HIERARCHICAL CLASSIFICATION OF MACROBENTHIC MOLLUSCS IN LONGSHORE WATERS OF THE TURKISH BLACK SEA

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Abstract

Single quantitative samples of macrobenthos were collected from 20 shelf stations of the Turkish Black Sea in September of 1988. The root-root transformed biomass of molluscs was subjected to multivariate analyses (cluster, multi-dimensional scaling and diversity analyses). In accordance with the distribution of molluscs in cluster grouping, the bottom of investigated area was classified into three zones, namely: shallow zone (20-40 m depth), intermediate zone (30-50 m) and deep zone (more than 50 m). Using MDS the simplest explanation for trends in the data is that depth and dissolved oxygen of the bottom water had an overriding influence on the macrofaunal distribution patterns of mollusc since both depth increased and oxygen content of bottom water decreased in a uniform manner from left to right in the MDS plot. In the grouped zones, Chameleae gallina-Pitar rudis-Gouldia minima and Mytilus galloprovincialis community, Spisula subtruncata-Venus casina community and Modiolula phaseolina community were recorded in the shallow, intermediate and deep zone, respectively.

Key words: multivariate, benthos, mollusc, the Black Sea.

Introduction

Biological surveys whether of benthos, plankton or nekton, usually result in complex bodies of biotic and abiotic data from which patterns and relationship need to be extracted. The resident species in the sea have a defined pattern unless the

environment is exposed to sudden or gradual drastic changes. Organisms has responsed changing abundance, biomass or number of species against fluctuations in the environment. In case, multivariate analyses find out what kind of abiotic factor is responsible for the distribution of benthic species. Numerical techniques were most commonly applied to benthic data (e.g. Sanders, 1958; Cassie and Michael, 1968; Stephenson et al., 1972; Field et al., 1982; Clarke and Green, 1988; Warwick and Clarke, 1991 and several recent papers). From available papers, Petukhov et al, (1991) only applied multivariate analysis to the macrobenthos in the Russian coasts (southern shore of Crimea) of the Black Sea. In Turkish Black Sea, some taxa groups of macrobenthos, molluscs and crustaceans were studied by Mutlu et al. (1991), Mutlu et al. (1992), Mutlu and Unsal (1992) and Mutlu (1994). Further Turkish study on the benthic amphipoda along the Anatolian coasts of the southern Black Sea was made by Kocatas and Katagan (1980).

This paper aimed to conduct a preliminary results on ecology of macrobenthic molluscs along the Turkish coasts of the Black Sea.

Material and methods

In summary, for field study, bulk sediments for macrobenthic molluscs were taken by means of a van Veen grab at 20 shelf stations of the Turkish Black Sea (Fig. 1), sieved at 0.5 cm and preserved in formalin in September-1988. Only single sample from each station was analyzed. Abundance and biomass of the sorted molluscs species were determined. In addition to biotic parameters, some abiotic factors (e.g. temperature, salinity and oxygen content of bottom water by CTD-probe and sediment texture by Folk's method, (1974) were measured.

For species biomass arrays, triangular matrices were computed of similarities between every pair of both stations and species using the Bray-Curtis coefficient (Bray and Curtis, 1957).

Because there is a danger of occasional, random inclusion of particularly large organisms which may swamp the other data, prior to this computation, the data were subjected to root-root transformation (Anon., 1991) and dendograms were formed by group-average sorting. Ordination was by non-metric Multi-Dimensional Scaling (MDS; Kruskal and Wish, 1978). Diversity was calculated as the Shannon-Wiener diversity index, using logarithms to the base e in the calculations, species richness as Margalef's and evenness as Pielou's indices (Gray, 1981). All computations were made with the help of computer package programme called "PRIMER" (Anon., 1991).

Results and discussion

The overall results of biotic and abiotic values at the sampling stations were given in Table I.

Table I. Overall results of biotic and abiotic factors at stations.

