Japan Review, 1997, **8**: 235-249

DIATOM ASSEMBLAGES FROM INLAND SALINE LAKES IN THE CENTRAL PART OF TURKEY —THEIR APPLICATION FOR QUANTITATIVE RECONSTRUCTIONS OF PALEOSALINITY CHANGES DURING THE LATE QUATERNARY—

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In arid and semi-arid areas, like inner Anatolia, small change in precipitation and evaporation rates can have marked effects on the water environment of inland lakes at closed basins. This study demonstrates the importance of detailed diatom analyses in attempt to identify lake level and lake water quality changes of inland lakes in Turkey. An important first step in using diatoms as salinity indicators is to obtain quantitative data on their ecological characteristics, such as optima and tolerances along salinity gradients. We took 51 samples of living diatoms from 38 lakes and rivers in the central part of Turkey, and calculated an abundance-weighted mean salinity (AWM) for each taxon (Kashima,1996). On the basis of a strong relationship between diatom composition and salinity, we defined the diatom-based transfer functions for salinity reconstruction, and then applied them to Late Quaternary sediments in Turkey. Our drilling surveys were done at Kaman Kalehoyük, Lake Tuz, Konya Basin and in Akgöl Marsh and its surrounding areas. The results show that there was a number of alternations between fresh and saline conditions during the Late Quaternary (Kashima *et al.*, in press).

Key words: DIATOM, HOLOCENE, LAKE DEPOSIT, QUATERNARY, SALT LAKE, TURKEY.

INTRODUCTION

Following the rise in temperature after the last glacial maximum, dated to about 20,000 years ago, climate characteristics such as precipitation and evaporation rates have apparently fluctuated in many arid and semi-arid regions (Street and Grove, 1976, 1979). Although a number of papers have been presented on the reconstruction of the fluctuations of precipitation and evaporation rates during the last 20,000 years in Africa and North America (Street and Grove, 1979), there have been few extensive studies undertaken on inland lake sediments to reconstruct similar changes in Turkey (Erol, 1978).

Diatom analysis is, like pollen analysis, one of the micro-paleontological methods for the reconstruction of paleoenvironments. Unlike pollen analysis that uses vegetation succession as an indicator of climatic change, diatom analysis is based on the change in aquatic environment that is closely related to village settings and agriculture. Therefore, diatom analysis is expected to provide archeological scientists with much interesting information.

In this paper, a new method is presented for quantitative reconstruction of paleosalinity changes of inland saline lakes using diatom analysis. Particular emphasis is given to the use of diatoms as indicators of water salinity. The data indicate great promise for generating predictive relationships useful in reconstructing paleosalinity fluctuations in closed inland saline lakes. Also, the results suggest that diatom stratigraphy of lake sediments can provide a sensitive high-resolution record of climate change, without the lags characteristic of many other paleoclimate proxies.

LIVING DIATOM FLORAS OF INLAND LAKES IN TURKEY

(1) Samples

Sixty-eight samples of living diatom floras from 38 sites of 23 lakes, ponds and rivers were collected in 1991 and 1992 (Kashima, 1996, Fig. 1, Table 1). Among these 68 samples, 51 samples are useful as data for diatom-based transfer function of paleosalinity reconstruction,

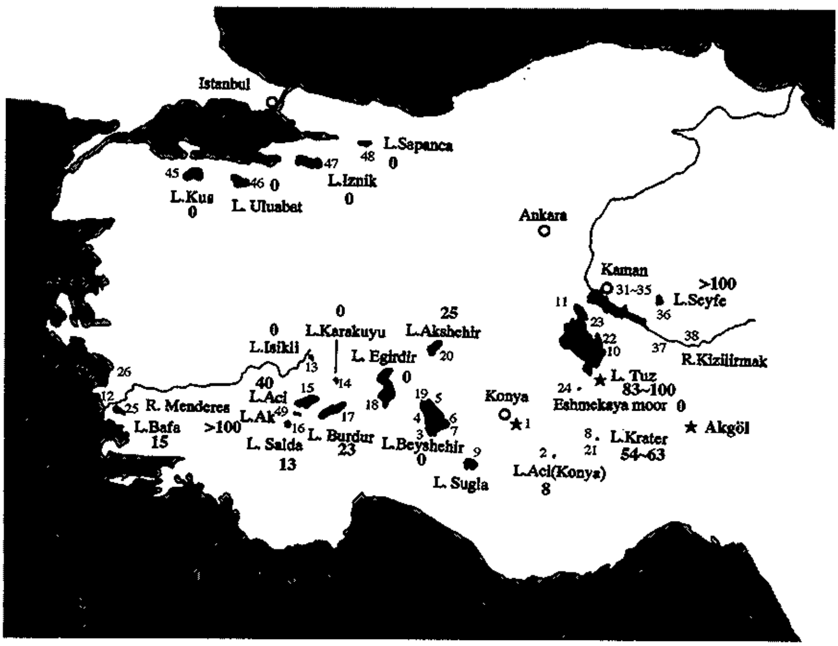

Fig. 1. Sites investigated in Anatolia Plateau, Turkey

Arabic small numbers indicate the number of sampling sites for living diatoms.
Number 27 ~ 30 and 39 ~ 44 were sites for marine diatoms.
The 51 samples from 38 sites were available for this paper.
Large bold numbers indicate measured salinity values of lakes (‰).
Black stars show the locations of drilling surveys.

