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Long term changes in the fish assemblage of Sulaibikhat Bay, Kuwait

J. M. WRIGHT*[1], F. ABOU-SEEDO[2] & D. A. CLAYTON[3]

[1] *WS Atkins, Woodcote Grove, Ashley Road, Epsom, KT18 5BW, UK*
[2] *Zoology Department, Kuwait University, P.O. Box 5969, Safat 13060, Kuwait*
[3] *Biology Department, Faculty of Science, Sultan Qaboos University, PO Box 32486, Al-Khod, Oman*

ABSTRACT

Between February 1986 and July 1990, a total of 47,761 fish representing 70 species from 38 families were captured using an otter trawl in Sulaibikhat Bay, Kuwait. Young of the year dominated the catches. The assemblage can be characterised by depth and season, with depth made up of intertidal and subtidal. Seasons consisted of winter, spring and summer. The 20 most numerous species can be placed into several categories with typical examples as follows: regular species are: *Leiognathus decorus* (de Vis); spring and summer intertidal species *Liza carinata* (Valenciennes); irregular species *Terapon puta* (Cuvier) and subtidal species *Solea elongata* (Day). Fish abundance data showed considerable variation between years. The long-term dominant species, *Leiognathus decorus* (de Vis), unlike most other species reported here, was present in all life history stages and in consistent numbers every year. The two numerical dominants, *Liza carinata* and *Pomadasys stridens* (Forsskal), showed marked between-year differences in numbers, being present in large numbers in one year only.

INTRODUCTION

Shallow coastal environments are recognised as important nursery areas in the absence of estuaries (Blaber & Blaber 1980, Lennanton 1982, Wright 1989a). Hyper-haline and semi enclosed Kuwait Bay and Sulaibikhat Bay (29°21′N, 47°52′E), a sub-system of Kuwait Bay, are probably Kuwait's most important and productive nursery areas (Dames & Moore 1983; Wright 1988a, 1988b, 1989a, 1989b, 1989c, 1990; Abou-Seedo *et al.* 1990a, 1990b, Wright *et al.* 1990). The extensive intertidal habitats of Sulaibikhat Bay are particularly important as prime habitat for over-wintering birds and as nursery habitat in the spring and summer for fishes and shrimps. Prior to the total ban on all (except intertidal stake traps) commercial fishing in Kuwait Bay, Sulaibikhat Bay supported an active gill net fishery for mullet. The Bay is an important roosting site in the spring and autumn for migratory wading birds, and is particularly important for the crab plover, a species of restricted distribution in the Gulf (Cowan 1990). The fish assemblage of Sulaibikhat Bay is characterised by juvenile stages with relatively few dominants. These dominants are of two ecological types, being either relatively variable in numbers between years as shown by *Liza carinata* (Valenciennes) and *Pomadasys stridens* (Forsskal), or relatively stable between years as shown by *Leiognathus decorus* (de Vis) (Wright 1990). Depending on the species, juvenile fish on the nursery grounds migrate depending on diurnal period, tidal condition and turbidity (Wright 1989a, Wright *et al.* 1990, Abou-Seedo *et al.* 1990a).

Considerable work has been published on fish assemblage consistency (Claridge *et al.* 1986; Potter *et al.* 1986). It is known that fishing activities may change tropical demersal fish communities (Harris & Poiner 1991), but documentation of changes due to other factors in non-estuarine tropical environments is rare (Rainer 1984). In Sulaibikhat Bay, marked differences between 1987 and 1988 fish assemblages were ascribed to differences of recruitment of *Liza carinata* (Wright 1990).

This study was undertaken to assess long term changes in the fish assemblage of Sulaibikhat Bay by examining the consistency of seasonal trawl catches over $4\frac{1}{2}$ years from February 1986 to July 1990. A novel analytical approach has been employed to examine this continuous data set. This approach reveals new insights into the structure and function of the fish assemblage of Sulaibikhat Bay. Previous work was limited to addressing monthly changes in the fish assemblage between September 1986 and September 1988 (Wright 1989a).

MATERIALS AND METHODS

Sulaibikhat Bay is a non-estuarine, shallow (<4 m deep at low tide) semi-enclosed area covering approximately 46 km^2 surface area (Fig. 1). The maximum tidal range of 4 m and gradual sloping bottom result in extensive intertidal mudflats (Jones & Clayton 1983). The tidal range is usually less than 3 m (Kuwait Ports Authority 1990). Five minute tows, by an otter trawl at 0.5 $m\,s^{-1}$ with a mouth width of 4 m and constructed of 13 mm stretch mesh with a 6.5 mm stretch mesh cod end, were used to sample monthly fish populations at 12 fixed stations. Five stations were in the subtidal zone and seven in the intertidal, reflecting the relative surface areas of the two zones.

Occasional inclement weather resulted in fewer than seven trawls in the intertidal zone. Water depth of stations in the subtidal stations ranged between 4 and 8 m, and depths in intertidal stations ranged between 0.6 and 2 m. All trawl samples were collected during daylight within two hours of high tide. Stem thermometers and refractometers measured to 0.5°C and 0.5‰ respectively. Bottom temperature and salinity were measured between September 1988 and July 1990.

