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Seven new taxa of late Tertiary freshwater diatoms are described from the Ogallala Formation of western Kansas, and observations on 2 previously recorded taxa are reported.
INDEX DESCRIPTORS: Diatoms, paleobotany, Ogallala Formation.

"Extending from Kansas and Colorado far into Nebraska there is a calcareous formation of late Tertiary age to which I wish to apply the distinctive name *Ogallala Formation*. It is a portion, if not the whole, of the deposit which in Kansas and southward has been called the "Mortar beds," "Tertiary grit," and other names. It has been regarded as a portion of the Loup Fork Formation. In its typical development the Ogallala Formation is a calcareous grit or soft limestone containing a greater or less amount of interbedded and intermixed clay and sand, with pebbles of various kinds sprinkled through it locally, and a basal bed of conglomerate at many localities. In places it merges into a light-colored sandy clay, generally containing much carbonate of lime in streaks or nodules. The pebbles it contains comprise many crystalline rocks, which appear to have come from the Rocky Mountains. These pebbles accumulate on the disintegrating surfaces of the Ogallala Formation, and they appear to have contributed largely to the gravel bed underlying the loess to the eastward."

It was with these words that Nelson Horatio Darton (1899) proposed the term Ogallala for the stratigraphically distinctive sediments that today form the surface of most of the Great Plains of North America. It is recognized as being continuous from the type locality near Ogallala station in western Nebraska, extending north and south through the Great Plains region for 800 miles (from South Dakota to the panhandle of Texas) and with a maximum extent of 300 miles from East to West (Frye, 1971) (Fig. 1). This widespread mantle "consists mainly of stream-laid sand, gravel, silt, and minor amounts of clay, all derived principally from the Rocky Mountains region. In places, the formation contains small deposits of volcanic ash, and locally there are important limestone beds and some erratic deposits of chert" (Smith, 1940). It rests with angular unconformity on older rocks of Permian to upper Cretaceous age and has a thickness which varies with the relief of the underlying topography.

Little information has been published concerning Tertiary nonmarine diatoms of the Great Plains. The first systematic study of a Tertiary nonmarine assemblage from this area was made by Andrews (1970). Numerous lists and counts appeared before that time (Cragin, 1891; Barbour, 1910; Wolle, 1889), with these high-lighted by a detailed floristic treatment of an assemblage of Pliocene diatoms from Wallace County, Kansas (Hanna, 1932). In addition to these, a number of diatoms "found in the fossil state" were included in Elmore's *The Diatoms of Nebraska* (Elmore, 1921).

In the present paper, seven taxa of late Tertiary freshwater diatoms from the Ogallala of western Kansas are described as new and observations on two previously recorded taxa are reported.

SITE DESCRIPTIONS AND METHOD OF STUDY

Diatom-bearing strata from three sites in Wallace County, one from Phillips County, and two from Ellis County, Kansas, are the source of material upon which systematic observations were made (Table 1). Due to the large amount of calcium carbonate, it is appropriate to call the rock a diatomaceous marl instead of diatomaceous earth. The largest single deposit is located on what was formerly known in the literature as the Marshall ranch. Samples from three separate locations (sites G, H, and I) were collected from this deposit. The diatomaceous marl outcrops on the south side of the North Fork of Smoky Hill River in Sections 10, 11, and 12, T. 11 S., R. 38 W., Wallace County, and extends into Sec. 7, T. 11 S., R. 37 W., Logan County. The total length of the exposures, interrupted in places by loess, is slightly more than 3 miles. The thickness of the bed ranges from 2-3 feet in the middle of Section 11, to 11 feet in the eastern part of this section. The average thickness from here to the easternmost exposure in Logan County is about 7 feet.