Table 1. Sampling sites for living diatoms in Turkey (see Fig.1)

No.	Salinity	Ph	Site	No.	Salinity	Ph	Site
1	1	7	small creek at Konya Basin	21a	63	7.9	L.Krater
2a	8	11	L.Aci(Konya)	21b	63	7.9	L.Krater
2b	8	11	L.Aci(Konya)	22aK*	>100	7	L.Tuz
3a	0	7	L.Beyshehir	22aQ*	>100	7	L.Tuz
3b	0	7	L.Beyshehir	22b*	>100	7	L.Tuz
4	0	7	L.Beyshehir	22c*	>100	7	L.Tuz
5	0	7	L.Beyshehir	22dK	>100	7	L.Tuz
6a	0	7	L.Beyshehir	22dQ*	>100	7	L.Tuz
6b	0	7	L.Beyshehir	23aK*	>100	6.8	L.Tuz
7	0	7	L.Beyshehir	23aQ*	>100	6.8	L.Tuz
8	54	8	L.Krater	23b*	>100	6.8	L.Tuz
9	1	7	small creek near L. Sugla	24a	0.8	7.7	Eshmekaya moor
10a	83	7	L. Tuz	24bK*	0.8	7.7	Eshmekaya moor
10b	83	7	L. Tuz	24bQ	0.8	7.7	Eshmekaya moor
11*	85	7	L. Tuz	24d*	0.8	7.7	Eshmekaya moor
12*	0	7	R. Menderes	25a	15	8.7	L.Bafa
13a	0.8	8.5	L.Isikli	25b	15	8.7	L.Bafa
13b	0.8	8.5	L.Isikli	25c	15	8.7	L.Bafa
14a*	0.2	7	L.Karakuyu	25e	15	8.7	L.Bafa
14b*	0.2	7	L.Karakuyu	26a	0	7.1	small creek near R.Menderes
15a	40	7.91	L.Aci	26b*	0	7.1	small creek near R.Menderes
15b	40	7.91	L.Aci	31	0	7.9	small pond near Kaman
15c*	40	7.91	L.Aci	32	0	8.3	small pond near Kaman
16a	13	9.03	L. Salda	33	0	9.4	small pond near Kaman
16b	13	9.3	L. Salda	34	0	8.5	small creek near Kaman
17a	23	8.9	L. Burdur	35	0	8.5	small creek near Kaman
17b	23	8.9	L. Burdur	36	>100	8	L.Seyfe
18a	0.2	8.8	L. Egirdir	37	0	8.4	R.Kizilirmak
18b	0.2	8.8	L. Egirdir	38	0	8.6	R.Kizilirmak
19a	0.2	8.6	L.Beyshehir	45	0	6.75	L.Kus
19b	0.2	8.6	L.Beyshehir	46	0	8.39	L. Uluabat
20a	25	9.1	L.Akshehir	47	0	8.56	L.Iznik
20b	25	9.1	L.Akshehir	48	0	7.14	L.Sapanca
20c	25	9.1	L.Akshehir	49*	>100	no data	L.Ak

The numbers with * were the samples omitted for calculation of the functions, because few diatoms existed in the samples.

because they contain enough diatoms for the calculation of the functions.

The central and western part of Turkey is a suitable region for diatom studies because of its wide range in salinity conditions. Among the 51 samples used for the calculation, 29 samples were taken from fresh water lakes, ponds and rivers; additional 22 samples were taken from saline lakes with a range in salinity of 8 to over 100 ‰ (Fig. 1).

(2) Grouping of living diatoms according to their salinity tolerances

Although taxonomic problems still remain, a total of 126 diatom taxa were identified from the 51 samples. We listed 61 taxa that occurred with at least 4 % abundance in any one sample. The cumulative percentage of the 61 taxa is 96.1 % on average. Sample 20a showed the minimum value of the cumulative percentage, which is 85 % (Table 1, 2). Using Cluster analysis, the 61 taxa were divided into 6 groups according to their salinity trends (Table 2).

Table 2. List of the 61 diatoms for calibration models to infer palaeo-environment from lakes and rivers in Turkey (Kashima,1996).

Genus	*Species*	*AWMS*	*Genus*	*Species*	*AWMS*
Nitzschia	*compressa*	90.00	*Achnanthes*	*minutissima*	7.59
Cyclotella	*chocwhatcheeana*	84.12	*Navicula*	*cryptocephala*	6.84
Cymbella	*pusilla*	81.72	*Diatoma*	*tenuis*	6.77
Gyrosigma	*striglis*	76.12	*Gomphonema*	*parvulum*	5.83
Amphora	*coffeaeformis*	75.26	*Cymbella*	*minuta*	5.50
Entomoneis	*alata*	73.06	*Cymbella*	*microcephala*	5.15
Navicula	*cincta?*	69.33	*Navicula*	*cryptotenella*	3.62
Nitzschia	*sigma?*	63.00	*Synedra*	*ulna*	3.34
Cocconeis	sp.(Krater)	56.76	*Epithemia*	*adnata*	2.08
Rhopalodia	sp.	47.20	*Cymbella*	*cistula*	0.98
Pleurosigma	sp.	45.93	*Gomphonema*	*gracile*	0.83
Nitzschia	*constricta*	43.88	*Fragilaria*	*vaucheriae*	0.81
Stauroneis	sp.	40.09	*Nitzschia*	*dissipata*	0.73
Synedra	*tabulata*	36.84	*Fragilaria*	*brevistriata*	0.37
Nitzschia	*obutusa*	27.23	*Amphora*	*libyca*	0.36
Anomoeoneis	*exilis*	25.04	*Fragilaria*	*pinnata*	0.32
Nitzschia	*littolaris*	25.00	*Cocconeis*	*placentura*	0.29
Navicula	*capitata*	24.25	*Amphora*	*pediculus*	0.28
Navicula	*pygmaea*	23.97	*Rhopalodia*	*gibba*	0.18
Navicula	*protracta*	23.00	*Epithemia*	*sorex*	0.12
Synedra	*pulchella*	22.43	*Cyclotella*	*comta*	0.06
Amphora	*ventricosa*	15.00	*Gomphonema*	*intricatum*	0.04
Mastogloia	*smithii*	14.95	*Navicula*	*eliginensis*	0.03
Nitzschia	*frustulum*	13.29	*Cyclotella*	sp.-1(Beyshehir)	0.00
Cymbella	lacastris	13.00	*Opephora*	*martyi*	0.00
Campylodiscus	*clypeus*	11.98	*Navicula*	*rotunda*	0.00
Rhoicosphenia	*curvata*	9.88	*Achnanthes*	*lanceolata*	0.00
Mastogloia	*elliptica*	9.64	*Gomphonema*	*truncatum*	0.00
Nitzschia	*palea*	8.20	*Achnanthes*	*clevei*	0.00
Anomoeoneis	*sphaerophora*	8.00	*Navicula*	*tuscula*	0.00
Cyclotella	*meneghiniana*	7.96			

