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Observations on the distribution of benthic organisms in Samarra impoundment, Iraq

ANMAR W. SABRI AND KHALID A. RASHEED

Faculty of Biology and Agriculture, Section of Aquatic Ecology, P.O. Box 765, Baghdad, Iraq

ABSTRACT

The distribution of benthic organisms in Samarra impoundment was investigated from November 1986 to October 1987. Water temperature, current velocity, dissolved oxygen content and BOD_5 were measured. A total of eight taxa were collected. *Limnodrilus hoffmeisteri* and *Tendipes* sp. larvae were the dominant taxa in sediments of the main water body, whilst *Mesocyclops leuckarti* dominated the pool region. Variations in the community structure within the impoundment were evident from the results of community analysis. The pool region receiving untreated sewage showed higher water temperatures, less oxygen content, higher BOD_5 values and absence of current. The possible factors influencing the distribution of benthic organisms are discussed.

INTRODUCTION

Investigations on the benthic fauna have seldom been carried out in Iraqi inland waters. Such a gap in information was indicated by Rzoska (1980) and emphasized six years later by Mohammad (1986). Moreover, apart from Alhamed (1976) who presented some data on the benthic community of the Dukan reservoir in the north, all other investigations have been carried out around Baghdad or in the south of the country (Arlt & Saad 1977; Mohammad 1980, 1986; Hussain & Ahmed 1983; Aldabbagh & Daoud 1985; Almukhtar *et al.* 1986).

The present work was undertaken to describe the benthic community of Samarra impoundment. Other aims were to provide information on the influence of untreated sewage wastes on benthic community structure.

STUDY AREA

Samarra impoundment (22 × 6 km maximum width) is located about 180 km (by river) north of Baghdad (Fig. 1). It regulates water level in the downstream sector of the river Tigris by directing the excess water to Tharthar "lake", especially during the high discharge season (winter and spring). The water level in the impoundment is maintained at about 68 m above sea level for the purpose of electricity generation. The impoundment is shallow (maximum depth 6·5 m) and includes many small islands covered with dense riverain-type vegetation. The impoundment has been operational since early 1956.

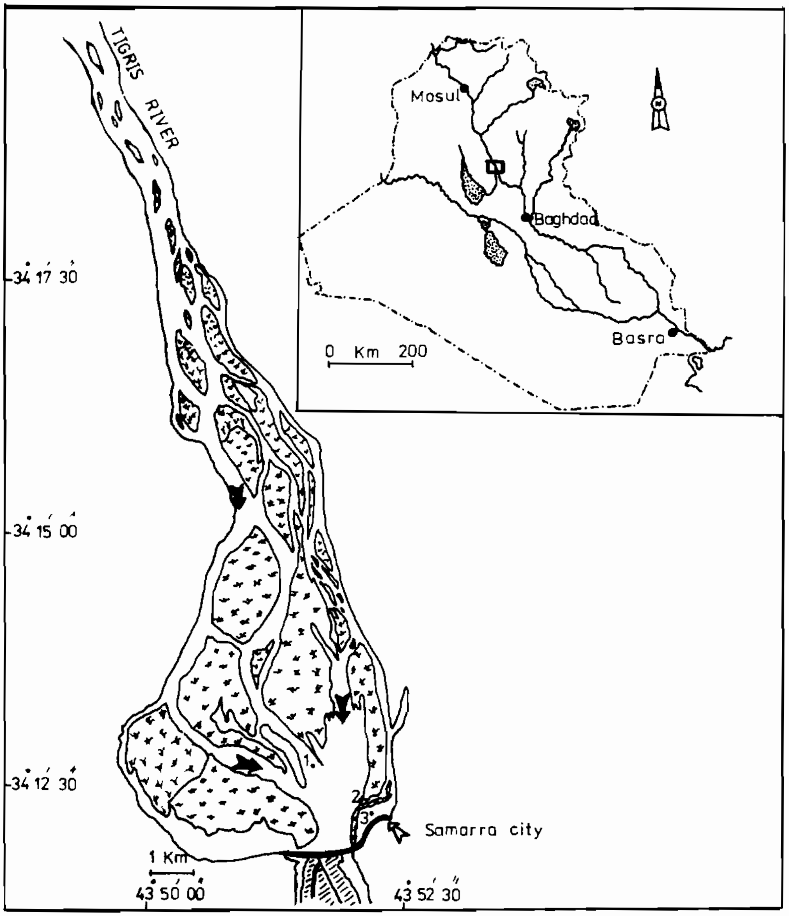

Fig. 1. Map of Iraq (inset) and Samarra impoundment showing locations of sampling stations (1–3). Solid arrows indicate the main river current pathways. Empty arrow indicates the location of sewage drainage. ⁎⁎⁎ = Islands covered with vegetation.