For each catch, fish were sorted by species using Fischer & Bianchi (1984), and were enumerated. Algal volume was measured to the nearest 100 ml using a 1000 ml graduated measuring cylinder.

The numbers of individuals of each species from September 1986 to May 1989 were subjected to analysis using two-way indicators species analysis (TWINSPAN) and detrended correspondence analysis (DECORANA) (Hill 1979a, b). The results from TWINSPAN for all samples were plotted as a dendrogram. The DECORANA results for the 20 most abundant species were plotted as an ordination of samples and species. The results from these analyses were used to formulate the approach to the subsequent 3-way ANOVA analysis and graphical presentation of the monthly data.

Unbalanced 3-way ANOVA, using SYSTAT, was undertaken on samples from

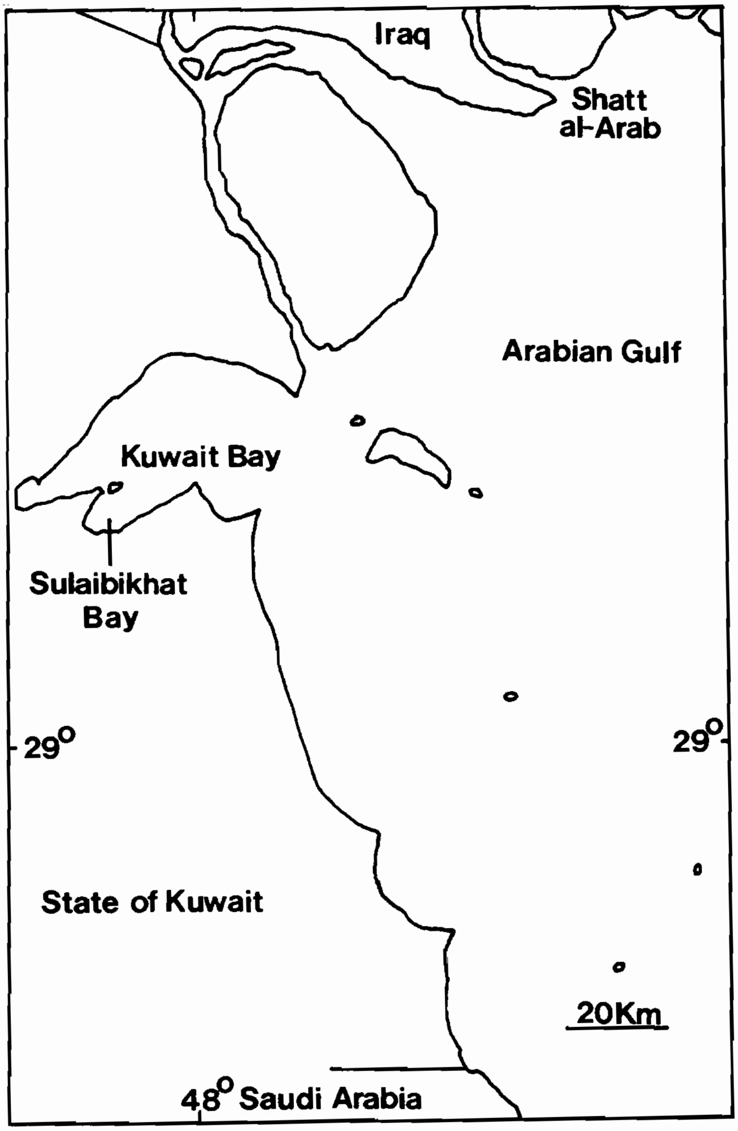

Fig. 1. Map of Kuwait showing location of Sulaibikhat Bay.

November 1986 to October 1989 (SYSTAT 1988). For the purposes of the ANOVA and graphical presentation, the months of the year were divided into three seasons. Winter months were considered to be November, December and January; spring months were considered to be February and March, and the remaining months were considered to be summer months. The ANOVA's were used to investigate the effect of depth of water (D), season of sampling (S) and year (Y), all on log of total number of fishes (N). The total number of fishes were subjected to log $(x + 1)$ as transformations were necessary to ensure that means were independent of variance (Underwood 1981).

RESULTS

The long term changes in surface temperature were consistent (Fig. 2) and were characterised by a gradual rise in surface temperature from 13°C in January to a maximum of 36°C between June and September. Surface temperature was 1 or 2 degrees warmer than bottom water during the summer months and there was no difference between surface and bottom temperatures during the winter months (Fig. 3). The salinity minimum usually occurred in April. The relationship between surface and bottom salinity was more complex but surface water was 1 part per thousand higher than the bottom water. The difference was more marked in the summer months and may be a reflection of high evaporation on the extensive intertidal region.

The volume of weed (*Ulva & Entermorpha*) collected in the trawl was measured during the study period (Fig. 2). No algal volume data were collected in 1986. The year 1988 appears atypical with a low volume of weed collected during the spring months. A total of 47,761 fish belonging to 70 species in 38 families were captured in the $4\frac{1}{2}$ years of the monthly regime (Table 1).

