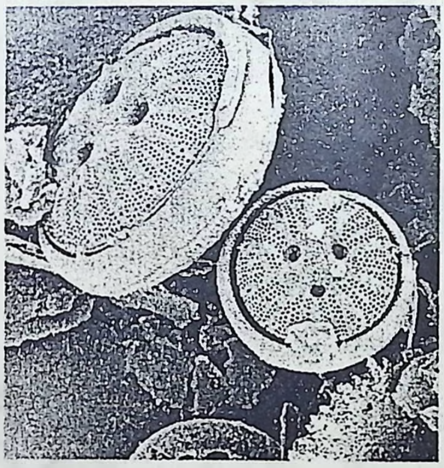
FLORA TERTIARIA MEDITERRANEA

Die tertiären Floren des Mittelmeergebietes

Vegetationsgeschichte, Phytostratigraphie, Paläökologie, Paläoklimatologie, Paläogeographie

herausgegeben
von
Dr. Hans-Joachim Gregor



Fünfter Band – Fünfte Abteilung

München
Verlag Documenta naturae
2001

documenta naturae

Sonderbandreihe:

FLORA TERTIARIA MEDITERRANEA

Band V - Abteilung 5

Jahrgang 2001

ISSN 1433-1705

Herausgeber für diesen Sonderband:

Dr. Hans-Joachim Gregor, Palsweiserstr. 5m, D-82140 Olching
Priv.-Doz. Dr. Diethard H. Storch, Sägematte 2, D-19183 Waldkirch

Der Sonderband aus dem Verlag Documenta naturae erscheint in zwangloser Folge mit Themen aus den Gebieten Geologie, Paläontologie, Paläophytologie, Botanik, Stratigraphie, Paläökologie, Taphonomie, Paläoklimatologie usw., nur das Mediterrangebiet betreffend

Der Sonderband ist Mitteilungsorgan der
Paläobotanisch-Biostratigraphischen Arbeitsgruppe (PBA)
im Heimatmuseum Günzburg und im Naturmuseum, Im Thäle 3, D-86152 Augsburg

Für die einzelnen Beiträge zeichnen der Autor bzw. die Autoren verantwortlich, für die Gesamtgestaltung der Herausgeber.

Überweisung des Heftpreises erbeten auf das Konto 1548460 bei der Sparkasse FFB (BLZ 700 530 70) - Inh. H.-J. Gregor.

Bestellungen: bei Buchhandlungen und den Herausgebern

Layout: Juliane Gregor und Hans-Joachim Gregor

Umschlagbild H.-J.GREGOR: Diatomeen aus der Valdarno-Region: Cyclotella gregori

2001

FLORA TERTIARIA MEDITERRANEA V.5

Silicious Microfossils (Diatoms – Bacillariophyceae) from Neogene Deposits of the Valdarno Region (Tuscany, Italy) – preliminary results

A. WITKOWSKY, M. BAK, & B. WAWRZYNIAK-WYDROWSKI

FLORA TERTIARIA MEDITERRANEA V.5 p. 1-47 4 figs. 1 tab. 10 pls. München 2001

SILICEOUS MICROFOSSILS (DIATOMS – BACILLARIOPHYCEAE) FROM NEOGENE DEPOSITS OF THE VALDARNO AREA (TUSCANY, ITALY) – PRELIMINARY RESULTS

A. WITKOWSKI, M. BAK & B. WAWRZYNIAK-WYDROWSKA

Address of the authors:

Department of Paleooceanology, Institute of Marine Sciences, University of Szczecin, Wąska 13, 71-415 Szczecin; e-mail: witkowsk@univ.szczecin.pl

The authors are free members of the Palaeobotanical-biostratigraphical Workgroup PBA in Günzburg and the Naturemuseum Augsburg

ABSTRACT

The subject of the study was diatom flora of the Neogene lacustrine deposits from the Valdarno region in Northern Italy. In samples of the clayey sediments collected from Meleto and St. Barbara south of Florence, over 200 taxa were identified. Light and electron microscopic studies revealed a diatom flora rich in terms of the number of species. The most abundant taxon was from the genus of *Cyclotella* which is here described as a new species *C. gregori*. Except for several fossil taxa e.g. *C. gregori*, *C. radiosa* var. *pliocaenica*, *Ethmodiscus hassiacus*, *Fragilaria bituminosa*, *F. zeilleri* var. *zeilleri*, *Navicula arenariaeformis*, *N. perobesa*, *N. turris* the diatoms represented modern flora of world wide distribution. The stratigraphic distribution of the fossil diatom taxa indicates the Late Miocene to Early Pliocene age.

Zusammenfassung

Es wird eine Diatomeenflora aus neogenen lakustren Sedimenten der Valdarno Region in Oberitalien untersucht. Über 200 Taxa konnten in den tonigen Sedimenten von Meleto und S. Barbara südlich Florenz bestimmt werden. Licht- und elektronenmikroskopische Untersuchungen ergaben eine artenreiche Diatomeenflora mit dem dominanten Taxon *Cyclotella gregorii* n. sp.

Ausser einigen speziellen fossilen Arten wie z.B. *C. gregori*, *C. radiosa* var. *pliocaenica*, *Ethmodiscus hassiacus*, *Fragilaria bituminosa*, *F. zeilleri* var. *zeilleri*, *Navicula arenariaeformis*, *N. perobesa*, *N. turris* repräsentieren die Diatomeen eine rezente Flora von weltweiter Verbreitung. Die stratigraphische Verteilung der fossilen Diatomeen deutet Ober-Miozän bis Unter-Pliozän für die Ablagerungen an.

Keywords: diatom flora, Neogene, lacustrine sediments, paleoecology, eutrophication, biostratigraphy, biogeography

Schlüsselworte: Diatomeenflora, Neogen, lakustre Sedimente, Paläoökologie, Eutrophisierung, Biostratigraphie, Biogeographie

Content **Seite**

1. INTRODUCTION AND ACKNOWLEDGEMENT

Application of diatoms in biostratigraphy and paleoecology of terrestrial aquatic deposits has long tradition. The use of diatom floras in various aspects of Neogene paleolimnology has been reviewed by BRADBURY (1988).

The Neogene freshwater diatom floras were subject to numerous studies. In the beginning diatom floras of Miocene and Pliocene age were predominantly studied in Europe and to the lesser extent in the United States. In Europe already in the mid-XIXth century and early XXth Century diatoms from continental aquatic sediments were studied by EHRENBERG (1854), PANTOCSEK (1886-1905), HÉRIBAUD (1903-1908). Later, diatomites were studied by e.g. KRASSKE (1932, 1934, 1938). The result of the diatom studies were numerous newly described taxa, both fossil and extant. Some of these taxa are still distributed world wide, e.g. *Fragilaria martyi*, *F. construens*, *Stephanodiscus* spp., *Navicula cari*. During last several decades the Neogene diatom floras were especially intensively studied in Bulgaria (e.g. TEMNISKOVA-TOPALOVA et al. 1990, TEMNISKOVA-TOPALOVA et al. 1994, TEMNISKOVA-TOPALOVA & OGNJANOVA-RUMENOVA 1997, OGNJANOVA-RUMENOVA & POPOVA 1992, OGNJANOVA-RUMENOVA 1996), for summary of the Balkan Peninsula see OGNJANOVA-RUMENOVA (2000), Germany (e.g. SCHILLER 1994, KRAMMER et al. 1997), Hungary (e.g. HAJOS 1990), France (e.g. EHRLICH 1966, SERIEYSSOL 1980), Macedonia (GERSONDE & VELITZELOS 1978), Spain (SERVANT-VILDARY 1984, HAWORTH & SABATER 1993), Russia (e.g. MOISSEJEVA et al. 1974a, MOISSEJEVA et al. 1974b) and in particular along the River Kama (e.g. LOSEVA 1978, 1980a, 1982), Slovakia (REHAKOVA 1980, OGNJANOVA-RUMENOVA & VASS 1998), Turkey (SERVANT-VILDARY et al. 1986), Eastern Africa, Ethiopia (e.g. GASSE 1980), China (e.g. LI & QI 1982, WANG 1999), Japan (e.g. TANAKA & KOBAYASI 1999), Peru (FOURTANIER et al. 1993) and Gwatemala (SCHILLER and NUÑEZ 1994). During last several decades a number of localities with Neogene diatom floras were also studied in the United States (e.g. VAN LANDINGHAM 1964, BRADBURY & BLAIR 1979, BRADBURY & KREBS 1982, KREBS et al. 1987, KOCIOLEK et al. 1988, MC LAUGHLIN 1992, BRADBURY 1995).

The present paper is dealing with the diatom flora from the Neogene lacustrine deposits from Valdarno region in Northern Italy. The sediments studied originated from the central Valdarno region. The study area is located in the Arno River Valley SE of Firence, which forms here a semi-graben. According to ALBIANELLI (1995) during the Neogene this area constituted a part of a lake district – a major sedimentary basin. Based on paleomagnetic (ALBIANELLI, 1995) and faunistic data (mammal remnants AZZAROLI & LAZZERI 1977) studies the beginning of the sedimentation is determined to the Upper Pliocene. However, latest studies of the abundant and excellently preserved plant macrofossils contradict former age determinations. FISCHER & BUTZMANN (2000), have shown that limnic sediments were deposited during the Late Miocene and Early Pliocene.

The authors are greatly indebted to Dr. H.-J. GREGOR and his team from the Palaeobotanical-biostratigraphical workgroup for providing samples of the sediments from the Valdarno region in Italy for diatom studies. MANFRED RUPPEL from the Botanical Institute at the University in Frankfurt am Main was doing the operating SEM and Dr. SARAH SPAULDING from the Diatom Collection, California Academy of Sciences in San Francisco corrected the English language of the manuscript.

2. MATERIAL AND METHODS

The material studied was collected from two localities. Location of the sampling sites is shown in Figure 1. The diatom flora was obtained from clayey sediments with vivianite $[Fe_3PO_4)_2 \times 8H_2O]$. The sediment was blue-greyish clay with minor admixture of silt. Meleto is located in the vicinity of Santa Barbara formerly an important brown coal open mine. The sediments from Santa Barbara were characterised by coarser grain size distribution i.e. silt content distinctly higher than in Meleto (FISCHER & BUTZMANN 2000).

The material was treated with 10 % HCl and washed several times with distilled water. Thereafter the samples were boiled in concentrated H_2O_2. Light microscope preparations were mounted in NAPHRAX and analysed by means of Nikon Eclipse E 600 microscope equipped with a PlanAPO, x 100-oil immersion objective. In each preparation 400 valves were counted. From each sample 6 permanent preparations were analysed quantitatively, and in one preparation relative percentages for the diatom taxa were determined. SEM studies were performed by means of a Hitachi S 4500. For diatom identification the following literature was used: LOSEVA 1982, KRAMMER & LANGE-BERTALOT (1986, 1988, 1991a, b), LANGE-BERTALOT 2001, LANGE-BERTALOT et al. 1996, LANGE-BERTALOT & METZELTIN 1996. Ecological requirements of particular taxa were taken from DENYS (1991) and VAN DAM et al. (1994).

Structure of the diatom flora and mutual relationships between taxa were determined by means of multivariate statistical analyses applying PRIMER software (Plymouth Routines in Multivariate Ecological Research; CLARKE & WARWICK, 1995). The following aspects of the relationships between diatom assemblages were considered:

- similarity between frequencies of taxa; the data from 2 samples were used for dominating species. To reduce discrepancies between contribution of abundant and less abundant taxa, the data were fourth-root transformed. Ranked similarity matrices were constructed using the Bray-Curtis similarity measure and group-average sorting (LANCE & WILLIAMS 1967). Hierarchical classification of abundances was performed using PRIMER's CLUSTER procedure and identification of homogenous groups.
- the procedure of multi-dimension scalling (MDS) was applied to construct 2-dimensional diagram of diatom taxa distribution in multi-dimensional space, where distances between particular taxa and their mutual distribution reflect similarity or dissimilarity of diatom assemblages.

Fig. 1. Location of the study area. S. Barbara and Meleto south of Florence in the Valdarno region in Upper Italy (also see FISCHER & BUTZMANN 2000, maps 1-3).

3. RESULTS

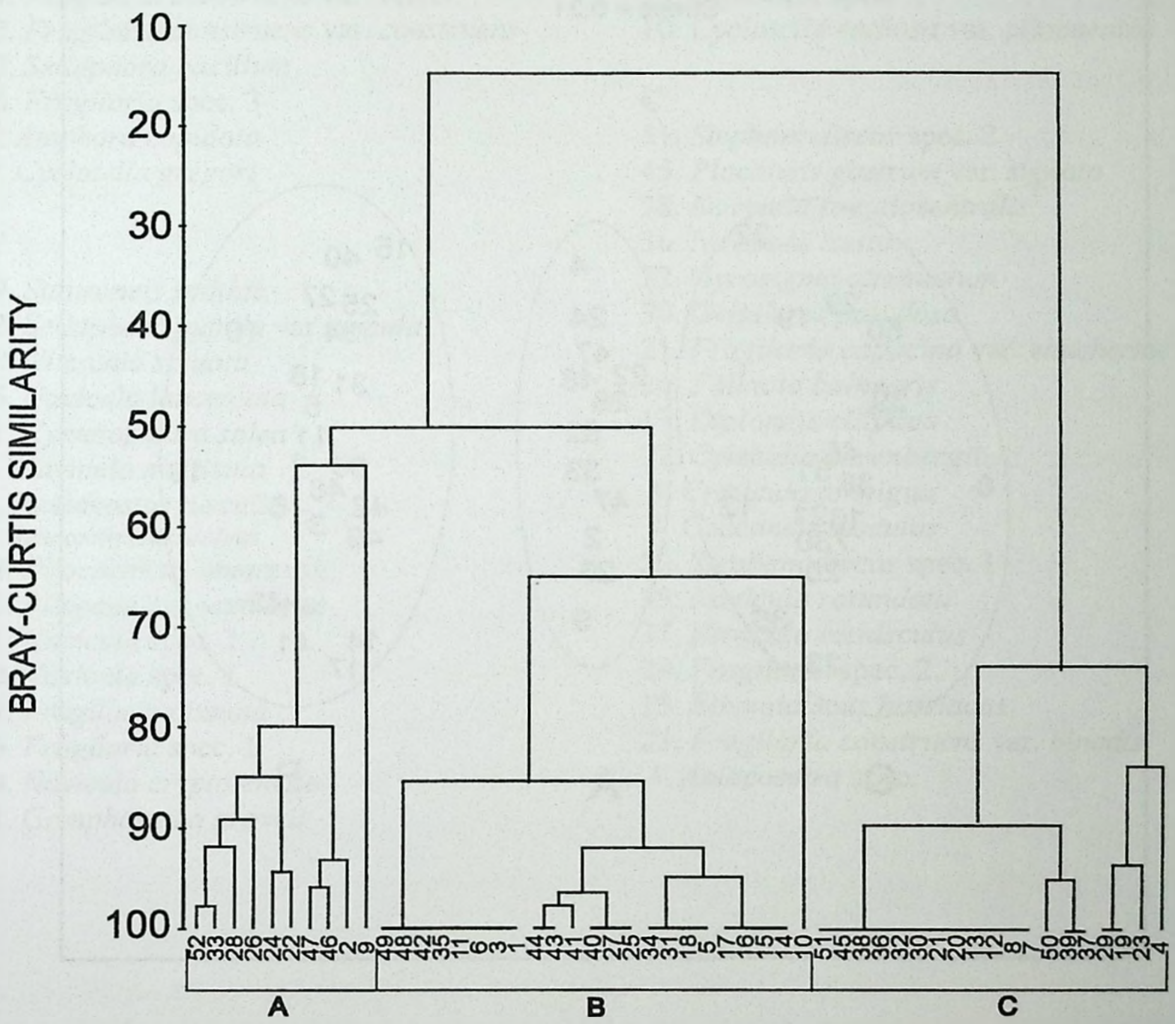
Microscopic analysis revealed the presence of abundant diatom flora in the sediment studied. All together, 211 diatom taxa were identified. Results of the microscopic analyses are presented in Table 1. The floras studied showed distinct difference with respect to preservation status. Diatoms from Meleto were strongly fragmented and to the high extent affected by dissolution processes. In contrast, diatoms from St. Barbara were excellently preserved, but strongly affected by compaction. In all preparations a single species representing genus *Cyclotella* strongly dominated. This taxon is here described as *Cyclotella gregori* spec. nov. It was associated with the relatively common *C. radiosa* var. *pliocaenica*, whereas in Meleto by unidentified taxon belonging to the genus of *Aulacoseira*. Both localities were characterised a large number *Fragilaria* species. Some of the taxa presented well expressed morphological features and thus were easy to identify, but numerous might be assigned to the broad groups (species complexes) e.g. *Fragilaria construens*, *Fragilaria pinnata*. The species list is presented in Table 1.

