





Collaboration with the scientific authorities is especially important and it will be a great accomplishment indeed when young Ecuadorian scientists study together with foreign specialists in our Station, a real international crossroad.

Moreover, we hope that the Ecuadorian government will consult with the Foundation in matters concerning the conservation of nature in Galápagos. All legal measures must be taken by Ecuador, for it is not our intention to interfere in any manner whatsoever with its sovereignty. We are willing, however, to answer official requests for advice, on the basis of scientific investigations made under Foundation auspices.

Our Foundation is probably unique in its class. It is an international institution whose aim is to advance our scientific knowledge specifically in the Galápagos region and to conserve the remarkable biota inhabiting it. The evolutionary theories of Charles Darwin, which belong to mankind as a whole, completely justify such an organization. On the other hand, the invaluable natural inheritance of Galápagos wildlife was threatened by men of all nationalities; it is logical, therefore, that scientists and conservationists from all nations collaborate with the Ecuadorians to study and save what is left of these islands for the benefit of generations to come.

OCCASIONAL PAPERS
OF THE
California Academy of Sciences

No. 45, 27 pages, 5 plates.

July 1, 1964

SOME FOSSIL DIATOMS FROM BARBADOS

By

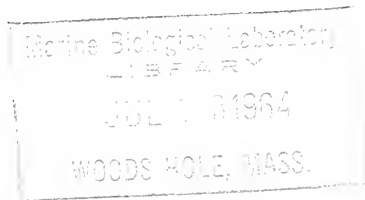
G Dallas Hanna

California Academy of Sciences

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The island of Barbados has attracted the attention of geologists and paleontologists for many years because of the existence there of a thick series of marine sediments known as the "Oceanic beds" or lately the "Oceanic formation." This name was selected because of the presence of Radiolaria in large numbers at several localities. The abundance of these organisms was thought to indicate deep water or "oceanic" deposition, a conclusion, however, which does not necessarily follow.

A very extensive literature exists on the geology of the island. No attempt will be made here to review it but reference to a few important titles seems necessary. The first extensive history of the island was by Schomburgh (1847) and the first description of the geology in detail was by Jukes-Browne and Harrison (1891, 1892). Schuchert (1935) gave an extensive account of the interrelationships of the various Caribbean islands and lately there have appeared numerous papers on various aspects of the geology of Barbados. Thus Senn (1940) discussed the various formations exposed on the island together with age determinations. He also gave the bases for the age determinations assigned and a bibliography of 95 titles. The Oceanic formation was believed, on good paleontological evidence derived from Foraminifera, to be of upper Eocene and lower Oligocene age.

Strange to say, geologists have given almost no notice to the extensive literature on the diatoms and radiolarians which have been described from these early Tertiary sediments. In fact, it would seem from the review made in connection with the present paper that the existence of this paleontological literature was unknown.

Ehrenberg did much work on the Radiolaria of Barbados material and published extensive papers. The last one (1875 [1876]) contains a recapitulation of his studies and 30 plates with illustrations of over 200 species of these siliceous organisms.

More than 100 species of diatoms have been found in the sediments and these are scattered through scores of publications. The importance of the deposits from this standpoint was first brought out through the publications of R. K. Greville (1861-1866). Some of his material was furnished to him by other diatomists but he described and illustrated the species in a series of 20 papers numbered serially and entitled: "Descriptions of new and rare diatoms." The Barbados species were included with others from various localities. Most of Greville's species and a very large number of additional ones have been described subsequently by many authors. This followed because of the rarity of early Tertiary diatoms and the demand for material by microscopists from near and far. Unfortunately, early collectors of such materials did not keep very accurate records of localities, certainly not sufficiently exact to serve the needs of modern geologists. And apparently not knowing of the existence of the published records, geologists of late have had no incentive to try to determine where the original collections were obtained.

There are several papers which are based entirely or almost entirely on Barbados diatom material. Greville (1862) published a paper "On the *Asterolamprae* of the Barbados deposit." Payne (1922) wrote a long account of *Lio-stephania* which certainly bears some resemblance to *Asterolampra*. Bergon (1892) monographed the genus *Entogonia* which is largely confined to the Barbados deposits. And the most beautiful illustrations of Barbados diatoms are those of Laporte and Lefébure (1929, 1930).

The late J. H. Robinson devoted much time and labor in an effort to relocate some of the famous localities on the island. As a result he published four papers (1934-1937) in the Journal of the Barbados Museum and Historical Society in which he described some of the localities in detail. In three of these papers he gave long lists of species which had been identified from his samples. Some of the identifications were by Robert Hagelstein and others by Frederick Adams.

The material upon which the present study is based was provided by Mr. Robinson. The sample which furnished the best preserved specimens came from "Joe's River," a locality which has not previously appeared in diatom literature to any great extent. This may be the chief reason why some unde-

scribed species were found although many hours of search was a contributing factor.

In 1958 Casier published a paper on the fossil fishes of Barbados and Trinidad islands. In this he gave a table of formations on Barbados, adapted in large part from Senn (1940, pp. 1578-1582). This table shows the "Joe's River clays" to be upper Eocene in age. The sediments immediately below this are referred to the "Scotland formation" which contains some names more or less familiar to diatomists. Thus, here we have "Chalky Mount," "Mount Hillaby," etc. Sediments below the Scotland formation are referred to as "from above Cambridge," but whether this has any bearing on the location of the famous "Cambridge Estate" diatom locality is not certain.

DESCRIPTIONS AND NOTES ON SPECIES

Actinoptychus hillabyanus Brun.

(Plate 1, figures 1, 2.)

Frustule circular with a narrow marginal band; each valve divided into six segments, adjacent ones differing in elevation only slightly; each segment has a very small nodule in the center at the margin and with a short radial blank line. One valve has discrete beads closely set in the marginal area but thinning toward a large blank central area, the beads being arranged in random order. The other valve is much more densely covered with the same size of beads; these are arranged in diagonal rows from the center of each segment the central blank area is smaller on this valve than on the other. Diameter, .116 mm.

HOLOTYPE (two valves of same frustule) no. 3508 (Calif. Acad. Sci., Geol. Dept. Type Coll.) from Joe's River, Barbados, West Indies. Eocene.

It is not often that the two valves of a single frustule of a fossil diatom can be obtained with certainty and in this case it is noteworthy that they are quite different.