Abundance-weight mean salinity (AWMS) of each taxa is based on the following function (Fritz and Battarbee,1988, Fritz *et al.*, 1991, Kashima, 1996).

$$AWMS_i = \sum_{i=1}^{m}(ahi \times MSi) / \sum_{i=1}^{m} ahi$$

AWMS i is an abundance-weight mean salinity (AWMS) value of taxon i (table 1).
ahi is an abundance (percentage) of taxon i in sample **h**.
MS $_h$ is a measured salinity value of sample h.
m is the number of samples. In this paper, m = 51.

Group I

Nitzschia compressa, Cyclotella chocwhatcheeana, Cymbella pusilla, Gyrosigma striglis Amphora coffeaeformis, Entomoneis alata, Navicula cincta (?)

The salinity optima (AWMS) of these taxa are over 70 ‰ in the area studied. Those species are adapted to high salinity and high concentration of sodium chloride which is more than double that of marine water. However, they are also distributed widely in brackish lagoons and on coasts in Japan. The salinity for the species is usually lower that 30 ‰ in Japan. The difference between the habitats of the species in Japan and in Turkey seems to be the key for understanding how diatoms have adapted from low saline conditions to highly saline conditions.

Group II

Nitzschia sigma (?), *Cocconeis* sp. 1 (Krater),

These species are distributed in highly saline lakes, similar to those of Group I. They have not been reported in Japan yet, and thus may represent unreported new species that have not been reported.

Group III

Rhopalodia sp., *Pleurosigma* sp., *Nitzschia constricta, Synedra tabulata, Nitzschia obtusa, Anomoeoneis exilis*

The salinity optima (AWMS) of the species are 25 ~ 56 ‰, slightly lower than those of Group I. The other characteristics of their habitat are similar to those of Group I.

Group IV

Nitzschia littolaris, Navicula capitata, Navicula pygmaea, Navicula protracta, Synedra pulchella, Amphora ventricosa, Mastogloia smithii, Cymbella lacustuis, Anomoeoneis sphaerophora, Cyclotella meneghiniana

The salinity optima (AWMS) of the species are below than 25 ‰. Unlike the species in Group V, Group IV species are not found in freshwater samples.

Group V

Nitzschia frustulum, Campylodiscus clypeus, Rhoicosphenia curvata, Mastogloia elliptica, Nitzschia palea, Achnanthes minutissima, Navicula cryptocephala, Diatoma tenuis Gomphonema parvulum, Cymbella minuta, Cymbella microcephala, Navicula cryptotenella, Synedra ulna, Epithemia adnata

The salinity optima (AWMS) of the species are 2 ~ 14 ‰. They are found not only in saline lakes but also in freshwater lakes, ponds and rivers. They are also distributed widely in fresh water areas in Japan.

Group VI

Cymbella ctstula, Gomphonema gracile, Fragilaria vaucheriae, Nitzschia dissipata, Fragilaria brevistriata, Amphora libyca, Fragilaria pinnata, Cocconeis placentula, Amphora pediculus, Rhopalodia gibba, Epithemia sorex, Cyclotella comta, Gomphonema intricatum var. *pumila, Navicula elginensis, Cyclotella* sp.-1, *Opephora marryi, Navicula rotunda, Achnanthes lanceolata, Gomphonema truncatum, Achnanthes clevei, Navicula tuscula*

These species are found only in freshwater lakes, ponds and rivers.

DIATOM-BASED TRANSFER FUNCTION FOR QUANTITATIVE SALINITY RECONSTRUCTION

In order to provide quantitative reconstructions of lake water salinity, Fritz *et al.* (1991) defined a diatom-based transfer function for the reconstruction of past changes in salinity of lakes in the northern Great Plain region of North America and applied it to a Late-Glacial and Holocene sediment record from Devil Lake, North Dakota. Their methods are applied here to the analysis of the diatoms, from Turkish study lakes.

In spite of some remaining taxonomic problems, the total number of diatom taxa from the 51 samples was 126. Sixty one taxa that occurred with at least 4 ‰ abundance in any one sample were listed and an abundance-weighted mean salinity (AWMS) was calcalated for each taxon (Table 1). Most of the AWMS of the species are slightly higher than those of previous studies in other areas (Fritz and Battarbee, 1989, Fritz *et al.* 1991, Gasse, 1980). This difference seems to have been caused by the small number of sampling sites for this study.

Predictive models developed from the surface sediment study of the lake samples in Turkey were used to compute a diatom-inferred salinity (DIS) value. The strong relationship between measured and diatom-inferred salinity supports the strength of the diatom-salinity model (Fig.2). The data indicate a very close agreement between inferred and measured salinity.

