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Ecological Observations on the Macrobenthos of the Nawran Stream, Mosul, Iraq

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Abstract

Ecological observations on the macrobenthos of the running stream of Nawran have been made for the past several years. The geography, physical and chemical environmental factors, and the seosanal variation in different populations of macrobenthos living there have been studied with respect to seasonal changes in the environment. The regional community comprises of *Dugesia* sp., *Dendrobaena atheca, Allolobophora, Eropbdella, Potamon magnum, Rivulogammarus syriacus, Caridina fossarum, Chironomoid* sp., *Melanoides tuberculata, Melanopsis praemorsa carraruta*, and nymphs of may fly and caddis fly. In spring and autumn the fauna is rich in number as well as in diversty.

The stream consists of two sections. The upper one has hard substratum and more slope gradient. resulting a fast current of water. The lower section has soft and muddy substratum. The current in this section is slow. Owing to such physical differences, these two sections of the stream support different groups of biota. Biota shows neither upward nor downstream movements but shows altitudinal seccession.

A statistical analysis has been made between the water temperature and different populations. The degree of association between the water temperature and the population density of different species is measured by the correlation coefficient positive and by significant at 0.05 level.

1. Introduction

Although there have been several faunistic studies on the streams in the different parts of the world (VAN SOMEREN, 1952; MARLIER, 1954; WINTERBOURN, 1964; MORGAN and EGGLISHAW, 1965; HUGES, 1966; MCLEAN, 1966; EGGLISHAW and MACKAY, 1967; WINTERBOURN and BROWN, 1967; NIELSEN, 1969; CLIFFORD, 1969; HYNES, 1971; HAMMER, 1971 etc.), but practically nothing is known about the stream fauna in the northern region of Iraq. The streams in this part of the country are important for the multiple utilization which includes water supply for domestic use, live stock watering, irrigation, sewage disposal and recreation. In the last couple of years, the University of Mosul, however, has launched a big limnological program to carry out the physical, chemical and biological characteristics of water and sediments of the streams, springs and rivers.

The Nawran stream is an interesting field in regard to regional limnology. It is of special interest to know whether biotypes of small stony streams in northern Iraq are occupied by characteristic community or by varying assemblage of species brought together by a chance of invasion. If there is characteristic community, each survey will reveal differences between parts of the stream and between different streams. It may prove possible to correlate these differences between parts of the stream and between different streams. It may prove possible to correlate these differences with differences in the environment and to formulate explanation that can be tested experimentally. The purpose of this communication, therefore, is to describe as far as possible the physical, chemical and biological characteristics of Nawran stream.

2. The study area

The perennial Nawran stream (Figures 1, 2, 3, 4) is located approximately 30km north of Mosul and 500m above sea level in the northern region of Iraq. The stream flows from a hilly region through open lands towards the river Khosur at about 2km. The maximum depth of the stream at different points is about 35cm and the width about 3m. The stream is divided into two parts, upper part and the lower part.

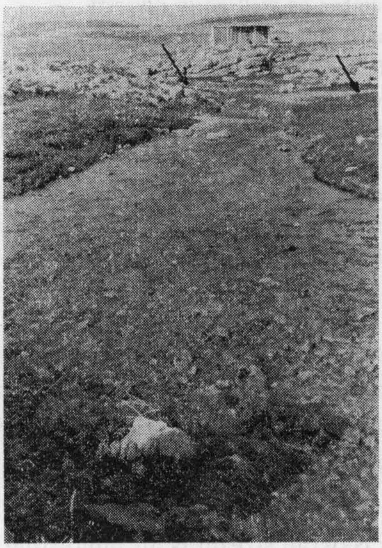

Fig. 1. Nawran stream. Arrows indicate the origin of the stream where subsoil water collects.

