THE DIVERSITY AND DENSITY OF MACROBENTHIC FAUNA IN THE WESTERN PART OF LAGOS LAGOON AND ADJACENT CREEKS

A THESIS SUBMITTED FOR THE DEGREE OF DOCTOR OF PHILOSOPHY (ZOOLOGY)

BY

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CERTIFICATION

I certify that the work embodied in this thesis for the Degree of Doctor of Philosophy (Zoology) has been carried out under my supervision.

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CERTIFICATION

This is to certify that the thesis:

Submitted to the
School of Postgraduate Studies
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For the award of the degree of

DOCTOR OF PHILOSOPHY (Ph.D)

is a record of original research carried out

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DEDICATION

To God,
The Mighty Warrior.

ABSTRACT

Diversity, density and distribution of macrobenthic fauna from eight stations in the western part of Lagos lagoon were studied between May 1996 and February 1998. Rainfall, salinity and nature of sediment were the major factors affecting fauna distribution in the lagoon, creeks and river.Air temperature ranged between 24.50^{0}C and 31.80^{0}C, while bottom water temperature ranged between 27.00^{0}C and 30.00^{0}C. Salinity values were low (0.00-5.00‰) in the rainy season and high 6.00-26.00‰) in the dry season. The pH ranged between 5.72 and 8.30, while conductivity ranged between 0.01m Scm^{-2} and 7.13m Scm^{-2}. Transparency was high (0.61-1.22m) in the dry season and low (0.15-0.6m) in the wet season. Rainfall affected temperature, salinity, conductivity and sediment type. It also affected density, diversity and distribution of fauna. Total organic content ranged between 0.50 and 11.93% and sediment type was either muddy, sandy mud or muddy sand with various amounts of silt and shells. A total of 20,730 individuals, eleven phyla, sixteen classes, sixty-two families and one hundred and twenty-four species were recorded in the sampling period. Species belonging to the following Phyla Porifera, Nemertina, Annelida, Pogonophora, Echiuroidea, Sipunculoidea, Mollusca, Arthropoda, Echinodermata, Hemichordata and Chordata were collected and documented. Thirty-six species were reported in the wet season, thirty-six in the dry season, while fifty-nine were euryhaline. The prevalence of pollution indicators *Capitella capitata*, *Polydora* sp., *Nereis* sp., *Gammarus* sp., *Tubifex* sp.

and *Chironomus* sp. in some stations were evidence of pollution. Although, the *Pachymelania* community was represented, twelve species collected by earlier workers were absent, while eleven species absent from earlier reports were documented. Economically important *Crassostrea gasar, Tympanotonus fuscatus, Pachymelania aurita, P. fusca quadrisenata, Mercierella enigmatica, Neritina glabrata, Aloidis trigona, Aloidis sulcata* and *Balanus pallidus* were recorded. The Mollusca, Annelida and Arthropoda ranked highest at all stations in the dry and wet seasons. In the dry season the Phylum Echinodermata (*Cucumaria* sp.) and Phylum Hemichordata (*Ptychodera* sp.) were recorded, while the Phylum Sipunculoidea, Phylum Chordata and Phylum Porifera were recorded in the dry season. Margalef's Index ranged between 0.00 and 4.18, Shannon and Weaver Information Function ranged between 0.00 and 2.44, while Equitability ranged between 0.00 and 0.95. Lower species diversity occurred in the wet season. A low positive relationship occurred between Total Organic Content and number of species. *Pachymelania aurita* had a wide salinity tolerance and was sediment specific, *Pachymelania* var *quadriseriata* were also sediment specific.

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INTRODUCTION

Benthos are organisms which live in, on or around the water sediment interface of an aquatic ecosystem (Olaniyan, 1968). They consist of the burrowing infauna as well as the sessile and mobile epifauna. The latter lives on the substratum (mud, clay or sand) or are attached to structures such as piers, stones rocks, coral reefs, tree roots, floats or pilings. The sedentary members of the epifauna have protective devices such as external shells or skeletons. Benthos may be classified by size of the organisms or the nature of sediment in which they are found. Comprising of all phyla, classes and species (Campbell, 1977), they are abundant in the West African coastal waters, interacting with visitors from fresh or marine zones. Worldwide, and in the coastal brackish Lagos lagoon, benthos have acquired increasing importance over the years. Whether they are microbenthos, meiobenthos or macrobenthos, they are economically important as fish feed and food for man, they constitute an important link in the aquatic food chain (Akpata *et al.,* 1993; Holme and McIntryre, 1971), and important fouling organisms, attached to rocks, wharf pilings, mangrove stumps and ship bottoms (Fagade & Olaniyan 1973). The benthos is used in the study of productivity (Ajao and Fagade, 1990a, b, c, d), fisheries (Fagade, 1969; Fagade and Olaniyan, 1973 and Kusemiju and Olaniyan, 1977), and more recently pollution studies (Akpata, 1987; Ajao, 1989; Nwankwo, 1993; Nwankwo and Akinsoji, 1989; Odiete, 1999). Bivalve shells can be used as sinkers in gill nets (Solarin, 1999), and are essential

ingredients of poultry feed. They are also important in aquaculture and can serve as a means of earning foreign exchange. Recently benthos have acquired a role in monitoring pollution levels (Odiete 1999).

The closeness of Lagos lagoon to the cosmopolitan city of Lagos, and the population pressure have caused environmental problems and highlighted the need for regular monitoring of the lagoon and adjoining water systems. At Oko Baba, on the southwestern border of Lagos lagoon, a timber industry thrives. Logs of various types are transported by water from Ondo State via Mahin, Lekki and Epe lagoons, for processing at Oko Baba. Biodegradable wood wastes emanating from sawmills affect bacteria, plankton and benthic fauna (Akpata, 1987; Akpata and Ekundayo, 1983; Linden, 1990; Nwankwo and Akinsoji, 1989 and Nwankwo *et al.,* 1994). Further south at Iddo, untreated and partially treated sewage are dumped into the lagoon (Adeniyi, 1980; Akpata, 1975; Akpata and Ekundayo, 1978; Ekundayo, 1977, 1981 and Nwankwo, 1986). Pollution by petrochemicals has also been reported in the Lagos lagoon (Ekundayo, 1977) while thermal pollution was reported at Ijora power station (Ekundayo, 1977) and Egbin power station (Ajao, 1990). Pollution through detergents and industrial effluents (Akpata, 1987; Ajao, 1990) deposition of DDT, dyes and heavy metals and siltation by sandfilling and dredging (Nwankwo, 1993) are also detrimental and need to be monitored in this ecosystem. Other activities that may affect the fauna of Lagos lagoon include boating, excavation, and construction activities, fishing with inappropriate gears.

Benthic communities in the Lagos lagoon are classified based on the nature of the bottom deposits/sediments (biotype) and the components of the fauna elements (biocenosis) (Oyenekan, 1988). Oyenekan (1975) surveyed the Lagos lagoon benthos, eleven years later, Ajao (1990) investigated the influence of domestic and industrial effluents on populations of benthic organisms in Lagos lagoon, and a year later Brown (1991) studied the community structure and secondary production of benthic macrofauna of Lagos lagoon and harbour. In Lagos, the need for land space has imposed pressure on the wetlands of the lagoon. The effect of this on the lagoon biota is not known. Moreover, the lower reaches of Ogun River, Ogudu, and Agboyi and Majidun creeks have not previously been investigated. The study of the benthos in these areas could provide vital information on the viability of these creeks as nursery grounds for finfish and crustaceans (shellfish) and provide information on the effect of habitat modifications. Such knowledge will assist in enacting necessary laws and edicts and putting in place adequate strategies for the management of the natural resources of the Lagos lagoon.

The aims of the study are to: -

1. Determine the diversity and density of macrobenthic fauna along a salinity gradient in the western part of the lagoon and the adjacent creeks,which were not previously surveyed.

2. Determine the physico-chemical parameters of the water with particular emphasis to salinity, conductivity, transparency and hydrogen-ion concentration,to determine if changes have occurred over the years.

3. Determine the total organic content and grain size of the sediments in the lagoon and adjacent creeks and to relate these to the density and diversity of the benthic fauna.

4. Carry out in the laboratory, experiments on salinity tolerance and sediment preference of the economically important mollusc *Pachymelania* species which have been reported to be endemic to West Africa and widespread in the Lagos lagoon.

LITERATURE REVIEW

The West African Lagoon System

The West African coastline is made up of 14 countries, 11 of which have coastal lagoons that are integrated with one another to form an intense network along the West African coastline. The lagoons have diverse morphologies and origins (Amadi, 1990). In Benin, there are two major lagoons Nokoue and Porto Novo, which cover 147km^2. They are separated by numerous channels of the deltaic fan of the Queme River and Rheme Lagoon (85km^2). Smaller lagoon systems (28km^2) connect the major bodies of water with the sea. They run parallel to the coast behind the dune systems. Burkina Faso is landlocked and therefore has no coastal lagoon. In Cameroon there is an extensive coastal mangrove swamp forest (swamp), but no significant coastal lagoon. Cote D'Ivoire, however, has three large lagoon complexes, Aby-Tend-Ehy, Tagba-Maki-Idio and Ebrie. There are also several small lagoons scattered along the coast. In Equatorial Guinea there are three large estuaries (Riocampo, RioBenito and RioMunitor Uttamboni), with brackish and acidic water as well as fairly extensive mangroves, which provide nursery grounds for many marine fish species and prawns. Gabon has four major lagoons (Nkomi, Ngobe, Ndogo, Mbia) and several smaller ones, while Gambia has only coastal lagoon on the north shore of the Gambia estuary. In Ghana there are 50 brackish water bodies, situated along the coast with a total surface area of

some reaching 400km^2. Biney (1981) reported that 75% of these lagoons in Ghana were polluted by sewage. The coast of Guinea comprises numerous estuaries and extensive mangrove forests but no major coastal lagoons, while Guinea-Bissau possesses none. In Liberia there are both marine and freshwater lagoons. The marine lagoons are either formed on a river coastline sealing off a bay (cut-off lagoon), or where tidal flow erodes an area of low ground (cut-in lagoon). The fresh water lagoons occur where a beach sandbar, creating a reservoir, blocks a river outlet. The picture in Senegal is quite different; Casamance River has an estuarine zone, which extends far inland. There are also estuarine lagoons around the mouth of the Saloum River, and the Senegal River has an extensive delta, which is deeply penetrated by salt water. There are small lagoons to the north of Dakar. Similarly, in Sierra-Leone the lower courses of the rivers are deeply invaded by saline waters, as are the extensive marshes surrounding the little Scarcies and Sewa Rivers. There are two large lagoons Mabegii and Mape. Togo has a series of lagoons centred along the Togo lagoon that extends to join the sea via the Mono. A smaller water body, the Lome lagoon, is now isolated from the main river system. Nigeria is not excluded from this vast network of water bodies. In Nigeria, there is an extensive lagoon system running parallel to the coast of western Nigeria. It consists of three main elements (a) Badagry creek, which carries excess floodwater from Que'me and Oshun rivers, (b) The Lagos lagoon and (c) Lekki lagoon. Other southern lagoons are Mahin, Ologe, Epe and Yewa.The whole system covers an area of 700km^2.

The Niger Delta's 36,260km^2 coastline consists of a network of distributaries up which saline waters penetrate for a considerable distance. There are estimated to be over 15,000km^2 of swamplands in the delta, which is suitable for aquaculture. The Lagos lagoon and surrounding ecosystem create a variety of ecological niches and nursery grounds for plankton, nekton and benthos.

Biological Features of the marine environment.

All natural elements are present in solution in the sea and all the constituents needed for the formation of protoplasm are present in forms of concentrations suitable for direct utilization by plants. Most of these chemicals or organic compounds are molecules that contain atoms of Carbon Hydrogen and Oxygen (Castro & Huber 1992). The salinity of the water and its high content of bicarbonates and other forms of Carbon dioxide provide an environment in the upper layers of the sea in which plants can manufacture organic materials by photosynthesis, and this way great quauntities of food become available for the animal population. Photosynthsis begins when solar energy in the form of sunlight is absorbed by chemicals (photosynthetic pigments –chlorophyll) contained within an organism. However, light penetrates only a short depth into water. Marine plants must therefore be able to float close to the surface, or if attached to the bottom, are limited to shallow depths. In an aquatic environment very simple and fragile forms of life can exist because the water affords them support, flotation, transport and protection thereby permitting very simple reproductive processes, and reducing the need for structural complications, such as locomotor organs,

skeletons or protective coverings. Organisms with small size can float and reproduce rapidly, thereby taking advantage of favourable conditions (Tait & Dipper, 1998). These may be prokaryotes (Bacteria and blue green algae or cyanobacteria). Unicellular algae (Diatoms & dinoflagellates), Siloflagellates Coccolithophorids or Cryptomonads. Fungi multicellular algae (seaweeds) are also present as well as flowering plants, saltmarsh plants and mangroves around the edges of the water body.

Plankton Studies

The phytoplankton are primary producers and the source of all aquatic food chains. Plankton from a Greek verb (wander) are responsible for primary production and the source of all aquatic food chains. They may be microscopic in size or macroscopic. Plankton are either permanent (holoplankton) or temporary (meroplankton), spending part of their life span as plankton e.g.planktonic spores, eggs or larvae of nektonic (free swimming) or benthic (bottom-living) organisms. For fixed sessile species the planktonic larval stages provide an essential means of dispersal. Phytoplankton are categorized into diatoms (Bacillariophyceae, Dinoflagellates-Dinophyceae), Class Prasinophyceae, brown coloured algae (Haptophyceae), blue-green algae (Cyanophyceae) and Coccolithophoridae.The zooplankton include crustacea with class copepoda being most prominent.Euphausiacea Cladocera (water fleas),Ostracoda (seed shrimps) and the Amphipoda are also present. Mysid or opossum shrimps (Mysidacea) are found in coastal plankton and live close to the bottom. The holoplankton forms of

zooplankton include larvae of crabs, barnacles and lobsters. Chaetognatha, protozoa, coelenterates, ctenophora, polychaetes mollusks and urochordata. They have been studied in detail. In some West African Ports, Hendey (1958) identified dominant marine diatoms, while in southwestern Nigeria, Nwankwo and Akinsoji (1992) studied the epiphytic community on the water hyacinth, *Eichhornia crassipes* (Mart) Solms. They concluded that diatoms formed the dominant group contributing 40 out of the 56 algal species identified. A year later Nwankwo (1993) studied cyanobacteria bloom species in coastal waters of southwestern Nigeria. He identified eight species in which, *Microcystis aeruginosa* was the most important freshwater sp. while *Trichodesmium thiebuutii* was the only marine bloom species identified. In the Epe lagoon 50 algal taxa were identified of which 28 were found to be diatoms (Nwankwo and Onitiri, 1992). The phytoplankton community of the Epe lagoon was dominated by *Aulacoserira* sp. (diatom) and *Microcystis* sp. (blue- green alga) (Nwankwo, 1998).

The first account of plankton in Lagos lagoon was the seasonal variation of plankton in the Lagos harbour (Olaniyan, 1957). Seaweeds in the same environs were documented (Fox, 1957; Steentor-Nelsen, 1958). Lawson's (1980) investigations into the phytoplankton of the Lagos lagoon started about 20 years ago. Nwankwo and Akinsoji (1989) studied the benthic algal community at a sawdust deposition site along the lagoon. They reported 32 species, which comprised of 26 diatoms and two blue-green algae, which species made up for

remaining taxa, which appeared in the dry season. Nwankwo (1990a) studied the distribution and seasonal variation of dinoflagellates in Lagos lagoon and observed that *Ceratium* sp. and *Peridinium* sp. dominated the dinoflagellate flora. Subsequent studies include Nwankwo (1991a) on taxonomic study on the estuarine armoured dinoflagellates. Thirty-six taxa were identified; twenty-three were new records for Nigerian coastal waters. In the same year, the periphyton on the fish fences (acadja) in Lagos lagoon were investigated (Nwankwo, 1991b). Out of the 36 algae recorded, thirty were diatoms, 3 species were green algae and three species were blue-green algae. According to him periphyton growth was higher in the dry season and in between seasons, than the rainy season. In 1994, forty-three bottom dwelling diatom species, consisting of 19 genera and dominated by pennates forms were collected from Iddo, a sewage disposal site in Lagos. Nwankwo (1994) noted that their occurrence and distribution were probably influenced by flood situations and salinity. He also noted that the presence of *Nitzschia palea* and *Gomphonema parvulum* was an indication that the site was heavily polluted (Nwankwo, 1994). Subsequently, the periphytonic algae on timber logs were observed (Nwankwo *et al.*, 1994). Fifty species, dominated by diatoms were recorded. Their density was higher during the dry season, than rainy season, and bark texture as well as the presence of exudates may have affected periphyton growth and development on the timber logs. More recently, the effects of sawmill wastes on diatom populations have also been studied. (Nwankwo, 1998) He noted that high suspended solids, total suspended solids,

total dissolved solids and high biochemical Oxygen demand, characterized the sawmill zone which was dominated by *Nitzchia, Coscinodiscus, Aulacoseira, Pleurosigma, Gyrosigma, Bacillaria, Melosira, Cyclotella, Streptothecca* and *Biddulphia.* Nwankwo also suggested that although the effects of woodwaste exudates and microbial decomposition of woodwastes may have contributed to the stressful environment, floodwater and tidal incursion might have operated as modifying factors. Nwankwo (2000) further studied the seasonal variations in estuarine littoral diatom populations in Lagos lagoon at the University of Lagos shoreline. Variables that determined the composition, abundance and distribution of littoral diatoms on the shore were rainfall, salinity and substratum type. *Achnanthes* and *Cocconeis* dominated the epipsammon while the biraphidineae (*Navicula* and *Pinnularia*) were prevalent epipelic genera. Non-motile genera and those that limited motility were abundant in the dry season, while motile forms were more important in the rainy season. Surf diatoms were also observed from the same beach during the dry season. Forty-two taxa from 23 genera were collected. All diatoms collected were euryhaline, supplying food for foraging fauna on the beach. Plankton, which trap energy directly from the sun, transfers this energy to the next trophic level, which may be either nekton or benthos.

Nekton in the Lagos Lagoon

Nekton are aquatic fauna which swim actively against a current (Olaniyan, 1968), they comprise of two types; shell fish and fin fish. Fagade (1969) studied the biology of fishes and fisheries of the Lagos lagoon and the food and feeding habits of *Tilapia* (Fagade, 1971). Food items included algal filaments and identified organic matter .Aging in the fish *Tilapia melanotheran* has also been studied (Fagade. 1974).Sequentially, Fagade(1979),observed the biology of *Tilapia melanotheron* and *Tilapia guineensis*. Both are economically important and can be harvested from the Lagos lagoon through out the year.Permanent and temporary species of *Tilapia* spp in the Lagos lagoon feed on phyto plankton and unidentified organic matter. The sex ratio of *T.melanotheron* in the Lagos lagoon was 1.00 male to 1.21 females,while that of T.guineensis was 1.00 male to 1.18 females.The biology of the west African shad *Ethmalosa fimbriata* (Bowdich) in the Lagos lagoon,Nigeria has also been observed in detail(Fagade and Olaniyan,1972).Three size ranges were established .Yoyo(35-69mm), Efolo(70-169mm) and Aybodo(170mm and above).They all fed actively throughout the year.Yoyo occurred between March and May and fed on plankton(*Biddulphia* sp.,*Coscinodiscus* sp.) and zooplankton (copepods-*Acartia* sp. , *Paracalanus* sp, larvae of bivalves *Ostrea* sp.,*Aloidis* sp.,*Iphigenia* sp as well as larvae of gastropods *Pachymelania* sp., *Tympanotomus* sp., and *Neritina* sp., larvae of crustacea megalopa of crabs crypris larvae fish eggs and ostracods.). Efolo was collected through out the year and stomach contents comprised of zooplankton

phytoplankton and sand grains. The Agbodo, which occurred in the dry season months, fed upon diatoms (*Coscinodiscus* sp., and *Biddulphia* sp.) zooplankton, unidentified organic matter and sand grains. They observed that the larger fish consumed more plankton, due to structural changes that take place in the gill rakers as the fish increase in size. The sex ratio of the fish was 1 male to 1.14 females. A year later the food and feeding inter-relationship of the fishes in the Lagos lagoon were reported. Fagade and Olaniyan (1973) studied the food of 26 common fish species of the Lagos lagoon, and classified them into three broad feeding groups: Planktophagous, predatory and deposit feeders. Planktophagous fish included the clupeids *Sardinella maderensis, Pellonula afzelinisi, Ilisha africana* and *Ethmalosa fimbriata,* while the bagrid was *Chrysichthys filamentosus.* Food fed upon was centric diatoms, copepods (*Acartia bifilosa* and *Paracalanus* sp.), ostracods, larvae of gastropods bivalves and crustacea, fish fry eggs and larvae as well as unidentified organic matter, mysids and penaeid prawns. The predatory fishes were either piscivorous or non-piscivorous. The piscivorous fish had fish as the main food item in their stomachs. *Elops lacerta, Epinepleus aeneus, Caranx hippos, Hemichromis fasciatus, Sphyraena barracuda, Sphyraena guachandro, Polydactylus qudrifilis* and *Scomberomorus maculates* fed on juvenile *E.fimbriata, G.melanopterus, Caranx* sp. *Elops* sp., *Trichiurus* sp., Mullets, Tilapia, Sphyraena sp., Schibeid, Cyprinodontid, Gobiid and unidentified fish as well as serranid and *Chrysichtys* sp. The non-piscivorous predators, *Chrysichthys nigrodigitatus, Monodactylus sebae, Lutjanus goreensis, Lutjanus*

eutactus, Gerres melanopterus, Pseudotolithus elongates, Pomasdasys jubelini, Cithanichthys stampflii and *Cynoglossus senegalensis* fed on other macroscopic animals than fishes. Their food items included bivalves, gastropods, decapod crustacea, errant polychaetes, fish larvae and fry, *Branhiostoma nigeriensis*, hydroid polyps, algal filaments and unidentified food.*M.banansis, M.cephalus, L.gradisquamis, L.falcipinnis, L.dumerilli, Tilapia macrocephala* and *T.guieenis* were classified as bottom (deposit-detritus) feeders. (Fagade and Olaniyan, 1973). They fed mainly on bottom deposits. The seasonal distribution of fish fauna (Fagade and Olaniyan, 1974) has also been studied. Kusemiju et al. (1983) studied the biology of *Pellonula afzeliusi* in the Lekki lagoon. He noted that the species exhibited a pelagic nature at night. Earlier studies by Kusemiju (1975b) had focused on comparative differences of the catfish *Chrysichthys nigrodigitatus* (Lacepede) from Lagos and Lekki lagoons. The Lekki lagoon is a freshwater lagoon adjacent to the Lagos lagoon. Later Kusemiju and Olaniyan (1977), observed the food and feeding of *C. filamentosus* and *C. nigrodigitatus*, The distribution, reproduction and growth of the catfish *C. walkeri* in Lekki lagoon has also observed (Kusemiju, 1976), and the food habits and sex ratios of the big eye, off Lagos coast, Nigeria. (Kusemiju and Olaniyan, 1979). More recent studies have focused on the biology of the shellfish (pink shrimp – *Peneaus notialis*)(Adetayo and Kusemiju, 1994). This shrimp has a well-developed and toothed rostrum, which extends beyond the distal margins of the eyes. It is perhaps the most valuable marine fishery resource off the Nigerian coast.

Solarin (1999) studied the hydrobiology, fishes and fisheries of the Lagos lagoon, Nigeria. Sixty fish species belonging to 34 families were collected. Shell fish collected included the pink shrimp *Peneaus notialis, Macrobracium* species as well as the crab *Callinectes amnicola.*

Benthic Communities

Olaniyan (1968) described a community as consisting of all different species within a particular area, while Odum (1971) described it as an assemblage of populations living in a prescribed area or physical habitat. Classification of animal communities in the benthic zone may be based on the nature of bottom deposits/sediments. This arises because all benthic organisms have some association with bottom deposits. Jones (1950) proposed this classification which he termed biotype. In contrast, Thorson (1958) classified communities based on characteristic fauna elements/dominant groups of animals in an area (biocenosis). However today communities may be classified by integrating the two terminologies; communities are thus classified based on sediment type as well as fauna composition (Oyenekan, 1988, Brown, 1991).

Along the West African coast various surveys have been carried out on the macrobenthic fauna communities a variety of equipment and samplers are used for the collection of benthos.Small spring –loaded,snapper grabs have been devised ,which take shallow bites of the floor of the water body,for deeper layers of

deposits corers are used.Trawls,dredges and seines are used to capture diverse fauna and demersal fish,which are epifauna.Rock-living species can be sampled using divers or photographed using remote camera's or submersibles like underwater video camera's and television camera's.(Tait and Dipper 1998). Smith (1871) collected and described West African shells. For instance, in Dahomey (Benin Republic), 92 species were described (bivalves and gastropods). Similarly, Knudsen (1950) studied the marine prosobranchs of tropical West Africa, while Sourie (1954a and 1954b) reported on benthic macrofauna communities along the West African coast. Furthermore, (Knudsen, 1956a and 1956b) investigated while Buchanan (1954) identified 195 species and varieties of marine molluscs from a general survey of the Gold coast marine fauna, 57% of which were endemic to West Africa. Further studies in Ghana (Buchanan, 1957 and Gauld and Buchanan, 1956) unveiled more fauna, while Buchanan (1958) collected 74 more species not recorded in previous records. Tebble (1955) named 95 species which were collected by Bassindale between 1949 and 1951 (Bassindale, 1961), from the littoral zone to 51 metres offshore. A further ecological survey on identification of species was carried out on the West African marine benthos in the late 1950's (Longhurst, 1958) and later on the littoral ecology (Lawson, 1956).

Jones (1950) used the bottom deposits to classify animal communities in West African Atlantic boreal regions, while Longhurst (1958) used the bottom deposits

as a basis for the classification of benthos in West Africa. The major subdivisions of the benthic fauna are shallow soft deposit communities, shallow hard substrate communities, deep soft deposit communities and deep hard substrate communities. Within this framework he described 12 communities, which consisted of 15 phyla, 73 classes and 622 species.Oyenekan(1988),classified bottom deposits from coarse shelly sand around the mouth of Lagos harbour through various grades of muddy sand to mud.Sandy mud or muddy deposits occurred in the central areas with muddy sand or sand towards the shor line.There was a rapid change in the nature of substratum within relatively short distances.Similar results were obtained by Ajao and Fagade (1990 e) and Brown (1991).Ajao and Fagade (1990 e),observed that a wide variety of sediments occurred in the Lagos lagoon throughout the year.These ranged from fine ,medium and coarse sands to admixtures of silt and clay which provided a wide selection of habitats.High levels of selected heavy metals occurred with petroleum hydrocarbon contamination in the western industrialized areas .Total organic content was closely associated with the sediment types and the influence of waste inputs.

The knowledge of macrobenthic fauna in and around Lagos lagoon started forty years ago. Webb and Hill (1958) and Webb (1958) gave an account of the life history of *Branchiostoma nigeriense* Webb. and its various reactions to factors in the environment.B.nigeriensis was present in Lagos lagoon in large densities in the high salinity season.Further studies (Sandison and Hill, 1966) described the

epifauna *Balanus pallidus* Darwin, *Gryhaea gazar.* Dautzenburg, *Mercierella enigmatica* Linnaeus. and *Hydroides uncinata* L. and their distribution in relation to salinity.They observed that the twosalinty regieme in the Lagos lagoon affected the distribution of benthos,and also affected the life cycle of *Balanus pallidus* (Sandison,1966) and *Tympanotonus fuscatus* var *radula* (Egonmwan and Odiete,1983). Other published works include the anatomy (Johanson, 1956) and biology (Egonmwan, 1980) of the gastropod periwinkle *Tymponotonus fuscatus*, the biology of the West African bloody cockle, *Anadara senilis* (Yoloye, 1969),whose sexual phases habit and of anatomy were investigated (Yoloye, 1974, 1975). Further benthic studies of benthos in the Lagos lagoon dwelt on the egg capsules of *Neritina glabrata* (Adegoke *et al.*, 1969a, 1969b).A new species and *Neritina kuramoensis* was reported from the Lagos lagoon system.This new species was larger and had a thicker shell , with a higher spire than *N.glabrata*. It was dull brown in colour and possessed an ornamental pattern,with a stout,deeply depressed operculum.The average height of 6-12mm contrasts with the 3-5mm shells of *N.glabrata*.(Yoloye and Adegoke, 1977).*N.kuramoensis* lives naturally on mangrove rhizophores, reedsand and other aquatic plants. It may also be found in muddy deposits of the mangrove swamps on the edges of the lagoon, in association with molluscs such as *Tympanotonus fuscatus, Pachymelania quadriesenata* and the crab *Sersama* sp., it is however predominantly present in Kuramo waters and Badagry creek. Kusemiju (1975a) studied the bionomics and distribution of the pink shrimp *Penaus duorarum* off Lagos coast. The highest

catch was recorded in July as well in the dry months December to January,while the lowest catch was recorded in March.In the dry months the pink shrimp occurred in depths of 27-55m,and the best catches were made between 43-55m.There was no relationship between average size of shrimp and depth of water.The nursery ground of shrimps off Lagos coast is Lagos lagoon and estuarine system.Catch per hour was 3.6-19.6 kg.Fagade and Olaniyan (1973),while studying the food and feeding interrelationship of 26 common fish in Lagos lagoon observed a variety of mollusks in the same environment.Two bivalves *Iphigenia* sp and *Aloides* sp and several gastropods including *Neritina* sp.,*Pachymelania* sp.,*Tympanotomus* sp.,and *Thais* sp., were collected. The crabs Callinectes latimanus,burrowing polychaetes and carid and penaeid prawns were also present.They observed that the carid prawns were seasonal and more abundant in the rainy season.*Branchiostoma nigeriensis* was spacially confined to the shallow sandy bottom water around Ikoyi jetty.The fouling organisms *Balanus pallidus* Strusburi and *Chthamalus* sp., the bivalve *Ostrea gasar* and the tubicolous polychaete *Mercierella enigmaica* were found attached to rocks,wharf pilings,marine stumps and ship bottoms in the Lagos lagon. It was not until a decade later that an in depth study of the benthic macrofaunal communities of the Lagos lagoon, Nigeria was undertaken. Oyenekan (1988) named five communities, mangrove, *Pachymelania* Amphioplus, Venus and Estuarine Rock Communities, based on nature of deposits as well as characteristic faunal elements.Salinity and nature of bottom deposits are the major factors governing

lagoon benthos. Brown (1991) studied the spatial distribution of macrofauna as well as the effect of salinity and sediment types on the control of macrobenthic faunal distribution in the lagoon. She concluded that salinity and sediment types were the major factors controlling macrobenthic faunal distribution in the lagoon and harbour.The faunal composition and diversity was low ,and only twenty-three species were collected.*Pachymelania aurita, Aloidis trigona* and *Nerita glabrata* were wide spread in the lagoon,but *P.aurita* was the dominant member of the faunal community.*Nereis succinea* was the dominant polychaete in the harbour.Faunal indices suggested an unstable environment.The life cycle of these dominant species showed maximum reproductive activity during the dry season,between November and May. Biomass and secondary production of *P.aurita* and *A.trigona* showed that molluscs in the Lagos lagoon had low biomass values and either low or negative production values. This is an indication of pollution,competition or predation which affected the turnover of these molluscs in the Lagos lagoon. Ajao and Fagade (1990a, b, c, d and e) carried out extensive studies on the benthic macrofauna .of Lagos lagoon.In the production and .population dynamics of *Pachymelania aurita*.Muller,he observed that greatest densities occurred at a site furtherest from anthropogenic imputs of sewage and industrial effluents and in sediments containing 6-40% silt –clay.The breeding season was between the end of the rainy season and beginning of the dry season(Nov-May),and spawning was observed from mid December to early April.

The annual production was between 0.475-6.479gCm^{-2}yr^{-1} (formalin –fixed ash-free dry weight),and amounted to 89.9-100% of the total molluscan production.The production /biomass ratio was between 0.007-2.227(Ajao and Fagade 1990a).For the polychaete worm *Capitella capitata* Claparede., the density was low in most parts of the lagoon(1-20m^2).Higher densities (3-435m^2),occurred in sites with high levels of silt,organic matter,metals and total hydrocarbons.They noted that breeding peaks occurred through out the year.Annual production was between 2.2917-5.8957mgCm^{-2}yr $^{-1}$,while the P:B ratio was between 0.12 and 0.33(Ajao and Fagade 1990b).Furthermore Ajao and Fagade (1990 c),studied the ecology of *Neritina glabrata* in the Lagos lagoon. They collected large densities in shallow shoals in north and north-east rims of the lagoon.Their distribution and abundance were dependent on silt –content ,Total Organic Matter and contamination of the sediment.The eggs developed during the low salinity months between April and December and hatched as veligers during the high salinity season,when breeding also occurred between January and March.The annual production was estimated between 0.086 and o.258gCm^{-2} yr^{-1} (formalin fixed ash-free dry weight), and P:B ratio varied between 1.29 and 2.11.Sequential to this a further study on the bivalve *Aloidis trigona* was also under taken in Lagos lagoon.High densities and production occurred in shallow shoal sands in the north and north–eastern rims of the lagoon at sites furtherest from anthropogenic inputs.*A.trigona* was conspicuously absent from the muddy centre and western industrilised parts of the lagoon.The breeding pattern was continuous

/protracted.Annual production varied between 0.13 and 400.62 $mgCm^{-2}yr^{-1}$ (formalin –fixed ash-free dry weight), while P:B ratio varied between 0.01 and 1.01 (Ajao *et al* 1991).in all these studiees it is clear that defaunation has ocured in the Lagos lagoon.

Effects of Ecological Factors and Pollution on Fauna

A major ecological factor limiting density and diversity of fauna in the tropics is salinity which is controlled directly or indirectly by rainfall. Sandison and Hill (1966), reported the effect of salinity on some macrobenthic fauna in Lagos lagoon and harbour. Brown (1991) attributed and density of *Pachymelania aurita* and *Aloidis trigona* the in Lagos lagoon to salinity regimes just as the distribution of both fresh and marine forms of cyanobacteria are limited by salinity (Nwankwo, 1993). Nwankwo (1990b) observed seasonal variations in estuarine littoral diatom populations in Lagos lagoon, Nigeria and noticed that rainfall, salinity and substratum type were important variables that determined the composition, abundance and distribution of littoral diatoms on the shore.

Along the coast of West Africa, sewage causes eutrophication and anoxia in lagoons around Abidjan, Lagos and Ghana.,and resultant fish kills occurred along the Nigerian coast.

Seventy-five percent of the lagoons investigated in Ghana are polluted with sewage, industrial effluent, domestic effluent or oil in the form of tarballs (Biney,

1981). The two most grossly polluted lagoons are Korle and Chemu, which are receptacles of industrial and domestic wastes.

In Nigeria, there are numerous urban settlements which exist all along the 850km of coastline. Many, like Lagos, Warri, Port Harcourt and Calabar serve as sea ports and have a variety of industries producing wastes and effluents.

In the Lagos lagoon, pollution comes from three main sources, namely human wastes, industrial discharges and petroleum products. Ajao *et al.* (1996) further classified pollution activities in Lagos coastal waters as mining, discharge of industrial and domestic effluents, storm water runoff, shipping activities(motorized boats and canoes), agricultural/farmland runoff (fertilizers and pesticides),atmospheric sources like gas flaring, incineration of domestic waste(garbage),combustion of leaded petrol in automobiles and industrial emissions; petroleum industry activities as well as logging and timber transportation in water. At Oko-baba sawmill activities produce biodegradable woodwastes and sawdust which increases suspended matter, lowers dissolved oxygen (Akpata, 1987; Nwankwo and Akinsoji, 1998; Nwankwo *et al.*, 1994; Linden, 1990) and results in higher fungal levels (Akpata and Ekundayo, 1983). Nwankwo (1998) also reported high total suspended solids, total dissolved solids and biological oxygen demand in this sawmill zone. He collected twenty-four diatom taxa and suggested that although effects of woodwaste exudates and

microbial decomposition of woodwastes may have contributed to the stressful environment, flood water and tidal incursion may have operated as modifying factors.

Further south at Iddo, where untreated and partially treated sewage is discharged, fauna (Ajao, 1990 and Brown, 1991) and flora (Nwankwo, 1994) occurrence and distribution were influenced by flood situations and salinity. Nwankwo (1994) noted that the appearance of *Nitzchia palea* and *Gomphonema parvulum* were an indication that the site was heavily polluted while Ajao and Fagade (1990b) noticed the presence of *Capitella capitata* and other opportunistic species and absence of members of the *Pachymelania* community and concluded that pollution existed there.

Petrochemicals (Ekundayo, 1977; Odum, 1971), detergent and industrial effluents (Akpata, 1987), industrial effluents (Ajao, 1989), deposition of DDT, dyes and petroleum hydrocarbons (Ajao, 1996) and radioactive wastes (Odiete, 1999) all contribute to heavy metal pollution in and around the Lagos lagoon. Heavy metal pollution affects fish (*Tilapia* sp.) (Fodeke, 1979) and plankton (Nwankwo, 1993). It was noted that plankton growth may have been suppressed by heavy metal pollution, despite increased nutrient levels .They also observed that heavy metals appear evenly distributed in the Lagos lagoon with higher levels in industrial areas around Apapa all the year round. Higher levels of trace metals and total

hydrocarbons have been reported at sites around the industrialized areas of Lagos lagoon while lower values were noticed in areas further away from anthropogenic inputs (Ajao *et al.*, 1996).

Organophosphates (Akintunde and Iseghohi, 1997) and organic and inorganic substances (Odiete, 1999) were reported in the Lagos lagoon. Furthermore, organochlorines and polychlorinated biphenyls have been recorded in the Lagos lagoon .

Topographical modifications of the coastline due to erosion (Awosika and Ibe, 1992) and siltation due to sandfilling and dredging (Nwankwo, 1993) also affect biota in the Lagos lagoon and environs.

Pollution Indicators

The study of benthic polychaetes is very important as these polychaetes form the food for some commercially important fishes in the lagoon and can be used as indicators of organic pollution (Ajao and Fagade, 1990b).

Oyenekan (1983) described the distribution of the polychaete fauna of the Lagos lagoon and harbour. He collected twelve families, and fourteen species which occurred in the sandy mud deposits of the upper part of Lagos harbour. The nature of substratum and salinity were major limiting factors affecting their distribution..

Similarly, Ajao and Fagade (1990b) observed the seasonal and spatial distribution of the polychaete *Capitella capitata*. They implicated silt-clay, organic matter, sediment metals and hydrocarbon content as limiting abundance.

MATERIALS AND METHODS

DESCRIPTION OF THE STUDY AREA

Lagos lagoon (Fig. 1) which lies between longitudes 3°20` and 3°40`E and latitudes 6°15` and 6°40`N, has an area of 208 km^2 and is the largest of the seven coastal lagoons of Southwestern Nigeria (others are Epe, Lekki, Mahin, Yewa, Badagry and Ologe) (FAO, 1969). It receives freshwater from Lekki lagoon, via Epe lagoon in the northeast and discharges from Majidun creek, Agboyi creek, Ogudu creek and River Ogun in the northwest. These lotic water bodies drain low land forests, mixed with farmlands and young secondary forests. The Lagos lagoon empties into the Atlantic Ocean via Lagos harbour. Freshwater enters the harbour through Yewa, Ologe, Badagry, Epe, Lekki, and Mahin. Five Cowrie creek and under Carter bridge into the lagoon twice daily at high tide and recedes during low tide. The lagoon is surrounded by swamp forest and riparian forest consisting of mangrove vegetation *Rhizophora racemosa*, *R. harrisonii* and *Avicennia germinans*. Woody plants include *Delbargia escataphyllum, Drepanocarpus lunatus, Hibiscus tiliaceus, Baphia nitida, Phoenix reclinata and Pandanus* sp. Non-woody halophytes and hydrophytes, grasses and sedges present are *Cyperus digitatus*, *Paspalum vaginatum* and *Thypha australis*, as well as the fern *Acrostichum aureum*. (Nwankwo 1984).

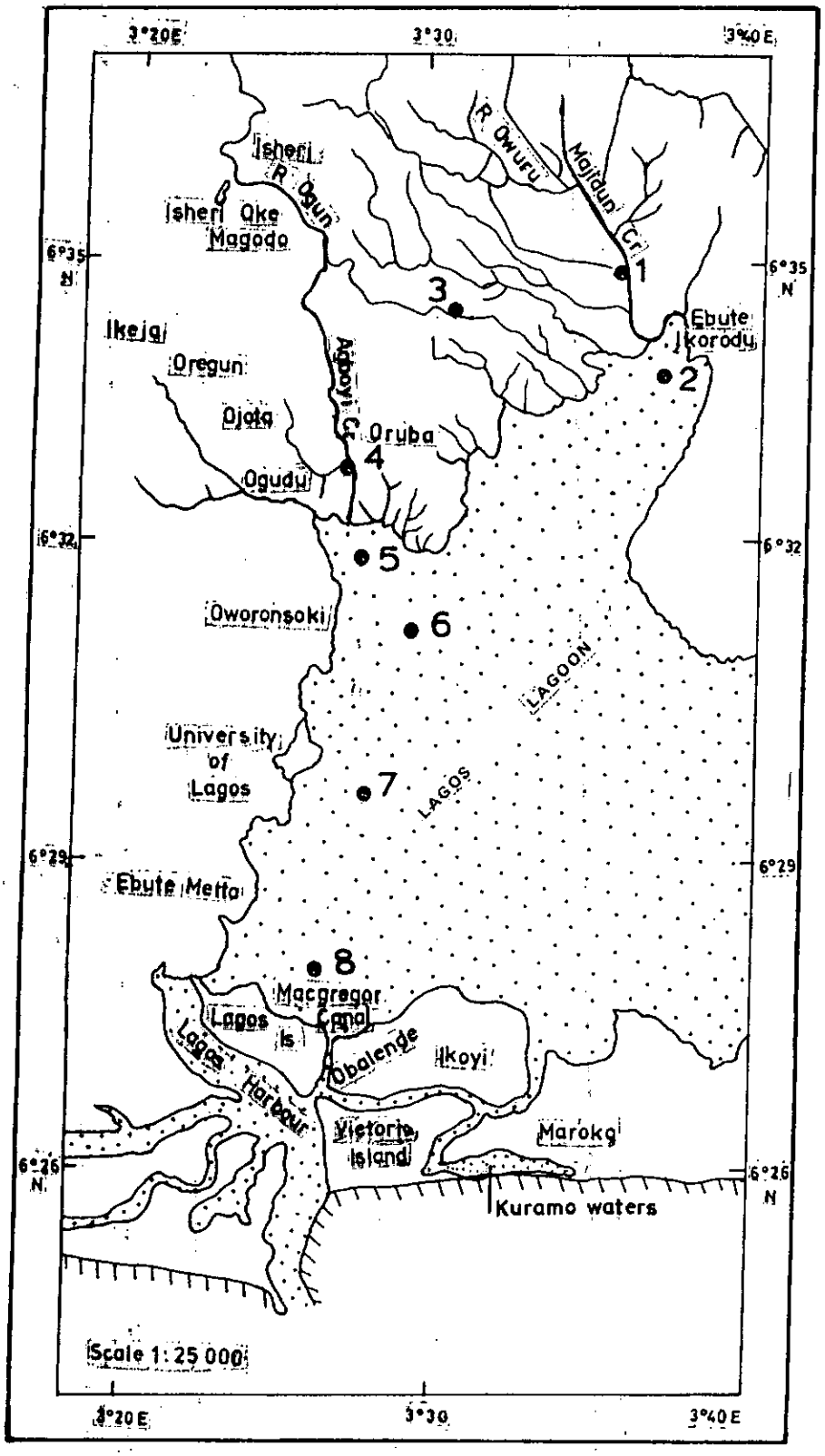

Fig.1. Sampling stations in the western part of [illegible]

Sampling locations.

Station 1. (Majidun Creek). Directly in front of the Majidun Village.

Station 2. (Ikorodu). In front of the warehouses at the jetty.

Station 3. (Ogun River). In front of the tributary /creek leading into the river.

Station 4. (Agboyi Creek) At the junction of the tributary.

Station 5. (Ogudu Creek) Directly in front of the river mouth.

Station 6. (Oworonsoki). In front of the ship wreck.

Station 7. (University of Lagos lagoon front). In front of Oduduwa Way.

Station 8. (Ikoyi). In front of the Julius Berger sandfilled site.

A. Field Studies

Benthic samples were collected from eight stations: Ikorodu, lower Majidun creek, Lower Ogun river, Lower Agboyi creek, Ogudu, Oworonsoki, University of Lagos lagoon front and Ikoyi (Fig. 1), between May 1996 and February 1998

i. Fauna Collection

Three grab hauls were taken from each station, using a $0.1m^2$ Van Veen grab (wt = 23g; ht 20cm), from an anchored boat with an outboard engine. The collected material was washed through a 0.5mm mesh sieve, in the field. The residue in the sieve was preserved in 5% formalin solution and kept in labelled jars for further analysis in the laboratory.

ii. Sediment Collection

The top 5cm layer of the first haul was placed in a labelled polythene bag for preservation in the deep freezer in the laboratory, for sediment analysis.

iii. Collection of Water for Physico-Chemical Analysis

Preliminary investigations showed that surface water temperature and bottom water temperatures ranged between 27°C and 30°C. Surface water temperature was therefore determined using a mercury-in-glass thermometer. Salinity, hydrogen-ion concentration and conductivity,of the water collected in the field were determined in the laboratory.

Transparency was measured with the use of a 20cm diameter white and black coloured Secchi disc. The disc was lowered into the water until the black and white surface disappeared. The depth of disappearance was measured, and also the depth at re-appearance. The average of the two depths represented transparency.

Rainfall data were obtained from the Meterological Department of the Nigerian Institute for Oceanography and Marine Research, Victoria Island.

B. Laboratory Investigations

i. Physico-chemical Parameters

(a) Salinity

Measurements were taken using the water sample collected during field studies. An optical temperature-compensated hand refractometer (New S-100) was used.A drop of the water sample was placed on the glass slide of the refractometer and the slide cover snapped closed. The refractometer was then observed towards a light source (natural sunlight) and read off from a graduated scale.

(b) Hydrogen-Ion Concentration

A BDH Lovibond comparator was used to estimate pH. These values were confirmed in the laboratory using a Griffin digital pH meter (model 80).The probe of the pH meter was dipped into the water sample, and read off from the graduated scale.

(c) Conductivity

A Hanna conductivity meter was used to measure conductivity .The probe was dipped into the water sample, and the reading taken from a graduated scale.

ii. Sediment Analysis

(a) Total Organic Content (TOC)

Oven dried sediment was placed in a pre-weighed crucible and weighed. It was re-weighed before ignition in a muffle furnace at 55°C for 6-8 hrs. The cooled crucible and contents were reweighed. Loss of weight after removal from the furnace was calculated as loss on ignition .The percentage combustible material in the sediment i.e total organic content, was estimated as:

$$\text{Total Organic Content (TOC)} = \frac{\text{loss in weight on ignition}}{\text{Initial weight of sediments before ignition}} \times 100\%$$

(b) Sediment Size Analysis

Samples preserved in the freezer were removed and left to thaw for one day. Sediment samples were oven dried to constant weight at 80°C. The sample was then passed through a graded series of standard sieves of aperture size 6.30mm, 5.00mm, 3.35mm,

2.00mm, 1.18mm, 600um, 425um, 300um, 212um, 150um and 63um and shaken. The fractions retained in each sieve (fine, gravel, coarse, medium and fine sand) were weighed and recorded. The portion that passed through the 63um mesh sieve (mud, silt and clay) were treated with hydrogen peroxide and hydrochloric acid (dispersing agents) and the pipette method/hydrometer method (Friedman and Johnson, 1982) used to determine size distribution of silt and clay, in the sediment sample.

iii. Sorting of Benthic Fauna

Preserved animal samples, which had been collected in field studies, were washed with tap water through a 0.5mm mesh sieve, to remove the preservative and any remaining fine sediment. The animals were sorted on a white tray into taxonomic groups (phyla, class, families, species), using suitable texts (Barnes, 1980; Day 1967a; 1967b; Edmunds, 1978; Campbell, 1977; FAO, 1992; Oliver, 1975; Tebble, 1955). The number of species and individuals for three grab hauls at each station were counted and recorded.

iv. Diversity and Faunal Indices

Margalef's Index, Shannon and Weaver Information Function, and Equitability were used in this study to characterize the communities present at the sampling stations.

(a) Margalef's Index

This is a diversity of species richness, which does not take into account dominance diversity, but it largely dependent on the species richness i.e. the more species present in a sample, the greater the diversity.

Margalef's d is calculated as:

$$d = \frac{S-1}{\text{Log}_e N} \qquad \text{Margalef (1957)}$$

Where,

d = diversity index

S = number of species

N = number of individuals

Log_e = natural logarithm.

(b) Shannon and Weaver Information Function

This index is sensitive to the number of species present, and how evenly or unevenly the individuals are distributed in the sample. It is sensitive to both species and dominance diversity.

It is calculated as $HS = - \Sigma p_i \log_e P_i$ Shannon and Weaver (1963).

Where,

S = total number of species

P_i = observed proportion of individuals that belong to the ith species.

(c) Equitability

This is a measure of how evenly the individuals are distributed among the species present in a sample.

It is calculated as:

$$J = \frac{HS}{Log_2 S}$$ Lloyd and Ghelandi (1964)

Where,

j = equitability measure

HS = Shannon and Weaver Information Function

S = number of species in sample or community

v. **Experimental Procedures**

a. Test Animals

Pachymelania fusca (Gmelin) var. *quadriseriata* Gray, were hand picked from the shores of the creek behind the Faculty of Science, University of Lagos.

Pachymelania aurita muller, were hand picked from the lagoon front of the University of Lagos.

The test animals were acclimated in the laboratory for three days before the commencement of salinity tolerance experiment. Two hundred specimens of *P. aurita* with shell length (20-30mm) and one hundred and fifty with shell length (6-21mm) were used for the experiments.

(b) Media Preparation

Sea water from Bar beach, brackish water from Lagos lagoon and dechlorinated tap water were diluted at different concentrations to obtain salinities of

0%, salinity range 0-8 $^{0}/_{00}$

25%, salinity range 5-12 $^{0}/_{00}$

50%, salinity range 10-26 $^{0}/_{00}$

75%, salinity range 30-35 $^{0}/_{00}$, and

100%, salinity range 30-35 $^{0}/_{00}$

For organisms that survived more than 30 days in 50% concentration, further dilutions

60%, salinity range 20-30 $^{0}/_{00}$

70%, salinity range 20-22 $^{0}/_{00}$

80%, salinity range 22-25 $^{0}/_{00}$

90%, salinity range 25-27 $^{0}/_{00}$, and

100% were set up. Dilutions for the set-ups were prepared in triplicates.

(c) Salinity Tolerance

Animals collected from the Lagos lagoon front were placed in the different bowls. Each bowl had 10 specimens. The experiments were set up for 100 days. Dead animals were removed as the experiment progressed. New dilutions were made and fresh sediment collected weekly, to change those in the experimental set-ups.

(d) Sediment Preference

Sediments from University of Lagos lagoon front, and behind Faculty of Science channel were collected and mixed in different proportions to form sandy, muddy sand, sandy mud and muddy sediment types. Each sediment type was placed in one quarter portion of the bottom surface of a bowl

(diameter 35cm; volume 15.55ml). The mid-point of the bottom inner surface of the bowl, where the four sediment types met, contained a mixture of the different types of sediment. The ten test animals (*P. aurita*) were placed in this mixture and water of salinity $1^0/_{00}$ poured into the bowl to a depth of 10cm. After 24 hrs, the preference of sediment type of each animal was observed.

RESULTS

PHYSICO-CHEMICAL PARAMETERS

A. TEMPERATURE

Air temperature ranged between 24.50°C and 31.80°C, surface and bottom water temperatures were similar, so surface water temperatures were recorded. Bottom water temperature values ranged between 27°C and 30°C (Table 1, Fig. 2) with a mean of 28.7±1.06°C (Table 2). There was only a slight variation of 1-3°C between the dry and rainy season bottom water temperatures, at all the sampling stations. Mean temperature values in the dry season were between 28.67±1.06 and 30.00±0.00. The minimum and maximum temperatures for the wet season were 28.25±0.96 and 29.50±0.58 respectively. Temperature differences in the dry and wet months were not significantly different ($P>0.05$).

Station 1 (Majidun Creek)

Temperature ranged between 27.00°C and 30.00°C in the dry season and 28.00°C and 30.00°C in the wet season. Mean temperature was 29.00±1.73 in the dry season and 29.25±0.96 in the wet season (Table 2).

TABLE 1: VARIATION IN TEMPERATURE (^{O}C) AT THE SAMPLING STATIONS IN THE WESTERN PART OF LAGOS LAGOON (MAY 1996 –MARCH 1997)

	1996								1997		
MONTHS/-- STATIONS	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR
1	28	-	-	30	29	30	30	-	30	-	27
2	28	-	-	29	29	30	30	-	30	-	27
3	28	-	-	29	27	29	30	-	30	-	30
4	-	-	-	29	27	29	29	-	30	-	30
5	-	-	-	29	29	29	30	-	30	-	30
6	30	-	-	30	29	29	29	-	30	-	30
7	29	-	-	30	29	29	28	-	28	-	30
8	28	-	-	30	29	29	29	-	29	-	30

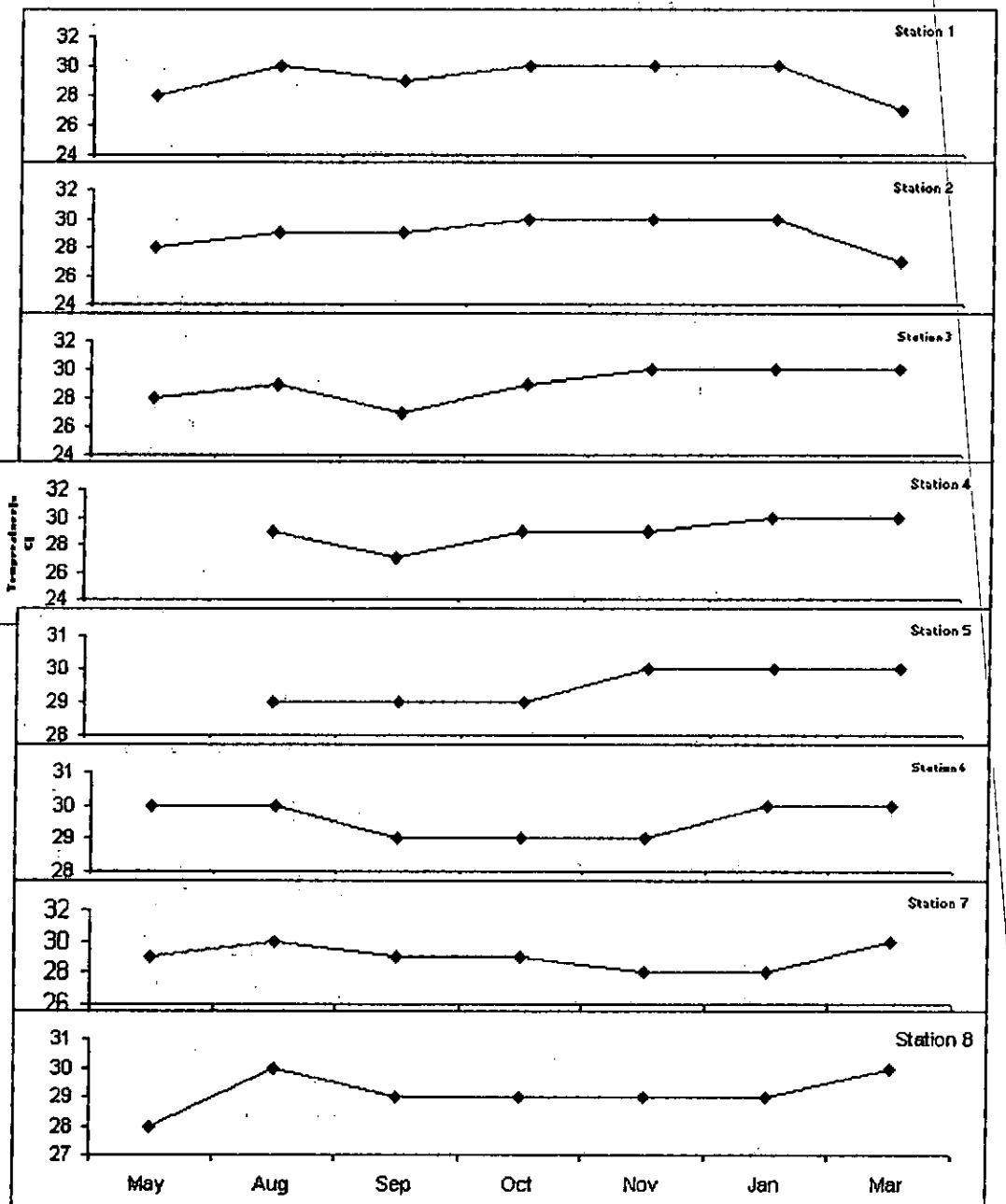

Fig. 2:Variation in Temperature (°C) at the sampling stations in the western part of Lagos lagoon (May 1996-March 1997).

