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Research Article

DISTRIBUTION OF *MARENZELLERIA* CF. *VIRIDIS* (POLYCHAETA: SPIONIDAE) ALONG THE POLISH COAST OF THE BALTIC SEA

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Abstract

The distribution of *Marenzelleria* cf. *viridis* was studied in the Polish zone of the southern Baltic in relation to major environmental variables. Quantitative samples were collected in the 1996-2002 period from 62 stations using a 25 kg van Veen grab and a 200 kg box corer. Individuals of *M.* cf *viridis* were found to be abundant throughout the area of study down to depths of about 25-30 m, while the polychaete was encountered sporadically down to 76 m. *M.* cf. *viridis* occurred mainly on sandy bottoms, and low abundance was recorded on the silty bottoms in the Gulf of Gdańsk. The highest abundance and biomass values were recorded off river mouths in the Pomeranian Bay and the Gulf of Gdańsk, while significantly lower values were noted off the open coast. The variability of the sandy sediment properties failed to explain the polychaete's spatial distribution pattern. On the other hand, the horizontal and bathymetric distribution of *M.* cf. *viridis* was found to correspond with variations in the water chlorophyll *a* content.

INTRODUCTION

Spionid polychaetes of the genus *Marenzelleria* were first recorded in European waters in the early 1980s in North Sea estuaries (McLusky *et al*. 1993, Essink and Kleef, 1988). It is still not known how the genus *Marenzelleria* arrived in Europe. The most plausible explanation is that it was transported in vessel ballast water from North America (Essink and Kleef 1988, Zettler 1997a). The *Marenzelleria* individuals encountered were initially identified as *M. wireni* and later as *M. viridis.* In the Baltic Sea area, the first *Marenzelleria* individuals were found in 1985 in the Szczecin Lagoon (Bick and Burckhardt 1989), and the first record of it in Polish waters dates to 1988 (Gruszka 1991). The North Sea and the Baltic populations were found to differ in both morphology (Bick and Zettler 1997) and reproduction period (Bochert 1997). Comparative genetic studies indicated that they were two different species: *Marenzelleria* cf. *wireni* in the North Sea and *Marenzelleria* cf. *viridis* in the Baltic (Bastrop *et al*. 1995). In their recent revision of the genus *Marenzelleria,* Sikorski and Bick (2004) described five species, four of which occur in brackish areas. These authors maintain that the species found in the Baltic represents *M. neglecta* Sikorski and Bick sp. nov.

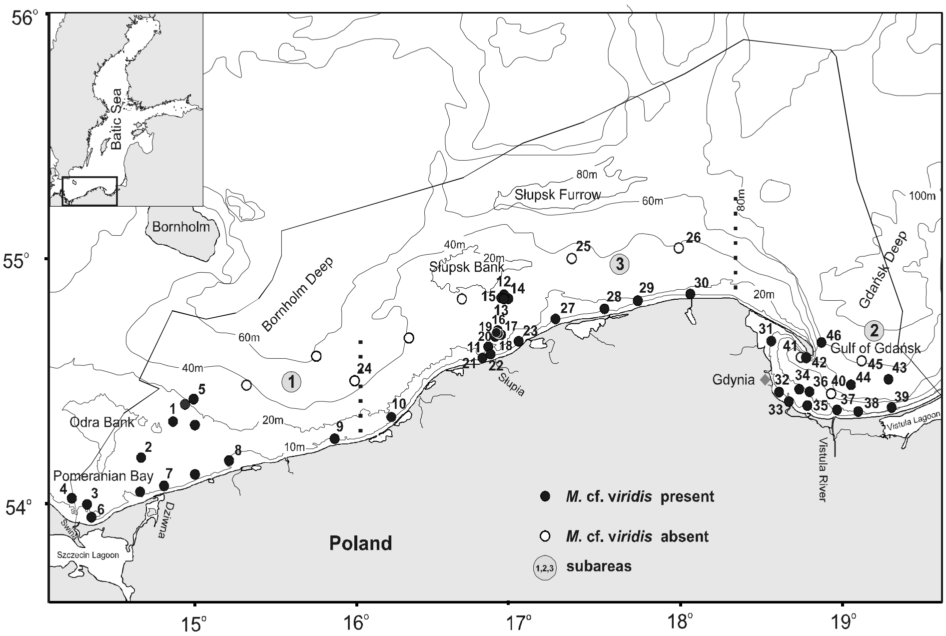

Fig. 1. Distribution of sampling stations and occurrence of *Marenzelleria* cf. viridis.