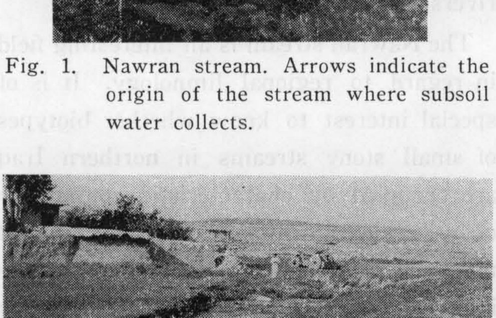

Fig. 2. Nawran stream.

Fig. 3. Burrows of the crabs (Arrows).

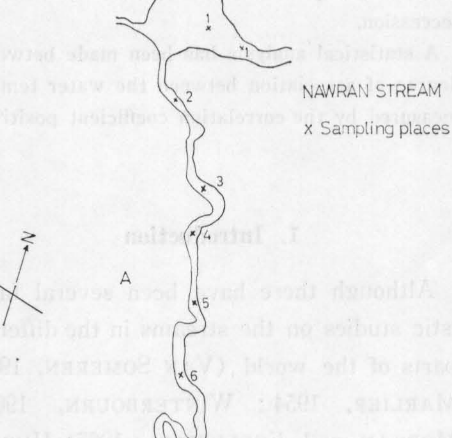

Fig. 4. Nawran stream: A, is the upper section of the stream; B, the lower section. Nos. 1 to 10 indicate the collecting stations.

The stream substratum of the upper part is mainly gravel and stony. Most of the stones are covered with algal masses. The upper part is about 1km long. The lower part running about 1km has muddy substratum and ends in Khosur. A narrow transitional belt between these two parts is also recognised. The slope gradient from the origin of the stream to the lower part is 23m. As a whole the stream may be recognized as relatively cool in receiving a great deal of ground water. The water is being used by the natives and has temporarily been so polluted as leading to considerable losses in some animal populations. The ground water accumulates at 1 (Fig. 1 and 4) and flows towards south. The water level remains more or less the same throughout the year. Stones, sand and mud are the predominant bottom types. There are several burrows above the water level on both sides of the stream.

Marginal and submerged aquatic vegetation comprise of *Centaurea iberica*, *C. pallescens*, *Alhagi maurorum*, *Polypogon monspeliesis*, *Trifolium fragiferum*, *Veronica* sp., *Juncus* sp., *Cyperus* sp., and *Typha* sp. The algal mass consists of *Chara* sp., *Oedogonium* sp., and *Nitella* sp.

3. Methods

The materials forming the basis for this study were collected from 1967 to 1971. The stream was visited at least once a month when animals and water samples were collected. Because the stream was very shallow no elaborate sampling equipment was necessary. The bottom fauna was collected by digging up bottom samples in the form of mud suspensions. Floating algal masses were collected by hand as were pieces of stones and wood in the spring. The quatitative study of the fauna for few animals was based on the entire collection of animals in one sq. ft. area at ten different stations on the course of the stream. Ten of one sq. ft. areas were selected at each station and the average was calculated. One square foot area was delimited by one square foot metal squares from where all the animals were collected. Every precaution was taken to collect all the animals attached to stones or on the substratum.

The environmental factors studied were 1) chemical (dissolved oxygen, hydrogen ion concentration, total dissolved solids, chlorides, sulphates, potassium, calcium, magnesium, hardness and alkalinity), 2) physical (temperature, current and turbidity). The water was sampled and analysed every four weeks from 1967 to 1971 according to the standard limnological procedures (AMER. PUBL. HEALTH ASSOC., 1966). Sediment samples were collected from different stations, washed, oven dried at 40°C and sorted by sieving into different particle size classes and passing percentage was calculated. The categories are listed in the table 1. Actually each of these designations indicates the sediment retained on a given screen having the stated size openings, thus, for example, the $\frac{1}{2}$ mm class consisted of particles having least diameters slightly less than 1mm to slightly greater than $\frac{1}{2}$ mm. The temperature of air, water, and burrows were recorded.

The corelation coefficient between temperature and population density of different species were studied.