TABLE 2: VARIATION IN TEMPERATURE VALUES (^{O}C) FOR DRY AND WET SEASONS, AT THE SAMPLING STATIONS IN THE WESTERN PART OF LAGOS LAGOON (MAY 1996 –MARCH 1997).

STATIONS	DRY SEASON				WET SEASON			
	MIN	MAX	MEAN	S.D	MIN	MAX	MEAN	S.D
1	27.00	30.00	29.00	± 1.73	28.00	30.00	29.25	± 0.96
2	27.00	30.00	29.00	± 1.73	28.00	30.00	29.00	± 0.82
3	30.00	30.00	30.00	± 0.00	27.00	29.00	28.25	± 0.92
4	29.00	30.00	29.67	± 0.58	27.00	29.00	28.33	± 1.16
5	30.00	30.00	30.00	± 0.00	29.00	29.00	29.00	± 0.00
6	29.00	30.00	29.67	± 0.58	29.00	30.00	29.50	± 0.58
7	28.00	30.00	28.67	± 1.06	29.00	30.00	29.25	± 0.50
8	29.00	30.00	29.33	±0.58	28.00	30.00	29.00	± 0.82
TOTAL	229	240.0	235.34	6.26	225	2237	231.58	5.80
MEAN	28.63	30.00	29.42	± 0.78	28.10	29.63	29.63	0.73

Station 2 (Ikorodu)

In the dry season, temperature ranged between 27^{O}C and 30^{O}C, while the range was between 28^{O}C and 29^{O}C in the wet season.The mean temperature was 29.00±1.73 in the dry season, and 29.00±0.82 in the dry season (Table 2).

Station 3 (Ogun River)

No variation in temperature occurred at Ogun River in the dry months. Temperature was constant at 30^{O}C.In the wet season values ranged between 27^{O}C and 29^{O}C. Mean temperature was 28.25±0.96 (Table 2).

Station 4 (Agboyi Creek)

Temperature ranged between 29^{O}C and 30^{O}C, with a mean of 29.6±0.58 in the dry season and 27^{O}C and 29^{O}C, with a mean of 28.33±1.16 in the wet season (Table 2).

Station 5 (Ogudu)

Temperature was constant in the dry season (30.00^{O}C) and wet season (29.00^{O}C). The range between the wet and dry season temperatures was 1^{O}C (Table 2).

Station 6 (Oworonsoki)

Temperature range between the wet and dry seasons were similar (29-30^{O}C). Lowest temperatures (29^{O}C) occurred in September, October and November 1996 (Table 1).

Station 7 (University of Lagos lagoon front)

The lowest temperature value was 28 ^{0}C and the highest 30^{0}C,in the dry season, while the lowest value was 29^{0}C and highest 30^{0}C in the wet season. The mean temperature value in the dry season was 28.67±1.06, while that in the wet season was 29.25± 0.50.(Table 2).

Station 8 (Ikoyi)

Temperature ranged between 29^{O}C and 30^{O}C in the dry season. Mean temperatures were 29.33±0.58. Temperature ranged between 28^{O}C and 30^{O}C in the wet season. Mean temperature was 29.00±0.82 (Table 2).

B. Salinity

Salinity values (Fig. 3b) ranged between 0.00 $^{0}/_{00}$ and 26.00 $^{0}/_{00}$ in the lagoon. Values were low during the rainy season (0.00 $^{0}/_{00}$ to 5.00 $^{0}/_{00}$) when freshwater from runoffs diluted the lagoon environment and precipitation diluted the surface of the water body. Higher salinity 6-26 $^{0}/_{00}$ occurred in the dry season. Low salinity values in the wet season and high salinity values in the dry season were observed at the eight stations,

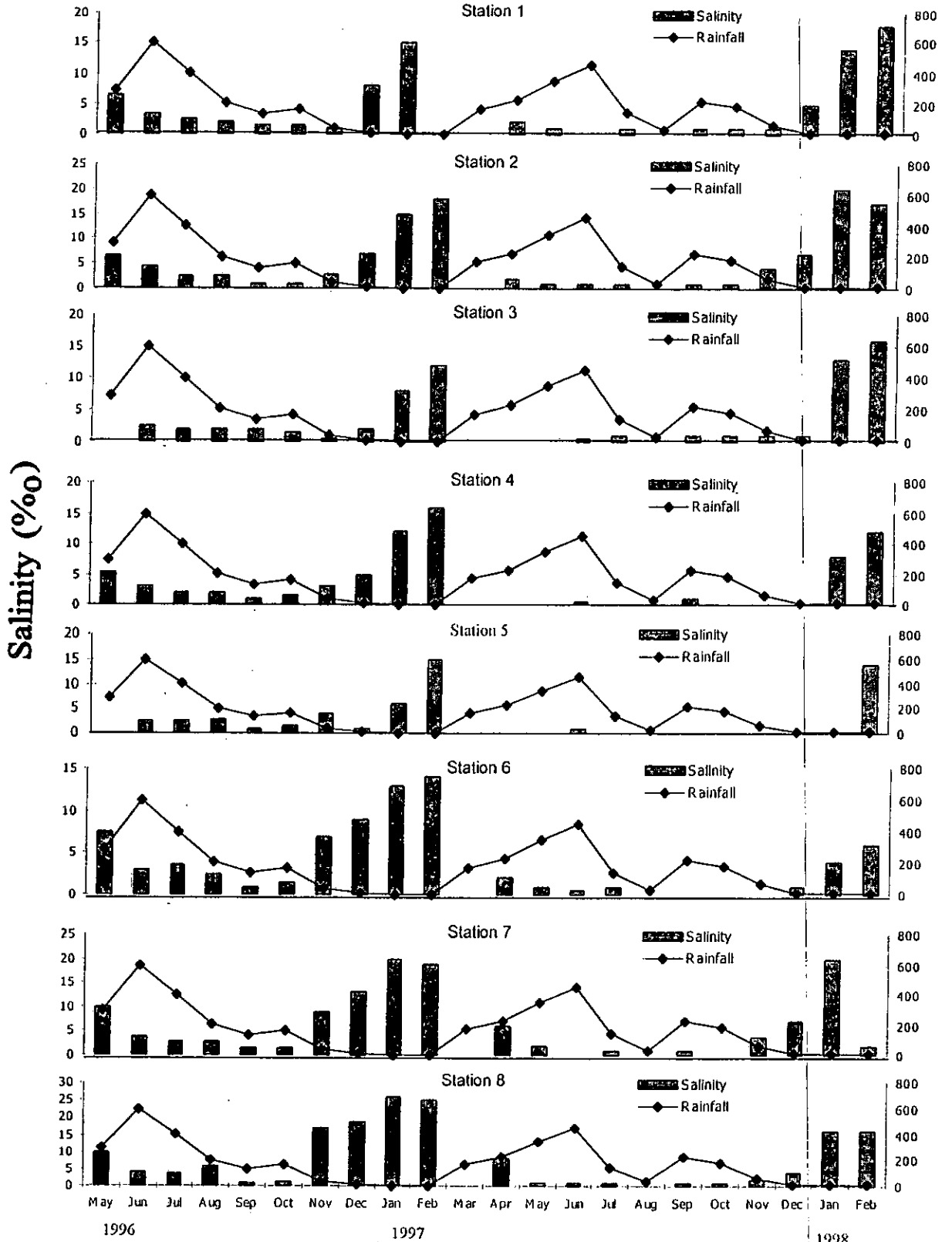

Fig 3b. Variations in salinity ($^0/_{00}$) at the sampling stations in the western part of Lagos lagoon. (May 1996 - February 1998).

although river/creek stations had slightly lower salinities than those of the open lagoon. The highest salinity value of 26.00 $^{0}/_{00}$ was recorded at Ikoyi (station 8) (Fig. 3b, Table 3).

The salinity values fell within the range for either freshwater (0 to 0.5 $^{0}/_{00}$), low brackish water (0.51 – 9.90 $^{0}/_{00}$),mid brackish (10.00 $^{0}/_{00}$ to 19.90 $^{0}/_{00}$) and high brackish (20.0 – 29.9 $^{0}/_{00}$) waters.

Station 1 (Majidun Creek)

In the dry season values ranged between 1.00 $^{0}/_{00}$ and 18.00 $^{0}/_{00}$, while in the wet season values ranged between 0 and 6.5 $^{0}/_{00}$ (mean 1.95±1.77) (Table 4, Fig. 3a). The highest salinity (18.00$^{0}/_{00}$) occurred in February 1998) (Fig. 3b). Freshwater conditions (0-0.5$^{0}/_{00}$) occurred between May and November 1996 and April and December 1997, while brackish water occurred between December 1996 and January 1997, as well as December 1997 and January 1998.

Station 2 (Ikorodu)

The dry season salinities ranged between 2.0 $^{0}/_{00}$ and 18.00 $^{0}/_{00}$ (Table 3). The highest value (18.00 $^{0}/_{00}$) occurred in February 1997 and February 1998 (Fig. 3b). Lower salinities 1.00-6.50 $^{0}/_{00}$ occurred in the wet season.

TABLE 3: VARIATION IN SALINITY ($^0/_{00}$) AT THE SAMPLING STATIONS IN THE WESTERN PART OF LAGOS LAGOON (MAY 1996 – FEBRUARY 1998).

	1996								1997												1998	
MONTHS / STATIONS	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB
1	6.5	3.5	2.5	2	1.5	1.5	1	8	15	0	-	2	1	0	1	-	1	1	1	5	14	18
2	6.5	4.5	2.5	2.5	1	1	3	7	15	18	-	2	1	1	1	-	1	1	4	7	20	17
3	-	2.5	2	2	2	1.5	0.5	2	8	12	-	0	0	0.5	1	-	1	1	1	1	13	16
4	5.5	3	2	2	1	1.5	3	5	12	16	-	0	0	0.5	0	-	1	0	0	0	8	12
5	-	2.5	2.5	3	1	1.5	4	1	6	11.5	-	0	0	1	0	-	0	0	0	0	-	14
6	7.5	3	3.5	2.5	1	1.5	7	9	13	14	-	2	1	0.5	1	-	0	0	0	1	4	6
7	10	4	3	3	1.5	1.5	9	13	20	19	-	6	1	0	1	-	1	0	4	7	20	20
8	10	4	3.5	6	1	1.5	17	19	26	25	-	8	2	1	1	-	1	1	2	4	16	16

TABLE 4: SEASONAL VARIATION IN SALINITY VALUES ($^0/_{00}$) FOR DRY AND WET SEASONS, AT THE SAMPLING STATIONS IN THE WESTERN PART OF LAGOS LAGOON (MAY 1996 – FEBRUARY 1998).

	DRY SEASON				WET SEASON			
STATIONS	MIN	MAX	MEAN	S.D	MIN	MAX	MEAN	S.D
1	1.00	18.00	.8.00	± 6.86	0.00	6.50	1.95	± 1.77
2	2.00	18.00	10.33	± 7.17	1.00	6.50	. . 2.09	± 1.84
3	0.00	16.00	5.94	± 7.75	0.00	2.50	1.35	± 0.71
4	0.00	16.00	6.22	± 5.77	0.00	5.50	1.50	± 1.67
5	0.00	14.00	4.56	± 5.54	0.00	3.00	1.15	± 1.18
6	0.00	14.00	6.22	± 5.04	0.00	7.50	1.95	± 2.17
7	4.00	20.00	13.11	± 9.01	0.00	10.00	2.45	± 2.79
8	2.00	26.00	14.78	± 8.53	1.00	10.00	2.82	± 2..92
MEAN	1.13	17.75	8.65	6.96	0.13	6.44	1.91	1.88

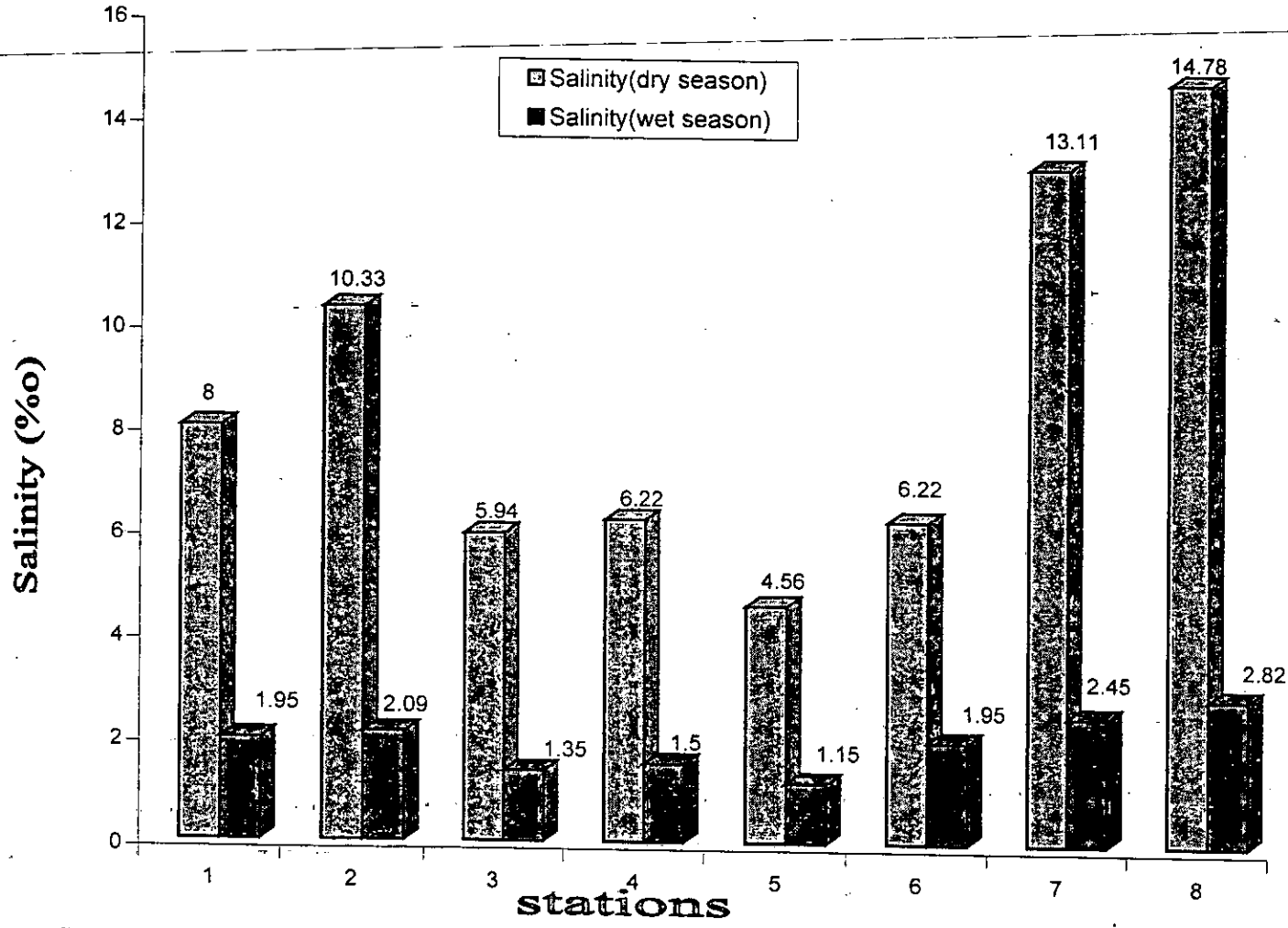

Fig. 3a: Seasonal variation in salinity values (‰) for dry season and wet seasons at the sampling stations in the western part of Lagos lagoon (May 1996 - Feb. 1998)

The mean was 2.09±1.84 (Fig. 4). Lower salinity values occurred between May 1996 and November 1996 and April 1997 and December 1997.

Station 3 (Ogun River)

The lowest salinity value was 0.00 $^{0}/_{00}$ and the highest 16.00 $^{0}/_{00}$ in the dry season, and 0.00 $^{0}/_{00}$ and 2.50 $^{0}/_{00}$ in the wet season (Fig. 3b). The range was significantly higher (0-16 $^{0}/_{00}$) in the dry season, than wet season (0-2.50 $^{0}/_{00}$) ($P<0.05$).

Station 4 (Agboyi Creek)

Salinity ranged between 0.00 and 16.00 $^{0}/_{00}$ in the dry season and 0 and 5.50 $^{0}/_{00}$ in the wet season (Fig. 3b). Salinity was 4.00 $^{0}/_{00}$ in the February 1997, but a higher value occurred (16.00 $^{0}/_{00}$) in February 1998. In the wet season a fresh water environment was observed with salinity between 0.00 and 5.50 $^{0}/_{00}$ and a mean value of 1.5±1.67 (Fig. 4).

Station 5 (Ogudu creek)

Dry season values ranged between 0.00 $^{0}/_{00}$ and 14.00 $^{0}/_{00}$ (February, 1998). Low values 0.0 $^{0}/_{00}$ to 3.00 $^{0}/_{00}$ occurred in the wet season. Mean salinity was 1.15±1.18 (wet season), and 4.56±5.54 (dry season) (Fig. 3a).

Station 6 (Oworonsoki)

The salinity range was between 0.00 and 14.00 $^{0}/_{00}$ in the dry season and 0.00 and 7.50 $^{0}/_{00}$ in the wet season. Mean salinity was 6.22±5.04 (dry season) and 1.95±2.17 (wet season) (Figs. 5 and 4).

Station 7 (University of Lagos lagoon front)

Salinity ranged between 4 and 20.00 $^{0}/_{00}$ in the dry season, and 0-10 $^{0}/_{00}$ in the wet season.Mean salinity was 13.11±9.01 in the dry season and 2.45±2.79 in the wet season. The maximum salinity (20.00) occurred in January 1997 and January and February 1998 (Fig. 3b, Table 3).

Station 8 (Ikoyi)

Salinity values ranged between 2 and 26.00 $^{0}/_{00}$. In the dry season the salinity ranged between 2 and 26.00 $^{0}/_{00}$, while the range was between 1.00 and 10.00 $^{0}/_{00}$ in the wet season (Fig. 3b).

Mean salinity was lower in wet season samples than dry season samples at all stations sampled. (Fig.3b). A salinity gradient occurred between Station 8 (2.82 $^{0}/_{00}$), station 7 (2.45 $^{0}/_{00}$), station 6 (1.95 $^{0}/_{00}$) and station 3 (1.35 $^{0}/_{00}$) in the wet season. Station 1 (mean salinity 1.95 $^{0}/_{00}$) and station 2 (2.09 $^{0}/_{00}$) there was no gradient, this could be due to salt water intrusion/tidal

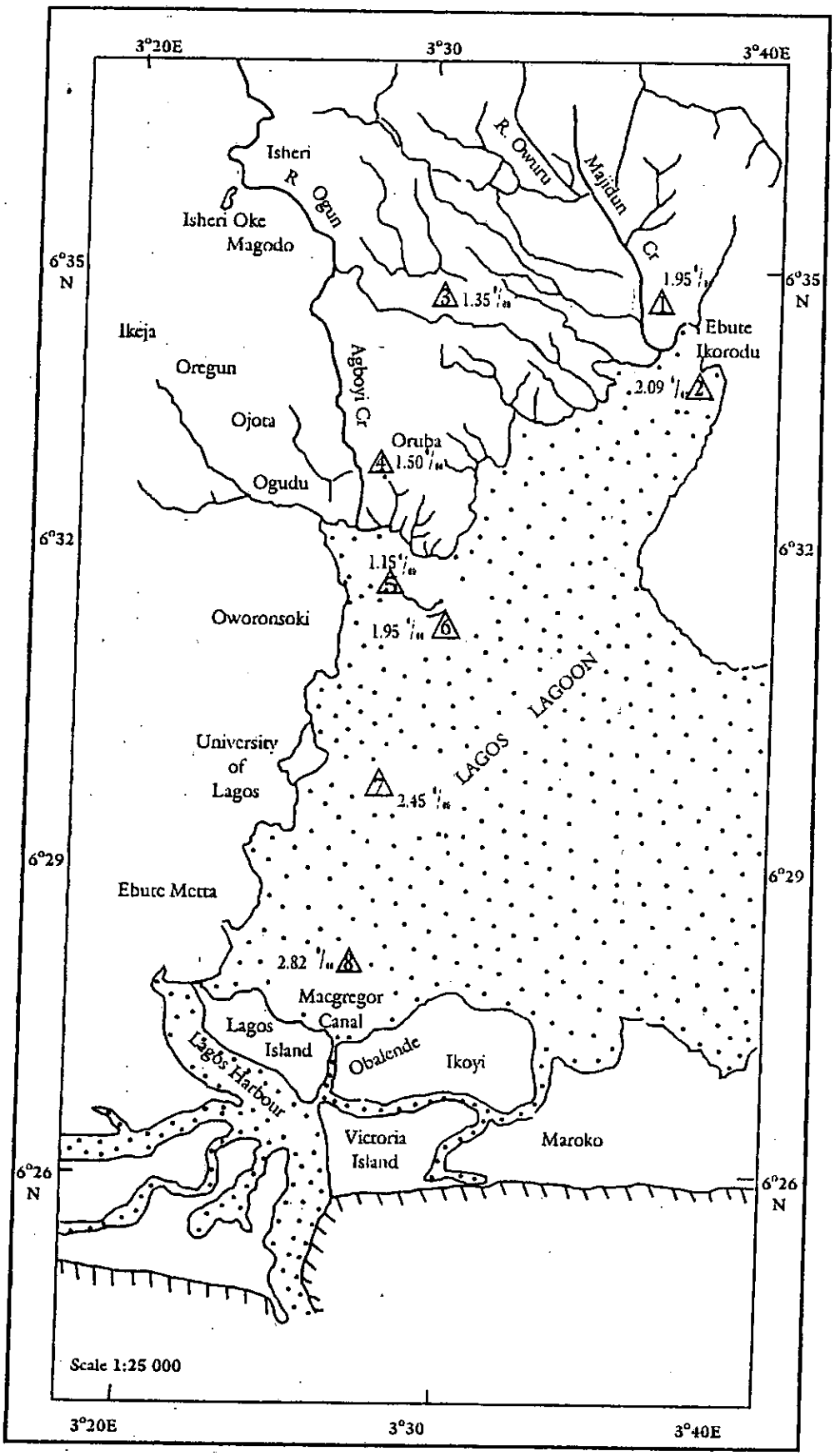

Fig. 4. Mean salinity values ($^0/_{00}$) for the wet season at the sampling stations in the western part of Lagos lagoon.(May 1996 - February 1998).

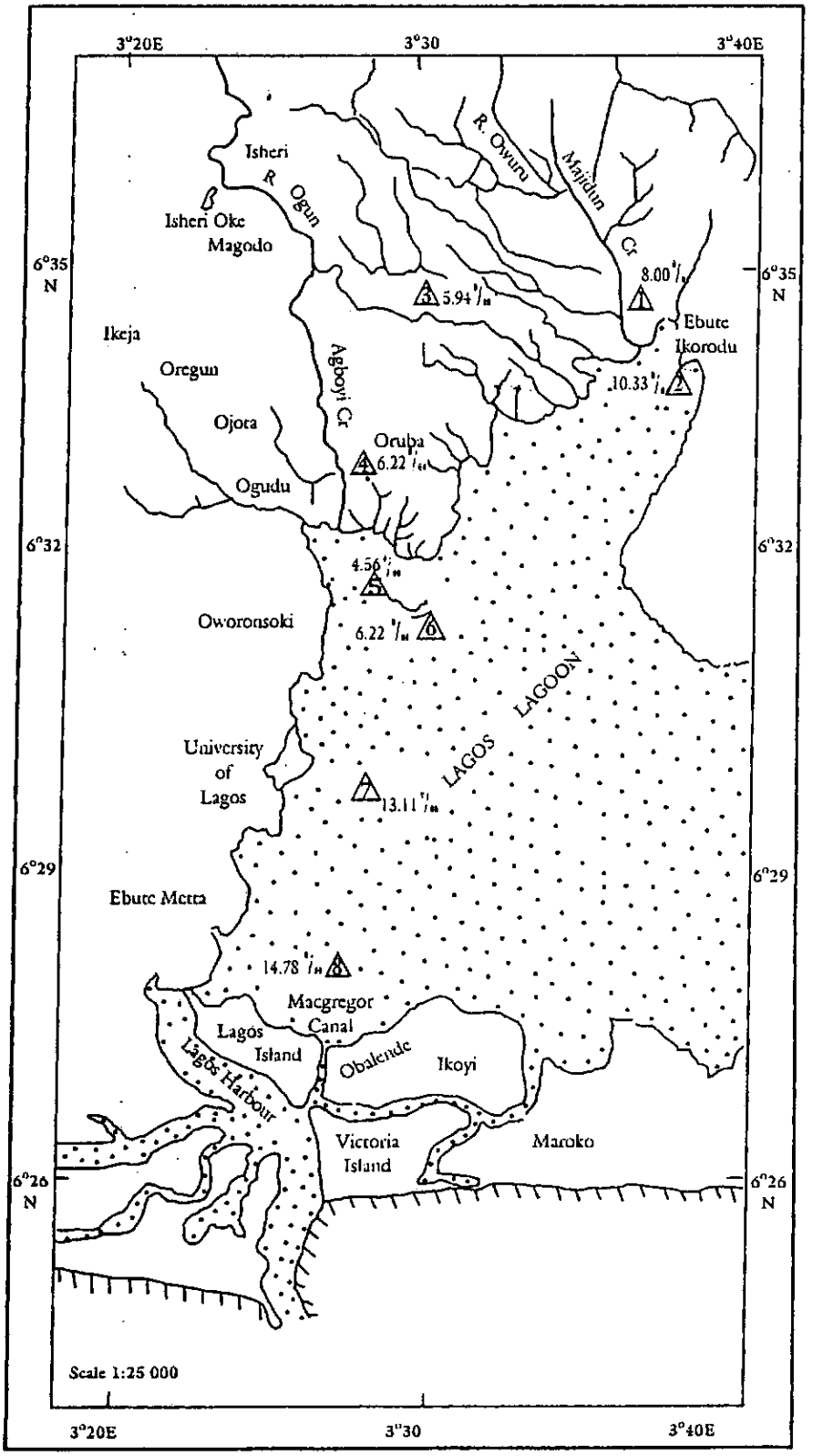

Fig.5. Mean salinity values (‰) for the dry season at the sampling stations in the western part of Lagos lagoon.(May 1996- February 1998).

effect on creek flow (Fig. 4). A similar trend with higher average values occurred in the dry season (Fig. 5). A gradient also occurred between station 1 (8.37 $^{0}/_{00}$) and station 2 (11.22 $^{0}/_{00}$); 3 and 4 (5.94 $^{0}/_{00}$ and 6.22 $^{0}/_{00}$ respectively); stations 5 and 6 (4.56 $^{0}/_{00}$ and 6.22 $^{0}/_{00}$ respectively) and 7 (13.11$^{0}/_{00}$) and 8 (14.78$^{0}/_{00}$).

C. HYDROGEN – ION CONCENTRATION (pH)

The pH values ranged between 7.7 and 8.3, except at stations 7 and 8. At stations 7 and 8 the pH was low with a range between 5.72 and 8.15.

Station 1 (Majidun Creek)

Minimum pH was 6.20, maximum 8.08 and mean 7.23±0.93 in the dry season. The range was lower in the wet season between 6.87 and 8.20, the mean value was 7.76±0.48 (Table 6).

Station 2 (Ikorodu)

The pH at station 2 in the wet season ranged between 6.59 and 8.14, while that in the dry season was between 6.07 and 8.07. Mean pH in the dry season was 7.32±0.90, while that in the wet season was 7.70±0.57 (Table 6).

TABLE 5:-VARIATION IN pH AT THE SAMPLING STATIONS IN THE WESTERN PART OF THE LAGOS LAGOON (MAY 1996 – FEBRUARY 1998).

	1996								1997		
MONTH S STATIONS	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	
1	8.13	7.96	8.20	7.72	6.87	7.66	8.08	6.68	6.20	-	
2	8.14	7.91	8.11	7.79	6.59	7.67	7.93	6.65	6.07	7.09	
3	-	8.25	8.15	8.02	6.96	7.55	8.31	6.75	6.31	8.15	
4	8.19	8.23	8.08	7.88	6.91	7.62	8.14	6.66	6.05	7.89	
5	-	0.08	8.05	7.83	6.98	7.55	8.23	5.89	6.25	7.79	
6	8.01	7.94	8.85	7.88	6.68	7.56	8.50	6.34	5.77	7.81	
7	8.01	8.04	8.08	7.90	6.68	7.52	8.00	6.52	5.72	7.83	
8	7.98	8.15	8.09	7.74	6.84	7.38	7.65	6.76	5.72	7.83	

TABLE 6: SEASONAL VARIATION IN pH VALUES FOR DRY AND WET SEASONS AT THE SAMPLING STATIONS IN THE WESTERN PART OF LAGOS LAGOON (MAY 1996 - FEBRUARY 1998).

	DRY SEASON							WET SEASON			
STATIONS	MIN	MAX	MEAN	S.D				MIN	MAX	MEAN	S.D
1	6.20	8.08	7.23	± 0.93				6.87	8.20	7.76	± 0.48
2	6.07	8.09	7.32	± 0.90				6.59	8.14	7.70	± 0.57
3	6.31	8.31	7.48	± 0.90				6.96	8.25	7.79	± 0.52
4	6.05	8.14	7.33	± 0.92				6.91	8.23	7.82	± 0.50
5	5.89	8.23	7.21	± 1.06				6.98	8.08	7.70	± 0.45
6	5.77	8.50	7.27	± 1.15				6.68	8.86	7.82	± 0.71
7	5.72	8.00	7.20	± 1.03				6.68	8.08	7.71	± 0.54
8	5.72	7.85	7.16	± 0.92				6.84	8.15	7.70	± 0.51
TOTAL	42.73	65.20	58.20	7.81				54.51	65.99	62.00	4.28
MEAAN	5.34	8.15	7.28	0.98				6.81	8.25	7.75	0.54

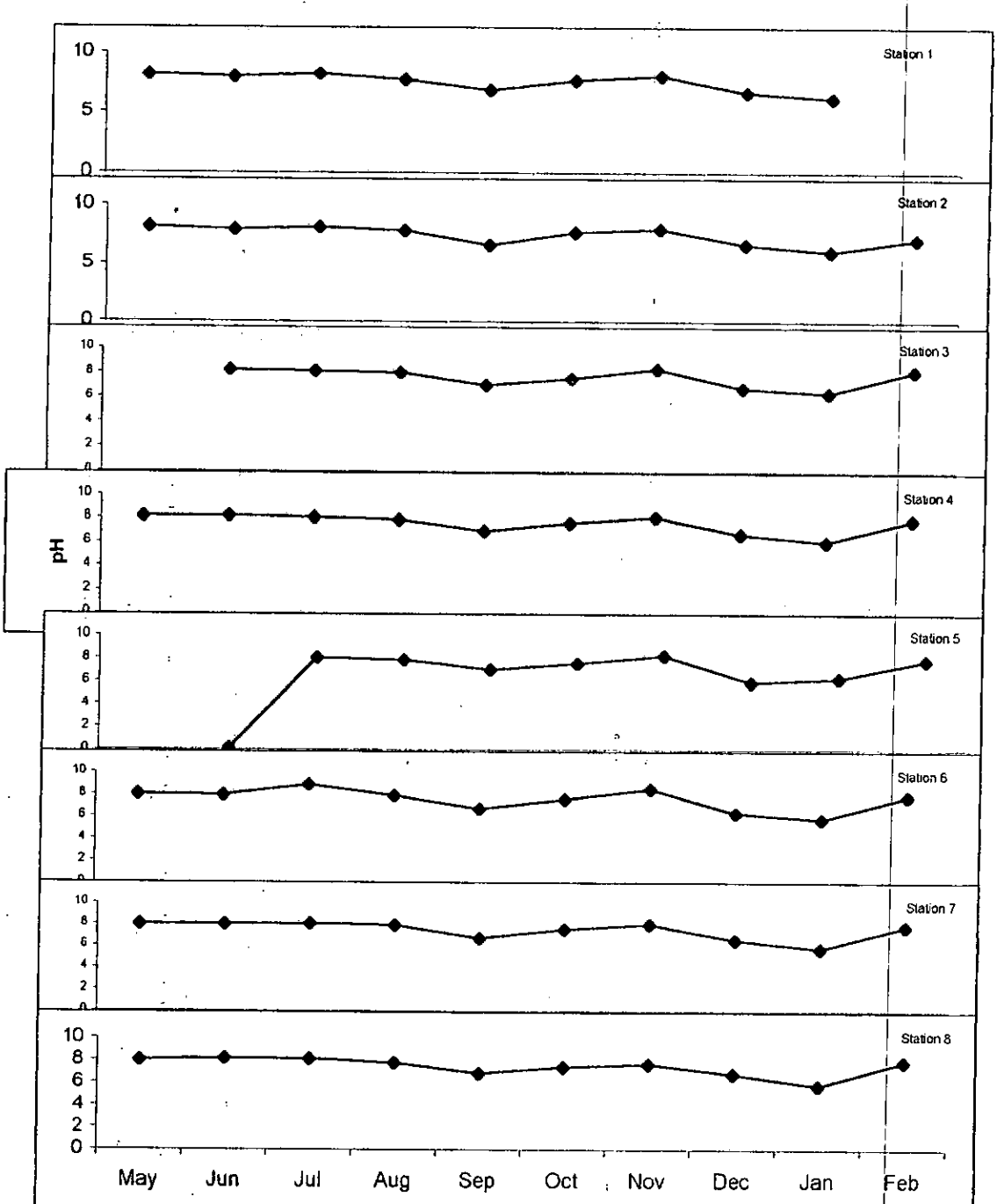

Fig 6. Variation in pH at the sampling stations in the western part of Lagos lagoon

Station 3 (Ogun River)

The highest dry season pH value (8.31) occurred in November 1996, while the lowest (6.31) occurred in January 1997. In the wet season values were between 6.96 and 8.25 (Table 5, Fig. 6).

Station 4 (Agboyi Creek)

A mean of 7.33±0.92 was computed for pH in the dry season period, while 7.82±0.50 was recorded for wet season. The lowest value occurred in January 1997, while the highest value 8.14 occurred in November 1996. The lowest value was 6.91 and the highest 8.23 in June 1996 (Fig. 6).

Station 5 (Ogudu Creek)

Minimum pH in the dry season was low, (5.89) and maximum 8.23, while mean was 7.21±1.06. In the wet season values ranged between 6.98 and 8.08 (Table 5).

Station 6 (Oworonsoki)

In the dry season the minimum pH was 5.72 and maximum pH was 8.50. In the wet season where mean pH was 7.82±0.71,minimum was 6.68 while maximum was 8.86 (Table 5).

Station 7 (University of Lagos lagoon front)

Mean pH was 7.20±1.03 in the dry season and 7.71±0.54 in the wet season (Table 6). Lowest temperatures were 5.72 and 6.68 in dry and wet seasons respectively.

Station 8 (Ikoyi)

Range of pH was between 5.72 and 7.85 (Table 6). In the wet season range was between 6.84 and 8.15, while mean was 7.70±0.51 (Table 6).

D. CONDUCTIVITY

The conductivity results ranged between 0.01mScm^{-2} and 7.13mScm^{-2}. The lowest readings occurred at Ogun River and Agboyi creek in August 1996. Agboyi creek in September 1996 and Majidun and Agboyi creek in October 1996. The highest value (7.13mScm^{-2}) occurred at Ikoyi in February 1997, indicating high ionic content of the water.

Station 1 (Majidun Creek)

The minimum value 0.10 mScm^{-2} in the dry season was higher than that in the wet season (0.01 mScm^{-2}). The maximum value was 4.04 mScm^{-2} in the dry season with a mean of 2.33±1.18 mScm^{-2}. The maximum value in the wet season was 2.64 mScm^{-2}, with a mean of 0.64±0.83 (Table 8).

TABLE 7: VARIATION IN CONDUCTIVITY AT THE SAMPLING STATIONS IN THE WESTERN PART OF LAGOS LAGOON (MAY 1996 FEBRUARY 1998).

	1996								1997												1998	
MONTHS / STATIONS	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB
1	-	0.43	0.04	0.06	-	0.01	0.10	2.28	4.04	3.58	-	-	2.64	0.63	1.08	-	0.61	0.31	2.53	2.00	2.07	2.07
2	-	0.58	0.05	0.09	0.02	0.03	0.58	0.26	4.07	4.26	-	-	2.77	0.96	0.97	-	0.91	0.31	2.05	2.06	2.07	2.05
3	-	0.03	0.02	0.01	-	0.05	0.42	0.92	3.01	3.29	-	-	0.18	0.16	0.16	-	0.57	0.23	2.11	2.05	2.08	2.07
4	-	0.02	0.02	0.01	0.01	0.01	0.63	1.76	4.11	2.98	-	-	0.26	0.15	0.16	-	0.14	0.14	1.58	3.65	2.07	2.06
5	-	-	0.02	0.02	0.01	0.03	1.00	0.47	1.32	2.54	-	-	0.93	0.22	0.27	-	0.17	0.13	2.17	2.04	2.08	2.07
6	-	-	0.06	0.09	0.03	0.03	2.08	2.95	4.24	4.50	-	-	1.98	0.56	2.10	-	0.28	0.28	3.57	2.05	2.07	2.05
7	-	0.49	0.10	0.08	0.07	0.04	-	3.79	4.79	5.69	-	-	5.10	0.81	1.13	-	3.06	0.33	2.07	2.06	2.07	-
8	-	0.44	0.07	1.16	0.12	0.08	5.40	0.02	0.71	7.13	-	-	6.92	0.65	0.88	-	0.29	0.27	0.27	2.00	2.05	2.04

TABLE 8: SEASONAL VARIATION IN CONDUCTIVITY VALUES ($mScm^{-1}$) FOR DRY AND WET SEASONS, AT SAMPLING STATIONS IN THE WESTERN PART OF LAGOS LAGOON (MAY 1996 – FEBRUARY 1998)

	DRY SEASON				WET SEASON			
STATIONS	MIN	MAX	MEAN	S.D	MIN	MAX	MEAN	S.D
1	0.10	4.04	2.33	± 1.18	0.01	2.64	0.64	± 0.83
2	0.26	4.26	2.18	±1.43	0.02	2.77	0.67	± 0.84
3	0.42	3.29	1.99	± 0.95	0.01	0.57	1.70	± 1.65
4	0.63	4.11	2.36	± 1.15	0.01	0.26	0.09	± 0.09
5	0.47	2.54	1.71	± 0.70	0.01	0.93	0.20	± 0.29
6	2.05	4.50	2.94	± 1.04	0.03	2.10	0.60	± 0.83
7	2.06	5.69	3.41	± 1.47	0.04	5.10	1.12	± 1.67
8	0.02	7.12	2.68	± 2.39	0.07	6.92	1.09	± 2.08
TOTAL	6.01	35.56	19.60	10.31	0.20	21.29	6.11	8.28
MEAN	0.75	4.45	2.45	1.29	0.03	2.66	0.76	1.04

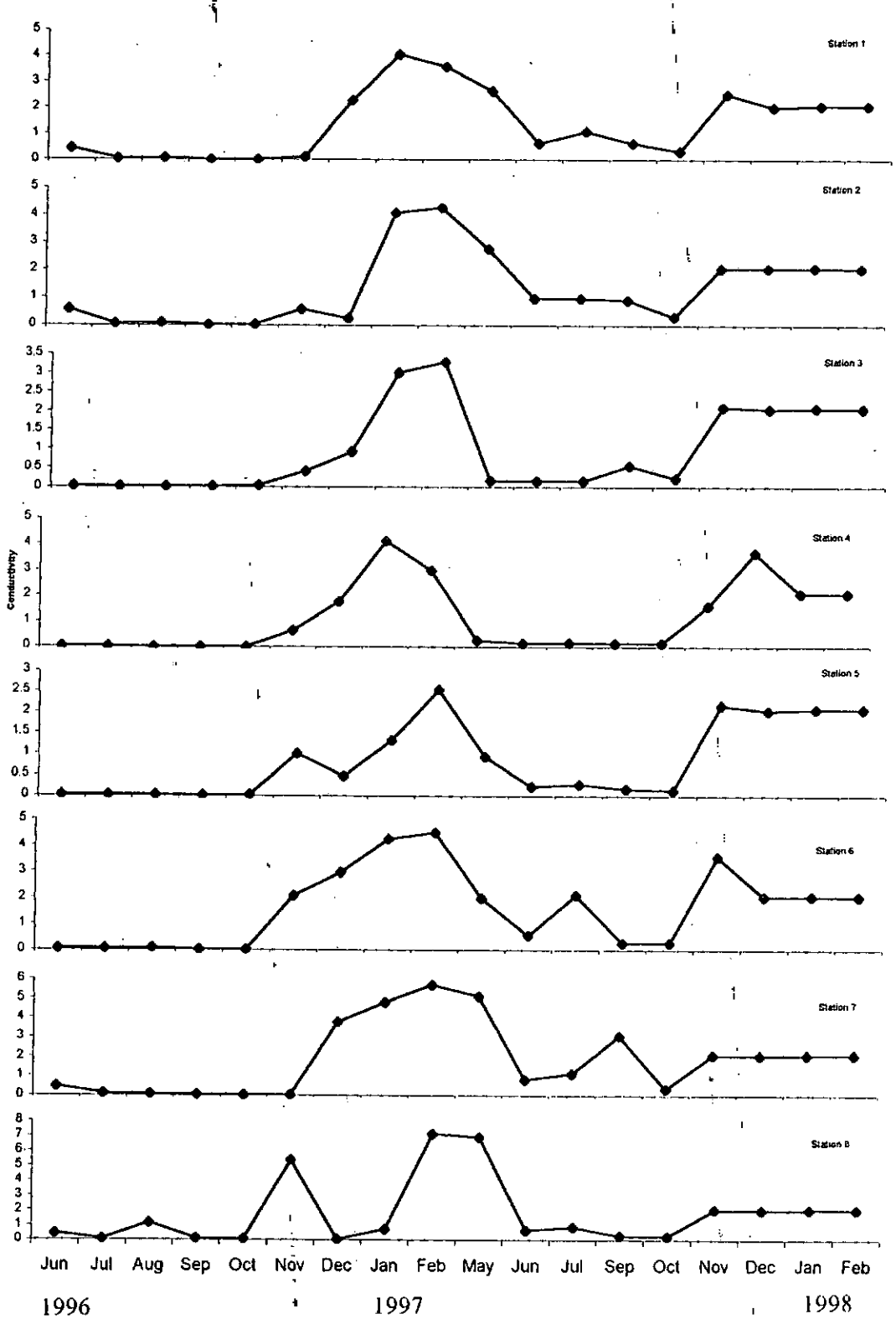

Fig 8.Variation in conductivity in the western part of Lagos lagoon (May 1996-February 1998).

Station 2 (Ikorodu)

In the dry season values ranged between 0.26 $mScm^{-2}$ and 4.26 $mScm^{-2}$, the mean was 2.18±1.43. Wet season values were between 0.02 $mScm^{-2}$ and 2.77 $mScm^{-2}$ (Fig. 8) with a mean of 0.67±0.84 $mScm^{-2}$ (Table 8).

Station 3 (Ogun River)

Conductivity values were lower (0.01-0.57 $mScm^{-2}$) in the wet season than dry season (0.42-3.29 $mScm^{-2}$). The mean value in the wet season was 1.70±1.65, while the mean in the dry season was 1.99±0.95 $mScm^{-2}$ (Table 8).

Station 4 (Agboyi Creek)

The range (0.01-0.26 $mScm^{-2}$) was low in the wet season (mean 0.09±0.09 $mScm^{-2}$). This range was however lower than that recorded for the dry season values (0.63-4.11 $mScm^{-2}$, mean 2.36 ± 1.15 $mScm^{-2}$ (Fig. 8).

Station 5 (Ogudu)

The lowest value was 0.01 $mScm^{-2}$ in the wet season, the range was between 0.01 and 0.93 $mScm^{-2}$. In the dry season the minimum value of 0.47 $mScm^{-2}$ occurred, while the highest value was 2.54 $mScm^{-2}$.

Station 6 (Oworonsoki)

In the wet season values of conductivity ranged between 0.03 $mScm^{-2}$ and 2.10 $mScm^{-2}$. Values in the dry season were between 2.05 and 4.50 $mScm^{-2}$, with a mean of 2.94 ± 1.04 $mScm^{-2}$ (Table 8).

Station 7 (University of Lagos lagoon Front)

Lower values of occurred in the wet season (0.04-5.10 $mScm^{-2}$) than dry season (2.00-5.69 $mScm^{-2}$) (Table 8). The mean value of conductivity in the wet season was 1.12 ± 1.67, it was lower than that in the dry season (3.41-1.47).

Station 8 (Ikoyi)

A minimum value of 0.07 $mScm^{-2}$ was obtained in July 1996, while the maximum value of 6.92 $mScm^{-2}$ was recorded in May 1996. In the dry season, the lowest value of 0.02 $mScm^{-2}$ was obtained in December 1996 and the highest, 7.13 $mScm^{-2}$ in February 1997 (Fig. 8).

Higher values of conductivity were recorded in the dry season, when salinity values were higher (due to higher concentration and lowered rainfall) than during the wet season.

E. TRANSPARENCY

Transparency was high (0.61-1.22m) with a mean of 0.83±0.21m in the dry season and low (0.15-0.61m) with a mean of 0.36±0.24m during the wet season. Minimum, maximum mean and standard deviation values for transparency, measured during the dry and wet seasons at the various stations are shown in Table 10.

Transparency values increased between October 1996 and January 1997, at all stations (Table 9, Fig. 9). Thereafter values increased (st. 1 and st. 7) or decreased (st. 2, 3, 4, 5 & 6) or were constant (st. 6) until the rise, which occurred in October 1997 (Table 9, Fig. 9).

F. RAINFALL

Rainfall data were obtained from the meteorological station at the Nigerian Institute for Oceanography and Marine Research. Values were low (0.2mm/month) in the dry season (Nov.-April) and high, maximum (599.5mm/month) in the wet season (May-October) (Table 11). Monthly average was higher (175.12) in 1996, than 1997 (155.20).

TABLE 9: VARIATION IN TRANSPARENCY AT THE SAMPLING STATIONS IN THE WESTERN PART OF LAGOS LAGOON (MAY 1996 – FEBRUARY 1998).

	1996								1997												1998	
MONTHS / STATIONS	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB
1	0.37	0.31	-	0.31	0.31	0.46	0.61	-	0.61	0	-	1.07	0.61	0.46	0.61	-	0.53	0.46	0.61	-	0.61	1.07
2	0.15	0.31	-	0.31	0.31	0.27	0.31	-	0.61	0.61	-	0.46	0.61	0.31	0.46	-	0.46	0.38	0.69	-	0.91	0.91
3	0.31	0.31	-	0.31	0.31	0.18	0.31	0.91	0.91	1.22	-	0.46	0.46	0.38	0.61	-	0.61	0.23	0.61	-	0.91	0.76
4	0	0.31	-	0.31	0.31	0.27	0.31	-	0.91	0.91	-	0.61	0.53	0.38	0	-	0.31	0,31	0.46	-	1.22	0.91
5	0	0.31	-	0.31	0.31	0.27	0	-	1.22	0.91	-	0.61	0.61	0.31	0.93	-	0.34	0.31	0.31	-	0.91	1.22
6	0.31	0.31	-	0.31	0.31	0.31	0.91	-	0.76	0.76	-	0.76	0.46	0.31	0.46	-	0.31	0.38	0.53	-	0.91	0.61
7	0.31	0.31	-	0.31	0.31	0.31	0.91	-	0.91	0.91	-	1.07	0.61	0.34	0.38	-	0.38	0.53	0.61	-	1.07	0.61
8	0.15	0.31	-	0.61	0.46	0.31	0.91	-	0.76	1.22	-	0.91	0.76	0.46	0.38	-	0.46	0.46	0.76	-	0.91	0.61

TABLE 10: SEASONAL VARIATION IN MEAN TRANSPARENCY (m) AT SAMPLING STATIONS IN THE WESTERN PART OF LAGOS LAGOON (MAY 1996 – FEBRUARY 1998)

	DRY SEASON				WET SEASON			
STATIONS	MIN	MAX	MEAN	S.D	MIN	MAX	MEAN	S.D
1	0.61	1.07	0.76	± 0.24	0.31	0.61	0.44	± 0.11
2	0.31	0.91	0.64	±0.22	0.15	0.61	0.36	± 0.24
3	0.31	1.22	0.76	± 0.37	0.18	0.61	0.37	± 0.14
4	0.31	1.22	0.76	± 0.31	0.27	0.53	0.34	± 0.08
5	0.31	1.22	0.86	± 0.74	0.27	0.93	0.41	± 0.22
6	0.53	0.91	0.75	± 0.13	0.31	0.46	0.35	± 0.06
7	0.61	1.07	0.87	± 0.19	0.31	0.61	0.38	± 0.11
8	0.61	1.22	0.83	± 0.21	0.15	0.76	0.44	± 0.17
TOTAL	3.60	8.84	6.23	2.41	1.95	5.12	3.09	1.13
MEAN	0.45	1.11	0.78	0.30	0.24	0.64	0.39	0.14

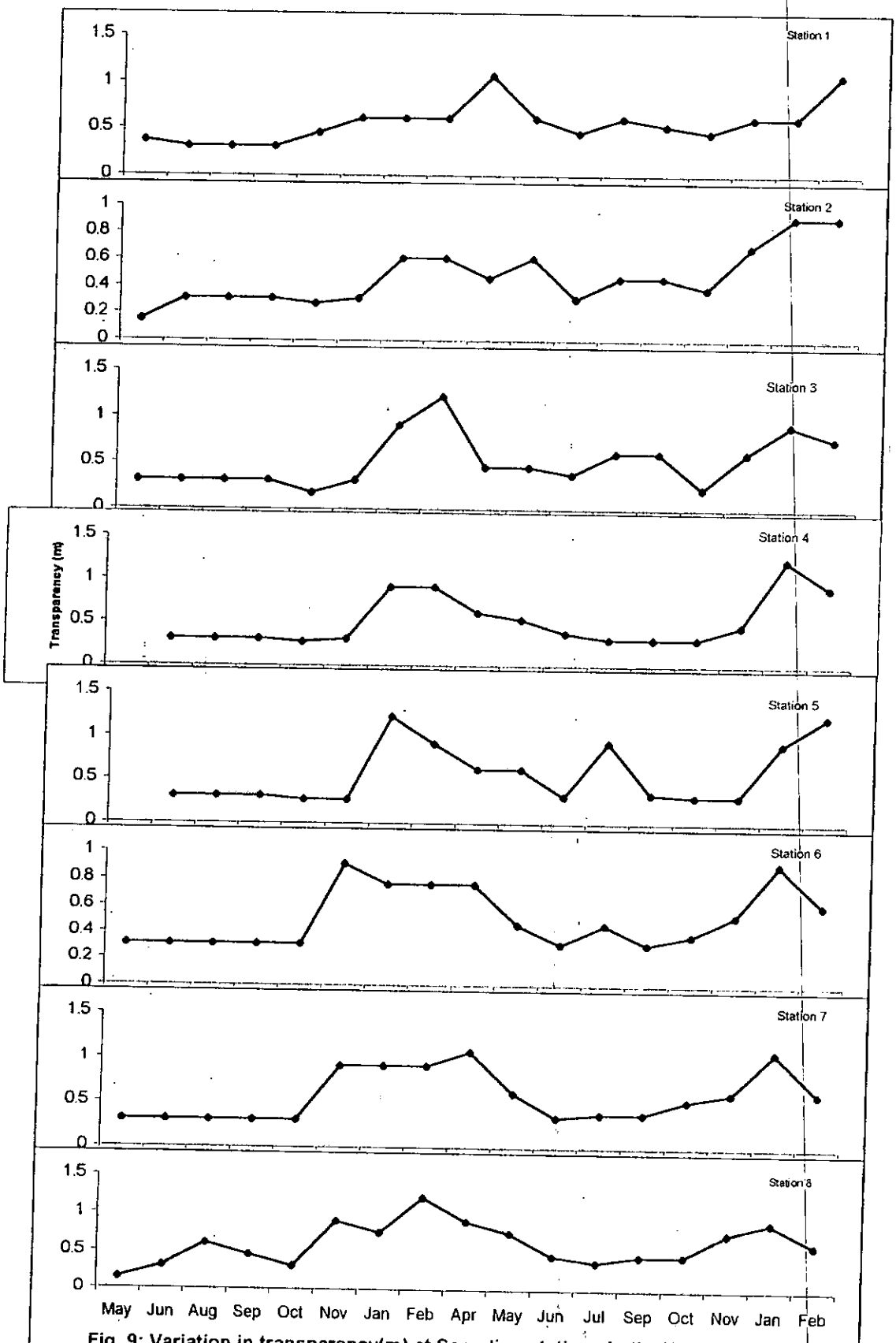

Fig. 9: Variation in transparency(m) at Sampling stations in the Western part of the Lagos lagoon (May 1996-Feb. 1998)

TABLE 11: RAINFALL DATA FOR LAGOS LAGOON (January 1996 – October 1998).