Brun described this species from Barbados (1896, p. 230) and his illustrations do not differ significantly from ours. There does not seem to be a trace of secondary structure such as appears so frequently in members of the genus *Actinoptychus*.

Aulacodiscus behani Hanna and Brigger, new species

(Plate 1, figure 6.)

Valve circular with five robust, blunt, conical spines; spaces between the spines slightly depressed, .0015 mm. Surface marked with fine irregularly

spaced bars producing a blotchy appearance between the spines but having a radial arrangement in the center. Most of these bars can be resolved into fine dots with sufficient magnification, aperture, and oblique light. Diameter, .0756 mm.

HOLOTYPE no. 3509 (Calif. Acad. Sci., Geol. Dept. Type Coll.), from Joe's River, Barbados, West Indies. Eocene.

The species is named for the late Richard N. Behan of San Francisco, who assembled a considerable collection of diatoms which is now a part of the collection of the California Academy of Sciences.

Aulacodiscus currus Hanna and Brigger, new species.

(Plate 1, figure 5.)

Valve circular with five blunt spines set in large ocelli-like spaces; from each of these marginal spines a blank space extends radially inward to a small blank central area; surface covered with closely spaced small round dots arranged in radial rows; these are interrupted a little more than a third of the way to the center by a narrow clear circle with dots heavier along it. Diameter, .0914 mm.

HOLOTYPE no. 3510 (Calif. Acad. Sci., Geol. Dept. Type Coll.) from Conset, Barbados, West Indies. Eocene.

The inner conspicuous circle, set as if to reinforce the spokes of a wheel, seems to set this diatom apart from other *Aulacodiscus*.

Aulacodiscus angulatus Greville.

(Plate 1, figure 3; plate 5, figure 7.)

This beautiful diatom usually has five spines with a sharp radial ridge extending from each toward but not to the center. The spines are low, .004 mm. high. Spaces between the radial ridges are gently concave but on the whole the disk is relatively flat. Markings consist of discrete radial rows of beads with the central circular area set apart and with a small blank area in the center. Diameter (pl. 1, fig.3), .117 mm.

HYPOTYPES nos. 3511, 3512 (Calif. Acad. Sci., Geol. Dept. Type Coll.), from Joe's River, Barbados, West Indies. Eocene.

Another specimen in the collection from the same locality has the spaces between the radial ridges more deeply concave and the size of the beads is slightly smaller than in the one described above.

Laporte and Lefébure (1929) illustrated a specimen, which may be this diatom, from Oamaru, New Zealand. It has only four radial ridges and the one on our plate 5 has six.

***Aulacodiscus hirtus* Barker and Meakin.**

(Plate 2, figure 1.)

Aulacodiscus hirtus BARKER AND MEAKIN, 19??. Journ. Quekett Micr. Club, ser. 4, vol. 2, no. 6, p. 301, pl. 37, fig. 1. SCHMIDT, 1874. Atlas Diat., pl. 461, figs. 3, 4 (issued 1958).

This species was originally described from material which came from Kamischev, U.S.S.R. It is very similar to *A. jutlandicus* Kitton from the Paleocene of Denmark, as drawn by Schmidt (Atlas Diat. pl. 41, fig. 5). The difficulties involved in making an accurate drawing of one of these objects has influenced us in choosing the name *hirtus* because it is well illustrated with a photograph.

HYPOTYPE no. 3534 (Calif. Acad. Sci., Geol. Dept. Type Coll.), Joe's River, Barbados, West Indies. Eocene.

***Aulacodiscus petersi* Ehrenberg.**

(Plate 1, figure 4.)

Aulacodiscus petersi EHRENBERG, 1845. Monatsber. Akad. Wiss. Berlin, p. 361. SCHMIDT, 1874. Atlas Diat., pl. 35, fig. 4 (issued 1876), "Algoa Bai"; pl. 102, fig. 6, (issued 1886), "Simoda, Japan." HUSTEDT, 1929. Krypt. Flora, Deutschland, etc., Kieselalgen, Lief. 3, p. 505, fig. 282.

Diatom circular with four prominent, spatula shaped spines near the margin; a clear line extends inward from each spine to the small clear central area; radial rows of small, closely spaced beads cover the areas between the radial clear lines. Immediately inward from the base of each spine the surface is raised into a pear-shaped area with about ten beads which are larger than those on the remainder of the diatom; these pyriform areas taper toward the center. Diameter, .0800 mm.

HYPOTYPE no. 3513 (Calif. Acad. Sci., Geol. Dept. Type Coll.), Joe's River, Barbados, West Indies. Eocene.

The auxillary spines on the pyriform elevations are very conspicuous but are slightly out of focus in figure 4.

This diatom is so close to the drawings cited that we hesitate to identify it otherwise. The original locality for *A. petersi* has been given as Africa.

PLATE 1

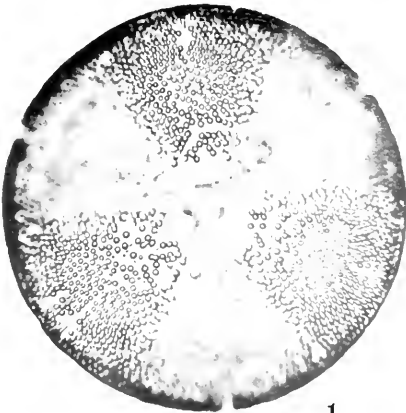
Figures 1, 2. *Actinoptychus billabyanus* Brun. Hypotype no. 3508 (Calif. Acad. Sci., Dept. Geol. Type Coll.). Joe's River, Barbados, West Indies. Eocene. Diameter, .116 mm.

Figure 3. *Aulacodiscus angulatus* Greville. Hypotype no. 3511 (Calif. Acad. Sci., Dept. Geol. Type Coll.). Joe's River, Barbados, West Indies. Eocene. Diameter, .117 mm.

Figure 4. *Aulacodiscus petersi* Ehrenberg. Hypotype no. 3513 (Calif. Acad. Sci., Dept. Geol. Type Coll.). Joe's River, Barbados, West Indies. Eocene. Diameter, .0800 mm.

Figure 5. *Aulacodiscus currus* Hanna and Brigger, new species. Holotype no. 3518 (Calif. Acad. Sci., Dept. Geol. Type Coll.). Conset, Barbados, West Indies. Eocene. Diameter, .0914 mm.