4. Observation

The water at different stations did not differ in its chemical composition (Table 2)

Table 1. Particle sizes and passing % of sediment samples from two sections of the stream.

Sieve No.	Opening in mm.	Sample no. 1	Passing %	Sample no. 2
2"		93.4		
1$\frac{1}{2}$"	38.1	79.2		
$\frac{3}{4}$"	19.0	48.6		98.8
$\frac{3}{8}$"	9.51	39.3		97.3
4"	4.76	33.7		85.6
10"	2.00	27.4		71.3
40"	420	8.5		47.7
80"	177	4.3		35.6
100"	149	4.3		33.5
200"	74	3.1		29.5

except hardness and alkalinity in the lower part of the stream. The samples did not differ also in their chemical composition throughout the year. The results of bottom sediments for soil texture (Table 1) indicated that the sample collected from the upper part of the stream had more passing percentage through sieve nos. 2", 1$\frac{1}{2}$", $\frac{3}{4}$", $\frac{3}{8}$", whereas sample no. 2. collected from the lower part of the stream had more passing percentage through sieve nos. $\frac{3}{4}$", $\frac{3}{8}$", 4", 10", 40", with 19.0mm, 9.51 mm, 4.76mm, 2.00mm, 420mm openings in mm respectively. It shows that the bottom sediments in these two sections of the stream are of different types, stony and gravel in the upper section and clay with fine particles in the lower section of the stream.

The water current as measured by floating paper boats had different speeds in different parts of the stream. The current speed was about 70cm per second in the upper region of the stream while it was 27cm in the lower section. The readings were the average of several trials. It was more or less uniform throughout the year.

The air, water and burrows temperatures are recorded in figure no. 5. It shows that the temperature of the water varies from 21.1°C to 24.3°C, while that of burrows varies from 20.9°C to 24.3°C. As evident from the figure 5, the air temperature ranges from 13.9°C to 31.3°C. Further the temperature of the water and burrows is higher than the air temperature in winter and lower in summer. The fluctuations in the air temperature are more wide whereas these are restricted to a narrow range in the water as well as in burrows.

The macrobenthic fauna of the stream comprises of *Dugesia* sp., *Dendrobaena atheca*, *Allolobophora* sp., *Eropbdella* sp., *Rivulogammarus syriacus*, *Caridina fossarum*, *Potamon magnum magnum*, *Chironomid* sp., nymphs of mayfly and caddis fly, *Melanoides tuberculata*, and *Melanopsis praemorsa carrauta*. The population density of different species studied by quantitative methods is shown in the table 3. In terms of number, *Melanopsis praemorsa carrauta* is the dominating species. The degree of association between the temperature and the population density of different species is measured by the correlation coefficients

Table 2. Physical and chemical analysis of water samples collected from Nawran spring.

pH	O_2 mg/*l*	Total dissolved solids mg/*l*	Cl mg/*l*	SO_4 mg/*l*	K mg/*l*	Na mg/*l*	Ca mg/*l*	Mg mg/*l*	Hardness* mg/*l*	Alkalinity** mg/*l*
8.0	7.7	759	8	275	1.1	125.0	125.0	31.0	430.0	31.0.

* Samples collected from lower section show 78mg/*l* hardness and 6.0mg/*l* alkalinity.