TWINSPAN revealed 6 groupings (Fig. 4). Group A consists of an outlier represented by the intertidal catches of January, 1989 and which consisted of two small *Gobius brevirostris* Gunther from a total of 7 trawls. Groups B&C are summer subtidal samples. Group D is made up of spring subtidal and summer intertidal samples. Group E is summer intertidal samples. Group F is made up of winter intertidal samples. Winter subtidal samples are found in groups B, C and D and spring intertidal samples are found in groups E and F.

These groupings are more clearly seen in the DECORANA analysis of samples that are grouped into intertidal/subtidal and winter/spring/summer (Fig. 5). Axis 1

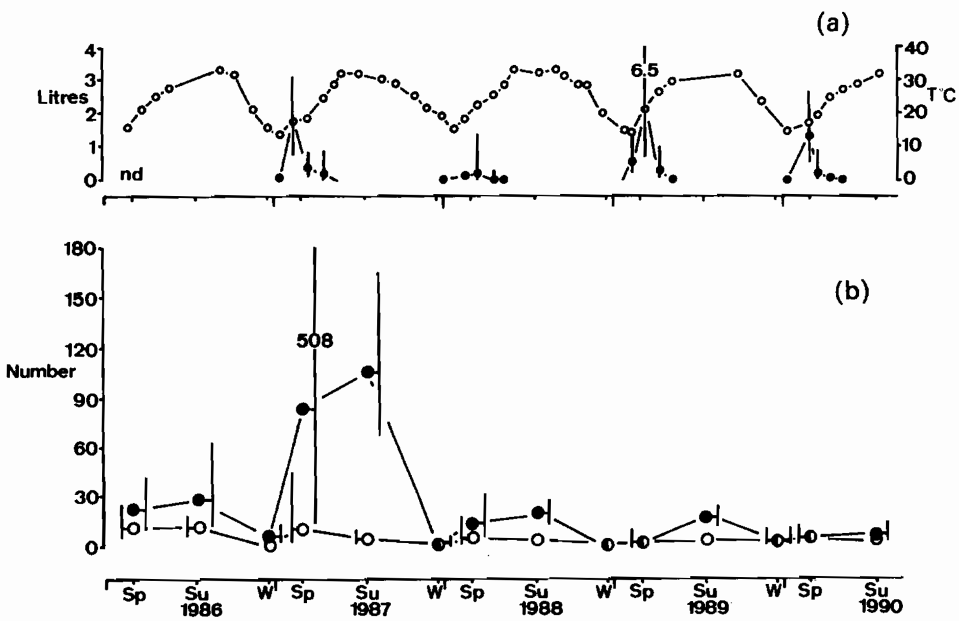

Fig. 2. For the period February 1986 to July 1990. (a): surface temperature (O), weed volume (●). (b): mean number of fishes for the intertidal (●) and subtidal (O), with 95% confidence limits. Numbers refer to upper 95% confidence limit. Sp, Spring; Su, Summer; and W, Winter. nd, no data.

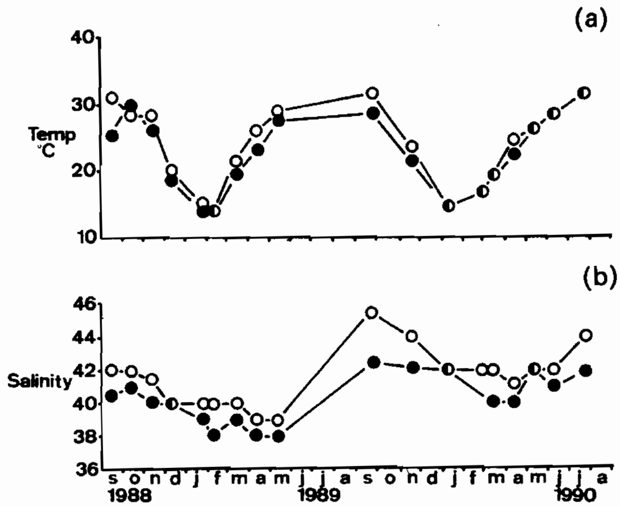

Fig. 3. Salinity and temperature fluctuation. (a): temperature and (b): Salinity, surface (O) and bottom (●) temperature and salinity in Sulaibikhat Bay.

represents the change from intertidal to subtidal and Axis 2 is more complex but is a measure of regularity of occurrence. The division between intertidal and subtidal is clear. The division on Axis 2 suggests an element of seasonality as well as regularity. The distribution of the twenty most abundant species shown by DECORANA also reflects the change from intertidal to subtidal on Axis 1 and from summer to winter on Axis 2 (Fig. 6). *Leiognathus decorus* is centrally located reflecting its presence all year round in both the intertidal and subtidal zones. Other species with a similar distribution include *Pseudosynanceia melanostigma*, an intertidal species, *Sillago sp.* and *Plotosus lineatus*, subtidal species. *Liza carinata* is toward the upper left reflecting its exclusively intertidal spring and summer distribution. Species showing a similar distribution, include the following: *Acentrogobius ornatus*, exclusively intertidal and *Thryssa hamiltonii*, mostly intertidal. *Solea elongata* is at the lower right reflecting its subtidal distribution. These species centred around *Pomadasys stridens* were typically captured irregularly in the subtidal zone.

