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Distribution of Manganese, Iron, Copper, Lead and Zinc in Water and Sediment of Kelang Estuary

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ABSTRAK

Satu kajian tentang taburan mangan, besi, kuprum, plumbum dan zink dalam air dan endapan muara Sungai Kelang telah dijalankan pada tahun 1981. Min jumlah kepekatan mangan, besi, kuprum, plumbum dan zink adalah 27.1 μg/1, 106.5 μg/1, 10.0 μg/1, 4.1 μg/1 dan 17.9 μg/1. Min kepekatan kuprum, plumbum dan zink terlarut dalam air adalah 4.3 μg/1, 1.6 μg/1 dan 3.9 μg/1. Kandungan kuprum, plumbum dan zink dalam endapan adalah 1.92, 0.48 dan 5.43 bsj endapan basah. Kepekatan logam-logam berat ini dalam air dan endapan muara Sungai Kelang didapati dalam julat kepekatan yang dilaporkan dalam muara-muara sungai yang lain. Kepekatan kuprum dan zink adalah hampir sama dengan kepekatannya yang terdapat dalam air lautan dunia. Keputusan kajian ini menunjukkan bahawa muara Sungai Kelang telah dicemari oleh plumbum, mangan dan besi tetapi kepekatannya masih dianggap selamat untuk akuakultur sekiranya tapak itu terletak lebih 10 km dari muara sungai (river mouth) ini.

ABSTRACT

A study was conducted on the distribution of manganese, iron, copper, lead and zinc in the water and sediment of Kelang estuary in 1981. The mean total levels of manganese, iron, copper, lead and zinc in the estuarine water were 27.1 μg/l, 106.5 g/l, 10.0 μg/l, 4.1 μg/l and 17.9 μg/l respectively. For the dissolved copper, lead and zinc, the values were 4.3 μg/l, 1.6 μg/l and 3.9 μg/l respectively. In the estuarine sediment, the copper, lead and zinc contents were 1.92, 0.48 and 5.43 ppm wet sediment respectively. The levels of these heavy metals in water and sediment were comparable to the values reported for other estuaries. The copper and zinc levels were similar to those found in the world oceans. The results indicate that Kelang estuary is polluted with lead, manganese and iron. However, levels of these heavy metals may still be considered safe for aquaculture, if the farm is located at least 10 km away from the river mouth.

INTRODUCTION

Estuaries are important features of the coastal ecosystem and act as transitional zones between fresh and saline waters. The hydrodynamic characteristics of an estuary are usually complex and unpredictable. This is due to the oscillation of salinity, hydrographical and sedimentological characteristics prevalent in the estuarine zone. Estuaries act as traps for nutrients as well as pollutants which have entered into this region. The processes make estuaries rich in nutrients and productive, and they become important nursery grounds for fish and shellfish. However, the trapping of pollutants, such as heavy metals in this area may cause

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hazards to human health if contaminated fish or shellfish harvested from this region are consumed. This was evident in the man-made epidemic of Minamatta disease in Japan which was caused by the consumption of mercury contaminated fish and shellfish (Takizawa, 1979).

Many studies have been conducted on the distribution and impact of heavy metals on the aquatic resources in estuaries (Portmann, 1972; Wharfe and Van Den Broek, 1977; Bloom and Ayling, 1977; Elderfield *et al.*, 1979; Menon *et al.*, 1979; Meyerson *et al.*, 1981). However, in Malaysia, no such study has been done except for some reports on the heavy metals in shellfish (Jothy, 1983; Liong, 1983; Low, 1978) and fish (Chia and Tong, 1981; Babji *et al.*, 1983; Jothy, 1983) taken from the coastal waters. Since the Kelang River is being heavily polluted with agro-based industrial wastes and domestic sewage (Chan *et al.*, 1978; Law, 1980), a study was initiated at the Faculty of Fisheries and Marine Science, Universiti Pertanian Malaysia to investigate the distribution of some heavy metals, such as manganese, iron, copper, lead, zinc and mercury in the water as well as the sediment, and fish in this estuary. This paper reports the results of manganese, iron, copper, lead and zinc levels in water and sediment. Studies on mercury distribution and heavy metals in fish will be reported in other papers.