** Calculated as equivalents of $CaCO_3$.

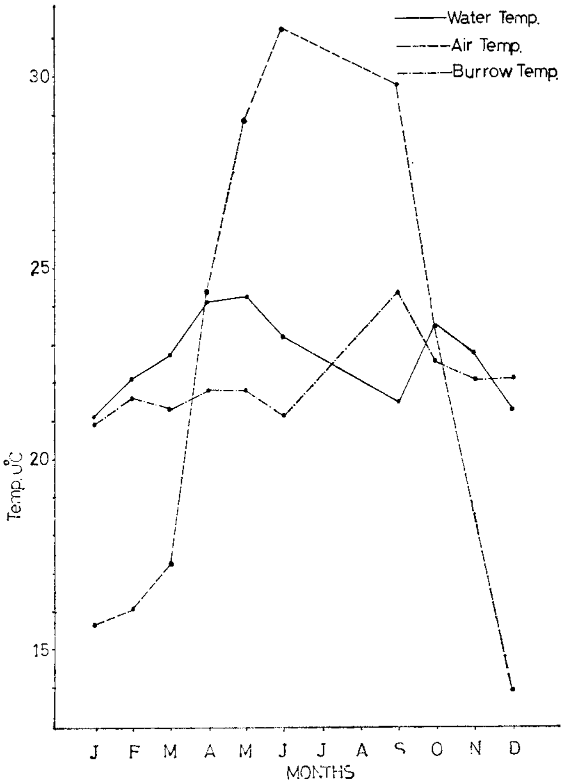

Fig. 5. Temperature of air, water and burrows.

(Table 4), which are all positive and significant at 0.05 level in most of them.

Dugesia sp. is found in the upper section of the stream attached beneath the stones. Even in this region, it is restricted to only the station no. 1 (fig. 4) where the subsoil water is accumulated and flows downwards. The attachment of *Dugesia* to underneath the stones is probably to avoid the direct contact with the current or the speed of the current. It appears that the most favourable period for *Dugesia* sp. is from April to October.

Dendrobaena atheca and *Allolobophora* sp.. These two species of oligocheates are found in the lower part of the stream where the substratum contains more of 841, 420, 177, 149, and 74 micron size particles. These two worms are found throughout the year but are most active during autum and spring when they breed. They are inactive during winter.

Eropdella sp.. This species is found underneath the stones in the upper part of the stream. The favourable period for it is from March to May.

Rivulogammarus syriacus, an amphipod, is an inhabitant of the upper section of the stream. It is found underneath the stones and is confined to the station no. 1 (Figure 4), where current is very slow. Drift as well as upstream movements of *Rivulogammarus* could not be observed. It flourishes well and forms a major biota (Table 3) from April to October. Having Judged by the presence of ovigerous females or females with empty brood pouches, breeding may occur throughout the year. It is, however, clear of unequal intensity.

Table 3. Population density of different invertebrates of Nawran spring. (Value represents the average of seven years).

Species	Population density during different months									
	J.	F.	M.	A.	M.	J.	S.	O.	N.	D.
Melanopsis praemorsa	39	60	88	104	107	105	55	61	46	36
Rivulogammarus syriacus	6	5	12	18	15	16	14	10	8	7
Caridina fossarum	5	5	7	9	7	6	9	9	8	6
Eropbdella sp.	1	1	3	4	4	—	2	2	1	1
Dusegia sp.	1	2	4	6	8	6	10	6	4	2

Table 4. The correlation coefficients between temperature and population density of macrobenthos in Nawran stream during 1967 to 1972.

Species	Year					
	1967	1968	1969	1970	1971	1972
M. praemorsa	+0.77*	+0.74*	+0.63′	+0.60′	+0.72*	+0.75*
R. syriacus	+0.78*	+0.29NS	+0.32NS	+0.70*	+0.75*	+0.79*
C. fossarum	+0.08NS	+0.40NS	+0.57NS	+0.34NS	+0.56NS	+0.75*
Eropdella sp.	+0.85**	+0.412NS	+0.10NS	+0.71*	+0.51NS	+0.66NS
Dugesia sp.	+0.90**	+0.53NS	+0.05NS	+0.37NS	+0.72*	+0.48NS

* Significant at 0.05 level.
** Highly significant.
′ Significant at 0.10 level.
NS Not significant.

Two maxima apparently occur, one, the larger in April and May and another the smaller, in October and November.

Caridina fossarum, similar to *Rivulogammarus*, is found only at the station 1 (Figure 4) in the upper part of the stream. Its swimming in the shallow water or hiding in between the stones has been observed. It has two peak periods (Table 3) April-May and September-October when they are found in large number.