Within the Polish zone of the Baltic, the distribution of *Marenzelleria* is best known in the Pomeranian Bay (Gruszka 1991, 1998; Powilleit *et al.* 1995; Żmudziński *et al.* 1996; Kube *et al.* 1996 a, b). There are, however, virtually no published data on the polychaete's occurrence in the Gulf of Gdańsk and off the open coast.

This study is aimed at describing the occurrence and spatial distribution of *Marenzelleria* abundance and biomass throughout the Polish Baltic zone in relation to major environmental variables.

MATERIALS AND METHODS

Area of study

The study was carried out in the 1996-2002 period in the Polish zone of the southern Baltic. The distribution of the sampling sites is shown along with the area's bathymetry in Fig. 1. For the purpose of this study, the area of study was divided into the following parts: 1 - the Pomeranian Bay area (eastwards to 16^o E); 2 - the Gulf of Gdańsk area (delineated by 18^o 15 E); 3 - the remaining part was the open coast area. The shallowest stations were located at depths of 4, 7, and 8 m on the open coast, the Pomeranian Bay, and the Gulf of Gdańsk areas, respectively. Samples were collected mainly from the sandy bottom, which prevailed throughout the study area. Sandy sediments cover the seafloor to depths of about 50 m in the Pomeranian Bay, 60-70 m in the open coast area, and 20-50 m in the Gulf of Gdańsk. The deeper parts of the bottom are covered by silt in the Bornholm and Gdańsk Deeps and in the deepest sections of the Słupsk Furrow. The Furrow's sills are covered by clay. A permanent halocline is present at about 50-60 m in the Bornholm Basin and at about 70-80 m in the Gdańsk and Gotland Basins. Salinity in the isohaline layer above the halocline is stable throughout the area of study (7-9 PSU). Below the halocline, salinity varies from 14-20 PSU in the Bornholm Deep to 10-13 PSU in the Gdańsk Deep. The layers beneath the halocline in the Gdańsk and Bornholm deeps feature oxygen deficiency. The summer thermocline is formed at depths of 10-20 and 30-40 m.

Sampling and data analysis

The macrozoobenthos was sampled in different years - in 1996 and 1997 in the Pomeranian Bay, in 1997 in the Gulf of Gdańsk, and in 1997 and 1999-2001 off the open coast.

Due to differences of the sampling times at the various areas, mean station abundance and biomass values are reported (Annex 1). All the samples were collected in summer (June – August). Samples from the silty bottoms were collected with a van Veen grab (0.1 m^{-2}, 25 kg), while a Reineck-type box corer (0.0225 m^{-2}, 200 kg) and the van Veen grab were used to sample the sandy bottoms. In the Pomeranian Bay, off the open coast, and in the Gulf of Gdańsk, the box corer was used to dig into the sediments to depths of 10-12, 12-15, and 13-18 (20) cm, respectively. Off the open coast, the light-weight van Veen grab only dug into the fine compact sand to a depth of 4-5 cm, and the number and weight of the individuals caught accounted for only a small percentage of the numbers and weights produced by the box corer samples. This is why the sandy bottom samples collected with the van Veen grab were only used to map *Marenzelleria* distribution (Fig. 1), while the abundance and biomass distribution on the sandy bottom are described with data from the box corer samples. At each station, an additional sediment sample from the uppermost 5 cm was collected for grain size and organic matter content (loss on ignition at 500^{o}C) analyses. Concurrently with sediment sampling, near-bottom water salinity, temperature, and oxygen content were measured.

The samples were sieved on a 1 mm mesh sieve, and the residue was preserved with 4% buffered formalin. The frequency of occurrence was calculated as the proportion of the number of *M.* cf. *viridis* in the total number of stations sampled. After the polychaetes had been dried on blotting paper, their wet weight was obtained by directly weighing them to the nearest 0.1 mg. Relationships between polychaete abundance and biomass versus sediment properties were tested with Spearman's rank correlation coefficient, while the Kruskal-Wallis test was used to test for the significance of differences in mean abundance and biomass among areas.

