could in some instances result in the type species for a genus periodically being changed. This conceivably could significantly alter the original type concept and create chaotic taxonomy. Furthermore, the designated type species of *Heterohelix* (Fig. 25 of *S. americana*) is not conspecific with *Textularia americana*. As recorded above, the lectotype of *S. americana* has been lost. The two remaining illustrated forms are herein synonymized with *T. americana*. Thus, a neotype for *S. americana* needs to be selected, preferably from EHRENBERG's original material because description of the type locality is too vague to be precisely relocated. This work is in progress.

Textularia americana has been recorded previously only once (FRERICHS & GASKILL 1978) since it was named, and this is from the "type" region in South Dakota. Specimens from the lower Mooreville Chalk of Mississippi are illustrated here, along with a similar but apparently unrelated form, which is probably aberrant. The lower Mooreville Chalk has been placed variously in the Santonian and in the early Campanian depending upon the group of organisms used for correlation.

Heterohelix globulosa (EHRENBERG)

(Pl. 1, Fig. 6-8)

1840 *Textularia globulosa* EHRENBERG, p. 135, Pl. 4, Fig. 2 β , 4 β , 5 β , 7 β (non 8 β).

Remarks. – The syntypic series published by EHRENBERG for *Textularia globulosa* represent one of his earliest attempts at illustrating foraminifers. The drawings are very schematic and impart little morphologic information. His type description is no better. Nevertheless, this name has been used in the literature more frequently than that of any other Cretaceous planktonic foraminifer.

PESSAGNO (1967, p. 260) designated the specimen represented by Figure 5 β as the lectotype of *Textularia globulosa*. The lectotype is in Box 33, Book 3 or 5, but unfortunately EHRENBURG did not indicate upon which mica slide nor the location on that slide the specimen is to be found. The slides were searched without success. It was simply not possible to relate the schematic drawing back to the specimen. The specimen is surely preserved, however, because the slides are intact. Thus, a neotype is not proposed.

A specimen of *Textularia globulosa* from Meudon, the same locality as the lectotype, was located (Box 33, Book 5, Slide 6cbl [blue circle], Drawing 2446, Fig. 4). The specimen fits the modern interpretation of the species. Topotypes taken from the same sample used by EHRENBURG are illustrated here. These will serve to establish the test morphology of this species.

The age of the associated nannoplankton is late Campanian.

Heterohelix striata (EHRENBURG)

(Pl. 1, Fig. 9-11)

1840 *Textularia striata* EHRENBURG, p. 135, Pl. 4, Fig. 1a-3a (? 9a).

Neotype description. – Test biserial, expanding moderately in width with a broadly rounded edge. Each chamber nearly equidimensional; eight chambers comprising the test increasing regularly in size; each slightly overlapping the one upon which it is constructed. Wall with small diameter pores located between coarse costae, which tend to be continuous over each chamber. Sutures moderately depressed, straight, angled slightly downward at the edge. Aperture interiomarginal, obscured but appears low. Maximum length: 0.27 mm, maximum width: 0.21 mm, maximum thickness: 0.09 mm.

Remarks. – Neither the lectotype (2a, designated by PESSAGNO 1967) of *Textularia striata* nor any of the remaining syntypes could be located in Box 34, Book 5 (Drawing 2453). The mica disc of the lectotype has separated from the strip and become mixed with other loose discs. Specimens on the slide containing those from Poland could not be matched to Figures 1a and 1a' because of the schematic nature of the drawings. However, all individuals on this slide have fine, closely spaced costae. So the species concept remained unclear. This necessitated the selection of a neotype. PESSAGNO (1967) designated Jutland as the type locality. According to EHRENBURG's notes, the locality of the lectotype is not Jutland, Denmark, but the island of Moen. This was reverified by S. Locher (correspondence, 1979) from EHRENBURG's Catalog I, which lists all the samples he ever investigated. The Jutland citation (EHRENBURG 1840, p. 145) is an error. The neotype has been taken from Moen (EHRENBURG sample No. 2344).

The associated nannoplankton correlate to the early Maastrichtian.

Acknowledgments

Sincere thanks are extended to Dr. Sigurd Locher, Humboldt Museum, East Berlin, DDR, for his generous assistance in making the Ehrenberg collections available for study. Dr. Frank R. Sullivan, Amoco, kindly provided age correlation data from the associated nannoplankton. Thanks are due to Dr.

Charles C. Smith, U.S. Geological Survey, Washington, D.C., and to Dr. Robert W. Scott, Amoco, for their critical evaluation of the manuscript, and to Amoco for permission to publish this paper. My wife, Shirley, translated EHRENBURG's notes and relevant papers.