Potamon magnum magnum is found in the upper part of the stream throughout the year. Several burrows are observed above the water level. The branched burrows incorporate from one to three chimneys (Fig. 6), extending horizontally about a meter and do not reach to the water level. Burrows are occupied by females. The temperature of the burrows varies from 20.9°C in January to 24.3°C in September. The crabs, both male and female have been observed on the stones and taking long excursions during sunny winter days as well as in the afternoon of summer days. The males, are usually, found very close to the burrows and between the stones. About 90% of the population is restricted to the upper part of the stream (stations 2 to 6). They don't extend their home range to the lower part of the stream. The mating of the crabs was observed during early April. The juveniles were found hiding beneath the stones. They were not observed in the burrows. In contrast to several reports (CROCKER and BARR, 1968; WILLIAMS, WILLIAMS and HYNES, 1974), it is strange that juveniles were found in burrows. WILLIAMS, WILLIAMS and HYNES (1974) have explained the rarity of crabs in the lower section in a temporary stream in Ontario and attributed to one or more of the following factors: an insufficient period of surface water during the spring for the young to be raised, no flowing water to aid in dispersal by drift after the young have

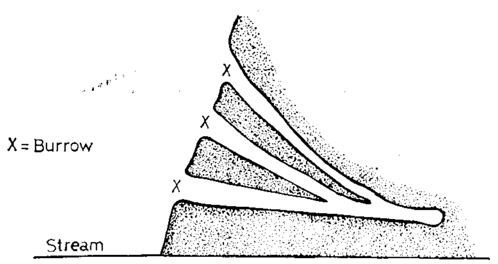

Fig. 6. Diagramatic representation of a typical burrow of Potamon in Nawran stream.

been released, and a lower water table making burrowing difficult for the adults.

The burrows as studied by different methods show that there is only a horizontal tunnel extending from 2 to 3 chimney upto 1 m. Neither these tunnels nor the chimney open below the water level. The chimneys are not plugged during any season. The form of a typical burrow does not change with respect to water level or temperature but remains in its typical form. The crabs are more active during nights.

Nymphs of May fly and Caddis fly. The nymphs of both mayfly and caddisfly are collected from stations 4 to 7 where they are attached beneath the stones during spring (March-May). It is very surprising that these taxes are represented by few numbers and neither their downstream nor upstream movements were noticed. Adults of these flies could not be collected in the vicinity of the stream.

Chironomid is found only in the lower part of the stream.

Melanopsis praemorsa and *Melanoides tuberculata.* These two species of gastropods make up a considerable part of the total fauna of the stream and are found throughout the year in the upper section of the stream. In terms of number, they are dominating species. Their most favourable period ranges from March to July. These two species are practically found everywhere, attached to stones. They are found just on the substratum where there are no stones, and also on both margins of the stream. They are more aggregrated on the margins because of less speed of current.

The organisms of the stream are divided into two associations depending on the nature of the substratum and the current. The association, which is restricted to the fast current and hard substratum, comprises of *Dugesia* sp. *Eropbdella* sp. *Rivulogammarus syriacus*, *Caridina fossarum*, *Potamon magnum magnum*, the nymphs of a mayfly and a caddis fly and two species of gastropods. Most of these organisms are found attached to the stones, some of which have 30cm in diameter. The other association, which is restricted to the soft muddy substratum, comprises of *Chironomid* sp. *Allolobophora* sp. and *Dendrobaena atheca*. These two associations have shown preferences to substratum and current.

The distribution of *Rivulogammarus* and *Caridina* is restricted to the parts of the upper section of the stream where the current is not fast. Both the gastropod species in the other part of the upper section are thrown towards the margin of the stream. Upstream movements of insects or crustacean could not be observed.

5. Discussion

From the results obtained three biological seasons are recognized in the stream. First, it is winter, when temperature is low; secondly, summer, when temperature is high, and thirdly, spring and autumn, when temperature is between the two extremes. These seasons seem to have a marked effect on the biota of the stream (Table 3). In spring and autumn the fauna is rich in number as well as in diversity in comparison to winter and summer.