Similarity analysis of the diatom flora based on the frequencies of particular taxa at Meleto and St. Barbara is presented as a cluster diagram. The differentiation of the diagram at the level exceeding 50 % points to rather low similarity of the diatom floras analysed. However, it was possible to distinguish three clusters (A B C, Fig. 2).

Fig. 2: Similarity dendrogram of taxa in the sediment studied (right)

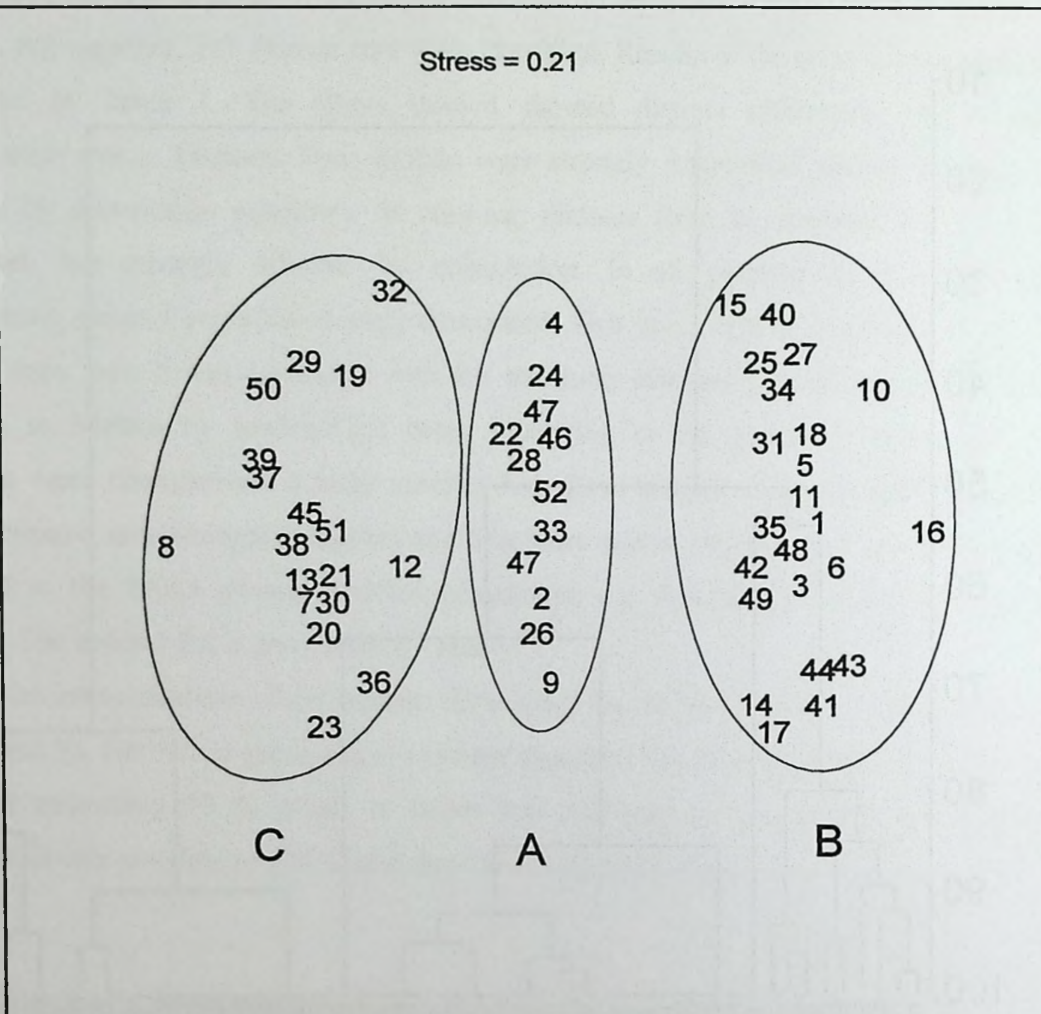
Cluster A is composed of taxa inhabiting freshwater to slightly saline waters or with high electrolyte content, eutrophic to mesotrophic with respect to trophic status. Included in this cluster were taxa with highest abundance e.g.: *Cyclotella gregori*, *C. radiosa* var. *pliocaenica*, *F. zeilleri* var. *zeilleri*, *F. martyi* and *Navicula cari.* **Cluster B** is composed of taxa which are predominantly inhabiting freshwater to slightly saline waters mostly alkalibiontic and alkaliphilous to circumneutral usually with high trophic tolerance (eutrophic to dystrophic). In this group included were taxa with low abundance e.g.: *Diploneis mauleri*, *Epithemia frickei*, *E. sorex*, *Gomphonema grovei*, *Navicula cryptocephala*. The third **cluster – C,** included taxa with similar ecological requirements as group B, but with lowest abundance. Examples included in this group were e.g.: *Cocconeis disculus*, *Cymbella ehrenbergii*, *Diploneis elliptica*, *Fragilaria capucina* var. *vaucheriae* and *Placoneis gastrum* var. *gastrum*.

Similarity dendrogram of taxa in the sediment studied



In Figure 3 results of the Multi-Dimentional Scalling (MDS) analysis are presented. The result of MDS analysis is 2-dimensional diagram, which corresponds to a map of taxa distribution in multi-dimentional space. The stress index value of 0.21 for frequency of occurrence indicates that the taxa configuration, provides potentially useful 2-dimentional image regarding the real relationships between taxa (capital letters on the diagram corresponds to the groupings of taxa as revealed by Bray-Curtis similarity analysis in Fig. 2).

Fig. 3. Multi-Dimentional Scalling (MDS) plot for taxa from the sediments studied.



In order to compare the two studied sites contingency tables analysis (χ^2 test) was applied. Due to low frequencies of the diatom taxa, the recommendation that no expected frequency be less than 1.0 and not than 20 % less than 5.0 is fulfilled. The resulting chi-square value is unbiased. The H_0 hypothesis was that the relative frequencies of the 9 selected taxonomic entities are independent of the sampling location. The H_A (alternative) hypothesis was that the relative frequencies of the 9 selected taxa are not independent of the sampling location. The chi-square test computed value was 74.898, whereas chi-square test critical value amounts to 15.507 at the significance level of 0.05. In such a case the H_0 hypothesis should be rejected and it means that the frequency of the selected 9 taxa is independent of location.

A
52. notdetermined
33. *Navicula cari*
28. *Fragilaria zeilleri* var. *zeilleri*
26. *Fragilaria martyi*
24. *Fragilaria construens* var. *venter*
22. *Fragilaria construens* var. *construens*
47. *Sellaphora bacillum*
46. *Fragilaria* spec. 3
2. *Amphora copulata*
9. *Cyclotella gregori*

B
49. *Stauroneis smithii*
48. *Sellaphora pupula* var. *pupula*
42. *Nitzschia sinuata*
35. *Navicula lanceolata*
11. *Cymatopleura solea*
6. *Cavinula mollicula*
3. *Aneumastus tusculus*
1. *Achnanthes lanceolata*
44. *Pliocaenicus omarensis*
43. *Pliocaenicus undulatus*
41. *Navicula* spec. 2
40. *Navicula* spec. 1
27. *Fragilaria pinnata*
25. *Fragilaria* spec. 1
34. *Navicula cryptotenella*
31. *Gomphonema groveii*
18. *Encyonema caespitosa*
5. *Cavinula cocconeiformis*
17. *Epithemia sorex*
16. *Epithemia frickei*
15. *Diploneis mauleri*
14. *Diploneis* spec.
10. *Cyclotella radiosa* var. *pliocaenica*

C
51. *Stephanodiscus* spec. 2
45. *Placoneis gastrum* var. *signata*
38. *Navicula pseudoventralis*
36. *Navicula hasta*
32. *Gyrosigma attenuatum*
30. *Geissleria paludosa*
21. *Fragilaria capucina* var. *vaucheriae*
20. *Fallacia balnearis*
13. *Diploneis elliptica*
12. *Cymbella ehrenbergii*
8. *Craticula ambigua*
7. *Cocconeis disculus*
50. *Stephanodiscus* spec. 1
39. *Navicula rotundata*
37. *Navicula menisculus*
29. *Fragilaria* spec. 2.
19. *Ethmoidiscus hassiacus*
23. *Fragilaria construens* var. *binodis*
4. *Aulacoseira* spec.

3.1 MELETO

The number of taxa identified in the material from Meleto amounted to 110 (Table 1, see pls. I-IV). Most of the valves were strongly affected by dissolution processes. The diatom flora from Meleto was strongly dominated by *Cyclotella* representatives and *C. gregori* spec. nov. in particular. The second species from this genus resembled *C. kurdica* HÅKANSSON, but the proper identification due to high extent of dissolution was difficult. An abundance of the dominating *C. gregori* attained ca. 60.0 %. The most abundant were vegetative cells, although the number of initial valves was significant. The second in terms of abundance was *Aulacoseira* spec. with a frequency of 7.3 %. A characteristic feature of its distribution is its restriction to Meleto. To the group of taxa with raised abundance i.e. exceeding 3 % belonged: *Fragilaria martyi*, *F. construens* var. *construens* and *F. construens* var. *venter*. The remaining taxa were usually represented by a few valves. The most interesting of them were: *Ethmoidiscus hassiacus*, *Fallacia balnearis*, *Fragilaria bituminosa*, *F. capucina* var. *vaucheriaeae*, *Navicula absoluta*, *N. arenarieaeformis*, *N. cari*, *N. hasta*, *N. menisculus*, *N. submuralis*, *N. perobesa*, *Pliocaenicus undulatus*, *P. omarensis*, *Actinocyclus tunkaensis*, *Aulacoseira italica*. The group of world wide distributed cosmopolitan taxa included: *Amphora copulata*, *A. inariensis*, *A. pediculus*, *Cocconeis placentula*, *C. disculus*, *Craticula ambigua*, *Cymbella ehrenbergii*, *C. lata*, *Diploneis elliptica*, *D. marginestriata*, *Fragilaria construens* and varr., *F. martyi*, *F. capucina* var. *vaucheriae*, *Gomphonema grovei*, *Gyrosigma acuminatum*, *G. attenuatum*, *Navicula cari*, *N. cryptotenella*, *N. radiosa*, *Nitzschia sigmoidea*, *N. sinuata*, *N. tabellaria*.

The group of fossil taxa, which were rarely found included: *Actinocyclus tunkaensis*, *Ethmodiscus hassiacus*, *Fragilaria bituminosa*, *F. transylvanica*, *Navicula arenarieaeformis*, *N. perobesa*, *Pliocaenicus omarensis*, *P. undulatus*.

3.2 S. BARBARA

Unlike Meleto, diatoms in St. Barbara deposits were unaffected by dissolution, but they were distorted by compaction. The diatom flora of St. Barbara (Table 1, see pls. V-X) was dominated by *Cyclotella gregori* and *C. radiosa* var. *pliocaenica* and their abundance attained 60.4 % and 9 % respectively. In this locality, vegetative cells of *C. gregorii* were associated by frequently occurring initial cells. Despite the stronger dominance of *C. gregori* and *C. radiosa* var. *pliocaenica* the diversity of the diatom flora in St. Barbara was by far higher than in Meleto. The number of taxa identified amounted to 172, numerous unidentified taxa. Compared to Meleto, only a very few taxa i.e. *Fragilaria zeilleri* var. *zeilleri* (6.0 %), *F. martyi* (4.2 %), *Navicula cari* (2.2 %) attained frequency of occurrence exceeding 2.0 %. Most of the remaining taxa were represented by a few specimens. The group of the most characteristic taxa included: *Melosira undulata*, *Achnanthes clevei*, *A. joursacense*, *A. rupestoides*, *Amphora aequalis*, *A. copulata*, *A. inariensis*, *A. pediculus*, *Cocconeis disculus*, *C. placentula* var. *placentula*, *Cavinula jentzschii*, *C. scutelloides*, *Cymbella affinis*, *C. lata*, *C. tumida*, *Diploneis mauleri*, *Gomphonema grovei* and a number of *Navicula* representatives e.g. *N. cari*, *N. hasta*, *N. perobesa*, *N. viridula*. The genus of *Aulacoseira*, second in terms of abundance in Meleto, in St. Barbara was rarely represented by well known taxa e.g. *A. granulata*, *A. italica* and *A. islandica*. In none of the preparations from St. Barbara was *Aulacoseira* spec. found, which attained rather high frequency of occurrence in Meleto. Another species *Ethmodicus hassiacus* characteristic for Meleto, was not found in St. Barbara. On the other hand some taxa found in St. Barbara were not recorded in preparations from Meleto. Examples of this group included: e.g. *Achnanthes oestrupii* var. *pungens*, *Amphora bilobata*, most of *Cymbella* taxa, *Diploneis mauleri*, *Encyonema caespitosa*, *Luticola mutica*, *Rhopalodia gibba*, *Stephanodiscus carconensis*, *Tetracyclus glans*.

With respect to the life habitat in St. Barbara, planktonic taxa strongly dominated. Their total content attained ca. 75 %. Next to dominating *Cyclotella gregori*, and *C. radiosa* var. *pliocaenica* they were represented by e.g. *Actinocyclus tunkaensis*, *Asterionella formosa*, *Aulacoseira ambigua*, *A. granulata*, *A. islandica*, *Pliocaenicus omarensis*, *P. undulatus*, *Stephanodiscus carconensis*, *S. hantzschii* and *S. minutulus*. Most of the remaining taxa are to be found living on the bottom sediments or as epiphytes. With respect to the number of taxa those inhabiting bottom sediments, in this particular case epipelic, forms dominated. Group of taxa, which live attached or adhered to other plants included representatives of the following genera: *Achnanthes*, *Cocconeis*, *Cymbella*, *Epithemia*, *Gomphonema* and *Rhoicosphenia*. However, the composition of the bottom sediments, in the contemporaneous lake, of very fine clay might have been very unfavourable for epipelic and epiphytic diatom taxa. The above may indicate that these taxa were redeposited from shallow water area or transported by river discharge.

The group of fossil taxa, which are rare to scarce included: *Amphora bilobata*, *A. borneti*, *Fragilaria bituminosa*, *F.* aff. *miocenica*, *Navicula arenarieaeformis*, *N. perobesa*, *N. turris*, *Pliocaenicus omarensis*, *P. undulatus*.