Three sampling stations were selected (Fig. 1). Station 1 was located in the main stream of the river Tigris within the impoundment. The water here was 6 m deep and the sediment was mainly silt and sand. Station 2 was 4·5 m deep and located about 500 m from the southeastern shore. The sediment was grayish in colour and composed of silt, clay and sand. Patches of *Potamogeton lucens* L., *Phragmites australis* (Cav.) Trin. ex Steud. and *Typha domingensis* Pers. filled the area around Stations 1 and 2. Station 3 was located in a pool connected to the main water body via a canal. It was 4·5 m deep and receives untreated sewage from a small residential sector of Samarra city (arrow in Fig. 1). The sediment here was mainly dark coloured clay and silt. Patches of *Meriophyllum spicatum* L. and *Ceratophyllum demersum* L. occupied the littoral area around the pool.

MATERIALS AND METHODS

The study period was from November 1986 to October 1987. Bottom fauna was sampled monthly using an Ekman dredge (15 × 15 cm). At each station, ten grabs were taken and combined to form a total sampling area of 2250 cm^2. The grabs were taken from the deepest point at each station to the nearest littoral zone along a transect. Members of the benthic community were separated from sediment and debris using a plankton sieve of 500 μm aperture size, preserved in 5% formalin, and counted and identified to genus or species when possible, using standard keys (Chu 1949; Edmondson 1959; Ahmad 1975; Pennak 1978). For practical reasons, Protozoa, Rotifera and young stages were not considered. Near-bottom water temperature was measured in the field using a mercury thermometer (range -10 to 60°C) within a Van-Dorn bottle. Dissolved oxygen concentration was determined using the Winkler azide modification method and the comparative degrees of pollution were measured by the 5-day Biochemical Oxygen Demand (BOD_5) test (APHA 1975). The water current was recorded using a Universal Current Meter type C31 "10. 001" (A. Ott GMBH, Kempten, West Germany).

Counts are expressed in terms of individuals m^{-2} and the numbers were rounded to the nearest integer. For faunal comparison, the species deficit (F) was computed from Kothe's formula (Meynell 1973):

$$F = 100\,\frac{(A_1 - A_x)}{A_1}$$

where:

A_1 = the number of species at Station 2.
A_x = the number of species at the other station (either Station 1 or 3).

The community index of similarity was estimated using the Ellenberg formula (IS_E) (Mueller-Dombois & Ellenberg 1974):

$$IS_E = \frac{Mc/2}{Ma + Mb + Mc/2} \times 100$$

where:

Mc = the sum of the mean annual density values (in %) of the species common to both stations.
Ma = the sum of the mean annual density values (in %) of the species restricted to the first station.
Mb = the sum of the mean annual density values (in %) of the species restricted to the second station.

For the purpose of IS_E and species deficit calculations *Tendipes*, Nematoda and Acari were considered to be represented by a single taxon each.

RESULTS

ENVIRONMENTAL CONDITIONS

The annual range of water temperature in the impoundment was 10 to 29°C (Fig. 2). Maximum values were recorded during summer (August) and minima occurred in winter and spring (December–April). The mean water temperature at Station 3 (19·6°C) was about 3 and 2°C higher than those of Stations 1 and 2. Dissolved oxygen ranged from less than 5 mg l^{-1} to more than 12 mg l^{-1} during summer and winter, respectively. Minimum concentrations were frequently recorded at Station 3.