MATERIALS AND METHODS

Study Area

The Kelang estuary is located on the western coast of Peninsular Malaysia. The river which drains into the estuary has a drainage area of approximately 1,087 square kilometers (Coleman *et al.*, 1970). It flows through the highly populated and industrial areas of Kuala Lumpur, Petaling Jaya, Kelang and Port Kelang. This river lies in the wet tropics where high rainfall is recorded during the monsoon seasons, from April to June and November to February. The atmospheric temperature varies from 20°C to 35°C with an average of 27°C.

Six sampling stations *(Figure 1)* were chosen for this study. They were the Connaught Bridge station (CB), Kota Bridge station (KB), Stations I, II, III and IV. Stations CB and KB were in the riverine system. Station I and IV were in the estuary which covered all the pathways of the river water after entry into the estuary. The distance between stations CB and KB was 5.1 km. Station I was 16.2 km from station KB, while stations II, III and IV were 4.2, 8.5 and

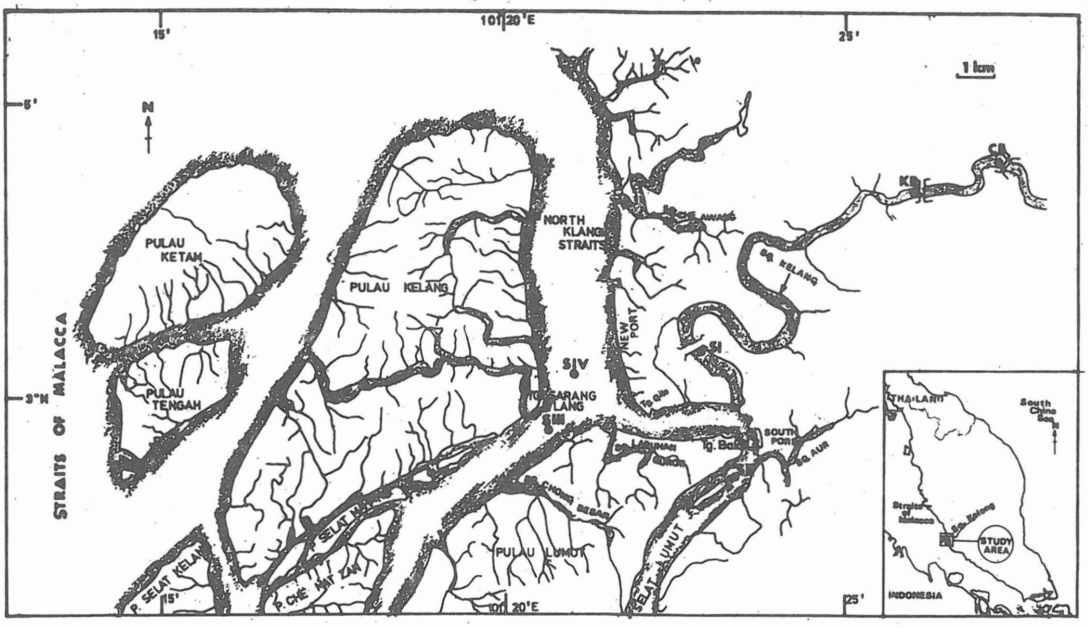

Fig. 1: Map of Kelang River estuary showing the sampling stations.

8.0 km from Station I respectively. The sampling stations were visited six times between April and December 1981.

Sampling Techniques

Water. Water samples at each selected depth were taken with a 1.7 liter polycarbonate Nansen Sampler (Hydrobios, Kiel-Holtenan Germany). In order to avoid contamination by the cable and the weight, the water sampler was suspended by a polypropylene rope and a plastic coated lead weight (5 lbs.), attached to the bottom of the sampler. 50 ml of the water sample was first used to rinse the acid-cleaned 125 ml polyethylene bottles (Kartell, Italy). Before filling it with water sample, 0.1 ml conc. HNO_3 (Merck) was added as a preservative.