Table 1: Distribution of Diatom-Taxa in the sediments of Meleto and S. Barbara

Taxa	Meleto	S.Barbara
Achnanthes cf. *lacusvulcanii* L.-B.		+
Achnanthes clevei GRUN.	+	+
Achnanthes conspicua MAYER		+
Achnanthes exigua GRUN.var. *exigua* GRUN.	+	+
Achnanthes exigua GRUN.var. *elliptica* HUST.	+	
Achnanthes holsatica HUST.	+	
Achnanthes joursacense HÉRIB.	+	+
Achnanthes laevis ØSTR.		+
Achnanthes lanceolata (BRÉB.) GRUN.	+	+
Achnanthes levanderi HUST.	+	+
Achnanthes minutissima KÜTZ.	+	+
Achnanthes oestrupii (CL.-EUL.) HUST.var. *pungens* (CL.) L.-B.		+
Achnanthes peragallii BRUN & HÉRIB.		+
Achnanthes ploenensis HUST.		+
Achnanthes rupestoides HOHN	+	+
Actinocyclus tunkaensis KHURS.	+	+
Amphora aequalis KRAMMER	+	
Amphora bilobata LOSEVA		+
Amphora borneti HÉRIB.		+
Amphora calumetica (THOMAS) PERAG.		+
Amphora copulata (KÜTZ.) SCHOE. & ARCH.	+	+
Amphora crucifera CL.-EUL.	+	+
Amphora fogediana KRAMMER		+
Amphora inariensis KRAMMER		+
Amphora ovalis (KÜTZ.) KÜTZ.	+	
Amphora pediculus (KÜTZ.) GRUN.	+	+
Aneumastus stroesei (ØSTR.) D. G. MANN	+	+
Aneumastus tsuculus (EHR.) D. G. MANN & STICK.	+	+
Asterionella formosa HASS.		+
Aulacoseira ambigua (GRUN.) SIMONSEN		+
Aulacoseira granulata (EHR.) SIMONSEN		+
Aulacoseira granulata (EHR.) SIMONSEN var. *angustissima* (O. MÜLL.) SIMONSEN		+
Aulacoseira islandica (O. MÜLL.) SIMONSEN	+	+
Aulacoseira italica (EHR.) SIMONSEN	+	+
Aulacoseira spec.	+	
Caloneis bacillum (GRUN.) CL.	+	
Caloneis fontinalis L.-B. & REICHARDT		+
Caloneis schumaniana (GRUN.) CL.	+	+
Caloneis schumaniana (GRUN.) CL.var. *biconstricta* (GRUN.) REICHELT		+
Campylodiscus lacus baicalii SKVORTZ.		+
Campylodiscus levanderi HUST.		+
Cavinula cocconeiformis (GREG.) D.G. MANN & STICK.		+
Cavinula cocconeiformis fo. *elliptica* (HUST.) L.-B.		+
Cavinula jaernefeltii (HUST.) D.G. MANN & STICK.		+
Cavinula mollicula (HUST.) L.-B.		+
Cavinula pseudoscutifotmis (HUST.) D.G. MANN & STICK.		+
Cavinula scutelloides (W. SM.) D.G.MANN & STICK.		+
Cavinula aff. *scutelloides* (W. SM.) D.G.MANN & STICK.		+
Cocconeis disculus (SCHUM.) CL.	+	+
Cocconeis neodiminuta KRAMMER		+
Cocconeis pediculus EHR.		+

Cocconeis placentula var. *euglypta* EHR.	+	+
Cocconeis placentula var. *klinoraphis* GEITLER		+
Cocconeis placentula EHR. var. *placentula* EHR.	+	+
Craticula ambigua (EHR.) D. G. MANN	+	+
Cyclostephanos dubius (FRICKE) ROUND		+
Cyclotella gregori spec. nov.	+	+
Cyclotella radiosa (GRUN.) LEMM. var. *pliocaenica* (KRASSKE) HÅKANSSON		+
Cymatopleura elliptica (BRÉB.) W. SM.	+	+
Cymatopleura solea (BRÉB.) W. SM.	+	
Cymbella affinis KÜTZ.		+
Cymbella aspera (EHR.) PERAG.		+
Cymbella cf. *citrus* CARTER & BAILEY-WATTS		+
Cymbella cistula (EHR.) KIRCHNER		+
Cymbella cuspidata KÜTZ.		+
Cymbella ehrenbergii KÜTZ.	+	
Cymbella hebridica (GRUN.) CL.		+
Cymbella lanceolata (EHR.) VAN HEURCK	+	+
Cymbella lata GRUN.		+
Cymbella leptoceros (EHR.) KÜTZ.		+
Cymbella minuta HILSE		+
Cymbella prostrata (BERKELEY) CL.	+	+
Cymbella schimanskii KRAMMER		+
Cymbella silesiaca BLEISCH		+
Cymbella tumida (BRÉB.) VAN HEURCK		+
Diatoma ehrenbergii KÜTZ.		+
Diploneis cf. *aestuari* HUST.		+
Diploneis elliptica (KÜTZ.) CL.	+	+
Diploneis marginestriata HUST.	+	+
Diploneis mauleri (BRUN) CL.		+
Diploneis modica HUST.		+
Diploneis ovalis (HILSE) CL.	+	
Diploneis parma CL.		+
Diploneis aff. *smithii* (BRÉB.) CL.		+
Ellerbeckia arenaria (MOORE) CRAWFORD		+
Encyonema caespitosum KÜTZ.		+
Epithemia adnata (KÜTZ.) BRÉB.	+	+
Epithemia frickei KRAMMER	+	+
Epithemia goeppertiana HILSE		+
Epithemia sorex KÜTZ.	+	+
Epithemia turgida (EHR.) KÜTZ.	+	+
Ethmodiscus hassiacus KRASSKE	+	
Eunotia boreotenuis L.-B. & NÖRPEL-SCH..	+	
Eunotia cf. *hexaglyphis* EHR.		+
Eunotia glacialis MEISTER		+
Eunotia rhomboides HUST.	+	
Eunotia septena EHR.		+
Fallacia balnearis (GRUN.) WITK., L.-B. & METZ.	+	
Fallacia cf. *helensis* (SCHULZ) D. G. MANN		+
Fragilaria bituminosa PANT.		+
Fragilaria brevistriata GRUN.	+	
Fragilaria capucina DESM. var. *vaucheriae* (KÜTZ.) L.-B.	+	+
Fragilaria construens (EHR.) GRUN. var. *binodis* (EHR.) GRUN.	+	+
Fragilaria construens var. *construens* (EHR.) GRUN.	+	+
Fragilaria construens var. *venter* (EHR.) GRUN.	+	+
Fragilaria costata (REHAKOVA) L.-B.	+	
Fragilaria lapponica GRUN.	+	+
Fragilaria leptostauron EHR.		+
Fragilaria martyi (HÉRIB.) L.-B.	+	+

Fragilaria microstriata MARCINIAK	+	
Fragilaria aff. *miocenica* JOUSE	+	+
Fragilaria oldenburgiana HUST.		+
Fragilaria parasitica (W. SM.) L.-B.	+	
Fragilaria pinnata EHR.	+	+
Fragilaria robusta MANGUIN		+
Fragilaria transylvanica PANT.	+	
Fragilaria zeilleri var. *elliptica* GASSE	+	+
Fragilaria zeilleri HÉRIB. var. *zeilleri* HÉRIB.	+	+
Fragilaria spec. 1	+	
Fragilaria spec. 2	+	
Fragilaria spec. 3	+	+
Frustulia rhomboides (EHR.) DE TONI		+
Geissleria paludosa (HUST.) L.-B. & METZ.	+	
Geissleria decussis (HUST.) L.-B. & METZ.		+
Geissleria schoenfeldii (HUST.) L.-B. & METZ.		+
Gomphonema clavatum EHR.		+
Gomphonema gracile EHR.		+
Gomphonema grovei M. SCHM.	+	+
Gomphonema olivaceum (HORN.) BRÉB.		+
Gyrosigma acuminatum (KÜTZ.) RABENHORST	+	+
Gyrosigma attenuatum (KÜTZ.) RABENHORST	+	+
Gyrosigma scalproides (RABENHORST) CL.		+
Hippodonta cf. *avittata* (CHOLN.) L.-B. & AL.		+
Hippodonta cf. *costulata* (GRUN.) L.-B. & AL.	+	
Hippodonta costulata (GRUN.) L.-B. & AL.		+
Hippodonta hungarica (GRUN.) L.-B. & AL.		+
Hippodonta lueneburgensis (GRUN.) L.-B. & AL.	+	
Luticola mutica (KÜTZ.) D.G. MANN		+
Melosira undulata (EHR.) KÜTZ.	+	+
Navicula aboensis HUST.	+	+
Navicula absoluta HUST.	+	+
Navicula angusta W. SM.		+
Navicula arenariaeformis PANT.		+
Navicula cari EHR.	+	+
Navicula cf. *striolata* (GRUN.) L.-B.		+
Navicula cf. *wiesneri* L.-B.	+	
Navicula concentrica CARTER	+	+
Navicula cryptotenella L.-B.		+
Navicula cryptotenelloides L.-B.		+
Navicula digitoradiata (GREGORY) RALFS		+
Navicula diluviana KRASSKE		+
Navicula hasta PANT.	+	
Navicula hastata JURILJ		+
Navicula jentzschii GRUN.	+	+
Navicula lanceolata (AGARDH) KÜTZ.		+
Navicula laterostrata HUST.	+	+
Navicula menisculus SCHUMANN	+	
Navicula oblonga KÜTZ.	+	
Navicula cf. *oligotraphenta* L.-B.		+
Navicula perobesa HUST.	+	+
Navicula platystoma EHR.		+
Navicula porifera HUST.	+	
Navicula pseudoanglica L.-B.		+
Navicula pseudomuralis HUST.		+
Navicula pseudoventralis HUST.	+	
Navicula radiosa KÜTZ.		+
Navicula raederieae L.-B.		+
Navicula reinhardtii (GRUN.) GRUN.	+	+
Navicula rotundata HANTZSCH		+

Navicula subrotundata HUST.		+	+
Navicula submuralis HUST.		+	
Navicula turris HUST.			+
Navicula viridula (KÜTZ.) EHR.		+	+
Neidium binodis (EHR.) HUST.			+
Nitzschia angustata GRUN.		+	+
Nitzschia brunoi L.-B.		+	
Nitzschia frustulum (KÜTZ.) GRUN.			+
Nitzschia sigmoidea (NITZSCH) W. SM.			+
Nitzschia solgensis CL.-EUL.			+
Nitzschia tabellaria GRUN.		+	+
Nitzshia sinuata (THWAITES?) GRUN.		+	+
Opephora naveana LE COHU		+	
Orthoseira roeseana (RABENHORST) O'MEARA		+	+
Parlibellus protracta (GRUN.) WITK., L.-B. & METZ.		+	+
Parlibellus protracta var. *elliptica* (HUST.)		+	
Pinnularia viridis (NITZSCH) EHR.		+	
Placoneis clementis (GRUN.)		+	+
Placoneis gastrum (EHR.) KÜTZ.		+	+
Placoneis gastrum (EHR.) KÜTZ. var. *signata* HUST.		+	
Placoneis placentula (EHR.) KÜTZ.		+	+
Pliocaenicus omarensis (KUPT.) ROUND & HÅK.		+	+
Pliocaenicus undulatus ROUND & HÅK.		+	+
Reimeria sinuata (GREGORY) KOCIOLEK & STOERMER		+	+
Rhoicosphenia abbreviata (AG.) L.-B.		+	+
Rhopalodia gibba (EHR.) O. MÜLLER			+
Sellaphora bacillum (EHR.) D.G. MANN		+	+
Sellaphora laevissima (KÜTZ.) D. G. MANN			+
Sellaphora lambda (CL.) L.-B. & METZ.		+	
Sellaphora lambda var. *densestriata* (SKVORTZ.) L.-B. & METZ.		+	
Sellaphora pupula var. *pupula* (KÜTZ.) MERESCHKOWSKY		+	
Sellaphora rectangularis (GREG.) L.-B. & METZ.			+
Stauroneis gracilis EHR.		+	+
Stauroneis smithii GRUN.		+	+
Staurosira punctiformis WITK., L.-B. & METZ.		+	
Stephanodiscus spec. 1		+	+
Stephanodiscus carconensis GRUN.			+
Stephanodiscus hantzschii GRUN.			+
Stephanodiscus minutulus (KÜTZ.) CL. & MÖLLER			+
Stephanodiscus parvus STOERMER & HÅKANSSON			+
Tetracyclus glans (EHR.) MILLS			+
Total number of taxa	**211**	**110**	**172**
Joint taxa	**71**		

3.3 SALINITY REQUIREMENTS

Amongst all taxa reported in both localities, only few from brackish- to slightly brackish-waters were identified. These were: *Fallacia balnearis*, *Opephora naveana* and *Staurosira punctiformis*. So far only one of these taxa, *F. balnearis* (as *Navicula forcipata* var. *balnearis*) was reported from Pliocene deposits of the Kama River area (LOSEVA 1982). *S. punctiformis* is common inhabitant of weakly saline lagoon environments around the Baltic Sea, e.g. Puck Bay, Vistula Firth, Szczecin Lagoon (WITKOWSKI & LANGE-BERTALOT 1993, WITKOWSKI et al. 2000, BAK et al. 2001). It finds optimum living conditions in waters with salinity of 1-2 psu. Only *F. balnearis* and *S. punctiformis* showed increased proportions, and the other taxa were very rarely recorded. Interesting is also *Opephora naveana* a brackish-water species described by LE COHU from southern Hemisphere, later on found in the North Sea estuaries (SABBE & VYVERMAN 1995) and in the Baltic Sea (WITKOWSKI et al. 2000). All these taxa were recorded in preparations from Meleto. The remaining taxa are considered freshwater ones. They inhabit inland lacustrine or riverine waters with moderate to increased electrolyte contents. In St. Barbara solitary valves of taxa resembling *Diploneis aestuarii* and *D. smithii* and few broken valves of other marine *Diploneis* were observed.

3.4 TROPHIC STATUS

Mass occurrence of a single species i.e. *Cyclotella gregori* associated by numerous initial cells may suggest that the floral development in the water basin studied occurred in a form of blooms. Also ROUND & HÅKANSSON (1992) stated that diatom assemblage in which *C. radiosa* var. *pliocaenica* occurred is inhabiting waters with similar characteristics. Apart from *Aulacoseira* spec., which trophic preferences are unknown, the most of the remaining taxa with increased abundance represented meso- to eutrophic forms with respect to nutrient requirements.

Interesting taxa

Cyclotella gregori spec. nov.

Pl. I, figs. 9-13, pl. V, figs. 8-15, pl. IX, figs. 1-8, pl. X, figs. 1-6

Holotype: Prep. 4092A, housed at the Institute of Marine Sciences, University of Szczecin, leg. Dr. H-J. Gregor

Isotype: No. 220059, housed at the Diatom Collection of the California Academy of Sciences in San Francisco.

Isotype: No. 4092B, housed in the Naturemuseum Augsburg, Germany

Locus typicus: Late Miocen/Early Pliocene limnic sediments from St. Barbara

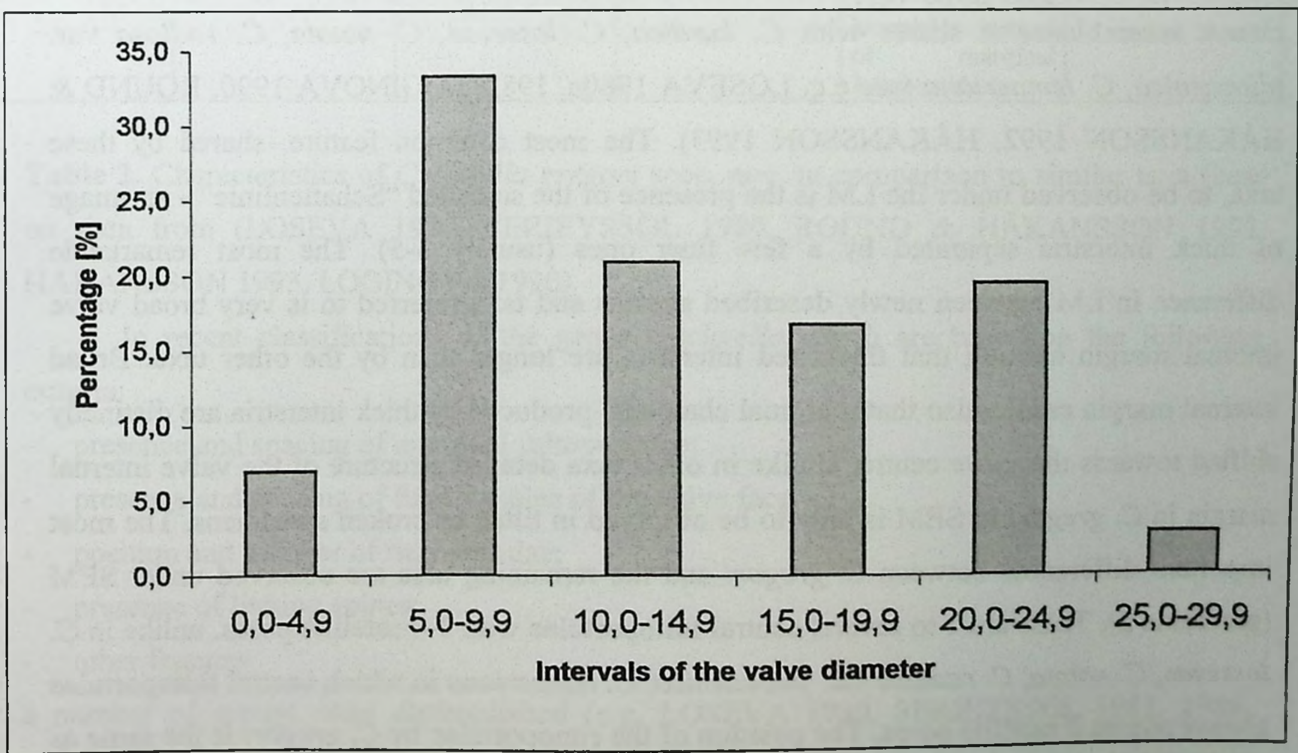
Stratum typicum: uppermost clays from the S. Barbara mine

Derivatio nominis: named after Dr. Hans-Joachim Gregor, working for more than 20 years in the Valdarno region, discovering the nature of the tiny fossils

Diagnosis (LM):

Cells united in chains. Valves circular, 4-26 μm in diameter (Fig. 4). The central very part slightly undulating with 3 to 6 depressions associated by distinct papilli up to 2 μm high. The valve face is divided into a hyaline central part and striated marginal one. Two types of striae are to be distinguished depending on their thickness. The longest striae, usually each fifth, are thick and form the, so called "Schattenlinie", between the long striae occur shorter ones. The number of striae amounts from 11 to 16 in 10 μm. On each thicker striae relatively robust spines occur. In LM also marginal furtoportulae on each thicker interstriae are to be observed.