	Stations in groups (Fig. 3)																	
Parameter	20	19	18	17	1	13	16	5	15	8	14	12	11	10	9	7	6	4
Number of species	11	7	6	4	2	2	9	10	19	12	20	2	3	6	5	2	10	2
Abundance (ind/m2)	2503	250	194	138	169	22	354	333	7858	2745	2251	57	182	2916	3361	1000	1395	12
Wet-weight (g/m2)	143	18	2	1	2	1	12	9	808	751	63	9	16	213	230	90	88	1
Richness	1.28	1.09	0.95	0.61	0.24	0.33	1.37	1.55	2.01	1.39	2.46	0.25	0.38	0.63	0.49	0.15	1.24	0.40
Evenness	0.39	0.66	0.89	0.96	0.92	1.00	0.82	0.77	0.45	0.18	0.65	0.71	0.84	0.11	0.07	0.05	0.45	1.00
Shannon&Wiener diversity	0.92	1.28	1.59	1.33	0.64	0.69	1.79	1.77	1.34	0.46	1.94	0.49	0.92	0.20	0.11	0.04	1.04	0.69
Water depth (m)	20	36	49	63	76	78	49	58	46	82	28	101	103	80	79	112	58	94
T (C)	7.93	7.70	7.78	nm	7.30	7.89	nm	7.49	nm	nm	nm	8.05	7.56	8.25	7.43	7.63	7.53	7.86
S (%.)	18.05	18.00	18.02	nm	18.49	20.01	nm	18.34	nm	nm	nm	20.29	19.59	20.61	19.54	19.78	18.24	20.23
O (ml/l)	8.17	7.21	7.23	nm	3.44	3.05	nm	5.80	nm	nm	nm	1.12	3.30	0.47	2.17	2.04	6.79	2.59
Gravel (%)	1	1	0	1	71	2	<1	5	17	1	<1	2	2	5	17	nm	6	nm
Sand (%)	94	18	13	17	28	1	<1	17	19	4	18	7	7	4	9	nm	67	nm
Silt (%)	5	61	64	55	<1	47	48	42	35	53	58	49	55	55	41	nm	13	nm
Clay (%)	1	20	23	27	<1	50	51	36	29	42	23	42	36	36	33	nm	14	nm
Mud (%)	6	81	87	82	1	97	99	78	64	95	81	91	91	91	74	nm	27	nm
Texture	(g)S	(g)sM	sZ	(g)sM	(g)M	(g)M	(g)M	(g)sM	(g)M	(g)M	sM	(g)M	(g)sM	(g)M	gM	nm	gsM	nm

e.g. (g)sM:slithly gravelly sandy mud; sZ:sandy silt; gsM:gravelly sandy mud

I found 36 mollusc species in macrobenthos of the Turkish Black Sea (Table II). Cluster analysis divided these species into three

Table II. List of macrobenthic mollusc species recorded along the Turkish coast of the Black Sea.

Species	Number in cluster analysis (Fig. 2)	Species number in groups
Gastropoda		
Prosobranchia		Group 1 **Shallow zone**
Bittium reticulatum	20	1, 2, 3,
Calyptraea chinensis	7	
Ventrosia ventrosa	19	4, 5, 6,
Cyclope neritae	12	
Pusillina parva	16	7, 8, 9
Trophon muricatus	30	
Turricaspia dybowski	23	
Opisthobranchia		
Chrysallida obtusa	18	Group 2 **Intermediate zone**
Odostomia scalaris	28	10, 11, 12,
Retusa truncatula	26	
Cylichnina umblicata	15	13, 14, 15,
Bivalvia		
Lamellibranchia		16, 17, 18,
Abra alba	33	
Abra prismatica	25	19, 20,
Acanthocardia tuberculata	35	
Acanthocardia paucicostata	13	
Acanthocardia sp. (juv.)	17	
Striarca lactea	36	
Parvicardium exiguum	29	
Plagiocardium papillosum	32	Group 3 **Deep zone**
Venus casina	11	21, 22, 23,
Lucinella divaricata	2	
Donax venustus	9	
Gouldia minima	5	
Hypanis plicatus	22	24, 25, 26,
Kellya suborbicularis	14	
Modiolus adriaticus	27	
Modiolula phaseolina	31	27, 28, 29,
Mysella bidentata	24	
Mytilaster lineatus	8	
Mytilus galloprovincialis	6	30, 31, 32,
Ostrea edulis	34	
Paphia aurea	3	33
Pitar rudis	4	
Spisula subtruncata	10	
Tellina tenuis	21	
Chameleae gallina	1	

depth and oxygen depended groups at an arbitrary similarity level of 12 % (Fig. 2). Thus, on the bottom of shelf of the Turkish Black Sea, three zones are identified, namely; shallower zone (20-46 m with averaged depth of 34 m); intermediate zone (30-60 with 40 m); and deep zone (35-112 with 55 m) (Figs. 2 to 5 and Table III). Petukhov et al. in 1991 found 26 mollusc species in the macrobenthos of Lapsy Bay and 49 species of the macrobenthos comprising the first group are recorded at shallow stations to a depth of 20-30 m (shallow zone), the second group at depths of 40-60 m (intermediate), and the third group at depths greater than 60 m (deep zone).

The third group was divided into two smaller entities-groupings. Three species were not statistically found significant in the cluster analysis in any of the associations. Figs. 2 to 4 show MDS analysis for biomass with 4th root. Using MDS the simplest explanation for trends in the data is that depth and dissolved oxygen of the bottom water (Table III) had an overriding influence on the macrofaunal distribution patterns of mollusc since depth increased in a uniform manner from left to right in the MDS plot (Figs. 4 to 6). On both dendograms (Fig. 2 and 4), Zones 1,2 and 3 are clearly separated from each other.

