Scholars Academic Journal of Biosciences (SAJB) **ISSN 2321-6883 (Online)**
Sch. Acad. J. Biosci., 2014; 2(12C): 973-977 **ISSN 2347-9515 (Print)**
©Scholars Academic and Scientific Publisher
(An International Publisher for Academic and Scientific Resources)
www.saspublishers.com **DOI:** 10.36347/sajb.2014.v02i12.025

Research Article

Study of the Life Table of *Oxya velox* (Fabricius, 1787) Induced by Arsenic Compound

Susanta Nath*, Barnali Roy
Post Graduate Department of Zoology, Bidhannagar College (Govt. of W.B., India), EB 2, Salt Lake, Kolkata-700 064, West Bengal, India.

***Corresponding author**
Susanta Nath
Email: susanta_nath@yahoo.com

Abstract: Arsenic induced life table of *Oxya velox* was conducted in the present experiment. Study expressed a significant response to various doses of this heavy metal. Increasing mortality in the early instars in 0.0125mg.l^{-1} dose was an important check to counterbalance the effect of reproduction in mature stage. With the advancement of doses, experimental insects were found to overcome the toxicity of arsenic and able to reduce early mortality significantly.
Keywords: grasshopper, arsenic, mortality, life table.

INTRODUCTION

Use of arsenic contaminated ground water in agriculture and for drinking is a grave problem in the gangetic plains of West Bengal, India as well as Bangladesh [1]. Arsenic deposition in this region is the natural process and due to unaware use of ground water this heavy metal is creating various problem to the human beings as well as other flora and fauna. Lindsay and Sanders [2] has been studied the pathways of arsenic uptake in estuarine ecosystem through a simplified food chain. Water was considered as the most effective pathway of trace element uptake in organisms, whereas primary pathway of arsenic uptake might be food [3,4,5].

In the natural environment arsenic have the capability to combine with other elements to form a variety of arsenic species [6]. The effect of arsenic on the activity of different enzymes like acid phosphatase, glucamate-pyruvate transaminase etc. in muscle and liver tissue of the fish were assessed [7]. It has been reported that arsenic increased the protein level of short horned grasshoppers and had the ability to recover from the stress of this toxic metal [8]. During the last few decades the source of drinking water has been shifted from surface water to ground water. Due to rapid population increase demand for drinking as well as irrigation water compel the people of this region to use ground water. This is causing arsenic input in the soil, can be taken up by plants and entered the food chain through the next trophic level. Herbivores like grasshoppers occurring in such environment are continuously exposed to such toxic metals, and may contribute to the accumulation and biotransfer like other heavy metals [9,10]. Life table is a statistical device which is illustrated a complete picture of mortality in a population [11]. This study was undertaken to evaluate the effect of different doses of sodium arsenate on stage specific life table of *Oxya velox* (Fabricius, 1787) this acridid was selected for its regular availability in and around agriculture field in the gangetic plains of India.

MATERIALS AND METHOD

To study the life table and mortality rate in laboratory conditions, adults of *Oxya velox* (Fabricius, 1787) were collected from the agriculture field near Piyali, South 24 Parganas West Bengal, India and were kept in bisexual pairs. They were acclimatized in laboratory conditions for 7 days in insectariums. Plastic jars of 10 liter capacity containing 4.0 cm thick sand at the bottom were taken as the rearing cage. The open portion of the cages was covered with nylon net in order to maintain the air supply properly. Conical flask of 50 ml capacity containing preferred leaves of *Cynodon dactylon* Lin. as food was placed in the jar for the rearing insects [12]. For the control experiments, untreated adults were fed on leaves grown in distilled Water. For contamination, arsenic salt (sodium arsenate) was dissolved in distilled water along with food plant [13] and kept for twenty four hours. Concentration of 0.0125mg.l^{-1} (d1), 0.025 mg.l^{-1} (d2), 0.050 mg.l^{-1} (d3), 0.10 mg.l^{-1} (d4) arsenic salt water were tested respectively. Bisexual pairs were fed upon the contaminated food along with the untreated.