RAINFALL/MONTHS	1996	1997	1998
January	4.80	1.20	8.2
February	2.50	0.00	7.7
March	109.80	170.20	43.1
April	135.20	227.50	87.1
May	293.30	348.40	110.8
June	599.50	454.60	58.8
July	401.30	145.00	30.4
August	206.30	30.70	16.5
September	135.40	221.50	362.6
October	166.60	183.70	45.33
November	36.50	65.30	
December	10.20	14.30	
Total	2101.40	1862.40	
Monthly Average	175.12	155.20	

Source: NIOMR Metrological station (1999).

SEDIMENT ANALYSES

A. TOTAL ORGANIC CONTENT (TOC)

Total organic content values ranged between 0.50 and 11.93%. Values were lower (0.50-7.83%) at Ikoyi, University of Lagos lagoon front, Oworonsoki, Ogudu and Ikorodu (lagoon stations), than Majidun creek, Ogun River, Agboyi creek (Creek/River stations) (Table 12, Fig. 10). Lower values were recorded for more sandy sites, than sites with higher silt, since TOC is directly proportional to silt.

Station 1 (Majidun Creek)

The lowest value was 0.61%. The highest value (10.03%) occurred on two sampling dates, February and April 1997 (Table 12, Fig. 10).

Station 2 (Ikorodu)

The range of total organic content was between 0.31% and 5.34%. The lowest value (0.31%) occurred in June 1996, while the highest (5.34%) occurred in December 1996.

TABLE 12: VARIATION IN TOTAL ORGANIC CONTENT (TOC) (%) AT SAMPLING STATIONS IN WESTERN PART OF LAGOS LAGOON (MAY 1996 – FEBRUARY 1998).

	1996								1997											1998		
STNS.	MAY.	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB
1	2.66	1.68	3.88	5.47	1.74	2.18	7.61	0.61	0.78	10.05	-	10.03	1.77	6.88	7.62	-	3.61	1.00	1.70	2.27	1.48	0.92
2	1.52	0.31	3.64	1.06	1.38	1.43	2.02	5.34	2.01	1.91	-	1.91	4.23	4.02	3.19	-	1.07	2.14	2.46	1.89	2.74	2.21
3	-	1.27	0.73	2.96	0.21	3.17	3.02	2.71	0.65	9.07	-	0.07	0.80	1.14	0.51	-	11.93	1.13	5.64	5.85	4.22	2.16
4	1.78	2.83	1.70	4.05	0.39	0.77	5.15	2.73	3.04	1.66	-	1.66	7.09	2.53	3.56	-	1.18	3.27	1.47	0.64	0.64	1.95
5	-	1.71	2.83	1.91	3.29	2.14	1.79	2.13	1.75	3.06	-	3.06	2.26	1.79	1.82	-	1.57	3.40	3.76	2.11	3.31	2.11
6	4.45	4.45	1.47	2.49	0.79	1.27	1.60	2.84	2.91	2.61	-	2.61	3.24	1.36	1.40	-	7.83	3.56	1.60	1.92	1.56	1.19
7	2.27	2.18	4.43	2.14	1.40	1.65	1.62	2.45	2.20	1.42	-	1.42	1.61	2.78	1.51	-	2.16	1.37	1.45	1.58	2.16	1.29
8	0.78	1.71	0.50	1.50	1.09	1.00	1.03	1.33	1.63	0.63	-	0.63	0.72	1.23	4.25	-	1.50	1.15	1.05	1.92	2.87	1.02

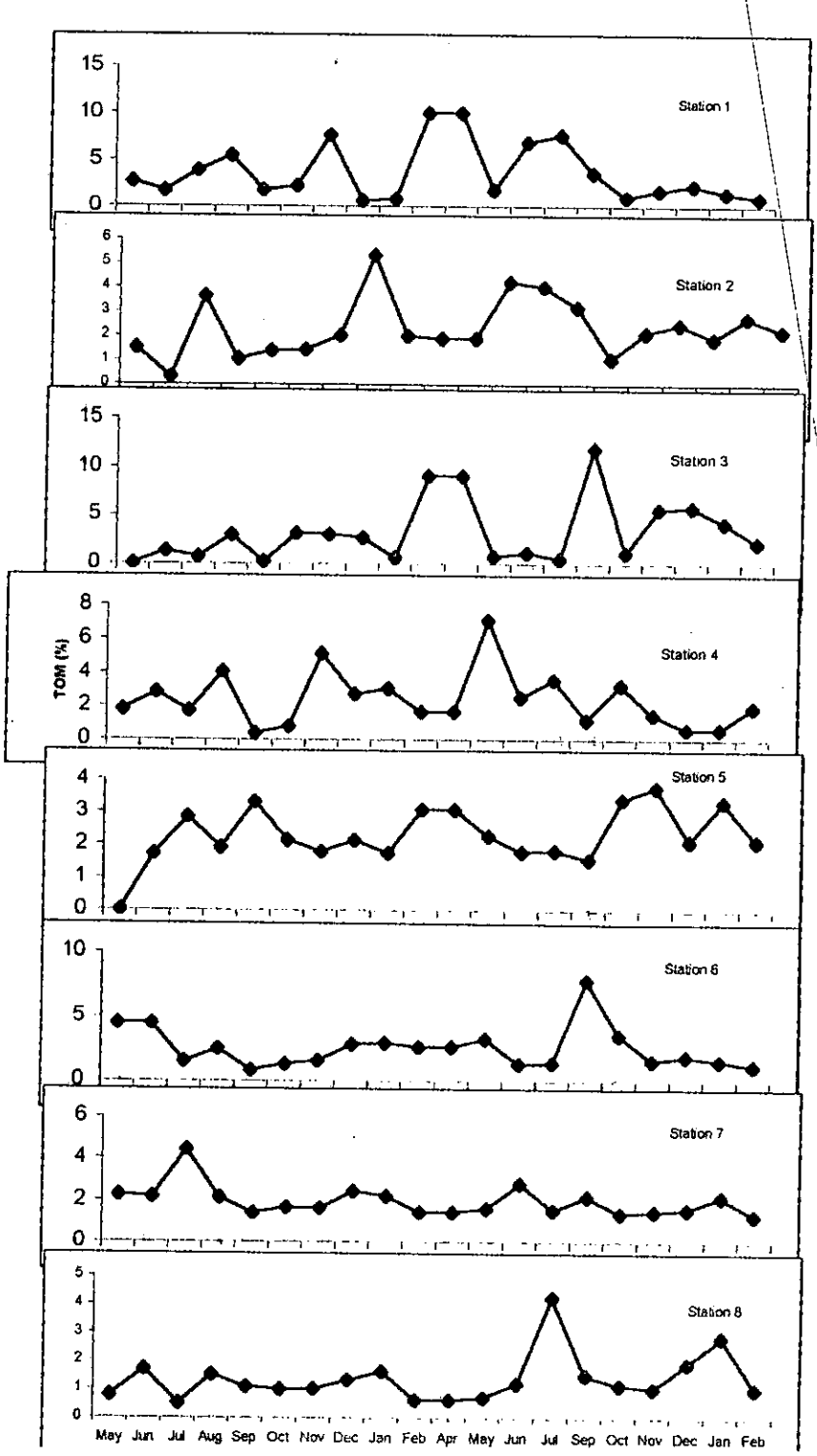

Fig 10. Variation in Total Organic Content (TOC) (%) at sampling stations in the western Part of Lagos lagoon.(May 1996-February 1998).

Station 3 (Ogun River)

All total organic content values at station 3 were below 12.00%. In September 1997 total organic content at Ogun River was highest at 11.93%. The lowest total organic value (0.21%) occurred in September 1996.

Station 4 (Agboyi Creek)

Total organic content at Agboyi creek ranged between 0.39% in September 1996 and 7.09% in May 1997.

Station 5 (Ogudu)

Total organic content values at Ogudu during the sampling period were low. Values ranged between 1.57% and 3.76%. The lowest value 1.57% occurred in September 1997, while the highest value occurred in November 1997.

Station 6 (Oworonsoki)

Total organic content ranged between 0.79% in September 1996 and 7.83% in September 1997. High values were obtained in May and June 1996. On all other sampling dates, total organic content was below 5.0%.

Station 7 (University of Lagos lagoon front)

In the sandy sediment of st. 7 total organic content was low, below 5% on all sampling dates. The highest value (4.43%) occurred in July 1996), while the lowest value occurred in February 1998 (1.29%).

Station 8 (Ikoyi)

Total organic content was highest in July 1997 (4.25%). Low values between 0.50 and 2.87 were collected on other sampling dates (Fig. 10).

B. SEDIMENT SIZE ANALYSIS

The sediment type at sampling sites consisted of either sandy, muddy, sandy mud or muddy sand sediments. At the northern part of the lagoon near the entrance of Agboyi creek, coarse sand with varying amounts of silt were collected. Shelly mud with medium sand and fine sand with a little silt were present at University of Lagos lagoon front. Lagoon stations had more sandy sediments in dry and rainy seasons, than the creeks.

Station 1 (Majidun Creek)

The sediment comprised of 82.7% mud in June 1996, and 61.8% mud in June 1997. In May 1996 mud comprised 79.4% of the sediment collected and 93% of sediment collected in February 1997. In July 1996 sediment was 62% mud, while in July 1997 it was 50.2% mud (Fig. 11, Table 13).

Station 2 (Ikorodu)

The sediment at Ikorodu was sandy throughout the sampling period, Sand ranged between 56.60% and 97.40% (Table 13).

Station 3 (Ogun River)

In February 1997, sediment was 74% mud, while at other sampling dates sandy sediment ranged between 85.9% and 94.5% (Table 13, Fig. 11).

Station 4 (Agboyi Creek)

In June 1996, July 1996, February 1997, May 1996 and December 1997 sandy sediments ranged between 82.8% and 97.0% (Table 13). This trend changed in June 1997, July 1997, February 1998, May 1997 and April 1997 when muddy sediment with between 72.6% and 84.2% mud were collected (Fig. 11, Table 13).

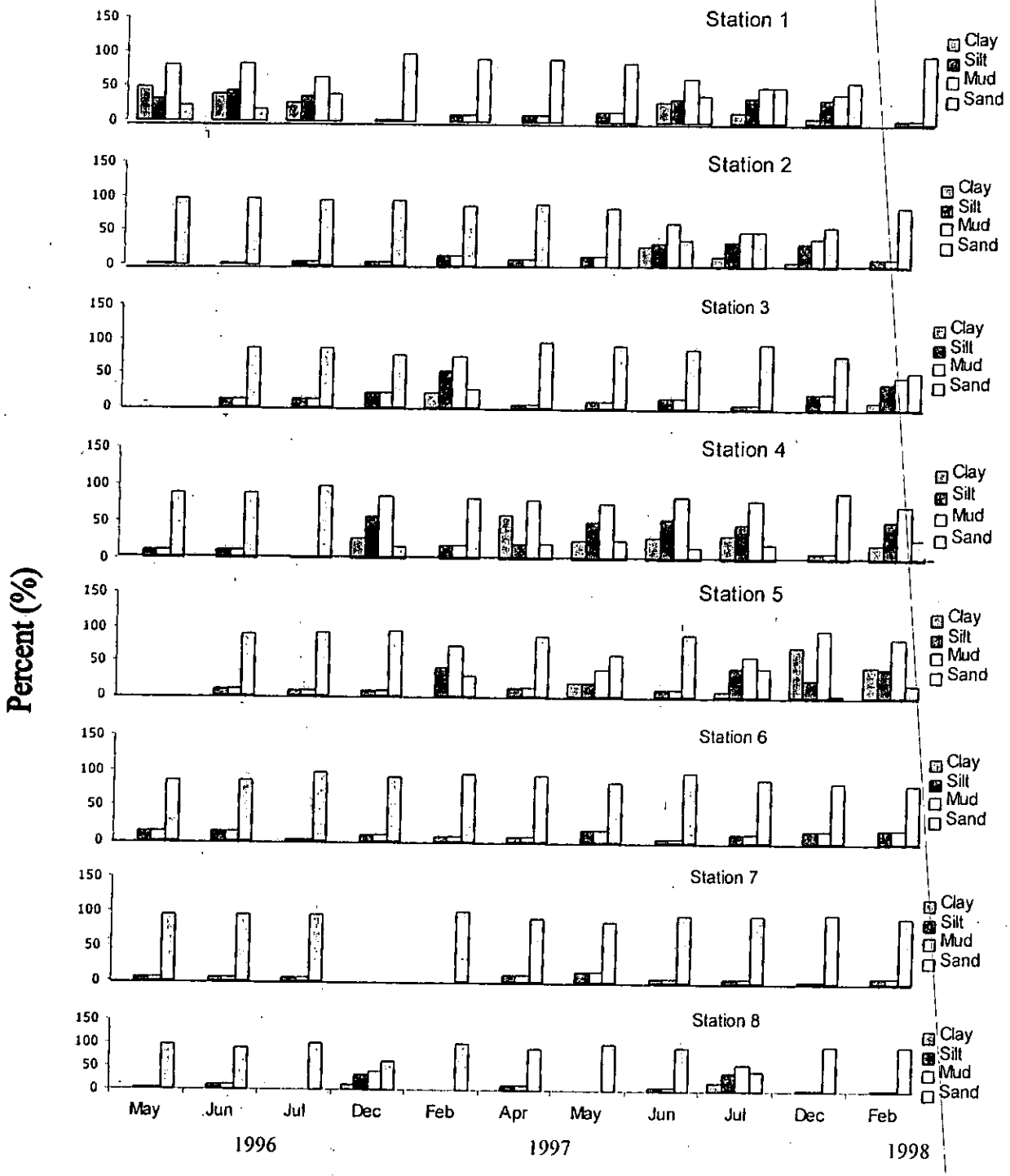

Fig.11. Seasonal Variation in Percentage Mud(Silt and Clay) and Sand in the Sampling Stations in the Western Part of Lagos Lagoon (May,1996-Feb.1998)

TABLE 14. SEASONAL VARIATION IN PERCENTAGE MUD (SILT AND CLAY) AND SAND IN SAMPLING STATIONS IN WESTERN PART OF LAGOS LAGOON (MAY 1996 – FEBRUARY 1997)

	JUNE 1996					JUNE 1997			
	CLAY	SILT	MUD	SAND		CLAY	SILT	MUD	SAND
1	39.1	43.6	82.7	17.3		28.3	33.5	61.8	38.2
2	-	3.3	3.3	96.7		-	6.4	6.4	93.6
3	-	12.8	12.8	87.2		-	14.1	14.1	85.9
4	-	12.4	12.4	87.6		-	54.3	84.0	16.0
5	-	10.2	10.2	89.8		-	10.7	10.7	89.3
6	-	14.6	14.6	85.4		-	2.7	2.7	97.3
7	-	3.9	3.9	96.1		-	3.8	3.8	96.2
8	-	9.0	9.0	91.0		-	7.7	7.7	92.3

Muddy

Sandy mud

Muddy sand

Sandy

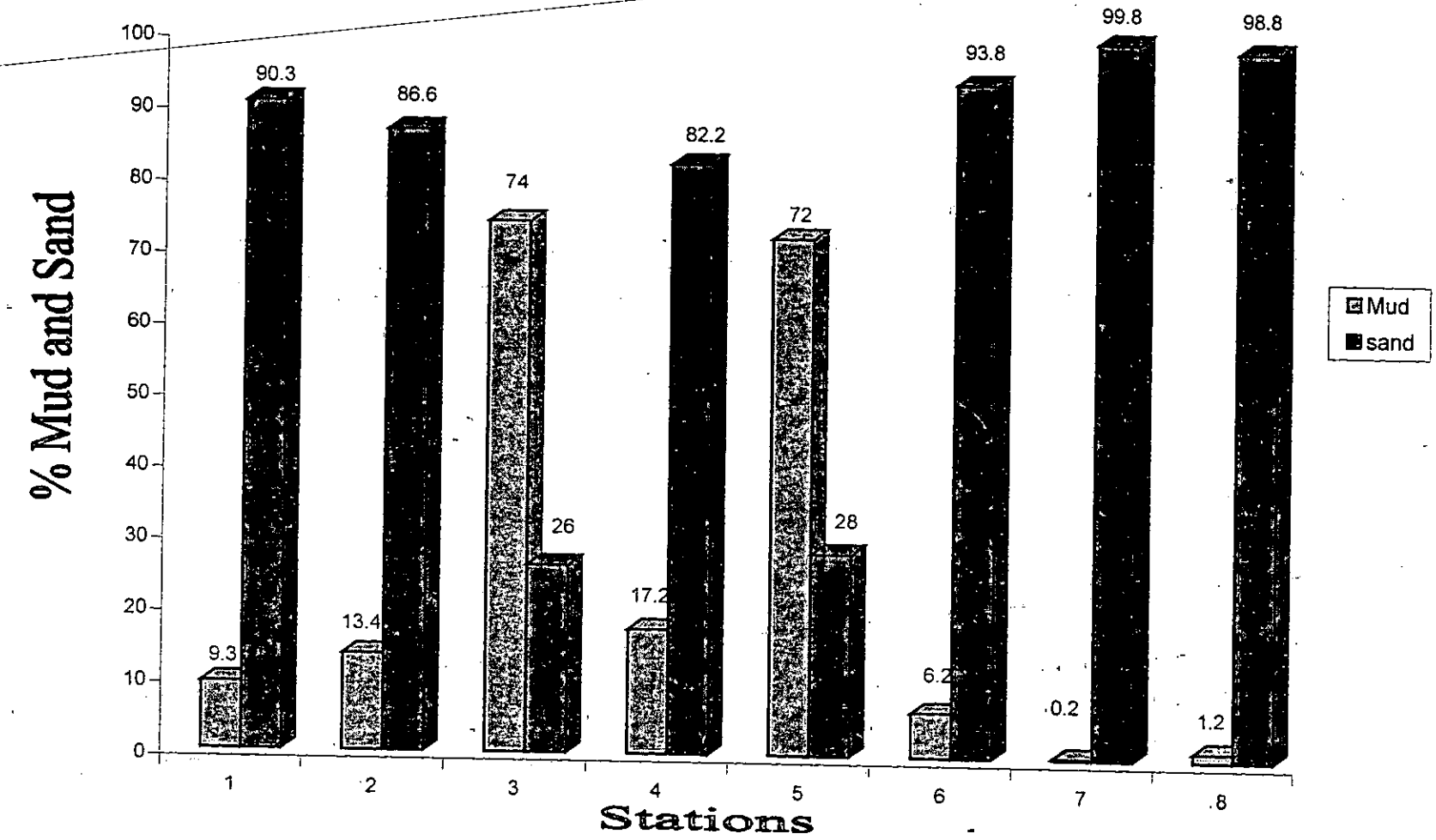

Fig.12: Percentage mud and sand at sampling stations in the western part of Lagos Lagoon(Dry Season: Feb.1997)

FIG. 14: PERCENTAGE MUD AND SAND AT SAMPLING STATIONS IN THE WESTERN PART OF LAGOS LAGOON (DRY AND WET SEASONS).

	JUNE 1996				JUNE 1997			
	Fig. 2a FEB 1997		Fig. 2b FEB 1998		Fig. 2c JULY 1996		Fig. 2d JULY 1997	
	MUD	SAND	MUD	SAND	MUD	SAND	MUD	SAND
1	9.3	90.3	4.2	95.8	62.0	38.0	50.2	49.8
2	13.4	86.6	13.1	86.9	4.6	95.4	7.9	92.1
3	74.0	26.0	45.6	54.4	11.7	88.3	5.5	94.5
4	17.2	82.8	72.6	27.4	3.0	97.0	80.0	20.0
5	72.0	28.0	84.0	16.0	7.6	92.4	57.7	42.3
6	6.2	93.8	18.6	81.4	2.4	97.6	11.6	88.4
7	0.2	99.8	7.4	92.6	53.8	46.2	4.0	96.0
8	1.2	98.8	4.1	95.9	1.7	98.3	58.2	41.8

DRY-WET SEASON

MAY1996				
ST	CLAY	SILT	MUD	SAND
1	48.3	31.1	79.4	20.6
2	-	2.6	2.6	97.4
3	-	-	-	-
4	-	11.1	11.10	88.9
5	-	-	-	-
6	-	13.5	13.5	86.5
7	-	5.7	5.7	94.3
8	-	3.5	3.5	96.5

APRIL 1997			
CLAY	SILT	MUD	SAND
-	9.5	9.5	90.5
-	10.5	10.5	89.5
-	4.3	4.3	95.7
58.4	20.2	78.6	21.4
-	12.1	12.1	87.9
-	12.7	12.7	87.3
-	7.8	7.8	92.2
-	9.7	9.7	90.3

MAY1997			
CLAY	SILT	MUD	SAND
-	14.5	14.5	85.5
11.5	31.9	43.4	56.6
-	8.5	8.5	91.5
24.6	49.4	74.0	26.0
19.0	19.7	38.7	61.3
-	16.6	16.6	83.4
-	14.8	14.8	85.2
-	0.6	0.6	99.4

WET – DRY SEASON.

DECEMBER 1996				
STATIONS	CLAY	SILT	MUD	SAND
1	-	3.0	3.0	97.0
2	-	4.4	4.4	95.4
3	-	22.6	22.6	77.4
4	27.5	56.7	84.2	15.8
5	- -	6.5	6.5	93.5
6	-	9.8	9.8	90.2
7	-	5.2	5.2	94.8
8	9.2	31.0	40.2	59.8

DECEMBER 1997			
CLAY	SILT	MUD	SAND
6.4	34.8	41.2	58.8
-	6.8	6.8	93.2
-	22.1	22.1	77.9
-	8.1	8.1	91.8
72.4	24.2	96.6	3.4
-	17.2	17.2	82.8
-	2.8	2.8	97.2
-	4.9	4.9	95.1

Dry Season

FEBRUARY 1996					FEBRUARY 1997			
STATIONS	CLAY	SILT	MUD	SAND	CLAY	SILT	MUD	SAND
1	-	9.3	9.3	90.3	-	4.2	4.2	95.8
2	-	13.4	13.4	86.6	-	13.1	13.1	86.9
3	21.0	53.0	74.0	26.0	9.0	36.6	45.6	54.4
4	-	17.2	17.2	82.8	21.3	51.3	72.6	27.4
5	30.7	41.3	72.0	28.2	43.3	40.7	84.0	16.00
6	-	6.2	6.2	93.8	-	18.6	18.6	81.4
7	-	0.2	0.2	99.8	-	7.4	7.4	92.6
8	-	1.2	1.2	98.8	-	4.1	4.1	95.9

Rainy Season.

JULY 1996					JULY 1997			
STATIONS	CLAY	SILT	MUD	SAND	CLAY	SILT	MUD	SAND
1	26.0	36.0	62.0	38.0	13.6	50.2	50.2	49.8
2	-	4.6	4.6	95.4	-	7.9	7.9	92.1
3	-	11.7	11.7	88.3	-	5.5	5.5	94.5
4	-	3.0	3.0	97.0	31.2	48.8	80.0	20.0
5	-	7.6	7.6	92.4	8.4	40.9	57.7	42.3
6	-	2.4	2.4	97.6	-	11.6	11.6	88.4
7	26.8	27.0	53.8	46.2	-	4.0	4.0	96.0
8	-	1.7	1.7	98.3	18.8	39.4	58.2	41.8

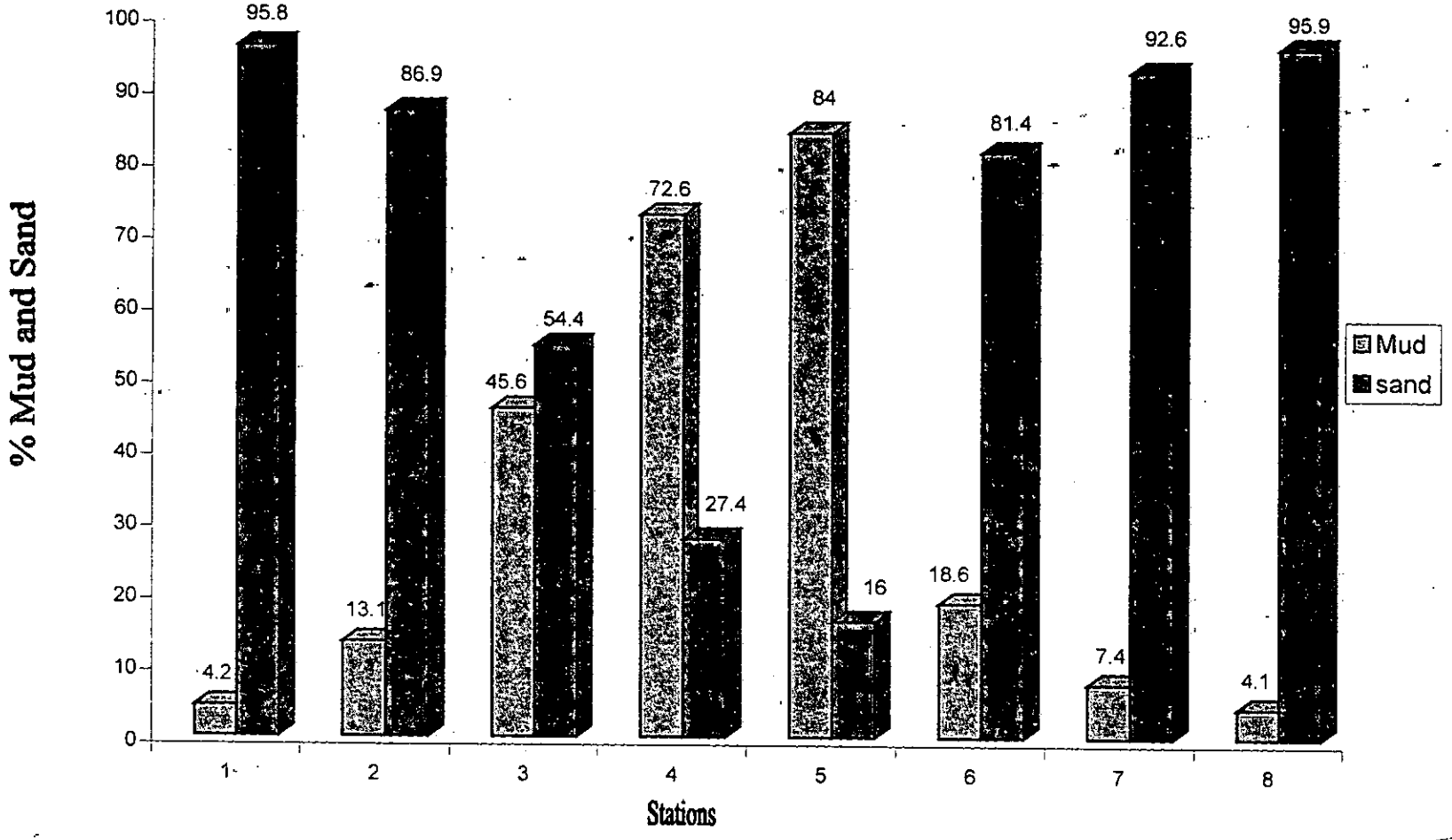

Fig 13. Percentage mud and sand at sampling stations in the western part of Lagos lagoon. (Dry season. February 1998).

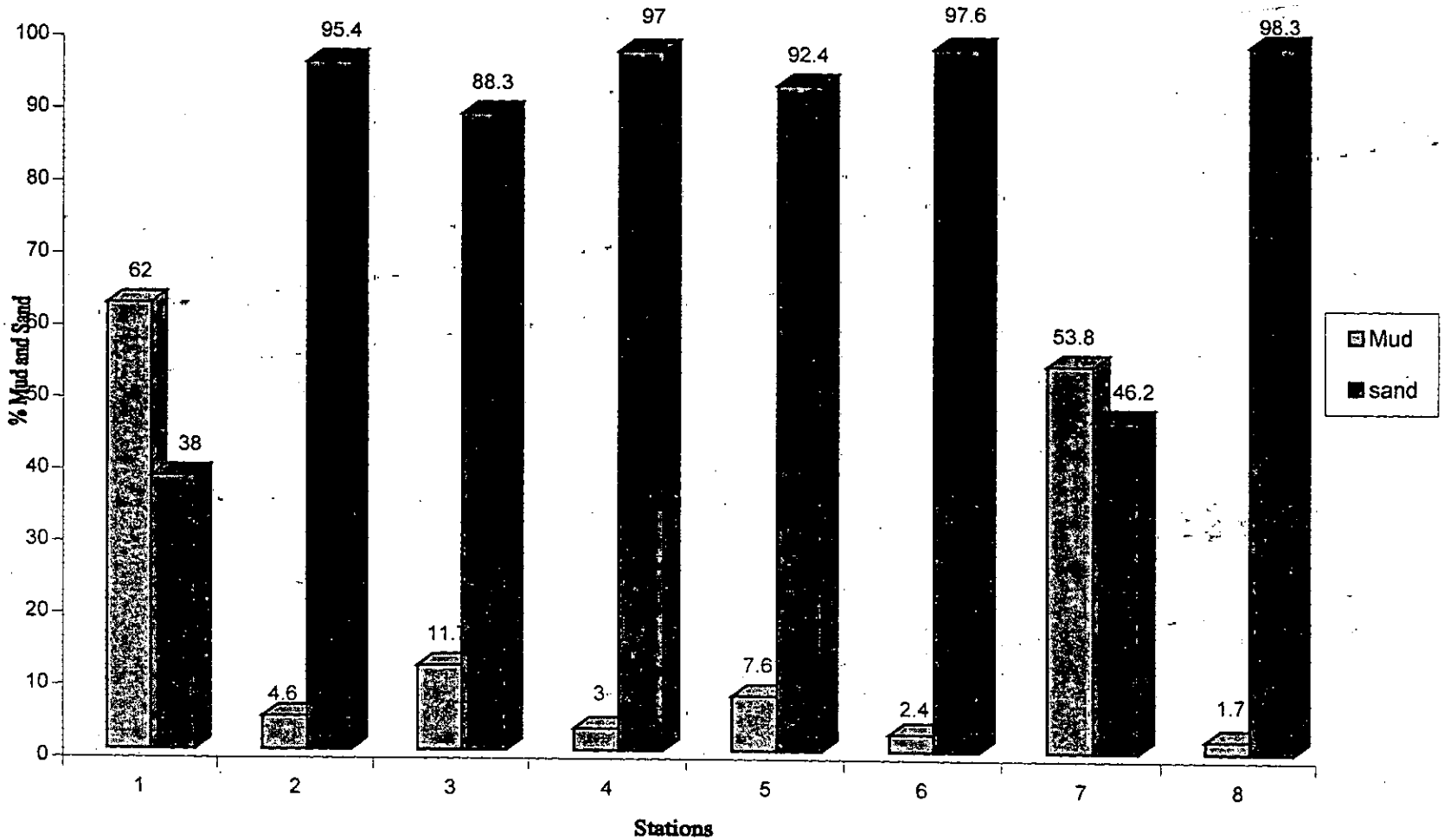

Fig.14: Percentage mud and sand at sampling stations in the western part of Lagos Lagoon(wet season, July 1996)

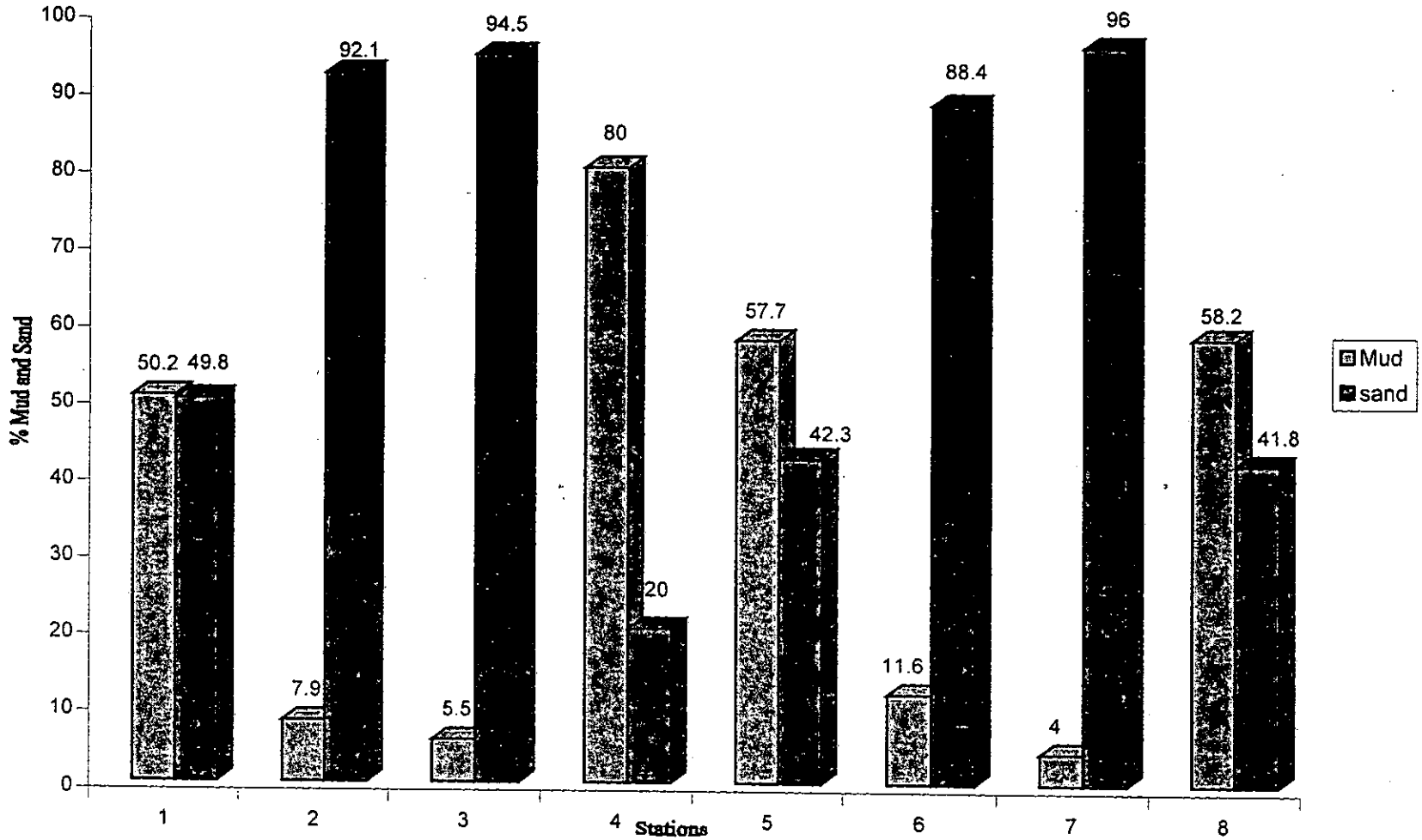

Fig. 15: Percentage mud and sand at sampling stations in the western part of Lagos Lagoon (wet season, July 1997)

Station 5 (Ogun River)

At River Ogun sandy sediment with percentage between 61.3% and 93.5% were collected in June 1996 1997, July 1996, May 1997, December 1996 and April 1997. Muddy sediment occurred in July 1997 (57.7%), February 1997 (72.0%), February 1998 (84%) and December 1997 (96.6%) (Table 13, Fig. 11).

Station 6 (Oworonsoki)

Oworonsoki comprised of sandy sediment, throughout the sampling period. The sediment was shelly sand. Sand ranged between 82.8 and 97.6%, while percentage mud ranged between 2.40% (July 1996) and 18.60% (February 1998) (Fig. 11, Table 13).

Station 7 (University of Lagos lagoon Front)

Sediment comprised the sandy type (85.2-99.8) on all sampling dates except July 1996, where sediment comprised of 46.2% sand and 53.8% mud (Table 13, Fig. 11).

Station 8 (Ikoyi)

Muddy sediment was collected in July 1997 (58.20%). Sandy sediment was collected on all other sampling dates and ranged between 59.8 and 99.4%.

Sediment type changed from one season to the next, and from one station to the other. These results showed the Lagos lagoon and surrounding river, creek beds comprised of an unstable, dynamic ecosystem. Sediment in the dry season (February 1997) comprised of sandy sediment at stations 1, 2, 4, 6, 7 and 8. Stations 3 and 5 comprised 26.0% and 28.0% sand each, and were muddy (Fig. 12, Table 14).

In February 1998 (Fig. 13) sandy sediment occurred at stations 1, 2, 3, 4, 7 and 8. The station with the highest percentage sediment sand 95.9% was st. 8, followed by st. 1 (95.8% sand). Station 4 had 72.6% mud and station 70.2% mud.

In the wet season of 1996 muddy sediment occurred at st. 1 (62.0%) and st. 7 (53.8%). The other stations had sandy sediment ranging between 88.3% (st. 3) and 98.3% (st. 8) (Fig. 14 and Table 14).

In comparism sand and mud proportions were similar (50.2% mud and 49.8% sand) in July 1997 (Fig. 15). Also stations 4 and 5 had muddy sediments (80.0% and 57.7% each respectively) which were absent in July 1996. St. 7 also had a sandy sediment in July 1997 (96.0% sand) and station 8 had 58.2% sand and 41.8% mud.

BENTHIC FAUNA

A checklist of benthic fauna collected at the eight stations, between May 1996 and February 1998 is shown in Table 15. Eleven phyla, sixteen classes 62 families, 125 species and 20,730 individuals were collected. They comprised 41.60% Annelida, 24.00% Mollusca, 22.40% Arthropoda, and 2.40% of Nemertina.The chordata contributed 3.20% of the total phyla only. (Table 16).

The *Pachymelania* community described by Oyenekan (1975) was collected with variations, which occurred due to salinity as well as sediment changes. Macrobenthic fauna belonged to three ecological groups based on the salinity of the lagoon.

A. ECOLOGICAL GROUPS OF BENTHIC FAUNA

i. Euryhaline group

Euryhaline fauna were present in the lagoon throughout the year. These consisted of 55 species (44%) of benthos collected. The prominent euryhaline species were *Cerebratulus* sp., *Eurythoe complanata, Glycera longipinnis, Goniada emerita, Ophiodromus spinosus, Nephtys dibranchis, Nereis agulhana, Nereis granulata, Dendronereis arboritera, Playnereis dumerilli, Schroederella pauliani, Capitella capitata, Notomastus aberans, N. latericeus, Maldane sarsi, Mercierella enigmatica, Serpula*

TABLE 15: BENTHOS COLLECTED AT THE EIGHT STATIONS IN WESTERN PART OF LAGOS LAGOON (MAY 1996 – FEBRUARY 1998).

	DRY SEASON NDJFMA	RAINY SEASON MJJASO
PHYLUM PORIFERA		
Class Demospongiae		
Axinella Lunaexcharta	1	-
PHYLUM NEMERTINA/RHYCHOCOELA		
Unidentified Nemertina	2	11
Nemertea sp.	5	-
Cerebratulus sp.	8	1
PHYLUM ANNELIDA		
Class Polychaeta		
Subclass Errantia(free-moving)		
Amphinomidae. Savigny.		
Eurythoe sp	-	46
E. Complanata	28	18
Eunicidae. Savigny.		
Eunice sp.	-	3
Glyceridae .Savigny.		
Glycera sp	10	1
G. longipinnis Grube.	23	2
G. Convoluta Kefertein.	-	2
Goniada emerita	4	1
Hesionidae		
O. phidromus spinosus (Ehlers).	3	3
O. phidromus sp.	2	-

Lospilidae		
Phalacrophorus sp		
Nephtyidae. Grube..	1	-
Nephtys sp .Cuvier.		
Nephtys caeca. (O.F.Muller)	1	2
Nephtys dibranchis Grube.	-	4
Nereidae. Johnson.	17	27
Nereis.sp . Linnaeus.		
N.agulhana. Day.	129	148
N. granulata	24	68
Dendronereis arborifera Peters.	37	32
D. zululandica	22	27
Playnereis dumerilli Audouin & Milne Edwards.	1	-
Playnereis calodonta	6	48
Orbiniidae.	-	1
Schr ederella paulianii Laubier.		
Orbinia sp	17	13
Syllidae	1	4
Exogone sp		
Syllis sp	-	2
Unidentified syllidae	2	5
	1	1
Subclass Sedentaria.(Tube dwellers).		
Ampharetidae		
Melinna cristata (Sars).	3	-
Mellina monoceroides	-	2
Unidentified Ampharetidae	1	-

Capitellidae. Grube.	1	-
Capitella capitata (Fabricius).	13	17
Capitella sp	25	32
Notomasstus aberans Day.	4	2
N. latericeus. Sars.	52	80
Notomastus sp	2	-
Pulliella armata . Fauvel.	-	22
Dasybranchus bipartilus	-	22
Magelonidae.		
Magelona papillicornis	1	-
Magelona sp	2	-
Maldanidae. Malmgren.		
Maldane sp	16	8
Maldane sarsi Malmgren.	3	9
Lumbriclyme sp Arwidsson.	-	2
Asychis capensis. Day.	-	1
Sabellidae. Malmgren.		
Sabella sp. Linnaeus.	2	1
Serpullidae.		
Hydroides sp.	-	1
Mercierella enigmatica. Fauvel.	350	259
Serpula vermicubulus	15	21
Serpula sp.	14	-
Terebellidae		
Pista quardrilobata	-	12
Spionidae. Grube.		
Unidentified spinoidae	3	-
Polydora capensis	5	-
Polydora armata	2	-
Terebella pterochaeta	1	-

Class Oligochaeta.		
Tubificidae.		
Tubifex sp	5	12
Naididae		
Dero sp	-	1
PHYLUM POGONOPHORA		
Unidentified Pogonophora	3	8
PHYLUM ECHIUROIDEA		
Pinuca sp	1	-
Echiurus echurus. (Pallas).	-	6
PHYLUM SIPUNCULOIDEA		
Phascolion sp	1	-
Sipunculus sp	4	-
Cerebratulus sp	4	-
PHYLUM MOLUSCA		
Class Gastropoda.		
Order Archaeogastropoda.		
Neritidae.		
Nerita senegalensis. Gmelin.	6	2
Neritina glabrata. Sowerby.	847	1207

Order Mesogastropoda.		
Melaniidae.		
Pachymelania aurita. (Muller).	1441	1892
P. fusca (Gmelin) var *quadriseriata* Gray.	824	673
Potamididae.		
Tympanotonus fuscatus.(L).	1253	395
Naticidae		
Natica fuliminea.(Gmelin).	2	-
Melita nitida	7	-
Order Nudibranchia.		
Unndentified Nudibranchia	-	1
Class Bivalvia / Lamellibranchia.		
Arcidae.		
Anadara senilis. (L).	2	-
Mytitlidae		
Mytilus edulis. Linnaeus.	117	55
Mytilus perna	-	1
Ostreidae.		
Crassostrea gasar. Dautzenberg.	33	322
Ungulinidae.		
Unguilina alba. Rang.	1	-
Veneridae.		
Dosinia isocardia. (Dunker).	11	-
Venus sp	4	-
Mactridae		
Mactra glabrata. Linne(=Lelisor Adanson).	2	2

Donacidae		
Donax rugosus. Linne(=Le Pamet Adanson).	52	10
Iphigenia truncata .(Von Martens).	97	79
T. rostrata. Roemer.	10	17
Egeria radiata. (Lamarck).	46	31
Psammobiidae.		
Tagelus angulatus. (Sowerby).	-	3
Tellinidae.		
Macoma cumana. (O.G.Costa).	56	177
Tellina sp	8	-
T. nymphalis. Lamarck.	191	210
Aloididae.		
Aloidis sulcata .(Lamarck).	3	111
A. Trigona (Hinds).	4153	3662
A. dautzenbergi.(Lamy).	55	8
A.striatissima. (Lamy).	-	1
Ungulinidae.		
Diplodonta diahpama. (Gmelin).	-	1
PHYLUM ARTHROPODA		
Class Crustacea.		
Subclass Cirripedia.		
Balanus pallidus.(Darwin).	319	201
Subclass Malacostraca.		
Mysidacea.		
Mysis sp.	-	5
Subclass Isopoda.		
Unidentified Isopoda	3	4
Cyathura sp	4	-
Asellus sp	1	1

Subclass Amphipoda.		
Undentified Amphipoda	-	8
Eusirus cuspidsitus	-	1
Colomastigidae		
Colomastrix sp	7	4
Gammaridea.		
Gammanus sp	2	4
Subclass Decapoda.		
Penaeidae		
Penaeus duorarum. Burkenroud.	1	-
P. notialis. Perez-Fanfante.	2	-
Sphaerana quadridentatum	-	4
Paguroidea.		
Clibinarius africanus. Orivillius.	40	56
Callianasidae.		
Callianassa sp.	1	-
Grapsidae		
Sersama huzardi. (Desm.).	5	8
Ocypodidae.		
Uca tangeri. (Eudoux).	2	-
Gecarcinidae.		
Cardiosoma armatum. (Herklots).	-	6
Goniopsis sp	-	1
Xanthidae..		
Mennippe nodifrons. Stimpson.	7	5
Ocypodidae.		
Ocypoda sp.	-	4
Geryonidae.		
Geryon maritae. Manning & Holthuis.	-	1

Callinectes sp	1	7
Class Insecta.		
Subclass Diptera.		
Chironomidae.	11	40
Chironomous sp	-	1
Unidentified dipteran larvae	1	-
Tabanus trimaculatus. (pupa).		
PHYLUM ECHINODERMATA.		
Class Holothuroidea.		
Cucumaria sp	-	1
PHYLUM HEMICHRODATA		
Class Enteropneusta.		
Saccogolossus kowalerskii	-	1
PHYLUM CHORDATA.		
Subphylum Urochordata.		
Class Ascidiacea.		
Unidentified ascidian	1	-
Subphylum Vertebrata.		
Class Osteichthyes.		
Infraclass Teleostei.		
Anguilla anguilla. (Linnaeus).	1	-
Cynoponticus ferox.	1	-
Subphylum Protochordata.		
Branchiostoma nigeriensis. Webb..	2	-

Table 16: Abundance of different types of benthic macro-invertebrates from eight stations in Lagos Lagoon.

PHYLA	CLASSES	FAMILIES	SPECIES	%
Porifera	1	1	1	0.81
Nemertina	1	1	3	2.41
Annelida	2	19	53	42.74
Pogonophora	1	1	1	0.81
Echiurodea	1	1	2	1.61
Sipunculoidea	1	1	3	2.42
Mollusca	2	16	30	24.20
Arthropoda	2	16	25	20.16
Echinodermata	1	1	1	0.81
Hemichordata	1	1	1	0.81
Chordata	3	4	4	3.22
TOTAL	16	62	124	100.00

vermicubulus, fresh water *Tubifex* sp. Euryhaline organisms in phylum Arthropoda included *Balanus pallidus*, unidentified Isopoda, *Asellus* sp., *Colomastix* sp., *Gammarus* sp. *Clibinarius africanus, Sersama huzardi, Mennippe nodifrons, Callinectes* sp. and *Chironomus* sp. Unidentified Pogonophora represented phylum Pogonophora, which were euryhaline. In the phylum Mollusca, *Nerita senegalensis, Neritina glabrata, Pachymelania aurita, P. fusca* var. *quadriseriata, Tympanotonus fuscatus, Mytilus edulis, Crassostrea gazar, Mactra glabrata, Donax rugosus, Iphigenia truncata, I. rostrata, Egeria radiata, Macoma cumana, I. hymphalis, Aloidis sulcata, A. trigona* and *A. dautzenbergi* were euryhaline (Table 15).

ii. Dry Season Benthic Fauna

Animals occurring during the dry season, when the salinity of the lagoon was high, 6-26$^{0}/_{00}$ (Nov.-April) comprised 36 species. These were *Axinella lunaecharta* (Phylum Porifera). *Nemertina* sp. (phylum Nemertina). *Ophiodromus* sp., *Phalacrophorus* sp., *Dendronereis zululandica*, unidentified nereidae, *Melinna cristata*, unidentified Ampharetidae, *Notomastus* sp., *Magelona papillicornis*, *Magelona* sp. *Serpula* sp. unidentified spionidae, *Polydora capensis*, *Polydora armata, Terebella pterochaeta* (Phylum Annelida). In phylum Arthropoda *Cyathura* sp., *Colomastrx halichondraie, Melita nitida, P. notialis, Callianassa* sp., *Uca tangeri* and *Tabanus trimaculatus* represented dry season species, while

Pinuca sp. (Echiuroidea) contributed to the dry season samples along side *Phascolion* sp. *Spunculus* sp. and *Golfingia* sp. (Phylum sipunculoidea). Phylum mollusca had dry season species also, these included *Natica fuliminea, Anadara senilis, Ungulina alba, Dosinia isocardia, Venus* sp. and *Tellina* sp. The only protochordata (*Branchiostoma nigeriense*) was collected during the dry season. Similarly,other members of the phylum chordata were collected only in the dry season. They were unidentified ascidian, *Anguilla anguilla* and *Cynoponticus ferox* (Table 15).

iii. Wet Season Benthos

Benthos recorded during the rainy season when salinity was very low 0-0.5% (May-October), comprised 36 species. This group included *Eurythoe* sp., *Eunice* sp., *Glycera convoluta, Nepthys caeca,* unidentified *Nepthys, Nereis succinea, Ptaynereis calodonta, Exogone* sp., *Melinna monoceroides, Pulliela armata, Dasybranchus bipartus, Lumbrichymene* sp., *Ayschis capensis, Hydroides* sp., *Pista quadrilobata, Polydora* sp., and *Dero* sp. (Phylum Annelida). *Mysis* sp., unidentified Amphipoda, *Eusinus cuspidsitus, Sphaerana quadridentatum, Cardiosoma armatum, Goniopsis* sp., *Ocypoda* sp., *Geryon maritae* and unidentified dipteran larvae (Phylum Arthropoda). *Echiurus echiiurus* represented phylum Echiuroidea in the wet season, while *Cerebratulus* represented phylum Nemertina. Phylum Mollusca was represented by *T. fuscatus* var. *radula,* unidentified

Nudibranchia, *Mytilus perna, Tagelus cumana, Aloidis striatissima, Diplodonta diaphana* in the wet season. The only specimen collected in phylum Echinodermata was *Cucumana* sp. The representative of phylum Hemichordata (*Saccoglossus kawalerskii*) was also present in the wet season (Table 15).

B. TEMPORAL VARIATION IN INDIVIDUALS AND SPECIES

The occurrence of individuals ranged between 442 and 2275 per month. There was no seasonal pattern in temporal variation of individuals (Table 17). In 1996 the highest number of individuals (821), occurred in November, and 763 in July. In 1997, 2275 individuals were collected in September, and 1694 in July. The pattern changed in 1998, as 1772 individuals were collected in January and 1773 in February when sampling ended.

High numbers of species occurred in January 1997 (33), August 1996 and October 1997 (34 each). In July 1997 and February 1998, 35 species were collected on each sampling date. A total of 41 species were collected in January 1998. This was the peak of species collected during the sampling period, another high peak in number of species occurred in January 1997 when 33 species were collected. These annual rises in number of species suggest a cyclic phenomenom (Table 17).

Table 17: Total Numbers of species and individuals collected at 8 stations in western part of Lagos lagoon in wet and dry seasons (May 1996 – February 1998).

	1996								1997												1998		
MONTHS	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	Total
Species	24	15	32	34	22	24	26	28	33	24	-	23	39	27	35	-	30	34	30	31	41	35	
Individual	500	531	763	442	453	522	821	684	1168	961	-	726	1047	949	1694	-	2275	1053	1149	1490	1772	1773	20,730

C. SPATIAL DISTRIBUTION IN SPECIES AND INDIVIDUALS.

Total species collected in both dry and wet seasons were lower (38), at the University of Lagos lagoon front, (st. 6), than at any other station (Fig. 16). At Ikorodu (st. 2) 68 species were collected while at Ikoyi (st. 8) 40 species were collected. In the dry season (Fig. 17) species ranged between 21 at University of Lagos lagoon front (st. 7) and 44 at Ikorodu (st. 2). During the wet season species per station were lowest (26) at Ikoyi (st. 8) and the highest 56, were collected from Majidun creek (st. 2) (Fig. 18).

Species absent from this study but collected in previous work included *Cultellus tenuis, Diapatra neapolitana, Sagitta* sp., *Bachyodontes puniceus, B. niger, Phoronis muelleri, Prionspio* sp., *Pagurus bernhardus, Caprella linearis, Corophium isidiosum, Lunfer* sp. and the shrimp, *Macrobrachium* sp., while *Eurythoe complanata, Glycera longipinnis, Geniada emerita, Dendronereis arborifera, Playnereis sp., Notomastus* sp., *Egeria radiata, Macoma* sp., *Aloidis dautzenbergi, Gammarus* sp. and *Chronomus* sp. which were absent in earlier studies were collected in the present study.