Table III. Averaged depth and oxygen content of bottom waters of cluster groups formed among the species.

Variable Mean ± SD	Cluster Groups		
	Group 1	Group 2	Group 3
Depth (m)	34±13	40±16	55±21
O_2	5.90±2.02	5.58±2.13	4.37±2.40

In case of classification analysis among the stations, three main groups were distinguished in more than 20% dominance at any of 20 stations. These are shallow zone (20-36), intermediate zone

(36–70 m) and deep zone (50–112 m depth; Fig. 3 and Table IV). Two stations (Sta. 2 and 3) seemed not to be related to the other stations.

Table IV. Mean values of some abiotic measurements of station groups.

Variable Mean ± SD	Cluster Groups		
	Group 1	Group 2	Group 3
Depth (m)	28±11	53±17	88±22
T (°C)	7.81±0.17	7.66±0.31	7.81±0.30
S (%.)	18.03±0.04	18.84±1.04	19.79±0.84
O_2 (ml/l)	7.69±.68	5.42±3.8	2.80±2.27
Gravel (%)	1±0	4±5	6±6
Sand (%)	56±54	11±7	19±3
Silt (%)	33±39.6	50±9	43±18
Clay (%)	11±13	35±11	32±11
Mud (%)	44±53	87±11	75±28

From the calculations of similarity percentage between stations, the greatest contribution to differences between zones is made by the following most important five species: Lucinella divaricata (13%), Chameleae gallina (11%), Plagiocardium papillosum (10%), Spisula subtruncata (9%), Paphia aurea (8%) between zones 1 and 2; Lucinella divaricata (19%), Chameleae gallina (13%), Spisula subtruncata (11%), Pitar rudis (9%) and Paphia aurea (8.6%) between zones 1 and 3; Modiolula phaseolina (30%), Plagiocardium papillosum (14%) Mytilus galloprovincialis (9%), Abra alba (7) and Pitar rudis (4%) between zones 2 and 3.

Shallow zone: This is a section of the bottom on which are found macrobenthic mollusc species, which cluster analysis placed in the first group. The zone takes up the depth interval from 20 to 46 m with an average 34 m only in the. The ground consists of gravelly or slightly gravelly sand or mud. Petukhov et al., (1991) named specifically the area between 3 and 20 m depth as shallow zone of which the surface sediment was composed of fine

and coarse sand, sometimes with a mixture of cobble.

In first group, the psammophilic species, Chameleae gallina Lucinella divaricata, Gouldia minima and Pitar rudis are predominant. The fine sand bottom was well-inhabited by these species in the Russian coasts which extend to 15 m deep, in places to 28 m Caspers, 1957). From the results of the study carried out by Bacescu et al., (1971) in the Rumanian sector, Gouldia minima, Lucinella divaricata and Chameleae gallina were mostly located around 20 m deep of Varna. According to Petukhov et al., (1991), Chameleae gallina and Gouldia minima-Pitar rudis were spatially distinguished in two different groups of the shallow zone.

This shallow zone with high content of the oxygen takes up the right bottom of 2-dimensional configuration (Fig. 6). This suggested that the zone was well in concurrence with shallow water and highly oxygenized water.

Intermediate zone: This is a part of bottom at depth between 30 and 60 m, which placed in the second group of the dendogram (Fig. 2 and 4). The ground was sediment-texturally characterized with the fine sand and slightly gravelly and sandy mud (Yucesoy and Ergin, 1992). Petukhov et al., (1991) classified similar bottom also intermediate zone which extends in narrow band between depths of 40 and 60 m and the ground is primarily mud and sand.

The second group of the macrobenthic mollusc comprises 11 species of which occurrence of frequency was lower than representatives of the first group. The majority was as follows: Bittium reticulatum, Ventrosia ventrosa, Acanthocardia pausicostata and Chrysallida obtusa. In the Lapsy Bay, only one grouping is recognized here with the mass species Amphiura stepanovi besides many polychaetes and at almost all stations Mytilus galloprovincialis dominated (Petukhov et al., 1991).

The greatest contribution to differences between zones 1 and 2 was made by the following most important five species: Lucinella divaricata (13%). Chameleae gallina (11%), Plagiocardium papillosum (10%), Spisula subtruncata (9%), Paphia aurea (8%).

Based on the water depth and oxygen content of the bottom water, this zone is like transition for molluscs species which survive relatively in lower oxygen and deeper bottom rather than the first group (Figs. 4 to 6).

Deep zone: This takes up depth more than 40-50 m where grain size of the superficial sediment was composed mainly of slightly gravelly mud, in places with fine sand. Petukhov et al., (1991) situated this zone below 60 m and sediment texture to be a compact gray mud with its consistency fluid-plastic in the upper 2-3 cm layer.