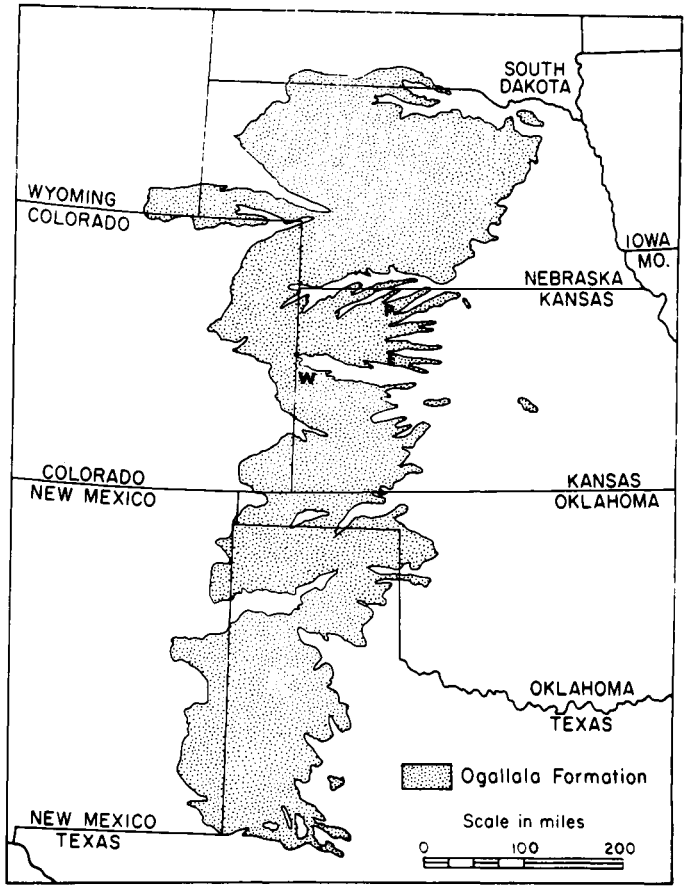

Fig. 1. *Generalized distribution of the Ogallala Formation (based on all available published maps), from Frye (1971). The approximate locations of the Wallace (W), Phillips (P), and Ellis (E) County sites are indicated.*

Table 1. *Location of each of the six sites*

Site	Location
A	Center W. line, Sec. 3, T. 12 S., R. 20 W., Ellis County
D	Center W. Line, Sec. 3, T. 12 S., R. 20 W., Ellis County
F	Center W. Line, Sec. 12, T. 2 S., R. 20 W., Phillips County
G	NE¼ Sec. 11, T. 11 S., R. 38 W., Wallace County
H	NW¼ Sec. 11, T. 11 S., R. 38 W., Wallace County
I	NE¼ Sec. 10, T. 11 S., R. 38 W., Wallace County

The single Phillips County location (site F) is a roadcut site approximately 75 miles east of the Marshall ranch deposits. The two Ellis County sites (sites A and D) are from opposite ends of a 300 foot roadcut exposure with a diatomaceous marl lentil averaging approximately 2 feet in thickness.

The diatomaceous marl exposed at each of the 6 sites was collected with the aid of a rock hammer and chisel and placed in a labeled bag for further preparation. In the laboratory, individual samples were dropped into beakers of concentrated HCl, out of which the insoluble siliceous material was allowed to settle for several days. The acid was decanted off and the sample was washed several times with distilled water. The cleaned sample was then filtered into a second beaker through 2 layers of cheesecloth and placed into labeled vials.

For preparation of slides, several drops of water containing the cleaned material were added to a clean 22 × 22mm coverslip, no. 1 thickness, and allowed to evaporate at room temperature. It was then inverted in a drop of Hyrax mounting medium on a glass slide. The slide was heated to evaporate the solvent, cooled, and labeled.

Photomicrographs of all taxa were made with a Leitz Ortholux microscope with attached Orthomat automatic camera. Kodak Panatomic-X film was used and subsequently developed according to standard photographic techniques.

A total of 203 taxa (representing 30 genera) were encountered during the course of this study (Selva, 1976). Seven of these are being described here as new.

TAXONOMIC SECTION

The following section is an alphabetical treatment of the 7 new taxa with previously unrecorded observations on two others. Following each citation is a reference to an illustration that can be found on subsequent pages of this work. All of the holotype slides are on deposit at the Academy of Natural Sciences in Philadelphia.