RESULTS

The occurrence of *Marenzelleria* was confirmed at 70% of the stations sampled (Fig. 1). The frequency of occurrence in the Pomeranian Bay, Gulf of Gdańsk, and off the open coast was 100, 91, and 70%, respectively. The mean abundance calculated for the Pomeranian Bay, the open coast area, and the Gulf of Gdańsk were 857, 147, and 388 ind m^{-2}, respectively, and were significantly different ($p < 0.001$). Significant differences ($p < 0.001$) were also detected between the mean biomass values for the three areas at 25.30; 4.79, and 37.11 g m^{-2}, respectively. At most stations, the abundance and biomass did not exceed 500 ind m^{-2} or 10 g m^{-2}, respectively (Fig. 2, 3). The highest abundance and biomass values were recorded off the Świna River mouth (more than 3000 ind m^{-2}) and the Vistula River mouth (in excess of 1500 ind m^{-2}), with respective biomass values of about 90 and 169 g m^{-2}. The sandy bottom off the open coast was found to support low abundances and biomass values which were prone to extensive variation, both throughout areas and within stations.

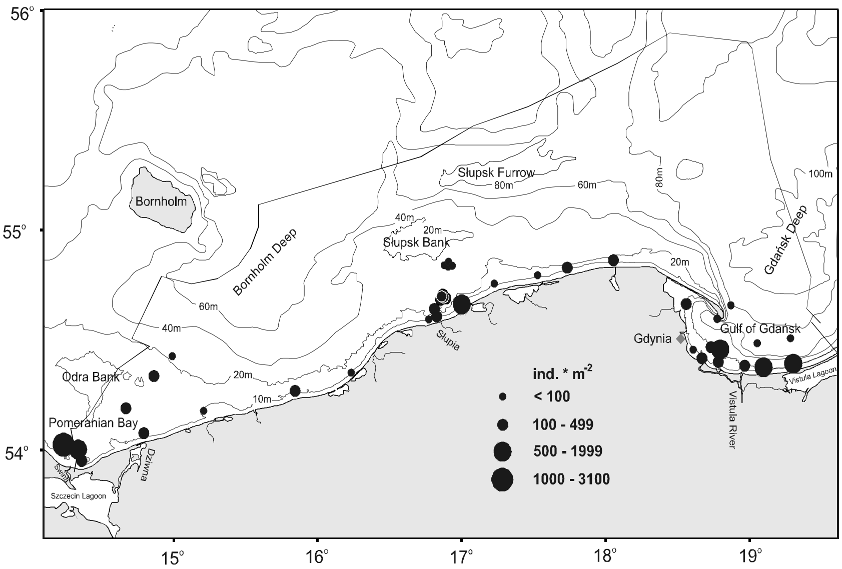

Fig. 2. Distribution of mean abundance values of *Marenzelleria* cf. *viridis* .

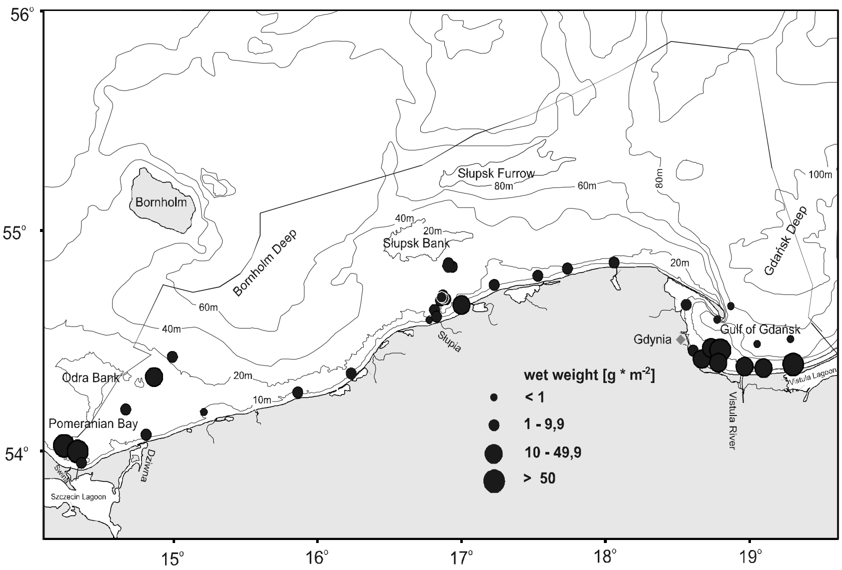

Fig. 3. Distribution of mean biomass values (wet weight) of *Marenzelleria* cf. *viridis.*

Marenzelleria occurred within a depth range of 4 m (the shallowest stations) to 45 m on sandy and to 76 m on silty bottoms (Fig. 1). The polychaete was abundant (more than 100 ind m^{-2}) to depths of 20-25 m, and single individuals were encountered deeper down. Within those depths, the abundance and biomass values were found to vary extensively (Fig. 2, 3). Spearman's test showed a lack of any significant relationship between depth and abundance and biomass within the depth range of polychaete occurrence.