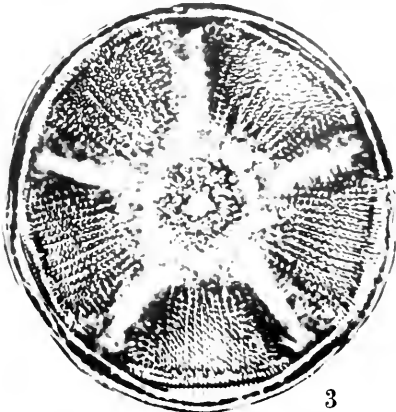
Figure 6. *Aulacodiscus behani* Hanna and Brigger, new species. Holotype no. 3509 (Calif. Acad. Sci., Dept. Geol. Type Coll.). Joe's River, Barbados, West Indies. Eocene. Diameter, .0756 mm.



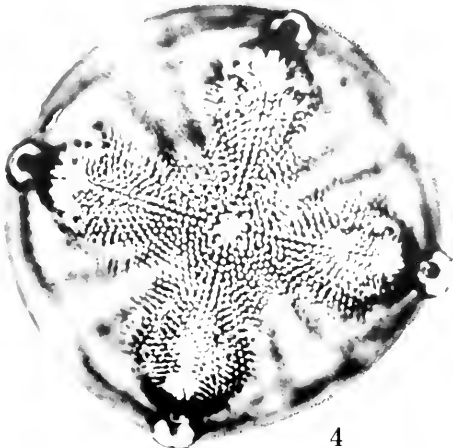
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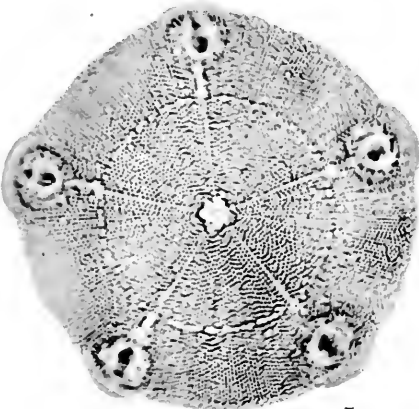
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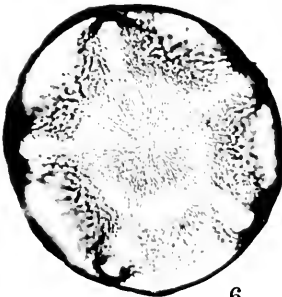
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***Biddulphia punctata* Greville.**

(Plate 2, figure 6.)

Biddulphia punctata GREVILLE, 1864. Trans. Micr. Soc. London, n. s., vol. 12, p. 83, pl. 11, fig. 10. "Cambridge Estate, Barbados."

Valve ovate with narrowly rounded ends, near each of which there is a high spine; the apex of the spine is a knob. Surface with a blank, steeply curved, transverse band with the convexity toward the center; markings consist of fine, sparse irregularly arranged beads with only a slight tendency toward arrangement in radial rows. Length, .0834 mm.; width, .0540 mm.; height of spines, .0085 mm.

HYPOTYPE no. 3515 (Calif. Acad. Sci., Geol. Dept. Type Coll.), from Joe's River, Barbados, West Indies. Eocene.

Our specimen does not differ significantly from the drawing which Greville published.

The species should be compared with *Biddulphia costata* Boyer (1922) from Chimborazo, Barbados. However, in place of terminal spines, that species has large, finely punctate processes.

Brun (Le Diatomiste, 1895, vol. 2, pl. 22, fig. 14) illustrated a variety of *B. punctata* under the name "*cretacea*." The locality from which the diatom came does not seem to have been recorded, but it was probably Barbados.

***Brightwellia pulchra* Grunow.**

(Plate 2, figure 2.)

Craspedodiscus coronatus BRIGHTWELL, 1860. Quart. Journ. Micr. Soc., vol. 8, p. 95, pl. 5, fig. 6.

Brightwellia coronata (Brightwell), RALFS in PRITCHARD, 1861. Infusoria, p. 940.

Brightwellia pulchra GRUNOW in VAN HEURCK, 1883. Syn. Diat. Belgique, pl. 128, fig. 9.

Brightwell's original specimen was a fragment, scarcely recognizable beyond the genus. It came from Barbados. Ralfs noticed the distinctness of the genus and described it as *Brightwellia* in 1861. *Heterodictyon* Greville, (Trans. Micr. Soc. London, n.s., vol. 3, 1863, p. 66) was described for two species, *H. rylandsianum* and *H. splendidum*, both from Barbados. The first with the large cellules at the margin is now selected for the genotype so that the second may be transferred to *Brightwellia* as *B. splendida* as Rattray and others have done.

HYPOTYPE no. 3514 (Calif. Acad. Sci., Geol. Dept. Type Coll.), from Joe's River, Barbados, West Indies. Eocene. Diameter, .0878 mm.

***Coscinodiscus intersectus* Brun.**

(Plate 2, figure 7.)

Valve circular, nearly flat, with 17 small spines close to the narrow margin; a much heavier spine (?) is located in the exact center of the disk. Surface markings consist of radial rows of beads very distinctly separated from each other. Diameter, .0816 mm.

HYPOTYPE no. 3516 (Calif. Acad. Sci., Geol. Dept. Type Coll.), from Joe's River, Barbados, West Indies. Eocene.

***Coscinodiscus normanianus* Greville.**

(Plate 2, figures 3, 4.)

Valve circular, nearly flat but with a broad raised zone about halfway between margin and center; a small blank area in the center, remainder of surface marked with closely spaced beads, uniform in size. These are arranged in 19 radial sectors with all of the beads in radial rows which produce a very striking pattern. The pseudonodule is inconspicuous, if, in fact, the slight marginal dot is a true structure of this nature. Diameter, .1470 mm.

HYPOTYPE no. 3517 (Calif. Acad. Sci., Geol. Dept. Type Coll.), from Joe's River, Barbados, West Indies. Eocene.

This is probably the species illustrated by Laporte and Lefébure (1929, pl. 11, fig. 73) as *Cocinodiscus normanianus* Greville from Barbados. Their photograph seems to be slightly out of focus and the beads are not as closely spaced in the center zone as in the presently considered specimen. However, individual variation in *Coscinodiscus* is so great that this distinction need not be sufficient for specific separation.

The junctions of the sectors are somewhat reminiscent of *Coscinodiscus rothi* but in that diatom they are distinct to the center. Hustedt (1928, p. 401) has published a drawing to show the characters of the junction in that diatom.

