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The relationship of oxygen consumption to substrate particle size in *Ephemera nadinae* (Ephemeroptera : Ephemeridae)

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ABSTRACT

The oxygen consumption of nymphs of the lotic burroowing mayfly, *Ephemara nadinae* is apparently affected by the substrate. The relationship between substrate particle size and oxygen consumption is indicated by a bimodal curve in the present investigation. Oxygen consumption was minimal when the substrate particle size was $\phi + 1$ as per the system of Inman (1952). The suitability of habitat by means of oxygen consumption by burrowing mayfly and correlation with the adaptive feature of nymphal legs is discussed.

Keywords : ***Mayfly, Ephemara nadinae, Oxygen consumption, Substrate particle size, Aquatic insects.***

INTRODUCTION

The parameters of great importance to the distribution of aquatic insect are substrate and oxygen consumption. Although many aquatic entomologist have considered the various roles that oxygen (Fox *et al*, 1937) and substrate (Hunt, 1953 & Lyman, 1956) independently and attempts have been ande to relate an animals respiratory physiology to substrate and its distribution (Waudier and Pattee, 1955; Erickson, 1954 & 1968). Lowest oxygen consumption was registered in the substrate best stimulating the type upon or upon which the nymphs generally taken in nature. The substrate induced respiratory rates might be factors in this insect selection of a particular bottom type. The objective of present investigation is to find out the relationship of oxygen consumption to substrate particle size in a burrowing mayfly, *E. nadinae*, found in highly elevated and less disturbed areas of Western Ghats.

MATERIALS AND METHODS

Mature nymphs of *E. nadinae* were collected from Kurangani stream, Western ghats (11^{0}N and 70^{0} 50^{0}E), 166 kilometers from the west of Madurai, Tamil Nadu, India. Twenty milliliters of microwinkler bottles were carefully filled with stream water without any air bubbles. Four different substrate particles were selected by sieving between $\phi + 5$ to $\phi - 5$ (Table-1). The methodology has been followed by Inman (1952). One fourth of a pair of microwinkler's bottles were filled with substrate particle size of $\phi + 5$. Likewise, for each

substrate particle size, a pair of microwinkler bottles was used. Two uniform sized nymphs (14 mm in length) of *E. nadinae* were introduced into each microwinkler bottle and closed tightly. A pair of bottles without substrate and insects was kept as control. Another pair of bottles without substrates and with insects was also used for this purpose. The entire set up was kept under running water of the same stream until oxygen analysis. The rate of respiration in all experimental and control bottles was calculated in different time intervals.

RESULT AND DISCUSSION

The rate of respiration of *Ephemera nadinae* in different particle size is given in Table 1. *E. nadinae* registered the lowest oxygen intake, 0.02 mg/mg/body wt./hr. in the coarse sand as the substrate, whereas, the respiratory rate was as high as 0.16 mg body wt./hr. in the absence of any substrate because due to spent their energy exorbitantly. The oxygen consumption fell and rose again as the particle size, degreased from ϕ - 5 to ϕ + 5. The more favourable particle size, the less would be the tendency for the nymphs to resort to swimming resulting in the comparatively lower oxygen consumption of the individuals (Erickson, 1963). The lowest rate of oxygen consumption of *E. nadinae* with sandy substrate (ϕ + 1) in the present study is in conformity with the field observations on the occurrence of abundance of this species in the coarse sandy stretch of the lotic aquatics. Such correlation was observed between the lowest rate of oxygen consumption and preferred natural substrate particle size viz., ϕ - 1 and ϕ + 3 was obtained in *E. simulans* and *Hexagenia limbata* respectively by Erickson (1964).