There was variation in dominant fauna with sediment type; (this indicated that fauna were sediment specific). Temporal variation in faunal abundance varied from station to station. The highest number of individuals collected between May 1996 and February 1998 was at Oworonsoki (st. 6) (4268),

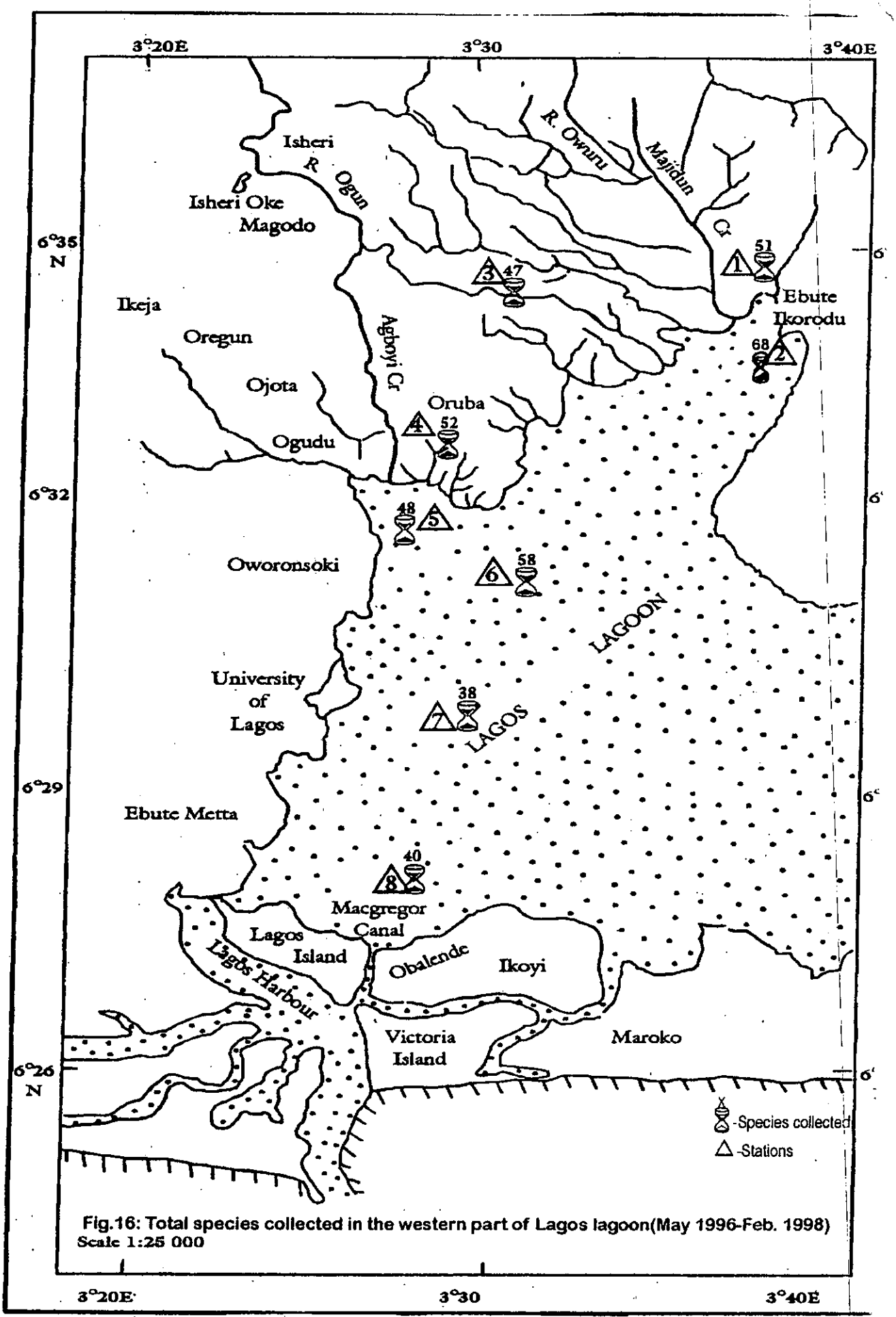

Fig.16: Total species collected in the western part of Lagos lagoon(May 1996-Feb. 1998)
Scale 1:25 000

this was followed by 3184 at Ikorodu (st. 2). These two stations had muddy sand sediment throughout the year. The station with the least faunal density was Ikoyi (st. 8) with 985 individuals.

D. DENSITY OF FAUNA PER STATION

Total density of fauna increased along a salinity gradient between station 8, 7 and 6 (955, 2433, 4373) (Fig. 19). These stations had similar sediment types (muddy sand). Therefore changes occurred were due to salinity differences. The density reduced northward (with reducing salinity) 3917 to 2340 to 1881 and to 1717 between Ogudu (st. 5), Agboyi Creek (st. 4), River Ogun (st. 3) and Majidun creek (st. 1). Total species in the wet and dry seasons (Fig.17) showed that there was no pattern in distribution of species. However, a high density, 68 species was collected at st. 2 (Ikorodu). Total species in the wet season ranged between 26 at st. 8 (Ikoyi) and 56 at st. 2 (Ikorodu) (Fig. 18). Number of species collected in the dry season was lower than those collected in the wet season at all stations except Ogudu (st. 5) and River Ogun (st. 3). At Ogudu 40 species were collected in the dry season and 28 in the wet season. At River Ogun (st.3). 32 species were collected in the dry season and 31 in the wet season. The station with the highest number of species was st. 2 (Ikorodu), while st. 8 (Ikoyi) had the lowest number, 25 species (Fig. 17). Total species, at all stations for 22 months was 91 for the wet season and 93 for dry season months (Fig. 20).

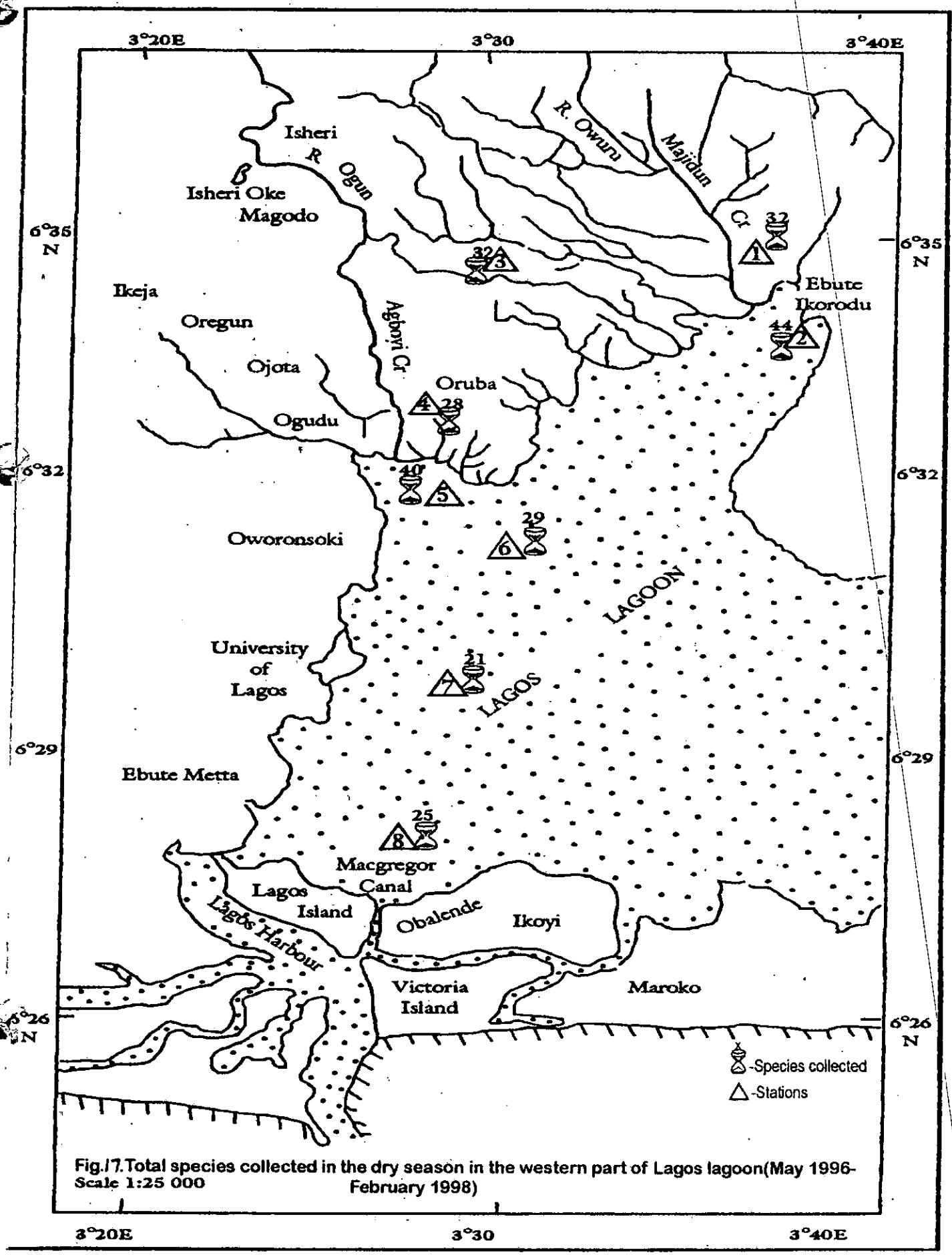

Fig.17.Total species collected in the dry season in the western part of Lagos lagoon(May 1996-February 1998)
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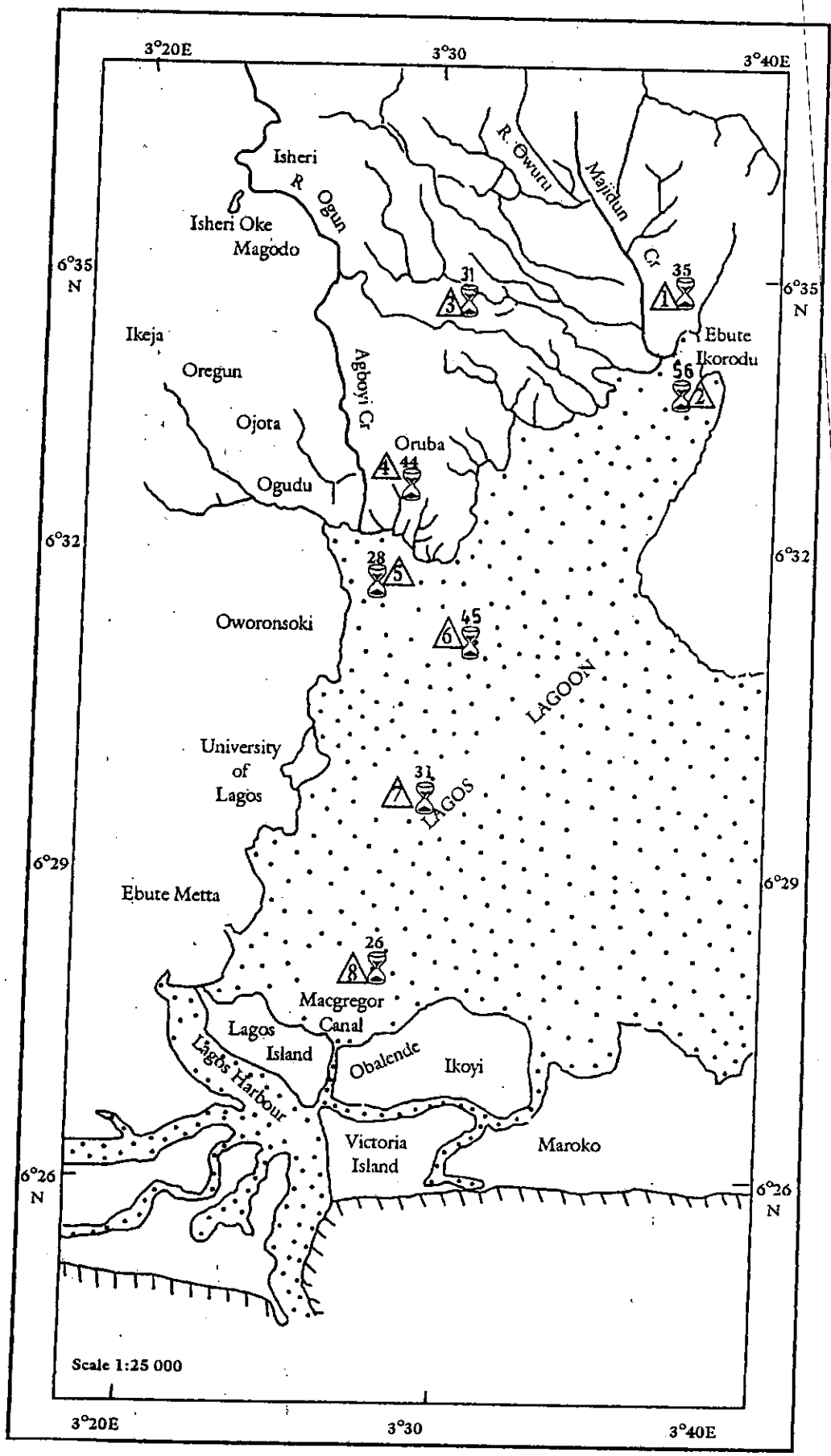

Fig 18. Total species collected in the wet season in western part of Lagos lagoon (May 1996 – February 1998)

⧖ = Species collected

Δ = Station

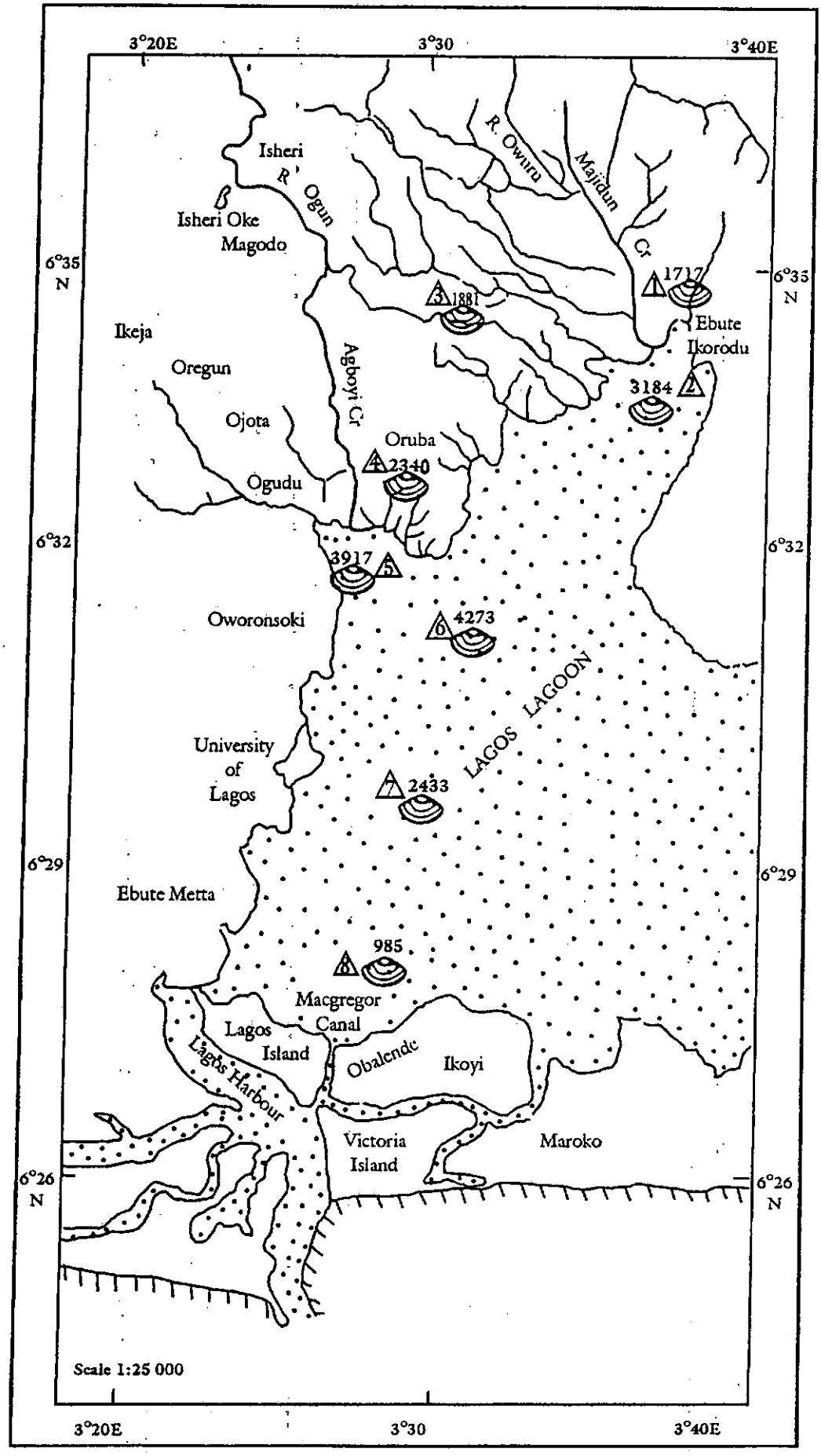

Fig.19. Abundance of fauna per station in the western part of Lagos lagoon (May 1996 - February 1998).

= Abundance of fauna

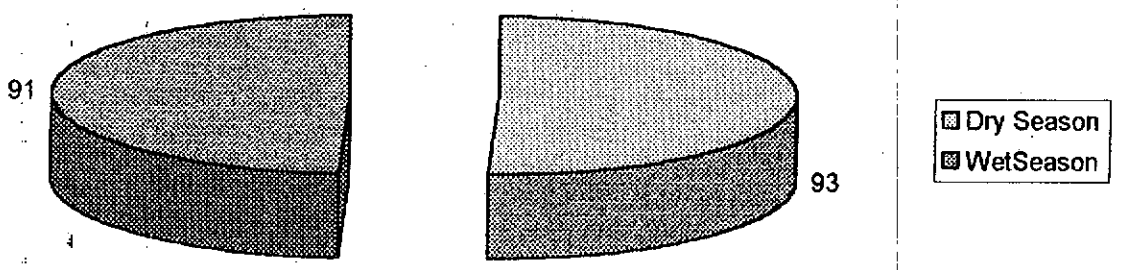

Fig.20.Total number of species collected at sampling stations in dry and wet seasons in the western part of Lagos lagoon (May 1996 - February 1998).

Density of fauna in the wet season at st. 6 (Oworonsoki) was 2841. The lowest density 460 was at st. 8 (Ikoyi) (Fig. 21). In the dry season density of fauna ranged between 525 (st. 8: Ikoyi) and 2011 at st. 5 (Oworonsoki) (Fig. 22). There seemed to be no significant difference (P>0.05) between density of fauna collected between the dry and wet seasons (49% and 51% respectively) (Fig. 23).

Percentage composition of phyla at stations showed that phylum Annelida comprised the highest percentage in both wet and dry seasons (Fig. 24 and Fig. 25).

E. POLLUTION INDICATORS

i. *Capitella capitata*

The pollution indicator *Capitella capitata* occurred in the Lagos lagoon. Higher densities occurred in the wet season than dry season. In the wet season at st. 2 (Ikorodu) 4 annelids were collected, at st. 3 (River Ogun), 12 annelids were collected, at st. 4 (Agboyi creek) 5 annelids were collected and at st. 5 (Ogudu) and st. 6 (Oworonsoki) 2 annelids were collected at st. 2 (Ikorodu), 1 at st. 1 (Majidun creek) 5 individuals of *C. capitata* were collected (Fig. 27). Two individuals were collected at st. 6(Oworonsoki) and st. 5 (Ogudu). The highest density of *C. capitata* occurred at st. 3 (River Ogun) in the wet season, where runoff and river discharge could affect fauna. In the dry and wet seasons there was a gradual decrease in

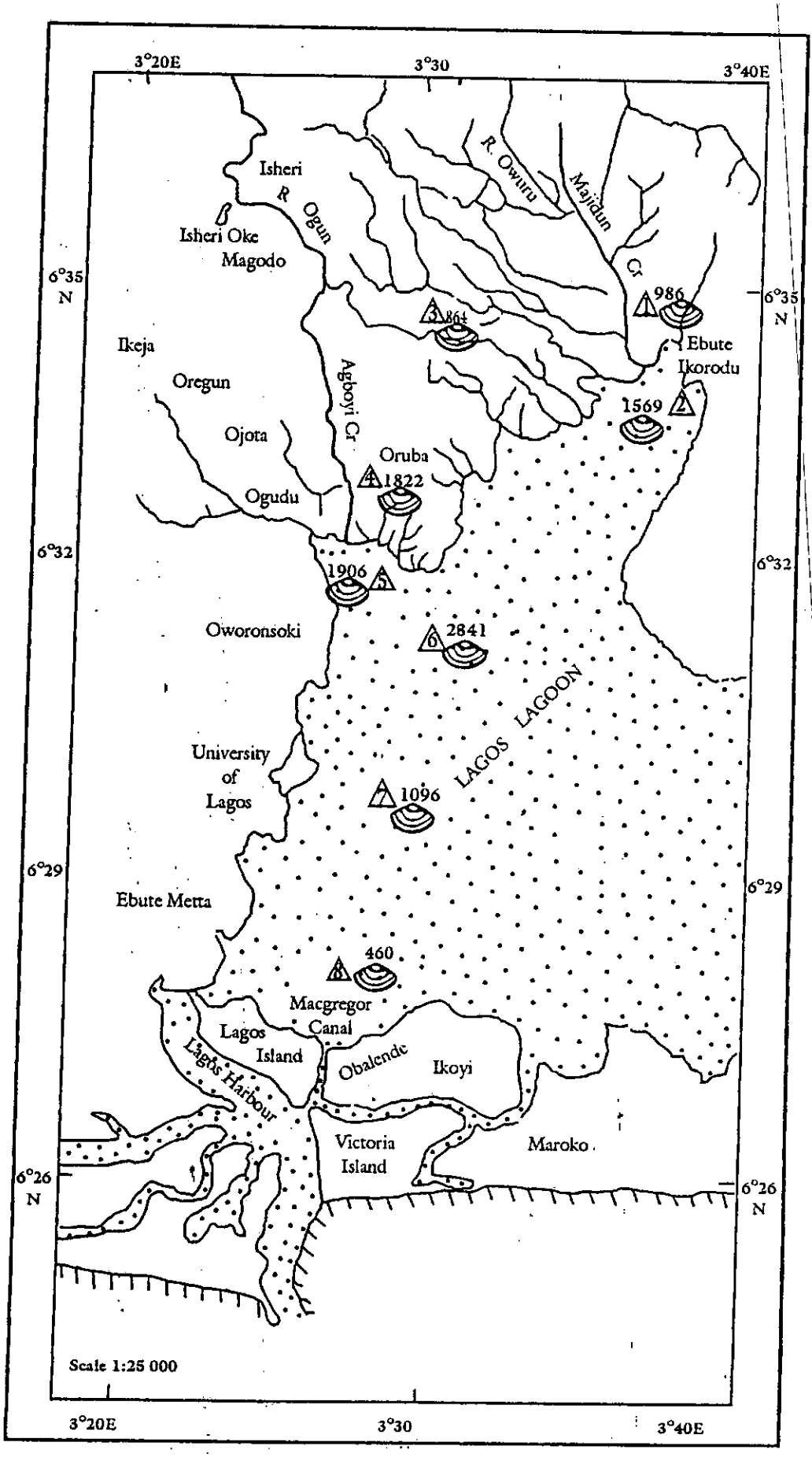

Fig 21. Abundance of fauna collected at the sampling stations in the western part of Lagos Lagoon in the wet season (May 1996 –February 1998).

= Abundance of fauna

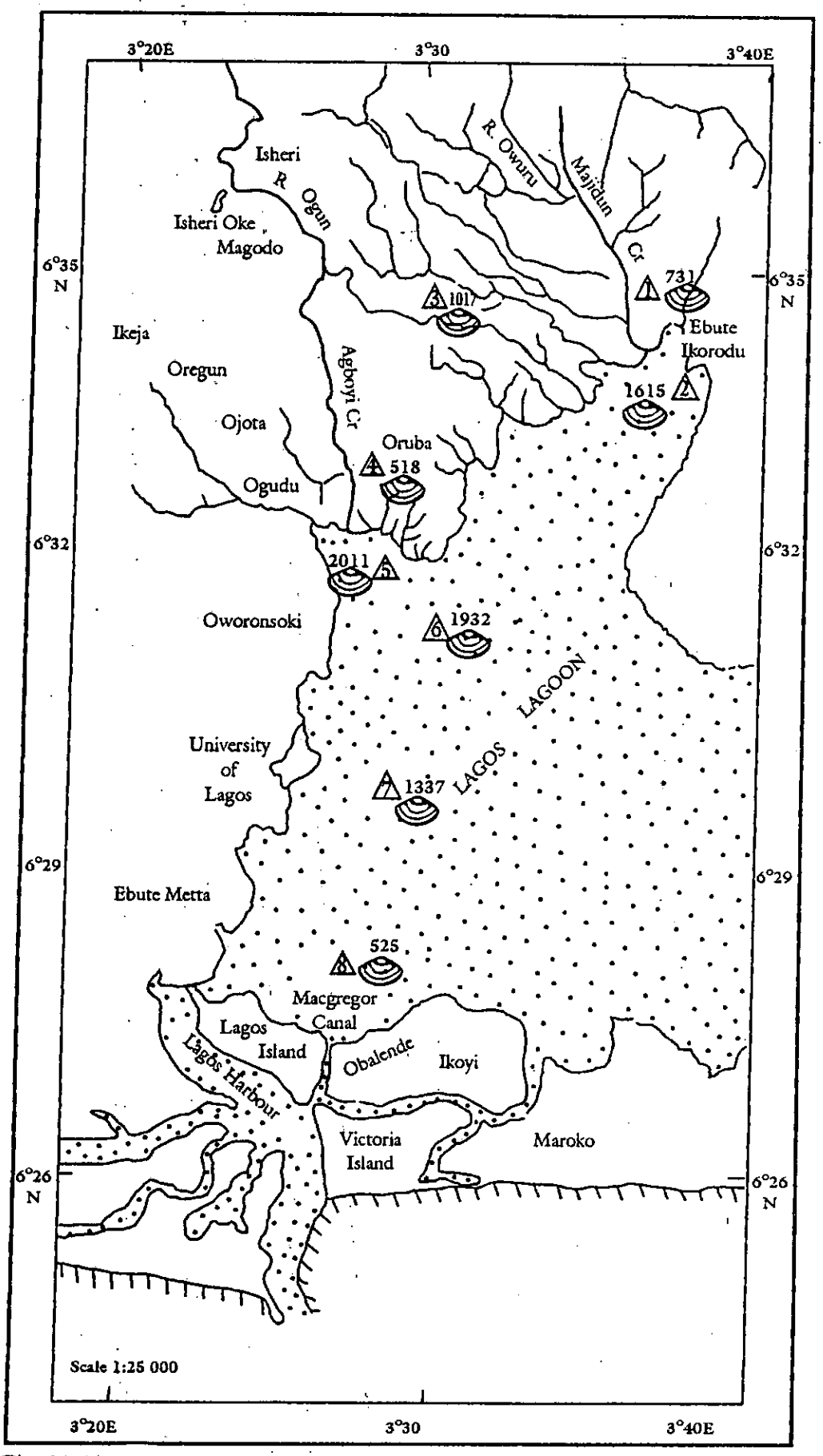

Fig .22. Abundance of fauna collected at the sampling stations in the western part of Lagos lagoon in the dry season.(May 1996- February 1998).

1933 = Abundance of fauna

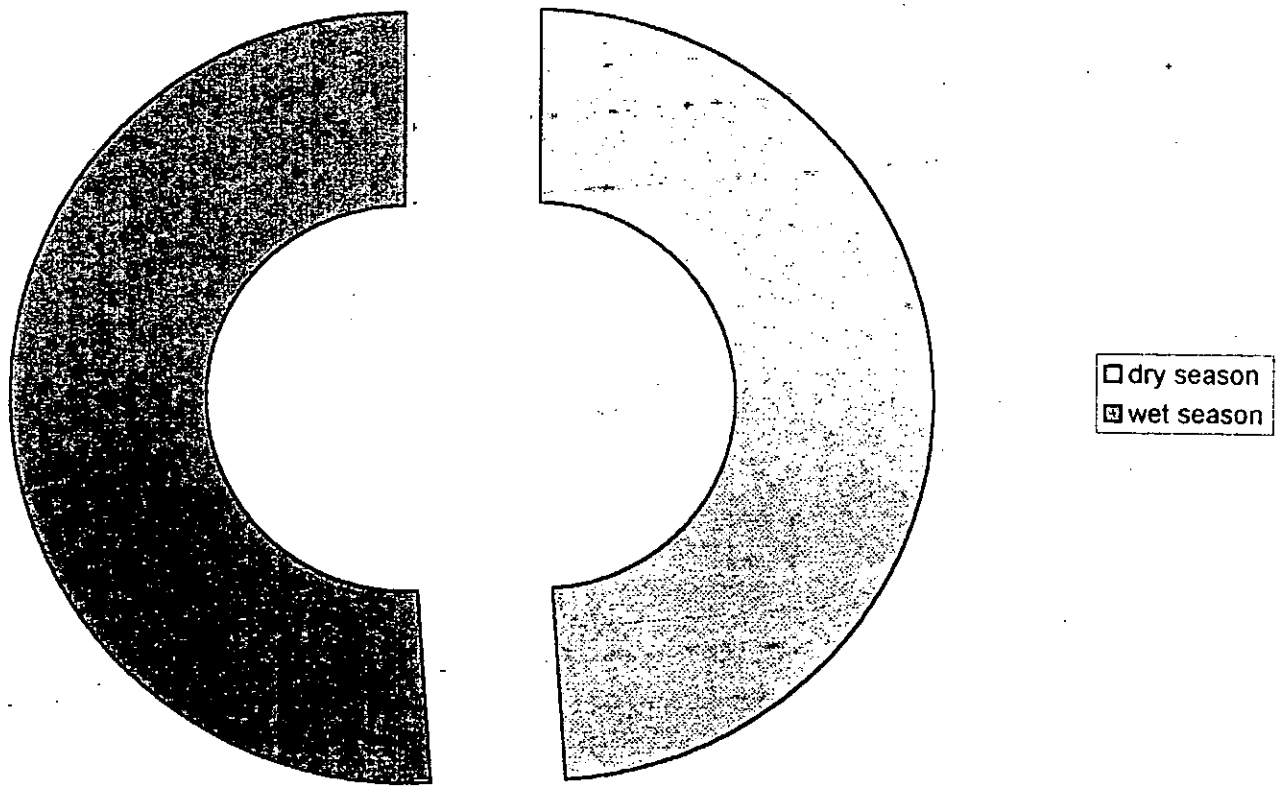

Fig 23. Total number of individuals collected in the dry and wet seasons at the sampling stations in the western part of Lagos lagoon(May 1996-February 1998).

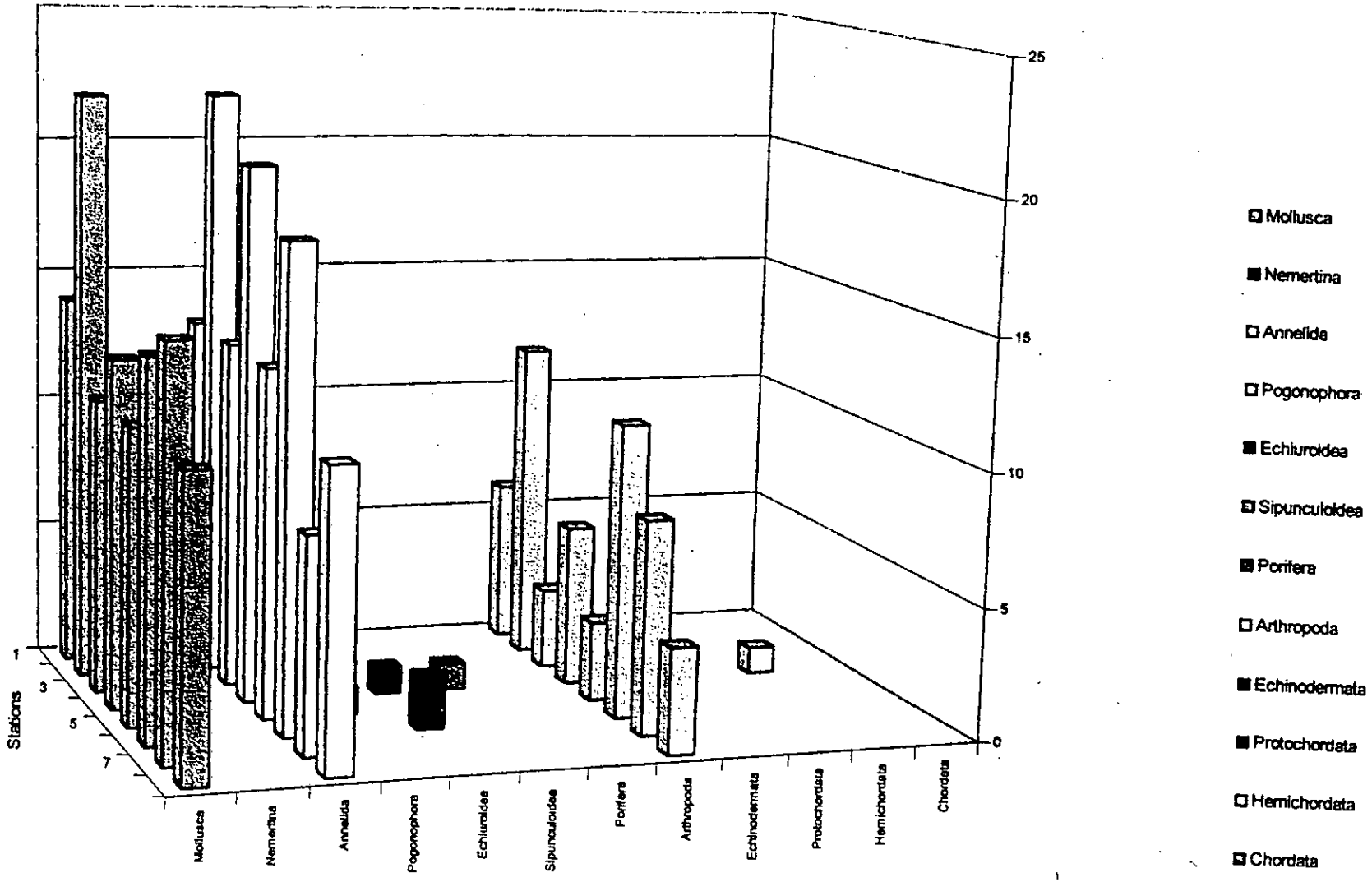

Fig.24. Seasonal diversity of phyla collected at sampling stations in the western part of Lagos lagoon in the wet season

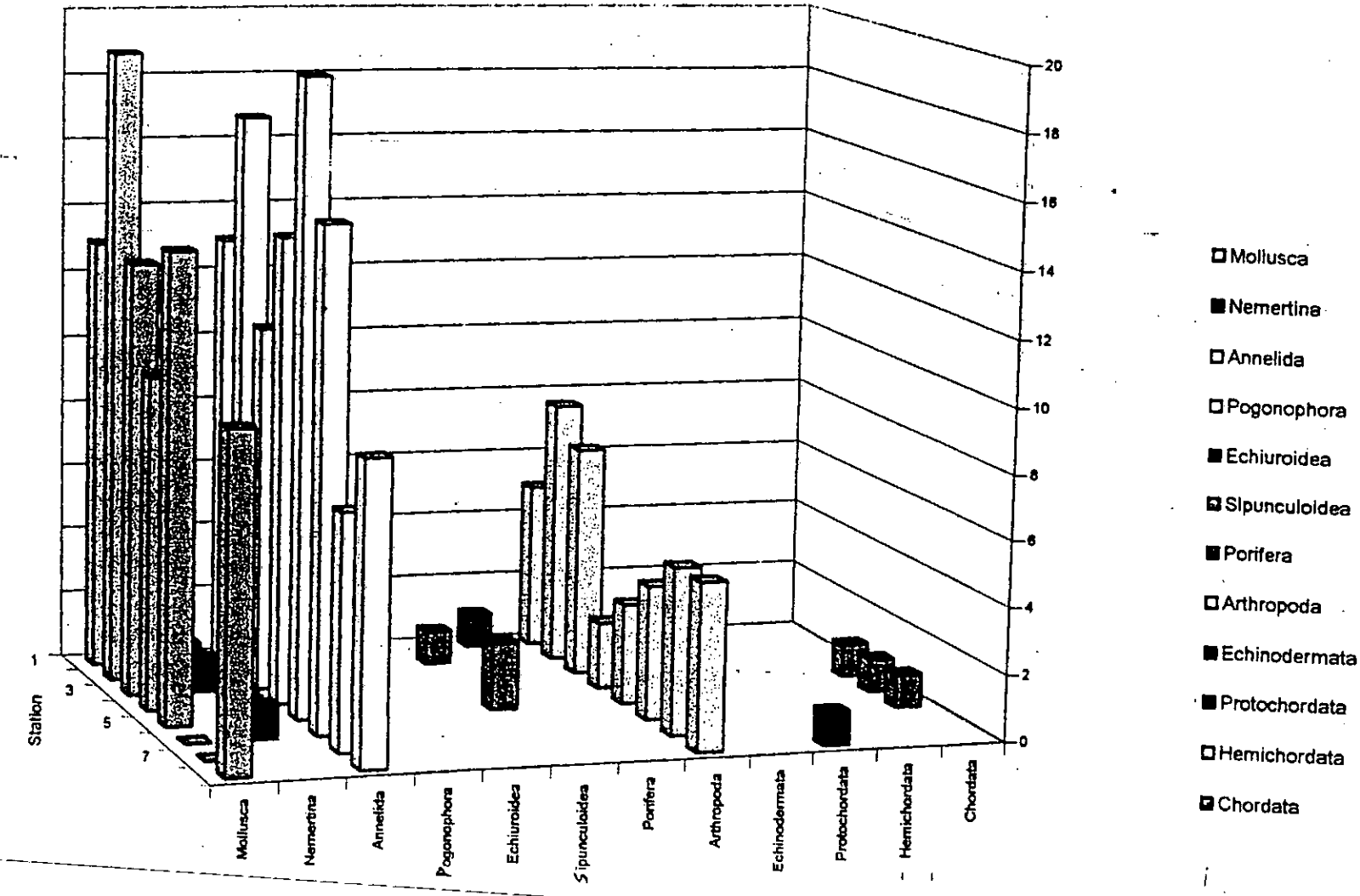

Fig.25.Seasonal diversity of phyla collected at sampling stations in the western part of Lagos lagoon in the dry season

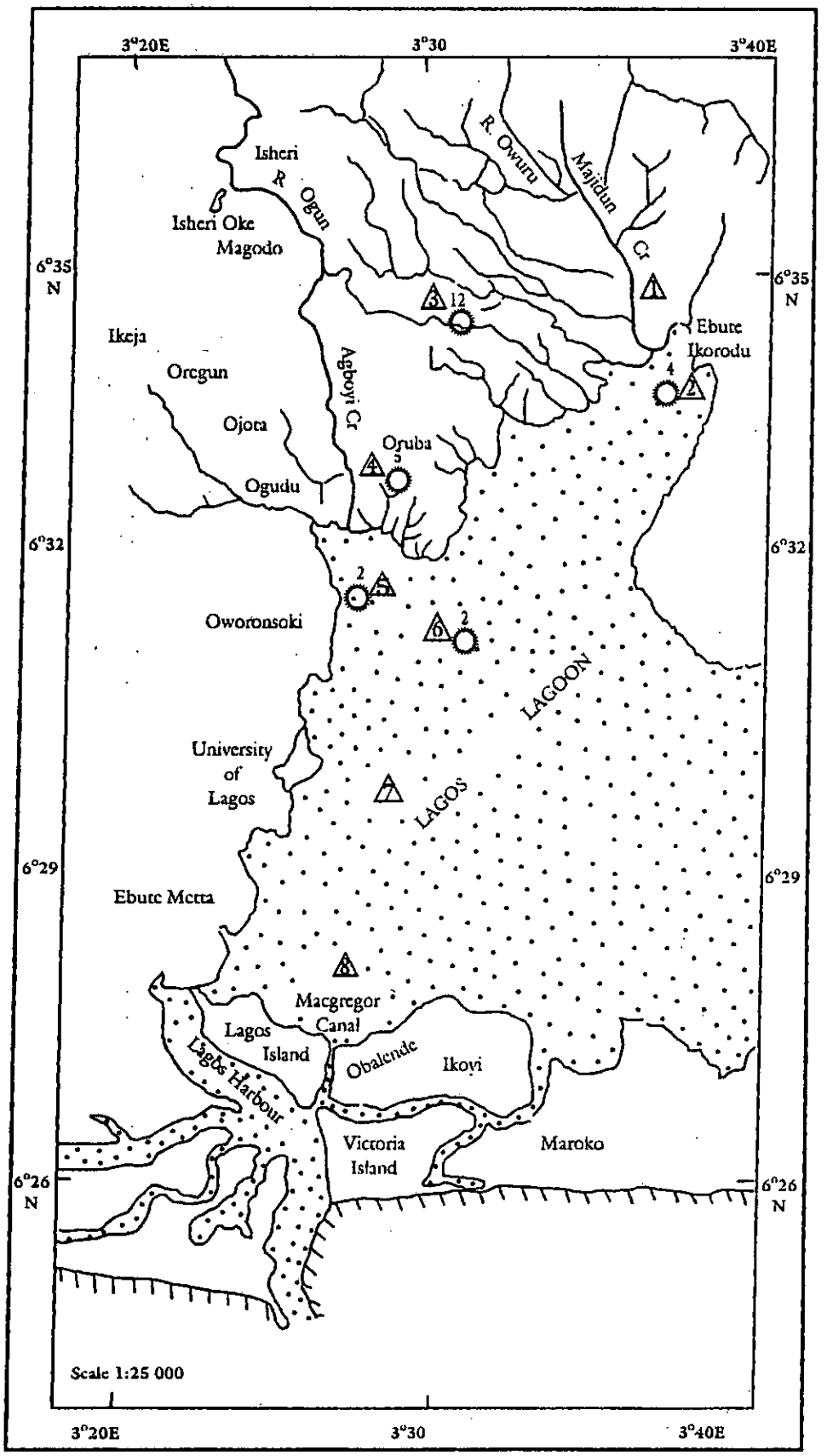

Fig .26. Density of *Capitella capitata* collected at the sampling stations in the western part of Lagos lagoon in the wet season.(May 1996 – February 1998).

X represent number of organism 5

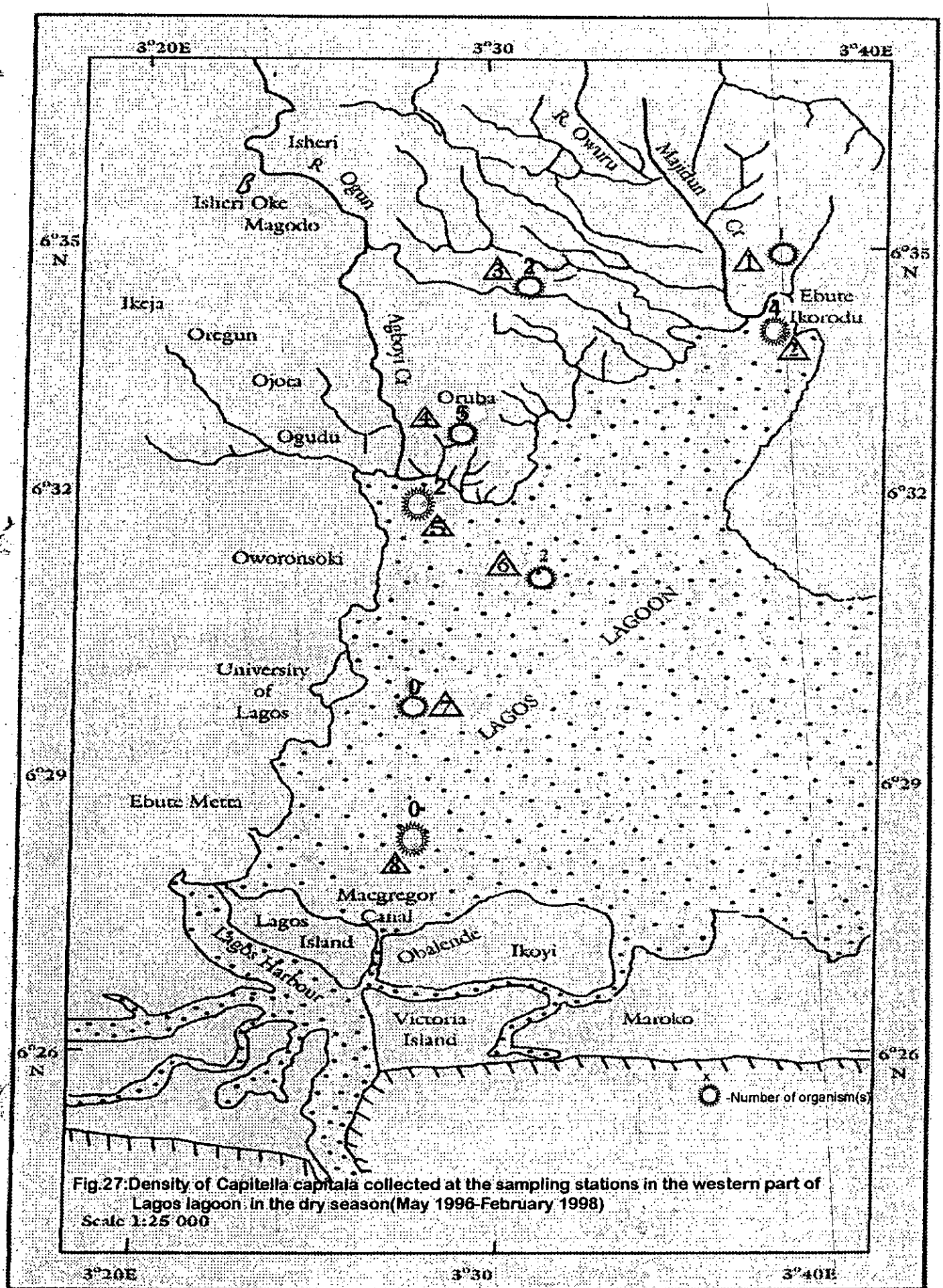

Fig.27:Density of Capitella capitata collected at the sampling stations in the western part of Lagos lagoon in the dry season(May 1996-February 1998)

Scale 1:25 000

this annelid worm from Agboyi creek, Ogudu creek and Oworonsoki, until it finally disappeared at University of Lagos lagoon waterfront and Ikoyi.

ii. *Nereis* sp.

In the dry season the density of *Nereis* sp. ranged between 03 at st. 8 (Ikoyi) and 74 at st. 5 (Ogudu). Where mean salinities were 14.78±8.53, 13.11±9.01, 6.22±5.04 and 4.56±5.54 at stations 8, 7, 6 and 5 respectively, a density gradient of *Nereis* sp. was observed. Densities were 3, 8, 29 and 74 for stations 8, 7, 6 and 5 respectively (Fig. 28). In the wet season, densities of *Nereis* sp. were significantly higher ($P<0.05$) than those collected in the dry season. At st. 2 38 specimens of *Nereis* sp. were collected. Densities were 43, 133, 63, 36, 09 and 14 for stations 3 (River Ogun), 4 (Agboyi creek), 5 (Ogudu), 6 (Oworonsoki), 7 (University of Lagos lagoon front and 8 (Ikoyi) respectively (Fig. 29).

iii. *Dero* sp.

One specimen of *Dero* sp was collected in the rainy season (October 1997) at Oworonsoki (Station 6).

iv. *Tubifex* sp.

Five specimens of the freshwater annelid *Tubifex* sp were collected in the dry season at Oworonsoki (St 6) in December 1997.In the wet season 12 annelids were collected. At Oworonsoki (St 6) 2 annelids were collected, while 8 annelids were collected at station 4(Agboyi Creek) in September 1997 and 2 from Ikoyi (St.8) in October 1997.

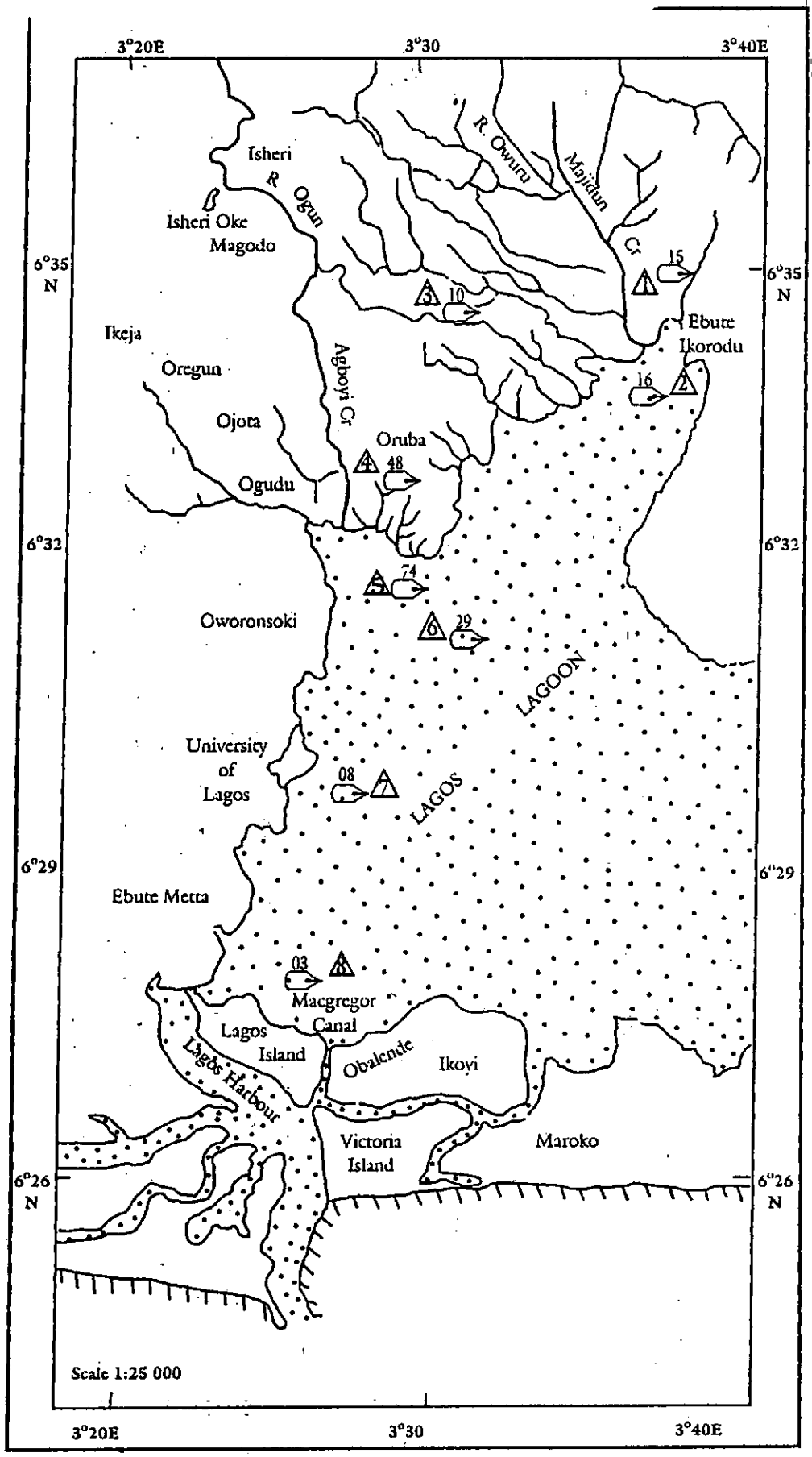

Fig .28.Density of *Nereis sp.* collected at the sampling stations in the western part of Lagos lagoon in the dry season.(May 1996 – February 1998).

X represent number of organism

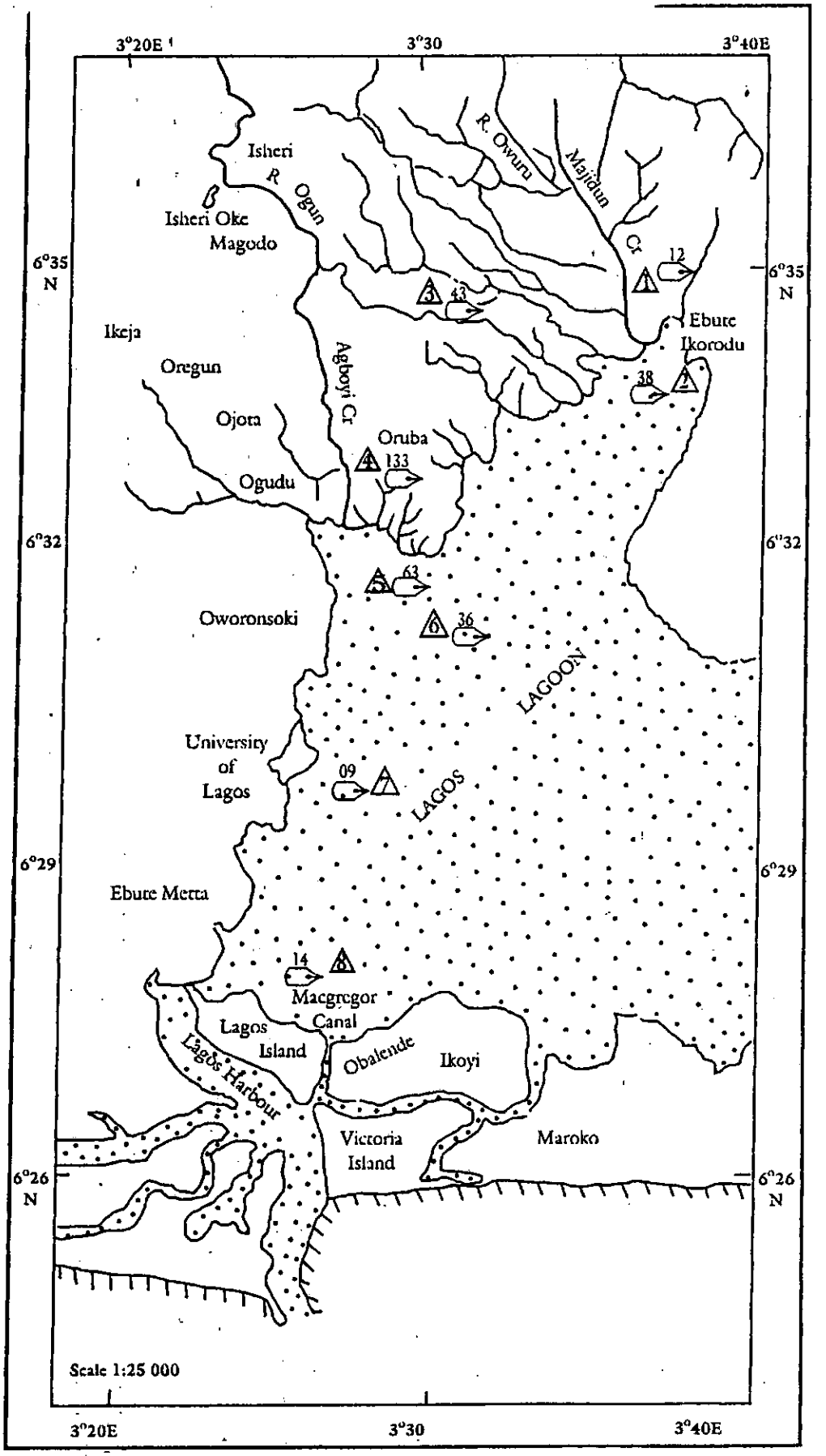

Fig .29. Density of *Nereis sp.* collected at the sampling stations in the western part of Lagos lagoon in the wet season.(May 1996 – February 1998).

X represent number of organism

F. ECONOMICALLY IMPORTANT SPECIES

i. *Crassostrea gazar*

The densities of the economically important oyster, *Crassostrea gasar* were higher at st. 2 (Ikorodu) in both seasons and st. 6 (Oworonsoki) in the wet season. In the dry season 14 fauna were collected at 51.3 (Ogun) and 2 at st. 6 (Oworonsoki) and 17 at st. 2 (Ikorodu). At all other stations *C. gasar* were absent (Fig. 30). In the wet season *C. gasar* were collected at six stations and absent at st. 3 (River Ogun) and st. 4 (Agboyi creek). One specimen was collected at st. 8 (Ikoyi) 09 at st. 7 (University of Lagos lagoon front, 212 at st. 6 (Oworonsoki) and 1 at st. 5 (Ogudu). At st. 2 (Ikorodu) 93 specimens were collected and at st. 1 (Majidun creek) 6 specimens were collected (Fig. 31).

ii. *Tympanotonus fuscatus*

In the present study *I. fuscatus* was collected in both seasons. In the dry season a large density (729 specimens) were collected from st. 5 (Ogudu, 481 specimens were collected at st. 6 (Oworonsoki) (Fig. 32). *I. fuscatus* were not collected at stations 1 (Majidun creek), 2 (Ikorodu) or 3 (River Ogun) in the dry season. However, in the wet season specimens were collected from all stations except st. 3 (River Ogun). Lower densities nine (st. 1: Majidun creek) to 232 (st. 6 Oworonsoki) occurred in the wet season (Fig. 33).