***Fenestrella picta* Hanna and Brigger, new species.**

(Plate 4, figure 3.)

Valve circular with 15 marginal scallops as in *Anthodiscus*; there are two spines on the disk, each a fourth of the diameter from the margin and each surrounded by a circular zone of radial beading set apart from that of the remainder of the disk. Where the two ordinary large processes would be on a *Biddulphia*, the border is thickened making these opposed "scallops" appear heavier than the other 13. Diameter, .0732 mm.

PLATE 2

Figure 1. *Aulacodiscus hirtus* Barker and Meakin. Hypotype no. 3534 (Calif. Acad. Sci., Dept. Geol. Type Coll.). Joe's River, Barbados, West Indies. Eocene. Diameter, .103 mm.

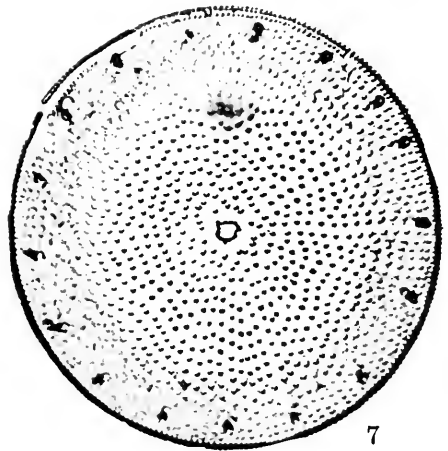
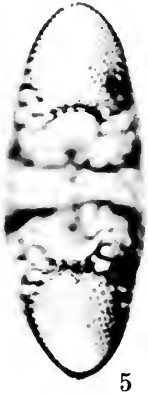
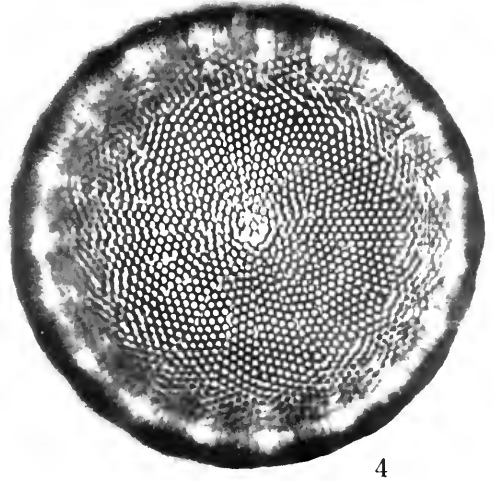
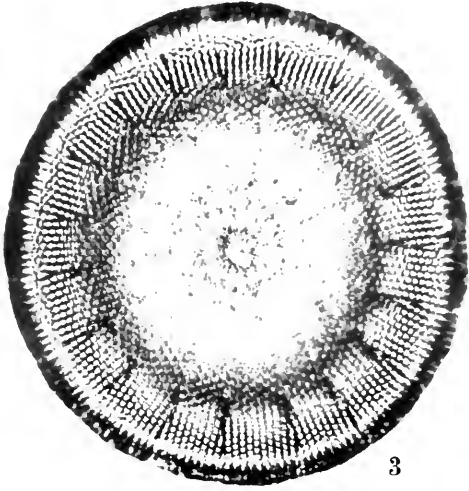
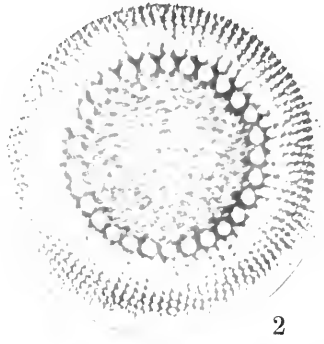
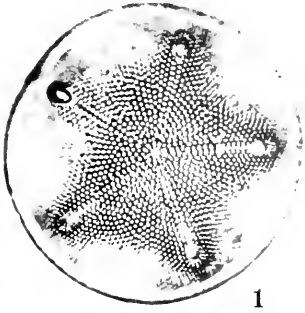
Figure 2. *Brightwellia pulchra* Grunow. Hypotype no. 3514 (Calif. Acad. Sci., Dept. Geol. Type Coll.). Joe's River, Barbados, West Indies. Eocene. Diameter, .0878 mm.

Figures 3, 4. *Coscinodiscus normanianus* Greville. Hypotype no. 3517 (Calif. Acad. Sci., Dept. Geol. Type Coll.). Joe's River, Barbados, West Indies. Eocene. Diameter, .1470 mm.

Figure 5. *Entogonia complexa* Hanna and Brigger, new species. Holotype no. 3518 (Calif. Acad. Sci., Dept. Geol. Type Coll.). Joe's River, Barbados, West Indies. Eocene. Length, .0670 mm.

Figure 6. *Biddulphia punctata* Greville. Hypotype no. 3515 (Calif. Acad. Sci., Dept. Geol. Type Coll.). Joe's River, Barbados, West Indies. Eocene. Length, .0834 mm.

Figure 7. *Coscinodiscus intersectus* Brun. Hypotype 3516 (Calif. Acad. Sci., Dept. Geol. Type Coll.). Joe's River, Barbados, West Indies. Eocene. Diameter, .0816 mm.



HOLOTYPE no. 3524 (Calif. Acad. Sci., Geol. Dept. Type Coll.), from Joe's River, Barbados, West Indies. Eocene.

Greville (Trans. Micr. Soc. London, n.s., 1863, vol. 3, p. 68, pl. 4, fig. 3.) described this genus for the species *Fenestrella barbadensis*. In 1891 Brun (Esp. nouv. Mem. Soc. Phys. d'Hist. Nat. Geneve, vol. 31, pt. 2, no. 1, p. 27, pl. 19, figs. 7, 8) described two more species from Oamaru (fig. 7) and Yedo, Japan (fig. 8). All three of these are very beautiful diatoms but differ radically from the one here described. The one from Joe's River is the only one with a scalloped margin.

Entogonia complexa Hanna and Brigger, new species.

(Plate 2, figure 5.)

In valve view this diatom is a long oval with heavily dotted areas at each end; across the center there is a band with large, flat, more or less circular plate-like protuberances; a central longitudinal thickening of silica crosses this band and terminates in two half round openings; the remainder of the area is covered with the same plate-like markings of the central band. Length, .0670 mm.; width, .0270 mm.