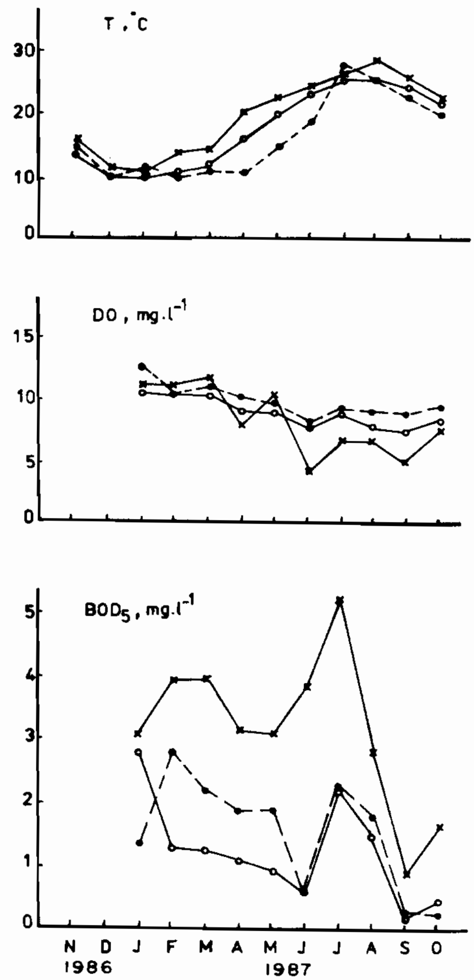

Fig. 2. Seasonal variations in water temperature (T), dissolved oxygen concentration (DO), and biochemical oxygen demand (BOD_5) at Station 1 (○), Station 2 (●) and Station 3 (×)

The mean value of BOD_5 was 3·18 mg l^{-1} (range 0·8–5·3) at Station 3, which was almost three times greater than those of Stations 1 and 2. At all three stations, the highest BOD's were recorded in January or February and July. Velocity of water current was recorded during April to October 1987. The ranges at Stations 1 and 2 were 0·19–1·98 m sec^{-1} and 0·09–1·3 m sec^{-1}. No current could be traced at Station 3 throughout the study period.

BENTHIC FAUNA

Table 1 shows the mean annual composition (in %) and frequency of the identified groups at Stations 1 to 3. Species deficits at Stations 1 and 3, in comparison to Station 2, were 12·5% and 37·5%, respectively. *Limnodrilus hoffmeisteri* was found to be the dominant species at Station 1 where it formed 60% of the annual composition. The peak of the population density was more than 800 individuals m^{-2},

Table 1. Mean annual density of the benthic organisms (in %) and frequency of occurrence (in brackets) at Stations 1 to 3

Macrozoobenthos	St. 1	St. 2	St. 3
Insect (larvae)			
Tendipes (= *Chironomus*)	23·6 (12)	47·6 (12)	2·9 (5)
Oligochaeta			
Limnodrilus hoffmeisteri Claparede	58·5 (11)	36·5 (12)	0·6 (3)
Nais sp.	4·5 (9)	5·6 (10)	—
Mollusca			
Corbicula fluminea Müller	3·5 (7)	2·4 (8)	—
C. fluminalus Müller	0·9 (6)	0·6 (5)	—
Nematoda	7·8 (10)	1·7 (5)	—
Acari	1·5 (3)	4·9 (7)	0·8 (4)
Copepoda			
Mesocyclops leuckarti Claus	—	0·7 (3)	95·3 (11)
Species deficit (F) %	12·5	0	37·5

recorded during May (Fig. 3). *Tendipes* sp. was the second most numerous species at this station and comprised 23·6% of the annual composition. These were also the dominant taxa at Station 2, but in reverse order (Fig. 3). *Tendipes* sp. comprised about 50% of the annual composition, whilst *Limnodrilus hoffmeisteri* comprised 36.5% (Table 1). The peak density of *Tendipes* sp. larvae at Station 2 was more than 900 individuals m^{-2}, observed during February. Moreover, remarkable similarities in seasonal fluctuations of *Limnodrilus hoffmeisteri* and *Tendipes* sp. were observed at both Stations 1 and 2 (Fig. 3). Both species were present in fairly high densities during winter, then declined to a minimum during summer. In contrast, *Mesocyclops leuckarti* was the dominant species at Station 3 and constituted more than 95% of the annual composition (Table 1). The peak population density was more than 2000 individuals m^{-2} observed during summer (June), preceded and followed by very low densities (Fig. 3). Each of the other faunal elements did not exceed 8% of the annual composition at any station. The peak densities of *Corbicula fluminea*, *C. fluminalus*, *Nais* sp., Nematoda and Acari were about 50, 80, 80, 150 and 190 individuals m^{-2} observed during August, August, February and May, January and January, respectively. *Corbicula* spp., Nematoda and *Nais* sp. were not collected from Station 3.