Significant two-factor interactions were found for the 3-way ANOVA that examined the effect of depth (D), season (S) and year (Y) on total numbers of fish (N) (Table 2). It was not considered worthwhile to try and isolate the effects of these variables given that all three of the two factor interactions were significant. The graphical presentation of the data illustrates the above two-factor interactions (Fig. 2). It should be noted that the 3-way ANOVA uses data between November 1986 and September 1989 but that Fig. 2 illustrates data from February 1986 to July 1990. The significant Year and Season (Y S) interaction is due to the marked differences in numbers in any given season between years. The significant Year Depth (Y D) interaction is due to differences in numbers between depths in both years so that numbers in the intertidal zone are not consistent between years as shown by intertidal numbers in all seasons of 1987 compared to 1988 (Fig. 2). The significant Depth Season (D S) interaction is due to the inconsistent difference in intertidal numbers in

Table 1. Alphabetical listing of families with species captured during the sampling programme.

FAMILY/SPECIES
Apogonidae
Apogonichthys uninotatus Smith & Radcliffe
Ariidae
Arius tenuispinis Day
Batrachoididae
Batrachus grunniens (Linnaeus)
Belonidae
Stronglyura strongylura (Van Hasselt)
Bothidae
Pseudorhombus arsius (Hamilton)
Callionymidae
Callionymus hindsi Richardson
Carangidae
Alepes djedaba (Forsskal)
Scomberoides commersonnianus Lacepede
Trachinotus mookalee Cuvier
Caranx sexfasciatus (Quoy & Gaimard)
Carcharhinidae
Scoliodon laticaudus Muller & Henle
Clupeidae
Nematolosa nasus (Bloch)
Ilisha melastoma (Schneider)
Sardinella melanura (Cuvier)
Dussumeria acuta Valenciennes
Sardinella longiceps Valenciennes
Sardinella gibbosa (Bleeker)
Cynoglossidae
Cynoglossus puncticeps (Richardson)
Cynoglossus arel (Schneider)
Cyprinodontidae
Aphanius dispar (Ruppell)
Dasyatididae
Dasyatis imbricatus (Bloch & Schneider)
Engraulidae
Thryssa hamiltonii (Gray)
Thryssa dussumieri (Valenciennes)
Thryssa mystax (Schneider)
Gerreidae
Gerres filamentosus Cuvier
Gerres lucidus Cuvier
Gobiidae
Apocryptes madurenesis Bleeker
Acentrogobius ornatus (Ruppell)
Scartelaos viridis (Hamilton-Buchanan)
Acentrogobius cyanomos (Bleeker)
Gobius brevirostris Gunther
Boleophthalmus boddarti Pallas
Ctenogobius criniger Cuvier & Valenciennes
Trypauchen vaginata (Bloch & Schneider)
Periophthalmus koelreuteri Pallas
Gymnuridae
Gymnura poecilura (Shaw)
Haemulidae
Pomadasys stridens (Forsskal)
Pomadasys argenteus (Forsskal)
Pomadasys maculatum (Bloch)
Hemiramphidae
Hemiramphus marginatus (Forsskal)
Leiognathidae
Leiognathus decorus (de Vis)
Leiognathus lineolatus (Valenciennes)
Mugilidae
Liza carinata (Valenciennes)
Liza subviridis (Valenciennes)
Mullidae
Upeneus sulphureus Cuvier
Upeneus tragula Richardson
Platycephalidae
Platycephalus indicus (Linnaeus)
Grammoliptes scaber (Linnaeus)
Plotosidae
Plotosus lineatus (Thunberg)
Polynemidae
Polynemus sextarius Bloch & Schneider
Rhynchobatidae
Rhynchobatus djiddensis (Forsskal)
Scatophagidae
Scatophagus tetracanthus (Lacepede)?
Sciaenidae
Pennahia macrophthalmus (Bleeker)
Otolithes ruber (Schneider)
Johnieops aneus (Bloch)
Johnius belangerii (Cuvier)
Scorpaenidae
Pseudosynanceia melanostigma (Day)
Minous monodactylus (Bloch & Schneider)
Sillaginidae
Sillago sihama (Forsskal)
Sillago sp.
Soleidae
Solea elongata Day
Euryglossa orientalis (Bloch & Schneider)
Sparidae
Acanthopagrus latus (Houttuyn)
Acanthopagrus berda (Forsskal)
Diplodus sargus kotschyi (Steindachner)
Synodontidae
Saurida undosquamis (Richardson)
Teraponidae
Terapon puta (Cuvier)
Tetraodontidae
Chelonodon patoca (Buchanan)
Triacanthidae
Pseudotriacanthus strigilifer (Cantor)
Trichuridae
Eupleurogrammus glossodon (Bleeker)

