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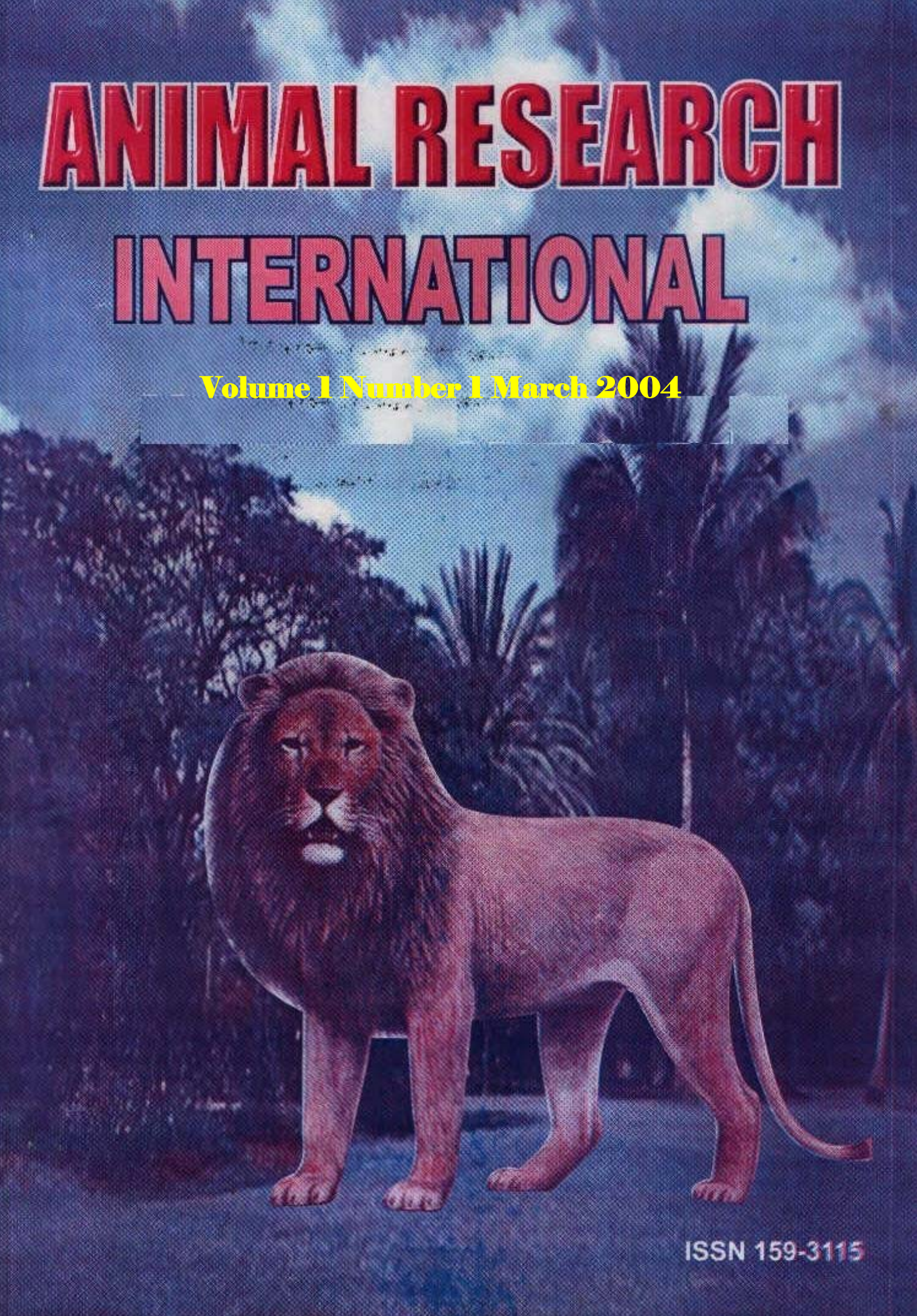

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LENGTH-WEIGHT RELATIONSHIPS OF FISHES FROM ANAMBRA RIVER, SOUTHEASTERN NIGERIA

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ABSTRACT

Length-weight relationships (LWR) and standard-total length relationships (STR) were estimated for 87 populations of fishes in Anambra river belonging to 18 families. 33 genera and 45 species The exponent, b , ranged from 2.007 to 3.750 and had a mean of 2.764 ± 0.338, which is significantly less than 3, indicating negative allometric LWR for the multispecies populations studied. The distributions of b and In a were normal and the correlation between them was negative (r = -0.864) and highly significant. STR permits conversion of standard to total length of each population.