Amphora blaingraysia Selva sp. nov. Plate 1, Figures 1, 2

Valves with flatly to smoothly arched dorsal margin, becoming more or less concave toward the rostrate ends. Ventral margin slightly concave throughout. Axial area narrow. Central area well-developed on both the dorsal and ventral sides; dorsal side semi-circular, the ventral side broadly U-shaped. Raphe straight to slightly arched ventrally; no deflection in raphe ends is observed. Dorsal striae radiate, the central ones slightly farther apart then the others; punctate. Ventral striae radiate, becoming perpendicular to the ventral margin towards the ends; punctate. Dorsal striae 16-20 in 10μm at the center, 22-24 in 10μm at the ends. Ventral striae 20 in 10μm at the center, 22-24 in 10μm at the ends. Length of valve, 36-60μm. Breadth, 8-10μm.

This taxon resembles *Amphora subacutiuscula* Schoeman (1972, figs. 1, 3) in general appearance but differs markedly in the coarsely punctate nature of the striae and in the uninterrupted and perpendicular aspect of the ventral striae at mid-valve. The continuation of the ventral striae to the ends of the valve and the straight to slightly ventrally-arching raphe branches are also distinctive.

It was at first thought that this form may represent a post-auxospore stage of *Amphora katii* Selva (see below) but it was encountered frequently enough at Ellis County site A and Phillips County site F to suggest otherwise.

(Holotype — Selva Collection, Slide 9 #14, Site A).

Amphora doddii Selva sp. nov. Plate 1, Figure 3

Valves with smoothly convex dorsal margin throughout. Mid-ventral margin convex (tumid), becoming concave toward the narrow, ventrally-deflected rostrate ends. Axial area narrow. Central area evidenced by a subtle shortening of both the mid-dorsal and mid-ventral striae. Raphe filiform, straight to slightly arched ventrally; no deflection in raphe ends is observed. Dorsal striae radiate and delicate. Ventral striae a series of short dashes restricted to the tumid mid-valve section. Dorsal striae 22-24 in 10μm. Ventral striae 22 in 10μm. Length of valve 16-18μm. Breadth 3-4μm.

The distinctive crescent shape distinguishes this taxon from the more or less trapezoidal form of *Amphora huronensis* Stoermer and Yang (1971). Also, the ventral striae are not interrupted at mid-valve nor are the ends protracted, but instead narrow gradually.

It was recorded at rather low frequencies at sites A and D in Ellis County and site F in Phillips County. (Holotype — Selva Collection, slide 9 #11, Site A).

Amphora katii Selva sp. nov. Plate 1, Figures 7, 8, 9, 10.

Valves with smoothly to flatly-convex dorsal margin. Mid-ventral margin slightly convex, becoming more or less concave near the ventrally-deflected ends. Axial area narrow, broadening abruptly at mid valve around a conspicuous central nodule. Central area best expressed on the ventral side as a broad U-shaped interruption of mid-ventral striae; only slightly expressed dorsally as dorsal striae shorten at mid-valve. Raphe branches filiform and slightly sinuous. Dorsal striae radiate, the central ones slightly farther apart than the others; punctate. Ventral striae radiate, becoming perpendicular to the ventral margin towards the ends. Dorsal striae 20-22 in 10μ at the center, 24 in 10μm at the ends. Ventral striae 24-26 in 10μ. Length of valve 14-31μm. Breadth 3-6μm.

This same taxon was photographed by Hanna (1932; Plate XXXI, fig. 2) and incorrectly identified as *Amphora veneta* Kutz. It is similar in shape and general appearance to *A. veneta* (see Plate 14, Fig. 2, Patrick and Reimer, 1975) but can be distinguished by the central nodule and the shape of the central area which results, in part, from the unequal lengths of the ventral striae.

This taxon was well represented at Wallace County sites G and H but only infrequent at site I. (Holotype — Selva Collection, Slide I290 #4, Site I).

Amphora stroppiana Selva sp. nov. Plate 1, Figures 11, 12, 13.

Valves with smoothly to flatly-arched dorsal margin. Ventral margin straight to slightly convex at mid-valve. Ends abruptly protracted, capitate. Axial area broadening toward midvalve. Central area not well expressed. Raphe branches straight to slightly dorsally-arching and oriented on the dorsal side of the axial area; no deflection of raphe ends is observed. Dorsal striae slightly radiate, the central ones frequently disrupted and slightly farther apart then the others; punctate. Ventral striae short marginal dashes restricted to the convex midvalve section.