The maximum value of community index of similarity IS_E was 99·3%, computed between Stations 1 and 2, and the minimum was 28·0% between Stations 1 and 3. The value of IS_E between Stations 2 and 3 was 90·2%.

DISCUSSION

Local differences were evident during the present work and seem to be related to more than one factor. The presence of *Corbicula* spp. at Stations 1 and 2 only is expected, since these organisms favor a sand-substrate, moderate-velocity type of environment (Wells & Demas 1979). Station 3 was characterized by the absence of current, higher BOD_5 values and dark coloured sediment due to its location in a pool near an urban sewage source. This is reflected in the results by the presence of only four species at Station 3 in contrast to seven or eight species at other areas

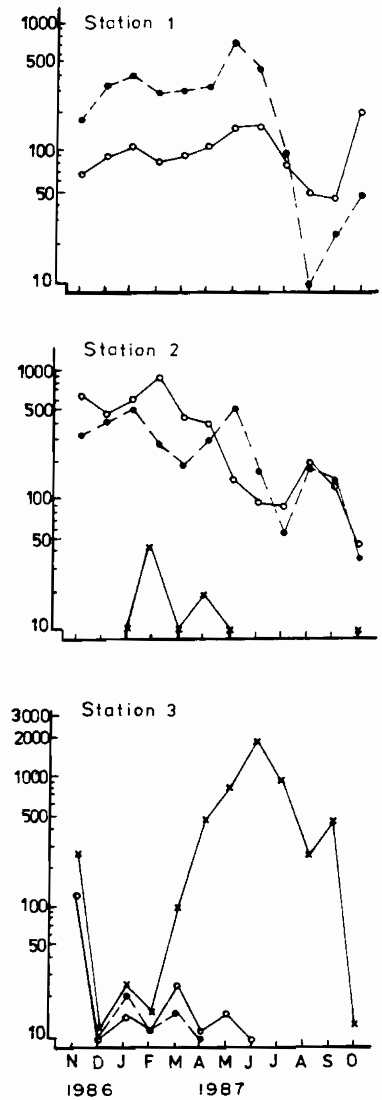

Fig. 3. Seasonal variations in population density (number of individuals m^{-2}) of the dominant taxa at Stations 1 to 3. (○) indicates *Tendipes* larvae; (●) *Limnodrilus hoffmeisteri*; and (×) *Mesocyclops leuckarti*.

which is a known effect of pollution (Mohammad 1980; Almukhtar *et al.* 1986; Pederson & Perkins 1986). Moreover, *Mesocyclops leuckarti* dominated the water column at Station 3 during the same period (Sabri, unpublished observations) and this may explain its abundance in the benthic samples at the same station. Changing from a planktonic to a benthic mode of life is not a rare occurrence in copepods and may be due to food availability (Hutchinson 1967). The presence of such predaceous copepods in the river bed may be the reason for the scarcity of worms and *Tendipes* sp. larvae at Station 3. This needs further investigation since *Mesocyclops leuckarti* is known to feed upon Crustacea, Rotifera and other small organisms (Green 1971).

The presence of *M. leuckarti* at Station 2 may be due to the exchange of water between the main water body and the pool (Station 3) through the connecting canal in which Station 2 was located. This suggestion is supported by the presence of *M. leuckarti* at Station 2 only during the high discharge season (spring and October). Nematoda were completely absent from Station 3, which supports previous conclusions of Sabri (1988) that these worms were allochthonous in origin, which drifted with the current and settled with the suspended load where current velocity was sufficiently low.