Fig. 4. Distribution of size classes of *Cyclotella gregori* spec. nov. Note the right-sided skewness. (SD – 6.449; asymmetry factor – 0.355)



Description (SEM):

Valve face is separated into two parts, slightly undulating central part and gently sloped marginal part. The central part is bearing 3-6 cub-shaped depressions, which internally are covered with cribra. Each depression is associated with a corresponding papilli. The uppermost surface of the papilli bears traces of a breakage (In LM short chains of cells united by papilli were observed). The striae in SEM are composed of more or less circular areolae arranged either in three or two rows. Two orders of striae can be distinguished. The longest (1st order) are separated by broad interstriae. Towards the valve margin they split into shorter striae (2nd order).

The valve internal side is surrounded by exceptionally broad margin. Valve interior is plain with only several circular elevations corresponding to a number of cup-shaped depressions at the valve face. These elevations are covered with cribra. Marginal fultoportulae with two satellite pores occur at each thick interstriae. They open outwards as very short tubules, which in SEM bear breakage traces. One to three central fultoportulae with 3 to 4 satellite pores in the central part was observed. They were observed as tube-shaped openings on the valve exterior. A single rimoprtulae close to the valve margin was observed at one of the thick interstriae.

The newly described species *Cyclotella gregori* resembles in LM several taxa. The closest resemblance it shares with *C. kurdica*, *C. lossevae*, *C. notata*, *C. radiosa* var. *pliocaenica*, *C. temperiana* (see e.g. LOSEVA 1980a, 1982, LOGINOVA 1990, ROUND & HÅKANSSON 1992, HÅKANSSON 1993). The most common feature, shared by these taxa, to be observed under the LM is the presence of the so called "Schattenlinie" - an image of thick interstria separated by a few finer ones (usually 3-5). The most remarkable difference in LM between newly described species and taxa referred to is very broad valve internal margin causing that thickened interstria are longer than by the other taxa. Broad internal margin causes also that marginal chambers produced by thick interstria are distinctly shifted towards the valve centre. Unlike in other taxa detailed structure of the valve internal margin in *C. gregori* in SEM is only to be observed in tilted or broken specimens. The most important differences between *C. gregori* and the remaining taxa are observed under SEM (see Table 2). These are 1 to several central fultoportulae with 3-4 satellite pores, unlike in *C. lossevae*, *C. notata*, *C. radiosa* var. *pliocaenica*, *C. temperiana* in which central fultoportulae always posses 2 satellite pores. The position of the rimoportulae by *C. gregori* is the same as in *C. radiosa* var. *pliocaenica* and *C. temperiana*, whereas different as in *C. notata* and *C. lossevae* where it occurs on additional interstriae (partition) according to LOGINOVA

(1990). According to HÅKANSSON (1993) in *C. notata* it replaces one of the marginal fultoportulae.

	Cyclotella gregori spec. nov.	*Cyclotella kurdica* HÅKANSSON	*Cyclotella lossevae* LOGINOVA	*Cyclotella notata* LOSEVA	*Cyclotella radiosa* var. *pliocaenica* (KRASS.) HÅK.
Centre	Slightly undulating	More or less flat	More or less flat	More or less flat	More or less flat
Central area	Moderate, circular to slightly polygonal	Small, polygonal	Small, more or less polygonal	Small, polygonal	Moderate, more or less circular
Valve face fultoportulae	1-3 (so far observed)	Numerous	1-3	1-3 (3-5 according to HÅKANSSON 1993)	1-7
Number of satellite pores in central fultoportulae	3-4	2	2	2	2
Schattenlinien	Yes	Yes	Yes	Yes	Yes
Rimoportulae	One	One?	One	One on the additional partition, (according to HÅKANSSON 1993 on the thick interstriae instead of marginal fultoportulae)	One

Table 2. Characteristics of *Cyclotella gregori* spec. nov. in comparison to similar taxa (base on data from (LOSEVA 1980, SERIEYSSOL 1980, ROUND & HÅKANSSON 1992, HÅKANSSON 1993, LOGINOVA 1990)

In recent classifications of the genus *Cyclotella* which are based on the following criteria:

- presence and spacing of marginal fultoportulae;
- presence and spacing of fultoportulae of the valve face;
- position and number of rimoportulae;
- presence of linking spines;
- other features

a number of groups were distinguished (e.g. LOSEVA 1980, SERIEYSSOL 1981, 1984, SERVANT-VILDARY 1984, LOGINOVA 1990). Light and electron microscope characteristics of newly described *C. gregori* point out its closest relationship to *Cyclotella* *comta* group or to *Cyclotella radiosa* group taking into consideration nomenclatural problems with Ehrenberg's epitheton *comta* as discussed by ROUND & HÅKANSSON (1992) and HÅKANSSON (1993).

4. DISCUSSION

The results of the light microscopic analyses showed an occurrence of abundant diatom flora in the sediments studied. Altogether ca. 213 taxa were identified (see Table 1) with numerous taxa unidentified due to corrosion and fragmentation. At both sites mass occurrence of *Cyclotella gregori* was recorded. Apart from this taxon only a few of the remaining ones attained increased frequencies. Within the latter group some distinct differences were noted. The most important of them is absence of *Aulacoseira* spec. and of *Ethmodiscus hassiacus* in Santa Barbara and lack of *C. radiosa* var. *pliocaenica* in Meleto. In general, diatom flora in St. Barbara showed distinctly greater diversity than in Meleto.

Comparison to the published data indicates that the diatom flora from the study area, with few exceptions, represents cosmopolitan taxa of world wide distribution (e.g. KRASSKE 1932, 1934, 1938, REHAKOVA 1965, GERSONDE & VELITZELOS 1978, GASSE 1980, SERIEYSSOL 1980, 1981, BRADBURY & KREBS 1982, LOSEVA 1980b, 1982, KOCIOLEK et al. 1988, HAJOS 1990, ROUND & HÅKANSSON 1992, BRADBURY 1995, OGNJANOVA-RUMENOVA 1996, 2000, TEMNISKOVA-TOPALOVA & OGNJANOVA-RUMENOVA 1997). The group of taxa with limited geographic distribution includes *C. gregorii* and *C. radiosa* var. *pliocaenica*. It is interesting to know that the latter taxon, to the best of our knowledge, was recorded so far in Pliocene deposits from Germany (KRASSKE 1932, ROUND & HÅKANSSON 1992), Russia (e.g. LOSEVA 1980a, 1980b, 1982), Bulgaria (only in Sofia Basin by TEMNISKOVA-TOPALOVA & OGNJANOVA-RUMENOVA 1997) and in Pleistocene deposits of Belarus (KHURSEVICH 1999) and of north-eastern European part of Russia (LOSEVA 2000). It was not recorded in other Neogene deposits from Europe (e.g. SERIEYSSOL 1981, GERSONDE & VELITZELOS 1978), United States (e.g. BRADBURY & KREBS 1982). As indicated by other authors its stratigraphic range is limited to Pliocene and Pleistocene (KRASSKE 1932, LOSEVA 1982, ROUND & HÅKANSSON 1992). TEMNISKOVA-TOPALOVA & OGNJANOVA-RUMENOVA (1997) summarising stratigraphic ranges of various taxa indicate Pliocene to Holocene for C. radiosa var. pliocaenica, but we did not find any published data confirming this indication. ROUND & HÅKANSSON (1992) use a phrase "present material", but this is related to the Pliocene samples which these authors used next to the original material of KRASSKE.

There is a tendency to classify Neogene lacustrine diatom assemblages depending on the proportions of dominating genera respectively as "*Aulacoseira*" or "*Actinocyclus*" type (e.g. BRADBURY & KREBS 1995, TEMNISKOVA-TOPALOVA & OGNJANOVA-RUMENOVA 1997). According to the latter authors the basic taxa for "*Aulacoseira*" assemblage apart from genus *Aulacoseira* included some pennate species, both extant and fossil. Characteristic feature of this flora type is absence of other centric taxa apart from single representatives of *Actinocyclus*. The second - "*Actinocyclus*" assemblage is characterised by representatives of the genus *Actinocyclus* and unlike the former assemblage by the presence of rich flora of the other centric genera including: *Cyclotella*, *Ellerbeckia*, *Pliocaenicus* and *Stephanodiscus*. (e.g. BRADBURY & KREBS 1995, TEMNISKOVA-TOPALOVA & OGNJANOVA-RUMENOVA 1997).

This interpretation seems to be simplified attitude to the floristic problem. It is not only our material where strong domination of other centric taxa was recorded (e.g. SERIEYSSOL 1980, SERVANT-VILDARY 1984, MC LAUGHLIN 1992), of centric associated by raphid forms (e.g. LI & QI 1982, SERVANT-VILDARY et al. 1986) or even raphid with some admixture of centric taxa (e.g. GERSONDE & VELITZELOS 1978, HAJOS 1990).

As already indicated by FISCHER & BUTZMANN (2000) the age of the sediments studied ranged from the Late Miocene to Early Pliocene and this contradicts paleomagnetic (ALBIANELLI, 1995) and faunistic data (AZZAROLI & LAZZERI 1977). Most of the diatom taxa identified in Meleto and St. Barbara has broad stratigraphic range, while several of them might be used as biostratigraphic markers (for details see review by TEMNISKOVA-TOPALOVA & OGNJANOVA-RUMENOVA 1997). One of the most indicative seems to be *Ethmodiscus hassiacus* KRASSKE. It was described by KRASSKE from the Miocene deposits in Germany (KRASSKE 1934, LANGE-BERTALOT et al. 1996). Although not mentioned explicitly, BRADBURY & KREBS (1982) illustrated *Stephanodiscus* type of "*Ethmodiscus*" from the Snake River Formation in the Western United States. Also MOISSEJEVA in SHESHUKOVA-PORETZKAJA & MOISSEJEVA (1964) described variety *ethmodiscus* of *Coscinodiscus gorbunovii*, but they did not refer to the considered species. Abundant occurrence of *Coscinodiscus gorbunovii* SHESHUKOVA var. *ethmodiscus* MOISSEJEVA was reported from Middle and Late Miocene of the Lake Baikal region and from Early Pliocene of the southern part of the Far East (MOISSEJEVA et al. 1974a, MOISSEJEVA et al. 1974b). To the best of our knowledge Meleto is the second confirmed finding of this species in Europe. It was already KRASSKE (1934) to suspect that this species is an extinct one. Thus *E. hassiacus* indicates the Late Miocene/Early Pliocene age of the sediments studied, at least in Meleto. The other fossil taxa are represented by *Pliocaenicus omarensis*, *P. undulatus*, *Navicula arenariaeformis*, *Navicula perobesa*, *Fragilaria bituminosa*, *F. costata*, *F.* aff. *miocenica*, *F. transylvanica* and *F. zeilleri* var. *zeilleri*. At least four of these taxa i.e. *F. bituminosa*, *F. costata*, *F.* aff. *miocenica* and *F. zeilleri* var. *zeilleri* confirm the Late Miocene/Early Pliocene age of the sediments studied. The further study will proof whether the other so far unidentified *Fragilaria* taxa have stratigraphic meaning. Altogether the diatom flora of the sediments studied is predominantly composed of extant taxa.

According to MERLA & ABBATE (1967) Valdarno basin constituted in the past a large lake. The characteristics of the sediments studied i.e. clay with minor admixture of silt point out to calm, rather deep water sedimentary basin with riverine discharge. Periods of increased riverine inflows are marked by raised contents of silt particles. As revealed by macrofossil analyses shores of the paleolake were grown by species rich forest communities. Detailed results of the macroplants remnants are presented by FISCHER & BUTZMANN (2000). According to these authors the recent counterparts of the fossil Valdarno region flora are common members of the Mesophytic Forests, especially the Mixed Mesophytic Forests, however, some of the elements are also members of the Decidous Broad Leaved Forests (cooler climate) and the Evergreen Broad Leaved Forests (warmer climate). Thus a typical Cfa-climate was reconstructed for the ancient Meleto locality. The plants of Meleto were part of the vegetational units Wetland Forest, Forest Border / Scrub Vegetation, Flood Plain Forest and Upland Forest. The latter authors apart from macroplants, recorded in the sediments studied also rich green algal flora i.e. *Botryococcus braunii* and *Pediastrum* spp.

Excellent preservation state of the fossil macroflora indicates peculiar sedimentary conditions. FISCHER & BUTZMANN (2000) based on occurrence of vivianite imply oxygen poor and rich in phosphate environment. Abundant occurrence, most probably blooms, of *Cyclotella gregori*, *Botryococcus braunii* and *Pediastrum* spp., indicate eutrophicated waters. The presence of vivianite points out to the sediment interstitial waters rich in phosphates, which were at particular conditions released to the water column. Thus the organic matter deposited in the lacustrine sediments originated from two sources. These were: allochthonous (redeposited) macroplants remnants and allochthonous organic matter deposited from the water column as a result of termination of the algal blooms.

5. CONCLUSIONS

Diatoms proved to be useful paleoenvironmental and biostratigraphic indicators. Diatomological analysis of the sediments studied revealed that they were deposited in a lacustrine environment characterised by algal blooms composed of diatoms and green algae. The sediments studied were deposited in phosphorous rich, eutrophic waters. The diatom flora although quantitatively predominated by extinct forms, with respect to the species number is by far dominated by modern freshwater taxa. Some of the extinct taxa allowed determining a stratigraphic position of the sediments studied to Late Miocene and Early Pliocene and this is in agreement with the results of the macrofloristic study.

REFERENCES

ALBIANELLI, A. (1995): Caratteri magnetici e magnetostratigrafici dei sedimenti anossici fluvio-lacustri e marini coevi. - Thèse, Univ. Parma

AZZAROLI, A. e LAZZERI, L. (1977): I laghi del Valdarno Superiore. Centro Studi Geologia Appennino CNR. - Università di Firenze, Publ., 26, 1-4, Firenze

BAK, M., WAWRZYNIAK-WYDROWSKA B. & WITKOWSKI, A. (2001): Odra river discharge as a factor affecting species composition of the Szczecin Lagoon diatom flora, Poland. In: R. JAHN, P. KOCIOLEK, A. WITKOWSKI & P. COMPERE (eds), Lange-Bertalot-Festschrift: Studies on diatoms. A. R. G. Gantner K. G., pp. 491-506, Ruggell.

BRADBURY, J. P. (1988): Fossil diatoms and Neogene paleolimnology.- Palaeogeography, Palaeoclimatology, Palaeoecology, 62: 299-316

BRADBURY & BLAIR (1979): Paleoecology of the Upper Miocene Hualapai Limestone Member of the Muddy Creek Formation, Northwestern Arizona. In: Rocky Mountain Assoc. Geol. Utah Geol. Assoc. Basin and Range Symp., Ely, Nev., 1979, pp. 293-303

BRADBURY, J.P. & KREBS W.M. (1982): Neogene and Quaternary lacustrine diatoms of the Western Snake River Basin Idaho-Oregon, USA.- Acta Geologica Academiae Scientiarum Hungaricae, 25: 97-122

BRADBURY, J. P. (1995): *Actinocyclus* species from lacustrine Miocene deposits of the Western United States.- U.S. Geological Survey Professional Paper, 1543A: 1-47

CLARKE, K., R. & WAWRICK, R. (1995): Change in marine communities: an approach to statistical analysis and interpretation. - Nat. Environ. Res. Council, U.K.: pp. 144

DENYS, L. (1991): A check-list of the diatoms in the Holocene deposits of the Western Belgian coastal plain with a survey of their apparent ecological requirements. - I. Introduction, ecological code and complete list. - Professional Papers Belgische Geologische Dienst. 246: 1-41

EHRENBERG, C., G. (1854): Mikrogeologie: das Erden und Felsen schaffende Wirken des unsichtbar kleinen selbständigen Lebens auf der Erde. - 374 S., Leopold Voss, Leipzig.