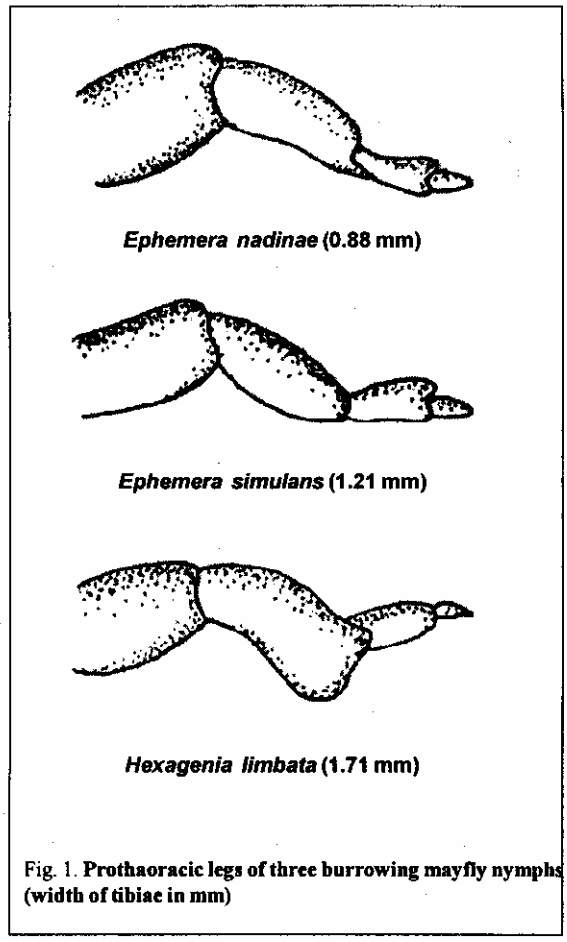

Fig. 1. **Prothaoracic legs of three burrowing mayfly nymphs (width of tibiae in mm)**

Furthermore, the total area of tibiae and tarsi of forelegs (Fig 1) of *E. simulans* and *H. limbata* show interesting adaptive features to burrow

Table 1. **The relationship of oxygen consumption with substrate particle size.**

Nature of substrate (Classification after Cummins, 1962)	ϕ Scale (Inman, 1962)	Size range (in mm)	Oxygen consumption/ mg body wt./hr.*
Pebble	- 5	32 - 62	0.09
Graved	- 3	08 - 16	0.17
Coarse Sand	+ 1	0.0 - 1	0.02
Fine Sand	+ 3	0.125 - 0.5	'0.13
Silt	+ 5	0.003-0.0625	0.06
Blank	--	---	0.16

smoothly in their respective preferred particle size. In other words, it is the leg morphology that determines the substrate into which a lotic burrowing mayflies, *E. nadinae* (0.88mm) in the present study and *E. simulans* (1.21 mm, after Erickson, 1964) when compared to that the lotic species, *H. limbata* (1.71mm after Erickson, 1964) can be correlated with the need for pointed structure for digging the coarse substrates with particle size ϕ + 1 and ϕ - 1 for *E. nadinae* and *E. simulans* respectively in contrast to the preference of the substrate particle size ϕ + 3 by lentic species *H. limbata*. This present study shows that oxygen consumption may be applied as a tool for assessing the habitat by preferring substrates for burrowing mayflies.

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REFERENCES

Cummins, K. W. 1962. An evaluation of some technique for the collection and analysis of benthic samples with special amphasis on the lotic waters. Amer. Midl. Nat. 67 : 477 - 504.

Erickson, C. H. 1963. The relationship of oxygen consumption to substrate particle size in two burrowing mayflies. J. Expt. Biol. 40 : 447 - 453.

Erickson, C. H. 1964. The influence of respiration and substrate for burrowing mayfly naids. Verch. Ver. Limnol. 15 : 903 - 911.

Erickson, C. H. 1968 Ecological significance of respiration and substrate for burrowing Ephemeroptera. Can. J. Zool. 46 : 93 - 103.

Fox, H. M. Wingfield, C. A. and Simmonds, B. G. 1937. The oxygen consumption of ephemerid nymphs from following and from still waters in relation to the concentration of oxygen in the water. J. Expt. Biol. 1 4 : 210 - 218.

Hunt, B. P. 1953. The history and economic importance of burrowing mayfly, *Hexagenia limbata* in southern Michigan lakes. Insti. Fisheries. Res. Bull. Mich. Dept. Conserv. 4 : 1 - 159.

Inman, D. L. 1952. Measures for describing the size distribution sediments. F. Sed Petrol. 22 : 125 - 145.

Lyman, F.E. 1956. Environmental factors affecting distributon of nymphs in Doughlas Lake, Michigan. Ecology. 37 : 76.

Waudier, J. and Pattee, E. 1955. Experience physiologique et experience ecologique. L'influence du substrat sur la consommation d' oxygen chez d' larves d' ephemeroptes. Bull. Mens. Soc. Linneenne Lyons. 7 : 178 - 183.

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