For dissolved heavy metal analysis, the suspended particles were removed by filtration. A Gelman filtration unit which had been previously cleaned with 0.1N HCl and distilled deionized water was used for the filtration. To avoid rupture of the plankton cell walls and the resultant increase in heavy metal level in the filtrate, the filtration was done under vaccum with pressure that was less than 20 cm Hg. The membrane used was an acid washed 0.45 μm (47 mm) millipore membrane filter.

Sediment. Samples of sediment were obtained at each station with an Ekman Grab which was attached to a polypropylene rope. The sediment sample was taken from the centre of the grab with an acid-cleaned polyethylene spoon. The sample was placed immediately in a plastic bag and cooled in an ice box. The samples were brought back to the laboratory and kept at $-20°C$ prior to analyses.

Collection of Hydrographic Data

Salinity was measured *in situ* with a Salinometer (EIL) which was calibrated by ISPSO Standard Seawater.

Analytical Techniques

A double beam Atomic Absorption Spectrophotometer (IL 251) was used for the analysis of the heavy metals. Manganese, iron, copper, lead and zinc in the water samples and membrane filtered water samples were analysed according to the concentration technique of Orpwood (1979) in which the heavy metals were chelated with ammonium pyrrolidinedithiocarbamate (APDC) and diethyl-ammonium diethyldithiocarbamate (DDTC) under acidic conditions and then extracted into 4-methylpentan-2-one (MIBK). Copper, lead and zinc contents in the sediment were determined according to the method of Agemian and Chau (1976). The standard solution for calibration was prepared from Titrisol ampoules (Merck).

RESULTS AND DISCUSSION

The salinity data (Appendix I) indicates that Stations CB and KB are situated in the fresh water zone of the Kelang River. There was no intrusion of saline water in these stations during ebb tide. Even during flood tide, the salinity at Stations CB and KB were only 1°/oo and 2.9°/oo respectively. The salinity depth profile at Station I is typical for an estuarine situation with partially mixed waters of lower salinity at the surface (0 to 10°/oo) with salinity increasing to 30°/oo with depth. Salinity depth profiles at Stations II, III and IV indicate that the water in these stations was well mixed.

The levels of heavy metals (manganese, iron, copper, lead and zinc) in water at the sampling stations are shown in Appendix II, while the mean levels at each sampling station are presented in *Figure 2.* The results indicate a substantial reduction of the heavy metals in the estuarine waters as compared to the levels detected in the fresh water zone stations CB and KB *(Figure 2).* In the estuarine waters, similar levels of the heavy metals were found at Stations II, III and IV, although higher levels were detected at Station I. The water of Station I was partially mixed, while the waters of all other estuarine