HOLOTYPE no. 3518 (Calif. Acad. Sci., Geol. Dept. Type Coll.), from Joe's River, Barbados, West Indies. Eocene.

This rather remarkable diatom has not been found in any of the literature we have consulted. It is obviously a biangulate form of *Entogonia*, the only other similar one in Barbados material being *Triceratium biangulatum* Greville which Bergon (Le Diatomiste, 1892, vol. 1, p. 136, pl. 3, figs. 7, 8), considered to be merely a biangulate variation of *Entogonia davyana* (Greville).

The name "*Heilbergia barbadensis*" Greville (Trans. Micr. Soc. London, vol. 13, 1865, p. 100, pl. 8, figs. 8, 9) was based on a biangulate form of *Entogonia* which Truan and Witt (Diatoms from Jérémie in Hayti, 1888, p. 16, pl. 4, figs. 2, 3) made a variety of *Entogonia davyana* Greville.

Entogonia versuta Hanna and Brigger, new species.

(Plate 3, figures 1, 2, 3, 4, 5.)

Valve triangular with convex sides; a coarse rounded knob at each corner; along each side there are six smaller, squarish knobs and from each a thin radial bar extends to a central triangle. In the central triangle there is a beautiful rosette of elongate petals; over the surface, outside of the central triangle small dots are widely scattered. Diameter, base to apex, .0650 mm.

HOLOTYPE no. 3519 (Calif. Acad. Sci., Geol. Dept. Type Coll.), from Joe's River, Barbados, West Indies. Eocene.

While the border markings set this diatom apart from others we have found in the literature it shows some similarity to *Entogonia formosa* Bergon.

This was first recorded from Jeremie, Hayti (1888) but was then considered to be Greville's *Entogonia puncticulata*. The central portion is almost exactly the same as Bergon showed in his monograph of the genus (1882, p. 146, pl. 14, fig. 13). It has also been figured by Schmidt (1896, pl. 203, figs. 2, 4). Perhaps the best illustration to date is that of Laporte and Lefébure (1929, pl. 1, fig. 5). Separate names have been given to numerous variations of *Entogonia* from Barbados and Hayti and we hesitate to add still another. This would not be done if connections between it and the other two species mentioned could be found.

Glyphodiscus dubiosus Hanna and Brigger, new species.

(Plate 3, figures 8, 9.)

Diatom circular, nearly flat with three short nodes or spines equally spaced about a third of the distance from the margin to the center; midway between these there are three faint depressions; inner side of border with short but distinct bars of uneven length; remainder of surface sparsely marked with radial rows of short transverse bars; all of the bars can be resolved into beads with sufficient numerical aperture and magnification. The surface is then seen to be divided into six sectors of very slight difference in elevation. Diameter, .0296 mm.

HOLOTYPE no. 3520 (Calif. Acad. Sci., Geol. Dept. Type Coll.), from Joe's River, Barbados, West Indies. Eocene.

This interesting diatom is believed to be a member of the *Glyphodiscus* group although the most common species have the ocelli close to the margin. However, Schmidt (1882, pl. 80, fig. 10) illustrated one from Barbados which has the ocelli very much as in the present form. His figure shows the markings as radiating lines and not as beaded zones as in the present form and this led him to consider the possibility of his figures 9 and 10 being varieties of *Liostaphania rotula* Ehrenberg. *Liostaphania* (?) *japonica* Brun (1889, p. 38, pl. 4, fig. 2), a fossil from Japan, does have beaded sculpture but not in zones as in the present form; and where ocelli would be expected, there are four double spine-like processes. According to Payne (1922), all of the examples of *Liostaphania*, as well as of several other named genera, are external and internal molds or casts of diatoms. The present form does not appear to fall in that category.

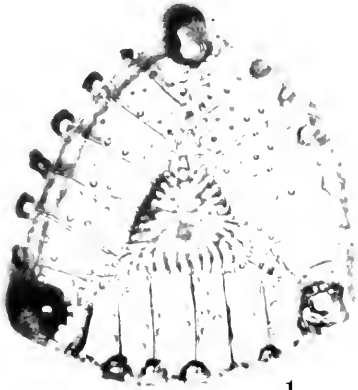
Some biologists have regretted the fact that there are odd shaped spore cases produced by some groups of diatoms and that these can rarely be associated with the species which has produced them. It has been suggested that such objects should not be included in systematic taxonomy but there is not uniform agreement in this respect. The reason for giving them names in a classification is that they have very definite use in determination of ages of sediments and are often as useful for that purpose as any other fossils.

PLATE 3

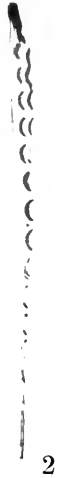
Figures 1-5. *Entogonia versuta* Hanna and Brigger, new species. Holotype no. 3519 (Calif. Acad. Sci., Dept. Geol. Type Coll.). Joe's River, Barbados, West Indies. Eocene. Diameter, base to apex, .0650 mm.

Figures 6-7. *Helminthopsis sokoli* Hanna and Brigger, new species. Holotype 3521 (Calif. Acad. Sci., Dept. Geol. Type Coll.). Joe's River, Barbados, West Indies. Eocene. Length, (fig. 6.) .2314 mm.

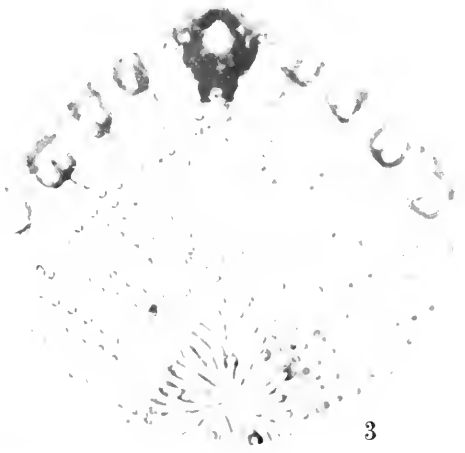
Figures 8-9. *Glyphodiscus dubiosus* Hanna and Brigger, new species. Holotype no. 3520 (Calif. Acad. Sci., Dept. Geol. Type Coll.), Joe's River, Barbados, West Indies. Eocene. Diameter .0296 mm.