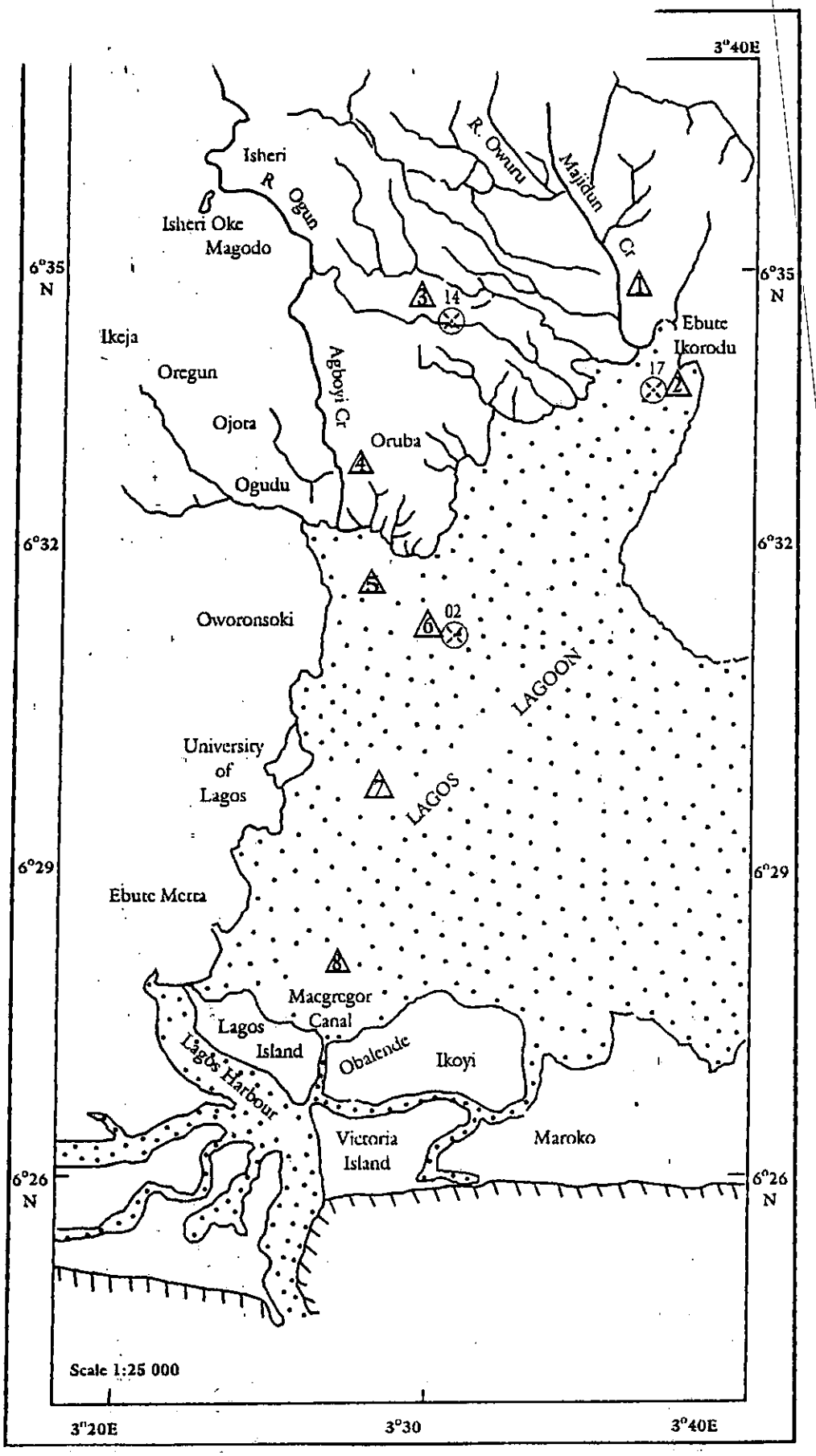

Fig.30.Density of *Crassostrea gasar* collected at the sampling stations in the western part of Lagos lagoon in the dry season(May 1996-Febuary 1998).

X represent number of organisms

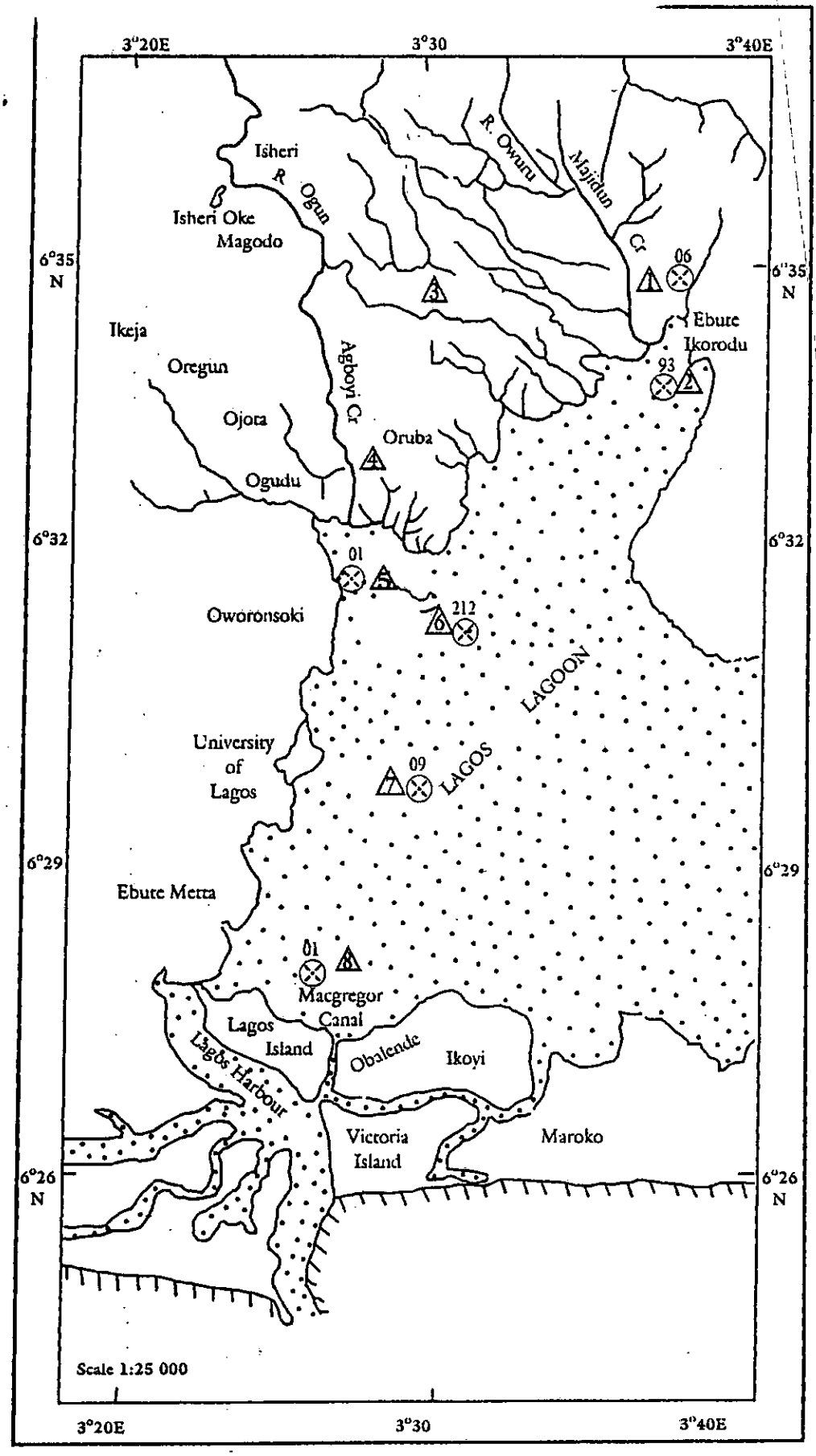

Fig.31.Density of *Crassostrea gasar* collected at the sampling stations in the western part of Lagos lagoon in the wet season.(May 1996 –February 1998).

⊗ represent number ot organism

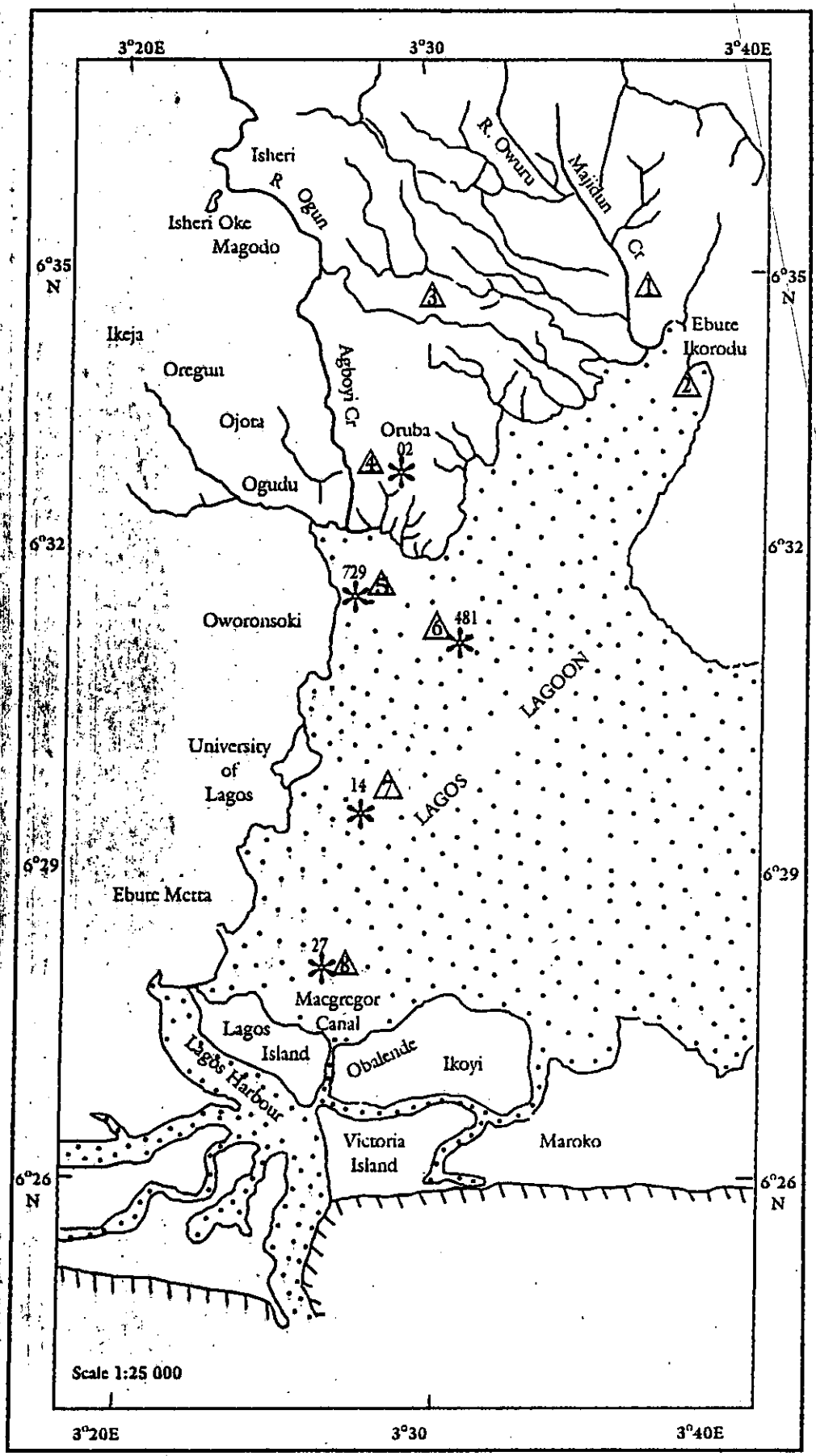

Fig.32. Density of *Tympanotonus fuscatus* collected at the sampling stations in the western part of Lagos lagoon in the dry season. (May 1996 – February 1998).

* represent number of organism

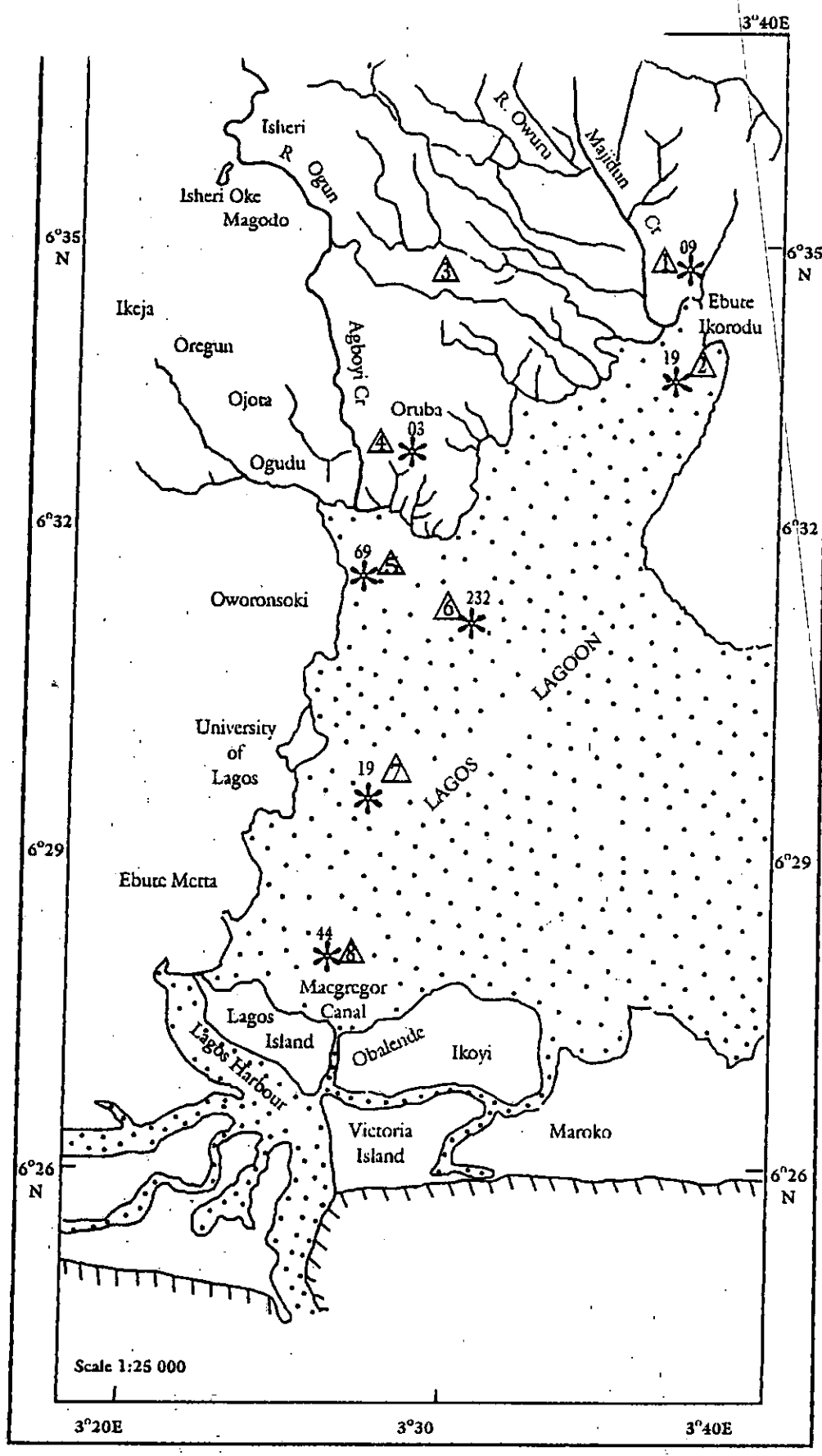

Fig.33. Density of *Tympanotonus fuscatus* collected at the sampling stations in the western part of Lagos lagoon in the wet season.(May 1996- February 1998).

* represent number of organism

iii. *Pachymelania aurita*

P. aurita was the most abundant fauna collected in the Lagos lagoon during the sampling period. The density was higher in the wet season, than dry season at stations 1, 2, 3, 4, 5, 6 and 7. At st. 8 (Ikoyi) the density *of P. aurita* was higher in the dry season (Figs. 34 and 35). Recruitments of *P. aurita* were higher in the wet season than dry season. Densities were 220 at st. 1 (Majidun creek), 483 at st. 2 (Ikorodu),362 at st. 3 (River Ogun) and 110 at st. 4 (Agboyi creek). At st. 5 (Ogudu) 70 individuals were collected, at st. 6 (Oworonsoki) 390 individuals were collected at st. 7 (University of Lagos lagoon front) 317 individuals and 102 at st. 8 (Ikoyi).

iv. Pachymelania quadriseriata

P. quadriseriata were collected at st. 55 and 6 during the wet season. (254 and 233 respectively), lower densities (4 to 64) occurred at other stations (Fig. 36). Similarly stations 4, 5 and 6 (Oworonsoki) also had relatively high densities *of P. quadriseriata* in the dry season (Fig. 37). This is an indication that *P. quadriseriata* could be cultured in this area throughout the year, or collected in large quantities for further studies.

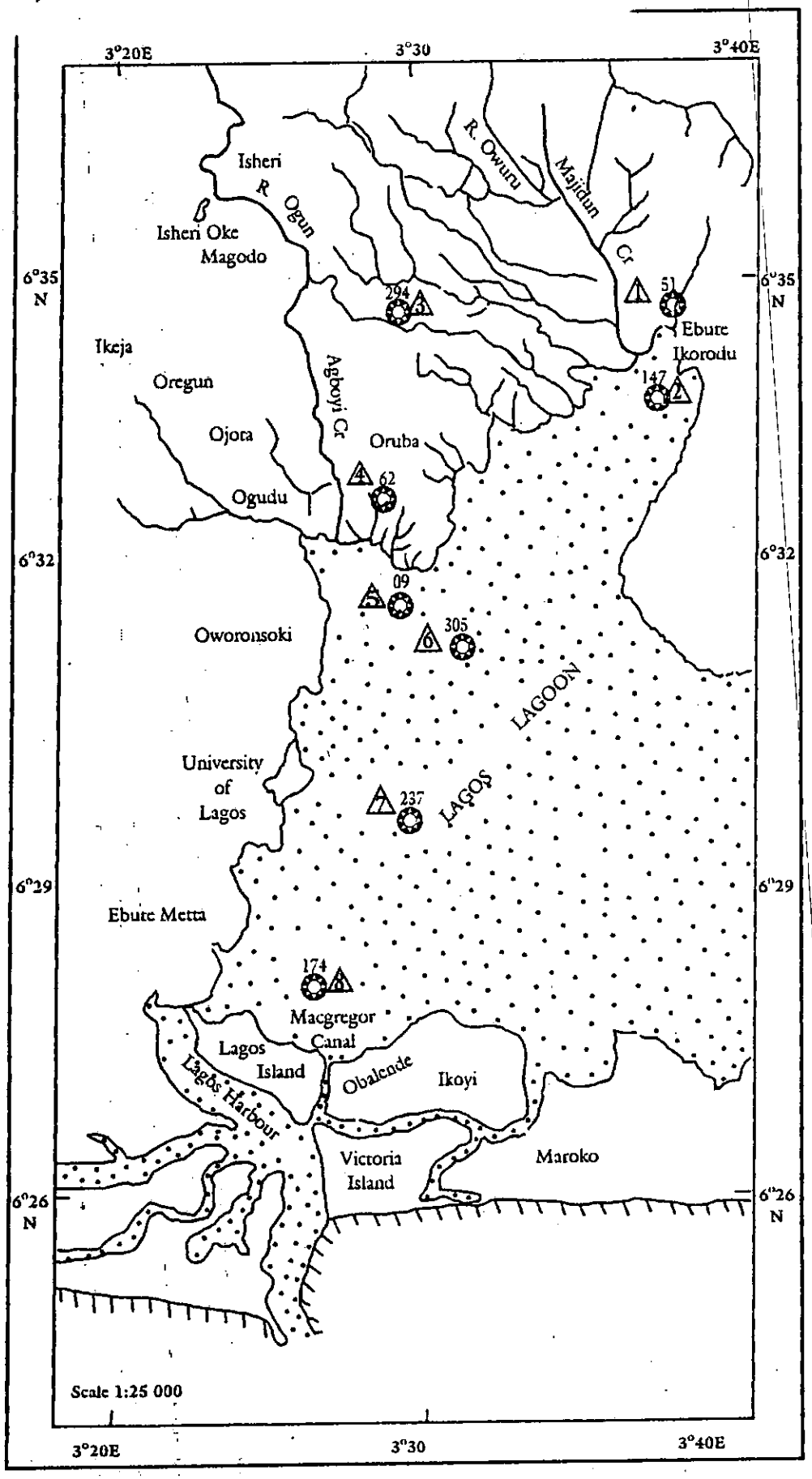

Fig.34.Density of *Pachymelania fuscatus* collected at the sampling stations in the western part of Lagos lagoon in the dry season(May 1996 – February 1998).

X represent number of organism

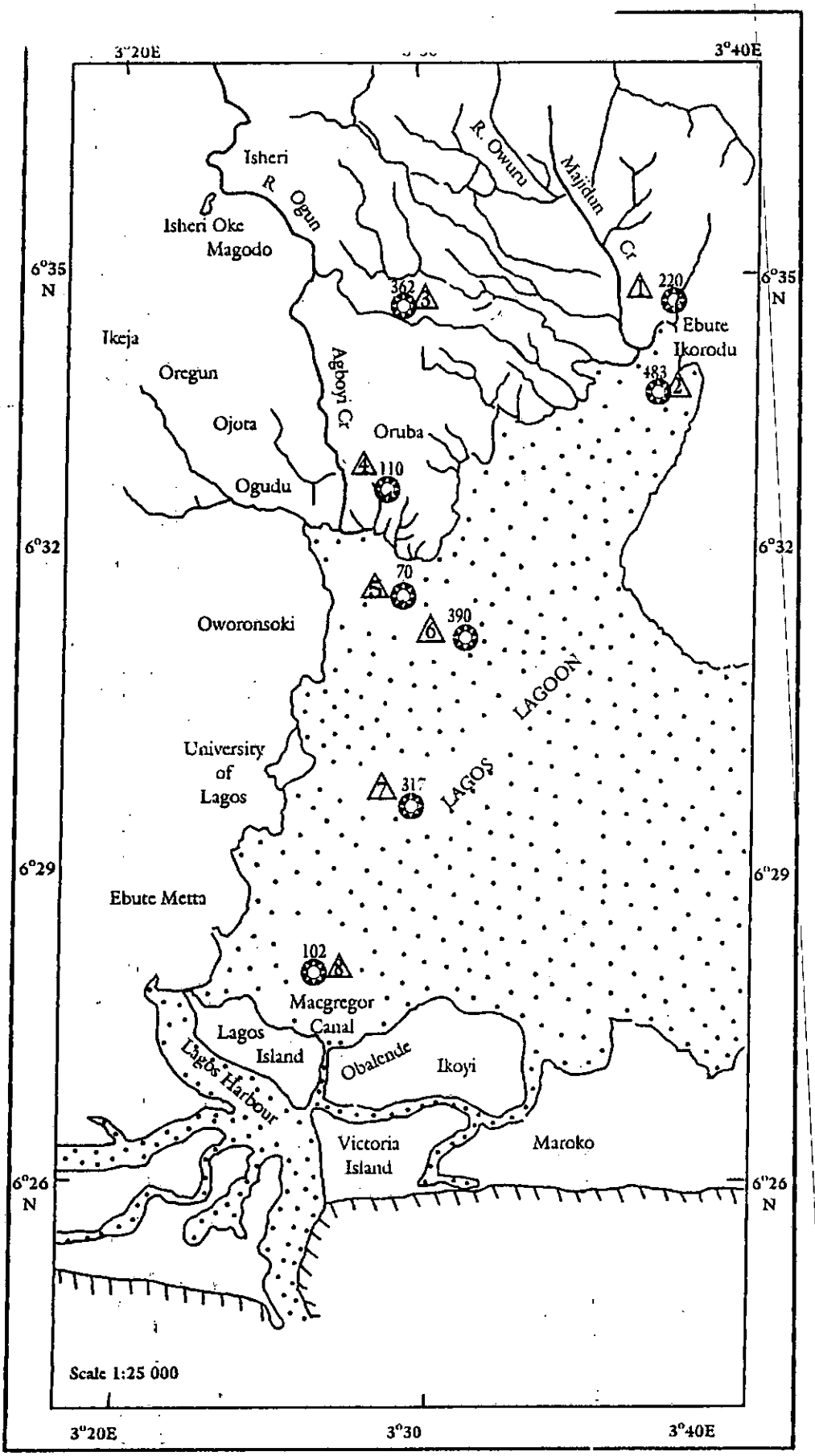

Fig.35.Density of *Pachmelania fuscatus* collected at the sampling stations in the western part of Lagos lagoon in the wet season(May 1996 –February 1998).

X represent number of organism

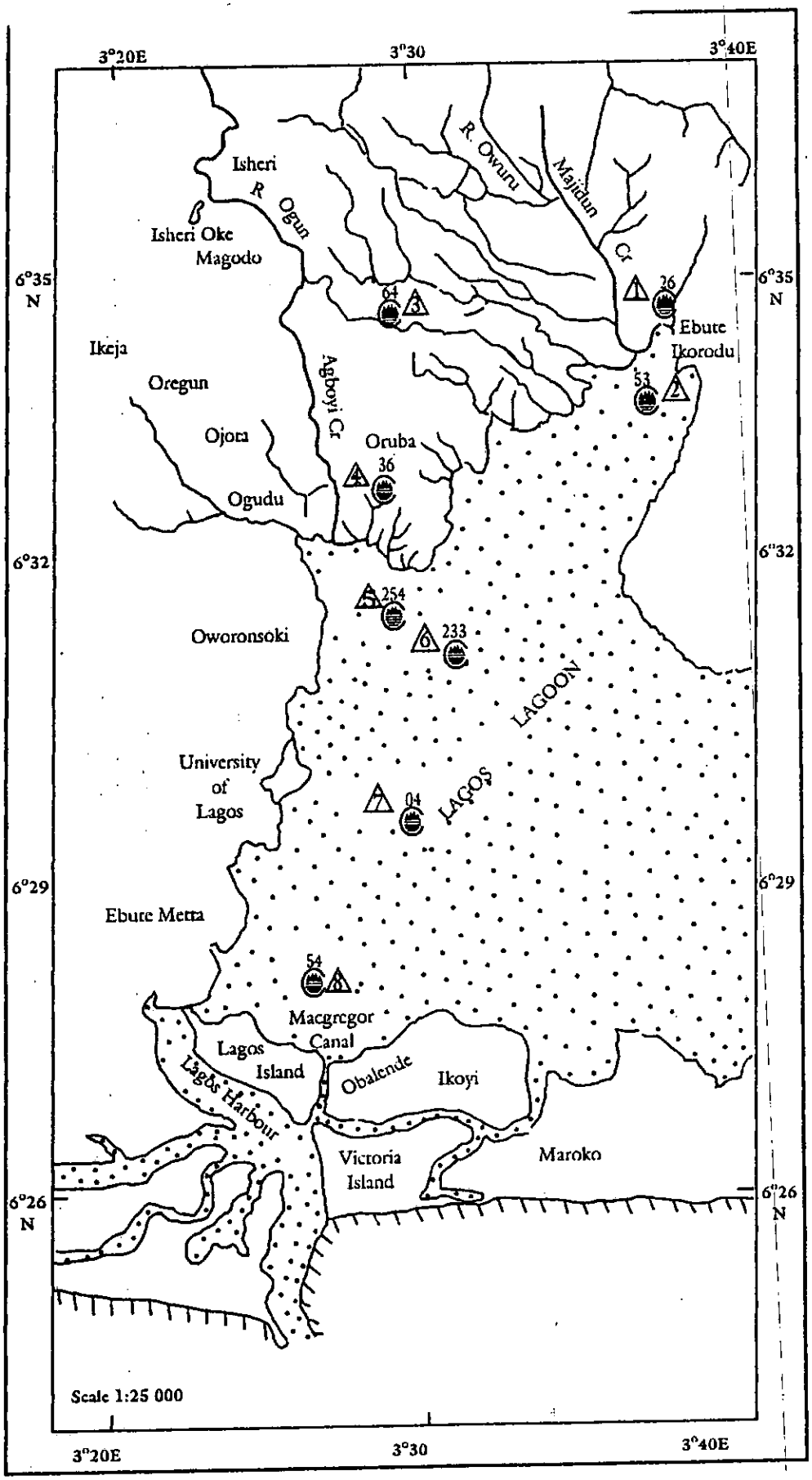

Fig.36.Density of *Pachymelania quadriseriata* collected at the sampling stations in the western part of Lagos lagoon in the wet season(May 1996 –February 1998)

X represent number of organism

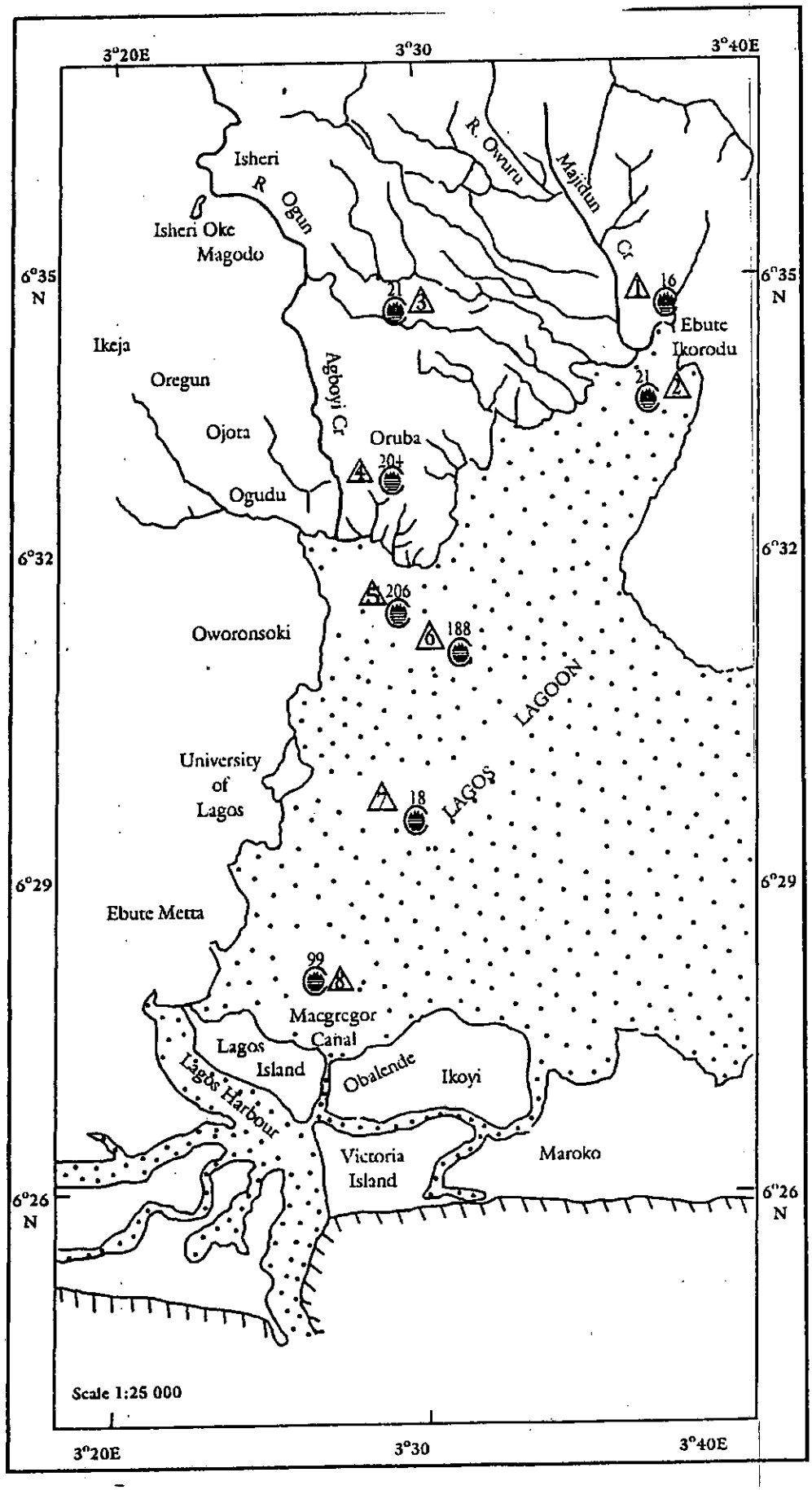

Fig 37.Density of *Pachmelania quadriseriata* collected at the sampling stations in the western part of Lagos lagoon in the dry season (May 1996- February 1998).

X represent number of organism

v. ***Mercierella enigmatica***

M. enigmatica is associated with *Crassostrea gasar*. Its characteristic orange tubes were found firmly attached to *C. gasar* shells or any other hard substrate. A large colony occurred at st. 2 (Ikorodu) in the dry season (289 specimens) (Fig. 38). Lower numbers, 60 occurred at st. 1 (Majidun creek), while the annelid was either absent or occurred in low numbers (<10) in other stations. In the wet season (Fig. 39) 138 specimens occurred in st. 2 (Ikorodu) 105 at st. 6 (Oworonsoki) and 20 at st. 1 (Majidun creek). At other stations it was either absent or occurred in very low densities.

vi. ***Neritina glabrata***

This is an integral member of the *Pachymelania* community in Lagos lagoon. It occurred in both wet and dry seasons. However, lower densities occurred in the wet season. The highest density in the wet season (353) was collected at st. 1 (Majidun creek) (Fig. 40). Another dense colony occurred at st. 6 (Oworonsoki) 321 individuals occurred. This colony comprising 289 individuals was also present in the dry season (Fig. 41).

vii. ***Aloidis trigona***

Densities ranged between 83 at st. 4 (Agboyi creek) and 907 at st. 7 (University of Lagos Lagoon front), in the dry season (Fig. 42). At st. 1 313 individuals were collected, st. 2 663 were collected, at st. 3 457 were collected and 781 individuals at st. 5. At st. 6 429 individuals were

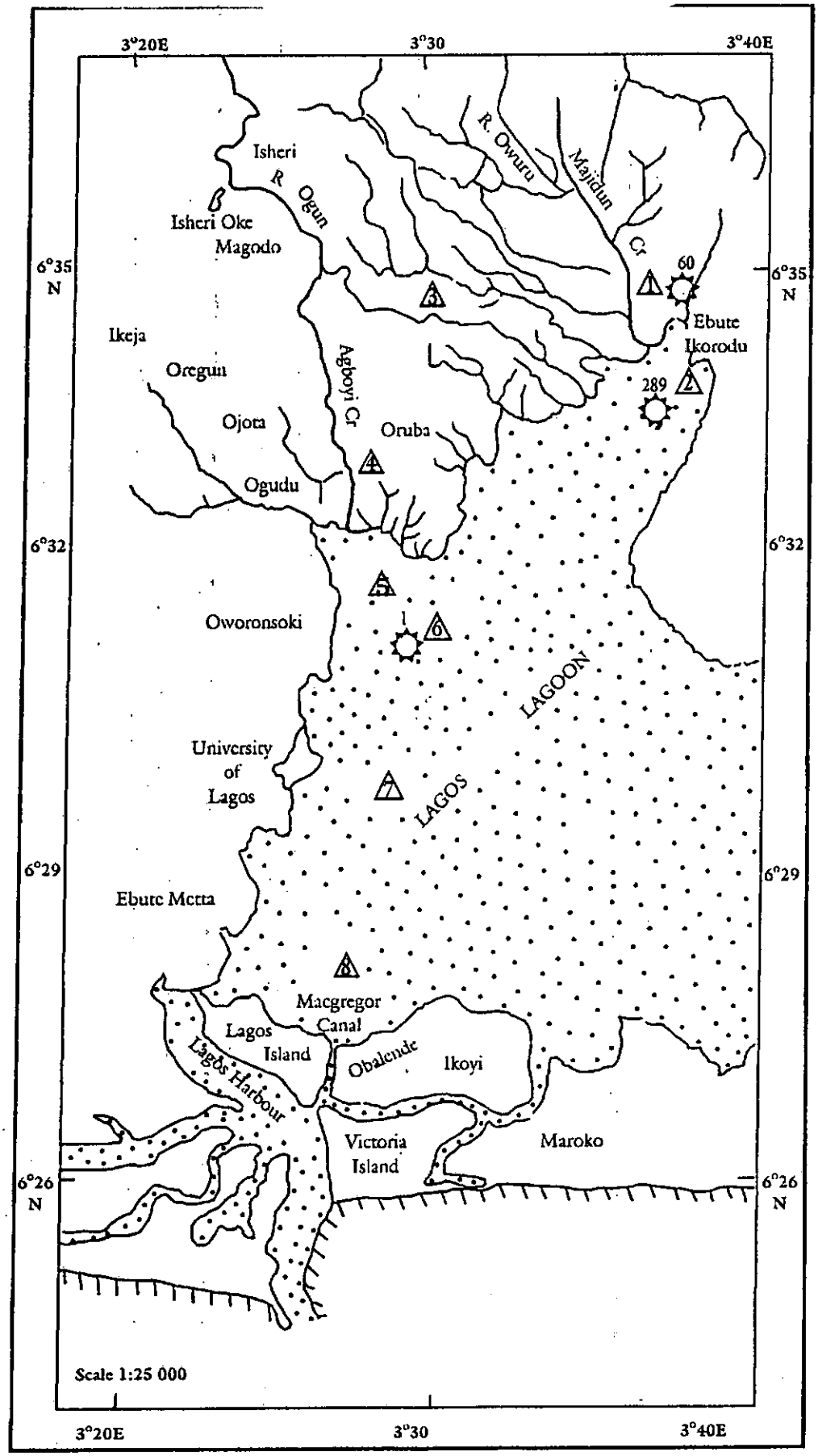

Fig 38. Density of *Mercierella enigmatica* collected at the sampling stations in the western part of Lagos lagoon in the dry season(May 1996 – February 1998).

X represent number of organism

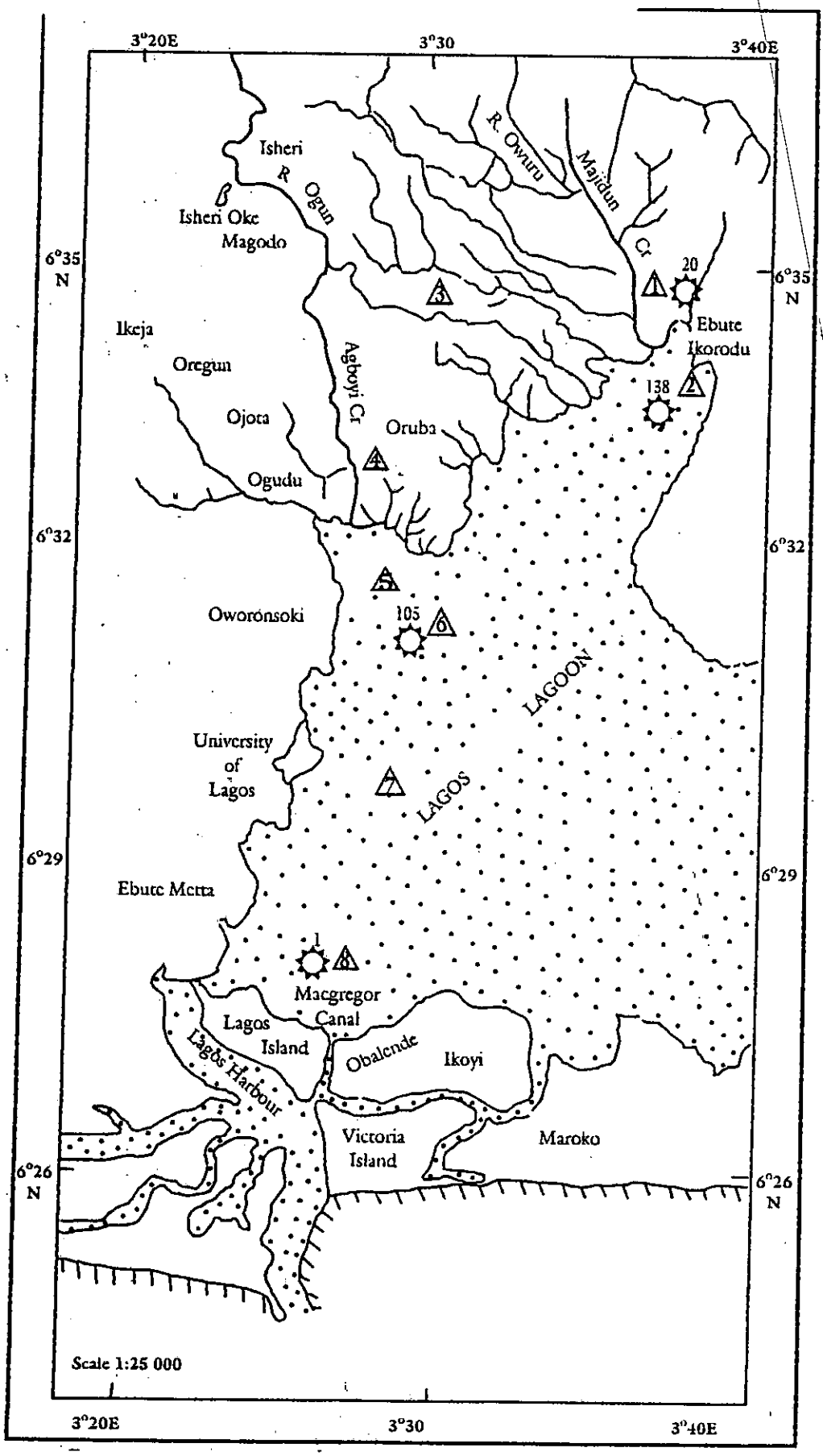

Fig 39. Density of *Mercierella enigmatica* collected at the sampling stations in the western part of Lagos lagoon in the wet season (May 1996 –February 1998).

X represent number of organism

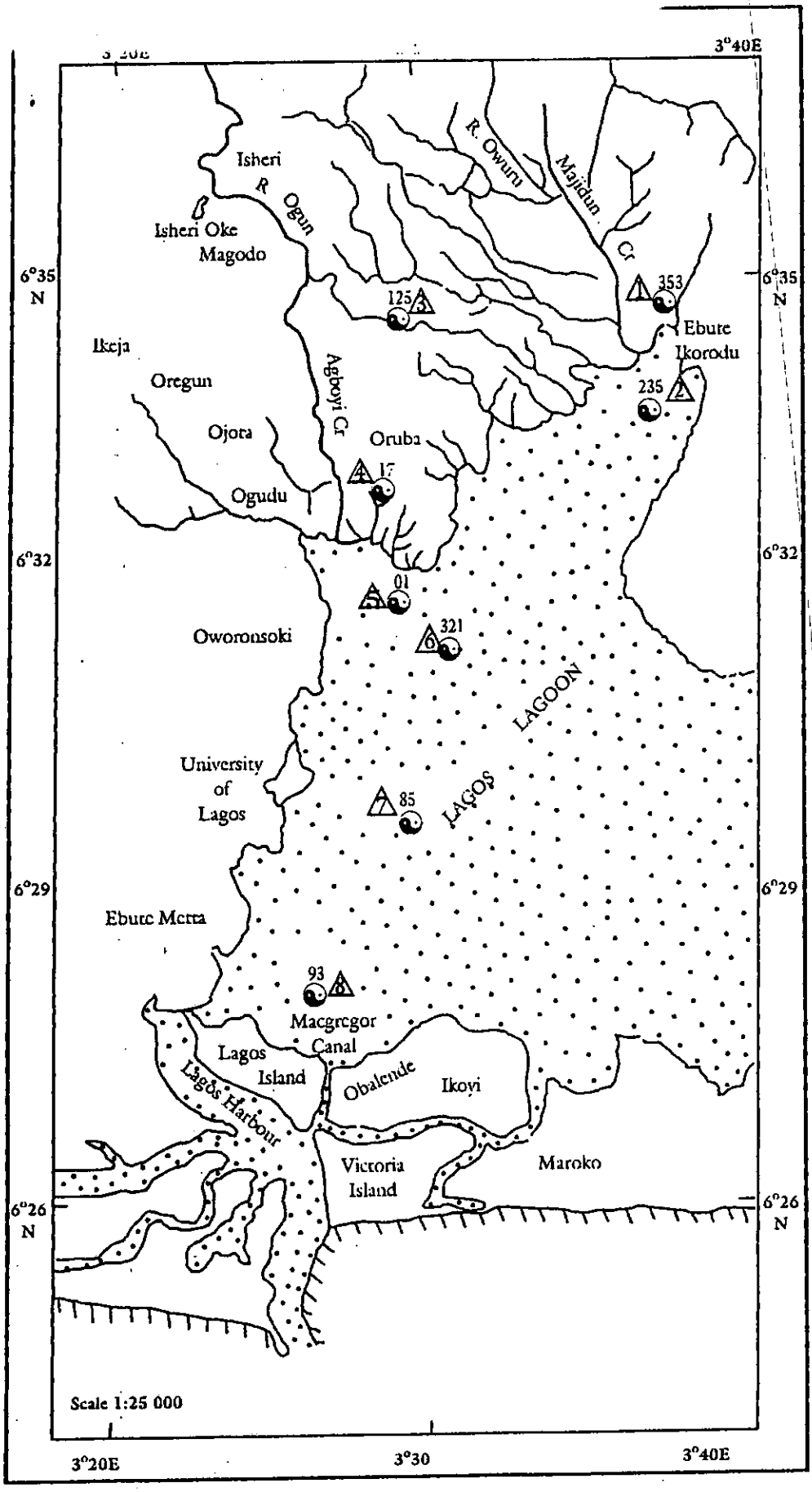

Fig 40. Density of *Neritina glabrata* collected at the sampling stations in the western part of Lagos lagoon in the wet season (May 1996 – February 1998).

represent number of organism

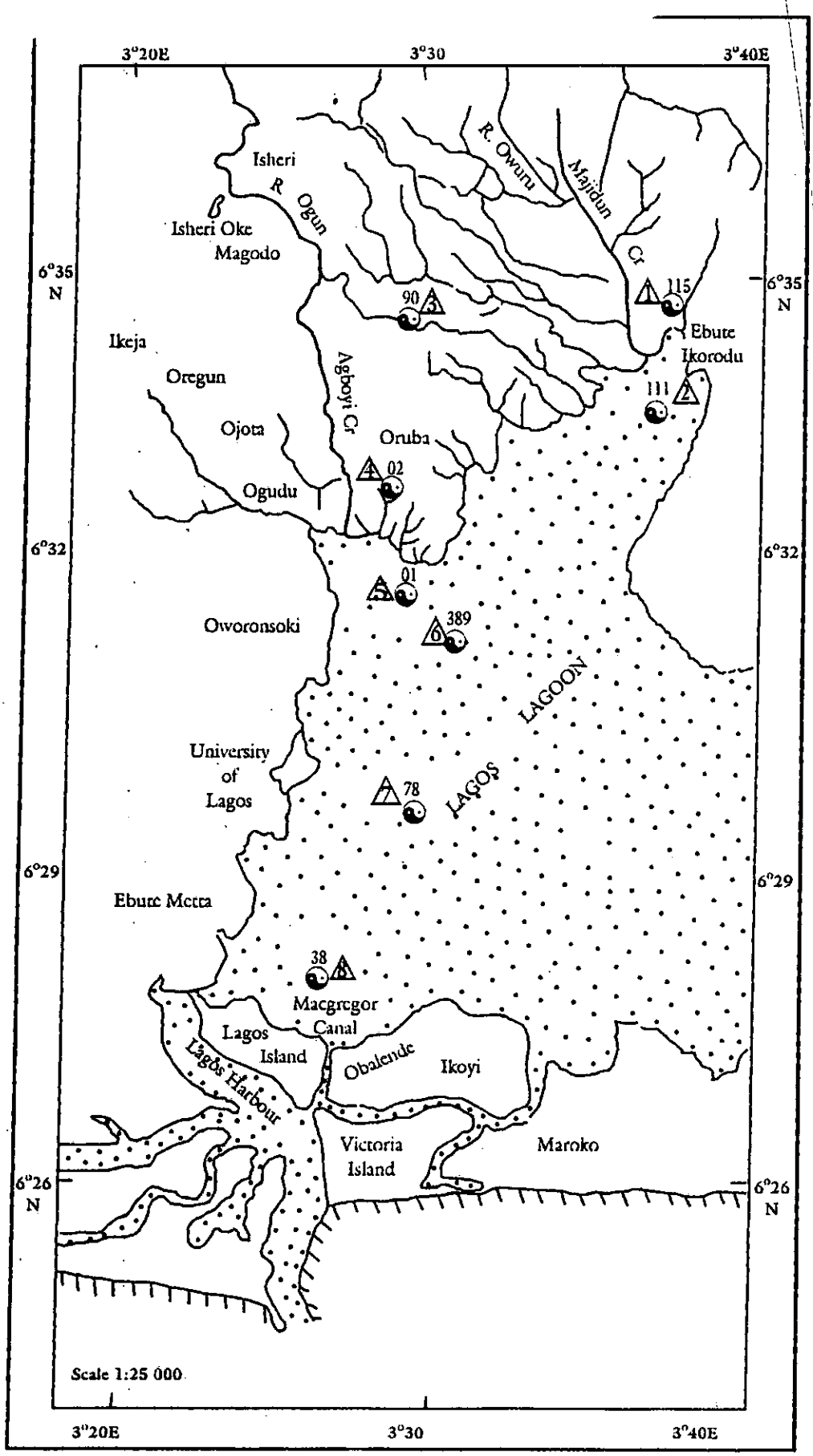

Fig 41. Density of *Neritina glabrata* collected at the sampling stations in the western part of Lagos lagoon in the dry season (May 1996 –February 1998).

represent number of organism

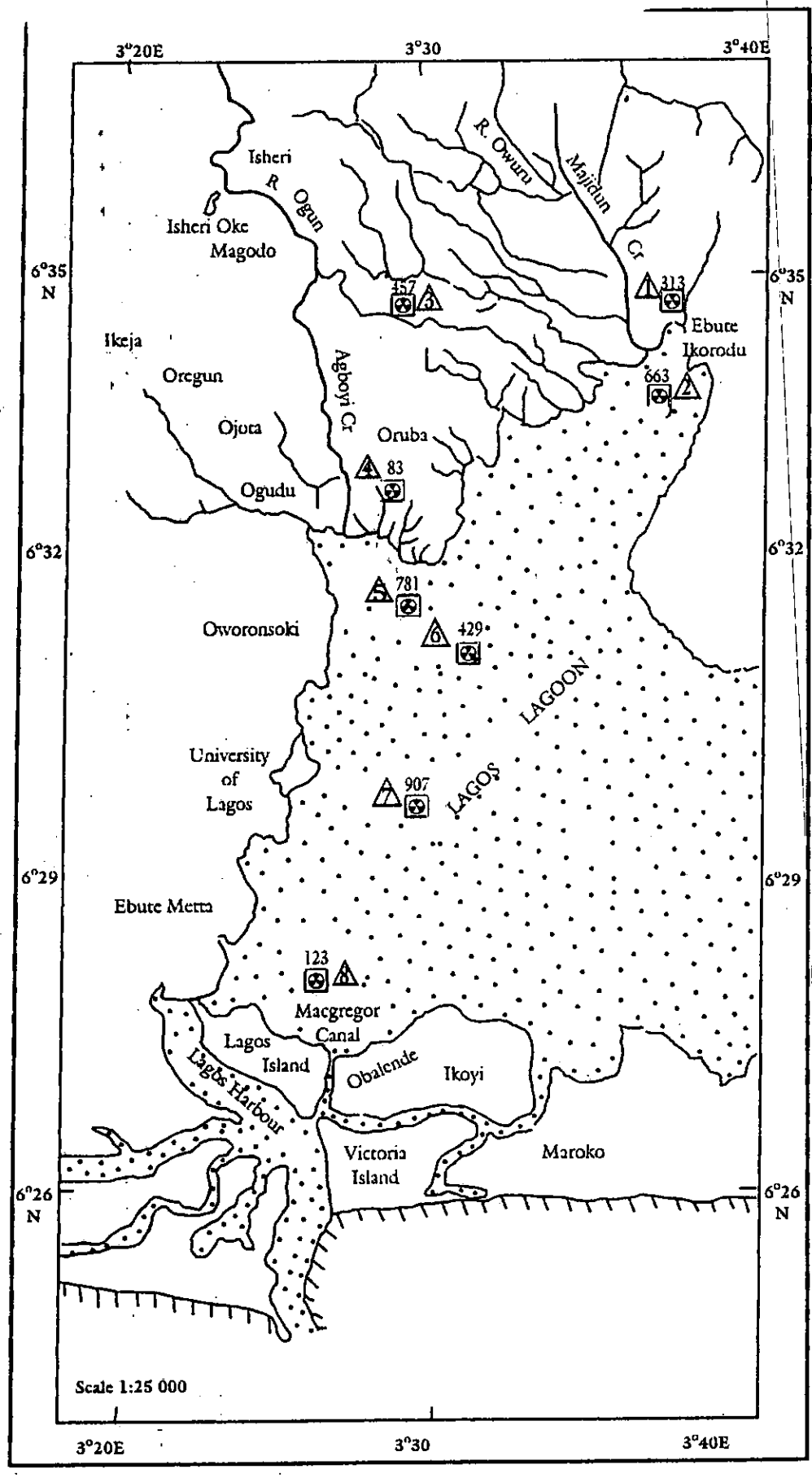

Fig.42. Density of *Aloidis trigona* collected at the sampling stations in the western part of Lagos lagoon in the dry season .(May 1996 – February 1998).