After copulation, the female laid eggs in the sand. After the appearance of the first instars those hatched out from the eggs, a total number of 100 newly hatched first instars were taken into account for sample survey. The first instars and their successive stages including the adult insects were also reared following the same procedure. The laboratory mortality data of *Oxya velox* were used to construct stage specific life tables. Explanation of symbols used in the life table [14,15]:

x = age in days;
l_x = Number of individuals out of the cohort, who are expected to complete exactly x days of life;
d_x = Number of individuals out of l_x who die before completing age x+1;
s_x = Survival rate (proportion of individuals of age x surviving to age x+1);
$100q_x$ = Mortality rate for an age interval;
MSR= Mortality/Survival Ratio
IM= Indispensible mortality
K values= Total generation mortality

RESULTS AND DISCUSSION

Comparison was made between the untreated and arsenic treated grasshopper. Maximum survival rate (Sx) was observed in third instars of untreated (table-1) and grasshoppers exposed to d1 (table-2) and d2 (table-3) respectively. Whereas, rhythmic survival rate was observed in d3 (table-3) and d4 (table-4) because this rate exhibited almost systematic pattern with the advancement of stages in the life cycle of this grasshoppers. In comparison to Sx, indispensible mortality(IM) was lowest in the third instars of the untreated grasshoppers, as well as d1 and d2 , but it was first and second instars of the both d3 and d4 exposed grasshoppers respectively (Fig. 1). Mortality survival ratio, apparent mortality and K value showed the same trend as was seen in IM.

The study indicated that various doses of arsenic had a profound impact on the survivorship of *Oxya velox* population. With increasing doses i.e. d3 and d4 IM was highest in fourth instars, which was different from untreated, d1 and d2 treated insects. Reduced survivorship in early stage in d1 was an important check to counterbalance the effect of reproduction in matured stage as was found in *Trilocha virescence* [15]. But in the later doses, experimental insects could overcome the early mortality and able to maintain steady morphogenesis as similar to untreated grasshoppers. The experiment revealed that 20% of the first instars was converted into adult in untreated grasshoppers whereas, this rate came down to 4% at d1, then increased gradually and reached the rate as found in untreated, indicating an initial stress situation. That was probably to cope up with the increasing doses so that insect could overcome the toxic effect of arsenic. Such effect was found commonly in fish treated with pesticide [16]. Malakar *et al* [17] also reported disruptive survival and growth in *Oxya fuscovittata* when treated with Cadmium. Our study revealed an increasing trend of population with the advancement of doses, as reported by Lapointe [18] that survival rate might not be associated with the doses of every metal as he observed that per cent survival of *Diaprepes abbreviates* did not decrease gradually with the increased copper concentration. Such recovery of *Oxya velox* in the present experiment was concerned with the ecological tolerance ability even in higher arsenic concentrations. Devkota and Schmidt [19] found decrease egg mortality even with increasing metal concentrations. A substantial increase in the mortality rate in mammal with arsenic deficit diet was also recorded [20].

Grasshopper like *Oxya velox* in one of the most abundant insect in the agriculture field as well as fallowland in India. As herbivores , grasshoppers might magnify heavy metals in their bodies and might transfer them to next trophic levels as found in case of aquatic insects [21,22]. Arsenic contamination, a magnifying problem in the gangetic plains of India and use of contaminated water deteriorating soil fertility, can be taken up by plants and thereby enter the food chain [23]. Being a primary consumer and also preyed upon by other insectivores, grasshopper may transfer arsenic to higher trophic levels in the nature [10]. Terrestrial birds from yellow knife, Canada were found to be highly adapted to arsenic compound and that was due to elevated concentration of these heavy metals in the study area [24]. As an outcome *Oxya velox* was found to be flourished with increasing doses of arsenic, confirming not only eco-toxicological effects as found in *Aiolopus thalassinus* exposed to Cadmium [25] but may also influence bio-transfer of this toxic metals up to the highest trophic level in a food chain.

Table 1. Life table of un-treated *Oxya velox.*

Stage X	l_x	dx	100qx	Sx	MSR	IM	Log lx	K values
First Instars	100	25	25	0.75	0.33	6.6	2	0.28
Second Instars	75	20	26.66	0.73	0.36	7.2	1.88	0.31
Third Instars	55	10	18.18	0.82	0.22	4.4	1.74	0.19
Fourth Instars	45	10	22.22	0.78	0.29	5.8	1.65	0.24
Fifth Instars	35	15	42.85	0.57	0.75	15	1.54	0.56
Adult	20	20	100	0	-	-	1.30	-
								K=1.58

Table. 2. Life table of *Oxya velox* exposed to 0.0125 $mg.l^{-1}$ of sodium arsenate .

Stage X	l_x	dx	100qx	Sx	MSR	IM	Log lx	K values
First Instars	100	80	80	0.2	4	16	2	1.60
Second Instars	20	4	20	0.8	0.25	1	1.30	0.22
Third Instars	16	0	0	1	0	0	1.20	0
Fourth Instars	16	2	12	0.87	0.14	0.56	1.20	0.14
Fifth Instars	14	10	71	0.28	2.2	8.8	1.15	1.27
Adult	4	4	100	0	-	-	0.60	-
								K=3.23

Table 3. Life table of *Oxya velox* exposed to 0.025 $mg.l^{-1}$ of sodium arsenate .