Keywords: Length-weight relationships, fishes, Anambra river

INTRODUCTION

Out of about 268 species of fish in the inland waters of Nigeria only the length-weight relationships (LWR) of 43 (16.04%) species have been reported (King, 1996; King and Udo, 1996; Ezenwaji, 1999; Anibeze, 2000; Olaosebikan and Raji, 1998). As LWR may vary geographically, it is important to obtain and use local LWR values (Sparre *et al.,* 1989; Merella *et al.,* 1997). LWR have many uses particularly in estimating the mean weight of a given length class, in comparing species and populations in different geographic areas and in estimating the condition or "well being" of the fish (Petrakis and Stergiou,1995; Garcia *et al.*,1998). This contribution from the Anambra river adds to the existing LWR data on Nigerian freshwater fishes.

MATERIALS AND METHODS

Fish collections were made from the Anambra river from August 1997 to January 2002 using a variety of fishing gears, including experimental set of gill nets of different mesh sizes (2.5, 3.8, 5.1, 7.6, 8.9, 10.2, 12.7, 17.8, 22.9 cm), cast nets, traps and *atalla* lift nets. The fishes were identified employing Daget *et al*. (1984, 1986a, b), Leveque *et al.* (1990,1991,1992), Teugels *et al.* (1992), and Olaosebikan and Raji (1998) and the length (cm; total length, TL; and standard length, SL) and weight (g) of each fish were measured using a metre rule measuring board and a spring balance respectively. The sex of each fish was also determined whenever possible. The parameters a and a_1 (intercepts) and b and b_1 (slopes) of the LWR and standard–total length relationships (STR) of the form: $W = a_{(1)}L^{b(1)}$, were estimated through base–10 logarithmic transformation of the L-W and SL-TL data pairs, i.e. Log W = log $a_{(1)}$ + $b_{(1)}$ log L, with a and a_1, and b and b_1 estimated by ordinary least square regression. The parameters of the LWR and STR were sometimes determined separately for both sexes of a species, and for the same species collected at different periods. These different estimates were considered separate 'populations' (King, 1996). In order to verify if calculated b was significantly different from 3, the Student's t-test was employed. The frequency distribution of the intercept, a, was expressed as In a. Correlation analyses were conducted between b and In a to determine significance (Caillouet, 1993) and between log a and b in *Pellonula leonensis* to determine outliers (Stergou and Moutopoulos, 2001), if any. The coefficient of variation (CV) was determined as: $CV = \{100\, x\, S / \bar{X}\}\%$, where S = standard deviation and $\bar{X}$ = population mean. The Kurtosis coefficient (KC) was estimated using: KC = $\mu_4 / \sigma^4 - 3$, where $\mu_4 = \sum (y - \eta)^4 / N$ and σ^4 = fourth moment of the standard deviation.

Table 1: Length-weight relationship and related statistics of fish in Anambra river, Nigeria