The predominant species in order of numerical occurrence were Modiolula phaseolina (44%), Abra alba (3%), Plagiocardium papillosum (2%). While these three species were abundantly observed in %50-70 of the sampling stations, the remaining species of the third group was found at a few stations. The biomass of Modiolula phaseolina varied from 0.02 to 230 g/m^2 (Mutlu et al, 1991 and Mutlu, 1994). In classification analysis made by Petukhov, et al., (1991), minimal values of biomass were recorded in the deep zone and Modiolula phaseolina was the dominant species by biomass varying from 0.23 to 19 g/m^2 within almost all stations. The dissimilarity between zones was contributed by the following main species: Lucinella divaricata (19%), Chameleae gallina (13%), Spisula subtruncata (11%), Pitar rudis (9%) and Paphia aurea (8.6%) between zones 1 and 3; Modiolula phaseolina (30%), Plagiocardium papillosum (14%) Mytilus galloprovincialis (9%), Abra alba (7) and Pitar rudis (4%) between zones 2 and 3.

This zone is plotted near the left bottom of the 2-dimensional illustration. On depth comparison with the other groups, the third zone was relatively deeper and carried the lower oxygen in bottom water (Figs. 4 to 6).

Acknowledgment

My special thanks go to Dr. Serge Gofas and Dr. Rudo Cosel for their helps in the identification of some questionable mollusc species, to Dr. J.S. Gray, Dr.R.M. Warwick and K.R. Clarke for giving statistical lecture in the course I attended in Egypt in December-1991.

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List of Figure:

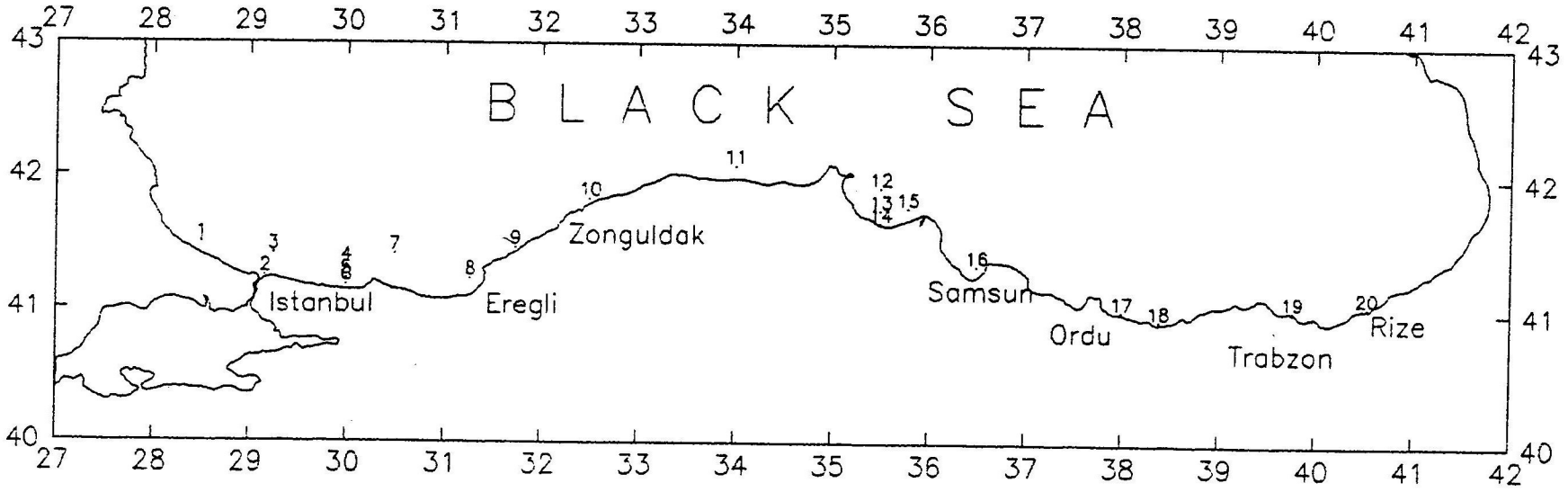
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Fig. 1.