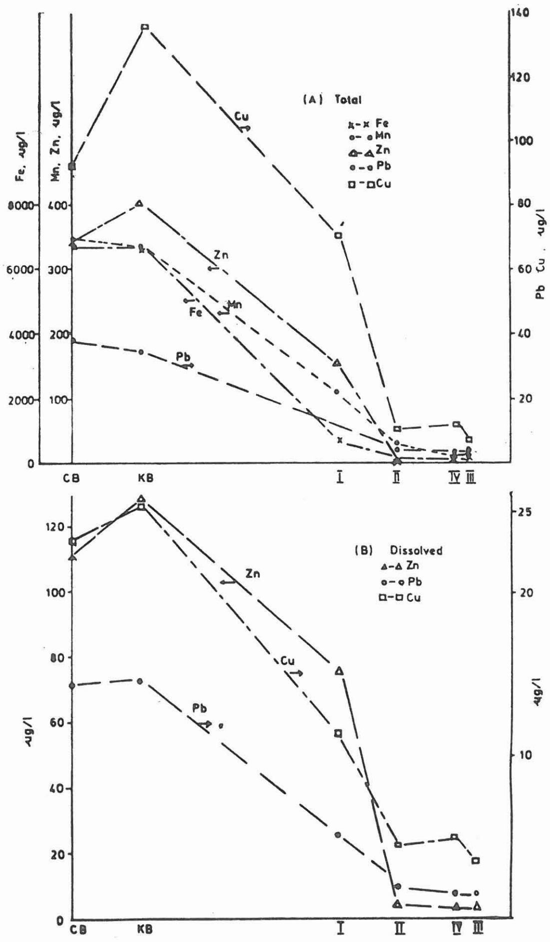

Fig. 2: Mean total and dissolved levels of manganese, iron, copper, lead and zinc at the sampling stations.
(The scale of X-axis is in proportion to the real distances in km from Station CB)

stations were well mixed with the sea water. The tidal current dilution effect of the water of Station I was less than that in other estuarine stations. Thus, higher levels of heavy metals could be expected at Station I.

The mean total levels of manganese, iron, copper, lead and zinc in the estuarine waters (average of the mean values of Stations II, III and IV) were 27.1 µg/1, 106.5 µg/1, 10.0 µg/1, 4.1 µg/1 and 17.9 µg/1 respectively (Appendix II). For dissolved copper, lead and zinc, the overall means were 4.3 µg/1, 1.6 µg/1 and 3.9 µg/1 respectively.

Table 1 shows the comparison of the levels of copper, lead and zinc in the estuarine waters of this study with other reports for estuaries elsewhere in the world (Holmes *et al.*, 1974; Montgomery and Santiago, 1978; Waldhauer *et al.*, 1978; Thornton *et al.*, 1975). The mean total levels of copper and zinc were in the range of the levels detected in other estuaries. However, the total level of lead was much lower. The dissolved levels of copper, lead and zinc in the Kelang estuary were all lower than the levels reported for other estuaries.

The copper, lead and zinc contents in the Kelang riverine and estuarine sediments are shown in Table 2. Heavy metals in the riverine sediments (at CB and KB) were much higher than that found in the estuarine sediments. Similar to the distribution of heavy metals in waters, the level of copper, lead and zinc in the sediment of Station I was higher than that detected in Stations II, III and IV.

The mean copper, lead and zinc contents in the estuarine sediments were 1.92 ppm wet sediment, 0.48 ppm wet sediment and 5.43 ppm wet sediment respectively (Table 2). They were much lower than that reported for other estuarine sediments: 13.8 ppm Cu and 23.6 ppm Pb in the estuarine sediment near Kennedy Space Centre (Menon *et al.*, 1979); 70 – 320 ppm Pb and 65 ppm Zn in Newark Bay estuarine sediment (Meyerson *et al.*, 1981); 9 – 40 ppm Cu and 5 – 25 ppm Pb in the sediment of Bay of Naples (Griggs and Johnson, 1978).

The mean levels of dissolved copper, lead and zinc in the world oceans are 3 µg/1, 0.03 µg/1 and 5 µg/1 respectively (Riley and Chester, 1971). The water of the Kelang estuary is therefore 53 times higher in lead and has almost the same levels in copper and zinc as the waters of the world's oceans. The total iron and manganese levels in the North Atlantic Ocean was 3.27 µg/1 and 0.43 µg/1 respectively (Patin, 1982). The total iron and manganese levels in the Kelang estuary was 33 times and 63 times higher than that of the North Atlantic Ocean. These results suggest that Kelang estuary is polluted with lead, iron and manganese.