			Total length (cm)				TL - Wt relationship			SL - TL relationship		
Family / species	**Sex**	**N**	**Mean**	**S.d**	**Min**	**Max**	**a**	**b**	**r**	**a_1**	**b_1**	**r**
Polypteridae												
Polypterus senegalus		39	19.07	1.98	16.0	25.7	0.0065	2.966	0.955	4.0012	0.556	0.798
Clupeidae												
Pellonula leonensis		104	6.12	1.07	3.4	8.5	0.0088	2.878	0.916	1.2132	0.997	0.993
Pellonula leonensis	M	14	5.84	0.60	5.0	7.1	0.0132	2.655	0.926	1.2955	0.950	0.969
Pellonula leonensis	F	36	6.07	0.69	5.1	8.4	0.0092	2.865	0.951	1.2977	0.953	0.975
Pellonula leonensis		50	6.00	0.67	5.0	8.4	0.0099	2.821	0.946	1.2891	0.956	0.974
Pellonula leonensis	M	23	5.05	0.76	3.4	6.3	0.0176	2.350	0.864	1.3287	0.942	0.988
Pellonula leonensis	F	13	6.61	0.66	5.9	8.5	0.0132	2.658	0.970	1.2788	0.980	0.980
Pellonula leonensis	M	14	6.51	0.47	6.0	7.7	0.0089	2.880	0.924	1.2733	0.977	0.984
Pellonula leonensis		27	6.56	0.56	5.9	8.5	0.0117	2.730	0.948	1.2715	0.981	0.980
Pellonula leonensis		45	6.80	0.46	6.1	8.2	0.0141	2.685	0.904	1.3169	0.950	0.963
Pellonula leonensis	M	20	6.72	0.41	6.1	7.5	0.0088	2.940	0.894	1.4427	0.897	0.955
Pellonula leonensis	F	25	6.86	0.50	6.2	8.2	0.0167	2.590	0.920	1.2307	0.989	0.968
Pellonula leonensis	M	18	5.43	0.55	4.6	6.5	0.0112	2.885	0.926	1.4421	0.886	0.969
Pellonula leonensis	F	13	5.48	0.66	4.8	7.3	0.0410	2.111	0.882	1.3468	0.932	0.974
Pellonula leonensis		31	5.45	0.59	4.6	7.3	0.0206	2.521	0.900	1.3989	0.906	0.970
Pellonula leonensis		48	6.43	0.60	5.6	8.3	0.0363	2.257	0.939	1.3526	0.937	0.964
Pellonula leonensis	F	25	6.50	0.68	5.6	8.3	0.0268	2.415	0.951	1.3944	0.919	0.962
Pellonula leonensis	M	22	6.00	0.43	4.9	6.7	0.0142	2.674	0.951	1.2874	0.956	0.947
Pellonula leonensis	F	24	6.08	0.42	5.3	7.3	0.0146	2.663	0.909	1.3098	0.947	0.935
Pellonula leonensis		46	6.04	0.43	4.9	7.3	0.0142	2.676	0.930	1.2947	0.953	0.941
Pellonula leonensis		47	4.54	0.51	3.8	6.0	0.0142	2.592	0.960	1.1965	1.011	0.978
Pellonula leonensis	F	28	4.45	0.38	3.8	5.9	0.0121	2.695	0.944	1.2211	0.997	0.964
Pellonula leonensis	M	19	4.67	0.66	4.0	6.0	0.0157	2.528	0.970	1.1703	1.026	0.984
Pellonula leonensis		49	5.78	0.81	4.7	8.0	0.0117	2.854	0.966	1.2478	0.983	0.990
Pellonula leonensis	M	23	5.81	0.77	5.0	8.0	0.0144	2.743	0.967	1.2662	0.973	0.985
Pellonula leonensis	F	26	5.75	0.86	4.7	7.9	0.0102	2.923	0.966	1.2344	0.990	0.994
Pellonula leonensis	F	32	6.12	0.41	5.5	7.2	0.0134	2.794	0.891	1.3622	0.932	0.928
Odaxothrissa mento		49	12.15	1.47	6.0	14.5	0.0097	2.911	0.969	1.4038	0.929	0.976
Osteoglossidae												
Heterotis niloticus		76	5.39	1.55	4.0	8.6	0.0089	3.026	0.994	1.2199	0.966	0.992
Notopteridae												
Papyrocranus afer		20	21.36	7.47	11.2	37.0	0.0052	2.997	0.997	0.8677	1.068	0.997
Mormyridae												
Hippopotamyrus psittacus		19	9.31	1.79	8.0	13.8	0.0766	2.156	0.975	1.0023	1.086	0.973
Petrocephalus bovei		16	8.31	1.24	7.0	12.2	0.0392	2.408	0.837	2.2038	0.725	0.923
Petrocephalus ansorgii		64	8.47	0.63	7.6	12.2	0.0910	2.007	0.787	1.6988	0.808	0.913
Hyperopisus bebe		15	16.04	8.92	11.7	32.0	0.0065	2.997	0.999	0.9213	1.076	0.999
Characidae												
Brycinus longipinnis		38	9.46	1.57	6.2	11.5	0.0106	3.212	0.942	1.0028	1.097	0.924
Brycinus nurse		43	10.93	4.89	6.1	28.1	0.0570	2.383	0.964	1.1404	1.020	0.994
Hydrocynus vittatus		13	17.83	3.87	14.0	25.3	0.0251	2.496	0.941	1.6907	0.893	0.927
Hepsetidae												
Hepsetus odoe		13	17.02	4.25	13.0	28.5	0.0011	3.643	0.979	1.3150	0.966	0.981
Hepsetus odoe		15	17.10	4.42	5.0	21.6	0.0188	2.681	0.996	1.4133	0.954	0.998
Distichodontidae												
Distichodus brevipinnis		17	12.69	2.82	9.2	17.4	0.0050	3.354	0.996	1.4124	0.788	0.983
Distichodus rostratus		59	13.38	5.94	6.5	47.2	0.0153	2.888	0.981	1.2977	0.979	0.991
Ichthyoborus monodi		17	16.80	1.78	15.1	20.5	0.0011	3.508	0.962	1.5679	0.891	0.963
Phago loricatus		14	12.08	3.46	8.4	15.5	0.0028	3.088	0.970	1.3434	0.917	0.999
Cyprinidae												
Labeo coubie		19	21.31	5.80	14.3	30.0	0.0103	3.078	0.988	1.1598	1.029	0.979
Barbus callipterus		106	4.72	0.88	3.2	7.1	0.0290	2.940	0.972	0.9049	1.082	0.981