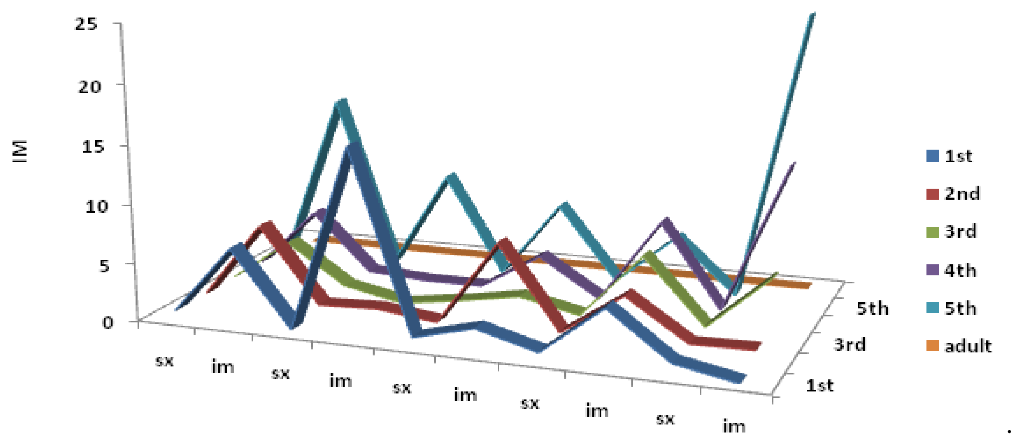
Stage X	l_x	dx	100qx	Sx	MSR	IM	Log lx	K values
First Instars	100	29	29	0.71	0.41	2.05	2	0.34
Second Instars	71	43	60.56	0.39	1.54	7.7	1.85	0.94
Third Instars	28	7	25	0.75	0.33	1.65	1.45	0.28
Fourth Instars	21	9	42.85	0.57	0.75	3.75	1.32	0.56
Fifth Instars	12	7	58.33	0.41	1.4	7	1.08	0.89
Adult	5	5	100	0	-	-	0.69	-
								K=3.01

Table 4. Life table of *Oxya velox* exposed to 0.050 $mg.l^{-1}$ of sodium arsenate .

Stage X	l_x	dx	100qx	Sx	MSR	IM	Log lx	K values
First Instars	100	35	35	0.65	0.54	4.86	2	0.43
Second Instars	65	21	32.30	0.67	0.48	4.32	1.81	0.40
Third Instars	44	18	40.90	0.59	0.69	6.21	1.64	0.52
Fourth Instars	26	12	46.15	0.53	0.86	7.74	1.41	0.63
Fifth Instars	14	5	35.71	0.64	0.56	5.04	1.14	0.44
Adult	9	9	100	0	-	-	0.95	-
								K=2.42

Table 5. Life table of *Oxya velox* exposed to 0.10 $mg.l^{-1}$ of sodium arsenate .

Stage X	l_x	dx	100qx	Sx	MSR	IM	Log lx	K values
First Instars	100	0	0	1	0	0	2	0
Second Instars	100	5	5	0.9	0.05	1	2	0.10
Third Instars	95	20	21.05	0.7	0.27	5.4	1.98	0.35
Fourth Instars	75	30	40	0.6	0.67	13.4	1.88	0.51
Fifth Instars	45	25	55.55	0.4	1.25	25	1.65	0.91
Adult	20	20	100	0	-	-	1.30	-
								K=1.87



:

Fig.1 Comaprison between survival rate(Sx) and indespensible mortality(IM) of untreated and arsenic induced *O. velox*

ACKNOWLEGDEMENT

Authors are thankful to University Grants Commission, New Delhi for providing financial support as Major Research Project to Dr. Susanta Nath for this work.