TABLE 1
Comparison of the mean levels of total and dissolved copper, lead and zinc in Kelang estuarine water with levels reported in other estuaries

	Authors	Location	Cu	Pb	Zn
A.	**Total level (mean, μg/l)**				
	Holmes *et al.*, 1974	Corpus Christi (estuary) Bay, Texas	—	—	6 – 480
	Montgomery and Santiago, 1978	Mouth of Rio Guanajibo, Puerto Rico	1.1	—	4.5
	Waldhauer *et al.*, 1978	Western Raritan Bay, New York.			
		Top water	36	11.5	—
		Bottom water	65	13.9	—
	Present study	Kelang River estuary	10	4.1	17.9
B.	**Dissolved level (mean, μg/l)**				
	Thornton *et al.*, 1975	Colnway estuary, U.K.	4	7	16
		Colney estuary, U.K.	4	6	29
		Helford estuary, U.K.	11	15	28
		Poole estuary, U.K.	6	47	26
		Restroragnet estuary, U.K.	65	250	570
	Present study	Kelang River estuary	4.3	1.6	3.9

Although the levels of lead and iron were much higher than that of the waters of the oceans and comparable to the levels reported in other estuaries, they are lower than the thresholds and permissible levels of pollutant concentration for organisms in inland seas, that is, lead 10 μg/l; and iron 50 μg/l (Patin, 1982). As far as these heavy metals are concerned, the waters of Kelang estuary (at least 10 km from the river mouth) may still be considered safe for aquaculture.

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TABLE 2
Copper, lead and zinc contents in the sediments of Kelang estuary

	Cu ppm[1]						Pb ppm						Zn ppm					
Sampling date	C.B.	K.B.	I	II	III	IV	C.B.	K.B.	I	II	III	IV	C.B.	K.B.	I	II	III	IV
29.04.81	— [2]	—	2.30	4.20	2.85	3.50	—	—	0.40	0.34	0.40	0.21	—	—	5.20	7 00	3.41	12.20
29.06.81	—	—	1.35	1.40	0.95	1.30	—	—	0.51	0.33	0.31	0.27	—	—	10.50	14.32	4.32	2.71
02.09.81	—	—	5.70	3.30	1.15	2.75	—	—	0.68	0.55	0.28	0.23	—	—	7.00	3.42	4.17	3.21
22.09.81	5.54	8.20	4.32	0.70	0.42	1.85	1.75	1.93	0.99	0.73	0.36	0.22	11.50	14.30	9.34	7.21	5.18	5.14
11.12.81	4.65	3.24	3.20	1.21	0.82	2.41	2.82	3.01	1.18	0.84	0.32	0.65	9.30	13.00	6.84	3.65	3.61	2.61
24.12.81	5.15	3.70	2.65	1.34	0.71	3.61	1.95	2.61	1.41	0.92	0.48	1.10	6.52	8.21	8.72	7.77	3.20	4.65
Mean	5.11	5.05	3.25	2.03	1.15	2.57	2.18	2.52	0.86	0.62	0.36	0.45	9.11	11.84	7.93	7.23	3.98	5.09

[1] In wet sediment.

[2] Not determined.