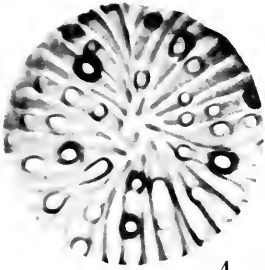
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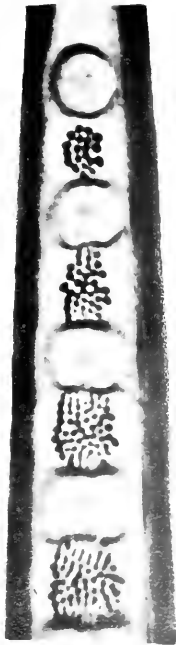
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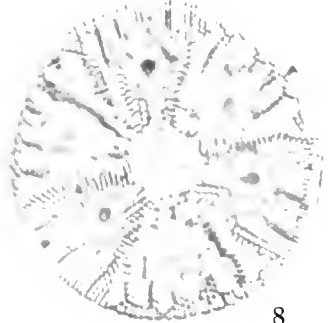
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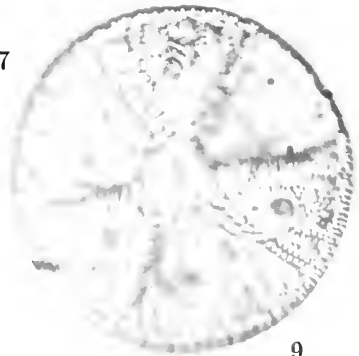
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Helminthopsis sokoli Hanna and Brigger, new species.

(Plate 3, figures 6, 7.)

Valve long and slender with a small knob on each end; margin finely serrated; surface with 16 clear cross ribs; 11 of the depressions between these are heavily marked with fine dots arranged in no regular order. Length of holotype (figures 6, 7), .2314 mm; width, .0172 mm.

The paratype (figure 5) is an edge view of an individual valve showing the very conspicuous elevated cross bars.

HOLOTYPE no. 3521 (Calif. Acad. Sci., Geol. Dept. Type Coll.), from Joe's River, Barbados, West Indies. Eocene.

The genus *Helminthopsis* was first described by Van Heurck (1896, p. 455) for a slightly sigmoid species from Oamaru, New Zealand named *H. weissflogii*. Distinguishing features of *H. sokoli* are a more slender shape, the possession of terminal knobs and the straightness of the valves.

The species is named for Mr. William Sokol, an enthusiastic student of diatoms.

Kittonia gigantea (Greville) Grove and Sturt.

(Plate 4, figures 1, 2.)

Valve ovate, dome-shaped with two very long intertwined processes uniform in diameter throughout the length except for small knobs at the outer ends; between the bases of the processes there is a connecting clear area of heavy silica as seen in edge view; otherwise the surface is marked with a series of radial rows of beads. Border missing on our best preserved specimen. Length of valve, .1240 mm.; height, including processes, .0458 mm.

HYPOTYPE no. 3522 (Calif. Acad. Sci., Geol. Dept. Type Coll.), from Chimborazo, Barbados, West Indies. Eocene.

Figure 2 is a process under greater magnification, approximately 1000/1; close examination shows very small pores along the sides; these markings are largely lost in a halftone reproduction.

Greville's original figure (1864, p. 13, pl. 3, fig. 9) is apparently a poor composite drawing. Grove and Sturt (1887, p. 75) remarked about this and proposed a new name "*grevilleana*" for the species, which would seem to be unnecessary.

Pseudauliscus ralfsianus (Greville).

(Plate 4, figures 4, 5.)

Auliscus ralfsianus GREVILLE, 1863. Trans. Micr. Soc. London, n. s. vol. 11, p. 52, pl. 3, fig. 21. "Cambridge Estate, Barbados."

Diatom circular, flat with a narrow margin; two slightly pyriform ocelli set a third of the radius in from the margin. Surface covered with a network of irregularly shaped cells, each marked with a cluster of very fine beads. The inner side of the marginal ring appears as if knurled with a fine machine tool.

HYPOTYPE no. 3526 (Calif. Acad. Sci., Geol. Dept. Type Coll.), from Joe's River, Barbados, West Indies. Eocene.

The slightly elliptical ocelli in Greville's illustration have the long axis at right angle to a diameter, whereas in the present specimen the long axis is radial. The finer markings seem to be identical.

***Pyxilla boothi* Hanna and Brigger, new species.**

(Plate 4, figure 9.)

The diatom valve proper is a small short dome with minute spines on the girdle margin; this is surmounted by a massive vertical column about ten times as long as the valve diameter; the column occupies the position of the spine on some species but is wholly different in structure; it is hollow and covered exteriorly with 26 rows of short spines, arranged horizontally; between these spines there are minute dots arranged in longitudinal rows; these dots extend over the entire dorsal surface of the valve. Length, .140 mm.; diameter, .0304 mm.

HOLOTYPE no. 3523 (Calif. Acad. Sci., Geol. Dept. Type Coll.), from Conset, Barbados, West Indies. Eocene.

Perhaps the reference of this strange diatom to *Pyxilla* is over conservative but it does bear some resemblance in structure to some of the species Forti illustrated in his monograph of the genus. No useful purpose would seem to be served at this time by creating a new genus name for it. This may well await more study of other early Tertiary and older deposits.

The species is named in honor of D. C. Booth, a member of the early San Francisco Microscopical Society and the first western technician to mount diatoms individually and in arranged patterns.

***Pyxilla gracilis* Tempère and Forti.**

(Plate 5, figure 6.)

The diatom is a long slender tube, slightly constricted outwardly and expanded at the distal end which becomes a conical spine. Aperture very slightly expanded and with a narrow margin. Markings consist of closely arranged hexagonal cells in longitudinal rows. Length, .1720 mm.; diameter, .0214 mm.

HYPOTYPE no. 3525 (Calif. Acad. Sci., Geol. Dept. Type Coll.), from Joe's River, Barbados, West Indies. Eocene.

PLATE 4

Figures 1, 2. *Kittonia gigantea* (Greville) Grove and Sturt. Hypotype no. 3522 (Calif. Acad. Sci., Dept. Geol. Type Coll.), Chimborazo, Barbados, West Indies. Eocene. Length, .1240 mm.