EHRLICH, A. (1966): Contributions a l'étude des gisements volcano-lacustres à Diatomées de la région de Rochessauve et de Saint Bauzile (Ardéche). - Bull. Soc. Géol. France ser. 7, 7: 311-321

FISCHER, T. C. & BUTZMANN, R. (2000): Die neogene Flora von Meleto (Valdarno, Italien) Paläobotanik, Paläoökologie und Paläoklima.- Flora Tertiaria Mediterranea, VI, 5: 1-187, 156 Figs, 19 Tab., 29 Taf., München

FOURTANIER, E., GASSE, F., BELLIER, O., BONHOMME, M.G. & ROBLES, I. (1993): Miocene non-marine diatoms from the western Cordillera basins of northern Peru. - Diat. Res., 8: 13-30

GASSE, F. (1980): Les diatomees lacustres pliopleistocenes du Ghadeb (Ethiopie). Systematique, paleoecologie, biostratigraphie.- Rev. Algol. Mém. H. s. 3: 1-249

GERSONDE, R. & VELITZELOS, E. (1978): Diatomeenpalaeökologie im Neogen-Becken von Vegora N-W Mazedonien.- Ann. Geol. Pays Hellen., 29: 373-382

HAJOS, M. (1990) : Diatoms in alginite from Hungarian Pliocene crater lakes. In : H. Simola (ed.), Proceedings of the 10th International Diatom Symposium Joensuu, pp. 365-371, Koeltz Sci., Koenigstein

HÉRIBAUD, F., J. (1893-1908): Les Diatomees d'Auvergne. - Librarie des Sciences Naturelles, Paris. (1893) : premier mémoire, p. 1-233. (1902): deuxième mémoire, p. 1-79. (1908): troisième mémoire, p. 1-70, Paris

HAWORTH, E., Y. & SABATER, S. (1993): A new Miocene *Aulacoseira* species in diatomite from the ancient lake in La Cerdanya (NE Spain). - Nova Hedwigia, Beih. 106: 227-242

HÅKANSSON, H. (1993): Morphological and taxonomic problems in four *Cyclotella* species (Bacillariophyceae). - Diat. Res. 8: 309-316.

KHURSEVICH G. K. (1999): Diatom communities from the middle Pleistocene deposits of Belarus. In: MAYAMA, IDEI & KOIZUMI (eds) Proceedings of 14th International Diatom Symposium, Tokyo 1996, pp. 591-601, Koeltz Sci., Koenigstein

KOCIOLEK J., P., JING-RONG, Y. & STOERMER, E., F. (1988): Taxonomy, ultrastructure and systematic position of the *Gomphonema grovei* M. Schm. – species complex (Bacillariophyceae).- Nova Hedwigia, 47: 145-158

KRAMMER, K. & LANGE-BERTALOT, H. (1986): Bacillariophyceae 1, Naviculaceae. - In: ETTL, H., GERLOFF, J., HEYNIG, H. & MOLLENHAUER, D. (eds.). Süßwasserflora von Mitteleuropa 2 (1), 876 pp., Fischer, Stuttgart

KRAMMER, K. & LANGE-BERTALOT, H. (1988): Bacillariophyceae 2, Epithemiaceae, Bacillariaceae, Surirellaceae. - In: ETTL, H., GERLOFF, J., HEYNIG, H., MOLLENHAUER, D. (eds.). Süßwasserflora von Mitteleuropa 2 (2), 596 pp., Fischer, Stuttgart

KRAMMER, K. & LANGE-BERTALOT, H. (1991a): Bacillariophycae 3, Centrales, Fragillariaceae, Eunotiaceae. - In: ETTL, H., GERLOFF, J., HEYNIG, H., MOLLENHAUER, D. (eds.). Süßwasserflora von Mitteleuropa 2 (3), 576 pp., Fischer, Stuttgart

KRAMMER, K. & LANGE-BERTALOT, H. (1991b): Bacillariophycae 4, Achnanthaceae. - In: ETTL, H., GÄRTNER, J., GERLOFF, J., HEYNIG, H. & MOLLENHAUER, D. (eds). Süßwasserflora von Mitteleuropa 2 (4), 437 pp., Fischer, Stuttgart

KAMMER K., LANGE-BERTALOT, H. & SCHILLER W. (1997): *Miosira rhoenana* n.gen. n.sp. (Bacillariophyceae) aus miozänen limnischen Sedimenten der Rhön im Vergleich mit anderen zentrischen Diatomeen. - Paläontologische Zeitschrift, 71: 5-18

KRASSKE, G. (1932): Diatomeen aus dem Oberpliocän von Willershausen. - Arch. Hydrobiol., 24: 431-448

KRASSKE, G. (1934): Die Diatomeenflora der hessischen Kieselgurlager. - Sitz.-Ber. Heidelberger Akad. Wiss., mathem.-naturw Kl., 5: 1-26

KRASSKE, G. (1938): Die Diatomeenflora der Kieselgur aus dem Phonolithtuff vom Nordost-Abhang des Hochsimmer bei Mayen (Eifel). - Jahrb. Preuss. Geol. Landesanst., 58: 472-477

KREBS, W., N. BRADBURY, J., P. & THERIOT, E., C. (1987): Neogene and Quaternary lacustrine diatom biochronology, Western USA. - Palaios 2: 505-513

LANCE, G., N. & WILLIAMS, W., T. (1967): A general theory of classificatory sorting strategies. I. Hierarchical systems. - Comp. J. 9: 373-380

LANGE-BERTALOT, H. (2001): *Navicula* sensu stricto. In: H. LANGE-BERTALOT (ed.), Diatoms of Europe. 2. A.R.G. Gantner K.G., pp. 1-96, Ruggell

LANGE-BERTALOT, H. & METZELTIN, D. (1996): Oligotrophie-Indikatoren, 800 Taxa repräsentativ für drei diverse Seen-Typen, kalkreich – oligodystroph – schwach gepuffertes Weichwasser. - Iconographia Diatomologica, 2: 1-390. Koeltz Sci. Koenigstein

LANGE-BERTALOT, H., KÜLBS K., LAUSER T., NÖRPEL-SCHEMPP M. & WILLMANN M. (1996): Dokumentation und Revision der von Georg KRASSKE beschriebenen Diatomeen-Taxa.- Iconographia Diatomologica 3: 1-358

LI, J. & Qi, Y. (1982): Neogene diatom assemblages in China. In: MANN D. G. (ed.), Proceedings of the 7th International Diatom Symposium, pp. 699-711, Koeltz Sci., Koenigstein

LOGINOVA, L., P. (1990): Classification of diatom genus *Cyclotella.* In: H. Simola (ed.), Proceedings of the 10th International Diatom Symposium Joensuu, pp. 37-41, Koeltz Sci., Koenigstein

LOSEVA, E., I. (1978): Diatomovye vodorosli is rasreza Omara v nischniem tetschenii reki Kamy. Biostratigraphia phanerosoia Severo-Vostoka evropeiskoi tschasti SSSR. - Trudy Inst. Geologii Komi Filiala AN SSSR., 25: 59-69

LOSEVA, E., I. (1980a): The valve ultrastructure of some fossil Cyclotella species. In: R. Ross (ed.), Proceedings of the 6th International Diatom Symposium Budapest, pp. 15-26, Koeltz Sci., Koenigstein

LOSEVA, E., I. (1980b): Some common fossil diatoms from the East European Plain (the Kama River Basin) and the Massif Central. In: R. ROSS (ed.), Proceedings of the 6th International Diatom Symposium Budapest, pp. 75-80, Koeltz Sci., Koenigstein

LOSEVA, E., I. (1982): Atlas posdnepliocenovykch diatomej prikamja. - Nauka., pp. 204, Leningrad

LOSEVA, E., I. (2000): Atlas presnevodnykh pleistocenovykch diatomej evropeiskogho severo-vostokha. – Nauka, pp. 213, . St.-Petersburg

MC LAUGHLIN, R., B. (1992): *Cyclotella jonesii*, a new diatom species from Pliocene deposits at Chiloquin, Oregon, USA. - Diatom Research, 7: 95-101

MERLA, G. e ABBATE, E. (1967): Note illustrative della Carta Geologica d'Italia. - Foglio 114, Arezzo, Serv. Geol. Ital., pp. 1-52, Roma

MOISEEJEVA, A. I., RUBINA N. V. & TCHEREMISOVA, E. A. (1974a): Miocene diatoms. In: GLESER, S. I., JOUSE, A. P., MAKAROVA, I. V., PROSCHKINA-LAVRENKO, A. P., SESHUKOVA-PORETZKAJA, V. S. (eds). The diatoms of the USSR. Fossil and recent. Nauka, Leningrad, pp. 191-204

MOISEEJEVA, A. I., KUPTSOVA, I. A., LUPIKINA, E. G. & TCHEREMISOVA, E. A. (1974b): Pliocene diatoms. In: GLESER, S. I., JOUSE, A. P., MAKAROVA, I. V., PROSCHKINA-LAVRENKO, A. P., SESHUKOVA-PORETZKAJA, V. S. (eds), The diatoms of the USSR. Fossil and recent. Nauka, Leningrad, pp. 204-224

OGNJANOVA, N., G. & POPOVA, E. (1991): Diatom biostratigraphy and comparative core correlation within the Sofia Basin, Bulgaria. - Pan-European Palaeobotanical Conference, pp. 197-203, Vienna

OGNJANOVA-RUMENOVA, N., G. (1994): Taxonomical composition of fossil diatoms from neogene nonmarine sediments, Sofia Basin.- Annuaire De L'Universite De Sofia " St. Kliment Ohridski" Faculte De Biologie, Livre 2. - Botanique, 85: 55-58

OGNJANOVA-RUMENOVA, N., G. (1996): Cyclotella iris Brun & Héribaud – a group from the upper miocene sediments of the Sofia Basin, Bulgaria. - Geologica Carpathica, 47: 301-310

OGNJANOVA-RUMENOVA, N., G. (2000): Lacustrine diatom flora from Neogene basins on the Balkan Peninsula; preliminary biostratigraphic data. In: A. WITKOWSKI & J. SIEMIŃSKA (eds), The origin and early evolution of the diatoms fossil, molecular and biogeographical approaches. W. Szafer Institute of Botany Polish Academy of Sciences, pp. 137-143, Cracow

OGNJANOVA-RUMENOVA, N., G. & VASS, D. (1998): Paleoecology of the Late Miocene maar lakes, Podrecany Basalt Formation, Southern Slovakia, on the basis of siliceous microfossils.- Geologia Carpathica, 49: 351-368

PANTOCSEK, J. (1886-1905): Beiträge zur Kenntnis der Fossilen Bacillarien Ungarns. Nagy Topolcsany, Julius Platzko. 1886- Vol. I. Marine Bacillarien: 74 p. 1889- Vol. II. Brackwässer Bacillarien: 123 p. 1892- Vol. III. Süsswasser Bacillarien. 1905- Beschreibung neuer Bacillarien welche in der Pars III. C.W. Wigand, Pozsony: 118 p.

REHAKOVA, Z. (1965): Fossile Diatomeen der südbohemischen Beckenablagerungen. - Rozpr. Ustr. Ustavu Geol. Svazek 32: 1-96

REHAKOVA, Z. (1980): Süsswasserdiatomeenflora des oberen Miozäns in der Tschechoslovakei. - Journ. Geol. Soc. Paleont. 23: 83-184

ROUND, F. E. & HÅKANSSON, H. (1992): Cyclotelloid species from a diatomite in the Harz Mountains, Germany, including *Pliocaenicus* gen. nov. - Diatom Research, 7: 109-125

SABBE, K. & VYVERMAN, W. (1995): Taxonomy, morphology and ecology of some widespread representatives of the diatom genus *Opephora*. - Eur. J. Phycol. 30: 235-249

SCHILLER, W. (1994): Miozäne Diatomeen von der Guckas bei Rüdenschwinden/Röhn. - Beiträge zur Naturkunde in Osthessen., 29: 35-47

SCHILLER, W. & NUÑEZ, C., A. (1994): Voralufige Mittelung über Diatomeen-führende Sedimente aus dem Neogen von Guatemala (Zentral-Amerika). - Documenta Naturae 84: 2-9, München

SERIEYSSOL, K., K. (1980): *Cyclotella* species from the late Miocene age from St. Bauzile France. In: R. Ross (ed.), Proceedings of the 6th International Diatom Symposium Budapest, pp. 27-42, Koeltz Sci., Koenigstein

SERIEYSSOL, K., K. (1982): *Cyclotella iris* Brun & Héribaud. In: D. G. MANN (ed.), Preceedings of the 7th International Diatom Symposium Budapest, pp. 197-212, Koeltz Sci., Koenigstein

SERIEYSSOL, K. (1986): *Fragilaria zeilleri* Héribaud. In: F. E. ROUND (ed.), Proceedings of the 9th International Diatom Symposium, Bristol, pp. 371-375, Biopress, Bristol

SERVANT-VILDARY, S. (1984): Fossil *Cyclotella* species from Miocene lacustrine deposits of Spain. In: M. RICARD (ed.), Proceedings of the 8th International Diatom Symposium, pp. 371-375, Koeltz Sci., Koenigstein

SERVANT-VILDARY, S., PAICHELER, J., C. & SEMELIN, B. (1986): Miocene lacustrine diatoms from Turkey. In: F. E. ROUND (ed.), Proceedings of the 9th International Diatom Symposium, Bristol, pp. 371-375, Biopress, Bristol

SHESHUKOVA-PORETZKAJA, V. S. & MOISSEJEVA, A. I. (1964): New and interesting freshwater diatoms from the Neogene of western Siberia and the Far East. - Novosti syst. niz. rastienii M. – L. Nauka pp. 92-103

TANAKA H. & KOBAYASI H. (1999): *Pliocaenicus costatus* and *P. omarensis* found in Japan. In: MAYAMA, IDEI & KOIZUMI (eds), Proceedings of 14th International Diatom Symposium, Tokyo 1996, pp. 135-143, .Koeltz Sci., Koenigstein

TEMNISKOVA-TOPALOVA, D., OGNJANOVA-RUMENOVA, N., VALEVA, M. (1990): Nonmarine Diatoms from Neogene Sediments of Bulgaria. In: H. SIMOLA (ed.), Proceedings of 10th International Diatom Symposium, Joensuu, Finland, pp. 357-365 Koeltz Sci., Koenigstein

TEMNISKOVA-TOPALOVA D. & VALEVA, M. (1996): Diatom analysis of Neogene sediments from the Korlovo coal basin (Southern Bulgaria). I. Species composition, taxonomic structure, analysis of diatom flora. - Phytologia Balcanica Vol. 2/1: 2-12

TEMNISKOVA-TOPALOVA, D., OGNJANOVA-RUMENOVA, N., G. & POPOVA, E. (1996): Diatom analysis of Neogene sediments from the Korlovo coal basin (southern Bulgaria). II. Stratigraphy and palaeoecology based on siliceous microfossils. - Phytologia Balcanica Vol. 2/1: 13-28

TEMNISKOVA-TOPALOVA, D. & OGNJANOVA-RUMENOVA, N., G. (1997): Description, comparison and biostratigraphy of the nonmarine Neogene diatom floras from Southern Bulgaria. - Geologica Balcanica, 27.1-2: 57-81

TEMNISKOVA-TOPALOVA, D., OGNJANOVA-RUMENOVA, N., G. & VALEVA, M. (1994): Nonmarine Biostratigraphy of some genera of subclass Centrophycidae. South Bulgaria. – In: P. J. KOCIOLEK (ed.), Proceedings of 11th International Diatom Symposium, San Francisco. pp. 301 - 310

TEMNISKOVA-TOPALOVA, D., IVANOV, D., A. & POPOVA, E. (1996): Diatom analysis on neogene sediments from the Elhovo Basin in south Bulgaria. - Geologica Carpathica, 47, 5: 289-300

VAN DAM, H., MERTENS, A. & SINKELDAM, J. (1994): A coded checklist and ecological indicator values of freshwater diatoms from the Netherlands. - Netherlands Journal of Aquatic Ecology 28: 117-133

VAN LANDINGHAM, S. (1964): Miocene non-marine diatoms from the Yakima region in southcentral Washington. - Nova Hedwigia, Beih., 14: 78 pp.