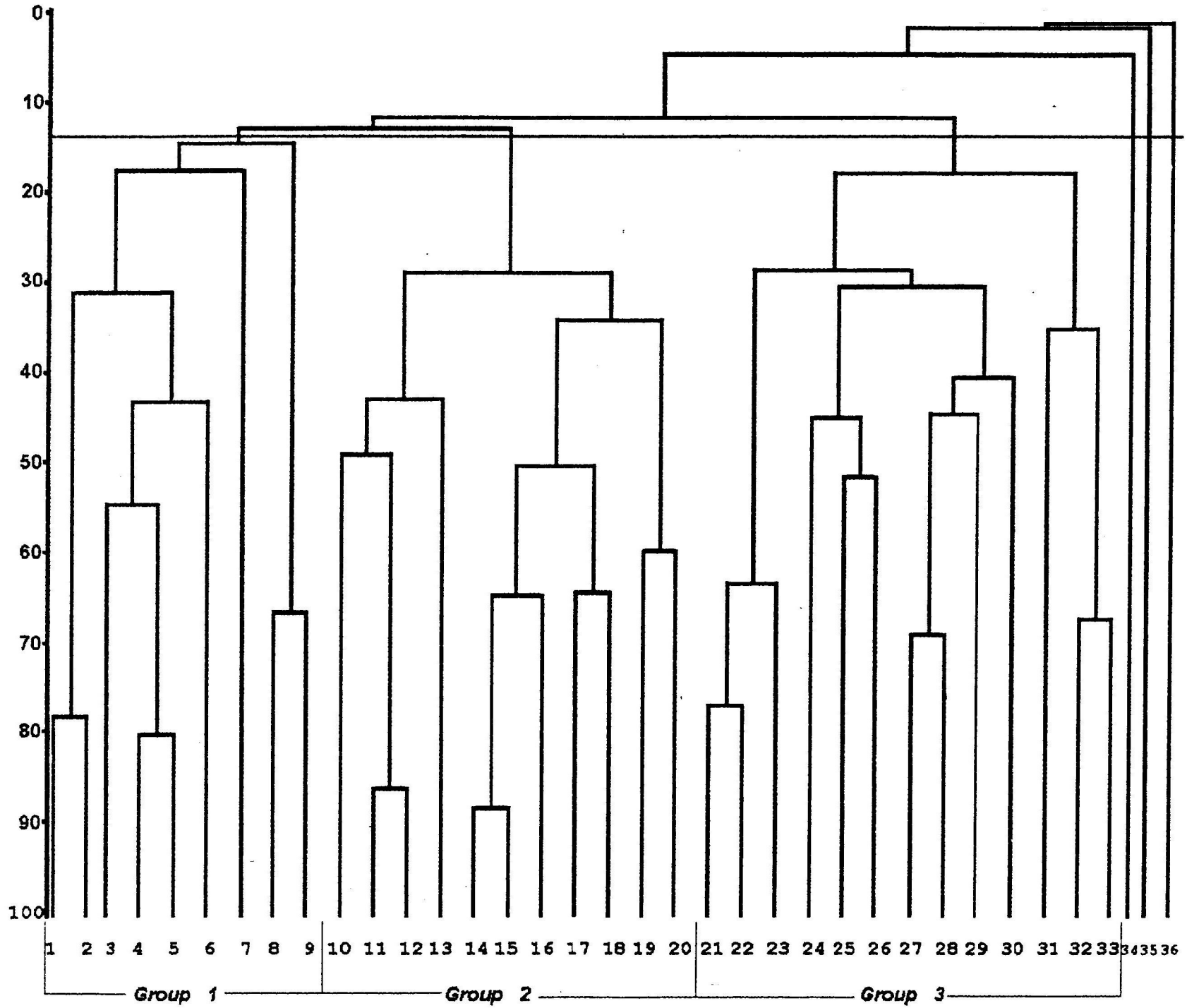
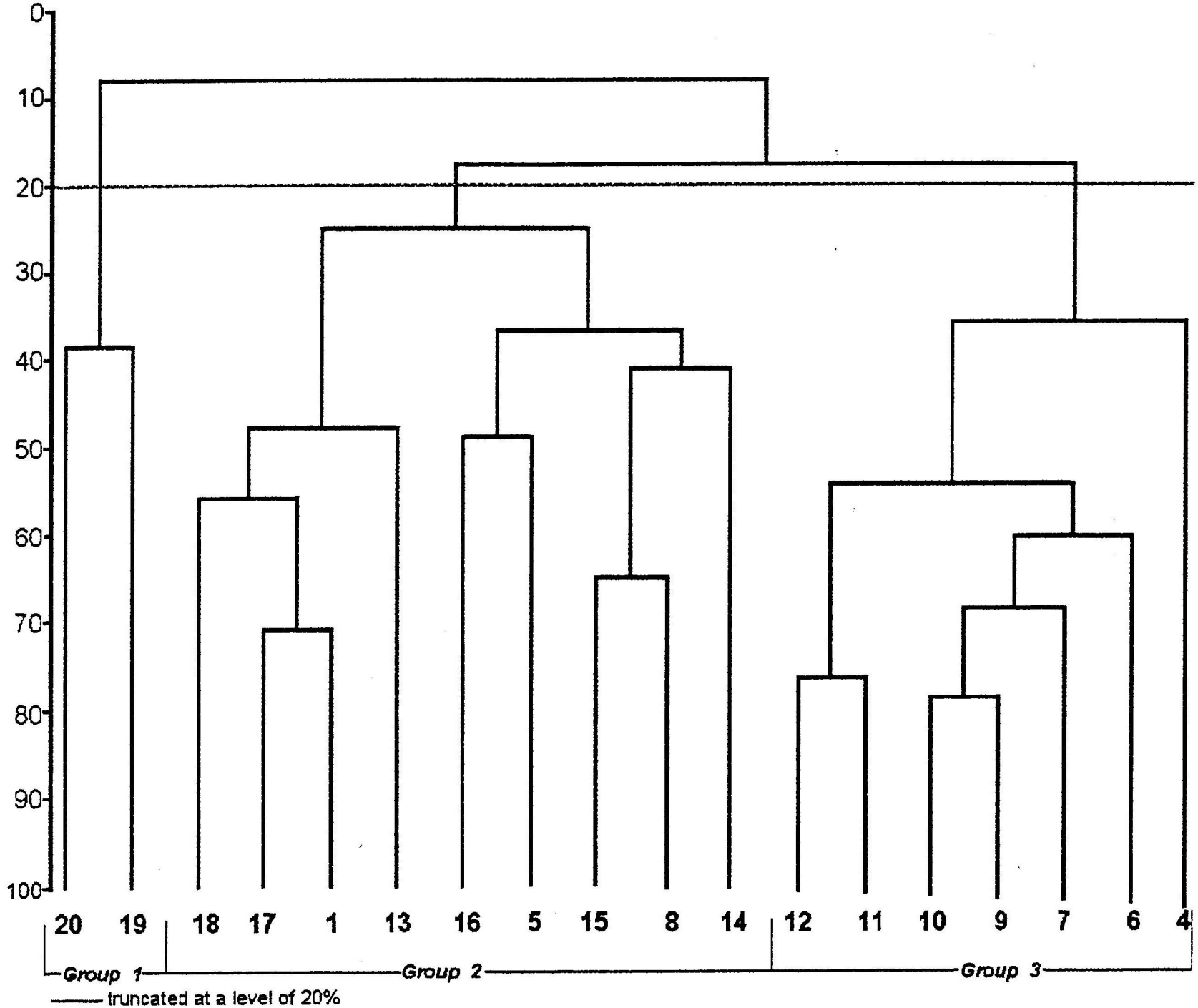