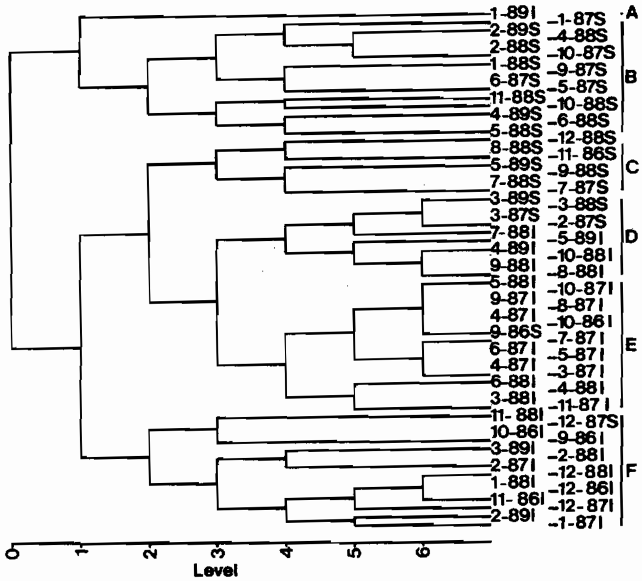

Fig. 4. TWINSPAN dendrogram of intertidal (I) and subtidal (S) samples in each month and year.

any given season, best illustrated by the huge numbers in the intertidal summer compared to winter in 1987.

The different between years in numbers captured is particularly obvious in the high catches in 1987 followed by lower numbers in the remaining years. Numbers in 1986, 1988, 1989 and 1990 and the distribution between depths and seasons in these years are broadly similar. Large volumes of weed were taken by the trawl during the spring months in 1987, 1989 and 1990, but low volumes were recorded in 1988. No data were collected in 1986.

Of the six dominant fish species, only *Leiognathus decorus* is present in every season of the sampling period (Fig. 7). This species is typically present in low numbers in

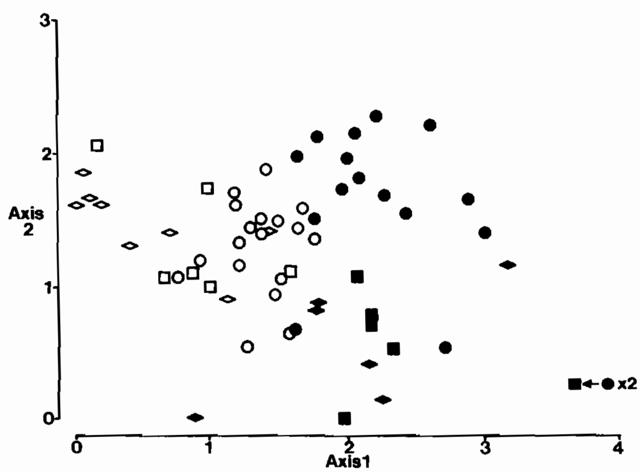

Fig. 5. DECORANA ordination of samples grouped into intertidal (unshaded) and subtidal (shaded) and spring (◇), winter (□) and summer (○).

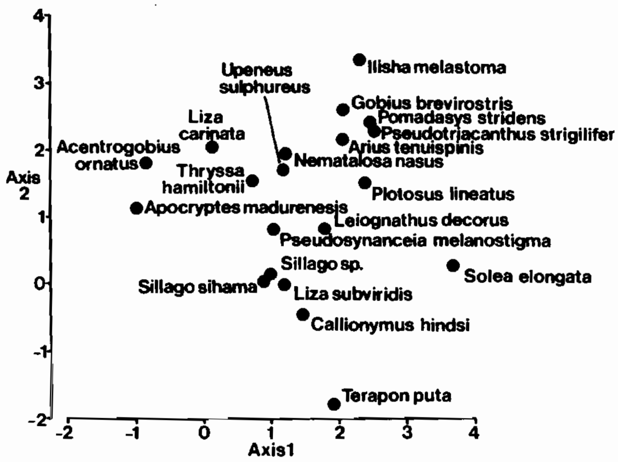

Fig. 6. DECORANA ordination of the twenty most abundant species.

Table 2. Three-way ANOVA of year (Y), season (S) and depth (D) with log total numbers of fish.

Source of variation	ssq	df	Mean sq	*F*-ratio	Probability
Y	75.0	2	37.5	18.7	0.000***
S	160.8	2	80.4	40.1	0.000***
D	134.3	1	134.3	67.0	0.000***
YS	26.2	4	6.5	3.3	0.012*
YD	31.3	2	15.6	7.8	0.001***
SD	22.9	2	11.4	5.7	0.004**
YD	4.9	4	1.2	0.61	0.653
Error	720.1	359	2.0		