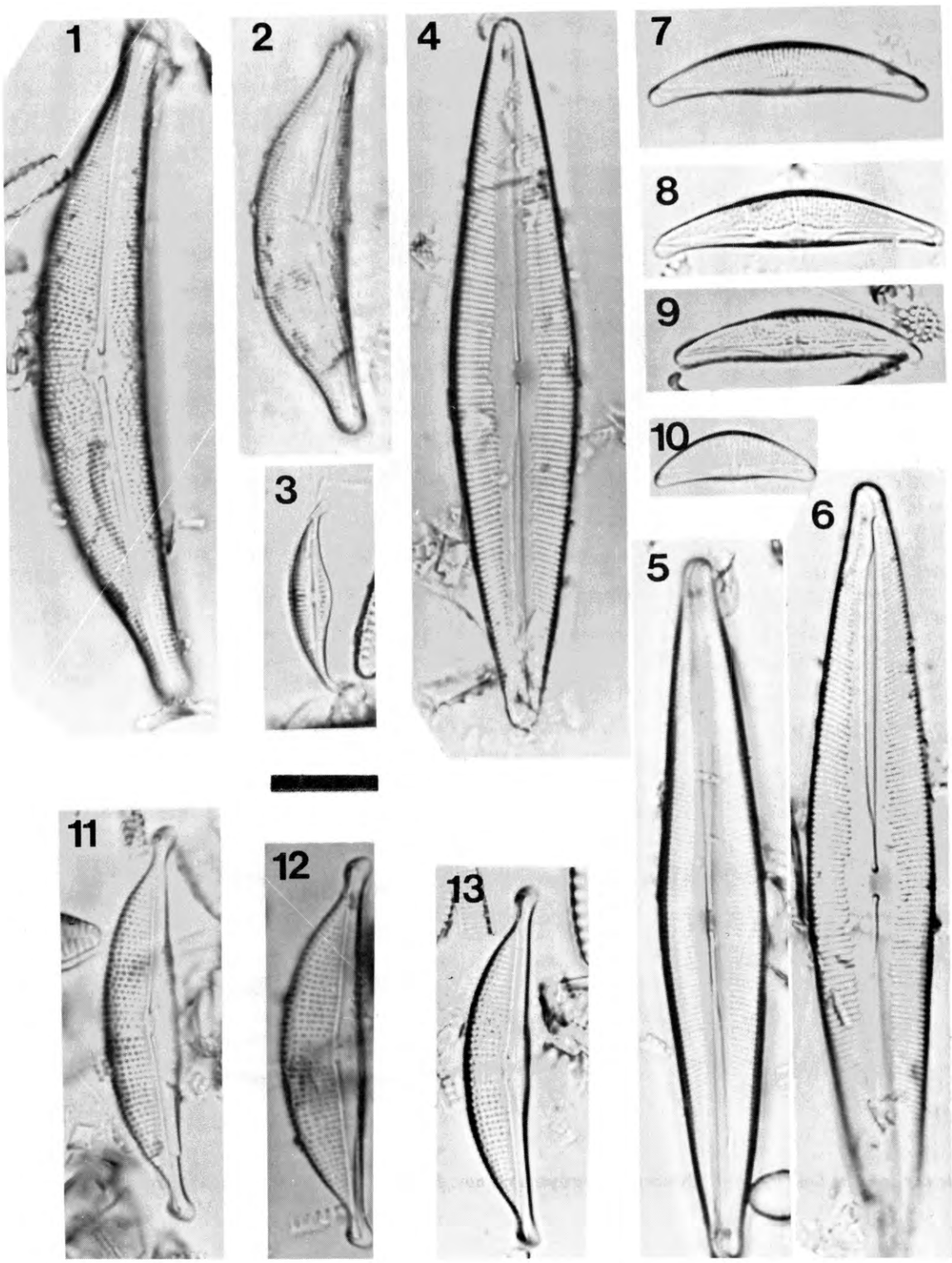

Plate I. *Scale bar is 10μm long. Fig. 1, 2.* Amphora blaingraysia *sp. nov. Fig. 3.* Amphora doddii *sp. nov. Fig. 4-6.* Cymbella cesatii *f.* schreinfrankii *fo. nov. Fig. 7-10.* Amphora katii *sp. nov. Fig. 11-13.* Amphora stroppiana *sp. nov.*