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APPENDIX I

Salinity at the sampling stations

Station \ Sampling Date	29-4-81		29-6-81		2-9-81		22-9-81		11-12-81		24-12-81	
	Depth (m)	S°/oo	Depth (m)	S°/oo	Depth (m)	S°/oo	Depth (m)	S°/oo	Depth (m)	S°/oo	Depth (m)	S°/oo
Connought Bridge		—[1]		—	1	0	0.5	1	0.5	1	0.5	0
					5.0	0	5.0	1			2.0	0
											6.0	0
					(0900 hrs)[2]		(0900 hrs)		(0900 hrs)		(0900 hrs)	
Kota Bridge		—		—		—	0.5	2.9		—	0.5	0
											2.0	0
											5.0	0
							(1000 hrs)				(1000 hrs)	
I	0.5	11.6	0.1	18.2	0.5	17.7	0.5	14.1	0.5	20.7	0.5	0
	1.0	—	0.5	18.8	1.0	22.0	1.0	30.0	1.0	23.5	2.0	18.00
	2.0	—	1.0	18.8	2.0	24.0	2.0	30.6	2.0	28.0	3.0	18.40
	3.0	—	1.5	20.2	3.0	25.5	4.0	31.0	3.0	29.2	4.0	20.00
	4.0	—	2.0	20.7	4.0	25.7	5.0	—	4.0	29.5	5.0	20.80
	5.0	29.8	2.6	20.4	5.0	26.0	6.0	31.4	5.0	30.2	6.0	21.20
	6.0	—	2.8	24.0	6.0	26.0	8.0	31.4	6.0	30.2	7.0	22.50
	7.0	29.9	3.5	25.2	7.0	26.8	10.0	31.5	7.0	30.0	8.0	22.30
			4.9	26.8	8.0	27.0			8.0	29.7	9.0	23.80
			5.7	27.6	9.0	27.2			9.0	29.7	10.0	24.20
			6.4	27.6	10.0	27.2						
			7.0	28.2								
			7.8	28.5								
			9.9	29.0								
			12.7	29.3								
	(1630 hrs)		(1240 hrs)		(1700 hrs)		(1500 hrs)		(1510 hrs)		(1145 hrs)	
II	0.5	24.7	1.0	31.4	0.5	27.5	0.5	30.6	1.0	30.3	0.5	28.0
	1.0	—	2.0	31.4	1.0	27.5	1.0	30.5	2.0	30.3	1.0	28.3
	2.0	—	4.0	31.4	2.0	27.5	2.0	31.5	3.0	30.4	2.0	28.3
	3.0	—	6.0	31.4	3.0	27.5	3.0	31.6	4.0	30.5	3.0	28.5
	4.0	—	8.0	31.4	4.0	27.5	5.0	31.8	5.0	30.6	4.0	28.5
	5.0	30.6	8.5	31.4	5.0	27.5	7.0	31.9	6.0	30.6	5.0	28.5
	6.0	—			6.0	27.5	8.5	31.9	7.0	30.6	6.0	28.5
	7.0	—							8.0	30.6	7.0	28.5
	8.0	30.2										
	(1540 hrs)		(1655 hrs)		(1100 hrs)		(1224 hrs)		(1000 hrs)		(1450 hrs)	
III	0.5	27.1	1.0	31.5	0.5	28.0	0.5	30.9	0.5	31.7	0.5	29.10
	1.0	—	2.0	31.5	1.0	28.0	1.0	10.9	1.0	31.9	1.0	29.10
	2.0	—	3.0	31.5	2.0	28.2	4.0	32.2	2.0	31.9	2.0	29.25
	3.0	—	4.0	31.5	3.0	28.2	6.0	32.2	3.0	31.9	3.0	29.50
	4.0	—	5.0	31.5	4.0	28.2	8.0	32.2	4.0	31.9	4.0	29.50
	5.0	30.7	6.0	31.5	5.0	28.2	10.0	32.2	5.0	32.0	5.0	29.50
	6.0	30.7	7.0	31.5	6.0	28.2	12.0	32.2	6.0	32.0	6.0	29.50
					7.0	28.2	14.0	32.4	7.0	32.0	7.0	29.50
					8.0	28.2	16.0	32.4			8.0	29.50
					9.0	28.2					9.0	29.50
											10.0	29.50
	(1430 hrs)		(1550 hrs)		(1400 hrs)		(1400 hrs)		(1315 hrs)		(1345 hrs)	
IV	0.5	29.6	1.0	31.2	0.5	28.0	0.5	31.5	0.5	30.5	0.5	29.2
	1.0	—	2.0	31.2	1.0	28.1	1.0	31.7	1.0	30.9	1.0	29.2
	2.0	—	3.0	31.4	2.0	28.2	2.0	31.9	2.0	30.9	2.0	29.2
	5.0	31.4	4.0	31.4	3.0	28.3	4.0	—	3.0	32.1	3.0	29.2
	8.0	—	5.0	31.5	4.0	28.3	5.0	32.2	4.0	32.2	4.0	29.2
	10.0	31.4	6.0	31.5	5.0	28.3	6.0	32.2	5.0	32.2	5.0	29.2
	11.0	—	8.0	31.5	6.0	28.3	8.0	32.2	6.0	32.2	6.0	29.2
	12.5	—	10.0	31.5	7.0	28.3	10.0	32.2	7.0	32.2	7.0	29.2
			12.0	31.5	8.0	28.3			8.0	32.2	8.0	29.2
			14.0	31.6	9.0	28.3			9.0	32.2	9.0	29.2
					10.0	28.3					10.0	29.1
											11.5	29.1
	(1130 hrs)		(1450 hrs)		(1200 hrs)		(1300 hrs)		(1130 hrs)		(1250 hrs)	
Tidal	Time	Height										
Condition	(Hours)	(m)										
	0035	3.5	0250	4.2	0145	0.7	0440	2.4	0400	4.5	0400	4.5
	0721	3.1	0927	1.6	0752	4.8	1201	3.6	1149	0.6	1055	1.3
	1326	3.9	1515	4.8	1401	0.9	1917	2.3	1753	4.8	1655	4.1
	2010	2.0			1958	4.5					2301	1.6