Fig. 2.

—— truncated at a level of 12%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Group 1
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Fig. 3.

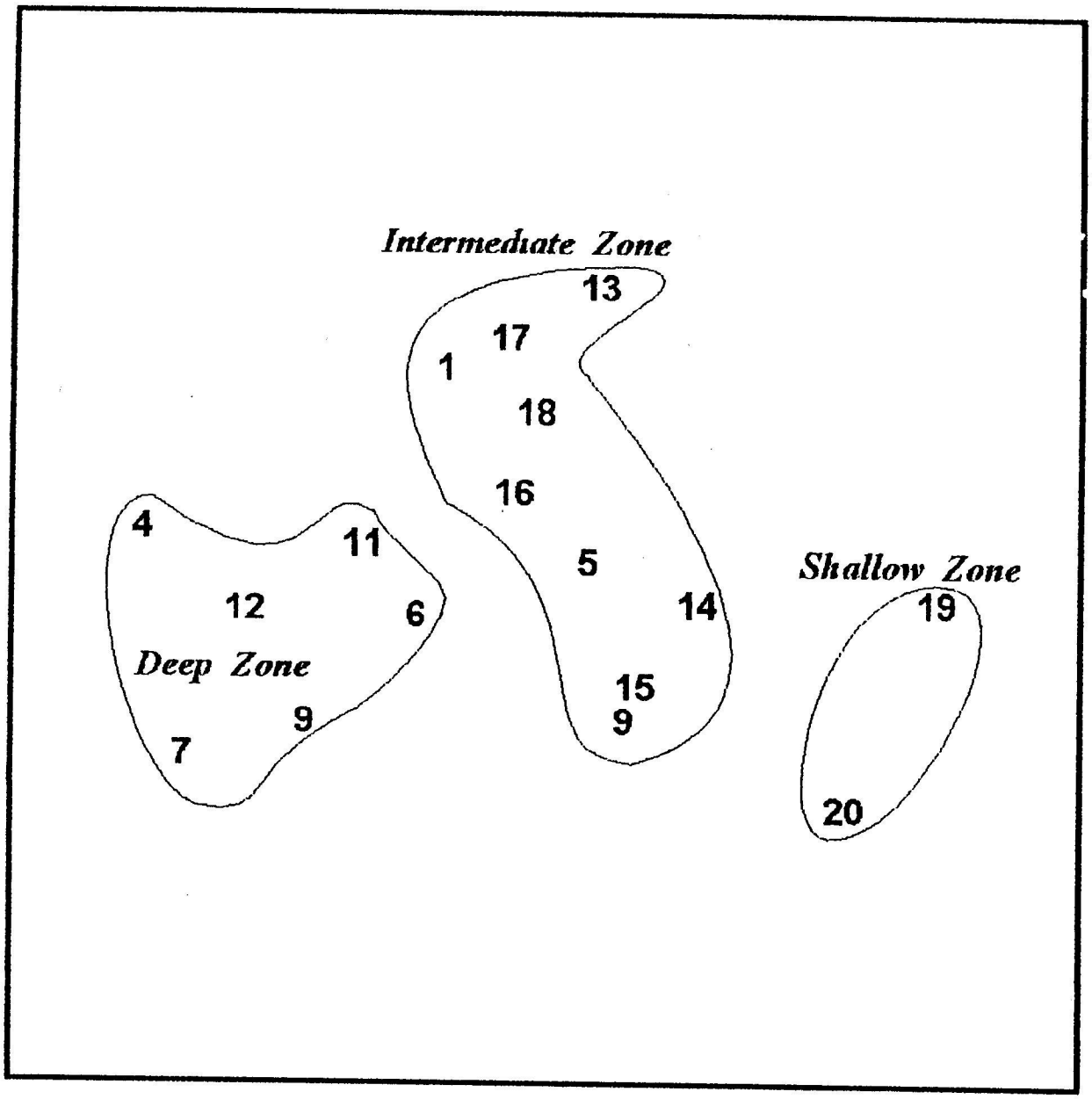
Intermediate Zone
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Fig-4.