WANG G. (1999): *Pliocaenicus cathayanus* sp. nov. and *P. jilinensis* sp. nov. From diatomite of Jilin Province, Northeast China. - In: MAYAMA, IDEI & KOIZUMI (eds), Proceedings of 14th International Diatom Symposium, Tokyo 1996, pp., 125-133, Koeltz Sci., Koenigstein

WITKOWSKI, A., LANGE-BERTALOT, H. & METZELTIN, D. (2000): Diatom flora of Marine coasts. I. - Iconographia Diatomologica, 7: 1-925. Gantner K.G., Ruggell

Plates

Plate I

Diatoms from the fossil site Meleto:

(magnification x 1600)

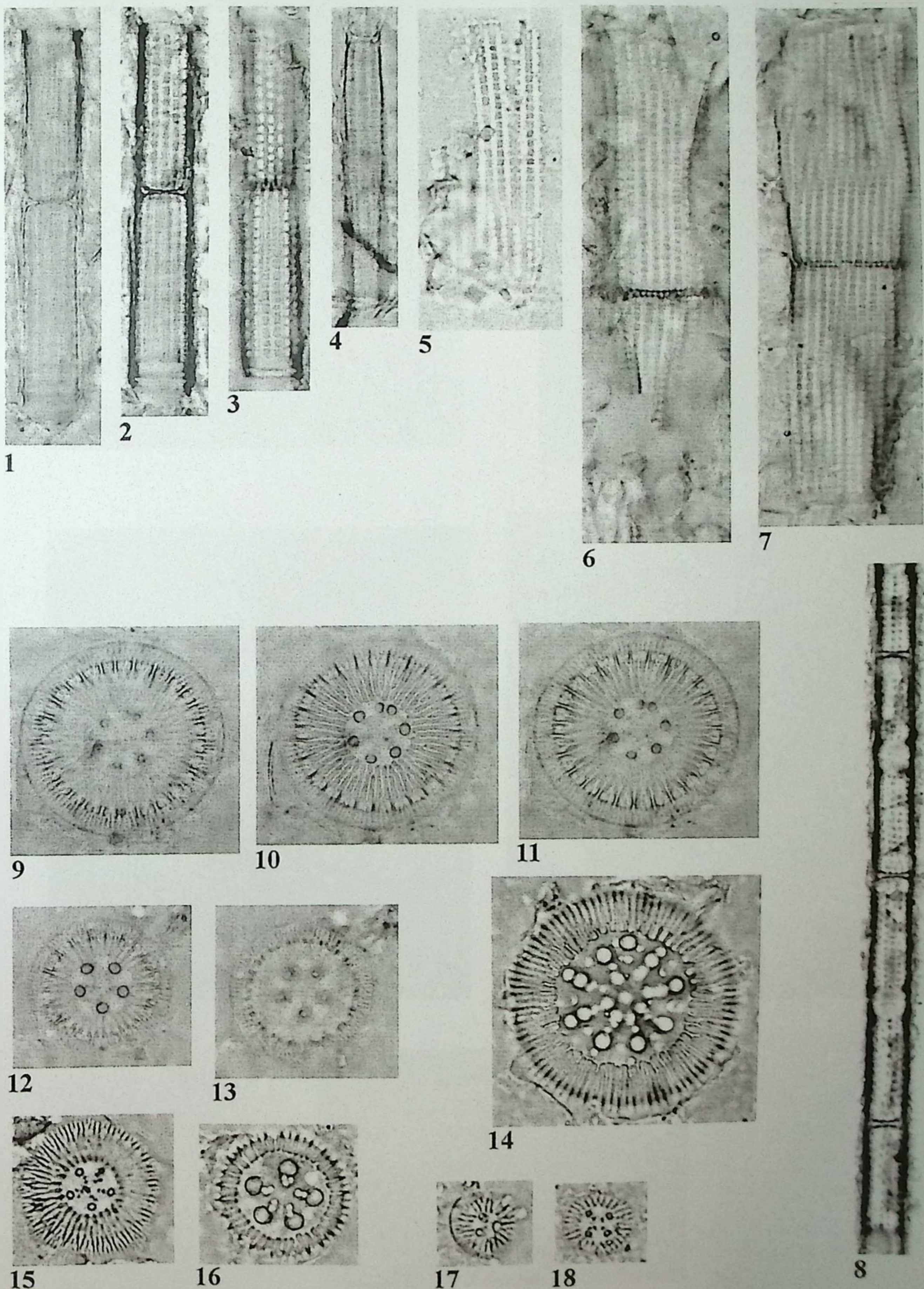
Figs 1-7: *Aulacoseira* spec.,

Fig. 8: *Aulacoseira italica*,

Figs 9-13: *Cyclotella gregori* spec. nov.

Figs 14-18: *Cyclotella* spec.

Plate I

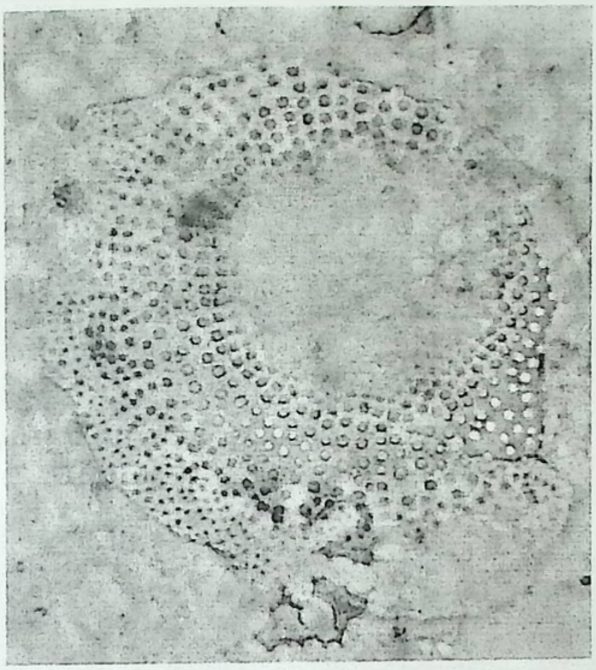


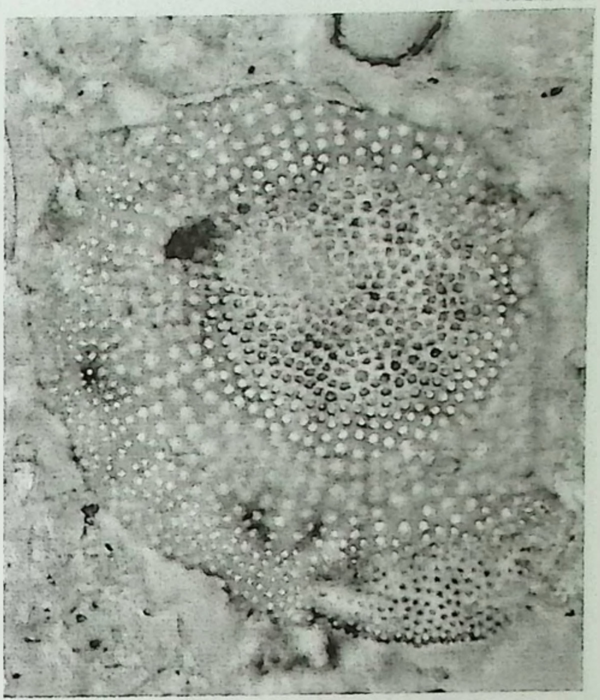
PlateII

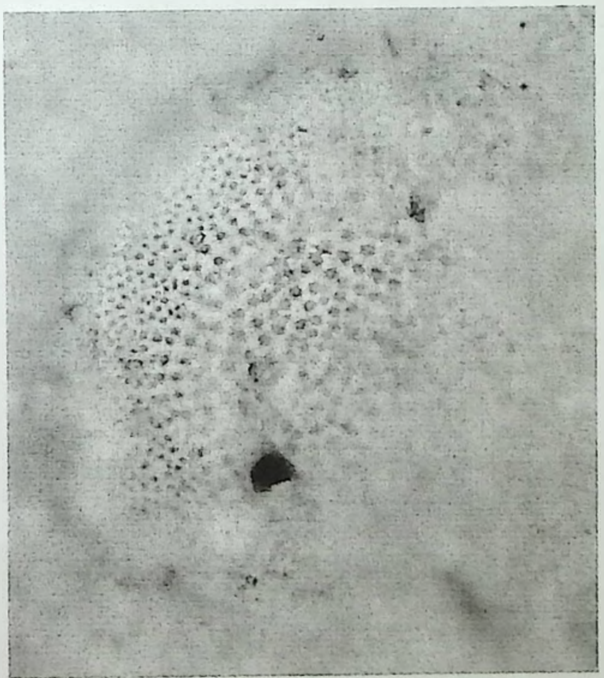
Diatoms from the fossil site Meleto:

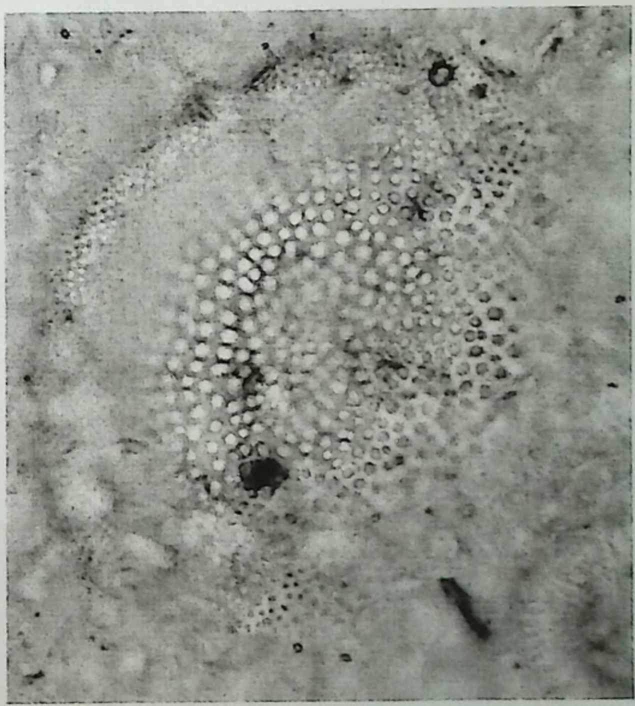
(magnification x 1600)

Figs 1-5: *Ethmodiscus hassiacus.*


1


2


3


4


5

PlateIII

(magnification x 1600)

Diatoms from the fossil site Meleto:

Figs 1-4: *Navicula laterostrata*

Figs 5-6: *Navicula submuralis*

Fig. 7: *Geissleria* spec.

Figs 8-9: *Gomphonem grovei*

Fig. 10: *Fallacia balnearis*

Figs 11-12: *Diploneis marginestriata*

Fig. 13: *Caloneis* spec.

Figs 14-17: *Amphora copulata*

Fig. 18: *Amphora aequalis*

Fig. 19: *Cymbella brehmii*

Fig. 20: *Epithemia sorex*

Fig. 21: *Epithemia adnata*

Fig. 22: *Fragilaria zeilleri* var. *zeilleri*

Figs 23-24: *Fragilaria* spec. 3

Fig. 25: *Fragilaria construens* var. *venter*

Figs 26-27 : *Fragilaria pinnata*

Figs 28-29: *Fragilaria* spec. 1

Fig. 30: *Fragilaria martyi*

Figs 31-32: *Fragilaria* aff. *miocenica*

Figs 33-35: *Fragilaria contruens* var. *construens*

Fig. 36 : *Fragilaria parasitica*

Fig. 37: *Fragilaria* spec. 2.

Plate III

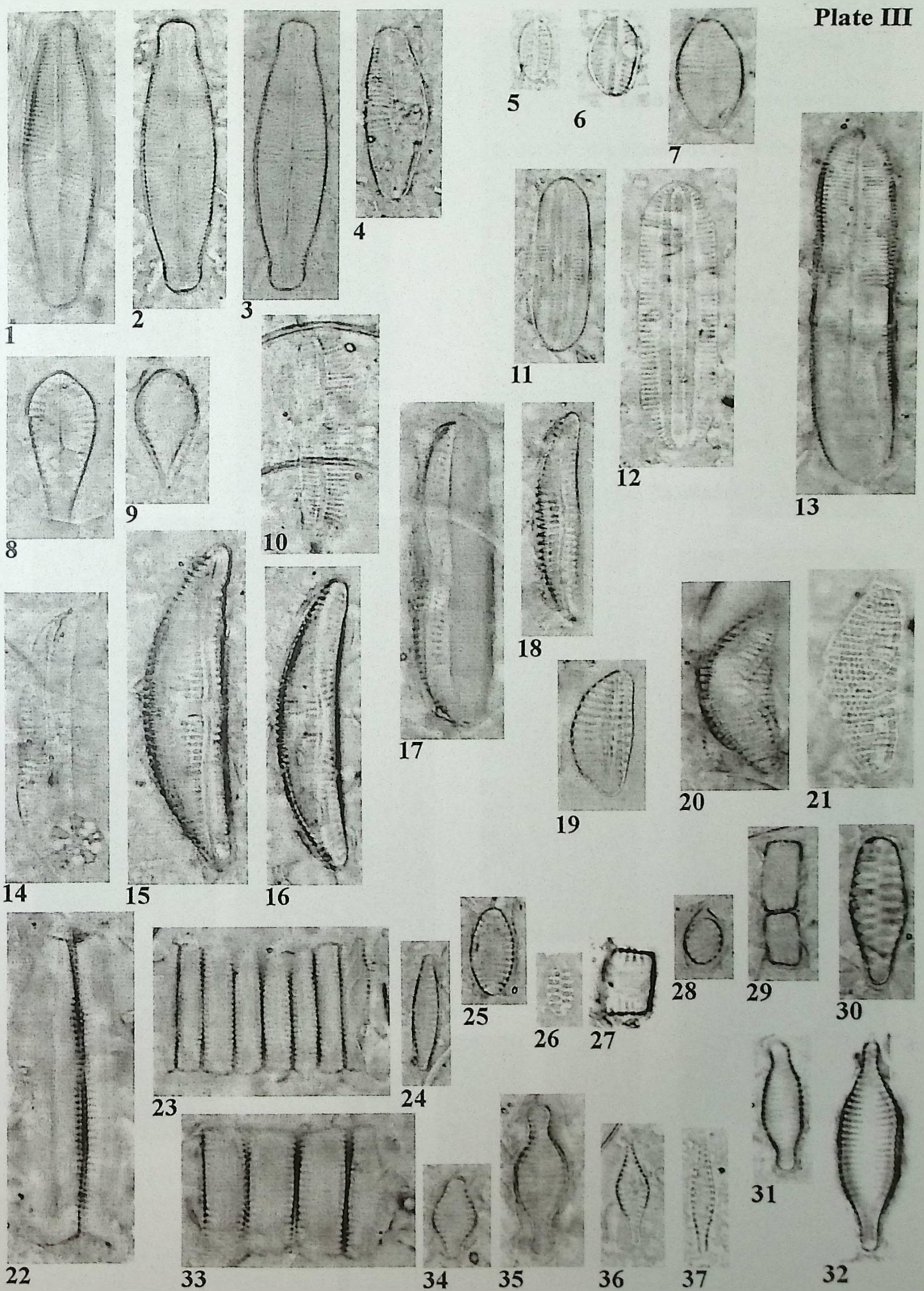

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37

Plate IV

(magnification x 1600)

Diatoms from the fossil site Meleto:

Figs 1-2: *Navicula perobesa*

Fig. 3: *Navicula hasta*

Fig. 4: ***Navicula arenariaeformis***

Figs 5-7: *Navicula cari*

Fig. 8: *Parlibellus protracta* var. *elliptica*

Fig. 9: *Gyrosigma attenuatum*

Fig. 10: *Cymbella* cf. *cuspidata*

Plate IV

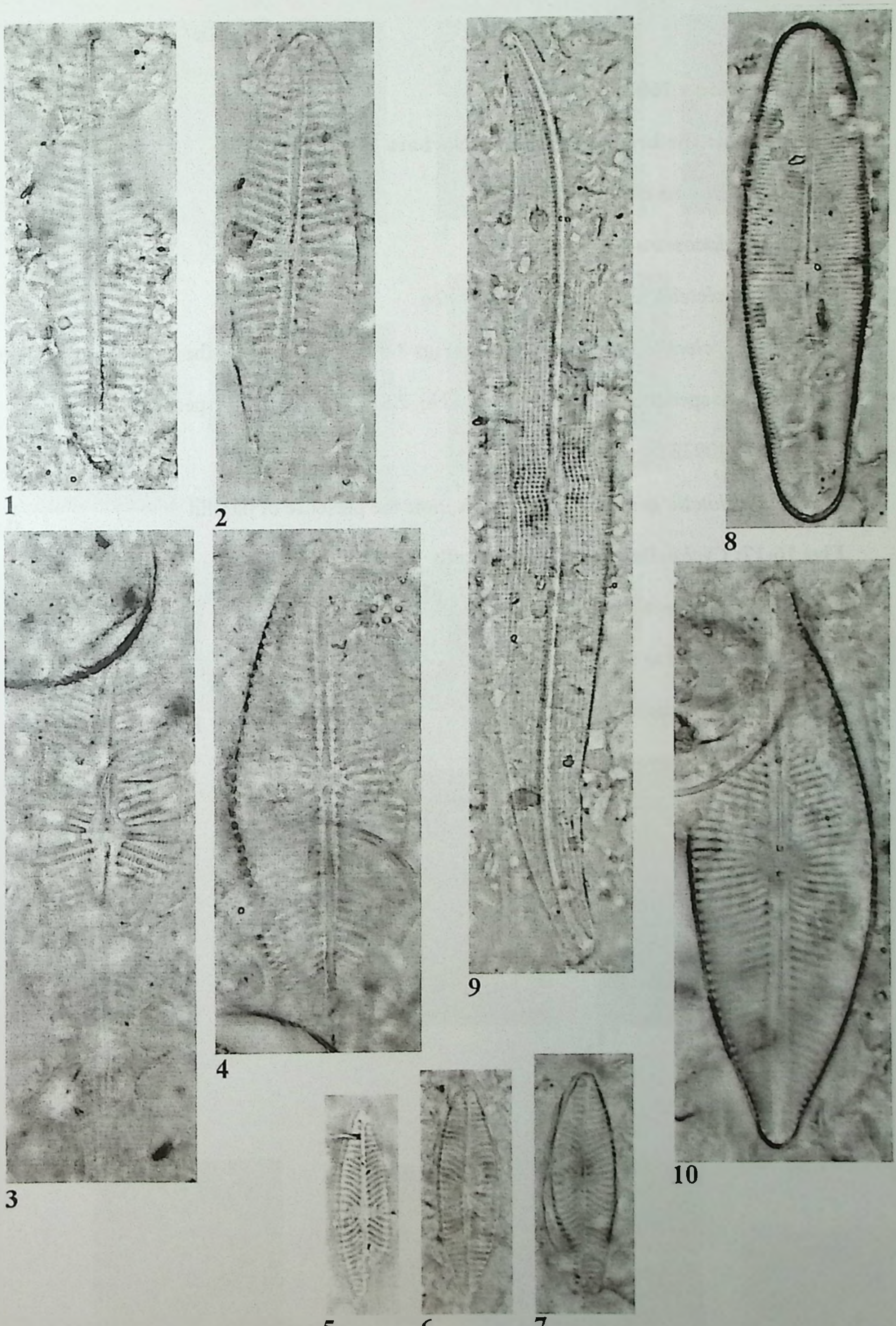


Plate V

(magnification x 1600)

Diatoms from the browncoal mine S. Barbara

Fig. 1: *Aulacoseira islandica*

Figs 2-3: *Aulacoseira granulata*

Figs 4-7: *Cyclotella radiosa* var. *pliocaenica*

Figs 8-15: *Cyclotella gregori* spec. nov. (Figs 8-9: specimens from the holotype slide; Figs 10-11, 14-15: specimens from the Isotype No. 220059; Figs 12-13: specimens from the Isotype No. 4092B).