[1] Not determined.

[2] Sampling time.

APPENDIX II

Distribution of mangenase, iron, copper, lead and zinc in Kelang estuary (in µg/l)

Station / Date	Depth (m)	Copper		Lead		Zinc		Fe	Mn
		Total	Dissolved	Total	Dissolved	Total	Dissolved	Total	Total
CB									
02.09.81	0.5	100.0	35.0	53.0	17.5	485.0	70.0	8500	900
22.09.81	0.5	35.0	12.0	35.2	12.8	560.0	220.0	7500	254
11.12.81	0.5	70.0	[1]	12.5		150.0		3700	325
24.12.81	0.5	164.5	22.5	51.6	12.7	181.0	47.0	5500	110
mean		92.38	23.17	38.08	14.33	344.0	112.3	6300	397.3
KB									
02.09.81	0.5	117.5	37.4	59.5	19.5	665.0	115.0	9500	450
22.09.81	0.5	58.0	22.0	22.5	26.0	490.0	210.0	4050	145
11.12.81	0.5	145.0	–	17.0	–	170.0	–	5200	700
24.12.81	0.5	221.0	16.0	35.1	13.8	284.0	64.0	6500	205
mean		135.38	25.3	34.4	15.1	402.3	129.7	6312.5	375
I									
29.04.81	0.5	35.0	–	16.0	–	72.0	–		57
	0.5	28.5	–	13.0	–	60.0	–	3550	40
	7.0	32.4	–	14.0	–	35.0	–		32
29.06.81	0.5	22.8	10.5	11.1	3.9	48.0	15.0	430	55
	5.0	15.9	7.3	11.6	2.8	61.7	13.2	380	45
	10.0	22.8	7.8	11.4	2.2	34.5	10.5	170	32
22.09.81	0.5	47.0	16.5	15.0	6.5	390.0	140.0	2450	185
	5.0	21.8	7.2	12.4	4.1	480.0	175.0	1900	143
	10.0	19.9	6.5	10.7	3.8	290.0	110.0	170	56
	15.0	15.6	6.8	12.4	4.0	380.0	170.0	210	65
11.12.81	0.5	–	32.5	–	11.1	–	175.0	230	120
	5	–	8.5	–	6.3	–	32.0	180	77
	10.0	–	12.6	–	4.2	–	40.0	210	47
24.12.81	0.5	333.5	13.5	12.3	6.2	125.4	34.0	5400	850
	5.0	176.0	11.0	9.9	5.7	81.0	39.0	370	42
	10.0	138.2	6.2	9.4	5.1	51.3	38.0	150	80
mean		70.0	11.3	12.2	5.1	157.6	76.3	837.5	120.4
II									
29.04.81	0.5	5.5	–	4.2	–	42.0	–	360	42
	5.0	2.1	–	3.7	–	29.0	–	320	34
	15.0	3.8	–	4.4	–	38.0	–	290	27
29.06.81	0.5	10.6	3.2	3.7	1.3	32.3	9.8	60	25
	7.5	4.5	1.8	2.6	0.8	24.8	6.8	45	18