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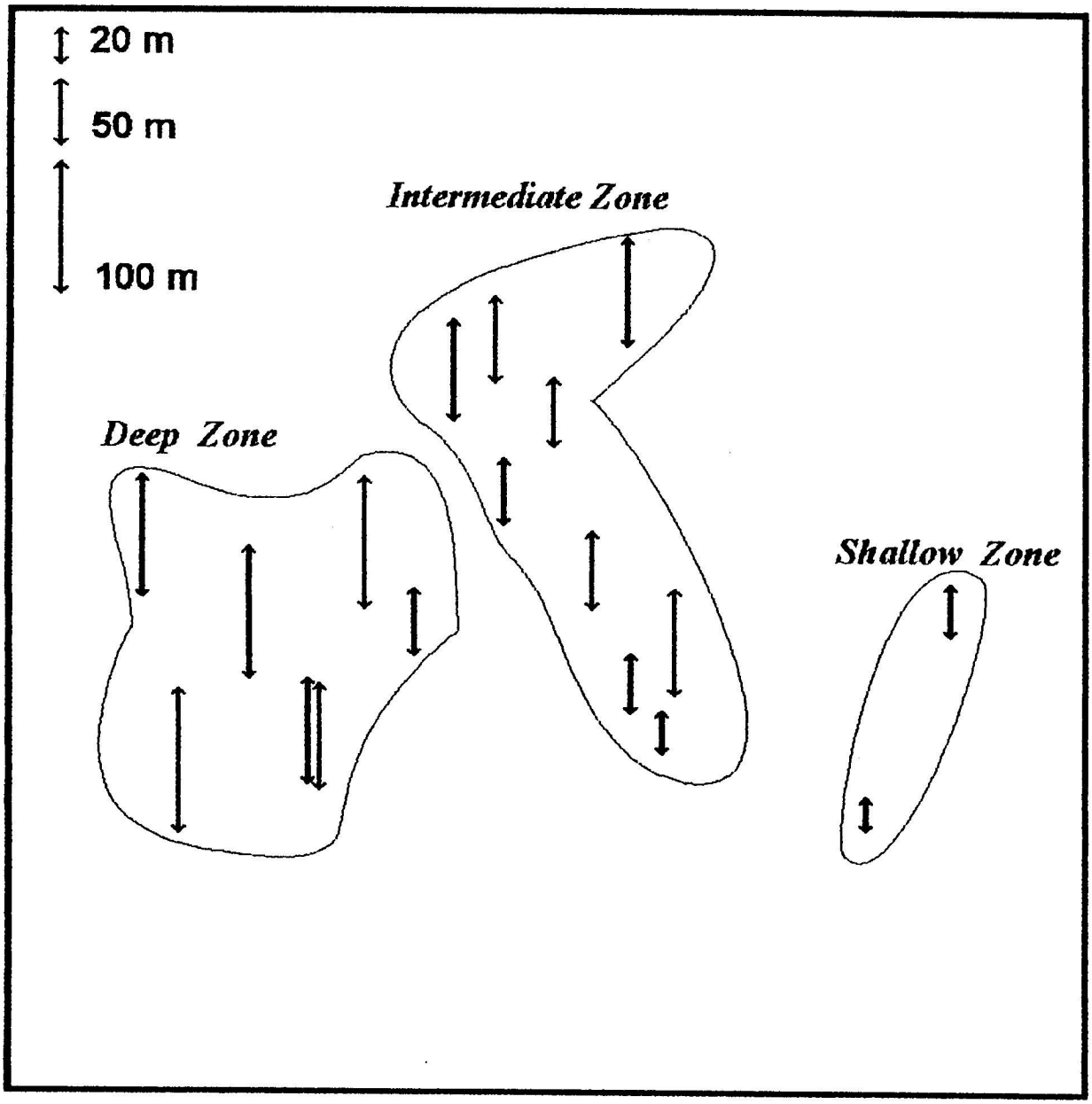