X represent number of organism

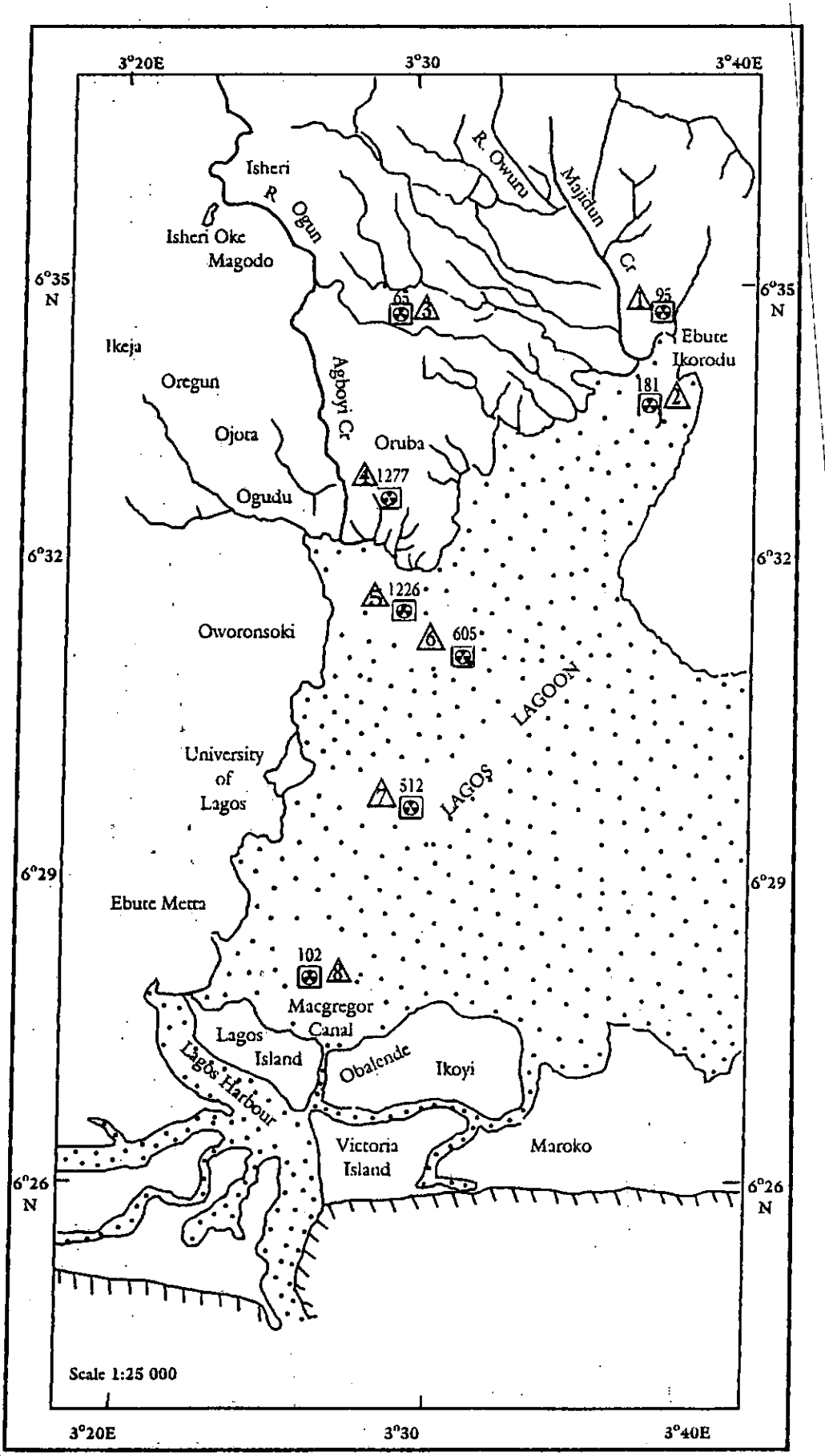

Fig.43 Density of *Aloidis trigona* collected at the sampling stations in the western part of Lagos lagoon in the wet season.(May 1996 – February 1998).

X represent number of organism

collected and 123 were collected at st. 8. In the wet season *A. trigona* were collected in higher densities than in the dry season (Fig. 43). The range was between 65 at st. 3 and 1277 at st. 4. At st. 1 95 specimens were collected, at st. 2, 181 individuals were collected and at st. 5 1226 individuals were collected. At stations 6, 7 and 8 densities of *A. trigona* in the wet season were 605, 512 and 102 respectively. There was an increase in density from station 8 to station 4, where mean salinities ranged from 2.82 $^{0}/_{00}$ to 1.50 $^{0}/_{00}$ respectively.

viii. *Aloidis sulcata*

This close relative to *A. trigona* also occurred at the sampling sites. In the dry season *A. sulcata* only occurred at st. 3 (River Ogun) 3 specimens were collected. *A. sulcata* was absent from all other sampling stations in the dry season (Fig. 44). In the wet season *A. sulcata* occurred at st. 8 (Ikoyi) 2 specimens. St. 3 (R. Ogun) 16 specimens, st. 2 (Ikorodu) 3 specimens and st. 1 (Majidun creek) 71 specimens. At other sampling stations it was absent (Fig. 45).

ix. *Balanus pallidus*

B. pallidus was collected in the Lagos lagoon and surrounding mangrove swamps. It occurred in association with *M. enigmatica* and *C. gasar*. In the dry season, densities ranged between 1 at station 3 (R. Ogun) and 200, at station 2 (Ikorodu) (Fig. 46). At st. 1 the density was 50, 18 at st. 4

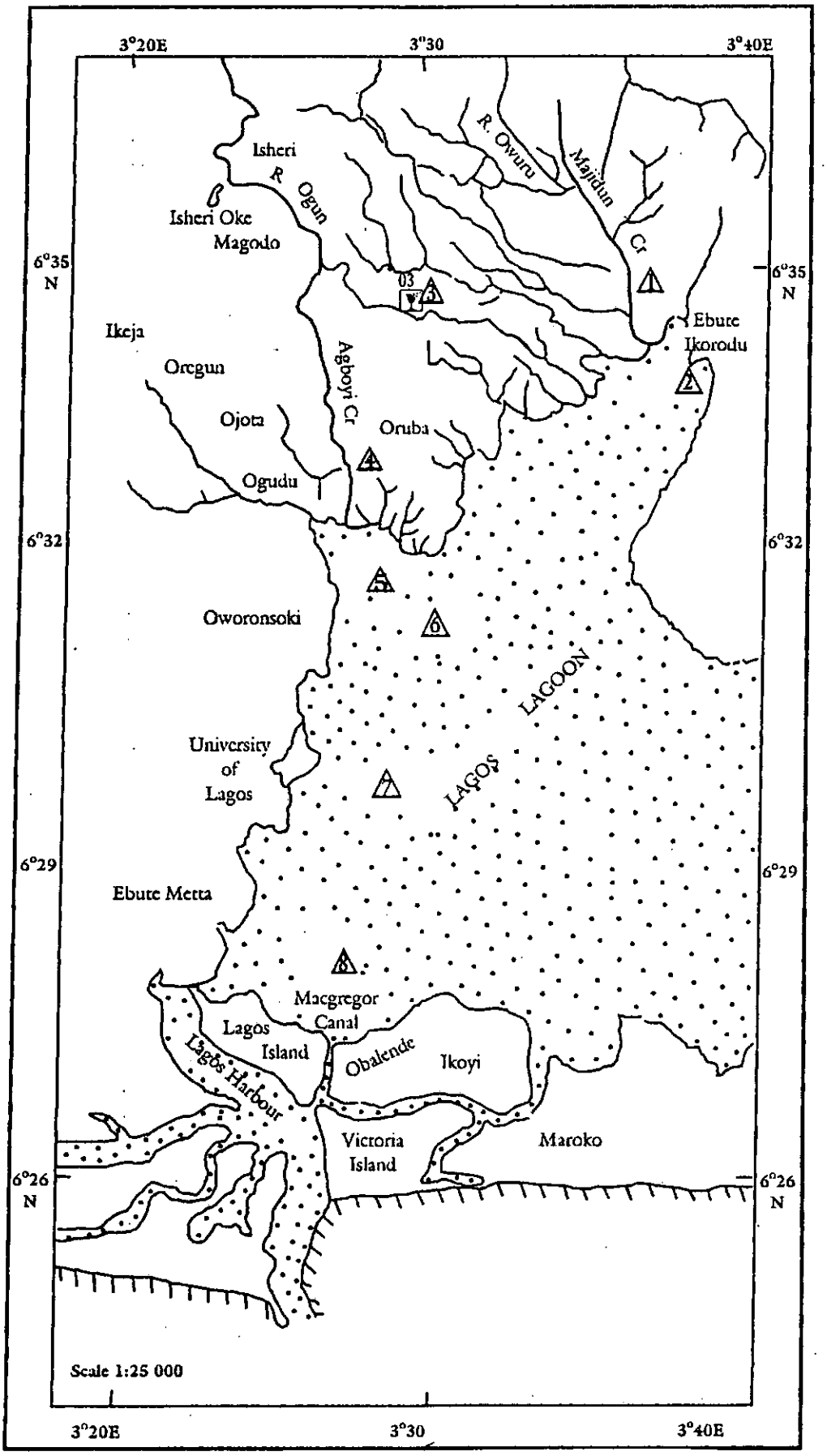

Fig.44. Density of *Aloidis sulcata* collected at the sampling stations in the western part of Lagos lagoon in the dry season.(May 1996 –February 1998).

X represent number of organism

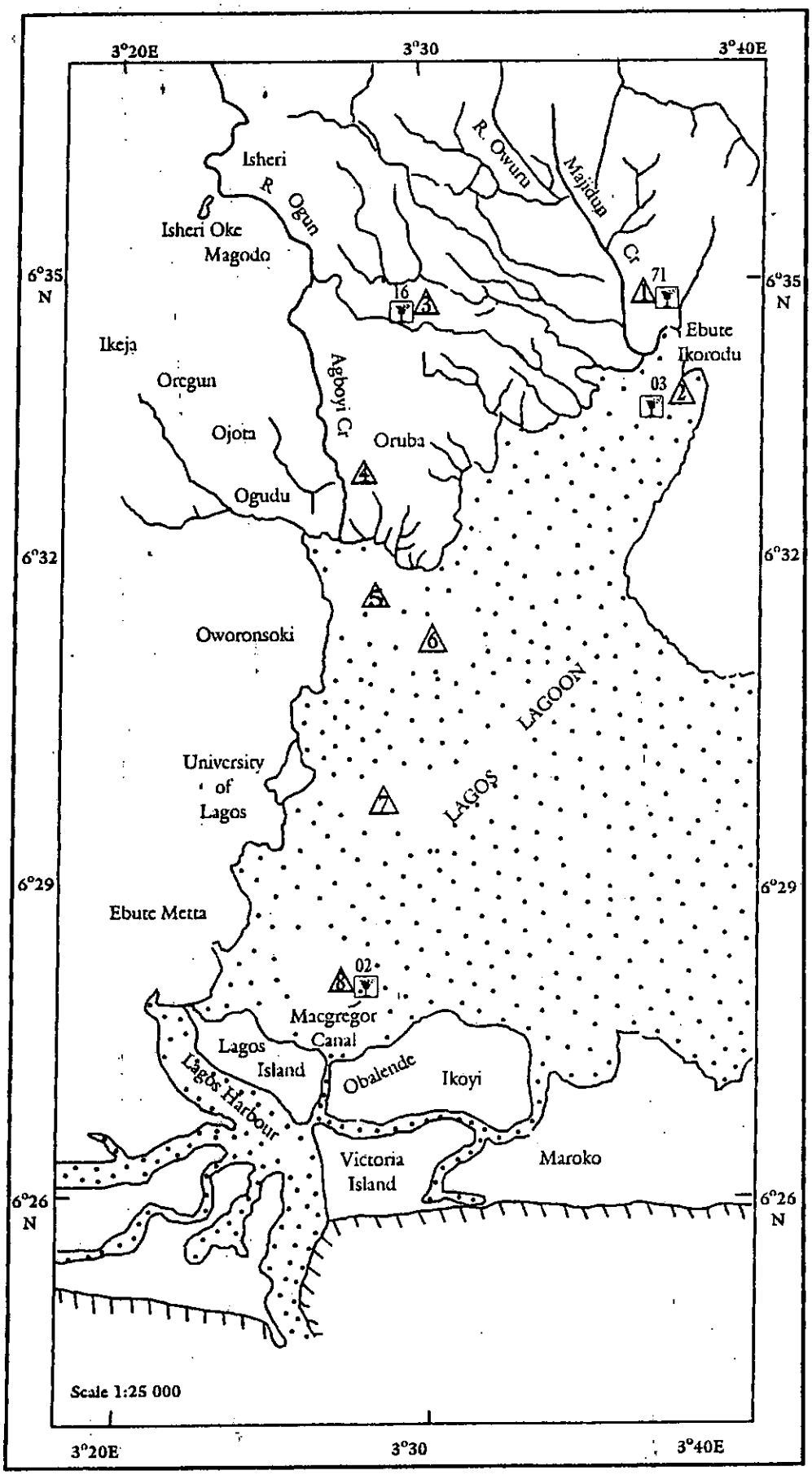

Fig.45. Density of *Aloidis sulcata* collected at the sampling stations in the western part of Lagos lagoon in the wet season.(May 1996 –February 1998).

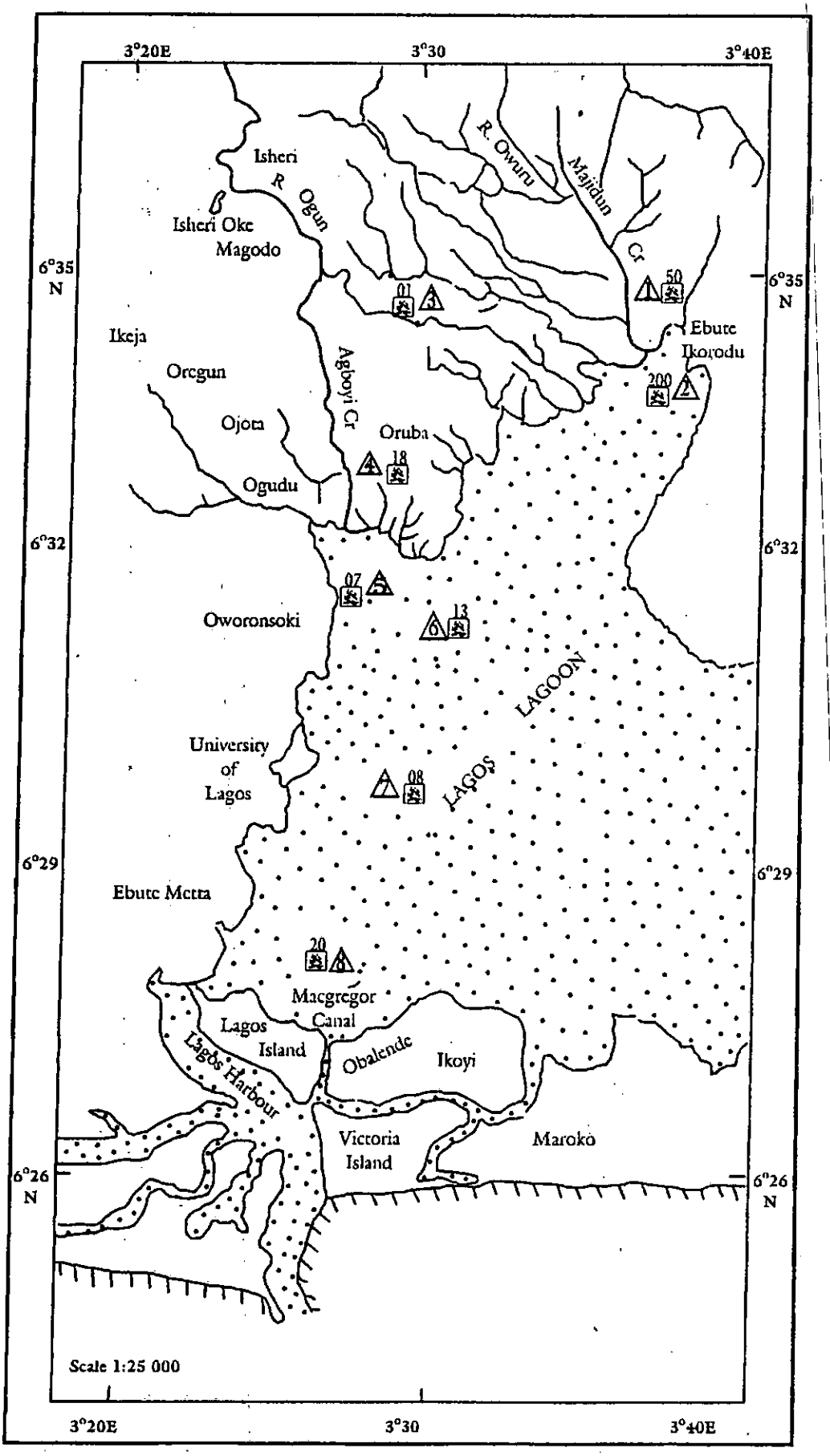

Fig.46. Density of *Balanus pallidus* collected at the sampling stations in the western part of Lagos lagoon in the dry season.(May 1996 – February 1998).

represent number of organism

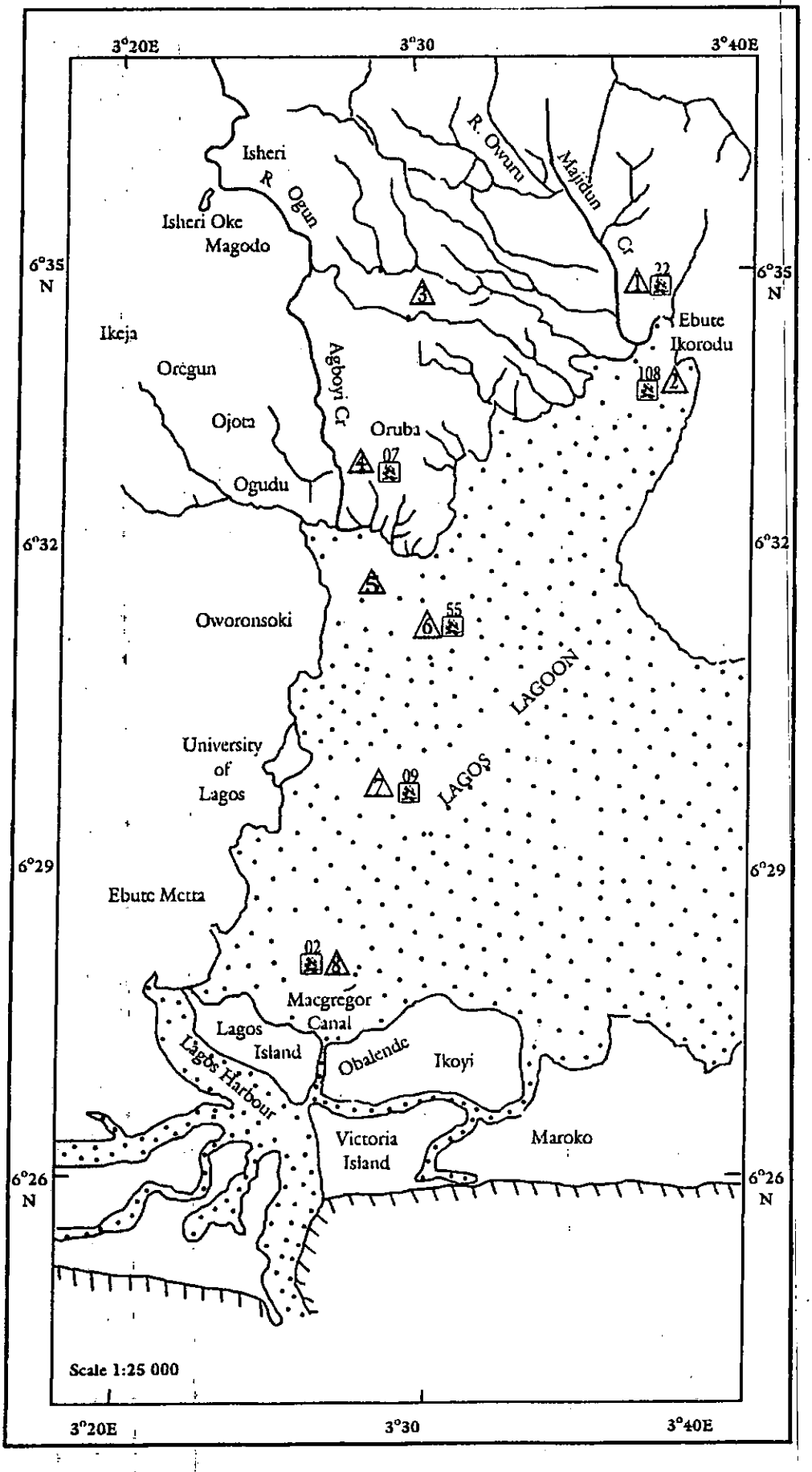

Fig .47. Density of *Balanus pallidus* collected at the sampling stations in the western part of Lagos lagoon in the wet season .(May 1996 –February 1998).

represent number of organism

(Agboyi creek), 7 at st. 5 (Ogudu), 13 at st. 6 (Oworonsoki), 8 at st. 7 (University of Lagos lagoon front) and 20 at st. 8 (Ikoyi). In the wet season, densities were lower, ranging between 02 at st. 8 (Ikoyi) and 108 at st. 2 (Ikorodu). At stations 3 (River Ogun) and 5 (Ogudu) *B. pallidus* was not collected in the wet season (Fig. 47). At st. 1 (Majidun creek) the density was 22, at st. 4 (Agboyi creek) the density was 7, at st. 6 (Oworonsoki) the density was 55 and 9 at st. 7 (University of Lagos lagoon front).

G. COMPOSITION OF ANIMAL PHYLA AT STATIONS.

i. Annual Occurrence

Station 1 (Majidun creek)

The phyla Mollusca, Arthropoda, Annelida Nemertina, Echuiroidea and Porifera were represented in the fauna collected at station 1 during the sampling period. Porifera occurred at st. 1 only (Fig. 27a). The mollusca was the dominant group comprising 84.49% of the total animal population.. Annelida made up 9.54% phyla, and the Arthropoda comprised 5.66%. The Echiuroidea and Porifera ranked lowest, making up of 0.06% each (Fig. 48, Tables 18a & b).

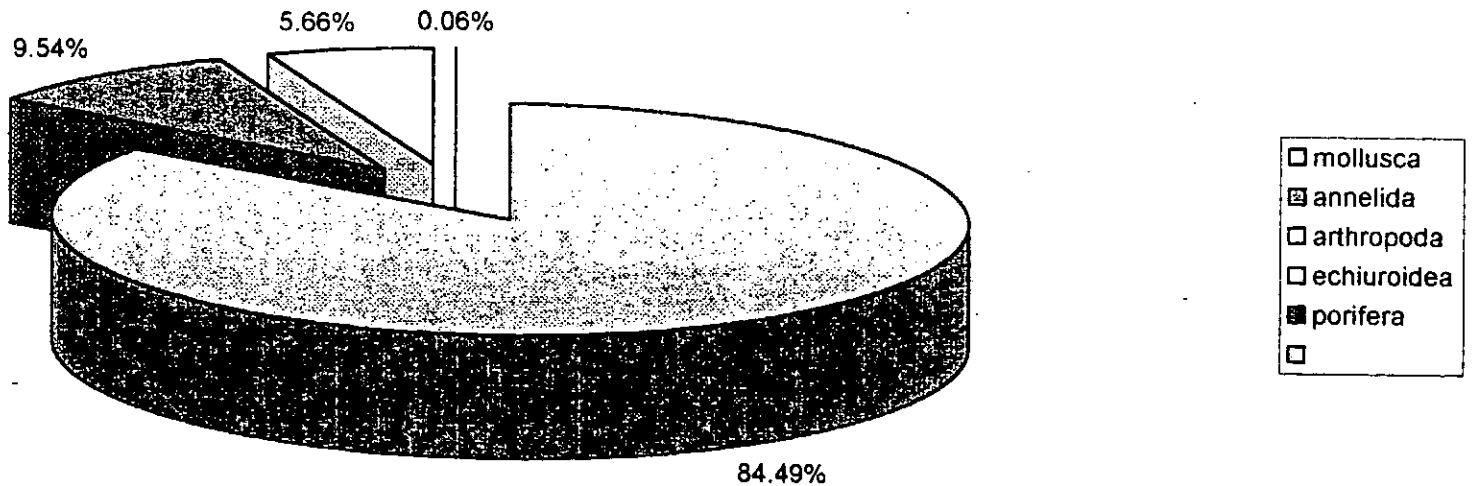

Fig 48.Percentage composition of animal phyla at station 1 in the dry and wet seasons in the western part of Lagos lagoon(May 1996-Feb.1998).

Table 18a: Composition of animal phyla collected at the sampling stations in the dry and wet season in the western part of Lagos lagoon (May 1996-February 1998) (Figures in parenthesis represent actual number of individuals)

	1	2	3	4	5	6	7	8
Mollusca	304.17 (1373)	253.24 (2213)	324.36 (1811)	301.89 (1969)	332.39 (3612)	326.46 (3786)	345.18 (2120)	334.70 (1204)
Nemertina	0.66(03)	0.34 (03)	1.97 (11)	0.92 (06)	0.18 (02)	0.08 (01)	-	-
Annelida	34.34 (155)	64.19 (561)	29.73 (166)	48.91 (319)	24.20 (263)	21.99 (255)	5.37 (33)	13.89 (50)
Pogonophora	-	0.11 (01)	-	0.61 (04)	0.46 (05)	0.08 (01)	-	-
Echiuroidea	0.22(01)	0.11 (01)	-	0.31 (02)	-	0.26 (03)	-	-
Sipunculoidea	-	0.34 (03)	-	0.15 (01)	0.28 (03)	-	-	-
Porifera	0.22(01)	-	-	-	-	-	-	-
Arthropoda	20.38(92)	4154 (363)	3.94 (22)	6.89 (45)	2.39 (26)	11.04 (128)	9.44 (58)	11.12 (40)
Echinodermata	-	0.11 (01)	-	-	-	-	-	-
Hemichordata	-	-	-	0.51 (01)	-	-	-	-
Chordata	-	-	-	0.51(01)	0.09 (01)	0.08 (01)	-	0.28(01).

Table 18b: Percentage composition of animal phyla collected at the sampling stations in the dry and wet seasons in the western part of Lagos lagoon (May 1996 – February 1998).

	1	2	3	4	5	6	7	8
Mollusca	84.49	70.34	90.10	83.86	92.33	90.68	95.88	92.97
Nemertina	0.18	0.09	0.55	0.26	0.05	0.02	-	-
Annelida	9.54	17.83	8.26	13.59	6.72	6.11	1.49	3.86
Pogonophora	-	0.03	-	0.17	0.13	0.02	-	-
Echiuroidea	0.06	0.03	-	0.09	-	0.07	-	-
Sipunculoidea	-	0.09	-	0.04	0.08	-	-	-
Porifera	0.06	-	-	-	-	-	-	-
Arthropoda	5.66	11.54	1.09	1.91	0.66	3.07	2.62	3.09
Echinodermata	-	0.03	-	-	-	-	-	-
Hemichordata	-	-	-	0.04	-	-	-	-
Chordata	-	-	-	0.04	0.03	0.02	-	0.08

Station 2 (Ikorodu)

Eight phyla, Mollusca, Nemertina, Annelida, Pogonophora, Echiuroidea, Sipunculoidea, Arthropoda and Echinodermata occurred at station 2 between May 1996 and February 1998. The Mollusca comprised 70.34% of the total animal while the Annelida made up 17.38%. The Arthropoda comprised 11.54% while the Pogonophora, Echiuroidea, and Echinodermata contributed 0.03%. The Phylum Echinodermata occurred only at station 2 (Fig. 49, Tables 18a & b).

Station 3 (River Ogun)

The Phyla collected at station 3 during the sampling period were Mollusca, Annelida, Arthropoda and Nemertina. The occurrence of the different phyla is shown in (Fig. 50, Tables 18a & b). Mollusca contributed 90.10% of the fauna, Nemertina 0.55%, Annelida 8.26%, and Arthropoda made up 1.09%.

Station 4 (Agboyi creek)

Nine phyla were collected from station 4 during the sampling period, May 1996 to February 1998. The Phylum Hemichordata, which did not occur at any other station, was collected. Phylum chordata was also collected. The

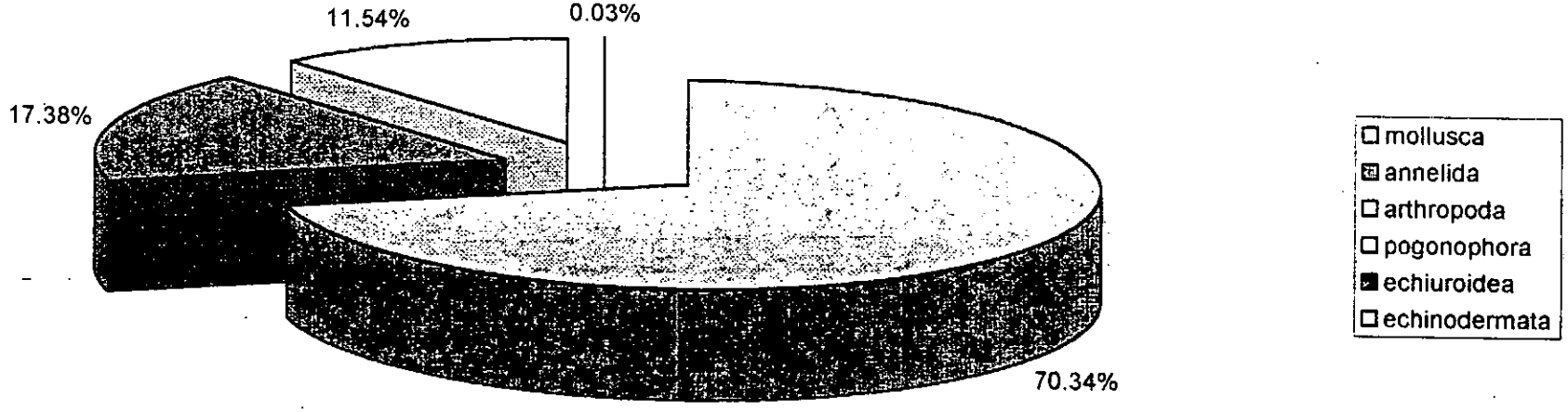

Fig.49.Percentage composition of animal phyla at station 2 in the dry and wet seasons in the western part of Lagos lagoon(May 1996- Feb.1998).

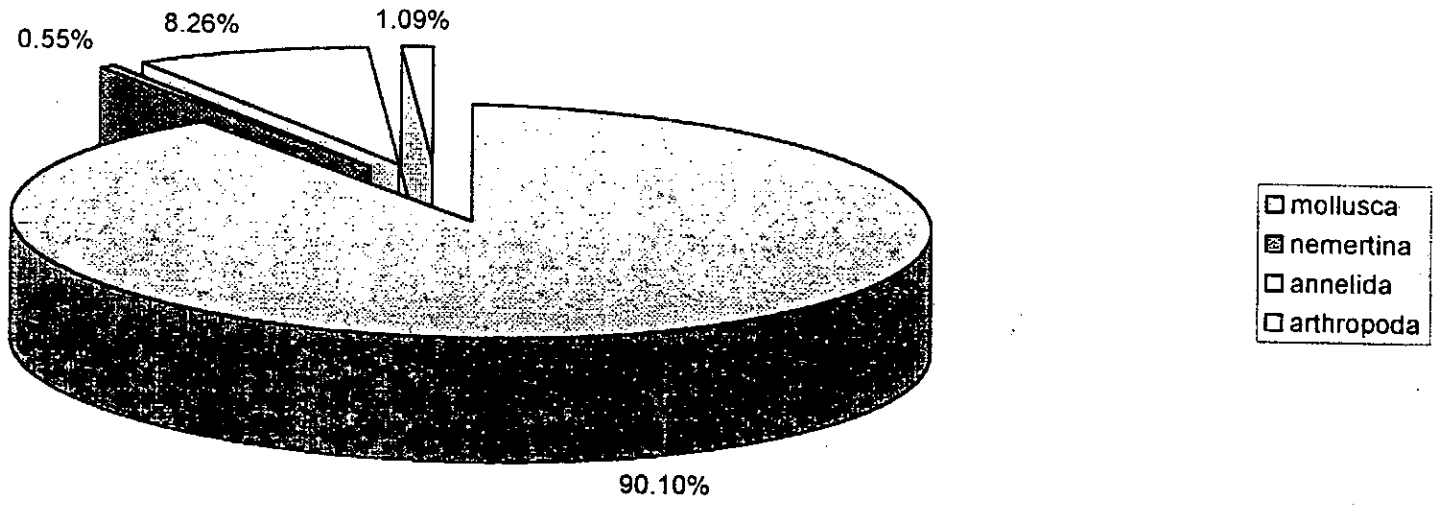

Fig 50.Percentage composition of animal phyla at station 3 in the dry and wet seasons in the western part of Lagos lagoon(May 1996- Feb.1998).

Mollusca contributed to 83.86% of the total fauna collected, the Annelida 13.51% and the Arthropoda 1.91% (Fig. 51, Tables 18a & b).

Station 5 (Ogudu)

Mollusca, Annelida, Arthropoda, Pogonophora, Sipunculoidea, Nemertina and Chordata were collected at station 5 between May 1996 and February 1998. The Mollusca made up 92.33% while the chordata contributed 0.03%, (Fig. 52, Tables 18a & b).

Station 6 (Oworonsoki)

The Phyla Mollusca, Nemertina, Annelida, Pogonophora, Echiuroidea, Arthropoda and Chordata were collected at station 6 between May 1996 and February 1998. Phylum Mollusca made up 90.86%, of the total fauna phylum Annelida contributed (6.11%), phyla Nemertina, Pogonophora and Chordata comprised 0.02% of the fauna (Tables 8a & b, Fig. 53).

Station 7 (University of Lagos lagoon front)

The phyla collected at station 7, throughout the sampling period included Mollusca that made up 95.88 of the fauna, Arthropoda 2.62% and Annelida contributed 1.49 (Tables 18a & b, Fig. 54).

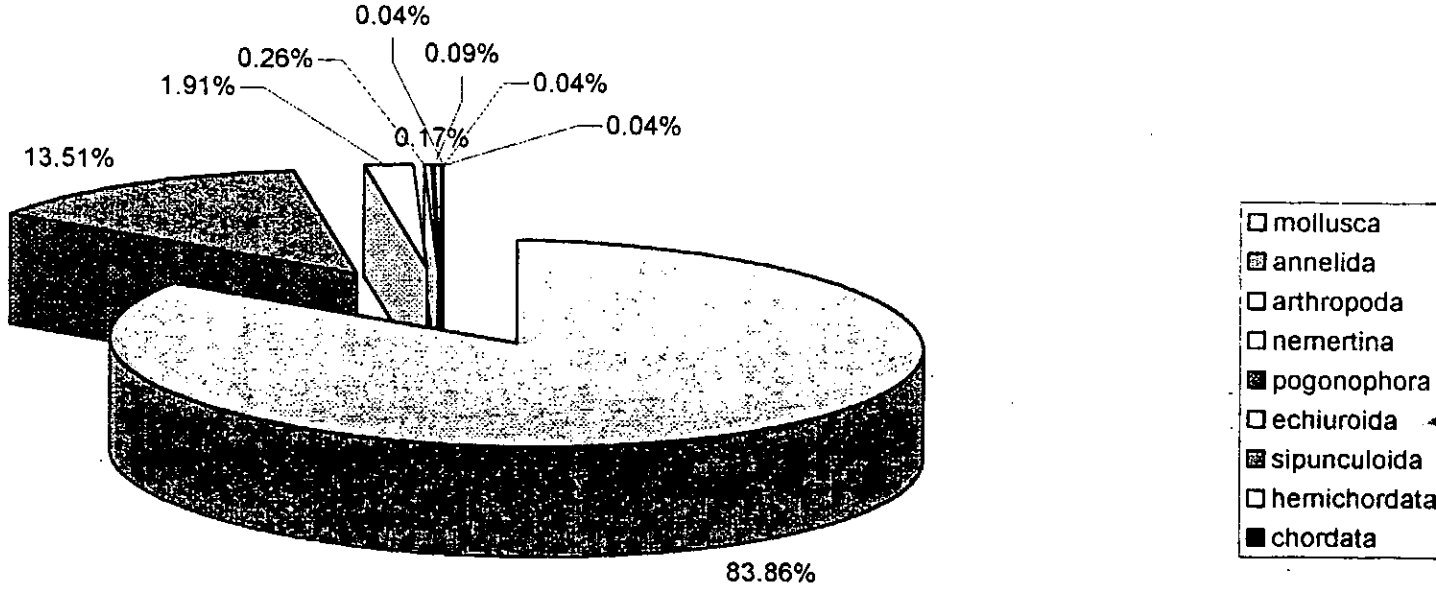

Fig.51.Percentage composition of animal phyla at station 4 in the dry and wet seasons in the western part of Lagos lagoon(May 1996-Feb.1998).

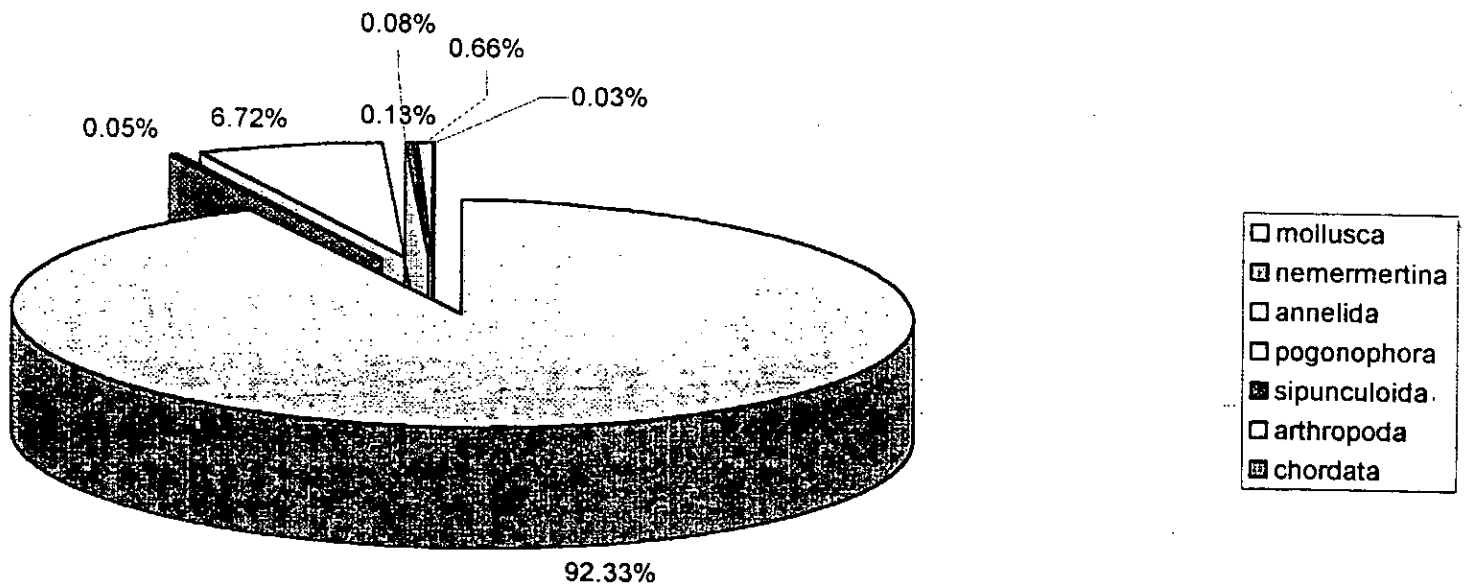

Fig 52.Percentage composition of animal phyla at station 5 in the dry and wet seasons in the western part of Lagos lagoon(May 1996-Feb.1998.

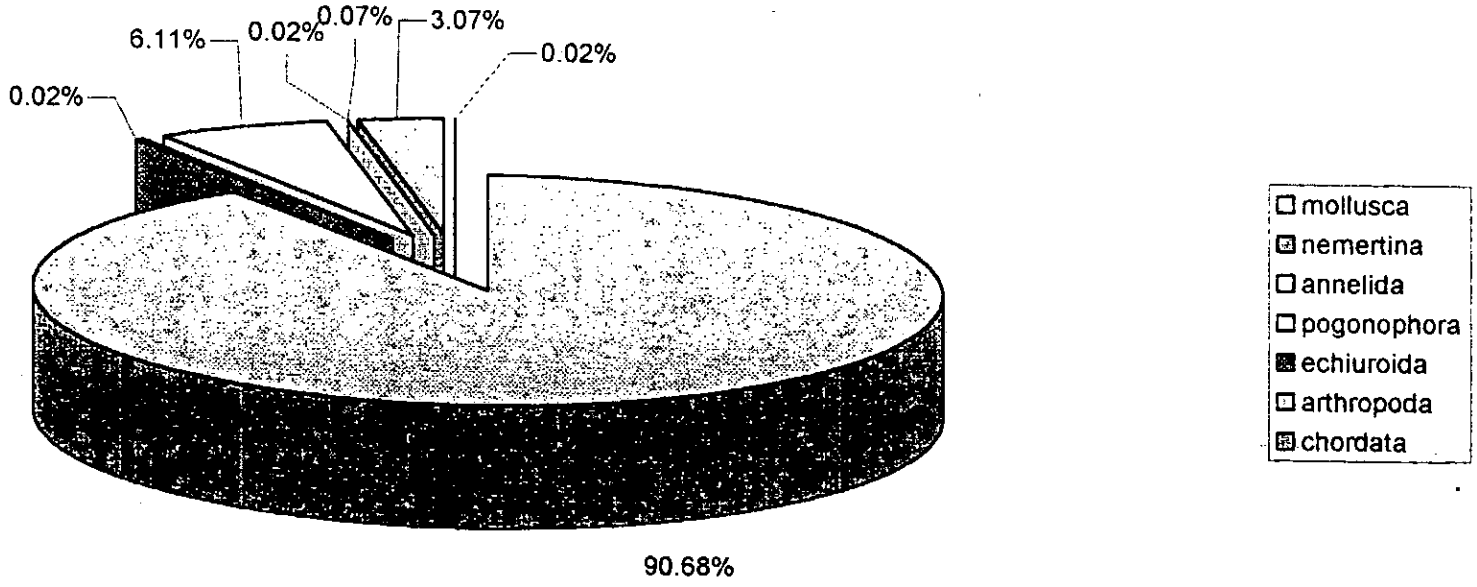

Fig.53.Percentage composition of animal phyla at station 6 in the dry and wet seasons in the western part of Lagos lagoon(May 1996-Feb.1998).

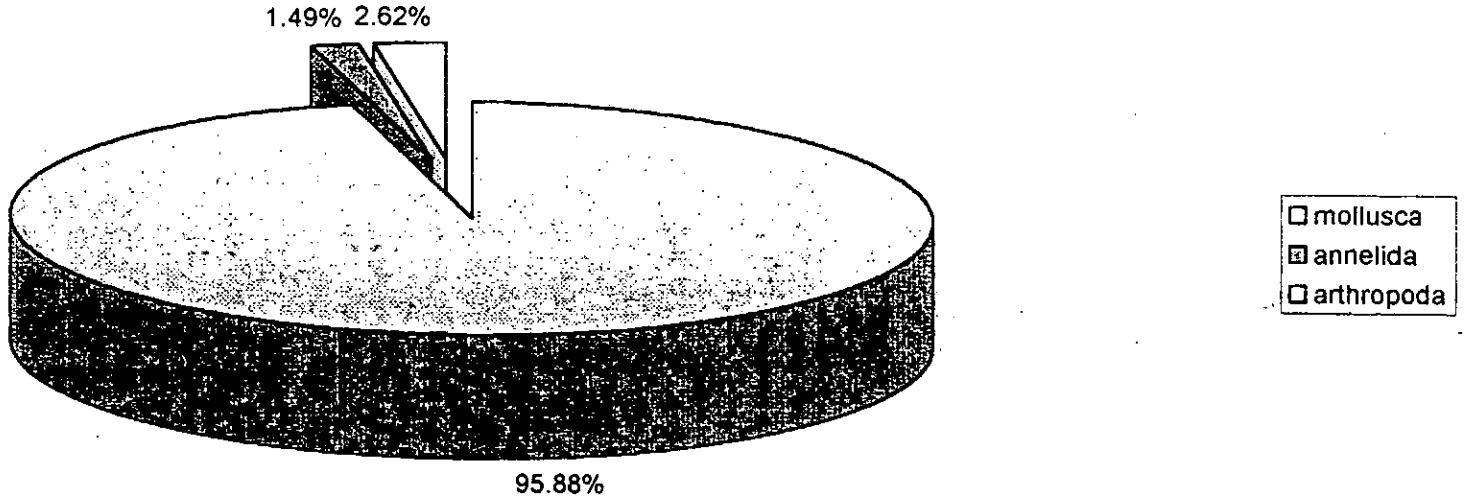

Fig 54. Percentage composition of animal phyla at station 7 in the dry and wet seasons in the western part of Lagos lagoon(May 1996- Feb.1998).

Station 8 (Ikoyi)

In addition to the phyla Mollusca, Arthropoda and Annelida, phylum Chordata was also present, and contributed 0.08% of the fauna collected. (Fig. 55, Tables 18a & b).

ii. Seasonal variation in animal phyla occurrence (Wet season)

Station 1 (Majidun creek)

Phylum Mollusca had the highest composition of all phyla found. (89.46%). This was followed by phylum Annelida, with a percentage of 6.90. Arthropoda and Nemertina had percentages of 3.24 and 0.30 respectively. Phylum Echiuroida had a percentage of 0.10, which was the lowest ranked fauna. The following phyla Pogonophora, Sipunculoidea, Porifera, Echinodermata, Hemichordata and Chordata were absent (Fig. 56, Table 19).

Station 2 (Ikorodu)

Phylum Mollusca contributed to 75.46% of fauna collected. Phylum Annelida ranked second (14.38%) and phylum Arthropoda ranked third (9.96%). Phylum Echinodermata ranked the lowest with a percentage of 0.07 (Table 19, Fig. 56).

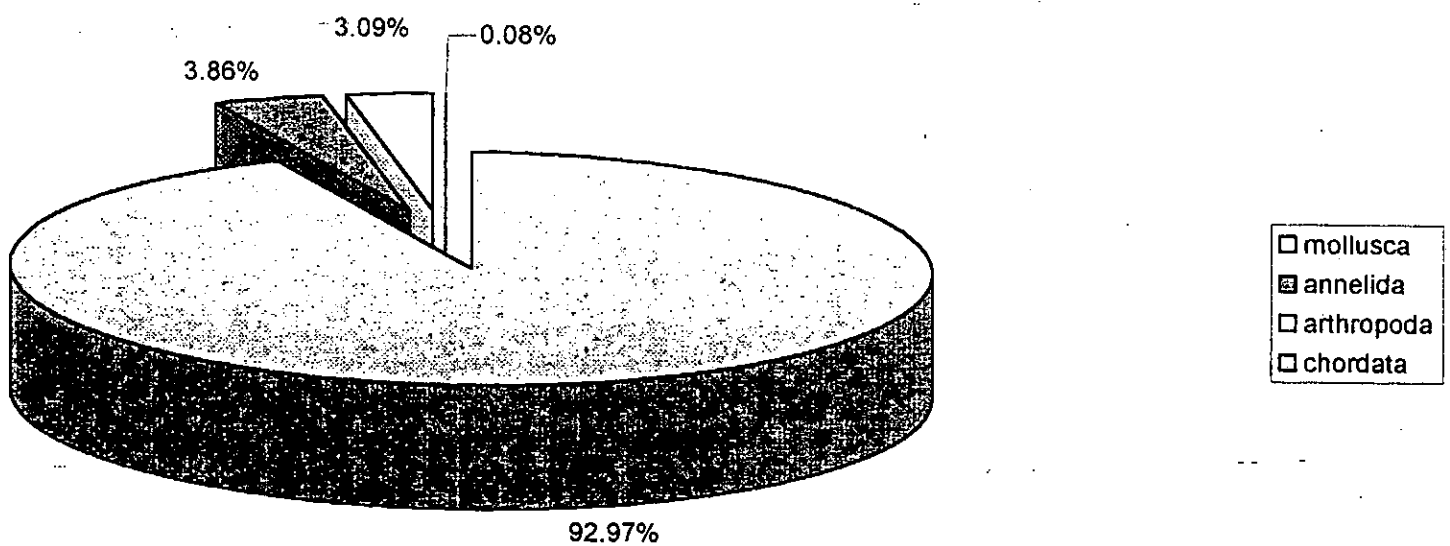

Fig 55. Percentage composition of animal phyla at station 8 in the dry and wet seasons in the western part of Lagos lagoon.(May 1996-Feb.1998).

Table 19: Percentage composition of animal phyla collected at the sampling stations in the western par of Lagos lagoon in the wet season (May 1996-February 1998) (Figures in parenthesis represent actual number of individuals).

	1	2	3	4	5	6	7	8
Mollusca	89.46 (882)	75.46(1076)	84.60 (698)	85.52 (1541)	92.40(1678)	87.24 (1901)	93.74 (674)	90.99(414)
Nemertina	0.30 (03)	0.14(02)	0.12 (01)	0.33(06)	-	-	-	-
Annelida	6.90(68)	14.38(205)	14.43	12.32 (222)	6.55 (119)	8.35 (182)	1.95 (14)	5.71 (26)
Pogonophora	-	-	-	0.17 (03)	0.22 (04)	0.04 (01)	-	-
Echiuroidea	0.10	-	-	0.11 (02)	-	0.14 (03)	-	-
Sipunculoidea	-	-	-	0.06	-	-	-	-
Porifera	-	-	-	-	-	-	-	-
Arthropoda	3.24(32)	9.96(142)	0.85 (07)	1.44 (26)	0.83 (15)	4.22 (92)	4.31 (31)	3.30 (15)
Echinodermata	-	-.07(01)	-	-	-	-	-	-
Hemichordata	-	-	-	0.06 (01)	-	-	-	-
Chordata	-	-	-	-	-	-	-	-

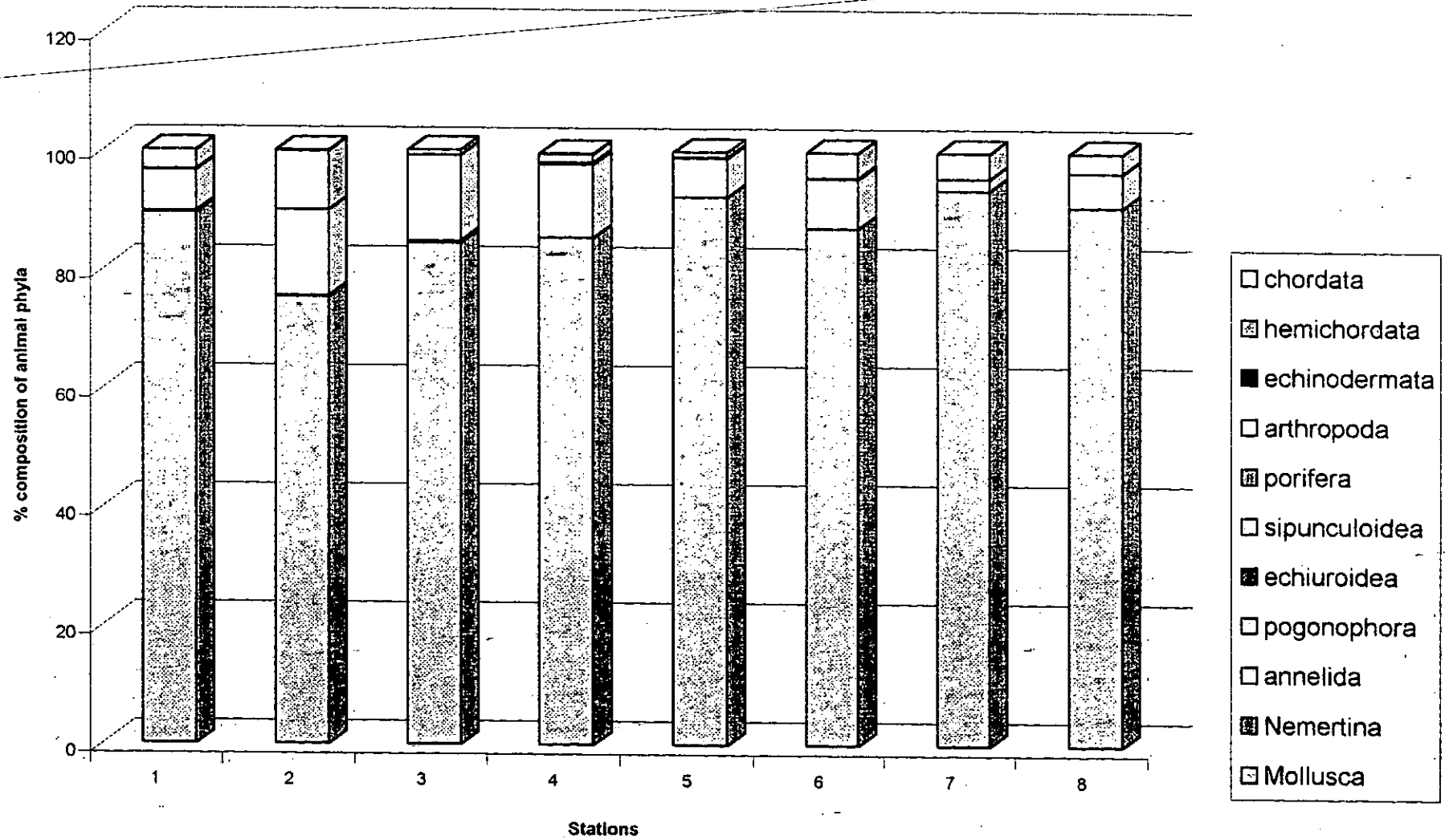

Fig. 56: Percentage composition of animal phyla collected at the sampling stations in the western part of Lagos lagoon in the wet season

Station 3 (River Ogun)

The Phylum Mollusca ranked first (84.60%). Phylum Annelida ranked second (14.43%) and phylum Arthropoda ranked third (0.85%). Phylum Nemertina had the least ranking (0.1.2%) (Table 19, Fig. 56).

Station 4 (Agboyi creek)

Station 4 comprised a diverse composition of fauna in the wet season such as Mollusca, Annelida, Arthropoda, Nemertina, Pogonophora, Echiuroidea, Sipunculoidea and Hemichordata which percentages were 85.52, 12.32, 1.44, 0.33, 0.17, 0.11, 0.06 and 0.06 respectively (Fig. 56, Table 19).

Station 5 (Ogudu)

Four phyla were collected at station 5 in the wet season. These were Mollusca (92.4%), Annelida (6.55%), Arthropoda (0.83%) and Pogonophora (0.22%) (Table 19, Fig. 56).

Station 6 (Oworonsoki)

Phylum Mollusca ranked first (87.24%), phylum Annelida second (8.35%), phylum Arthropoda third (4.22%) and phylum Echiuroidea (0.14%) fourth.

Phylum Pogonophora ranked fifth and lowest with a percentage of 0.04 (Table 19, Fig. 56).

Station 7 (University of Lagos lagoon Front)

Phylum Mollusca contributed 93.74% of fauna collected at station 7 in the wet season. Phylum Arthropoda contributed 4.31% and phylum Annelida 1.95% (Table 19, Fig. 56).

Station 8

In station 8 Phylum Mollusca contributed of 90.99%, Annelida (5.71%) and Arthropoda (3.30%) were collected at stations 8 in the wet season between May 1996 and February 1998 (Table 19, Fig. 56).