Fig. 15: *Cyclotella gregori* in girdle view, note the presence of papillii

Figs 16-17: *Cyclotella gregori* – initial cells

Figs 18-20: *Pliocaenicus omarensis*

Fig. 21: *Pliocaenicus undulatus*

Fig. 22: *Stephanodiscus* spec.

Fig. 23: *Orthoseira roeseana*

Plate V

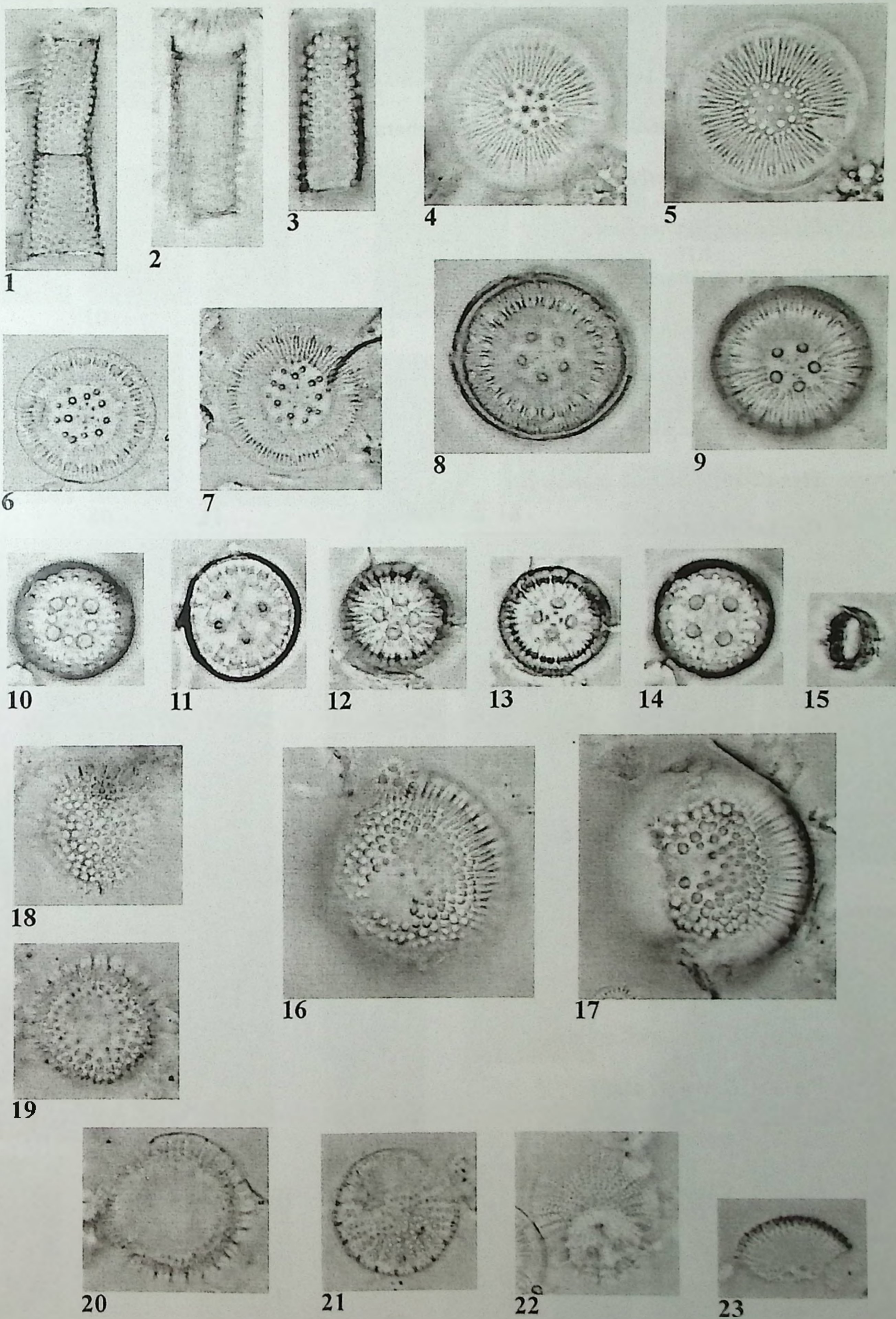


Plate VI

(magnification x 1600)

Diatoms from the browncoal mine S. Barbara

Figs 1-4: *Achnanthes clevei*

Fig. 5: *Achnanthes* spec.

Figs 6-7: *Achnanthes minuscula*

Fig. 8: *Achnanthes lanceolata*

Figs 9-10: *Achnanthes joursacense*

Fig. 11: *Achnanthes rupestoides*

Figs 12-16: *Cavinula scutelloides*

Fig. 14: initial cell?

Figs 17-18: *Cavinula jentzschii*

Figs 19-21 : *Gomphonema grovei*

Figs 22-23: *Achnanthes oestrupii* var. *pungens*

Fig. 24 : *Cymbella ehrenbergii*

Fig. 25: *Cymbella affini*

Fig. 26 : *Cymbella helvetica*

Fig. 27: *Cymbella silesiaca*

Fig. 28: *Cymbella brehmii*

Fig. 29: *Cymbella obscura*

Fig. 30: *Cymbella* cf. *affinis*

Fig. 31: *Diploneis ovalis*

Fig. 32: *Amphora inariensis*

Fig. 33: *Amphora pediculus*

Plate VI

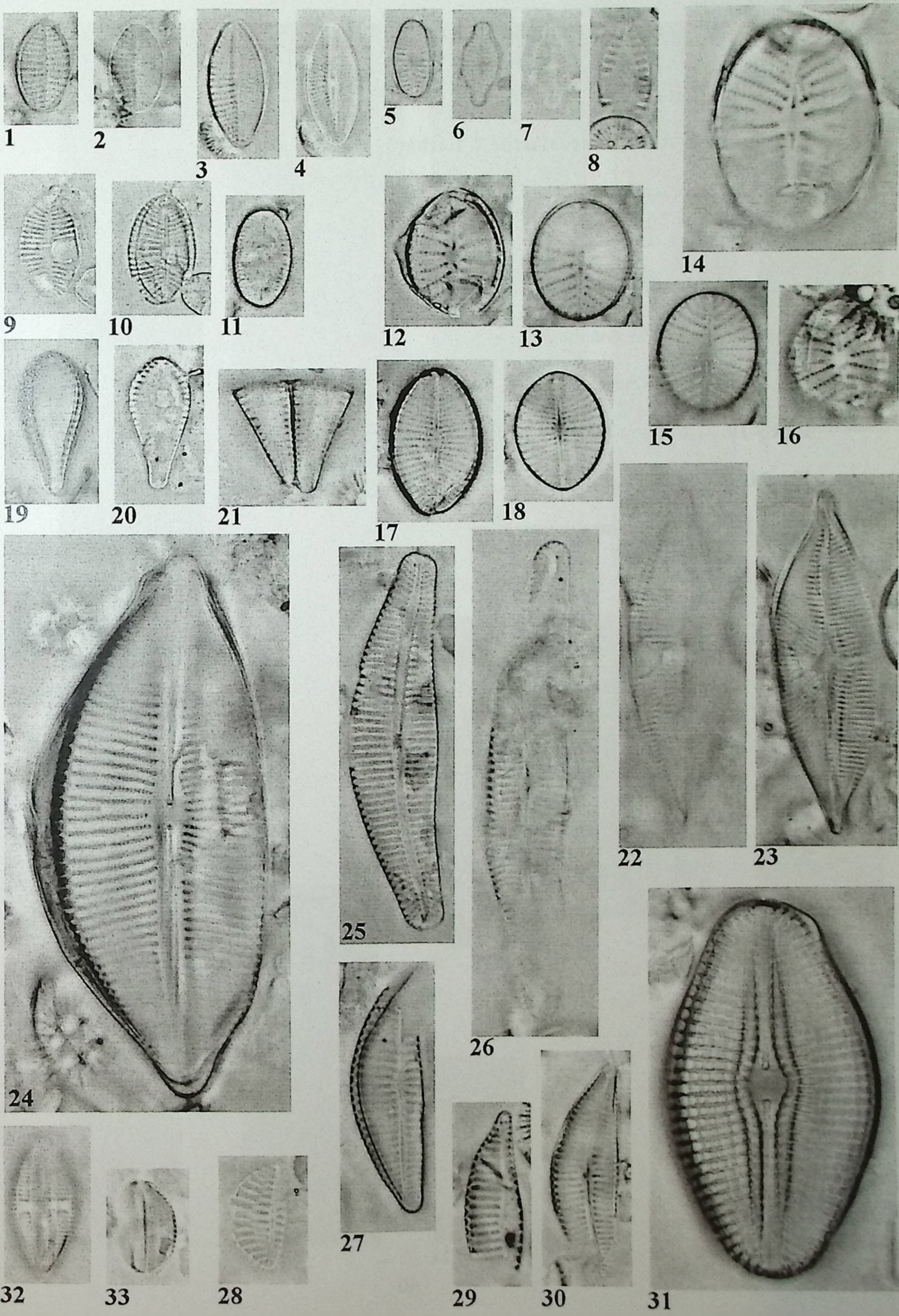

1
2
3
4
5
6
7
8
14
9
10
11
12
13
15
16
19
20
21
17
18
22
23
24
25
26
27
29
30
31
32
33
28

Plate VII

(magnification x 1600)

Diatoms from the browncoal mine S. Barbara

Figs 1-2: *Navicula hasta*

Fig. 3: *Navicula arenariaeformis*

Figs 4-5: *Navicula viridula*

Fig. 6: *Navicula concentrica*

Figs 7-8: *Navicula perobesa*

Figs 9-10: *Sellaphora bacillum*

Fig. 11: *Salleaphora* cf. *pupula*

Figs 12-13: *Gomphonema minusculum*

Plate VII

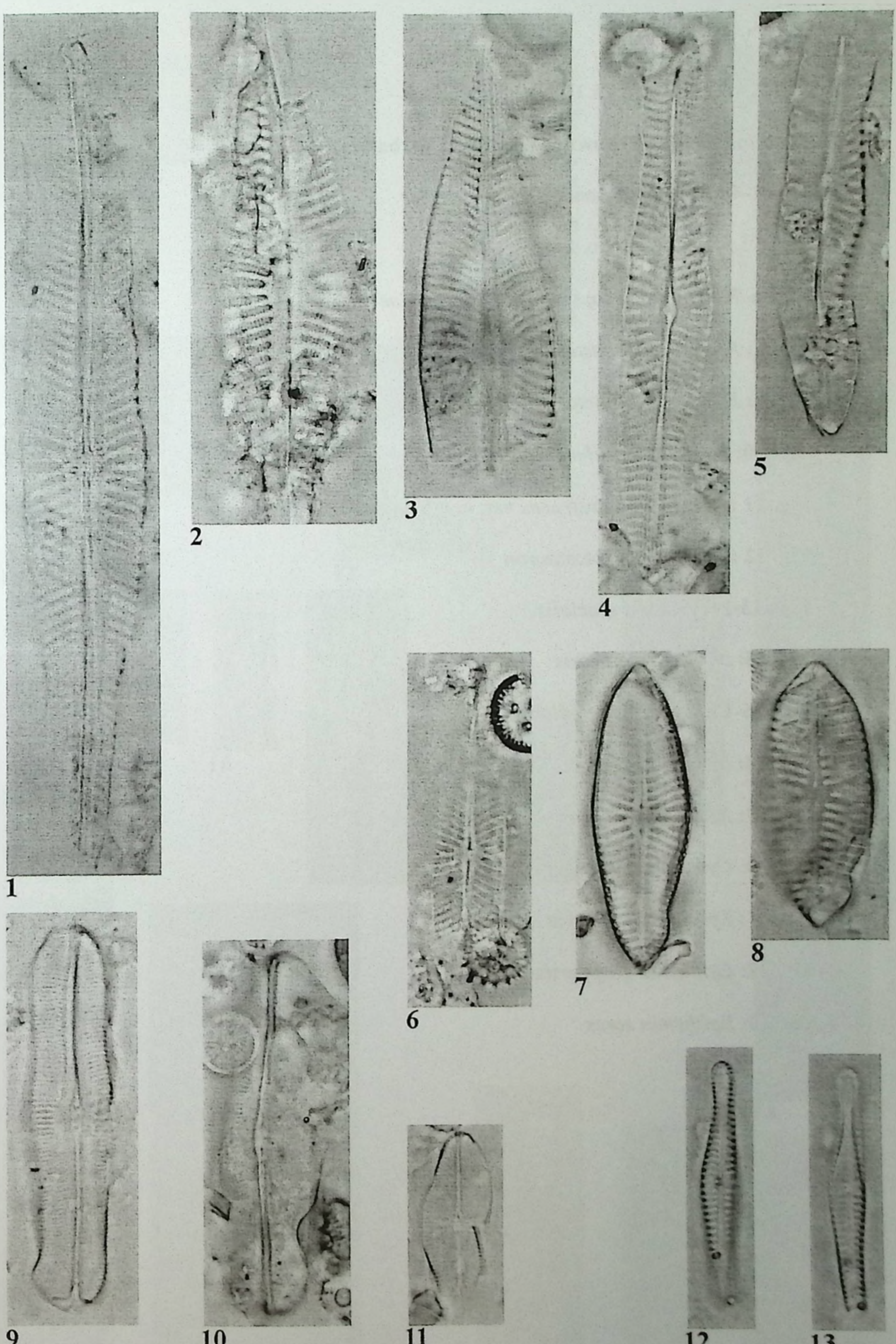


Plate VIII

(LM, magnification x 1600)

Diatoms from the browncoal mine S. Barbara

Figs 1-4 : *Fragilaria construens* var. *venter*

Fig. 5 : *Fragilaria* spec. 2

Figs 6-7: *Fragilaria capucina* var. *vaucheriae*

Fig. 8: *Fragilaria robusta*

Fig. 9: *Fragilaria pinnata*

Fig. 10: *Fragilaria zeilleri* var. *elliptica*

Fig. 11 : *Fragilaria construens* var. *construens*

Fig. 12 : *Fragilaria leptostauron*

Figs 13-14: *Eunotia glacialis*

Fig. 15: *Nitzschia solgensis*

Figs 16-17: *Nitzschia tabellaria*

Fig. 18: *Nitzschia* spec. (cf. *N. palea*)