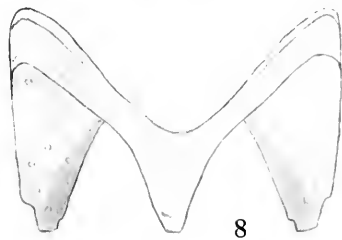
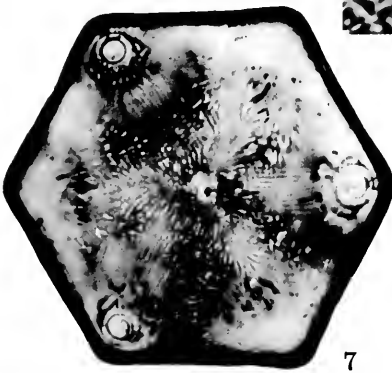
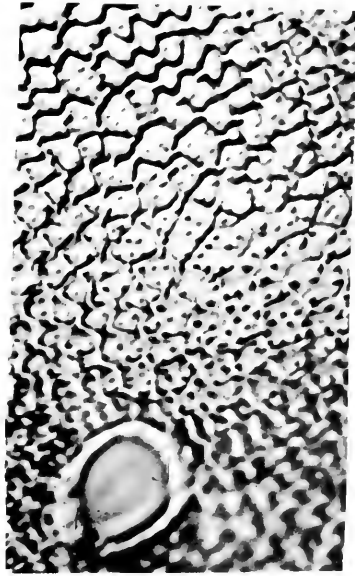
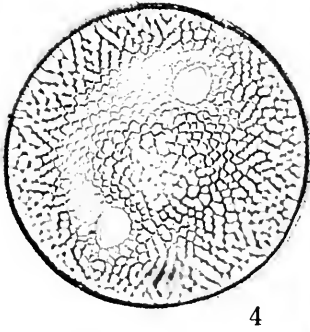
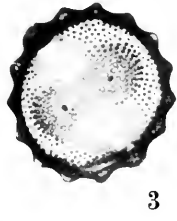
Figure 3. *Fenestrella picta* Hanna and Brigger, new species. Holotype no. 3524 (Calif. Acad. Sci., Dept. Geol. Type Coll.). Joe's River, Barbados, West Indies. Eocene. Diameter .0732 mm.

Figures 4-5. *Pseudauliscus ralsianus* Greville. Hypotype no. 3506 (Calif. Acad. Sci., Dept. Geol. Type Coll.). Joe's River, Barbados, West Indies. Eocene. Diameter, .080 mm.

Figure 6. *Stephanopyxis herzbergi* Hanna and Brigger, new species. Holotype no. 3530 (Calif. Acad. Sci., Dept. Geol. Type Coll.). Joe's River, Barbados. Eocene. Diameter, .060 mm.

Figures 7-8. *Robinsonetta barboi* Hanna and Brigger, new species. Holotype no. 3528 (Calif. Acad. Sci., Dept. Geol. Type Coll.). Chimborazo, Barbados, West Indies. Eocene. Diameter, .0484 mm.

Figure 9. *Pyxilla boothi* Hanna and Brigger, new species. Holotype no. 3503 (Calif. Acad. Sci., Dept. Geol. Type Coll.). Conset, Barbados, West Indies. Eocene. Length, .140 mm.



In his studies for a monograph of *Pyxilla* and its allies, Forti (1909) illustrated numerous forms of general similarity to the one shown herein. Our specimen is more like *Pyxilla gracilis* of his report than any of the other species and seems to be close enough to bear the same name. Ours has a slightly more expanded outer end than do the specimens illustrated by Forti.

Ratrayella decipiens Hanna and Brigger, new species.

(Plate 5, figure 4.)

Diatom circular with seven clear ocelli around a depressed central zone; marginal band very narrow with 14 clear ocelli, flattened oval in shape and about the same size as those in the central area. Surface in central zone densely covered with fine dots arranged in no regular order; toward the margin the dots tend to form a zone of anastomosing, short radial rows. Diameter, .100 mm. Depression of central zone from margin, approximately .007 mm.

HOLOTYPE no. 3527 (Calif. Acad. Sci., Geol. Dept. Type Coll.), from Joe's River, Barbados, West Indies. Eocene.

Robinsonetta Hanna and Brigger, new genus.

Diatom hexagonal with deeply depressed areas between the prominent marginal ocelli. Genotype, *Robinsonetta barboi* Hanna and Brigger, new species.

Robinsonetta barboi Hanna and Brigger, new species.

(Plate 4, figures 7, 8.)

Diatom hexagonal with a clear, prominent ocellus at each of three corners which bound an upper plane; the ocelli are raised .0045 mm. above this surface; the other three corners are deeply depressed .0085 mm. below the tops of the ocelli; radiating lines project inward from the ocelli toward the center, leaving a small irregular shaped clear area in the center; with very oblique light these lines are disclosed to be faintly beaded. Diameter, .0484 mm. over the straight sides.

HOLOTYPE no. 3528 (Calif. Acad. Sci., Geol. Dept. Type Coll.), from Chimborazo, Barbados, West Indies. Eocene.

Although it is obvious that this strange diatom is somewhat similar to *Actinoptychus* since alternate sectors are in different planes, this character is carried to an extreme. Furthermore the presence of the *Auliscus*-like ocelli removes it definitely from any other generic group known to us.

The genus name was chosen to honor the late Mr. J. H. Robinson of Barbados. We are under obligations to Mrs. Evalyn Robinson for the bulk material which, when processed, formed the basis of this report.

Stephanogonia mutabila Hanna and Brigger, new species.

(Plate 5, figure 1.)

Diatom circular, divided into eight segments by elevated radial ribs; these extend inward to a central circular blank ring; margin narrow and at the margin each radial ridge widens and turns upward in spatula-like shape. Surface markings between the ridges under moderate magnification and aperture appear as indefinite mottling but with more power the areas are found to be covered with very fine, closely spaced dots; these dots also cover the inner ends of the radial ribs. The central area is a zone of very fine beads with an outer margin of radial ridges of irregular lengths; this produces a sort of sunburst central zone. Diameter, .060 mm.

HOLOTYPE no. 3529 (Calif. Acad. Sci., Geol. Dept. Type Coll.), from Joe's River, Barbados, West Indies. Eocene.

Stephanopyxis herzbergi Hanna and Brigger, new species.

(Plate 4, figure 6.)

Holotype consisting of one complete frustule and an attached single valve; each valve is nearly hemispherical in shape, slightly broader than long, with a group of short, closely spaced spines at the top; valves joined by a very distinct, clear girdle. Surface marked with small dots very evenly spaced and arranged fairly regularly in radial rows. Diameter, .0246 mm.; length over all, .0636 mm.