Table 1 continued

Family / species	Sex	N	Mean	S.d	Min	Max	a	b	r	a_1	b_1	r
Bagridae												
Auchenoglanis biscutatus		15	14.56	5.77	9.0	23.8	0.0076	3.164	0.984	1.8824	0.863	0.998
Bagrus bajad		17	27.80	7.61	19.7	38.3	0.0051	3.049	0.978	1.7871	0.885	0.983
Chrysichthys auratus		64	11.08	1.50	9.0	16.2	0.0151	2.862	0.824	3.3760	0.548	0.786
C. nigrodigitatus		43	13.12	4.01	9.2	26.2	0.0651	2.273	0.869	1.0609	1.068	0.976
Clariidae												
Clarias macromystax	M	49	18.80	4.19	9.9	30.1	0.0386	2.419	0.977	1.1905	0.981	0.998
Clarias macromystax	F	55	18.27	6.21	9.7	28.5	0.0317	2.521	0.982	1.2066	0.980	0.999
Clarias macromystax		104	18.52	5.34	9.7	30.1	0.0345	2.475	0.978	1.2061	0.979	0.998
Clarias agboyiensis		112	17.81	4.64	9.6	29.0	0.0077	2.967	0.982	1.2451	0.965	0.999
Clarias agboyiensis	M	61	18.41	4.70	9.6	29.0	0.0101	2.858	0.986	1.2231	0.971	0.998
Clarias agboyiensis	F	51	17.10	4.51	9.8	26.8	0.0046	3.166	0.985	1.2734	0.956	0.999
Clarias buthupogon		142	16.01	4.49	6.4	28.1	0.0174	2.705	0.982	1.2114	0.975	0.999
Clarias buthupogon	M	62	16.96	4.12	11.3	27.5	0.0279	2.542	0.973	1.1740	0.985	0.998
Clarias buthupogon	F	80	15.23	4.65	6.4	28.1	0.0149	2.757	0.985	1.2141	0.976	0.999
Clarias albopunctatus		46	19.11	4.67	10.0	29.5	0.0874	2.126	0.894	1.2685	0.957	0.997
Clarias ebriensis	M	56	21.41	7.65	5.9	34.3	0.0256	2.550	0.985	1.1980	0.981	0.999
Clarias ebriensis	F	56	17.93	6.40	5.4	28.5	0.0251	2.582	0.977	1.2072	0.976	0.999
Clarias ebriensis		112	19.67	7.24	5.4	34.3	0.0267	2.548	0.981	1.1978	0.980	0.999
Mochokidae												
Brachysynodontis batensoda		15	22.22	7.00	14.0	29.8	0.0237	2.821	0.983	1.2617	0.996	0.976
Synodontis clarias		17	14.13	5.44	10.0	23.5	0.0893	2.331	0.980	1.1292	1.051	0.973
Synodontis gobroni		17	15.16	6.00	10.5	26.5	0.0205	2.835	0.993	1.1457	1.099	0.997
Schilbeidae												
Schilbe intermedius		15	12.80	2.68	10.7	17.2	0.0088	2.932	0.976	1.2841	0.956	0.991
Schilbe mystus		64	14.43	4.20	5.6	25.5	0.0066	3.003	0.954	1.0711	1.052	0.982
Schilbe mystus		11	5.95	2.20	4.4	12.3	0.0204	2.402	0.982	1.1503	1.022	0.996
Parailia pellucida		412	6.90	1.25	4.7	10.8	0.0082	2.772	0.794	1.2282	0.966	0.968
Parailia pellucida		49	6.35	0.58	5.1	7.3	0.0029	3.276	0.913	1.3146	0.930	0.958
Parailia pellucida		50	6.63	1.37	4.7	9.2	0.0067	2.834	0.937	1.1254	1.014	0.984