Marenzelleria was found to inhabit the sandy bottom; it was only in the Gulf of Gdańsk that some individuals were retrieved from the silty bottom. The sandy sediment of the sampling stations was characterized by relatively low variability; fine and medium sand were prevalent with a median grain size range of 0.15–0.35 mm at most stations. The organic matter content at most sandy stations did not exceed 1%. Only in the areas located off the river mouths did the sedimentary organic matter content increase - to 4% off the Świna mouth and to about 7-10% in the silty sediments of the Gulf of Gdańsk. There were no significant correlations between the sediment grain size and organic matter content on the one hand or abundance (R=-0.28; p=0.049 and R= 0.13; p=0.36) and biomass (R=-0.090; p=0.50) of *Marenzelleria* on the other.

The vertical distribution of the polychaete in the sediment samples varied highly among the sampling stations. However, the mean relative abundance in individual layers calculated for each area showed a certain pattern. In both the Gulf of Gdańsk and off the open coast, the majority of individuals and biomass were concentrated in the 5–15 cm sediment layer, while about 50% of the biomass in the Pomeranian Bay occurred in the topmost sediment layer.

DISCUSSION

When describing the distribution of deep burrowing species, it is important to know the efficiency of the sampling gear. The burrowing depth changes in relation to sediment characteristics such as hydration, silt/clay fraction, and grain size (Dauer *et al.* 1981, Zettler *et al.* 1995), which differ among various areas. In the study area, no sampling gear that can dig deeper into the sediment than the box corer has ever been used. In the sandy bottom of the River Świna that discharges into the Pomeranian Bay, Gruszka (1998) found that *Marenzelleria* individuals occur to depths of 25 cm. An average of 66% of all the individuals and biomass was present in the 6-15 cm sediment layer, and 21% of the abundance and 29% of the biomass were contained within the 16-25 cm layer. The uppermost 5 cm supported as little as 13% of the abundance and 5% of the biomass. Pomeranian Bay sediments occasionally contain a layer consisting of shell fragments which enables the animals to burrow deeper than

10-12 cm. Consequently, the corer used in that area could have retrieved most, or even all, of the individuals present (Kube *et al.* 1996 a, authors' unpublished data). The few cores taken for this study that reached down to the 18-20 cm layer either contained no animals or just single individuals below 15 cm. Off the river mouths at depths below a few cm the sediment was black indicating oxygen deficiency that could have limited the vertical distribution of the polychaete.

In the Baltic *M.* cf. *viridis* occurs in both inshore areas and coastal lagoons within a wide range of environmental conditions (*e.g.*, Żmudziński *et al.* 1996, Kube *et al.* 1996 a, Zettler *et al.* 1995, Kotta and Kotta 1998). As regards geographic distribution, the major pattern observed in this study is significantly higher abundances and biomasses in the Gulf of Gdańsk and Pomeranian Bay than off the open coast. With regards to bathymetric distribution, high abundance was noted to depths of about 20-25 m (35-40 m at the maximum) on the sandy bottom and 60 m on the silty seafloor.