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

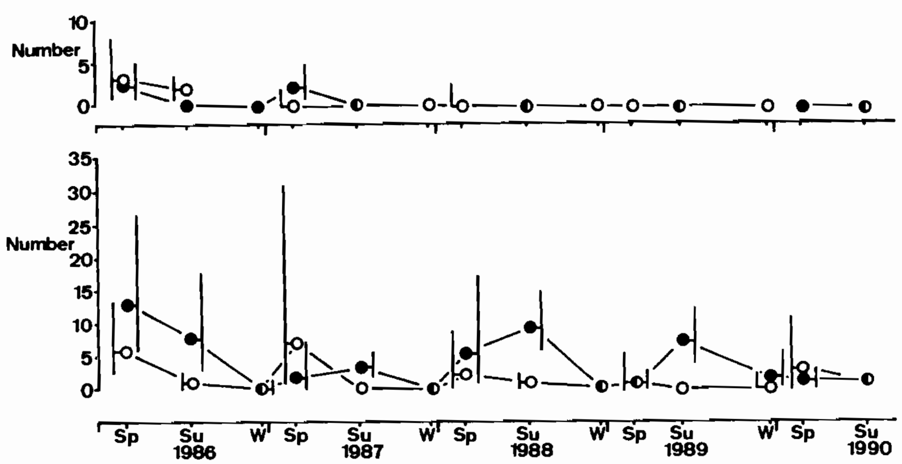

Fig. 7. Mean number of *Solea elongata* (upper) and *Leiognathus decorus* (lower) for the intertidal (●) and subtidal (O), with 95% confidence limits. Note different scales on the Y-axes. Sp, Spring; Su, Summer; and W, Winter.

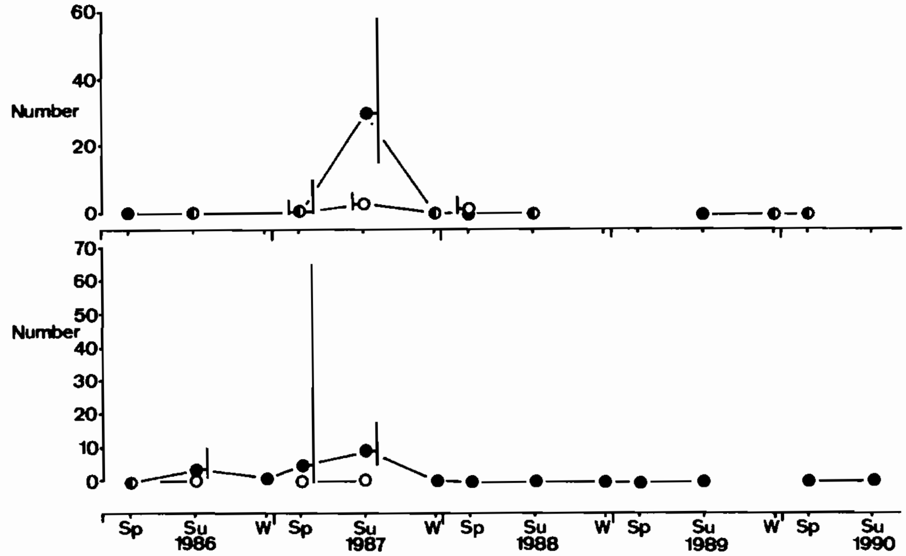

Fig. 8. Mean number of *Pomadasys stridens* (upper) and *Liza carinata* (lower) for the intertidal (●) and subtidal (○), with 95% confidence limits. Note different scales on the Y-axes. Sp, Spring; Su, Summer; and W, Winter.

both depths during the winter months with larger numbers in the intertidal region during spring and summer. Larger numbers were found in the subtidal than in the intertidal regions during spring 1987 and to a lesser extent in 1990. The numbers of both *Liza carinata* and *Pomadasys stridens* reflect the exceptional catches in 1987 (Fig. 8). The catches of *Liza carinata* were due to shoals being taken in two spring trawls and high summer catches. The catches of *Pomadasys stridens* reflect high catches in the summer months of 1987. In 1988 to 1990, catches of these two species were infrequent. The catches of *Solea elongata* have been higher in the intertidal regions during 1986 and 1987 with low numbers almost exclusively in the subtidal

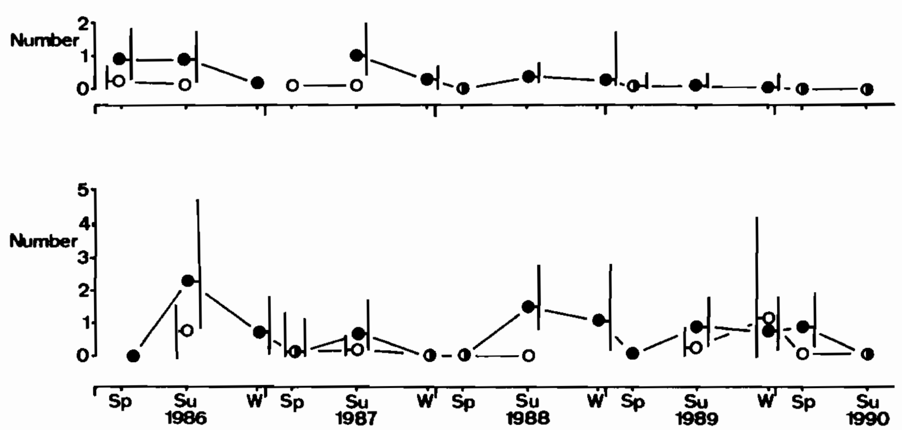

Fig. 9. Mean number of *Pseudosynanceia melanostigma* (upper) and *Thryssa hamiltonii* (lower) for the intertidal (●) and subtidal (○), with 95% confidence limits. Note different scales on the Y-axes. Sp, Spring; Su, Summer; and W, Winter.

regions for the remaining years of the programme (Fig. 7). *Pseudosynanceia melanostigma*, whilst present in lesser numbers, is present all year and is more abundant in the intertidal zone (Fig. 9). *Thryssa hamiltonii* is characteristic of the intertidal zone with larger numbers present in the summer months (Fig. 9).