Three major phyla were collected from all stations during the wet season. The Phylum Mollusca, comprised the highest density at the stations while the Phylum Annelida and Phylum Arthropoda though present were also collected for all sampling stations at lower numbers. Phylum Nemertina was collected in the creek and river stations and at Ikorodu (st. 2), but was absent at all the other lagoon stations. Phylum Pogonophora was collected at stations 4, 5 and 6 while phylum Echiuroidea at stations 1, 4 and 6. The Phylum Echinodermata was recorded at station 2 (Ikorodu) while phylum Hemichordata was recorded at station 4 (Agboyi creek) only.

iii. Seasonal variation in animal phyla occurrence (dry season)

Station 1 (Majidun Creek)

Four phyla, Mollusca (76.84), Annelida (136.1), Porifera (0.81) and Arthropoda (9.39) were collected from the Majidun creek in the dry season months, between May 1996 and February 1998.

Station 2 (Ikorodu)

The following Phyla Mollusca (66.11%), Annelida (20.69%), Arthropoda (12.85%) and Sipunculoidea (0.18%) were collected at station 2 during the dry season. The Phyla Nemertina, Pogonophora and Phylum Echiuroidea were also collected and both contributed 0.06% of the phyla composition each (Fig. 57, Table 20).

Station 3 (River Ogun)

The composition of phylum Mollusca was high, at station 3 (3.93%) while the Phylum Annelida contributed 3.97%, phylum Arthropoda 1.27% and phylum Nemertina 0.84% of the total (Table 20, Fig. 57).

Station 4 (Agboyi creek)

In addition to the three most prominent phyla, Mollusca, Annelida and Arthropoda, which contributed 78.39%, 17.77% and 3.48% of the phyla

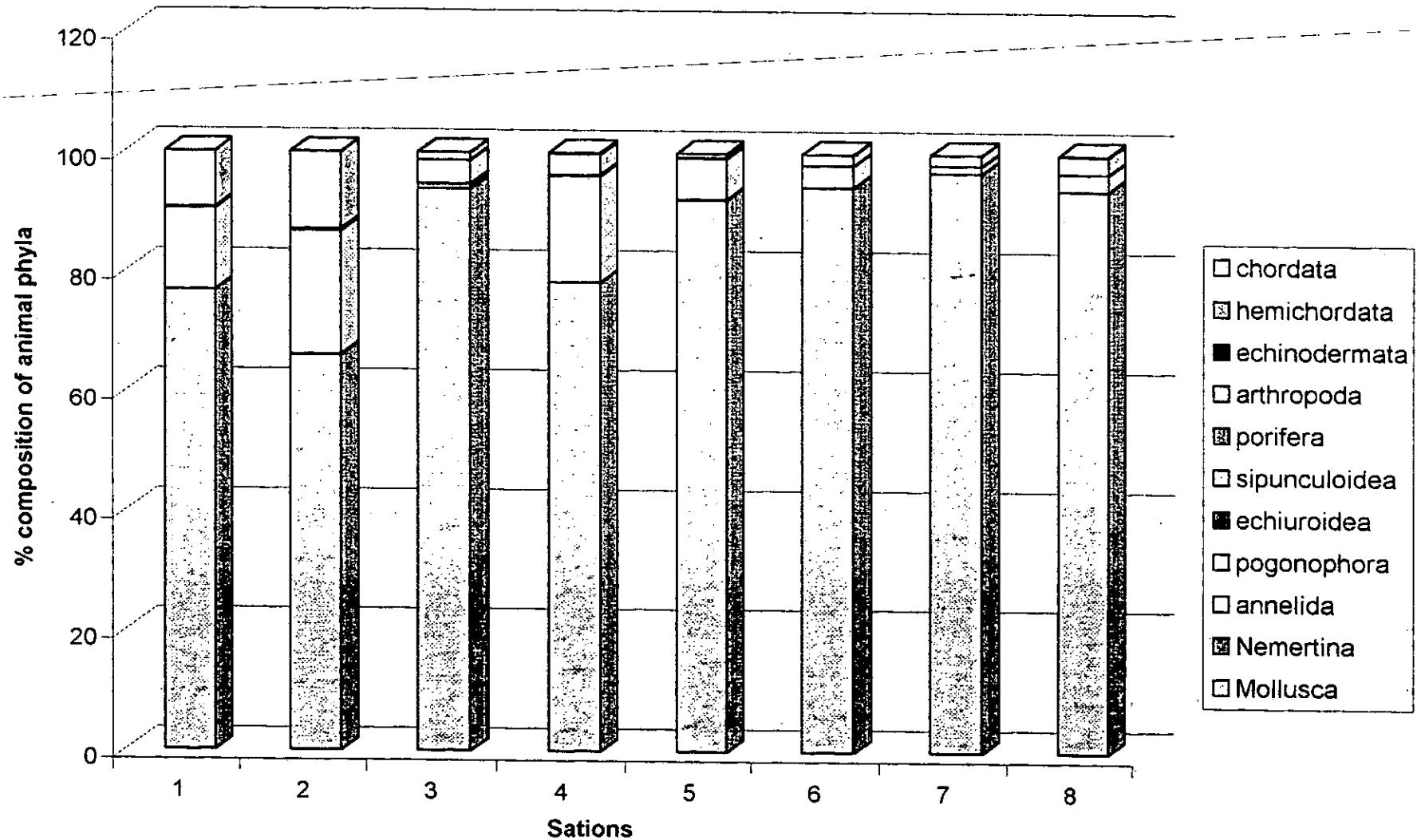

Fig. 57: Percentage composition of animal phyla collected at the sampling stations in the western part of Lagos lagoon in the dry season.

Table 20: Percentage composition of animal phyla collected at the sampling stations in the western of Lagos lagoon in the dry season (May 1996-February 1998) (Figures in parenthesis represent actual number of individuals).

	1	2	3	4	5	6	7	8
Mollusca	76.84 (491)	66.11 (1137)	93.93 (1113)	78.39 (428)	92.27 (1934)	94.44 (1885)	6.92 (1446)	94.05 (790)
Nemertina	-	0.06 (01)	0.84 (10)	-	0.09 (02)	0.05 (01)	-	-
Annelida	13.61 (87)	20.69 (356)	3.97 (47)	17.77 (97)	6.87 (144)	3.66 (73)	1.27 (19)	2.86 (24)
Pogonophora	-	0.06 (01)	-	0.18 (01)	0.05 (01)	-	-	-
Echiuroidea	-	0.06 (01)	-	-	-	-	-	-
Sipunculoidea	-	0.18 (03)	-	-	0.14 (03)	-	-	-
Porifera	0.16 (01)	-	-	-	-	-	-	-
Arthropoda	9.39 (60)	12.85 (221)	1.27 (15)	3.48 (19)	0.53 (11)	1.81 (36)	1.81 (27)	2.98 (25)
Echinodermata	-	-	-	-	-	-	-	-
Hemichordata	-	-	-	-	-	-	-	-
Chordata	-	-	-	0.18 (01)	0.05 (01)	0.05 (01)	-	0.12(01)

composition at st. 4 in the dry season, phylum chordata (0.18%) and Pogonophora (0.18%) were also collected (Fig. 57, Table 20).

Station 5 (Ogudu)

In the dry season, a variety of phyla was recorded in station 5. For instance, the Mollusca made up 92.27%, Annelida 6.87%, Arthropoda 0.53%, Sipunculoidea 0.14%, Nemertina 0.09% and the Pogonophora and Chordata made up 0.05 each (Fig. 57, Table 20).

Station 6 (Oworonsoki)

The Mollusca, Annelida, Arthropoda had percentages of 94.44, 3.66 and 1.81 each, at st. 6 in the dry season. The Phyla Nemertina and Chordata contributed 0.05% each (Fig. 57, Table 20).

Station 7 (University of Lagos lagoon Front)

Phylum Mollusca contributed to 96.92% of fauna collected, phylum Arthropoda 1.81% and phylum Annelida 1.27% (Fig. 57, Table 20).

Station 8 (Ikoyi)

In the dry season at Ikoyi, four phyla were collected. The Mollusca contributed 94.05% of species collected, the Arthropoda 2.98% and the Annelida 2.86%. The Phylum Chordata (0.12%) was only collected at this

station in the dry season, it contributed to 0.12% of the taxa collected (Fig. 57, Table 20).

The Mollusca, Annelida and Arthropoda were collected at all stations during the dry season. While the Nemertina occurred at 4 stations (2, 3, 5, & 6), while phylum Pogonophora occurred at stations 2, 4 & 5. The Phylum Sipunculoidea occurred only at stations 2 & 5 while the chordates occurred at stations 4, 5 and 6,and 8.Phylum Echiuroidea occurred only at st. 2 during the dry season.

Certain phyla were confined to one season whereas Phylum Porifera occurred in st.1 Majidun creek only in the dry season the Phylum Chordata also restricted to station 4, 5 and 6 only in the dry season. Similarly, in the wet season, phylum Echinodermata occurred at st. 2, while phylum Hemichordata occurred at st. 4 (Fig. 56).

H. DIVERSITY AND FAUNAL INDICES

i. Margalef's Index (d)

Station 1 (Majidun Creek)

Margalef's index values ranged between 0.87 (May 1996) and 3.23 (Sept. 1997). There was no trend and values did not vary seasonally (Fig. 58, Table 21).

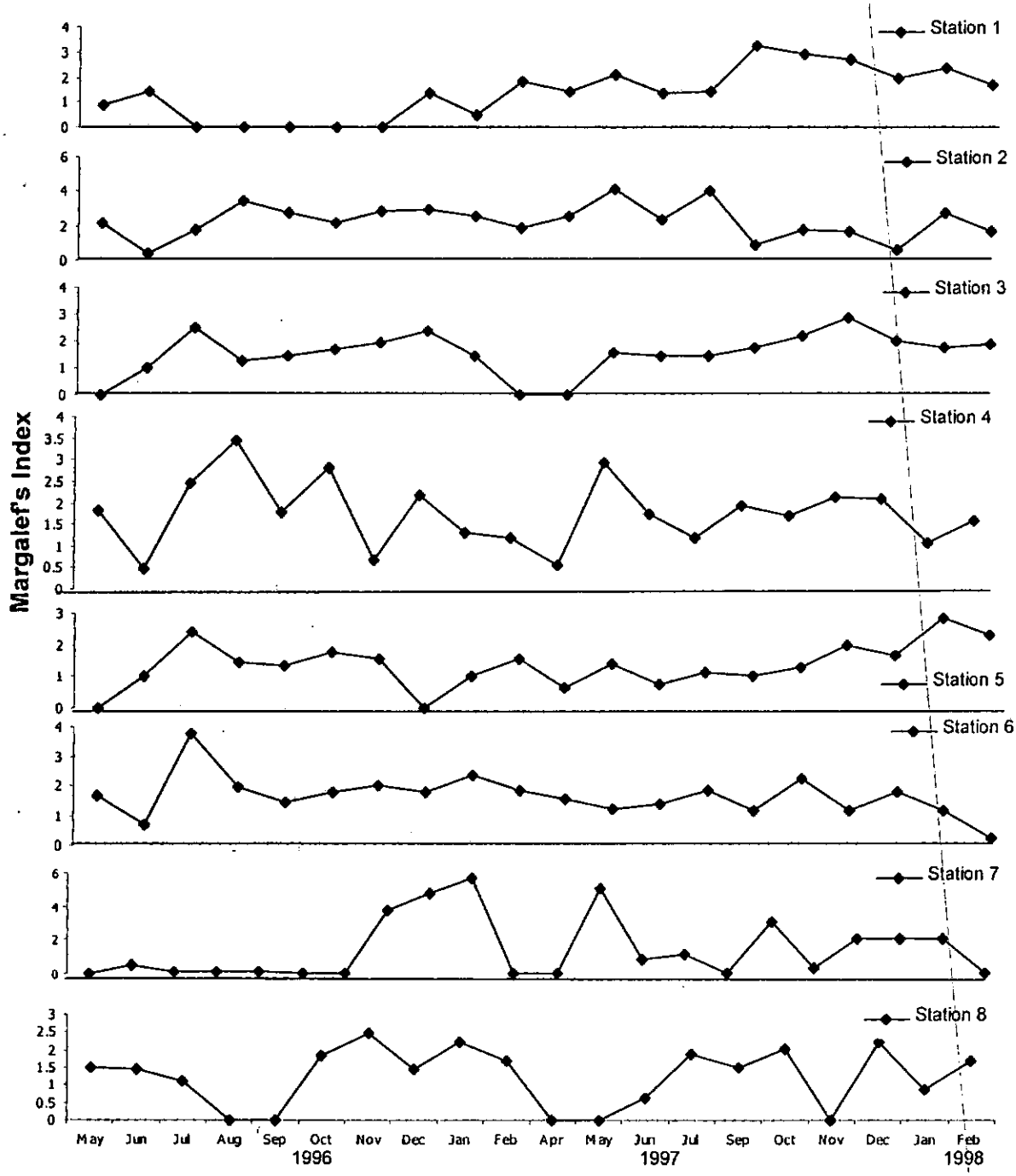

Fig.58: Margalef's Index values computed for fauna collected at sampling stations in the western part of Lagos Lagoon (May 1996 - Feb.1998)

Table 21: Margalef's Index values computed for fauna collected at stations in the western part of Lagos Lagoon (May 1996 to February 1998)

	1996								1997										1998	
MONTHS / STATIONS	M	J	J	A	S	O	N	D	J	F	A	M	J	J	S	O	N	D	J	F
1.	0.87	1.37	0.00	0.00	-	-	-	1.33	0.47	1.81	1.42	2.09	1.35	1.43	3.23	2.93	2.73	1.95	2.34	1.69
2.	2.21	0.42	1.78	3.48	2.71	2.14	2.82	2.92	2.58	1.88	2.59	4.18	2.35	4.08	0.85	1.75	1.70	0.58	2.79	1.71
3.	-	0.99	2.50	1.25	1.44	1.69	1.91	2.40	1.42	0.00	0.00	1.56	1.43	1.44	1.72	2.19	2.87	1.98	1.72	1.88
4.	1.81	0.46	2.47	3.43	1.80	2.82	0.67	2.16	1.31	1.17	0.54	2.92	1.74	1.19	1.96	1.69	2.12	2.10	1.05	1.57
5.	-	1.03	2.41	1.43	1.34	1.75	1.57	-	1.02	1.56	0.64	1.39	0.77	1.15	1.00	1.27	1.96	1.66	2.85	2.32
6.	1.68	0.66	3.77	1.97	1.42	1.80	1.98	1.75	2.37	1.83	1.52	1.18	1.36	1.81	1.16	2.24	1.71	1.77	1.16	0.24
7.	3.03	2.28	0.60	0.59	0.69	1.41	1.35	0.87	1.39	1.89	1.48	1.89	1.64	1.15	2.04	2.05	0.75	1.43	1.78	1.60
8.	1.52	1.45	1.11	-	0.00	1.82	2.48	1.44	2.23	1.67	0.00	-	0.63	1.89	1.48	2.01	-	2.24	0.89	1.69

Station 2 (Ikorodu)

In a dry month (Dec. 1997) the lowest Margalef's value was 0.58. The highest, 4.18 occurred in May 1997 (Fig. 58, Table 21).

Station 3 (River Ogun)

Margalef's value ranged between 0.99 and 2.87 (Fig. 58, Table 21). In July 1996, the value was 2.50; this decreased in August to 1.25 and increased progressively to 2.40 in December. Thereafter the value decreased to 0.00 in February and April. In May 1997 the value was 1.56, which decreased to 1.43 in June, and rose slightly to 1.44 in July. An increase occurred between July and November and a decrease between December and February 1998.

Station 4 (Agboyi Creek)

Margalef Index value was 1.81 in May 1996 and this decreased to 0.46 in June 1996. An increase to 2.47 was recorded in July and a decrease to 3.43 in August. There was a further decrease to 1.80 in September. The index was 2.82 in October and this decreased to 0.67 in November (Table 21, Fig. 58). The Margalef's index alues continued to fluctuate throughout the sampling period.

Station 5 (Ogudu)

Margalef Index values fluctuated throughout the sampling period. The highest value was 2.85 and the lowest 0.64, which occurred in April 1997 (Fig. 58, Table 21).

Station 6 (Oworonsoki)

At station 6 the Margalef's index ranged between 0.24 (February 1998) and 3.77 (July 1996) (Fig. 58, Table 21). Values fluctuated throughout the sampling period.

Station 7 (University of Lagos lagoon Front)

Margalef index values were 3.03 in May 1996 when sampling commenced. This reduced to 2.28 in June, o.60 in July and 0.59 in August and thereafter an increase occurred between September (0.69) and October (1.41). There was a drop from 1.35 to 0.87 (Nov.-Dec.), before another rise occurred Jan-Feb (1997). Values fluctuated in a similar pattern, throughout the rest of the sampling period (Fig. 58, Table 21).

Station 8 (Ikoyi)

Margalef's values ranged between 0.63 and 2.48 (Table 21, Fig. 58). There were fluctuations throughout the sampling period.

ii. Shannon and Weaver Information Function (H')

Station 1 (Majidun Creek)

The lowest value was 0.68, occurred in June 1996, while the highest 2.38 occurred in September 1997 (Fig. 59, Table 22). In July and August values were 0.00 while on other occasions the index fluctuated.

Station 2 (Ikorodu)

Shannon and Weaver Information Function value was highest (2.18) in November 1996 and July 1997 and lowest (0.36) in December 1997 (Fig. 59, Table 22) during the sampling period. The information function fluctuated in other months.

Station 3 (River Ogun)

At River Ogun Shannon and Weaver Information Function values were lower than those computed for stations 1 (Majidun creek) and 2 (Ikorodu). The lowest value 0.99 was recorded in May 1977 while the highest value 2.12 was recorded in October 1997 (Fig. 59, Table 22). Values were 0.00 in February and April 1997, and fluctuated in other sampling dates.

Station 4 (Agboyi Creek)

The range of Shannon and Weaver Information Function values at station 4 during the sampling period fluctuated between 0.35 in June 1996 and 2.44

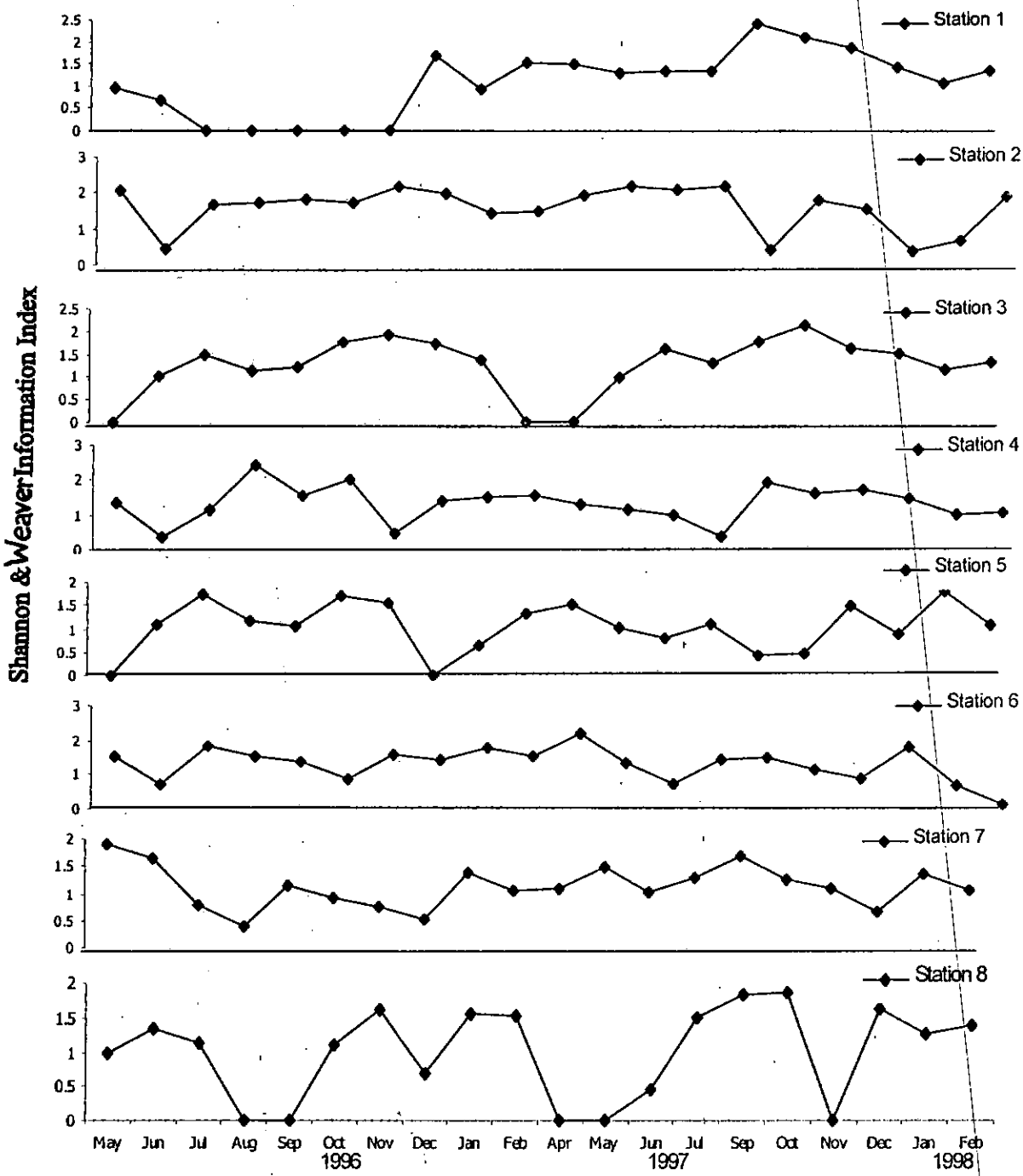

Fig. 59: Shannon & Weaver Information Function values computed for fauna collected at sampling stations in the western part of Lagos Lagoon (May 1996 - Feb.1998)

Table 22: Shannon and Weaver Information Function values computed for fauna collected at sampling stations in the western part of Lagos lagoon (May 1996 to February 1998)

Sampling period	1996								1997										1998	
Stations	M	J	J	A	S	O	N	D	J	F	A	M	J	J	S	O	N	D	J	F
1.	0.94	0.68	0.00	0.00	-	-	-	1.67	0.91	1.51	1.47	1.28	1.31	1.32	2.38	2.06	1.83	1.38	1.05	1.31
2.	2.08	0.43	1.67	1.70	1.84	1.72	2.18	1.95	1.44	1.49	1.93	2.18	2.07	2.18	0.39	1.78	1.51	0.36	0.63	1.88
3.	-	1.03	1.50	1.12	1.21	1.77	1.92	1.73	1.36	0.00	0.00	0.99	1.60	1.28	1.76	2.12	1.62	1.50	1.13	1.28
4.	1.35	0.35	1.14	2.44	1.55	2.02	0.45	1.39	1.49	0.56	1.28	1.12	0.99	0.37	1.89	1.62	1.71	1.44	0.97	1.02
5.	-	1.08	1.75	1.17	1.07	1.71	1.54	-	0.65	1.33	1.50	1.01	0.80	1.09	0.41	0.45	1.48	0.87	1.79	1.05
6.	1.51	0.73	1.82	1.52	1.38	0.86	1.60	1.41	1.76	1.53	2.17	1.33	0.72	1.43	1.46	1.14	0.84	1.77	0.68	0.09
7.	1.89	1.65	0.80	0.40	1.16	0.91	0.75	0.54	1.38	1.06	1.08	1.46	1.02	1.29	1.68	1.24	1.07	0.64	1.36	1.06
8.	0.99	1.35	1.14	-	0.00	1.10	1.61	0.69	1.56	1.52	0.00	-	0.46	1.48	1.82	1.86	-	1.61	1.25	1.38

in August 1996. On other dates values fluctuated between these values (Fig. 59, Table 22).

Station 5 (Ogudu)

The index was 1.08 in June 1996, this increased to 1.75 in July 1996, decreased to 1.17 in August and 1.07 in September. Thereafter the value increased to 1.71 (October), decreased in November and decreased further in January 1997. In 1997 and 1998 peaks of 1.50, 1.09, 1.48 and 1.79 occurred in April, July, November 1997 and January 1998 respectively (Fig. 59, Table 22).

Station 6 (Oworonsoki)

Peaks occurred in July 1996 (1.82), November 1996 (1.60), January 1997 (1.76), April 1997 (2.17), and December 1997 (1.77). The lowest value occurred in February 1998 (0.09) (Table 22, Fig. 59).

Station 7 (University of Lagos lagoon Front)

The standard index value was highest (1.89) in May 1996 and lowest (0.40) in August 1996. There was no seasonal variation between these values (Fig. 59, Table 22).

Stations 8 (Ikoyi)

The standard index varied between 0.69 and 1.86 (Fig. 59, Table 22). Peaks occurred in June 1996 (1.35), November 1996 (1.61), January 1997 (1.56) and October 1997 (1.86).

iii. Equitability (j)

Station 1 (Majidun Creek)

The lowest equitability values occurred in July and August 1996 (0.00). The highest values occurred in November 1997 (0.65) (Fig. 60, Table 23).

Station 2 (Ikorodu)

Equitability values ranged between 0.15 in January 1998 and in October 1997. A value of 0.58 was recorded in May 1996, April 1997 and June 1997 (Table 23, Fig. 60).

Station 3 (River Ogun)

Equitability values were 0.00 in February and April 1997 whereas in December 1996 the equitability value was 0.67 (Fig. 60, Table 23).

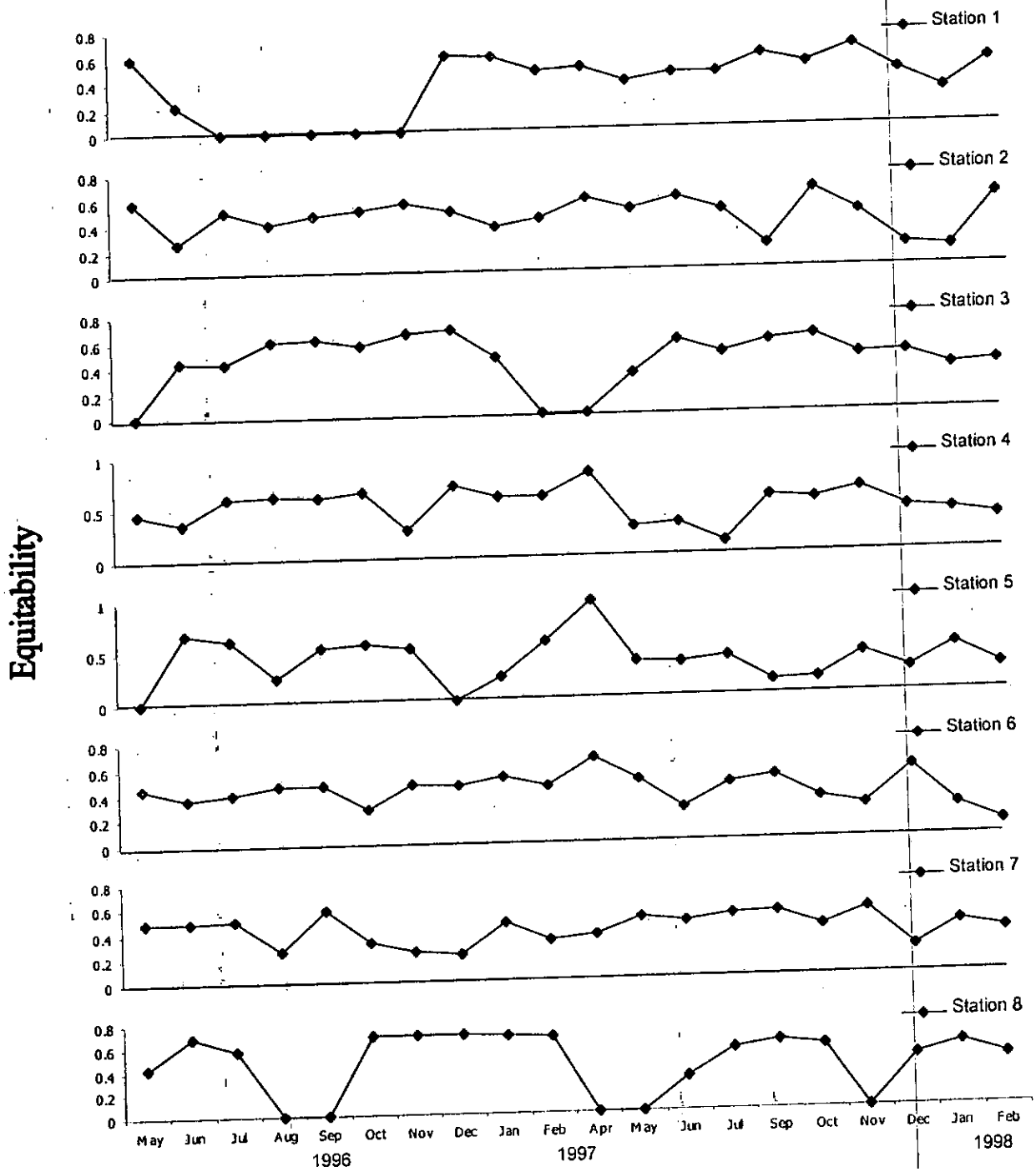

Fig.60: Equitability values computed for fauna collected at sampling stations in the western part of Lagos Lagoon(May 1996 - Feb.1998)

Table 23: Equitability values computed for fauna collected at sampling stations in the western part of Lagos lagoon (May 1996 to February 1998)

Sampling period	1996								1997										1998	
Months / Stations	M	J	J	A	S	O	N	D	J	F	A	M	J	J	S	O	N	D	J	F
1.	0.59	0.22	0.00	0.00	-	-	-	0.60	0.58	0.47	0.49	0.37	0.44	0.44	0.58	0.50	0.65	0.44	0.28	0.51
2.	0.58	0.26	0.50	0.40	0.47	0.50	0.56	0.49	0.36	0.43	0.58	0.49	0.58	0.48	0.20	0.63	0.45	0.18	0.15	0.57
3.	-	0.44	0.42	0.60	0.61	0.56	0.64	0.67	0.45	0.00	0.00	0.31	0.57	0.46	0.56	0.59	0.44	0.45	0.33	0.36
4.	0.45	0.35	0.59	0.62	0.60	0.64	0.28	0.69	0.58	0.58	0.81	0.27	0.30	0.12	0.55	0.51	0.61	0.42	0.38	0.32
5.	-	0.68	0.62	0.24	0.53	0.57	0.51	-	0.23	0.57	0.95	0.36	0.34	0.39	0.14	0.16	0.40	0.25	0.47	0.26
6.	0.45	0.36	0.39	0.46	0.46	0.27	0.46	0.44	0.51	0.43	0.65	0.47	0.24	0.43	0.48	0.31	0.24	0.53	0.23	0.09
7.	0.49	0.48	0.50	0.25	0.58	0.31	0.24	0.21	0.46	0.31	0.36	0.49	0.44	0.50	0.51	0.39	0.53	0.21	0.41	0.34
8.	0.42	0.68	-	-	0.00	0.69	0.69	0.69	0.67	0.65	0.00	-	0.29	0.53	0.58	0.54	-	0.43	0.54	0.42

Station 4 (Agboyi Creek)

The lowest value of equitability 0.12 was recorded at station 4 while the highest 0.81 was recorded in (Fig. 60, Table 23). Another peak occurred in December 1996 (0.69).

Station 5 (Ogudu)

Equitability was 0.68 in June 1996, 0.62 in July and 0.24 in August while in September the value increased to 0.53 and further to 0.57 in October, this decreased in November to 0.51 and lower to 0.23 in January 1997. Values fluctuated in 1997 and a low equitability value of 0.26 occurred in February 1998 (Fig. 60, Table 23).

Station 6 (Oworonsoki)

Fluctuations in equitability occurred in station 6, throughout the sampling period. The highest value was 0.65, while the lowest was 0.09 (Fig. 60, Table 23).

Station 7 (University of Lagos lagoon Front)

Equitability was 0.49 in May 1996 when sampling began. This reduced slightly to 0.48 in June 1996 and increased to 0.50 in July 1996. Thereafter another decrease occurred (0.25) in August and an increase (0.58) in September. In October 1996 a value of 0.31 was recorded this reduced to

0.24 in November and 0.21 in December. A value of 0.46 occurred in January 1997, and fluctuations occurred between January and December 1997. In 1998 a value of 0.41 occurred in January and 0.34 in February (Fig. 60, Table 23).

Station 8 (Ikoyi)

Equitability values varied between 0.00 and 0.69. In September 1996 and April 1997 equitability values were 0.00. In October, November and December 1996 equitability values were 0.69 (Fig. 60, Table 23).

I. PHYSICO-CHEMICAL PARAMETERS AND FAUNA RELATIONSHIP

i. Salinity vs. log number of individuals

Salinity was higher in the dry season (Jan, Feb) (9, 10, 21 & 22 $^{0}/_{00}$) than the rainy season. Lower salinity values were recorded in the wet season months, September, October (5 and 6 $^{0}/_{00}$) and May, June, September and October 1997 (13, 14, 15, 17 and 18‰). This variation in salinity did not affect the log number of individuals. The log number of individuals varied only slightly during the sampling period. Therefore salinity as an independent chemical parameter did not affect density of fauna adversely (Fig. 61, Table 24).

ii. Salinity vs. log number of species

Although percentage species were nearly equal in both dry and wet seasons (Fig. 62, Table 25) and values were low (<2.00) throughout the sampling period, slight variations occurred in log number of species in low salinity months (June 1996 with salinity $2^0/_{00}$), and September 1996 ($5.0^0/_{00}$). In 1997 February, May and July (10, 12 and $14^0/_{00}$) lower species diversity occurred during the wet season, this could be due to leaching of loosely attached fauna which were eventually washed into the ocean via the harbour.

iii. Total Organic Content (TOC) vs log number of species

There was a low positive relationship between TOC and number of species. In June, July and August 1996 when TOC was 2.02, 2.40 and 2.70% respectively. Log number of species also increased (1.18, 1.51 and 1.53). In September when TOC decreased to 1.29%, log number of species was 22. A slight increase occurred in TOC and species hereafter. A further decrease in TOC (2.52) and increase in log number of species (1.45) occurred in December 1996. In January and February 1997, TOC was 1.87% and 3.80% respectively, while log number of species was 1.52 and 1.38 (Fig. 63, Table 26).

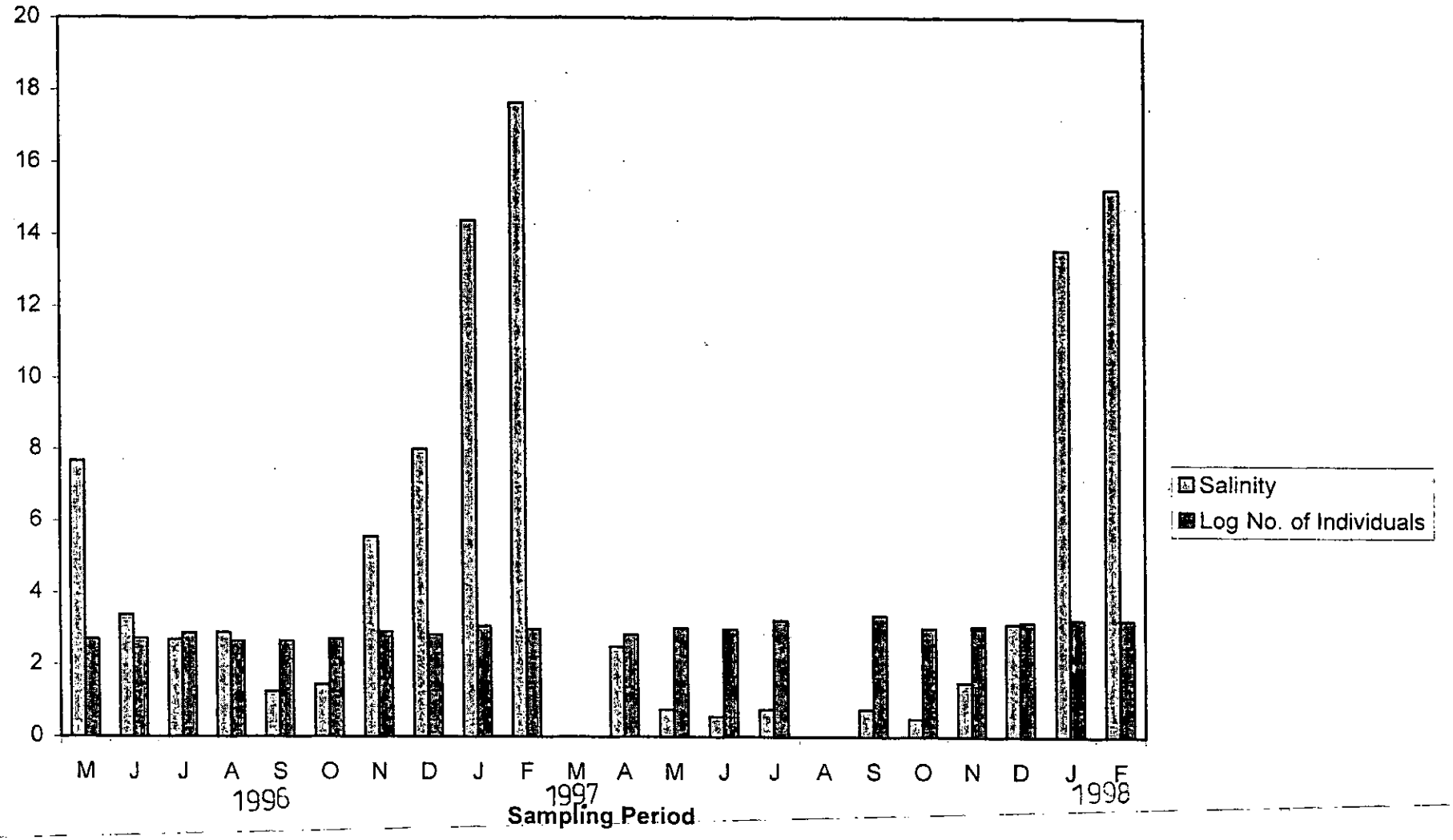

Fig. 61: Salinity ‰ vs log number of individuals for fauna collected at the sampling stations in the western part of Lagos Lagoon (May 1996 - February 1998)

Table 24: Salinity (‰) VS log number of individuals for fauna collected at sampling stations in the western part of Lagos Lagoon (May 1996- February 1998)

Salinity (‰)	No of individuals	Log no-of individuals
7.67	500	2.6990
3.38	531	2.7251
2.69	763	2.8825
2.88	442	2.6454
1.25	453	2.6561
1.44	522	2.7`77
5.56	821	2.9143
8.00	684	2.8351
14.38	1168	3.0674
17.64	961	2.9827
-	-	-
2.50	672	2.8274
0.75	1047	3.0199
0.56	947	2.9763
0.75	1694	3.2289
-	-	-
0.75	2275	3.3570
0:50	1053	3.224
1.50	1149	3.0603
3.13	1501	3.1764
13.57	1772	3.2485
15.25	17773	3.2487

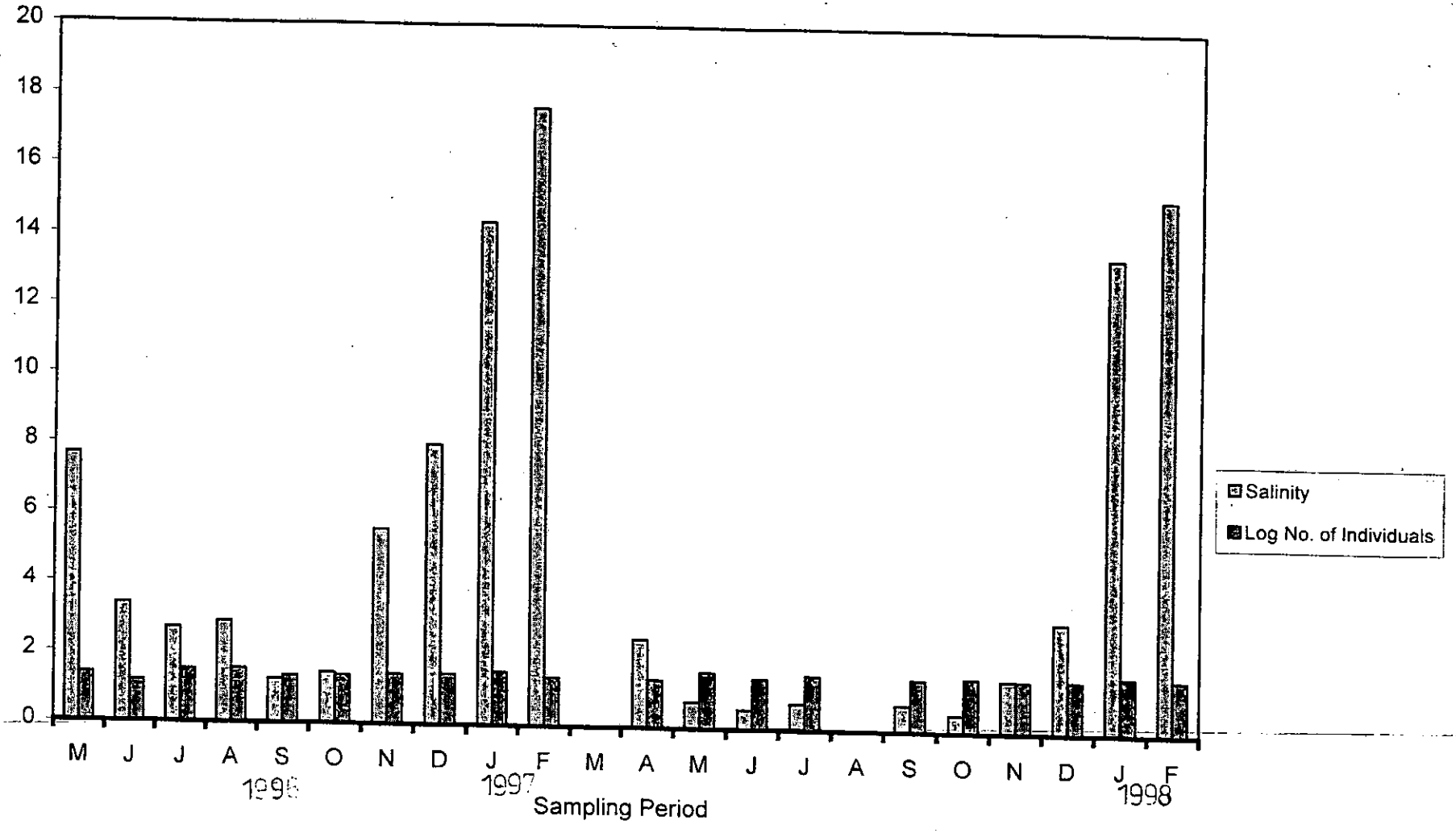

Fig. 62: Salinity ‰ vs log number of species for fauna collected at the sampling stations in the western part of Lagos Lagoon (May 1996-February 1998)

Table 25: Salinity (‰) VS log number of species for fauna collected at the sampling stations (May 1996- February 1998)

Salinity (‰)	No of individuals	Log no-of species
7.67	24	1.3802
3.38	15	1.1761
2.69	32	1.5051
2.88	34	1.5315
1.25	22	1.3424
1.44	24	1.3802
5.56	26	1.4150
8.00	28	1.4472
14.38	33	1.5185
17.64	24	1.3802
-	-	-
2.50	23	1.3617
0.75	39	1.5911
0.56	27	1.4314
0.75	35	1.5441
-	-	-
0.75	30	1.4771
0.50	34	1.5315
1.50	30	1.4771
3.13	31	1.4914
13.57	41	1.6128
15.25	35	1.5441

iv. Total Organic Content (TOC)% vs log number of individuals

In July 1996, there was an increase in TOC (2.40%), with a corresponding increase in log number of individuals (2.88). Although TOC increased further to 2.70% in August, log number of individuals decreased to 2.64 and remained constant at 2.65 in September, when TOC decreased to 1.29% (Fig. 64, Table 27). A slight increase to 1.70% occurred in October, while log number of individuals was 2.71. An increase in TOC to 2.98% was recorded in November. Similarly, the log number of individuals also increased to 2.91. TOC decreased to 1.87% in January 1997, while the log number of individuals was 3.07, which was followed by an increase in TOC to 3.80% in February, and a decrease in log number of individuals (2.98). In spite of the sporadic TOC values during 1997, log number of individuals increased steadily between October, November and December 1997 (3.02, 3.06 and 3.17 respectively). A further increase to 3.24 was recorded in January 1998. Similarly, in February 1998 TOC decreased to 1.61%.

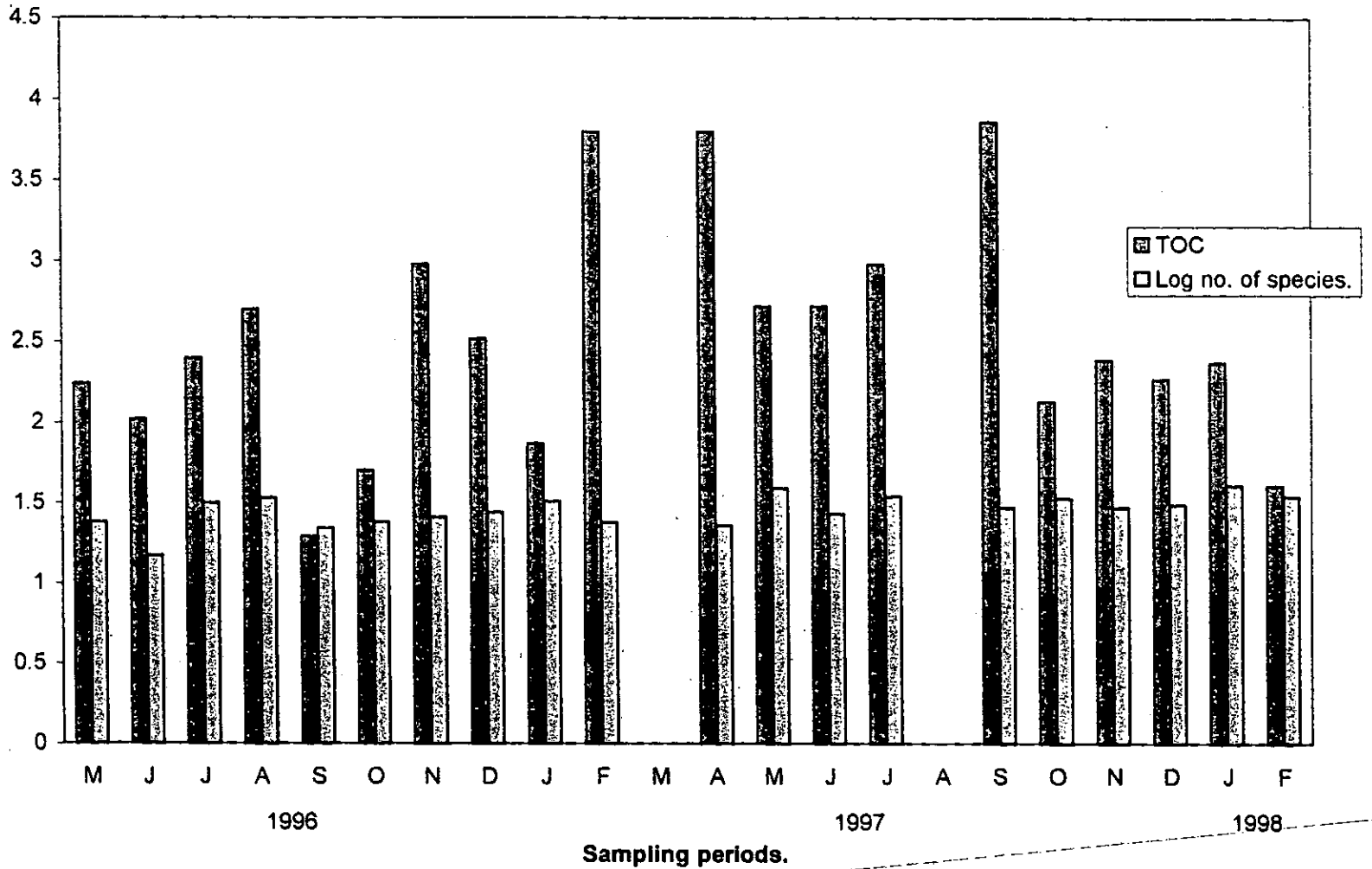

Fig .63. Total organic content (TOC) ‰ log number of species for fauna collected at the sampling stations in the western part of Lagos lagoon (May 1996-Feb.1998).

Table 27: Total Organic Content (TOC) % VS log number of individuals for fauna collected at sampling stations in the stations in the western part of Lagos lagoon (May 1996 – February 1996).

TOC (%)	No. of individuals	Log no. of individuals
2.24	500	2.990
2.02	531	2.7251
2.40	763	2.8825
2.70	442	2.6454
1.29	453	2.6561
1.70	522	2.7177
2.98	821	2.9143
2.52	684	2.8351
1.87	1168	3.0674
3.80	961	2.9827
-	-	-
3.80	672	2.8274
2.72	1047	3.0199
2.72	947	2.9763
2.98	1694	3.2289
-	-	-
3.86	2275	3.3570
2.13	1053	3.0224
2.39	1149	3.0603
2.27	1501	3.1764
2.37	1772	3.2485
1.61	1773	3.2487

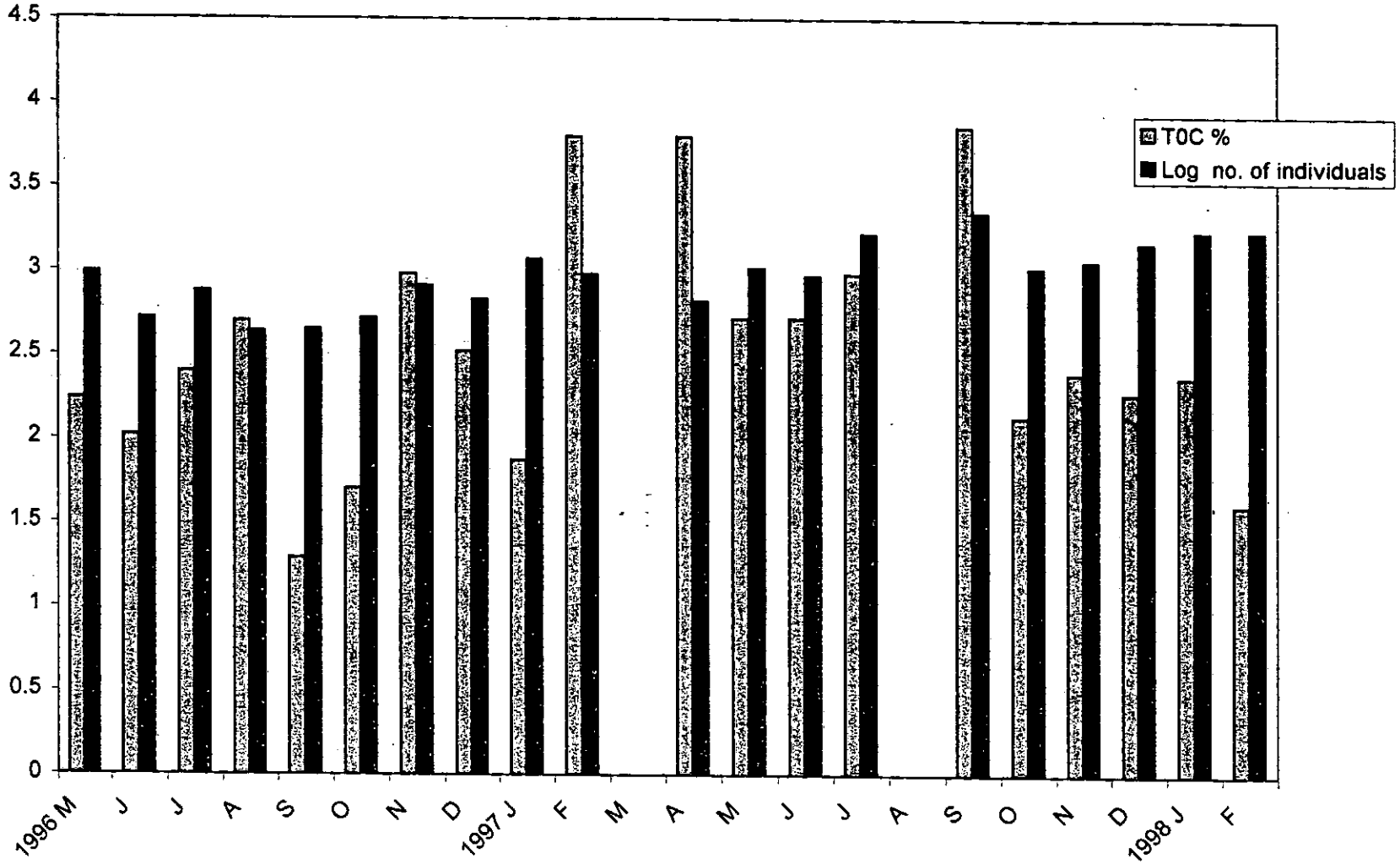

Fig.64.Total organic content (TOC) %/ log number of individuals for fauna collected at the sampling stations in the western part of Lagos lagoon (May 1996-Feb.1998).

J. EXPERIMENTAL RESULTS

i. Survival – Time Experiments on *P. aurita*

For *P. aurita* in various salinities, the animals survived in salinity of 30-35$^0/_{00}$ for 8 days, 20-27$^0/_{00}$ for 9 days and 0-20$^0/_{00}$ for 90 days. This showed that *P. aurita* had a wide range of salinity tolerance and could survive in a brackish or euryhaline environment. In the natural habitat of the Lagos lagoon *P. aurita* survived in a salinity which ranged between 0-26$^0/_{00}$.

Survival-time graphs for *P. aurita* against salinity showed that *P. aurita* was euryhaline and had a wide range of tolerance 0$^0/_{00}$ to 30$^0/_{00}$ (Fig. 65). Above 30‰ salinity values were less tolerable, *P. aurita* did not survive the time span of the experiments (80-90 days).

P. aurita survived for 9 days at salinities between 20-22$^0/_{00}$ (Fig. 65), 9 days of salinities between 22 and 25$^0/_{00}$ (Fig. 65), 9 days at salinities 25-27$^0/_{00}$ and 8 days at salinities 35$^0/_{00}$ and above (Fig. 65). All values were represented as averages of triplicate experiments.

Although *P. aurita* is euryhaline, these experiments show that it can survive for a few days at very high salinities.