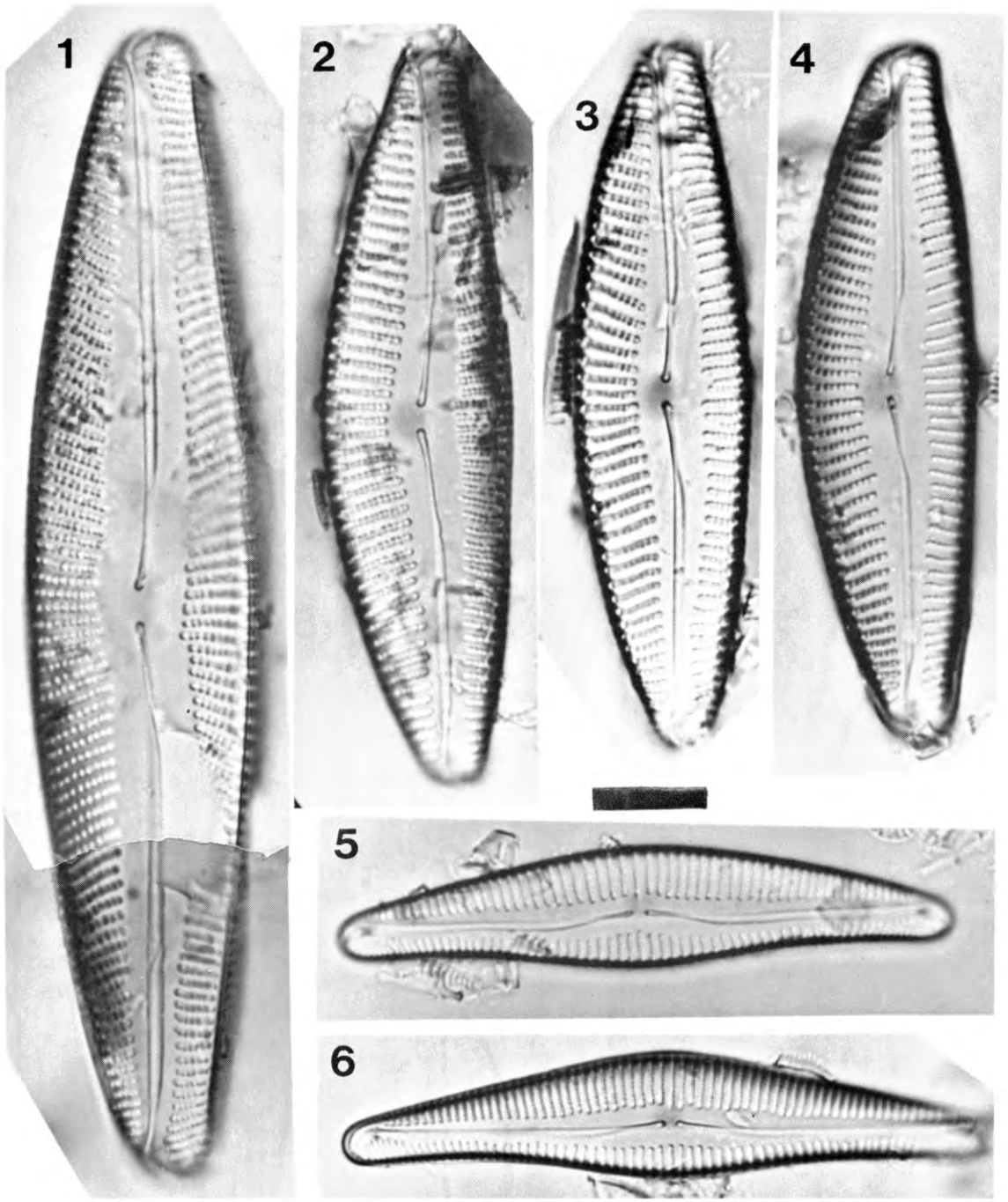

Plate II. *Scale bar is 10μm long Fig. 1-4.* Cymbella antogaryana *sp. nov. Fig. 5, 6.* Cymbella marcinia *sp. nov.*