DISCUSSION

Salinity and temperature cycles in Kuwait have been extensively reported and related to fish and shrimp catches (Wright 1988b, 1991; Joseph & Shalash, 1991). The Shatt al-Arab River is the major freshwater input to the northern Arabian Gulf (Abaychi *et al.* 1988). The peak input during the spring and the minimum in November affects the salinity cycle in Sulaibikhat Bay (Wright 1989b). High annual shrimp catches have been related to low average annual temperatures, salinities and bottom oxygen concentrations (Joseph & Shalash 1991). It was further observed that shrimp and commercial fish production were inversely related.

Whilst the reported temperature cycles remain broadly constant between years, there are annual differences during the critical month of March, previously noted as affecting the scale of the spring bloom of chlorophytes, with high temperatures likely to result in a dieback of the bloom (Wright 1989c). The size of the bloom of chlorophytes was markedly lower in 1988 compared to 1987, 1989 and 1990, with no data collected in 1986. This supports the previous observation that early onset of high summer temperatures results in a die-back of the chlorophytes.

Salinities show more inter-annual variation when compared to that of temperature. Surface salinities in November of each year at the time of minimum input from the Shatt al-Arab can be used to indicate the supply of nutrients from the Shat al-Arab to Sulaibikhat Bay. Surface salinity in November was 46 (1986), 44 (1987), 42 (1988), 46 (1989), and probably at least 44 (1990). The poor bloom reported in spring 1988 occurred after a high input from the Shatt al-Arab as indicated by surface salinities. This suggests that nutrient supply from land-based sources, possibly via waste water effluent discharged directly into Sulaibikhat Bay and therefore likely to be consistent, was sufficient to produce the observed blooms and that temperature is the factor determining the time of decline of the bloom.

Surface salinity is typically higher than bottom salinity with the difference more marked in the summer. This gradient reflects high evaporation rates at the water surface and on the extensive intertidal mud flats.

The fish assemblage of Sulaibikhat Bay is dominated by young-of-the-year fish. During the $4\frac{1}{2}$ year sampling programme 93% of the 47,761 fish were captured in the two years between September 1986 and August 1988 (Wright 1989b). A total of 70 species from 38 families were recorded compared to 50 species in 30 families between 1986 and 1988 (Wright 1989b). The dominant families; in terms of number of species are Gobiidae (8 species) and Clupeidae (6 species). The dominance of the Gobiidae reflects the intertidal environment sampled with all four possible "mudskippers" captured.

The two numerically dominant species, *Liza carinata* and *Pomadasys stridens*, accounted for 80.4% of the total catch in this study. Ichthyoplankton studies in Kuwait Bay have identified the Engraulidae, Gobiidae and Clupeidae as the most abundant families (Houde *et al.* 1986). A subsequent ichthyoplankton study identified Sparidae, Clupeidae and Gobiidae as the dominant families (Grabe *et al.* 1992). In the tropical Gulf of Carpentaria 25 species accounted for 82% of the commercial catch dominated by Leiognathidae, Haemulidae and Clupeidae (Blaber *et al.* 1990). This difference of a much higher diversity compared to the present study reflects the use of the study area as a nursery ground. When compared to long-term beach seine studies in a temporate Australian estuary, the familial and species numbers are similar with 71 species in 36 families (Loneragan *et al.* 1989).

The use of TWINSPAN and DECORANA allowed the samples to be divided into three seasons. DECORANA split the 20 most abundant species on the ecological criteria of water depth and seasonality. The assemblage could be divided into several groups: *Leiognathus decorus*, *Pseudosynanceia melanostigma*, *Sillago sihama*, *Sillago sp. Liza subviridis* and *Callionymus hindsi* which are found in both water depths at all times of the year. *Solea elongata* is most typical of the subtidal zone. *Terapon puta* and *Illisha melastoma* both occur irregularly in the subtidal and intertidal zone respectively. *Apocryptes madurenesis*, *Acentrogobius ornatus* and *Liza carinata* are typical of the intertidal zone in the spring and summer. *Nematolosa nasus*, *Upeneus sulphurus*, *Thryssa hamiltonii* and *Plotosus lineatus* are typical of the intertidal area and are captured irregularly, predominantly in the spring and summer. *Gobius brevirostris*, *Pomadasys stridens*, *Pseudotriacanthus strigilifer* and *Arius tenuispinis* are typically found in the subtidal region, predominantly in the summer. It should be noted that of the six dominant species only *Liza carinata* and *Pomadasys stridens* are pelagic. The juvenile distribution of these two species appears to be intertidal but may be an artefact of their increased catchability in shallow waters. When used to sample the intertidal region, the headline of the otter trawl typically broke the surface. The trawl therefore sampled surface waters in the intertidal region. During subtidal sampling the trawl was at least 4 m below the surface. *Liza carinata* can be seen to typically form shoals at the water surface and the catches of this species may therefore be an artefact of the use of an otter trawl. The observed intertidal distribution of *Pomadays stridens* may also reflect this fishing method.