Fig. 5.

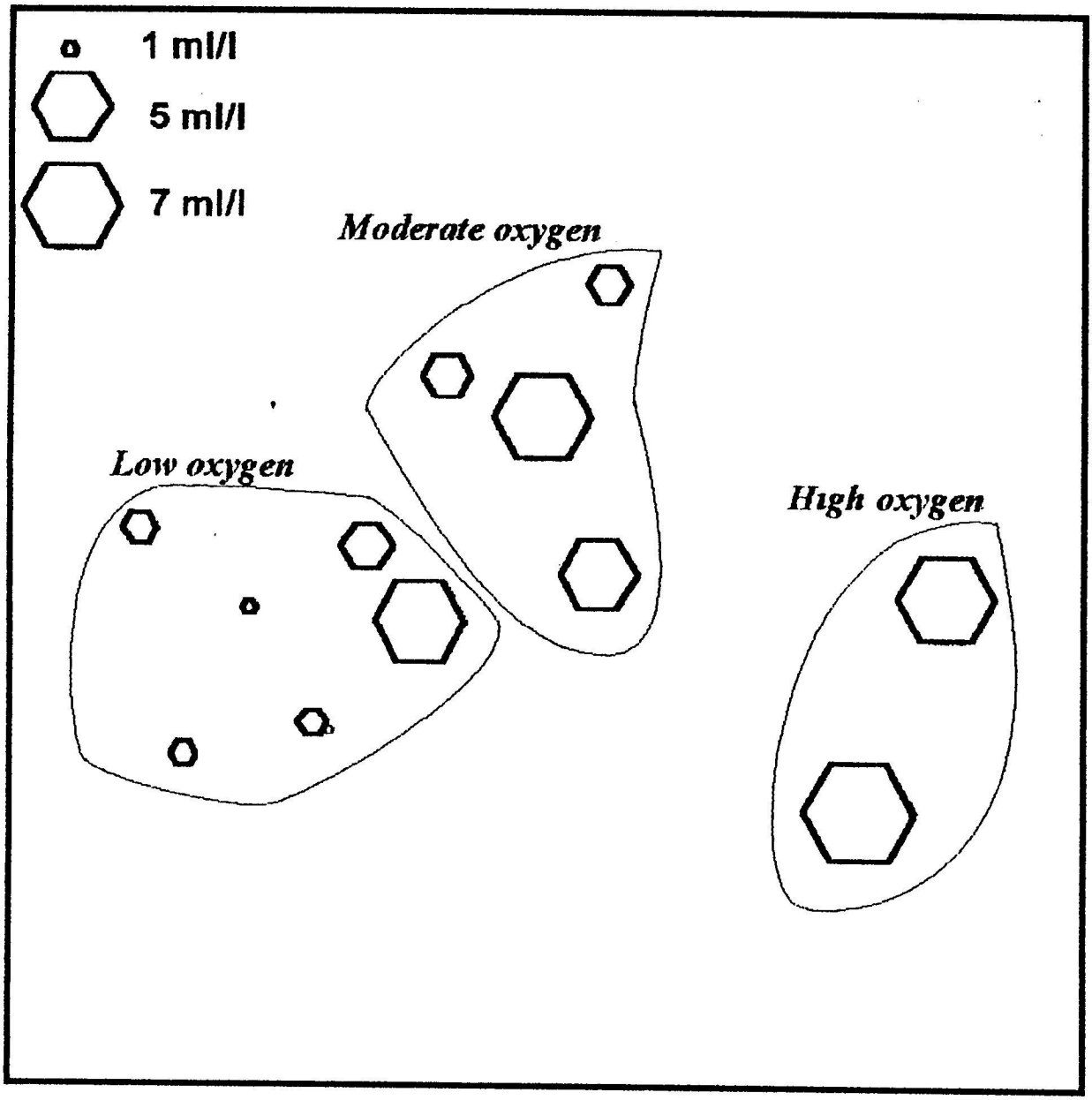

Fig-6.