M. cf. *viridis* is regarded as a typical brackish water species with a salinity preference that varies within 1(0.5)-15 PSU (*e.g.*, Boesch 1977, Arndt 1989, Sikorski and Bick 2004). In the southwestern Baltic, the highest abundances were recorded at salinities of 5 and 8 PSU. Larval development was found to be inhibited at salinity lower than 5 PSU (Zettler *et al.* 1995, Bochert and Bick 1995, Kube *et al.* 1996 a). Thus, in the present study area, salinity is not a factor that would limit the geographic and bathymetric distribution of *M.* cf. *viridis* (Gruszka 1991, Kube *et al.* 1996 a). Sediment type also could not explain the spatial variability in the area of study. Sediment properties mainly affect burrowing potential (tube building). Depending on food availability, *M. viridis* is capable of collecting food particles from the water column and from the sediment content. Therefore, the sedimentary organic matter content does not reflect food availability in areas with high phytoplankton abundance (Hempel 1957, Fauchald & Jumars 1979, Dauer *et al.* 1981, Kube *et al.* 1996 a, Zettler 1997b). Earlier research in the Pomeranian Bay (Kube *et al.* 1996a, b) showed clearly positive correlations between the distribution and abundance of *Marenzelleria* on the one hand and phytoplankton concentrations on the other. In the present study, the horizontal and bathymetric differences in abundance and biomass, particularly the densest concentrations of *Marenzelleria* individuals, also reflect the pattern of water chlorophyll *a* contents (Ochocki *et al.* 1999, 2000). This indicates that it is the availability of water-borne food that is the major factor affecting the horizontal and bathymetric distribution of *Marenzelleria* individuals. Off the open coast, where phytoplankton forms the least dense concentrations, detritus accumulating on the sediment surface may be more important as a food source. This is indicated by the very wide variability in small-scale spatial distribution (*e.g.*, within a station) that corresponded to the patchy distribution of detritus accumulating in sediment depressions, as observed by the present authors on video footage.

The range of the abundant distribution of *Marenzelleria* found in this study also corresponds with the lower boundary of the isothermal warm water layer in summer and early fall, *i.e.*, at the time when *Marenzelleria* gametes mature and planktonic larvae develop. Bochert *et al.* (1996) observed that the onset of gamete development took place in May, adult individuals attained sexual maturity in late September, and sediment settlement beginning in October. The individuals that failed to achieve maturity before the water cooled began reproducing the following spring. Gruszka (1998) also observed that the planktonic larvae transformation into the benthic stage began in fall and early winter as well as in spring.

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Annex 1.