The connecting canal between Stations 3 and 2 would also explain the high value of IS_E between the two stations. However, the species deficit between the two stations (37·5%) which resulted from the absence of *Corbicula* spp., *Nais* sp. and Nematoda from Station 3 reflects the variations in benthic community structure between the two localities. On the other hand, the high IS_E value (99·3%) between Stations 1 and 2 and the low species deficit (12·5%) which resulted from the absence of the quantitatively unimportant taxon (*Mesocyclops leuckarti*) reflects that samples from both stations were taken from the same community.

Population density of oligochaetes has often been used as an indicator of water quality. Generally, the population density increases remarkably following organic pollution (QiSang & Erseus 1985). For example, Goodnight & Whitley (1960) reported that oligochaetes representing 60% of the macrobenthos is a sign of good conditions, whilst 80% or more indicates a high degree of organic or industrial pollution. Carr & Hiltunen (1965) suggested that if the worms occur in a density of 100–999 individuals m^{-2} the water is unpolluted, 1000–5000 individuals m^{-2} indicates moderate pollution, and more than 5000 individuals m^{-2} indicates heavy pollution. Accordingly, the results of the present study indicate that the water at Stations 1 and 2 was unpolluted, since the population density of oligochaetes was about 1000 individuals m^{-2} which represents less than 60% of the population. However, the results obtained at Station 3 appear to be contradictory. Here there were higher BOD_5 values than at Stations 1 and 2, but oligochaetes were scarce throughout the study period and comprised only 0·6% of the annual density. However, the values suggested by Goodnight & Whitley (1960) and Carr & Holtunen (1965) are not absolute, as indicated by Maciorowski *et al.* (1977) who found oligochaete densities of $<670\ m^{-2}$ in a polluted section of the river Kanawha in West Virginia, U.S.A., in contrast with 400–2400 m^{-2} in unpolluted areas. Oligochaetes represented about 70% of the population at two stations in the river Khir characterized by different degrees of organic pollution and Mohammad (1979) commented that it seems that no two polluted aquatic ecosystems are exactly identical with respect to their environment. As freshwater animals are euryoecious and adapted to a wide variety of environments, contradictory results are to be expected (Pederson & Perkins 1986). In conclusion, the present study suggests that oligochaetes cannot be used as biological indicators of water quality at Samarra impoundment, and other means such as the community analysis carried out during the present work could be suggested. This is certainly the case at Station 3 where only four species were present and *M. leuckarti* was in very high numbers.

It was found that 8 taxa represent the benthic community at Samarra impoundment. This was higher than the number of taxa reported over an annual cycle in the rivers Tigris, Ephrates, an unpolluted section of the river Diayla and in Dukan reservoir (Alhamed 1976; Almukhtar *et al.* 1986; Mohammad 1986). The impoundment provides a greater number of habitats and a richer vegetation than the above locations, and should therefore support a higher number of species (Jenkins *et al.* 1984).

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مشاهدات على توزيع الأحياء القاعية في حوض سد سامراء بالعراق

أنمار وهبي صبري و خالد عباس رشيد
شعبة بيئة الأحياء المائية
هيئة الزراعة والبايولوجي ، ص . ب . ٧٦٥ بغداد ، العراق

خلاصة

تم اجراء دراسة على توزيع أحياء القاع في حوض سد سامراء للفترة من تشرين الثاني (نوفمبر) ١٩٨٦ ولغاية تشرين الأول (أكتوبر) ١٩٨٧ . وتم خلال البحث قياس درجة الحرارة ، وسرعة التيار وكمية الأوكسجين المذاب ، والمتطلب الحيوي للأوكسجين المستهلك . وجمعت ثماني وحدات تصنيفية . ولوحظ أن « ليموندريلاس هوفمايستري » ويرقات « تنديبس » هي الحيوانات الأكثر سيادة في المجرى الرئيسي للنهر ، بينما ساد « ميزوسايكلوپس لوكارتي » المنطقة القريبة من الساحل التي يكون فيها تيار الماء غير محسوس والمتأثرة بمياه مجاري جزء من مدينة سامراء .

نوقش في متن البحث تأثير الأحياء المفترسة والعوامل البيئية على الاختلافات الظاهرة في تركيب المجتمع الحياتي للمنطقة المدروسة .