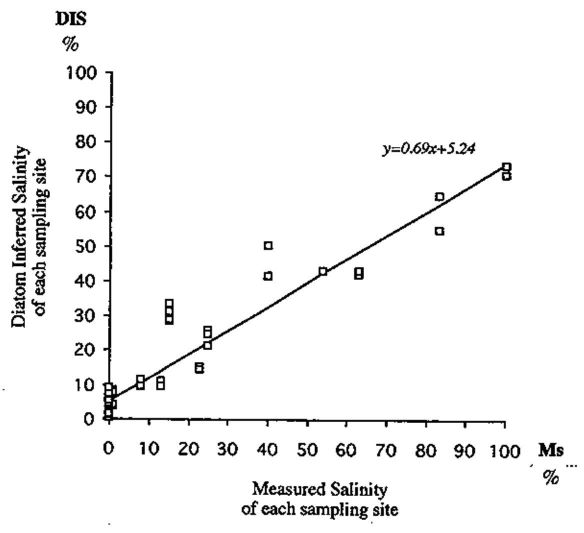

Fig. 2. The relationship between measured salinity (MS) and diatom inferred salinity (DIS)

Measured salinity values were taken using a reflective salinometer.
Diatom Inferred Salinity (DIS) of each sample was obtained by the following function (Fritz *et al.*, 1991).

$$DISh = \sum_{i=1}^{n}(AWMSi \times ahi) / \sum_{i=1}^{n} ahi$$

DIS h is a DIS value of sample h,
AWMS i is an abundance-weight mean salinity (AWMS) value of taxon i (Table 1), ahi is the abundance (%) of taxon i in sample h.
n is the number of taxa for DIS calculation. In this paper, n = 61.

DIATOM ASSEMBLAGES FROM SALINE LAKE SEDIMENTS IN THE CENTRAL PART OF TURKEY AND THEIR SEDIMENTARY ENVIRONMENTS

(1) Kaman Kalehöyük; Japanese excavation site for archaeological studies

In 1991, 17 samples of sediment were taken from the drilling site in the northwestern part of the Kaman excavation area. Enough diatom fossils were collected to compute diatom-inferred salinity (DIS) values in 4 samples from the lower part of the core (Fig. 3). The DIS of the lowest 2 samples (sample number 16 and 17) are 10 ~ 15 ‰. The DIS rose in the upper layers and became 25 ~ 30 ‰ (sample number 14 and 15) (Kashima and Matsubara, 1995).

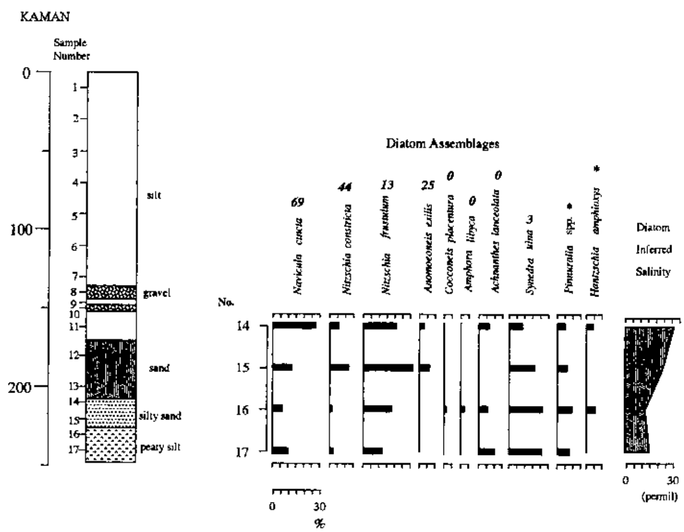

Fig. 3. Diatom assemblages from samples of the well near Kaman Kalehoyük (Kashima and Matsubara, 1995).

(2) Lake Tuz

At the southeastern part of the Lake Tuz basin, large scale sedimentation occurred between 20,000 and 13,000 years ago, and created widespread terraces along the lake side. The water level during this period rose 10 ~ 30m higher than the present level and the lake area spread to the southern edge of the basin (Kashima *et al.*, in press). A drilling survey was done at 5 sites to take bore-hole samples of the lake terrace deposits for lithostratigraphic and biostratigraphic analyses. Although diatoms were severely fractured or strongly dissolved, with only the most heavily silicified parts of the valve remaining in most of the layers, their siliceous remains are well preserved in lake sediments from two layers of two sites (Fig.4, Kashima, 1996). The composition of the diatom assemblages in both layers indicated that the water level rose and the salinity decreased to the present level at Lake Tuz between about 20,000 and 13,000 years ago.

(3) Konya Basin

The Konya plain lies on the southern edge of the Anatolian plateau at an elevation of ca. 1,000m above sea level. A ground-hydrological and sedimentological study used to build up lithostratigraphic sequences at the various places along the edge of the paleolake in order to examine the relationships between alluvial, lacustrine and archaeological sediments (Roberts,

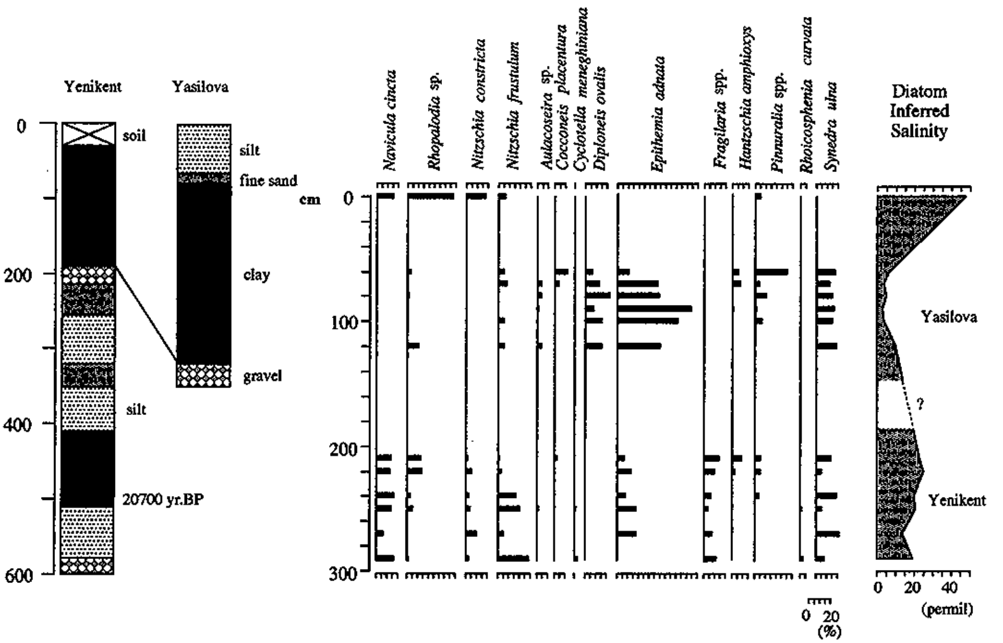

Fig. 4. Diatom assemblages at Lake Tuz, central Turkey (after Kashima, 1996).