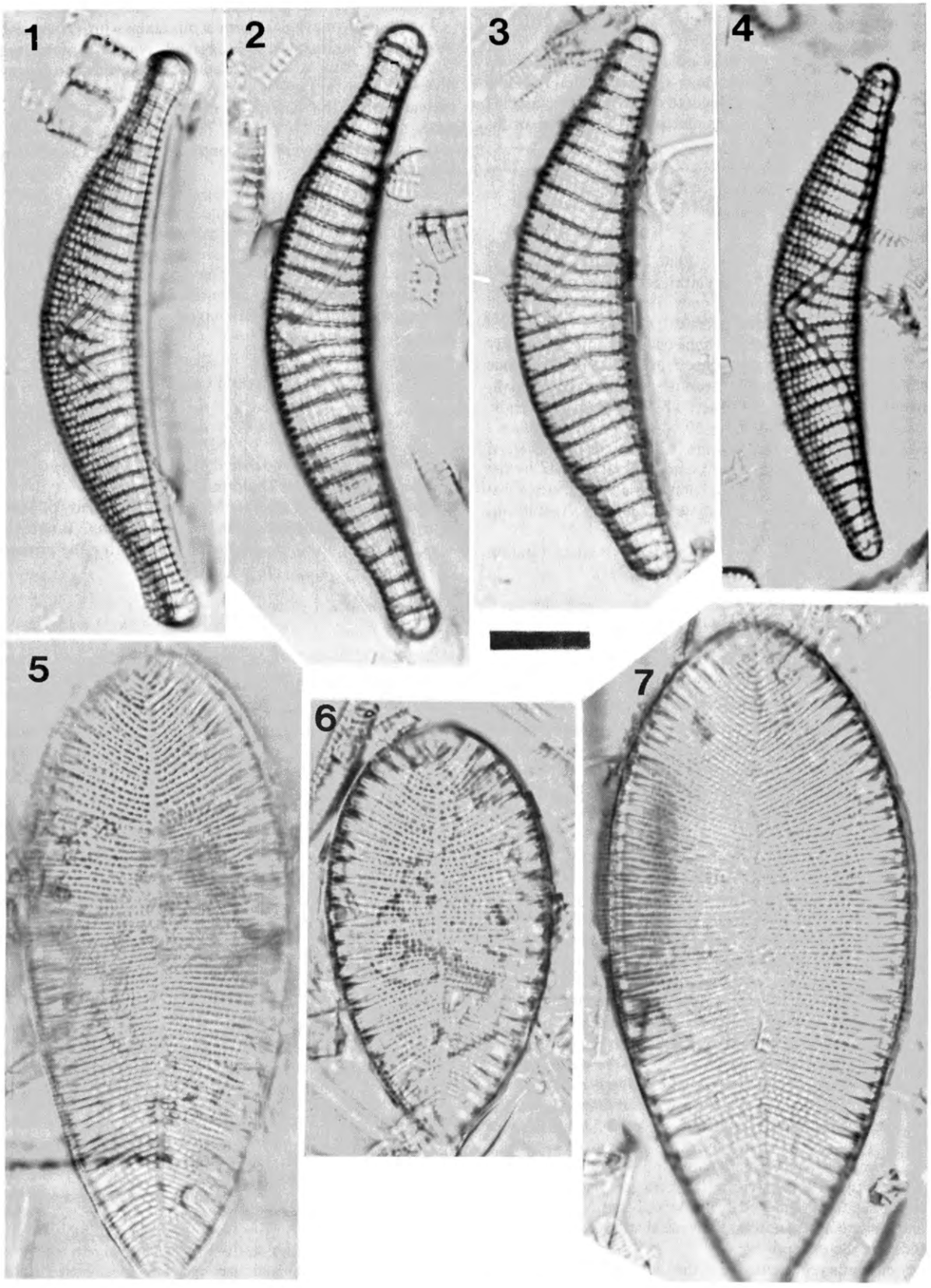

Plate III. *Scale bar is 10μm long. Fig. 1-4.* Epithemia sorex *var.* gracilis *Hust. Fig. 5-7.* Surirella ovalis *Brebisson.*

Dorsal striae 16 in 10μm at the center, 18-20 in 10μm at the ends. Ventral striae 24-26 in 10μm. Length of valve 33-36μm. Breadth 5-7μm.