Station	**Date**	**Latitude**	**Longi-tude**	**Depth [m]**	**Abundance ± SD** [ind.*m^{-2}]	**Biomass ± SD** wet weight [g*m^{-2}]
1	26.05.97	5420.36	1452.36	12	205 ± 67	14.41 ± 7.56
2	19.05.97	5411.00	1440.48	13	286 ± 342	5.44 ± 2.58
3	17.05.97	5400.01	1420.45	11	1716 ± 836	68.33 ± 27.47
4	02.10.93	5401.16	1412.50	11	2765 ± 315	65.97 ± 12.60
4	20.07.96	5401.16	1412.50	11	3037 ± 877	84.99 ± 18.93
4	21.05.97	5401.16	1412.50	11	2537 ± 713	81.88 ± 29.93
5	27.07.96	5425.81	1459.52	23	44 ± 45	2.24 ± 1.94
6	26.05.99	5356.06	1422.01	11	445 ± 281	8.31 ± 7.34
6	21.05.00	5356.04	1421.99	8	222 ± 70	1.90 ± 0.34
6	02.06.01	5356.20	1421.90	9	160 ± 74	3.39 ± 3.54
7	26.05.99	5403.42	1449.01	11	165 ± 95	5.88 ± 3.06
7	21.05.00	5403.05	1449.09	9	144 ± 99	2.42 ± 2.28
7	02.06.01	5403.43	1449.06	10	142 ± 119	4.85 ± 3.89
8	26.05.99	5410.38	1512.51	11	71 ± 60	0.84 ± 1.08
8	21.05.00	5410.00	1512.00	11	36 ± 37	0.54 ± 0.92
8	02.06.01	5410.00	1512.00	11	71 ± 40	0.77 ± 0.92
9	26.05.99	5415.80	1551.80	10	284 ± 304	7.09 ± 7.19
9	21.05.00	5415.80	1551.80	8	418 ± 143	7.08 ± 3.20
9	02.06.01	5415.70	1551.70	10	18 ± 24	0.20 ± 0.28
10	27.05.99	5420.90	1613.30	13	116 ± 212	2.76 ± 4.88
10	02.06.01	5420.95	1613.29	12	36 ± 49	1.50 ± 2.10
11	28.05.99	5435.80	1650.90	10	471 ± 205	9.62 ± 6.90
11	20.05.00	5435.87	1651.07	10	311 ± 166	4.67 ± 3.99
11	03.06.01	5435.87	1650.90	10	124 ± 96	3.24 ± 2.78
12	30.06.99	5451.31	1654.94	33	15 ± 25	1.78 ± 3.08
12	09.07.00	5451.31	1654.94	33	15 ± 25	1.48 ± 2.56
13	30.06.99	5450.93	1654.81	33	59 ± 68	4.59 ± 4.13
13	09.07.00	5450.93	1654.81	33	59 ± 103	2.58 ± 4.46
14	30.06.99	5450.74	1655.29	31	44 ± 45	4.44 ± 5.55
14	09.07.00	5450.74	1655.29	31	0	0.00
15	31.06.99	5451.04	1654.09	34	0	0.00
15	09.07.00	5451.04	1654.09	34	15 ± 25	0.16 ± 0.28
16	31.06.99	5442.29	1652.26	23	326 ± 289	10.81 ± 8.07
16	09.07.00	5442.29	1652.26	23	74 ± 51	2.07 ± 2.79
17	31.06.99	5441.57	1652.03	23	341 ± 219	12.98 ± 8.17
17	09.07.00	5441.57	1652.03	23	0	0.00
18	31.06.99	5441.70	1652.88	23	311 ± 44	9.03 ± 4.53
18	09.07.00	5441.70	1652.88	23	59 ± 51	1.38 ± 1.25
19	01.07.99	5441.80	1651.27	23	370 ± 296	14.51 ± 10.96
19	11.07.00	5441.80	1651.27	23	59 ± 26	1.34 ± 0.39
20	01.07.99	5436.88	1650.22	17	193 ± 129	5.42 ± 2.78
20	11.07.00	5436.88	1650.22	17	89 ± 89	3.53 ± 3.45
21	02.07.99	5434.82	1647.67	4	0	0.00
21	11.07.00	5434.82	1647.67	4	148 ± 118	1.1 ± 0.74
22	02.07.99	5435.90	1651.40	10.5	148 ± 219	3.41 ± 4.45
23	27.05.97	5440.00	1700.00	20	992 ± 245	43.38 ± 20.57
24	27.05.97	5430.00	1600.00	40	0	0.00
25	25.05.97	5500.00	1720.00	29	0	0.00
26	25.05.97	5430.00	1600.00	40	0	0.00
27	28.05.99	5444.22	1712.86	10.9	36 ± 58	1.14 ± 2.40
28	20.05.00	5446.95	1633.71	10	100 ± 92	2.20 ± 1.79
28	03.06.01	5445.97	1733.68	11	36 ± 37	0.83 ± 0.92
29	28.05.99	5448.91	1746.20	11	231 ± 115	5.91 ± 4.31
29	24.05.00	5448.66	1746.14	10	133 ± 44	2.81 ± 2.01
29	03.06.01	5448.94	1746.26	10	36 ± 37	0.99 ± 1.56
30	19.05.00	5450.55	1803.10	10	302 ± 145	6.09 ± 3.01
30	03.06.01	5450.56	1803.09	11	231 ± 58	3.51 ± 1.65
31	21.08.97	5438.10	1833.40	8	1037 ± 68	9.01 ± 8.79
32	19.08.97	5427.35	1836.52	12	597 ± 103	3.14 ± 5.44
33	19.08.97	5425.03	1840.16	7	155 ± 95	15.94 ± 2.48
34	19.08.97	5428.05	1844.00	18	163 ± 26	11.90 ± 2.81
35	18.08.97	5424.04	1847.00	13	2817 ± 136	23.89 ± 15.20
36	18.08.97	5425.08	1848.05	20	600 ± 220	64.91 ± 51.70
37	09.05.97	5423.30	1857.84	18	1555 ± 716	169.74 ±184.03
38	09.05.97	5421.98	1908.85	16	563 ± 286	38.84 ± 29.65
39	10.05.97	5423.60	1920.29	23	400 ± 154	33.76 ± 31.81
40	20.08.97	5423.08	1858.03	22	0	0.00
41	30.10.97	5434.72	1844.81	45	10 ± 17	0.31 ± 0.54
42	30.10.97	5435.08	1847.00	55	0	0.00
43	09.09.00	5431.74	1916.97	75	10 ± 14	0.07 ± 0.10
44	05.09.00	5426.96	1903.75	64	10 ± 0	0.0796 ± 0.06
45	01.07.01	5436.00	1906.00	80	0	0.00
46	19.09.00	5438.40	1851.50	76	13 ± 15	0.11 ± 0.13