The complex results produced by the 3-way ANOVA reflect the marked differences in the assemblage between years, between seasons and between depths. In general, Sulaibikhat Bay is characterised by differences between years. These differences are not directly related to the size of the spring bloom of chlorophytes which are determined by spring temperatures. It is acknowledged that year-class strength is determined in two stages with coarse control taking place during planktonic stages and fine control taking place later in life (Gulland 1965). The particularly good year of 1987 for both *Liza carinata* and *Pomadasys stridens* has been discussed elsewhere (Wright 1990). The catches of these two species in 1987 account of 77.8% of the total numbers captured.

Liza carinata juveniles have been shown to be closely associated to patches of chlorophytes during the spring bloom (Wright, 1989c). However, the present study suggests that the size of the blooms does not directly influence the success of the year class of *Liza carinata* once recruited. Similarly, the success of the *Leiognathus decorus* year class, whilst being associated with the chlorophytes early in the spring bloom (Wright 1989c), is not directly related to the size of the spring bloom. This supports previous observations made on the data from 1987 and 1988 (Wright 1990), that blooms may alleviate predation pressure, particularly from piscivorous birds during daylight, but that bloom size does not have a direct effect on the year-class success.

Leiognathus decorus is one of the few species that is present year round. This is a reflection of the fact that trawling captures adults as well as young of the year whilst many of the other species are captured only as juveniles for a few months each year. The larger catches in the subtidal region during the spring of 1987 and 1990 reflect a spawning migration of larger fish (Wright 1988b, 1989b).

Long-term changes in the Southeast Gulf of Carpentaria are related to intense trawling activity and disposal of by-catch with marked changes in abundance and diel behaviour of species (Harris & Poiner 1991). It is suggested that the observed changes in catches in Sulaibikhat Bay are dependent on factors other than fishing activity and are more dependent on environmental factors. Long-term trends, such as noted in the Gulf of Carpentaria, may be masked by the more pronounced between year variations. These between-year variations are driven by environmental factors for *Liza carinata* and *Pomadasys stridens* as discussed elsewhere (Wright 1990). The consistency in catches of *Leiognathus decorus* in Sulaibikhat Bay suggests that fishing pressure is not affecting this population at the present level of fishing activity. Sulaibikhat Bay is rarely subjected to large-scale commercial trawling partly because of the shallowness of the waters. There is a well-developed shrimp fishery in the Northern Arabian Gulf with the typical associated by-catch disposal problems (Harris & Poiner 1991).

The intertidal zone of the western side of the northern Arabian Gulf is characterised by extensive mud flats. These flats are good nursery grounds for *Liza carinata*. A number of other species are closely associated with the intertidal in this region including: *Leiognathus decorus*, *Pseudosynanceia melanostigma*, *Sillago sihama*, *Sillago* sp., *Liza subviridis*, *Callionymus hindsi* and the Clupeidae and Gobiidae generally. The intertidal flats have also been identified as important shrimp nursery grounds, particularly for *Metapenaeus affinis* (Bishop & Khan 1991).

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تغيرات بعيدة المدى في تجمعات أسماك جون الصليبيخات ـ الكويت

جيم رايت، فدوى أبوسيدو*، وديفيد كلايتون
*قسم علم الحيوان بجامعة الكويت، ص. ب 5969، 13060 الصفاة
دولة الكويت

خلاصة

تم إصطياد ما مجموعه ٤٧,٧٦١ سمكة تمثل ٧٠ نوعاً و ٤٨ فصيلة في جون الصليبيخات بالكويت في الفترة ما بين فبراير ١٩٨٦ ويوليو ١٩٩٠ وذلك بإستخدام شباك الجر، وكانت معظم الأنواع ممثلة بصغار السن. ويتأثر التجمع بالعمق والفصول؛ العمق مأخوذاً في المد والجزر وما يليهما، وتتمثل الفصول بالشتاء والربيع والصيف.

ويمكن وضع عشرون نوعاً متواجدة بوفرة في فئات متعددة بأمثلة نموذجية كالتالي: أنواع منتظمة مثل *Leiognathus decorus* (de Vis)؛ أنواع ما بين المد والجزر في فصلي الربيع والصيف مثل *Liza carinata* (Valenciennes)؛ وأنواع غير منتظمة مثل *Terapon puta* (cuvier) وأنواع ما بعد المد والجزر مثل *Solea elongata* (Day).

ولقد أظهرت النتائج إختلافاً ملحوظاً عن التجمع السمكي بين السنوات، فالأنواع السائدة لفترة طويلة *Leiognathus decorus* (de Vis)، والتي تختلف عن معظم الأنواع التي تم ذكرها وإدراجها هنا، كانت موجودة بجميع أطوار حياتها وبأعداد ثابتة سنوياً. وأظهر النوعان السائدان عددياً (*Liza Carinata* و *Pomadasys stridens* (Forsskal)) إختلافات جوهرية في الأعداد في السنوات المختلفة؛ حيث كانت متواجدة بأعداد كبيرة في سنة واحدة فقط.