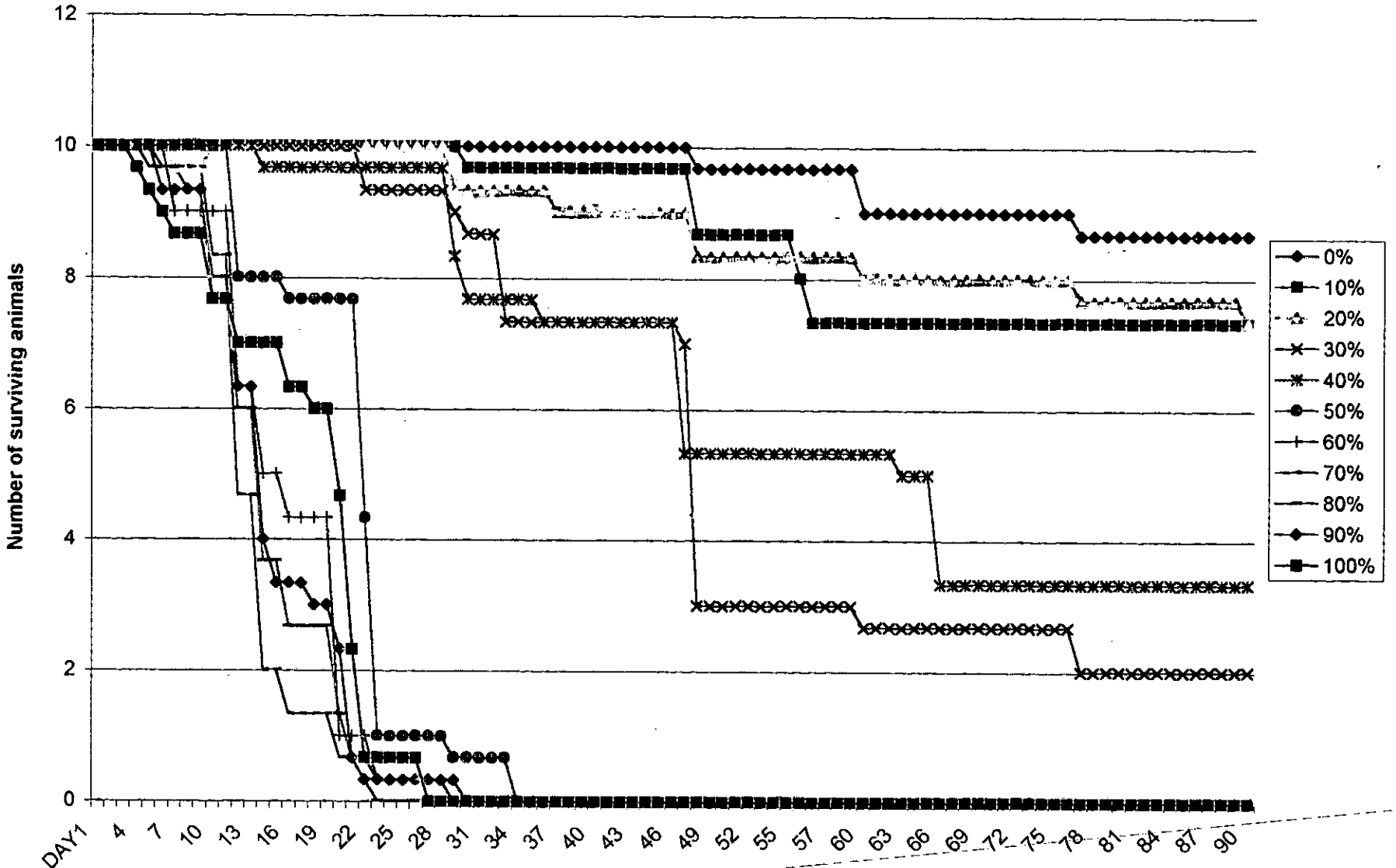

FIG.65.Number of surviving animals of *P.aurita* in various salinities.

ii. Sediment Preference

At the end of twenty-four hours, all the ten experimental specimens of *P. aurita* had moved to the sandy mud portion. This showed the preference of *P. aurita* to sandy-mud sediment. In nature they are collected in sandy mud, muddy sand and sandy sediments (Plate 1).

For *P. fusca quadriseriata* after 24 hours, 6 specimens were in the muddy sediment, 2 in the sandy-mud and 2 in muddy sand. This showed the preference of *P. fusca quadriseriata* to muddy/sandy mud sediments. In nature *P. fusca quadriseriata* were collected in muddy and sandy mud sediments (Plate 2).

PLATE 1.

Sediment preference of *Pachymelania aurita* in four selected sediment types.

PLATE 2.

Sediment preference of *Pachymelania quadriseriata* in four selected sediment types.

PLATE 1

PLATE 2

DISCUSSION

The tropical estuarine features of the Lagos lagoon as well as its location, being the only outlet into the sea between Porto Novo and the Benin River make it a very interesting ecological environment for aquatic studies. Pioneering studies involving different aspects of the lagoon include the works of Webb (1958). Hill and Webb (1958), Hill (1967), Webb (1958a & b), Webb and Hill (1958), Sandison (1966a & b), Fagade (1969, 1971), Fagade and Olaniyan (1972, 1974), Kusemiju (1975a & b), Oyenekan (1975, 1979), Kusemiju *et al.* (1983), Nwankwo (1984), Oyenekan (1988), Nwankwo (1986, 1988, 1991a), Brown 1991 and Solarin (1999). The present work extends to lower Ogun River, Agboyi creek and Majidun creek, which are quieter and less polluted stations but which still experience the diurnal tidal effect from the sea via the lagoon. The physical and chemical parameters of the water and sediment affect density, diversity and distribution of fauna. Some of these factors affect fauna adversely, while others affect fauna minimally. These shall be discussed singly and in combination with one another, as no single factor can affect density, diversity or distribution independently of others. Physical and chemical factors are however, not the only parameters that affect density, diversity and distribution of fauna, as other extrinsic factors like biological and physiological influences may equally be involved.

temperature ($27^{O}C$) was observed in this study. This was higher than the lowest temperature of earlier workers, and indicated a gradual increase in minimum water temperature. Lower water temperatures which occurred in the rainy season May – September could be attributed to rainfall, cloud cover, or increased runoff from rivers, streams and creeks. During the dry season water temperatures could also be lowered due to harmattan winds. Fagade (1969) also observed low temperatures in the rainy season and harmattan period. The highest temperature he observed was $30^{O}C$. A similar maximum temperature was observed in this study. Since temperature is not considered as an important pysico-chemicals factor, it was not considered an important ecological factor to affect density, diversity or distribution of fauna. However, temperature may be considered an important physical factor under certain circumstances as a change in temperature of an ecosystem brought about by effluent discharge that affect the stability of biota (Ajao and Fagade, 1990b).

Hydrogen ion content (pH)

Bottom water pH values for stations in the northwestern part of the lagoon fell within that of a "clean unpolluted water body" (Lagler, 1978). The picture however, changed for the southwestern stations, where the range was wider 5.72 – 8.15. This was probably an indication of slight pollution in these areas that are close to sources of point pollution such as sewage disposal and sawmill sites. Ajao (1990, 1996) described the southwestern part of Lagos lagoon as polluted

Akinsoji, 1992 and Nwankwo 1993). These observations were similar to those made in the present work. Fagade (1969) also concluded that the amount of silt present in the lagoon was dependent on the quantity of sea water entering the lagoon.

Conductivity

Conductivity was higher in the dry season than rainy season, confirming the higher concentration and higher salinity. According to previous authors (Ajao, 1990, Oyenekan, 1975 and Webb, 1958), salinity gradient increases from the harbour inland.

Salinity

The Lagos lagoon experiences annually two major seasons, the rainy and dry seasons. The rainy and dry seasons affect salinity which in turn affects the density, diversity and distribution of fauna. Salinity is one of the major features which affect fauna in the Lagos lagoon (Brown, 1991). The seasonal distribution of fauna in the Lagos lagoon and adjourning harbour have been previously documented by Hill and Webb (1958), Olaniyan (1961), Sandison and Hill (1966), Fagade (1969), Oyenekan (1975), Oyewo *et al.* (1982), Ajao (1990) and Brown (1991). Changes in salinity could occur temporally or spatially. During the wet (low salinity) season salinities range between 0 and $10^{0}/_{00}$, between June and October 1996 and May and November 1997 at all stations. Similarly, Fagade

(1969) observed lower salinity values between May and July 1967 and September and October 1967, March and June 1968 in Lagos lagoon. He also recorded freshwater conditions at the entrance of Ogun River into the lagoon between mid-June and early November and at Ikoyi in July-September 1969. Likewise higher salinity values occurred in the dry season when rainfall either ceased or was minimal. Salinity values were high ($26^0/_{00}$) in the dry season, April 1997, December 1997 – February 1998 when sampling ended. Fagade (1969) observed high salinities in the Lagos lagoon between January and March 1967. He observed that the Lagos lagoon was brackish between December and May, but consisted of freshwater between June and November. There was however, an exception at Ikoyi, a site close to the Lagos harbour, which opens into the sea. This station was brackish throughout the year. Similar results were obtained in the present study. The maximum salinity at Ikoyi and University of Lagos lagoon front in the wet season was $10.00^0/_{00}$. Similar high salinities for stations in the southern part of the lagoon have been obtained by Fagade (1969), Oyenekan (1988), Ajao (1990) and Brown (1991). The salinities of stations in northwest part of Lagos lagoon were lower. Minimum salinities ranged between 0 and $2^0/_{00}$ at each station, in both seasons, while maximum salinities were between 2.50 and $7.50^0/_{00}$ in the wet season and 4.56 and $10.33^0/_{00}$ in the dry season. Maximum salinity was 6.50 at Majidun creek and Ikorodu, while it was ($2.5^0/_{00}$) at Ogun River in the wet season. An increase in salinity to $5.5^0/_{00}$ occurred at Agboyi creek. The maximum salinities in the dry season confirm the decrease in salinity

gradient from south to north of the lagoon between Oworonsoki and Majidun creek, and a further increase between University of Lagos lagoon front and Ikoyi. Similar observations of a salinity gradient in Lagos lagoon have been noted by Fagade (1969), Oyewo *et al.* (1982), Ajao (1990) and Nwankwo (1990b). This salinity gradient was more pronounced in the dry season than wet season. These salinity variations could be due to (i) tidal influence and (ii) proximity of stations to the ocean. Minimum salinity values in this study were lower than values recorded by Oyenekan (1975), however, Ajao and Fagade (1990d) also recorded low values ($0.00^0/_{00}$) for salinity at Ikoyi, Oworonsoki, Ikorodu and University of Lagos lagoon front in the wet season of 1985 and 1986. This shows a decrease in salinity over the years, which could be due to increased flow of creeks and rivers into the lagoon or increased rainfall.

Salinity variations gave rise to a diverse population of organisms, varying between stenohaline and euryhaline species.

Sediment types

Although physico-chemical parameters of water are very important in the study of benthos, the physical characteristics of the sediment are more important since benthic organisms live on the surface or burrow into the sediment. Oyenekan (1988) and Ajao (1990) noted that the Lagos lagoon consisted of various sediment types. In the Lagos lagoon Oyenekan (1988) classified fine, medium and coarse

sand mixed with various proportions of silt and clay. The results of Oyenekan (1988) and Ajao (1990) supported those of Longhurst (1958) who classified sediment type and fauna along the West African coast. Oyenekan (1988) and Ajao (1990) observed sandy muddy deposits in the central Lagos lagoon, and muddy sand and sandy deposits at the edges. In the present study, the creeks and river beds which have a silty nature and carry debris and silt were always muddier than the lagoon stations in both dry and wet seasons. These results were in consonance with earlier work carried out (Oyenekan, 1975; 1988). Futhermore, Ajao (1990) reported inland marshy swamps, surrounding the Lagos lagoon. There was a rapid change in the nature of substratum within relatively short distances. For instance, in the northern part of Agboyi creek Oyenekan (1988) observed coarse sand with varying amounts of silt, shelly mud at University of Lagos lagoon front and medium sand at Ikoyi with little silt. These results were similar to those of Ajao (1990) and Brown (1991). The sediment of the Lagos lagoon system has not changed as similar observations on the sediment type were obtained in this study. Spatial distribution of sediments showed a decreasing amount of silt in the sediment from northwestern to southwestern parts of the Lagos lagoon. Creek and river waters stations had a heavier silt load in both seasons, when compared with sandier lagoon stations (Ikorodu, Ikoyi, Oworonsoki, Ogudu and University of Lagos lagoon front).

It is therefore possible that the sediment type in Lagos lagoon primarily affected density, distribution and diversity of benthic fauna along with other factors.

Total Organic Content (TOC)

Total organic content (TOC) is important to benthos since substrate organic content represents a food source for deposit feeding organisms (Mare, 1942). It is also an indicator of pollution (Raman and Ganapati, 1983). Ajao (1990) observed a range between 0.18 and 53.21% with no seasonal trend for Lagos lagoon. In this study a lower range was observed (0.50 – 11.93%). This could be because areas known for heavy pollution were not covered in this research. Ajao (1990) reported high total organic content values at the mouth of Ogun River and Ikorodu, which could be attributed to the organic load from the rivers and creeks in the area. The heavy load Ajao observed at Ikoyi, which was not observed in this study, may be attributed to the effect of dumping untreated sewage and sawmill activities near the site. In the present study, lagoon (sandier stations) had lower total organic content values than the rivers/creeks (siltier stations). This may probably be because mud (silt and clay) had a higher binding capacity than sand.

Fauna Communities

Oyenekan (1988) classified Lagos lagoon into five broad benthic macro faunal communities: These are Mangrove, *Pachymelania*, Estuarine Amphioplus, Venus

and Estuarine Rock. The Lagos lagoon is unusually dominated by molluscs (Ajao, 1990).

Ajao (1990) stated that bivalve and gastropods were tolerant to physical and chemical variations in the lagoon and were present in a broad range of habitats. Although Oyenekan (1988) set a major baseline for benthic studies in the Lagos lagoon, categorizing them into communities, Ajao (1990) went a step further by separating the lagoon based on polluted and unpolluted areas. These two broad categories consisted of the previously mentioned *Pachymelania* community in the Lagos lagoon and Mangrove community in the creeks and edges of the main lagoon. The elements of the communities were an unpolluted area controlled by large densities of *P. aurita, N. glabrata* and *A. trigona*, and a polluted area with abundance of the opportunistic species. *C. capitata* , *Polydora* sp. and *Nereis* sp. The former was similar to that reported by Oyenekan (1988) , however, six species collected by Oyenekan (1988) were absent from Ajao (1990) collections. Similarly, in the present study, 12 species earlier recorded were not collected in this study,however 39 species not previously reported were mentioned. Ajao (1990) and Nwaokoro and Odiete (1997) stated that increased amounts of pollutants being discharged into the lagoon periodically gave rise to more tolerant species in the Lagos lagoon. This view is confirmed by the presence of *C. capitata*, Polydora sp. and *Nereis* sp. found in organically polluted areas with organic matter, trace metals and petroleum hydrocarbons. According to Reish

(1960), *C. capitata* is an indicator of organic pollution. Similarly, results of Ajao and Fagade (1990b) in Lagos lagoon and Oyenekan (1983) for Southampton implicate *C. capitata* as an indicator of organic pollution. Although *Gammarus* sp., *Tubifex* sp. and *Chironomus* sp. are freshwater species, they have all been used as biotic indices in defining the level or zone of pollution in freshwater rivers (Mason, 1981 Pauw and Vanhooren (1983). Ajao (1990) also reported that the family Tubificidae were collected in areas of low oxygen or depleted oxygen. Their presence in this study could therefore be an indication of a pollution load or anaerobic conditions in the rivers, at creeks emptying into the lagoon. A member of the estuarine Amphioplus community, the lancelet *B. nigeriensis* was reported earlier in the southern part of the Lagos lagoon at Ikoyi during the dry season (Oyenekan, 1988; Ajao, 1990). Similarly, it was present at Ikoyi in the dry season in this study. Ajao (1990) reported the presence of the nemertean *Cerabratulus* sp. for the first time in Lagos lagoon. This small red nemertean was also present in this study and had a higher density in the dry season.

Spatial and Temporal Distribution of Benthic Fauna

The change in the spatial distribution of the *Pachymelania* community observed by Sandison and Hill (1966), Oyenekan (1988) and Ajao (1990) was also observed in this study. During the dry season (December-March), barnacles, oysters and serpulids were abundant but they suffered heavy mortality during the low salinity season. Ajao (1990) stated that natural death caused by competition of gregarious

animals in a crowded situation can also contribute to mortality. Likewise Webb and Hill (1958) noticed the disappearance of *B. nigeriense* from the Lagos lagoon and reduced number in the Harbour during the wet season. They attributed this to the increased water flow as well as death by blockage of gills arising from heavy siltation. Similar results were obtained in this study. The siltier stations in the rivers and creeks had lower salinities and consisted of freshwater species for most of the year. Brown (1991) reported the presence of *A. trigona* in large densities in the northwest and northeast lagoon. These results were in consonance with results of Oyenekan (1988) and Ajao (1990). She however, observed a decrease in density during the wet season and attributed this to blockage of the gills by mud resulting in death. Similar results were obtained in this study. *A. trigona* could therefore be classified as a brackish water bivalve inhabiting silty sand sediment.

Crassostrea gasar were collected in higher densities at the muddy sand stations at Ikorodu and Oworonsoki. The abundance of the oyster *C. gasar* in the rainy season is contrary to the result of Sandison (1966a) and Sandison and Hill (1966) for barnacles, oysters and serpulids in the Lagos lagoon.

Tympanotonus fuscatus is a truly euryhaline benthos, occurring in the wet and dry season. However a higher density of specimens were collected in the sandy mud sediment at Ogudu in the dry season. In siltier stations it was absent, and occurred in lower densities in the wet season. Egonmwan and Odiete (1983) noted an

increased gonadal activity in *T. fuscatus* var. *radula* which could bring about an increase in population in the dry season. Also, its preference for muddy sediment type with low oxygen level has also been observed (Ajao, 1990).

In a related species, (*P. aurita)*, the breeding season was observed to coincide with the end of the rainy season and the beginning of the dry season (Ajao and Fagade, 1990d). *Pachymelania aurita* occurred at the muddy sand sites. An euryhaline organism, *P. aurita* occurred in all stations. These results were similar to those of Ajao (1990). However, the density was higher in the wet season, except at Ikoyi, where higher densities occurred in the dry season. Similarly, *N. glabrata* breed in high salinity months Jan. – March (Ajao and Fagade, 1990c).

Likewise in the wet season *P. quadriseriata* was abundant in the silty mud sediments at Oworonsoki and Ogudu. In the dry season, the high density spread to the creeks, revealing the euryhaline nature of the gastropod.

High densities of *M. enigmatica* and *B. pallidus* occurred along side each other at the muddy sand of Ikorodu and on hard substrates in the dry season. These results were in consonance with those of Sandison and Hill (1966), who observed higher densities of serpulids, oysters and barnacles in the dry season than rainy season. Although these serpulids and barnacles also occurred in the rainy season, their density was lower.

combined action of salinity and sediment type determined the distribution of the fauna in the lagoon, although intrinsic factors such as feeding, reproduction rate, recruitment of juveniles, predator-prey relationship, tidal dislodgment and human activities like dredging and sandfilling frequent in the lagoon could also affect distribution.

Although *P. aurita* is euryhaline it can only survive for long periods in wide ranges (0-30$^0/_{00}$) beyond which it became moribund and died. In practice, the salinity of the lagoon never exceeds 30$^0/_{00}$, hence *P. aurita* could survive throughout the year in the lagoon. It was also sediment dependent, hence recruitment which occurred throughout the lagoon did not limit its distribution. However, sediment selectivity occurred since the animal exhibited a slow crawling movement. The sediment selectivity of *P. aurita, N. glabrata* and *A. trigona* in the Lagos lagoon has been shown by their distribution within the *Pachymelania* community (Oyenekan, 1988; Ajao and Fagade, 1990d, c, d and Brown, 1991). The *Pachymelania* community was present in the muddy sand shores of the Lagos lagoon, while the related *P. quadriseriata* was collected in the muddier sediments of the mangrove community (Ajao, 1990) and therefore showed preference to muddier sediment. Although a lot of habitat modification by way of sand digging, sand filling and riparian vegetation modification have occurred, this still reveals that some habitat still exist in the lagoon to prevent total loss of diversity.

Diversity

Diversity indices were low, giving the picture of a high density, low diversity ecological niche. Indices did not vary specifically from wet to dry season, showing the ecological balance which occurred. These results were in consonance with those of Ajao (1990) and Brown (1991) for macrobenthic fauna and Nwankwo (1984) for phytoplankton in Lagos lagoon and the adjacent sea.

CONCLUSION

The omnivorous *Nereis* sp., *Nephtys* sp., the deposit feeding *Tympanotonus* sp. and *C. capitata*, the ciliary feeding *P. aurita*, the filter feeding *A. trigona*, the herbivorous *Neritina* sp. and carnivorous *Glycera convoluta* were all collected in this study. The variety in feeding habits showed the versatility of the Lagos lagoon in providing ecological niches for macrobenthic fauna and the strategy of the fauna to avoid competition. This is very important in a system such as the Lagos lagoon, since fauna at higher ecological levels depended on them for food (Fagade, 1969; Fagade and Olaniyan, 1974; Kusemiju, 1975). This may be a strategy to survive.

Inspite of previous work carried out on the benthic fauna of Lagos lagoon (Webb and Hill, 1958; Sandison and Hill, 1966; Yoloye, 1969, 1974, 1975; Adegoke *et al.*, 1969a, b; Oyenekan, 1975; Yoloye and Adegoke, 1977; Oyenekan and

Adediran, 1987; Ajao and Fagade, 1990a, b, c and d and Brown, 1991) little or no investigations have been carried out on food and feeding habits and reproductive strategies of macrobenthos in Lagos lagoon and surrounding water bodies. This dearth of information leaves us in doubt as to whether these economically important species can be economically cultured in Nigeria. Although attempts have not been made, it could prove to be a very viable venture, as all fauna collected were either economically important to man directly or indirectly. They also constitute an important link in the aquatic food chain (Amadi, 1991; Taylor *et al.*, 1998).

SUMMARY

The physico-chemical features and macrobenthic fauna of eight stations, (Majidun creek st. 1; Ikorodu st. 2; River Ogun st. 3; Agboyi creek st. 4; Ogudu st. 5; Oworonsoki st. 6, University of Lagos lagoon front st. 7; Ikoyi st. 8) in the western part of Lagos lagoon, were investigated for two years between May 1996 and February 1998.

Air temperature ranged between 24.50°C and 31.80°C, while bottom water temperature varied between 27.00 and 30.00°C. Mean temperature values in the dry season were between 28.67±1.06 and 30.00±0.00. The minimum and maximum temperatures for the wet season were 28.25±0.96 and 29.50±0.58 respectively. The lowest temperature was 27°C; this was higher than lowest temperatures recorded by previous workers.

Salinity values ranged between 0.00‰ and 26.00‰ in the Lagos lagoon. Salinity was low (0.00 to 5.00‰) in the rainy season and high (6.00 to 26.00‰) in the dry season. Creek and river stations had slightly lower salinities than those of the open lagoon. The highest salinity 26.00‰ occurred at Ikoyi (Station 8).

Hydrogen ion concentration (pH) ranged between 7.7 and 8.3 except at stations 7 and 8, where the range was between 5.72 and 8.15.

The lowest conductivity value was 0.01mScm^{-2} (Ogun River, Agboyi Creek and Majidun). The highest was 7.13mScm^{-2} at Ikoyi in February 1997.

Transparency was high (0.61 – 1.22m) with a mean of 0.83±0.21m in the dry season and low (0.15 – 0.61m) with a mean of 0.36±0.24m in the wet season. Transparency increased in the dry season and was lower in the wet season.

Rainfall affected temperature, salinity, conductivity and sediment type. It also affected density, diversity and distribution of fauna in the lagoon.

Total organic content (TOC) ranged between 0.50 and 11.93%. Values were lower (0.50 – 7.83%) at Ikoyi, University of Lagos lagoon front, Oworonsoki, Ogudu and Ikorodu (lagoon stations), than Majidun Creek, Ogun River, Agboyi Creek, Ogun River, Agboyi Creek (creek and river Stations). TOC was lower at sandy stations and higher at muddy stations.

Sediment was either muddy, sandy, sandy mud or muddy sand with various amounts of silt and shells.

A total of 20, 730 organisms were collected at the sampling stations at the western part of Lagos lagoon between May 1996 and February 1998. Eleven phyla, sixteen classes, 62 families and 125 species were collected.

The phyla Porifera, Nemertina, Annelida, Pogonophora, Echiurodea, Sipunculoidea, Mollusca, Arthropoda, Echinodermata, Hemichordata and Chordata were collected.

Species were separated based on occurrence in wet season (36 species), dry season (36 species) or euryhaline species (59 species).

Individuals at the stations ranged between 442 and 2275 per month. The highest number of individuals collected between May 1996 and February 1998 was at Oworonsoki (4268) where muddy sand sediment existed throughout the year. The station with the least density of fauna was Ikoyi with 988 individuals.

The *Pachymelania* community inhabited the Lagos lagoon. There were slight variations in the community structure described by Oyenekan (1975). Species absent from this study but collected in previous studies included *Cultellus tenuis, Diapatra neapolitana, Sagitta* sp., *Bachyodontes puniceus, B. niger, Phoronis muelleri, Prionspio* sp., *Pagunus berhardus, Caprella lineans, Copophium isidiosum, Lucifer* sp. and the shrimp *Macrobracium* sp. Those absent in earlier studies but present in this work are *Eurythoe complanata, Glycera longipinnis, Goniada emerita, Dendronereis arborifera, Playnereis* sp., *Notomastus* sp., *Egeria radiata, Macoma* sp., *Aloidis dautzenbergi, Gammarus* sp. and *Chironomus* sp.

These could represent a shift from low pollution tolerant species to high pollution tolerant species.

Pollution indicators *Capitella capitata, Nereis* sp, *Dero* sp and *Tubifex* sp were recorded in this study. In dry and wet seasons there was a gradual decrease in *C. capitata* from Agboyi creek, Ogudu and Oworonsoki, until it finally disappeared at University of Lagos lagoon front and Ikoyi. Where salinity varied from 14.78±8.53, 13.11±9.01, 6.22±5.04 and 4.56±5.54 at stations 8, 7, 6 and 5 (Ikoyi, University of Lagos lagoon front, Oworonsoki and Ogudu) respectively. Densities were higher in the dry season. The occurrence of *C. capitella*, *Polydora* sp., *Nereis* sp., *Gammarus* sp., *Tubifex* sp. and *Chironomus* sp. was evidence of pollution in the sampling stations.

The economically important *Crassostrea gasar* used as protein source for man and fish and production of pearls were recorded. Densities were highest in the wet season at Oworonsoki and at Ikorodu in both wet and dry seasons, where they could be cultured.

Tympanotonus fuscatus (periwinkle) was recorded throughout the year. A large population occurred at Ogudu in the dry season.

Pachymelania aurita had higher densities in the wet season than dry season. It was more abundant in the wet season at Majidun creek, Ikorodu, R. Ogun, Agboyi creek, Ogudu, Oworonsoki and University of Lagos lagoon front and could be cultured and used as fish feed and food supplement to poultry feed.

Pachymelania fusca quadriseriata was recorded at Ogudu and Oworonsoki in the wet season.

A large colony of *Mercierella enigmatica* (289 specimens) occurred at Ikorodu in the dry season while lower densities occurred on other sampling dates.

Nertina glabrata was reported all through the year in the wet and dry seasons, however, lower densities were recorded in the wet season.

Aloidis trigona ranged between 83 (Agboyi creek) and 907 (University of Lagos lagoon front). Densities increased along a salinity gradient between stations 8, 7, 6, 5 and 4. (Ikoyi,University of Lagos lagoon front, Oworonsoki, Ogudu and Agboyi creek).

Aloidis sulcata varied between 2 specimens at Ikoyi and 71 specimens at Majidun creek in the wet season. *A. sulcata* was only collected at R. Ogun in the dry season (3 specimens).

Balanus *pallidus* ranged between 1 at R. Ogun and 200 at Ikorodu.

Mollusca was the most prevalent phylum, followed by the Annelida and Arthropoda, at the stations in both dry and wet seasons.

In the wet season phylum Nemertina was collected in the creek and river stations at Ikorodu, but absent from all other lagoon stations. The Phylum Pogonophora was recorded at Agboyi creek, Ogudu and Oworonsoki and the phylum Echiuroidea at Majidun creek, Agboyi creek and Oworonsoki. The Phylum Echinodermata was reported at Ikorodu, while the phylum Hemichordata was documented at Agboyi creek only.

The Mollusca, Annelida and Arthropoda were recorded for all stations in the dry season. The Phylum Nemertina was collected at Ikorodu, R. Ogun, Ogudu and Oworonsoki, Pogonophora at Ikorodu, Agboyi creek and Ogudu, while Sipunculida was reported at Ikorodu and Ogudu. The chordates were collected at Agboyi creek, Ogudu and Oworonsoki, while the Echiuroidea was reported only at Ikorodu, Protochordata at Ikoyi and Porifera at Majidun creek.

Margalef's index values were low at all stations between 0.00 and 4.18 (at Ikorodu in May 1997).

Shannon and Weaver Information Function values ranged between 0.00 and 2.44 (at Agboyi creek in August 1996).

Equitability ranged between 0.00 and 0.95 (at Ogudu in April 1997).

Salinity did not affect density of fauna adversely.

Slight variations in occurrence in log number of species with salinity, in low salinity months (June 1996 and September 1996) lower species diversity occurred in the wet season.

There was a low positive relationship between Total Organic Matter and number of species. Total organic matter and log number of individuals did not have any definite relationship, between May 1996 and February 1998.

Survival-time experiments confirmed that *Pachymelania aurita* is euryhaline, having a wide tolerance. It survived in salinity of 0-20%0 for 90 days, at higher salinities survival time decreased to 8-9 days.

P. aurita was sediment specific. Sediment preference was sandy mud *P. fusca quadriseriata* was also sediment specific, 60% in muddy sediment, 20% in muddy sand and 20% in sandy mud.

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Appendix 1: Number of Individuals collected at per phyla at the sampling stations in the stations (Wet Season)

Taxa	Stations →	1	2	3	4	5	6	7	8
Mollusca		882	1076	698	1541	1678	1901	674	414
Nemertina		03	02	01	06	-	-	-	-
Annelida		68	205	119	22	119	182	14	26
Pogonophora		-	-	-	03	04	01	14	-
Echiroidea		01	-	-	02	-	03	-	-
Sipunculoidea		-	-	-	01	-	-	-	-
Porifera		-	-	-	-	-	-		
Arthropoda		32	142	07	26	15	92	31	15
Echinodermata		-	01	-	-	-	-	-	-
Hemichordata		-	-	-	01	-	-	-	-
Chordata		-	-	-	-	-	-	-	-

Appendix 2: Total number of individuals collected per phyla at all sampling stations in the western part of Lagos Lagoon in the dry season (May 1996-February 1998).

Taxa	Stations →	1	2	3	4	5	6	7	8
Mollusca		491	1137	1113	428	1934	1885	1446	790
Nemertina		-	01	10	-	02	01	-	-
Annelida		87	356	47	97	144	73	19	24
Pogonophora		-	01	-	01	01	-	-	-
Echiroidea		-	01	-	-	-	-	-	-
Sipunculoidea		-	03	-	-	03	-	-	-
Porifera		01	-	-	-	-	-	-	-
Arthropoda		60	221	15	19	11	36	27	25
Echinodermata		-	-	-	-	-	-	-	-
Hemichordata		-	-	-	-	-	-	-	-
Chordata		-	-	-	01	01	01	-	-

Appendix 3: Total number of species collected per phyla at all sampling stations in the western part of Lagos lagoon in the wet season (May 1996-February 1998).

Taxa	**Stations →**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Mollusca		14	22	11	13	11	14	15	11
Nemertina		01	01	02	02	-	-	-	-
Annelida		13	22	13	20	13	18	08	11
Pogonophora		-	-	01	01	01	-	-	-
Echiroidea		01	-	-	01	-	02	-	-
Sipunculoidea		-	-	-	01	-	-	-	-
Porifera		-	-	-	-	-	-	-	-
Arthropoda		06	12	03	06	03	11	08	04
Echinodermata		-	01	-	-	-	-	-	-
Hemichordata		-	-	-	0	-	-	-	-
Chordata		-	-	-	1	-	-	-	-

Appendix 4: Total number of species collected per phyla at all sampling stations in the western part of Lagos Lagoon in the dry season (May 1996 – February 1998).

Taxa	Stations -->	1	2	3	4	5	6	7	8
Mollusca		13	19	13	10	14	09	09	10
Nemertina		-	01	01	-	01	-	-	-
Annelida		13	17	11	14	19	07	07	09
Pogonophora		-	01	-	01	01	-	-	-
Echiuroidea		-	01	-	-	-	-	-	-
Sipunculoidea		-	01	-	-	02	-	-	-
Porifera		01	-	-	-	-	-	-	-
Arthropoda		05	08	07	02	03	05	05	05
Echinodermata		-	-	-	-	-	-	-	-
Hemichordata		-	-	-	-	-	-	-	-
Chordata		-	-	-	01	01	-	-	01-

Appendix 5: Temporal variation of taxa at sampling stations in the western part of Lagos Lagoon in the wet season (May 1996 –February 1998)

Mollusca	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
May-96	09	129	-	06	-	195	54	11
June-96	152	111	50	-	04	88	72	03
Jul-96	06	153	68	03	06	253	26	14
Aug-96	-	158	07	38	46	93	29	-
Sep-96	-	153	01	08	13	135	78	-
Okt-96	-	77	67	05	50	81	139	03
Mei-97	113	56	158	296	70	156	39	-
Jun-97	177	59	46	147	181	173	33	22
Jul-97	132	123	56	828	165	142	75	15
Sep-97	91	32	101	124	1034	392	82	210
Oct-97	202	25	144	86	109	193	47	136
Total	882	1076	698	1541	1678	1901	674	414

Nemertina	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
May-96	1	01	-	05	-	-	-	-
June-96	-	-	-	-	-	-	-	-
Jul-96	-	-	-	-	-	-	-	-
Aug-96	-	-	-	-	-	-	-	-
Sep-96	-	-	-	-	-	-	-	-
Okt-96	-	01	-	01	-	-	-	-
Mei-97	-	-	-	-	-	-	-	-
Jun-97	-	-	-	-	-	-	-	-
Jul-97	-	-	-	-	-	-	-	-
Sep-97	-	-	-	-	-	-	-	-
Oct-97	03	-	01	-	-	-	-	-
Total	03	02	01	06	-	-	-	-

Annelida	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
May-96	-	06	-	35	-	-	04	02
June-96	02	02	06	09	03	01	04	02
Jul-96	-	03	09	12	04	143	-	-
Aug-96	02	10	04	17	21	04	-	-
Sep-96	-	15	07	08	23	01	-	01
Okt-96	-	25	46	10	03	01	03	-
Mei-97	04	53	11	36	04	-	-	-
Jun-97	03	20	19	23	-	-	-	-
Jul-97	02	64	08	19	05	-	-	02
Sep-97	27	01	02	27	52	12	01	11
Oct-97	28	06	07	26	04	20	02	08
Total	68	205	119	222	119	182	14	26

Pogonophora	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
May-96	-	-	-	-	-	-	-	-
June-96	-	-	-	-	-	-	-	-
Jul-96	-	-	-	-	-	-	-	-
Aug-96	-	-	-	-	-	-	-	-
Sep-96	-	-	-	-	-	-	-	-
Okt-96	-	-	-	01	-	-	-	-
Mei-97	-	-	-	-	-	-	-	-
Jun-97	-	-	-	-	-	-	-	-
Jul-97	-	-	-	02	-	-	-	-
Sep-97	-		-	-	04	-	-	-
Oct-97	-	-	-	-	-	01	-	-
Total	-	-	-	03	04	01	-	-

Echiuroidea	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
May-96	1	-	--	02	-	03	-	-
June-96	01	-	-	-	-	-	-	-
Jul-96	-	-	-	-	-	-	-	-
Aug-96	-	-	-	-	-	-	-	-
Sep-96	-	-	-	-	-	-	-	-
Okt-96	-	-	-	-	-	-	-	-
Mei-97	-	-	-	-	-	-	-	-
Jun-97	-	-	-	-	-	-	-	-
Jul-97	-	-	-	-	-	-	-	-
Sep-97	-	-	-	-	-	-	-	-
Oct-97	-	-	-	-	-	-	-	-
Total	01	-	-	02	-	03	-	-

Sipuncluloidea	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
May-96	-	-	-	-	-	-	-	-
June-96	-	-	-	-	-	-	-	-
Jul-96	-	-	-	-	-	-	-	-
Aug-96	-	-	-	-	-	-	-	-
Sep-96	-	-	-	-	-	-	-	-
Okt-96	-	-	-	01	-	-	-	-
Mei-97	-	-	-	-	-	-	-	-
Jun-97	-	-	-	-	-	-	-	-
Jul-97	-	-	-	-	-	-	-	-
Sep-97	-	-	-	-	-	-	-	-
Oct-97	-	-	-	-	-	-	-	-
Total	-	-	-	01	-	-	-	-

Arthropoda	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
May-96	-	07	-	-	-	13	15	01
June-96	02	06	-	-	-	09	04	02
Jul-96	-	02	04	02	02	50	02	01
Aug-96	-	09	-	04	-	-	-	-
Sep-96	-	07	-	-	-	03	-	-
Okt-96	-	05	-	-	01	02	01	-
Mei-97	01	43	-	02	-	03	01	-
Jun-97	01	29	02	05	-	01	06	02
Jul-97	-	33	-	-	12	02	01	07
Sep-97	24	01	01	13	-	09	-	02
Oct-97	04	-	-	-	-	-	01	-
Total	32	142	07	26	15	92	31	15

Echinodermata	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
May-96	-	01	-	-	-	-	-	-
June-96	-	-	-	-	-	-	-	-
Jul-96	-	-	-	-	-	-	-	-
Aug-96	-	-	-	-	-	-	-	-
Sep-96	-	-	-	-	-	-	-	-
Okt-96	-	-	-	-	-	-	-	-
Mei-97	-	-	-	-	-	-	-	-
Jun-97	-	-	-	-	-	-	-	-
Jul-97	-	-	-	-	-	-	-	-
Sep-97	-	-	-	-	-	-	-	-
Oct-97	-	-	-	-	-	-	-	-
Total	-	01	-	-	-	-	-	-

Hemichordata	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
May-96	-	-	-	-	-	-	-	-
June-96	-	-	-	-	-	-	-	-
Jul-96	-	-	-	-	-	-	-	-
Aug-96	-	-	-	-	-	-	-	-
Sep-96	-	-	-	-	-	-	-	-
Okt-96	-	-	-	-	-	-	-	-
Mei-97	-	-	-	-	-	-	-	-
Jun-97	-	-	-	-	-	-	-	-
Jul-97	-	-	-	01	-		-	-
Sep-97	-	-	-	-	-	-	-	-
Oct-97	-	-	-	-	-	-	-	-
Total	-	-	-	01	-	-	-	-

Appendix 6: Temporal variation of taxa at sampling stations in the western part of Lagos lagoon in the dry season (May 1996-February 1998).

Echiuroidea	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Nov-96	-	-	-	-	-	-	-	-
Dec-96	-	-	-	-	-	-	-	-
Jan-97	-	-	-	-	-	-	-	-
Feb-97	-	-	-	-	-	-	-	-
Apr-97	-	-	-	-	-	-	-	-
Nov-97	-	-	-	-	-	-	-	-
Dec-97	-	-	-	-	-	-	-	-
Jan-98	-	01	-	-	-	-	-	-
Feb-98	-	-	-	-	-	-	-	-
Total	-	01	-	-	-	-	-	-

Sipunculoidea	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Nov-96	-	-	-	-	-	-	-	-
Dec-96	-	-	-	-	-	-	-	-
Jan-97	-	-	-	-	01	-	-	-
Feb-97	-	-	-	-	-	-	-	-
Apr-97	-	-	-	-	-	-	-	-
Nov-97	-	-	-	-	01	-	-	-
Dec-97	-	-	-	-	-	-	-	-
Jan-98	-	03	-	-	01	-	-	-
Feb-98	-	-	-	-	-	-	-	-
Total	-	03	-	-	03	-	-	-

Chordata	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Nov-96	-	-	-	-	-	-	-	-
Dec-96	-	-	-	-	-	-	-	-
Jan-97	-	-	-	-	-	-	-	01
Feb-97	-	-	-	-	-	-	-	-
Apr-97	-	-	-	-	-	-	-	-
Nov-97	-	-	-	-	-	-	-	-
Dec-97	-	-	-	01	-	-	-	-
Jan-98	-	-	-	-	-	-	-	-
Feb-98	-	-	-	-	01	01	-	-
Total	-	-	-	01	01	01	-	01
Porifera	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Nov-96	-	-	-	-	-	-	-	-
Dec-96	-	-	-	-	-	-	-	-
Jan-97	-	-	-	-	-	-	-	-
Feb-97	-	-	-	-	-	-	-	-
Apr-97	-	-	-	-	-	-	-	-
Nov-97	-	-	-	-	-	-	-	-
Dec-97	-	-	-	-	-	-	-	-
Jan-98	01	-	-	-	-	-	-	-
Feb-98	-	-	-	-	-	-	-	-
Total	01	-	-	-	-	-	-	-

Arthropoda	1	2	3	4	5	6	7	8
Nov-96	-	02	-	-	-	-	02	01
Dec-96	-	08	-	-	-	-	-	01
Jan-97	-	163	-	18	-	03	03	-
Feb-97	49	30	-	-	-	15	09	-
Apr-97	05	08	-	-	-	07	03	-
Nov-97	01	-	05	-	02	-	-	-
Dec-97	-	-	02	01	-	01	01	-
Jan-98	01	07	05	-	02	01	03	-
Feb-98	04	03	03	-	07	-	06	23
Total	60	221	15	19	11	36	27	25

Mollusca	1	2	3	4	5	6	7	8
Nov-96	-	134	07	20	51	149	366	03
Dec-96	-	92	130	01	03	-	94	309
Jan-97	68	37	134	10	354	60	150	04
Feb-97	28	57	27	03	12	390	184	11
Apr-97	135	10	11	17	19	357	54	-
Nov-97	05	196	56	15	432	327	55	-
Dec-97	51	175	92	86	404	130	264	203
Jan-98	190	287	324	112	70	413	145	89
Feb-98	14	149	332	164	589	59	134	171
Total	491	1137	1113	428	1934	1885	1446	790

Nemetina	1	2	3	4	5	6	7	8
Nov-96	-	-	05	-	-	-	-	-
Dec-96	-	-	04	-	-	-	-	-
Jan-97	-	01	-	-	-	-	-	-
Feb-97	-	-	-	-	-	-	-	-
Apr-97	-	-	-	-	02	01	-	-
Nov-97	-	-	01	-	-	-	-	-
Dec-97	-	-	-	-	-	-	-	-
Jan-98	-	-	-	-	-	-	-	-
Feb-98	-	-	-	-	-	-	-	-
Total	-	01	10	-	02	01	-	-

Appendix 7: Temporal variation of individuals at sampling stations in the western part of Lagos Lagoon (May 1996-February 1998).

Wet Season

Period	Station ←	1	2	3	4	5	6	7	8	T
May-96		10	144	-	48	-	211	73	14	500
June-96		156	119	56	09	07	98	80	07	532
July-96		06	158	81	17	12	446	28	15	763
Aug-96		02	177	11	59	67	97	29	-	442
Sep-96		-	175	08	16	36	139	78	01	453
Oct-96		-	108	113	17	54	84	143	03	522
Mei-97		118	152	169	335	74	159	40	-	1047
June-97		181	108	67	175	181	174	39	24	949
July-97		134	220	64	850	182	144	76	24	1694
Sep-97		142	34	104	164	1096	413	83	223	2259
Oct-97		237	31	152	112	113	214	50	144	1053
Total		986	1426	825	1802	1822	2179	719	455	10214

Dry Season

Nov-96		-	143	39	20	87	157	370	05	821
Dec-96		92	171	08	04	-	98	309	02	684
Jan-97		68	332	138	45	357	68	155	09	1172
Feb-97		83	206	27	13	13	414	194	11	961
Apr-97		140	32	11	41	23	367	57	01	672
Nov-97		09	197	65	17	458	348	55	-	1149
Dec-97		60	175	95	116	414	161	267	213	1501
Jan-98		260	309	330	117	95	417	153	91	1772
Feb-98		19	193	343	165	646	60	147	201	1784
Total		731	1758	1056	548	2093	2089	1707	533	10516

Appendix 8:Temporal variation in euryhaline species collected at the sampling station in the Western part of Lagos lagoon (May 1996 - February 1998).

Unidentified *Nemertina*

Eurythoe complanata

Glycera sp.

G. longipinnis

Goniada emerita

Ophiodromus spinosus

Nephtys sp.

Nephtys dibranchis

Nereis sp.

N. agulhana

N. granulata

Dendronereisarborifera

Playnereis dumerillii

Schro ederella pauliani

Orbinia sp

Syllis sp.

Unidentified syllidae

Capitella capitata

Capitella sp

Notomastus aberans

N. lalericeus

Maldane sp.

Maldane sarsi

Sabella sp.

Mercierella enigmatica

Serpula vermicubulus

Tubifex sp.

Unidentified pogo nophora

Cerebratulus sp.

Nerita senegalensis

Neritina glabrata

Pachymelania aurita

P. fusca var quadriseriata

Tympanotonus fuscatus

Mytilus edulis

Crassostrea gazar

Mactra glabrata

Donax rugosus

Iphigenia truncata

I. rostrata

Egeria radiata

Macoma cumana

Tellian hymphalis

Aloidis sulcata

A. trigona

A. dautzenbergi

Balanus pallidus

Unidentified Isopoda

Asellus sp

Colomastix sp.

Gammarus sp.

Clibinarius africanus

Sersama huzardi

Mennippe nodifrons

Callinectes sp.

Chironomus sp.

Appendix 9:Temporal variation in dry season species collected at the sampling stations in the Western part of Lagos lagoon (May 1996 - February 1998).

Axinella lunaecharta
Nemertea sp.
Ophiodromus sp.
Phalacrophorus sp.
Dendronereis zululandica
Melinna cristata
Unidentified Ampharetidae
Notomastus sp.
Magelona papillicornis
Mayelona sp.
Serpula sp
Unidentified spionidae
Polydora capensis
Polydora armata
Terebella pterochaeta
Pinuca sp.
Phascolion sp.
Sipunculus sp.
Golfingia sp.
Natica fuliminea
Anadara senilis
Ungulina alba
Dosinia isocardia
Venus sp.
Tellina sp.
Cyathura sp.
Melita nitida
Peaneus durarum
P. notialis
Callianassa sp.
Uca tangeri
Tabanus trimaculatus
Branchiostoma nigeriense

Appendix 10:Temporal variation in wet season species collected at the sampling stations in the Western part of Lagos lagoon (May 1996 - February 1998)

Eurythoe sp
Eunice sp
Glycera convoluta
Nephtys caeca
Playnereis calodonta
Exogone sp
Molinna monoceroides
Pulliella armata
Dasybranchus bipartilus
Lumbriclymene sp.
Asychis capensis
Hydroides sp.
Pista quadrilobata
Polydora sp.
Dero sp.
Echiurus echiurus
Unidentified Nudibranchia
Mytilus perna
Tagelus angulatus
Aloidis striatissima
Diplodonta diaphana
Mysis sp.
Unidentified Amphipoda
Eusinus cuspidsitus
Colomastix halichondraie
Sphaerana quadridentatum
Cardiosoma armatum
Goniopsis sp.
Ocypoda sp.
Geryon maritae
Unidentified dipteran larvae
Cucumaria sp.
Saccoglossus kowalerskii
Unidentified ascidian
Anguilla anguilla
Cynoponticu ferox

APPENDIX II. Survival of Daphnia in various salinities for 90 days

UNITIES	0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
DAY 1	10	10	10	10	10	10	10	10	10	10	10
DAY 2	10	10	10	10	10	10	10	10	10	10	10
DAY 3	10	10	10	10	10	10	10	10	10	10	10
DAY 4	10	10	10	10	10	10	10	10	10	10	9.67
DAY 5	10	10	10	10	10	10	10	9.67	10	10	9.33
DAY 6	10	10	10	10	10	10	10	9.67	9.67	9.33	9
DAY 7	10	10	10	10	10	10	9	9.67	9.67	9.33	8.67
DAY 8	10	10	10	10	10	10	9	9.67	9.33	9.33	8.67
DAY 9	10	10	10	10	10	10	9	9.67	9.33	9.33	8.67
DAY 10	10	10	10	10	10	10	9	9.33	8	7.67	7.67
DAY 11	10	10	10	10	10	10	9	8.33	8	7.67	7.67
DAY 12	10	10	10	10	10	8	8.33	4.67	6	6.33	7
DAY 13	10	10	10	10	10	8	8.33	4.67	6	6.33	7
DAY 14	10	10	10	10	10	8	5	2	3.67	4	7
DAY 15	10	10	10	10	9.67	8	5	2	3.67	3.33	7
DAY 16	10	10	10	10	9.67	7.67	4.33	1.33	2.67	3.33	6.33
DAY 17	10	10	10	10	9.67	7.67	4.33	1.33	2.67	3.33	6.33
DAY 18	10	10	10	10	9.67	7.67	4.33	1.33	2.67	3	6
DAY 19	10	10	10	10	9.67	7.67	4.33	1.33	2.67	3	6
DAY 20	10	10	10	10	9.67	7.67	1	0.67	1.33	2.33	4.67
DAY 21	10	10	10	10	7.67	7.67	1	0.67	0.67	0.67	2.33
DAY 22	10	10	10	9.33	9.67	4.33	1	0.67	0.33	0.33	0.67
DAY 23	10	10	10	9.33	9.67	1	0.33	0.33	0	0.33	0.67
DAY 24	10	10	10	9.33	9.67	1	0.33	0.33	0	0.33	0.67
DAY 25	10	10	10	9.33	9.67	1	0.33	0.33	0	0.33	0.67
DAY 26	10	10	10	9.33	9.67	1	0.33	0.33	0	0.33	0.67
DAY 27	10	10	10	9.33	9.67	1	0.33	0.33	0	0.33	0
DAY 28	10	10	10	9.33	9.67	1	0.33	0.33	0	0.33	0
DAY 29	10	10	9.33	9	8.33	0.67	0	0	0	0.33	0
DAY 30	10	9.67	9.33	8.67	7.67	0.67	0	0	0	0	0
DAY 31	10	9.67	9.33	8.67	7.67	0.67	0	0	0	0	0
DAY 32	10	9.67	9.33	8.67	7.67	0.67	0	0	0	0	0
DAY 33	10	9.67	9.33	8	6.67	0.67	0	0	0	0	0
DAY 34	10	9.67	9.33	7.33	7.67	0.67	0	0	0	0	0
DAY 35	10	9.67	9.33	7.33	7.667	0	0	0	0	0	0
DAY 36	10	9.67	9.33	7.33	7.67	0	0	0	0	0	0
DAY 37	10	9.67	9.33	7.33	7.33	0	0	0	0	0	0
DAY 38	10	9.67	9	7.33	7.33	0	0	0	0	0	0
DAY 39	10	9.67	9	7.33	7.33	0	0	0	0	0	0
DAY 40	10	9.67	9	7.33	7.33	0	0	0	0	0	0
DAY 41	10	9.67	9	7.33	7.33	0	0	0	0	0	0
DAY 42	10	9.67	9	7.33	7.33	0	0	0	0	0	0
DAY 43	10	9.67	9	7.33	7.33	0	0	0	0	0	0
DAY 44	10	9.67	9	7.33	7.33	0	0	0	0	0	0
DAY 45	10	9.67	9	7.33	7.33	0	0	0	0	0	0
DAY 46	10	9.67	9	7.33	7	0	0	0	0	0	0
DAY 47	10	9.67	9	7	5.33	0	0	0	0	0	0
DAY 48	9.67	9.67	8.33	3	5.33	0	0	0	0	0	0
DAY 49	9.67	9.67	8.33	3	5.33	0	0	0	0	0	0
DAY 50	9.67	9.67	8.33	3	5.33	0	0	0	0	0	0
DAY 51	9.67	9.67	8.33	3	5.33	0	0	0	0	0	0
DAY 52	9.67	9.67	8.33	3	5.33	0	0	0	0	0	0
DAY 53	9.67	9.67	8.33	3	5.33	0	0	0	0	0	0
DAY 54	9.67	9.67	8.33	3	5.33	0	0	0	0	0	0
DAY 55	9.67	9.67	8.33	3	5.33	0	0	0	0	0	0
DAY 56	9.67	9	8.33	3	5.33	0	0	0	0	0	0
DAY 57	9.67	7.33	8.33	3	5.33	0	0	0	0	0	0
DAY 58	9.67	7.33	8.33	3	5.33	0	0	0	0	0	0
DAY 59	9.67	7.33	8.33	3	5.33	0	0	0	0	0	0
DAY 60	9	7.33	8	2.67	5.33	0	0	0	0	0	0
DAY 61	9	7.33	8	2.67	5.33	0	0	0	0	0	0
DAY 62	9	7.33	8	2.667	5.33	0	0	0	0	0	0
DAY 63	9	7.33	8	2.67	5	0	0	0	0	0	0
DAY 64	9	7.33	8	2.67	5	0	0	0	0	0	0
DAY 65	9	7.33	8	2.67	5	0	0	0	0	0	0

	%	0	10	20	30	40	50	60	70	80	90	100
DAY66		9	7.33	8	2.67	3.33	0	0	0	0	0	0
DAY 67		9	7.33	8	2.67	3.33	0	0	0	0	0	0
DAY 68		9	7.33	8	2.67	3.33	0	0	0	0	0	0
DAY 69		9	7.33	8	2.67	3.33	0	0	0	0	0	0
DAY 70		9	7.33	8	2.67	3.33	0	0	0	0	0	0
DAY 71		9	7.33	8	2.67	3.33	0	0	0	0	0	0
DAY 72		9	7.33	8	2.67	3.33	0	0	0	0	0	0
DAY 73		9	7.33	8	2.67	3.33	0	0	0	0	0	0
DAY74		9	7.33	8	2.67	3.33	0	0	0	0	0	0
DAY 75		9	7.33	8	2.67	3.33	0	0	0	0	0	0
DAY 76		9	7.33	8	2.67	3.33	0	0	0	0	0	0
DAY 77		8.67	7.33	7.67	2	3.33	0	0	0	0	0	0
DAY 78		8.67	7.33	7.67	2	3.33	0	0	0	0	0	0
DAY 79		8.67	7.33	7.67	2	3.33	0	0	0	0	0	0
DAY 80		8.67	7.33	7.67	2	3.33	0	0	0	0	0	0
DAY 81		8.67	7.33	7.67	2	3.33	0	0	0	0	0	0
DAY 82		8.67	7.33	7.67	2	3.33	0	0	0	0	0	0
DAY 83		8.67	7.33	7.67	2	3.33	0	0	0	0	0	0
DAY 84		8.67	7.33	7.67	2	3.33	0	0	0	0	0	0
DAY 85		8.67	7.33	7.67	2	3.33	0	0	0	0	0	0
DAY 86		8.67	7.33	7.67	2	3.33	0	0	0	0	0	0
DAY 87		8.67	7.33	7.67	2	3.33	0	0	0	0	0	0
DAY 88		8.67	7.33	7.67	2	3.33	0	0	0	0	0	0
DAY 89		8.67	7.33	7.67	2	3.33	0	0	0	0	0	0
DAY 90		8.67	7.33	7.33	2	3.33	0	0	0	0	0	0