02.09.81	0.5	13.2	5.4	7.8	3.3	4.5	1.7	55	18
	5.0	11.6	6.1	5.9	2.7	5.5	1.4	65	27
22.09.81	0.5	5.7	2.6	4.1	1.7	11.8	9.1	55	24
	5.0	6.0	2.8	2.8	1.1	9.9	5.5	35	18
11.12.81	0.5	2.4	–	0.9	–	14.0	–	45	35
	8.0	2.8	–	0.5	–	25.0	–	50	45
24.12.81	5.0	31.3	7.3	5.7	2.3	4.7	3.4	145	49
	7.0	38.3	6.4	7.9	2.8	3.5	2.3	135	37
mean		10.6	4.5	4.2	2.0	18.9	4.9	103.8	30.7
III									
29.04.81	0.5	5.0	–	9.4	–	31.0	–	195	16
	5.0	10.3	–	9.3	–	30.0	–	230	24
29.06.81	0.5	6.5	1.3	1.2	0.3	20.4	4.2	130	32
	5.0	2.2	0.9	2.0	0.7	30.1	8.3	110	26
02.09.81	0.5	10.4	4.9	2.9	1.1	5.7	1.8	35	22
	5.0	8.3	3.2	1.4	0.8	4.6	1.1	47	24
	8.0	6.9	2.8	1.6	0.8	4.2	1.5	42	14
22.09.81	0.5	6.8	3.0	6.7	2.1	12.4	5.9	42	15
	5.0	6.9	2.5	5.2	1.5	8.0	3.4	85	22
11.12.81	0.5	4.3	–	3.5	–	45.0	–	170	45
	5.0	2.1	–	0.9	–	32.0	–	155	32
24.12.81	0.5	10.4	4.2	5.9	1.8	3.8	1.0	40	21
	5.0	11.3	6.5	5.4	2.1	3.3	1.3	32	17
	10.0	10.7	5.2	5.2	1.88	2.4	1.0	25	21
mean		7.29	3.20	4.33	1.30	16.64	2.95	95.6	23.7
IV									
29.04.81	0.5	19.8	–	10.5	–	39.0	–	180	15
	5.0	22.7	–	4.3	–	35.0	–	205	21
	10.5	8.3	–	5.7	–	37.0	–	225	23
29.06.81	0.5	5.0	1.8	5.9	3.8	22.7	7.4	250	35
	5.0	5.2	2.2	2.9	2.1	25.6	6.8	185	28
	10.0	7.4	3.2	1.9	1.3	29.3	7.6	155	
	18.0	21.3	12.8	1.5	1.1	31.9	8.2	140	18
02.09.81	0.5	19.2	7.2	1.4	0.6	9.3	3.2	35	19
	5.0	20.3	6.8	2.1	0.9	7.4	2.6	24	16
	10.0	16.8	5.1	1.2	0.6	4.9	1.7	31	14
22.09.81	0.5	8.8	3.4	1.7	0.8	7.3	5.5	85	35
	5.0	8.5	3.7	2.1	1.3	4.4	1.7	105	30
	10.0	8.2	3.1	0.7	0.4	7.4	3.2	95	37
11.12.81	0.5	11.5	–	4.8	–	36.0	–	165	52
	5.0	7.9	–	1.3	–	12.8	–	132	35
	9.0	3.4	–	3.2	–	17.0	–	148	55
24.12.81	0.5	15.3	4.2	8.7	1.8	7.3	1.0	50	22
	5.0	10.6	8.5	6.8	2.1	6.8	1.3	42	18
	10.0	11.3	5.2	4.8	1.8	4.0	1.0	30	15
mean		12.18	5.17	3.8	1.43	18.2	3.92	120.1	26.9

[1] Not determined.