The drilling surveys were done at two sites (Yenikent and Yesilova) in the southeast part of Lake Tuz.

1982, 1983, 1995).

A core of 60.85 m was taken at the central part of the basin (Fig.5; Kashima, 1996; Naruse, *et al.* 1997; see Kitagawa *et al.* in this volume). Although the lithoface of the core indicated a

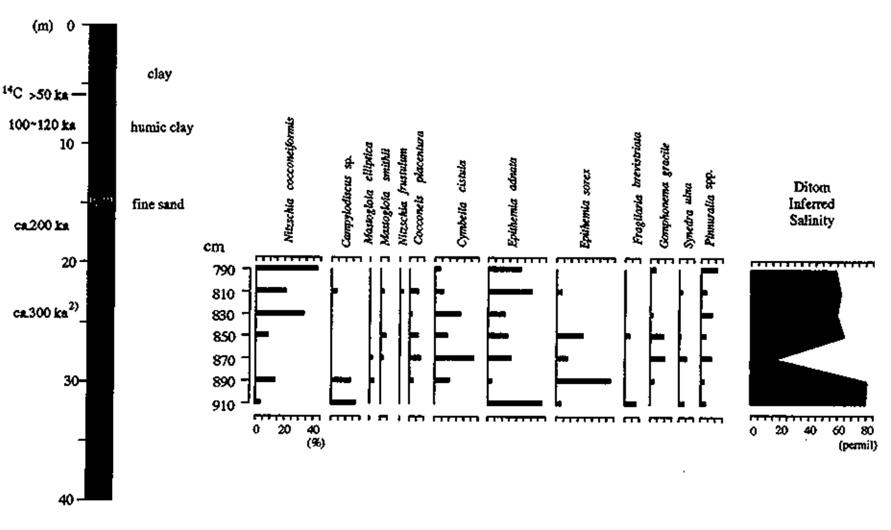

Fig. 5. Diatom assemblages at Konya Basin, central Turkey (after Kashima, 1996).

lacustrine deposit, it contained diatoms in only one layer (7.9 m ~ 9.1 m depth). Diatom assemblages indicated a hypersaline environment at this layer. Owing to the poor state of preservation of the sample, and the dominance of only robust species, there may be no actual ecological significance to the assemblage.

(4) Akgöl Marsh

Akgöl Marsh is the eastern part of the Konya Basin. It usted to be a fresh water to brackish lake, the water level has fallen recently. Very shallow water overlays the marsh only during the wet season. It is thus easy to take core samples close to the center of the marsh during summer time.

A 30 m deep core (CAK core) was taken for paleoecological studies (Fig.6, Table 3). In nearly half of the core, diatoms were well preserved with entire frustules. In the remainder of the core sample, diatoms were severely fractured or strongly dissolved with only the most heavily

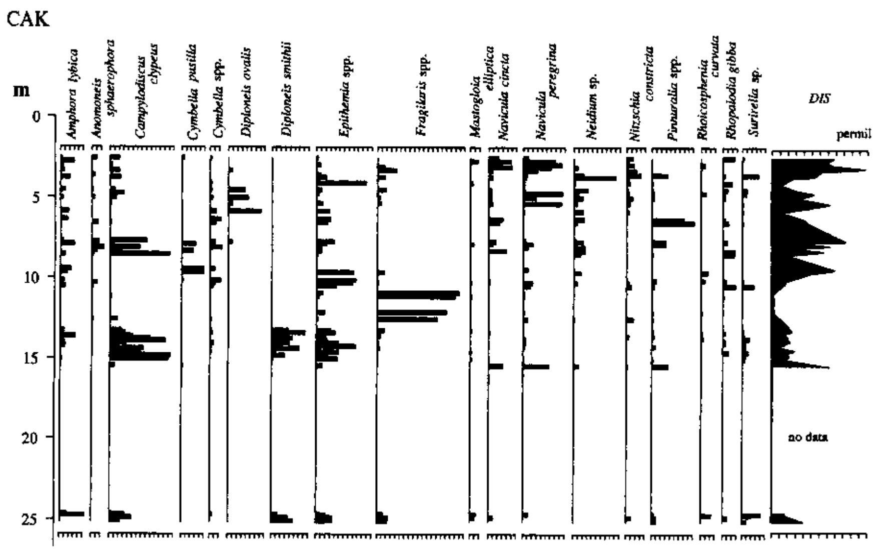

Fig. 6. Diatom assemblages of CAK core samples at Akgöl Marshes, central Turkey (after Kashima *et.al*, in press).

silicified parts of the valve remaining (Fig.6).

Eight diatom zones were defined and values of diatom inferred salinity (DIS) of the zones were calculated by their compositions of diatom assemblages (Table 3). DIS fluctuated ranging from 0 to 40 ‰. This might indicate that salinity of this area has changed from nearly fresh water to a salinity higher than that of marine water. However, this DIS value must be treated with caution as most of the dominant species in the core had strongly structured valves, like *Epithemia* and *Campylodiscus*. Diatom species with fine structures were probably broken in the sediments.

QUATERNARY SUCCESSIONS OF LAKE SALINITY INFERRED BY DIATOM ASSEMBLAGES

Diatom inferred salinity values of the three districts indicated that the salinity of the lake

Table 3. Diatom zones and diatom inferred salinities at CAK core samples at Akgöl Marsh, central Turkey.