Parailia pellucida		33	9.36	0.99	6.5	10.8	0.0182	2.422	0.886	1.2833	0.944	0.976
Parailia pellucida		20	7.97	0.98	6.8	10.3	0.0151	2.537	0.877	1.1277	1.007	0.953
Parailia pellucida		12	7.51	1.09	6.3	9.6	0.0094	2.733	0.866	1.1331	1.005	0.971
Parailia pellucida		15	5.66	0.38	5.0	6.0	0.0019	3.750	0.956	1.0835	1.043	0.880
Siluranodon auritus		49	8.49	0.96	6.4	11.3	0.0089	2.861	0.877	1.3375	0.928	0.934
Siluranodon auritus		50	8.19	1.18	5.5	11.3	0.0098	2.811	0.896	1.0749	1.044	0.958
Channidae												
Parachannna obscura		16	17.85	2.76	14.5	22.0	0.0106	2.971	0.946	1.9528	0.818	0.979
Centropromidae												
Lates niloticus		14	12.18	2.75	8.4	12.8	0.0276	2.724	0.981	1.3321	0.936	0.969
Cichlidae												
Chromidotilapia guntheri		82	10.38	1.33	6.8	13.1	0.0252	2.895	0.939	1.2098	1.015	0.977
Hemichromis fasciatus		45	9.67	2.08	6.4	17.4	0.0294	2.779	0.905	1.3487	0.956	0.959
Hemichromis bimaculatus		16	7.85	1.36	6.5	11.0	0.0577	2.481	0.979	1.2524	0.996	0.984
Tilapia mariae		26	9.41	2.96	6.3	18.7	0.0192	3.066	0.986	1.2273	1.000	0.995
Tilapia zillii		11	15.25	3.41	10.5	22.8	0.0383	2.788	0.994	1.0463	1.083	0.967
Oreochromis niloticus		16	15.32	2.90	11.1	20.1	0.0033	3.689	0.997	1.8407	0.841	0.994
Nandidae												
Polycentropsis abbreviata		16	6.26	0.97	5.2	8.5	0.0304	2.897	0.972	1.3220	0.949	0.931
Anabanntidae												
Ctenopoma kingsleyae		13	10.13	4.00	6.0	21.7	0.1268	2.165	0.938	1.2195	1.012	0.972

RESULT AND DISCUSSION

A total of 87 populations of freshwater fish in the Anambra river were identified. The results of the LWR and STR analyses of these 87 populations of fish are summarized in Table 1. All correlations were highly significant ($P<0.05$) with coefficients ranging from 0.786 to 0.999 for both the LWR and STR. Apart from the LWR of P*apyrocranus afer, Petrocephalus ansorgi, Brycinus longipinnis, B. nurse, Hepsetus odoe, Barbus callipterus, Chrysichthys auratus, Clarias*

macromystax, C. buthupogon, Schilbe mystus, Parachanna obscura, Chromidotilapia guntheri, Hemichromis fasciatus, Tilapia mariae, T.zillii and Ctenopoma kingsleyae (King, 1996) and the LWR and STR of *Clarias agboyiensis* (Ezenwaji, 1999), the LWR of the other 28 species as well as the STR of the remaining 44 species of this study are reported for the first time in Nigerian freshwater systems.