REFERENCES

1. De M; Arsenic- India'shealth crisis attracting global attention. Current Science, 2005; 88(5):683-684.
2. Lindsay DM and Sanders JG; Arsenic uptake and transfer in a simplified estuarine food chain. Environmental Toxicology and Chemistry**,**1990;9:391-395.
3. Sander JG and Riedel GF; Control of trace element toxicity by phytoplankton. In J.A.Saunders, L.Kosak-Channing and E.E. Conn.eds., Phytochemical Effects of Environmental Compounds .Plenum Press, New York, 1987 ; 131-149
4. Macek KJ, Petrocelli SR, and Sleight BH; Considerations in assessing the potential for, and significance of, biomagnifications of chemical residues in aquatic food chains. In L.L. Marketing and R.A. Kimerle, eds., Aquatic toxicology.STP 667. American Society for Testing and Materials , Philadelphia, PA, 1979; 251-268
5. Fowler SW and Unlu MY; Factors affecting bioaccumulation and elimination of arsenic in the shrimp *Lysmata seticaudata.* Chemosphere, 1978; **7:**711-720
6. Templeton DM, Ariese F, Cornelis R, Danielsson L-G, Muntau H, Van Leeuwen HP, and Lobinski R; Guidelines for terms related to chemical speciation and fractionation of elements. Definitions, structural aspects, and methodological approaches(IUPAC Recommendations 2000). Pure Appl Chem. 2000;72:1453-1470
7. Humtosoe N, Davoodi R, Kulkarni BG and Chavan B; Effect of arsenic on the enzymes of the Rohu carp, *Labeo rohita (*Hamilton,1822). The Raffles Bulletin of Zoology, 2007;14:17-19.
8. Nath S, Bose S and Roy B; Effect of arsenic on protein of a short horned grasshopper, *Oxya velox* (Fabricious, 1787), 2013; 11(1-2): 59-61.
9. Devkota B, and Schmidt GH; Accumulation of heavy metals in food plants and grasshoppers from the Taigetos Mountains, Geece. Agriculture Ecosystem and Environment, 2000; 78:85-91.
10. Nath S, Rai A, Gurung K, Das M, Pradhan N ,Burman S and Haldar P; Comparison of heavy metals level in grasses and grasshoppers from Darjeeling hills. Journal of Hill Research, 2008; 21(2): 67-69.
11. Odum EP. and Barrett GW; Fundamental of Ecology. Fifth edn. Thomson Books/Cole, USA, 2005; 229.
12. Nath S and Rai A; Study of life table of *Ceracris nigricornis laeta* (Orthoptera: Acrididae) in laboratory conditions. Romanian Journal of Biology, 2010;55: 159-165.
13. Schmidt GH, Ibrahim NMM; Heavy metal content (Hg+, Cd+, Pb+) in various body parts: Its impact on Cholinesterase activity and binding glycoprotein in grasshopper *Aiolopus thalassinus* adults. Ecotoxicology & Environmental Safety, 1994; 29: 148-164.
14. Ricklefs RE, Miller GL; Ecology. 4th Edn. W. H. Freeman And Company, New York, 1999;292-293.
15. Aziz MA, Ayesha I and Hanif M; Life table studies of Trilocha *virescence* (Bombycidae: Lepidoptera) on *Ficus nitida.* Asian Journal of Agriculture and Biology, 2013; 1(1):2-7.
16. Tripathi PR, Srivastava V. and Singh A; Toxic effects of dimenthoate(organophosphate) on metabolism and enzyme system of freshwater fish *Channa punctatus*. Asian Fisheries Science, 2003;16:349-359.
17. Malakar C, Ganguly A and Haldar P; Influence of cadmium on growth survival and clutch size of a common Indian short horned grasshopper *Oxya fuscovittata*. American-Eurasian Journal of Toxicologic Sciences, 2009; 1(1): 32-36.
18. Lapointe SL, Weathersbee AA, Doostdar H and Mayer RT; Effect of dietary copper on larval development of *Diaprepes abbreviates* (Coleoptera: Curculionidae). Florida Entomologist, 2004; 87(1):25-29.
19. Devkota B and Schmidt GH; Effect of heavy metals ($Hg^{2+,}$ $Cd^{2+,}$ Pb^{2+}) during the embryonic development of Acridid Grasshoppers (insect, caelifera). Archives of Environmental Contamination and Toxicology, 1999. 36:405-414.
20. Anke M, Groppel B, Grun M, Henning A and Meissner, D; The influence of arsenic deficiency on growth reproductiveness, life expectancy and health of goats. In : Spurenelement Symposium, 1980; 25-32.
21. Roberts RD, Johnson MS, Firth JNM; Predator prey relationships in the food chain transfer of heavy metals. In: Hemphill, D.D.(Ed.), Trace Substances in Environmental Health-XIII University of Missouri, Columbia. 1979; 104.
22. Jamil K. and Husain S; Biotransfer of metals to the insect *Neochetina eichhornae* via aquatic plants**.** Archives of Environmental Contamination and Toxicology, 1992; 22(4): 459-463.

23. Meharg AA, and Rahman M; Arsenic contamination of Bangladesh paddy field soils: Implications of rice contribution to arsenic consumption. Environmental Science and Technology, 2003 ;37:229-234.
24. Koch I, Mace JV and Reimer KJ; Arsenic speciation in terrestrial birds from Yellow knife, Northwest territories, Canada: the unexpected finding of Arsenobetaine. Environmental Toxicology and Chemistry, 2005; 24(6):1468-1474.
25. Schmidt GH; Long term effects Of Heavy Metals in the soil on the development Of an Acridid(*Aiolopus thalassinus*). Proceedings of the 4th ECE/XIII. SIEEC, Godollo, 1991 ; 227-230.