Fig. 19: *Nitzschia* aff. *elgei*

Fig. 20: *Cymatopleura solea*

Fig. 21: *Epithemia argus* var. *alpestris*

Fig. 22: *Epithemia goeppertiana*

Fig. 23: *Epithemia sorex*

Plate VIII

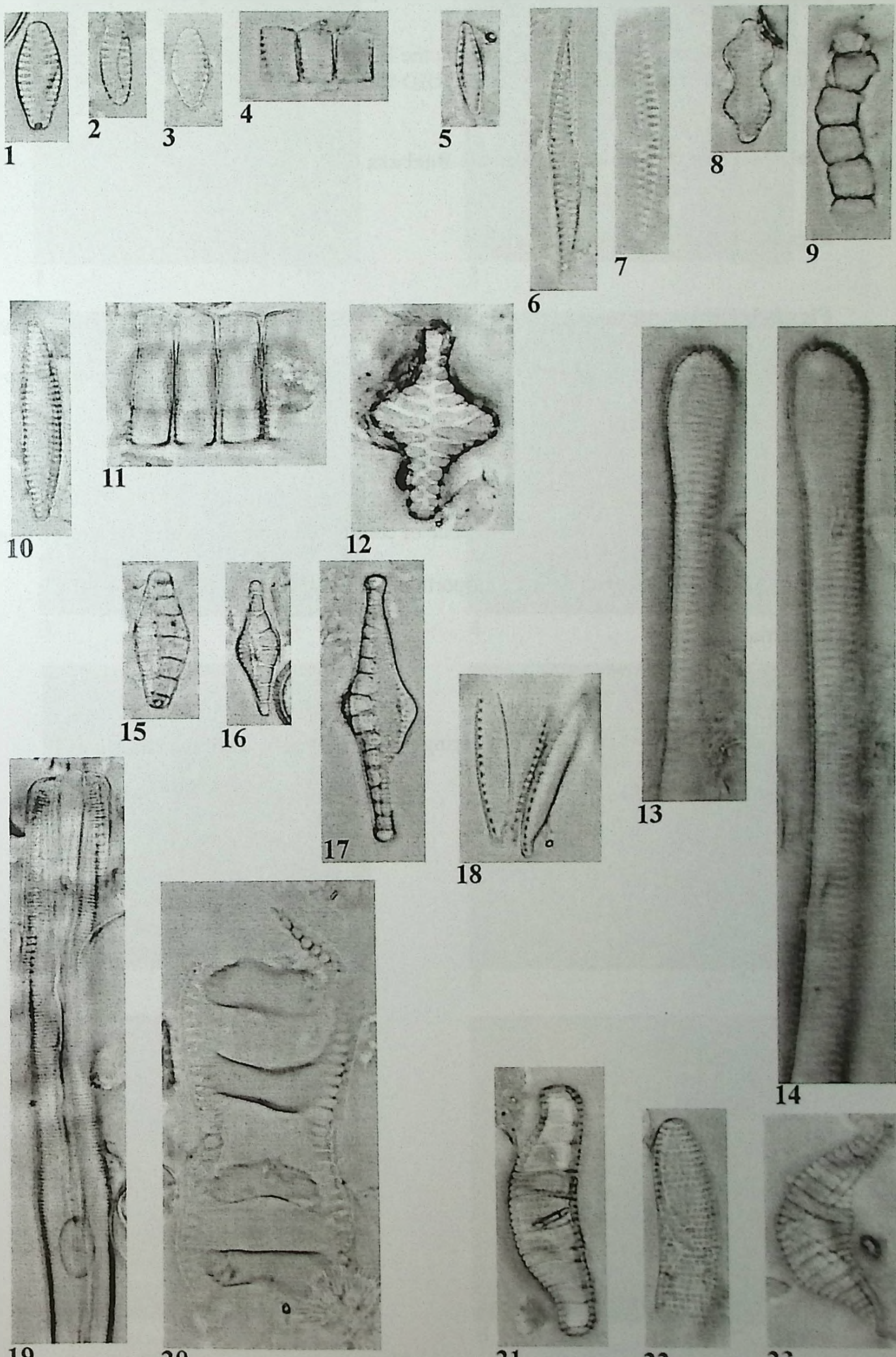


Plate IX

The following micrographs were made in the Botanical Institute at the J-W. Goethe University in Frankfurt/Main by MANFRED RUPPEL by SEM.

Diatoms from the browncoal mine S. Barbara

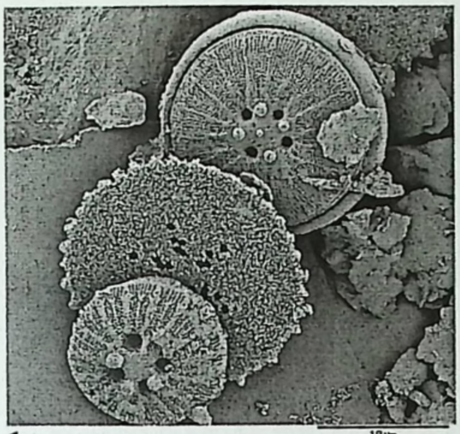
Figs 1-8. *Cyclotella gregorii* spec. nov.

Figs 1-5: Different images of the valve face exterior. Note the presence of relatively high papillii associated with cup-shaped depressions and of small openings corresponding to the marginal fultoportulae

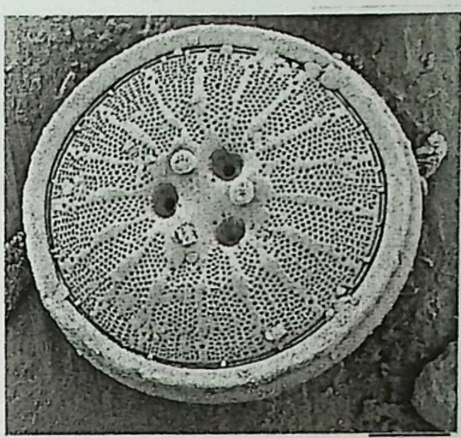
Figs 6-8: Valve interior. Note the presence of central fultoportulae with 3-4 satellite pores, one rimoportulae and of marginal fultoportulae with two satellite pores at each thick interstriae

Fig. 8: Note the presence of cribra covering the internal opening of the cup-shaped depressions

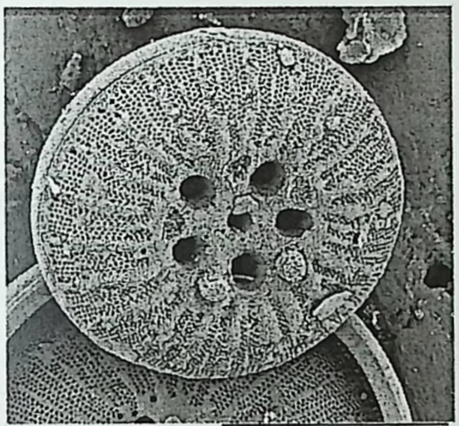
Plate IX



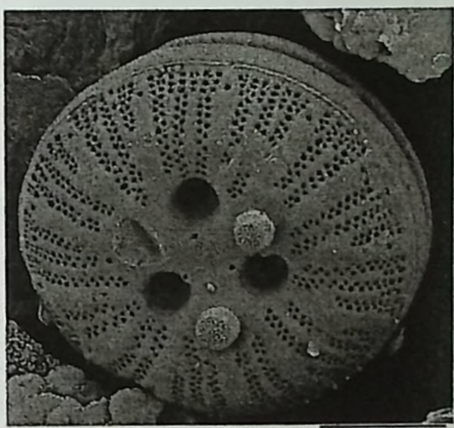
1 10µm



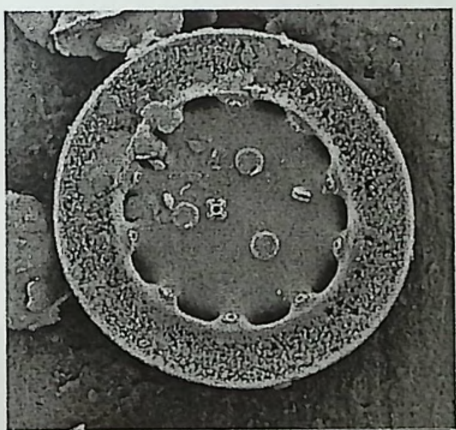
2 3µm



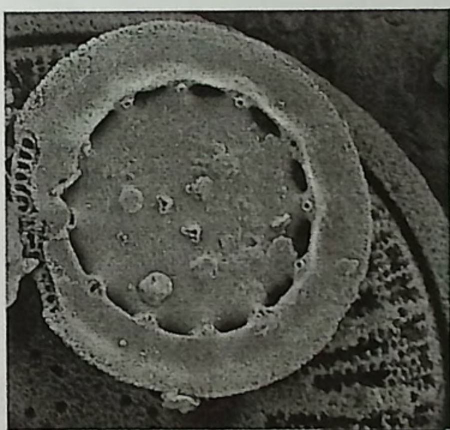
3 10µm



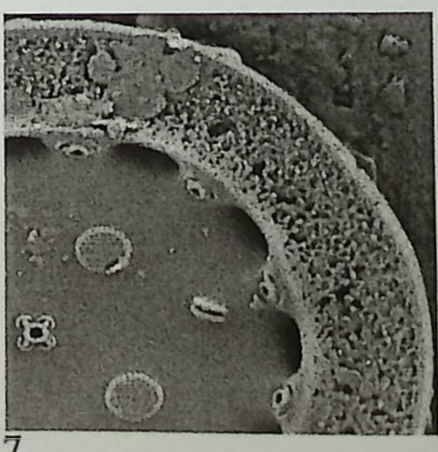
4 3µm



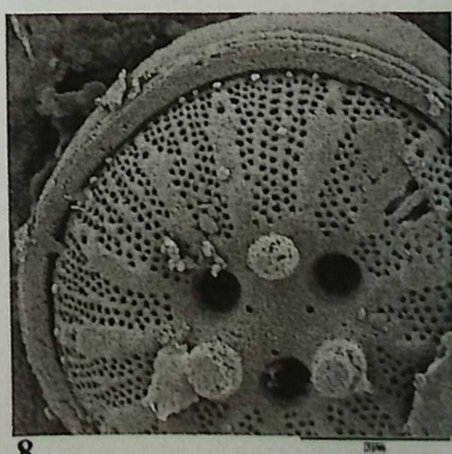
5 3µm



6 3µm



7



8 3µm

Plate X

The following micrographs were made in the Botanical Institute at the J-W. Goethe University in Frankfurt/Main by MANFRED RUPPEL by SEM.

Diatoms from the browncoal mine S. Barbara

Figs 1-6: *Cyclotella gregori* spec. nov.

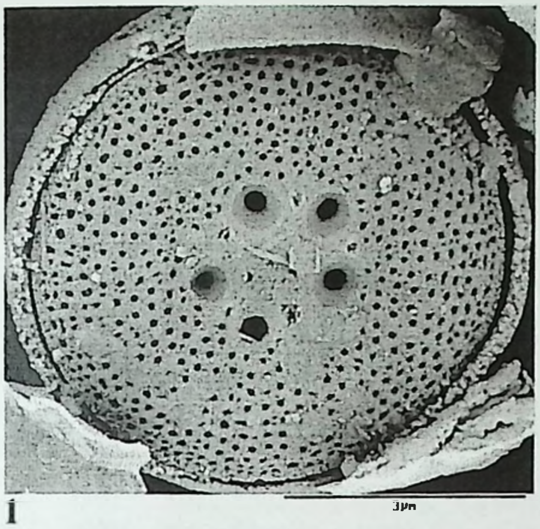
Fig. 1: Initial cell

Figs 2-6: Details of the valve external part

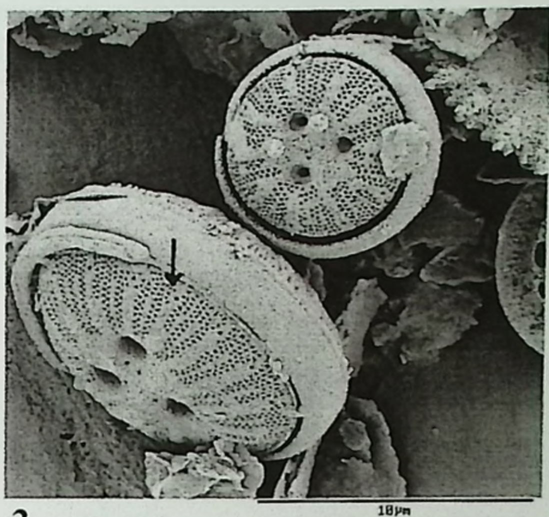
Figs 2-3: Note broken tubules marking external openings of marginal and central fultoportulae (arrows)

Figs 5-6: Note the presence of linking spines

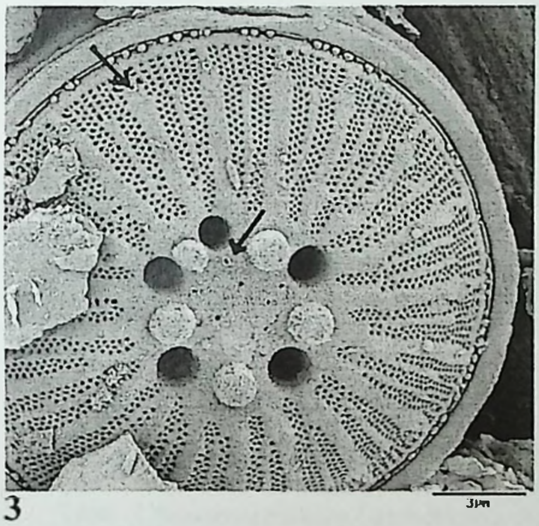
Plate X



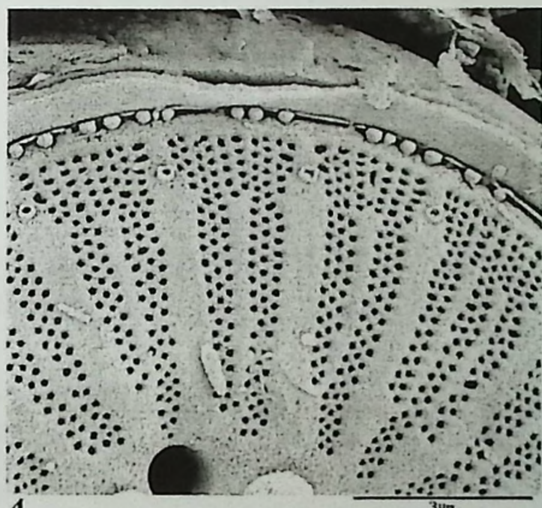
1



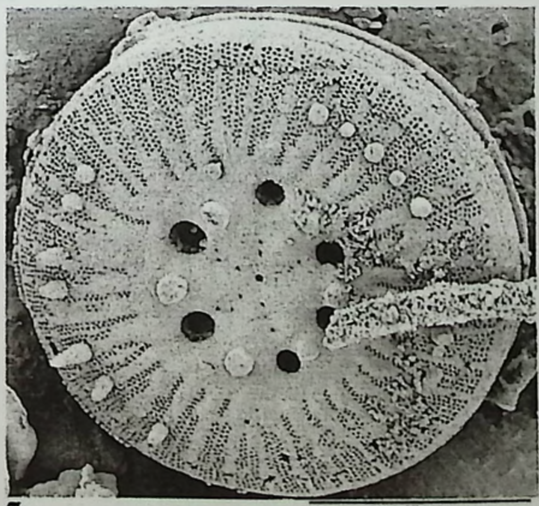
2



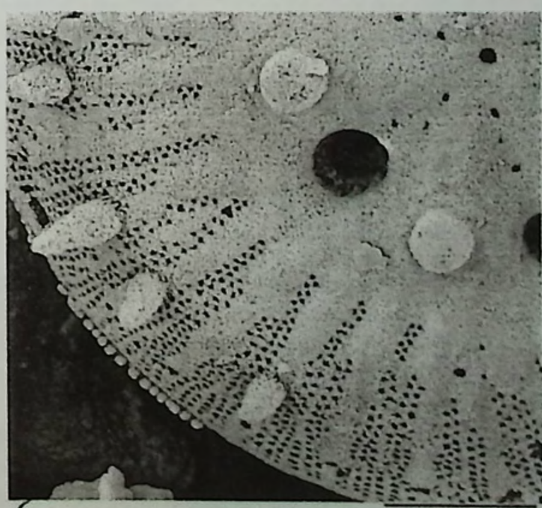
3



4



5



6