The intercept, a, of the LWR showed high heterogeneity among the populations (CV = 102.86%) and varied from 0.0011 (*Hepsetus odoe* and *Ichthyoborus monodi*) to 0.1268

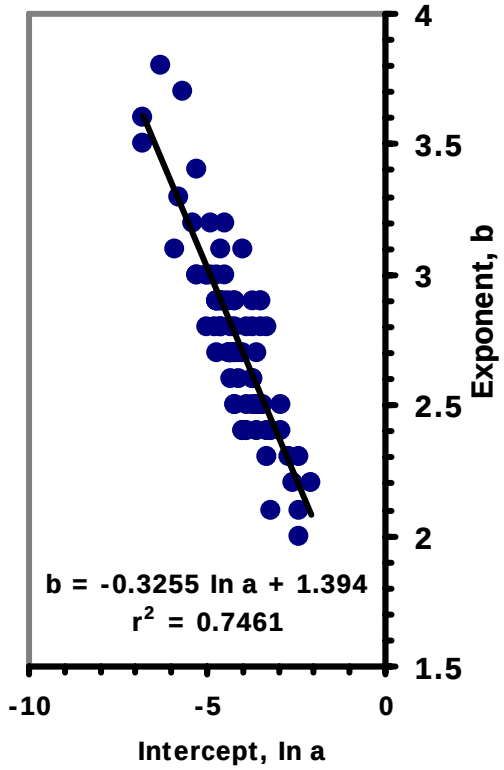

Fig. 1: The relationship between the exponent, b, and the intercept, ln a, in the multispecies samples of fishes from the Anambra river

(*Ctenopoma kingsleyae*). Conversely, the exponent, b, showed low variation among the populations (CV = 12.24%) and ranged from 2.007 in *Petrocephalus ansorgii* to 3.750 in *Parailia pellucida.* The estimates of the b–values obtained fall within the limits reported by Lagler et *al*. (1977), King (1996) and Stergiou and Moutopoulos (2001).

The mean exponent ($\bar{b}$ = 2.764; s.d. = 0.338) is significantly less than 3 (t - test, df =86, p< 0.05) indicating negative allometric LWR for the multispecies populations studied. Similar negative allometric LWR have been reported by Torres (1991) and King (1996) in multispecies samples of fishes, in contrast to Carlander (1969) and Ruiz-Ramirez et al. (1997) who reported a mean exponent of 3.

As Caillouet (1993) observed in multispecies groups, the plot of exponent, b, versus intercept, ln a, for the 87 populations showed very strong, highly significant but negative correlation (r = -0.864, P<0.05) (Fig.1); such relationships were attributed to variations in the maximum size of individuals of each species.

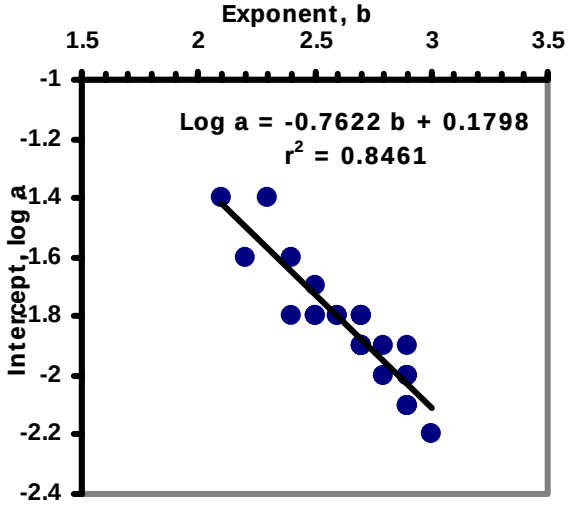

Fig. 2: The relationship between the intercept, log a, and the exponent, b, in *Pellonula leonensis* from Anambra river.