Diatom Zone	Sample number	Depth (m)	Abundant Diatom Assemblages	Diatom Inferred Salinity
			no diatom	
VIII	2/2-1~3/1-2	2.6~3.4	*Navicula difitradiata, Navicula cincta, Campylodiscus slypeus*	30~40‰
VII	3/2-2~4/2-1	3.4~5.9	*Diploneis ovalis, Epithemia adnata, Navicula difitradiata, Neidium* sp. *Surirella* sp.	10~30‰
			no diatom	
VI	5/1-2~5/1-3	6.4~6.6	*Cymbella cistula, Epithemia adnata, Navicula cincta, Pinnuralia gibba*	20‰
			no diatom	
V	6/1-1~6/2-4	7.75~8.6	*Campylodiscus slypeus, Cymbella pussila, Epithemia adnata, Navicula cincta, Neidium* sp. *Pinnuralia gibba, Rhopalodia gibba*	10~30‰
			no diatom	
IV	7/1-2~7/2-3	9.5~11.0	*Amphora lybica, Cymbella pusilla, Cymbella cistula, Epithemia adnata, Epithemia sorex, Epithemia turgida*	10~20‰
III	8/1-1~9/1-1	11.0~12.2	*Fragilaria construens*	0~5‰
			no diatom	
II	9/2-3~11/1-1	13.35~15.5	*Campylodiscus slypeus, Diploneis smithii Epithemia turgida, Eithemia sorex, Epithemia adnata, Surirella* sp.	10‰
			no diatom	
I	17/2-4~17/3-1	25.1~26.1	*Amphora lybica, Campylodiscus slypeus, Diploneis smithii, Epithemia turgida, Eithemia sorex, Epithemia adnata, Surirella* sp. *Rhoicosphenia curvata*	10~20‰
			no diatom	

fluctuated from 1 to more than 100 ‰ during the Late Quaternary. At Lake Tuz, low saline layers were found, in contrast to the present hypersaline lake water. On the other hand, a layer of hypersaline environment, similar to the present Lake Tuz, was found in the Konya Basin. At Akgöl Marsh, a series of salinity fluctuations is suggested by diatom assemblages.

Erol (1978) showed the distribution of lake terraces along Lake Tuz and of other lakes located in central Turkey and discussed the lake level fluctuation during Late Quaternary using geomorphological methods. The current lithological and paleontological surveys of lakes and basins also show that the salinity in this lake varied during the Late Quaternary. The salinity and lake level changes seem to have been caused mainly by fluctuations of climate characteristics such as precipitation and evaporation rates.

CONCLUSION

Based on the strong relationship between diatom composition and salinity, the diatom-based transfer functions for salinity reconstruction were defined, and then applied to the Late Quaternary sediments in Turkey. The drilling surveys at Kaman Kalehoyük, Lake Tuz, Konya Basin and Akgöl Marsh show that diatom stratigraphy of saline-lake sediments can provide sensitive high-resolution records of salinity changes. A number of alternations between fresh and saline conditions is indicated by diatom assemblages in this survey. More dated samples are helped to compile detailed Quaternary geohistories of lakewater salinity and water level changes in order to make clear the regional evaporation or temperature changes in Turkey.

The lithological and paleontological survey at lakes and basins will be continued with the focus on the geohistorical contrast between the lakes and basins during the late Quaternary in Turkey.

ACKNOWLEDGMENTS

Our research is supported by the International Science Research Program of the Ministry of Education, Science and Culture of Japan. We thank Prof. Yoshinori Yasuda, Prof. Toshiro Naruse and other members of the research team in 1991 and 1992, for providing facilities, logistical support, discussions, and encouragement during our studies. We are also very pleased to acknowledge Dr. Sachihiro Omura and the members of Kaman Kalehoyük Excavation Team, Turkey. Research in the Akgöl marsh was supported by MTA, in the frame of the Türkish/CNRS Research Project.

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トルコ中部の内陸塩性湖沼の珪藻遺骸群集
—第四紀後期における古塩分変動の定量的復元への応用—

鹿島　薫・松原　久・カトリーヌ　クズジュオル・ムスタファ　カラブルコル

要旨：トルコ中部には、流出河川のない内陸閉鎖湖沼が多く分布しており、それらのいくつかは塩性湖沼となっている。このような乾燥・半乾燥地域の内陸閉鎖湖沼においては、その湖水準変動や水質変動（主として塩分変動）から、その地域の第四紀における降水量と蒸発量の変動を復元することができる。

筆者らは、珪藻分析を用いて、これらの湖沼における湖水準や水質の変動を復元することを試みた。研究にあたり、まず、古環境変動の基礎となる現生珪藻の分布とその生息環境に関する調査を行った。トルコ中部の38の湖沼と河川から51の試料を採取し、それぞれの種ごとの出現頻度加重平均塩分（AWM）を産出した。珪藻群集の構成と湖沼の塩分とは大変良い相関が認められることが明らかとなったことから、珪藻群集に基づく古塩分の変換公式を設定し、第四紀後期の堆積物から湖水の塩分変動の定量的な復元を可能とし可能とした。ボーリングコア試料は、カマン、トウズ湖、コンヤ、アクギョル湿原において採取した。その結果、これらの地域では第四紀後期に何回かの塩分変動が存在したことが明らかとなった。