REFERENCES

- CUSHMAN, J. A. (1927a): *The American Cretaceous Foraminifera figured by Ehrenberg*. - J. Paleont. 1/3, 213-217.
- (1927b): *The designation of some genotypes in the Foraminifera*. - Contr. Cushman Lab. foram. Res. 3/4, 188-190.
- (1938): *Cretaceous species of Gumbelina and related genera*. - Contr. Cushman Lab. foram. Res. 14/1, 2-28.
- EHRENBURG, C. G. (1840): *Die Bildung der europäischen, libyschen und arabischen Kreidefelsen und des Kreidemergels aus mikroskopischen Organismen*. - Abh. preuss. Akad. Wiss. Berlin (phys.-math. Kl.), 1-91.
- (1843): *Verbreitung und Einfluss des mikroskopischen Lebens in Süd- und Nord-Amerika*. - Abh. preuss. Akad. Wiss. Berlin (phys.-math. Kl.) (1841), pt. 1, 291-446.
- (1844): *Eine Mittheilung über 2 neue Lager von Gebirgsmassen aus Infusorien als Meeres-Absatz in Nord-Amerika und eine Vergleichung derselben mit den organischen Kreide-Gebilden in Europa und Afrika*. - Ber. k. preuss. Akad. Wiss. Berlin, 57-98.
- (1854): *Mikrogeologie. Das Erden und Felsen schaffende Wirken des unsichtbar kleinen selbständigen Lebens auf der Erde* (vol. 1, 1-374; vol. 2, 1-88; Atlas). - Leipzig.
- ELLIS, B. F., & MESSINA, A. R. (1940 et seq.): *Catalogue of Foraminifera*. - Amer. Mus. nat. Hist., New York.
- FRERICHS, W. E., & GASKILL, C. H. (1978): *Textilaria americana Ehrenberg: Type species of Heterohelix*. - J. foram. Res. 8/2, 143-146.
- KAUFMANN, F. J. (1865): *Die Zeit der Kreidebildung. A: Polythalamien des Seewerkalkes*. In: HEER, O.: *Die Urwelt der Schweiz* (p. 198). - Zürich.
- LOEBLICH, A. R., Jr. (1951): *Coiling in the Heterohelicidae*. - Contr. Cushman Found. foram. Res. 2, 106-110.
- LOEBLICH, A. R., Jr., & TAPPAN, H. (1962): *Type localities of some American Cretaceous foraminiferal genotype species described by Ehrenberg*. - J. Paleont. 36/2, 352-354.
- MASTERS, B. A. (1977): *Mesozoic planktonic foraminifera. A world-wide review and analysis*. In: RAMSAY, A. T. S. (Ed.): *Oceanic Micropalaeontology*. (vol. 1, p. 301-731). - Academic Press, New York/London.
- MONTANARO GALLITELLI, E. (1957): *A revision of the foraminiferal Family Heterohelicidae*. - Bull. U.S. natl. Mus. 215, 133-154.
- PESSAGNO, E. A., Jr. (1967): *Upper Cretaceous planktonic foraminifera from the Western Gulf Coastal Plain*. - Palaeontographica amer. 5/37, 245-445.

Plate 1

- Fig. 1-5 *Globigerinelloides asper* (EHRENBERG). $\times 268$. Topotypes. EHRENBERG sample No. 2404, Rügen, DDR.
- 1: Umbilical view. Ephebic individual (U.S.N.M. 244604).
 - 2: Umbilical view. Geronitic individual with paired apertures (U.S.N.M. 264605).
 - 3: Peripheral view. Single aperture (U.S.N.M. 264606).
 - 4: Peripheral view. Paired apertures (U.S.N.M. 264607).
 - 5: Umbilical view. Early ephebic individual (U.S.N.M. 264608).
- Fig. 6-8 *Heterohelix globulosa* (EHRENBERG). $\times 250$. Topotypes. EHRENBERG sample No. 2217, Meudon, France. Note fine, discontinuous costae.
- 6: Edge view (U.S.N.M. 264609).
 - 7: Side view (U.S.N.M. 264610).
 - 8: Side view (U.S.N.M. 264611).
- Fig. 9-11 *Heterohelix striata* (EHRENBERG). $\times 268$. EHRENBERG sample No. 2344, Moen, Sjaelland, Denmark.
- 9: Side view of topotype (U.S.N.M. 264613).
 - 10: Side view of neotype (U.S.N.M. 264612).
 - 11: Edge view of neotype (U.S.N.M. 264612).
- Fig. 12 *Heterohelix americana* (EHRENBERG). Selma Group, lower Mooreville Chalk, 65 ft above water level (51 ft above ledge-forming sandstone) at Plymouth Bluff on the Tombigbee River, Lowndes Co., Mississippi, USA. Sample 7291-2. Side view. Tubulospine not yet developed. Note large apertural flaps. $\times 268$ (U.S.N.M. 264615).



Plate 2

Fig. 1-3, 6-7 *Heterohelix americana* (EHRENBERG). Selma Group, lower Mooreville Chalk, 65 ft above water level (51 ft above ledge-forming sandstone) at Plymouth Bluff on the Tombigbee River, Lowndes Co., Mississippi. Sample 7291-2.

- 1: Side view. Tubulospine on ultimate chamber. $\times 268$ (U.S.N.M. 264614).
- 2: Side view. Same as Figure 1. Note spar calcite filling inside broken spine. $\times 1800$.
- 3: Edge view. Same as Figure 1. Note curve of costae around spine. $\times 1000$.
- 6: Edge view. Penultimate chamber with broken spine. Note curve of costae. Same as Figure 7. $\times 1800$.
- 7: Edge view. Initial end missing. $\times 268$ (U.S.N.M. 264616).

Fig. 4, 5 *Heterohelix* sp. Same locality as above. Probably an aberrant form unrelated to *H. americana*.

- 4: Side view. Same as Figure 5. $\times 890$.
- 5: Side view. Penultimate chamber projected into a spine. Note coarse costae. $\times 268$ (U.S.N.M. 264617).