HOLOTYPE no. 3530 (Calif. Acad. Sci., Geol. Dept. Type Coll.), from Joe's River, Barbados, West Indies. Eocene.

The species is named for the late Mr. W. F. Herzberg, one of the early members of the State Microscopical Society of Illinois and an enthusiastic diatomist.

Triceratium diversum Hanna and Brigger, new species.

(Plate 5, figure 5.)

Diatom quadrangular with small blunt spines at each corner; on the outer part of the border there is a clear, slightly convex projection but what appears to be the true margin has straight sides with three to six short, sharp spines extending outwardly. Surface slightly raised with rather large beads arranged in radial rows; the beads decrease in diameter toward the small, clear, central area. Distance across the sides of the square, .0474 mm.

HOLOTYPE no. 3531 (Calif. Acad. Sci., Geol. Dept. Type Coll.), from Joe's River, Barbados, West Indies. Eocene.

PLATE 5

Figure 1. *Stephanogonia mutabila* Hanna and Brigger, new species. Holotype no. 3529 (Calif. Acad. Sci., Dept. Geol. Type Coll.). Joe's River, Barbados, West Indies. Eocene. Diameter, .060 mm.

Figure 2. *Triceratium firthi* Hanna and Brigger, new species. Holotype no. 3532 (Calif. Acad. Sci., Dept. Geol. Type Coll.). Joe's River, Barbados, West Indies. Eocene. Diameter, base to apex, .0568 mm.

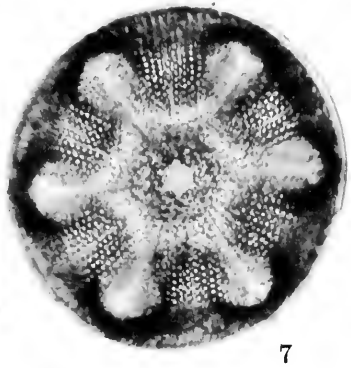
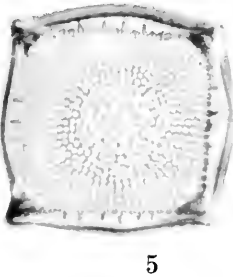
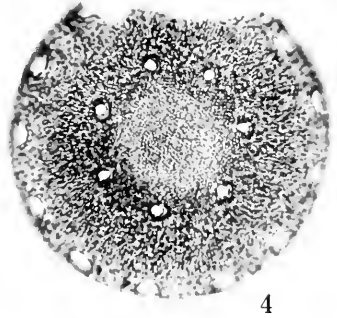
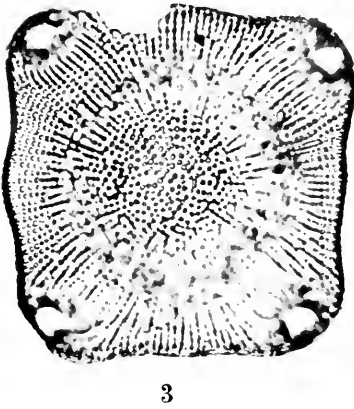
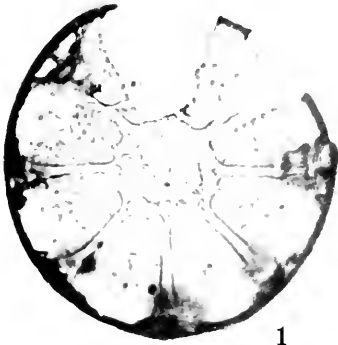
Figure 3. *Triceratium needhami* Hanna and Brigger, new species. Holotype no. 3533 (Calif. Acad. Sci., Dept. Geol. Type Coll.). Joe's River, Barbados, West Indies. Eocene. Length of one side, .0646 mm.

Figure 4. *Ratrayella decipiens* Hanna and Brigger, new species. Holotype no. 3527 (Calif. Acad. Sci., Dept. Geol. Type Coll.). Joe's River, Barbados, West Indies. Eocene. Diameter, .100 mm.

Figure 5. *Triceratium diversum* Hanna and Brigger, new species. Holotype no. 3531 (Calif. Acad. Sci., Dept. Geol. Type Coll.). Joe's River, Barbados, West Indies. Eocene. Length of one side, .0474 mm.

Figure 6. *Pyxilla gracilis* Tempère and Forti. Hypotype no. 3525 (Calif. Acad. Sci., Dept. Geol. Type Coll.). Joe's River, Barbados, West Indies. Eocene. Length, .1720 mm.

Figure 7. *Aulacodiscus angulatus* Greville. Hypotype no. 3513 (Calif. Acad. Sci., Dept. Geol. Type Coll.). Joe's River, Barbados, West Indies. Eocene. Diameter, .0968 mm.



The peculiar border of this diatom does not seem to be duplicated in *Triceratium* although there are many square diatoms referred to this genus. *Triceratium intermedium* Grove and Sturt (1886, pl. 2, fig. 1) from Oamaru, New Zealand, has the same general shape, but the surface markings are few and scattered.

Triceratium firthi Hanna and Brigger, new species.

(Plate 5, figure 2.)

Diatom triangular with convex sides; a heavy blunt spine at each corner; inside the narrow border a nearly flat zone is marked by small rounded beads in radial rows; these rows continue well toward the center which is highly convex. Diameter, base to apex, .0568 mm.; height of center from border .007 mm.

HOLOTYPE no. 3532 (Calif. Acad. Sci., Geol. Dept. Type Coll.), from Joe's River, Barbados, West Indies. Eocene.

The peculiar high-domed central area and the outer border zone distinguish this diatom from any other which we have found in the literature thus far.

The species is named for Mr. R. I. Firth of 6 Windover Crescent, Lewes, Sussex, England, well known for his skill in the preparation of flawless slides of diatoms.

Triceratium needhami Hanna and Brigger, new species.

(Plate 5, figure 3.)

Diatom, quadrangular with a very low ocellus - clear area or spine at each corner. The sides have a slight convexity in the centers and a concavity on each side of these. Surface marked with radial rows of fine dots. Distance over the sides of the square, .0646 mm.

HOLOTYPE no. 3533 (Calif. Acad. Sci., Geol. Dept. Type Coll.), from Joe's River, Barbados, West Indies. Eocene.

The species is named for Mr. George Needham, master microscopist of Seattle, Washington.

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