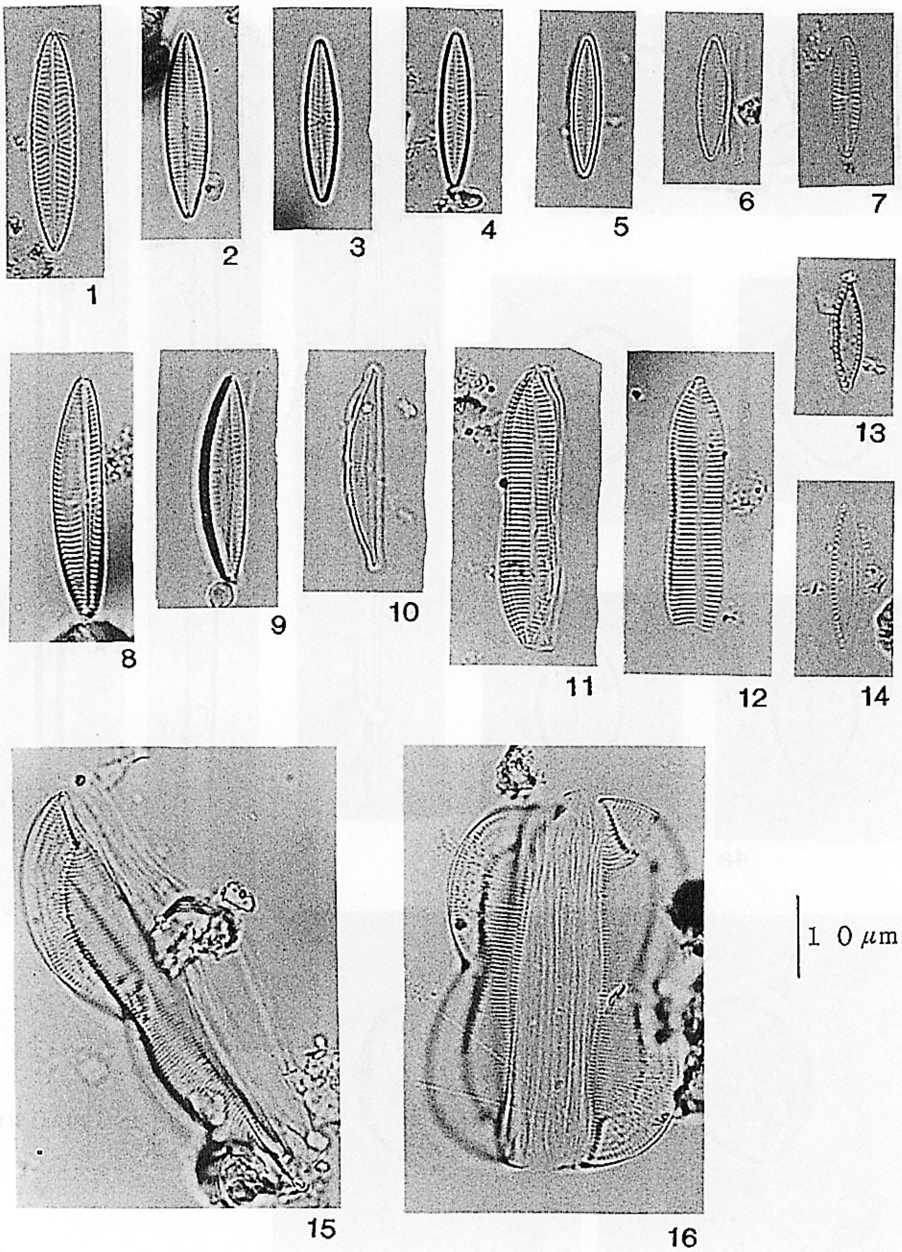

Plate 1. Photos of living diatoms from Turkish saline lakes in 1991 (Loc. 10 Lake Tuz; Salinity 83 ‰, PH 7).

1: *Navicula cincta*
2: *Navicula* cf. *erifuga*
3 ~ 7: *Navicula cincta*
8 ~ 9: *Cymbella pusilla*
10: *Amphora coffeaeformis*
11 ~ 12: *Nitzschia constricta*
13 ~ 14: *Nitzschia frustlum*
15 ~ 16: *Entomoneis alata*