The current as well as the nature of the substratum are the main factors involved in the distribution of macrobenthos. NEEL

(1973) has shown that streams with alkalinity and hardness below 20mg/l developed no vegetation other than sparse algal growth, and, with one exception of molluscs lacked. Those with alkalinity and hardness greater than 50mg/l had extensive growths of algae or aquatic flowering plants and well-developed snails and clam populations. The upper section of the Nawran stream supports entirely different macrobenthos than that of the lower section. These differences in the biota are related to differences in the nature of the substratum (Table 1). It appears that the species collected depict the true macrobenthos character of the stream in most respects. MINSHALL, WAYNE and PARLEY (1968) have shown that artificial reduction of stream discharge resulted in an increase in benthic invertebrates in the drift. Virtually all bottom dwelling forms were effected.

There are no fluctuations in the chemical composition of the stream water throughout the year, except that in the lower section the alkalinity and hardness of the water has considerably decreased seasonally. Along with the current and the substratum, these factors may be important in the distribution of the fauna. The importance of temperature as a limiting factor in stream ecology has been emphasized. Many workers in this field have rated temperature as a primary determinant of distribution (RICKER, 1934 ; SPRULES, 1947 ; ZAHER, 1951 ; IDE, 1953 and HUGES, 1966). The temperature of water in the stream varies seasonally. In winter (Fig. 5), the spring water is warmer. The figure 5 shows that the fluctuations in water temperature are restricted to a narrow range (21.1°C to 24.3°C) in comparison with the temperature of the air. In winter, there is a wide difference in the temperatures of the air and the water (Fig. 5). It shows that stream temperature in this region is not very much influenced by air temperature. Contrary to this, EGGLISHAW and MACKAY (1967) reported stream temperatures in the United Kingdom are very much influenced by air temperature.

In lenitic waters, organisms-substrate relationships have been reviewed by CUMMINIS (1966). HUNT (1930) recognized the importance of substrate type in determining stream benthos distribution. ELLIS (1936) brooded an idea of erosion-deposition concept which was expressed by MOON (1939). With this concept two main types of substrate are recognized in the Nawran stream. These are the erosional and depositional types. In rapidly flowing water (erosional) all but the coarse substrate units are washed away, resulting in characteristic fauna adapted for attachment or avoidance of the current. In regions of reduced flow (depositional) fine sediments are deposited and the organisms are variously adapted to deal with such an environment.

Altitudinal zonations and altitudinal succession have been reported by HYNES (1948, 1971). Altitudinal succession is well known in temperate latitudes (HYNES, 1970a, b). The biota shows altitudinal zonation in the Nawran spring. There is a dhange in the faunal composition with the water course descends. It appears that the slope gradient, nature of the stream bed are really important factors, and that altitude *per se*, which effect upon temperature, is yet another factor imposed upon the stream system. This has been reported by HYNES (1970). The change in the faunal composition of the Nawran stream is parallel to altitudinal zonations reported by HYNES (1970a, b).

Colonization cycle (MULLER, 1954) has been reported for a number of amphibiotic insects inhabiting lotic types. It comprises of downstream transport in the juvenile stages (drift) and upward movements in the aerial adult stages (ROOS, 1957; ELLIOTT, 1969). In organisms lacking an aerail life stage, such as turbellarians (STEINMANN, 1913), Amphipoda (MICKLEY, 1964; LEHMANN, 1967; and HULTIN, 1968), and Isopoda (THOMAS, 1969) both upstream and downstream movements are carried out under the water, i.e. during the juvenile stages of the species (BISHOP and HYNES, 1969; SCHUHMACHER, 1969). The upstream movements of turbellarians and amphipods could not be established during the course of this study. The inability of upstream movements of these invertebrates may be due to swift water current.

This study has revealed that spring and autumn support a rich macrobenthic community and that the biota shows zonations with respect to altitude, substratum, and current.

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