This taxon is similar to the invalidly published *Amphora sydowii* Cholnoky (1963, fig 5), a species for which a nomenclatural type was never designated. It is distinct in the straight to slightly dorsally-arching proximal raphe branches and in the uninterrupted occurrence of the ventral striae through the central area.

It was observed in very low numbers at scattered levels of Ellis County site A, Phillips County site F, and Wallace County site G. (Holotype — Selva Collection, Slide 9 #14, Site A).

Cymbella antogaryana Selva sp. nov. Plate 2, Figures 1, 2, 3, 4.

Valves slightly to moderately dorsi-ventral, asymmetrically lanceolate, tapering smoothly to sub-truncate ends. Axial area rather broad and slightly arched, tapering near the ends. Central area not well expressed. Raphe lateral, the proximal raphe ends filiform and slightly deflected dorsally; distal ends comma-shaped, curving ventrally. Striae radiate except at the ends where they become parallel to convergent; punctate. Striae 7-10 in 10μm at the center, 10-12 in 10μm at the ends. Punctae 16-18 in 10μm. Length of valve 59-94μm. Breadth 14-19μm.

This taxon is similar in general appearance to *Cymbella austriaca* Grun. (See Fig. 647 Hustedt, 1930) but can be distinguished by the ventrally-deflected distal raphe ends, the dorsal and ventral striae that become parallel to convergent towards the ends, and the slight development of the ends.

It was encountered very infrequently at site H in Wallace County. (Holotype — Selva Collection, Slide HO #2, Site H).

Cymbella cesatii forma *schreinfrankii* Selva fo. nov. Plate 1, Figures 4, 5, 6.

Very few intermediates between this larger form and the nominate variety (See Plate 3, Figs. 1, 2, Patrick and Reimer, 1975) were observed in the material being studied. In addition to its larger size, it can be distinguished by the proportionately broader mid-valve, the wider axial space, and the less defined ends. Other features as in the nominate variety.

It was frequently observed at Ellis County sites A and D, Phillips County site F, and Wallace County site H. (Holotype — Selva Collection, Slide HO #3, Site H).

Cymbella marcinia Selva sp. nov. Plate 2, Figures 5, 6.

Valves moderately to strongly dorsi-ventral, gradually tapering to somewhat bluntly rounded ends. Dorsal margin low-arched. Ventral margin slightly concave except at midvalve where it is tumid. Axial and central areas uniting into an axial space which broadens somewhat toward midvalve. Raphe lateral, becoming filiform near the proximal and distal ends. Proximal raphe ends slightly deflected dorsally; distal ends ventrally deflected. Dorsal striae parallel to radiate to convergent at the ends; central dorsal striae terminating with a tiny stigma. Ventral striae appearing somewhat undulate with those at the center mostly parallel to slightly radiate, becoming strongly convergent toward the ends; punctate. Striae 10-12 in 10μm at the center, 18-20 in 10μm at the ends. Punctae, ca. 20 in 10μm. Length of valve 42-52μm. Breadth 9-11μm.

This taxon resembles a specimen appearing in Schmidt's Atlas (1874, Table 71, Figure 46) which he characterizes as questionable ("fraglich"). It can be distinguished by the dorsally deflected proximal raphe ends and the undulate nature of the ventral striae which crests at mid-valve and near the ends.

It was a very common representative of the samples from sites H and I in Wallace County. (Holotype — Selva Collection, Slide HO #3, Site H).

Epithemia sorex var. *gracilis* Hust. Plate 3, Figures 1, 2, 3, 4.

In addition to the typical form of this taxon with its more rostrate ends (see Fig. 737 in Hustedt, 1930; Plate 3, Figs. 3, 4 in the present text), numerous specimens with subcapitate ends were also observed in this material (Plate 3, Figs. 1, 2). As all other features are as the more typical form of the variety, no new designation is being made at this time.

It was recorded very frequently at the Ellis County and Phillips County sites.

Surirella ovalis Brebisson Plate 3, Figures 5, 6, 7.

The coarser nature of the punctate striae is in marked contrast to the more typical form of this taxon (See Fig. 860, Hustedt, 1930), but it is suggested that this distinction is merely the result of the coalescence of smaller punctae in the fossilization process. All other features are as the more typical form and no new taxon is being designated.

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