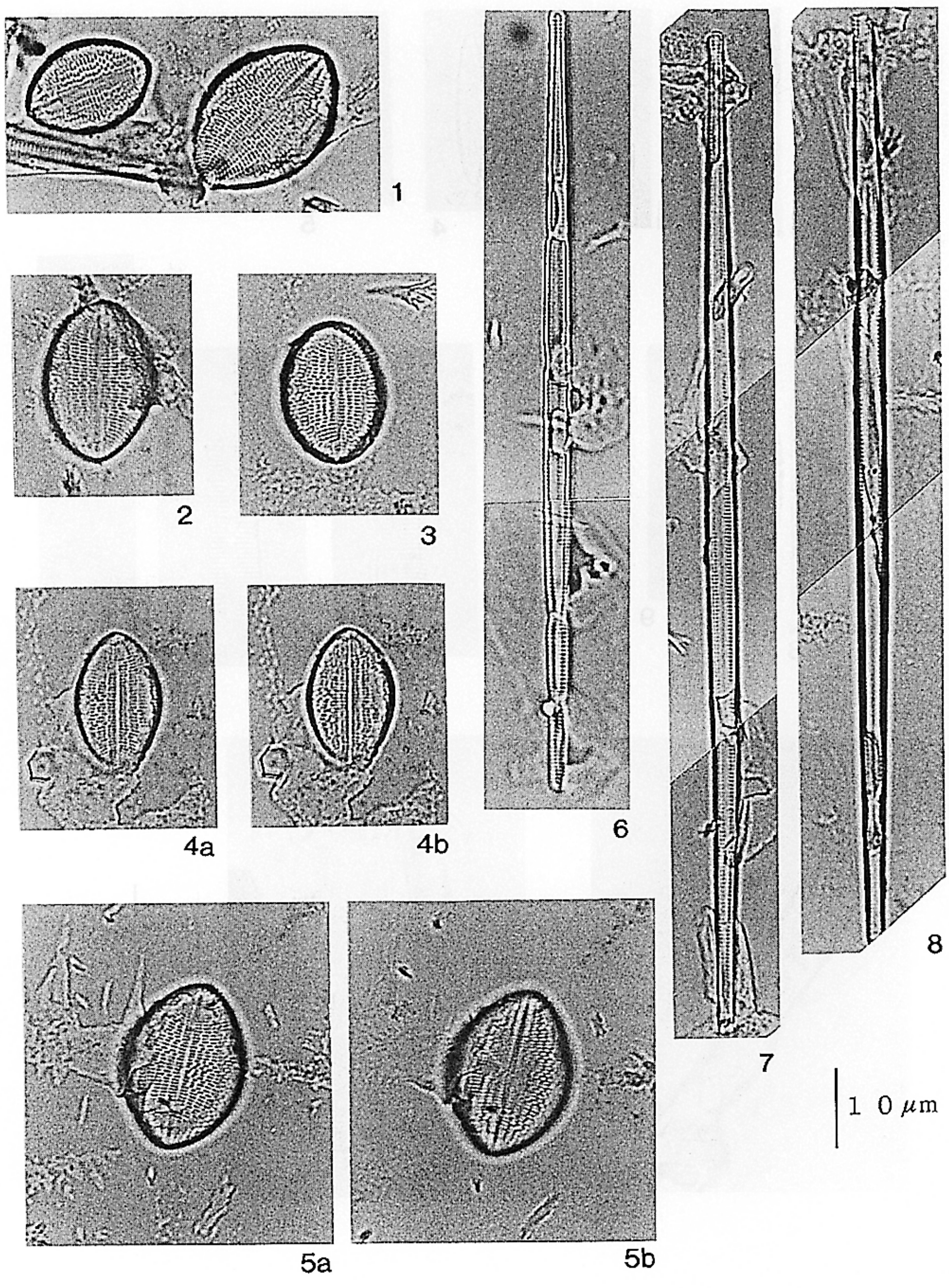

Plate 2. Photos of living diatoms from Turkish saline lakes in 1991 (Loc. 8 Lake Krater; Salinity 54 ‰, PH 8).
1 ~ 5b: *Cocconeis* sp.1
6 ~ 8: *Synedra tabulata*

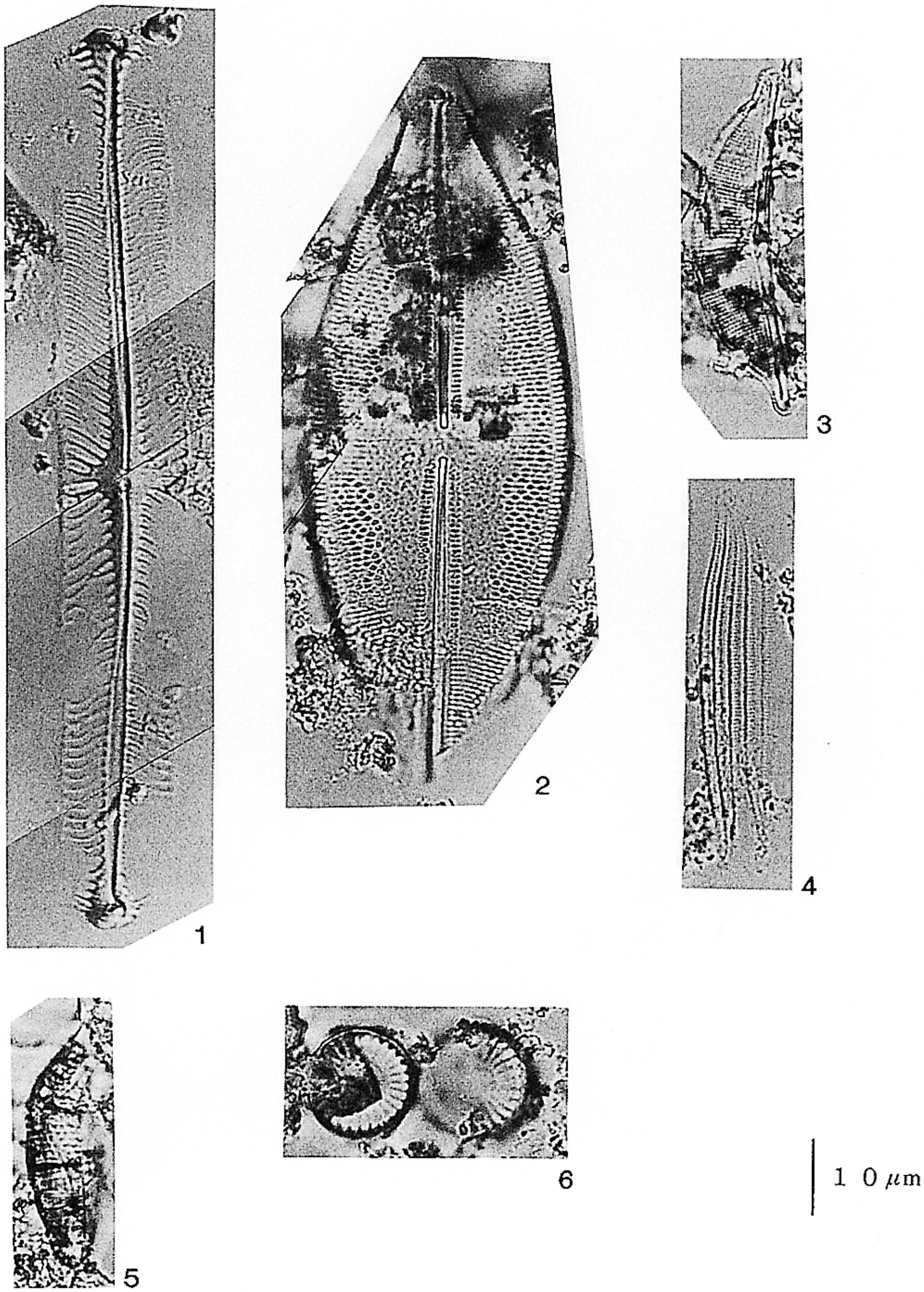

Plate 3. Photos of living diatoms from Turkish saline lakes in 1991
(Loc. 2 L. Aci (Konya), eastern part of Konya Basin; Salinity 8 ‰, PH 11).

1: *Pinnularia* sp.
2: *Anomoeoneis sphaerophora*
3: *Amphora* sp.
4: unknown
5: *Epithemia* sp.
6: *Cyclotella meneghiniana*