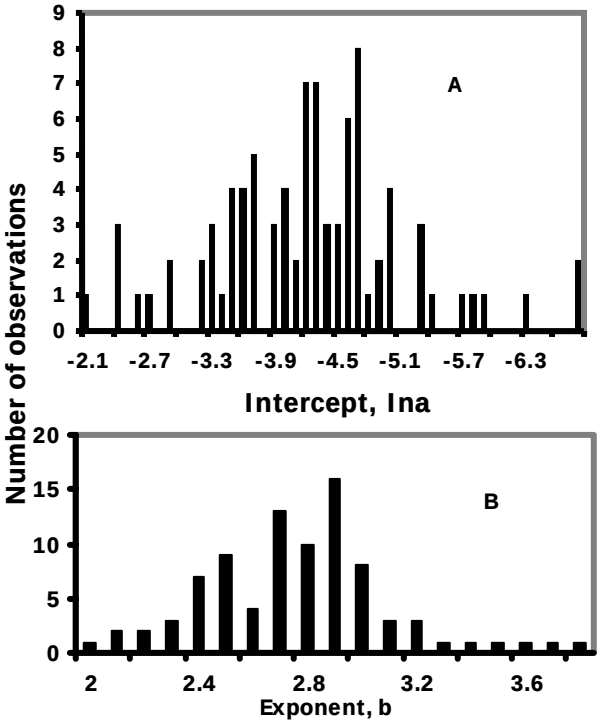

Fig. 3: Frequency distribution of the intercept, ln a (A) and exponent, b (B) of the LWR of fishes from Amanbra river

A plot of log a versus b for the 26 LWR of *Pellonulla leonensis* revealed no outliers (Fig.2). Stergiou and Moutopoulos (2001) employed this type of plot to show outliers in *Cepola rubescens* and *Pagelius erythrinus.*

The frequency distributions of In a values (Fig. 3A) and b-values (Fig. 3B) were normal as indicated by the Kurtosis coefficients (KC) of 0.77 and 0.76 respectively which approach zero, whereas the distribution of a-values was not normal (KC = 6.68). Similar results were obtained by Torres (1991).

In the STR, the exponent, b_1, was homogenous (CV = 9.54%) and varied from 0.548 in *Chrysichthys auratus* to 1.099 in *Synodontis gobroni.* The mean exponent ($\overline{b_1}$ = 0.959) was not different from 1 indicating that, as an assemblage, the linear model, TL = $\alpha+\beta$SL, is also valid for the estimation of the parameters of the LWR.

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PREVALENCE OF *Fasciola gigantica, Cysticercus bovis* AND SOME OTHER DISEASE CONDITIONS OF CATTLE SLAUGHTERED IN NSUKKA URBAN ABATTOIR

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ABSTRACT

The prevalence of some parasitic infections and other disease conditions of cattle slaughtered in Nsukka urban abattoir was studied from November to December 2001. The tongues, hearts, masseter muscles, intercostal muscles, lungs, spleens, and livers of cattle were examined for various parasitic infections and disease conditions. The examinations were done by dissection, palpation and other physical procedures. Of the organs examined, the lungs, spleen, and liver were infected. The only case of Cysticercus bovis infection found was in a liver. Also, all cases of Fasciola infections were detected from the liver. Cases of tuberculosis and pneumonia were detected from the lungs. Other disease conditions seen were splenomegaly, jaundice, and telangiactasis. Out of the 150 cattle examined, 30 (20%) were infected or have disease. A total of 150 cattle comprising 116 males and 34 females were examined. The distribution of infections is as follows: 1(0.70%) was infected with Cysticercus bovis, 15 (10%) with Fasciola gigantica, 4 (2.70%) with tuberculosis. Other disease conditions include 2 (1.33%) with pneumonia, 3(2%) with telangiactasis, 2(1.33%) with splenomegaly and 2(1.33%) with jaundice. The overall prevalence of the conditions studied in the slaughtered cattle include Cysticercosis bovis 3.33%, Fascioliasis 50%, tuberculosis 13.33%, pneumonia 6.67%, telangiactasis 10%, splenomegaly 6.67% and jaundice 6.67%.

Key Words: Prevalence, *Fasciola gigantica, Cysticercus bovis,* Cattle, disease.

INTRODUCTION

Cattle rearing form a substantial part of agriculture not only because cattle are a rich source of food (blood, milk and meat) but also a source of industrial raw materials (horn, hair and hide). The major tropical and subtropical areas of Asia, Africa, South and Central America contain approximately 66 per cent of the world's cattle (Andrews *et al;* 1992). The tropics, however, produce only 30-40 per cent of the world's beef and veal and 20-25 per cent of the world's milk. This low productivity has been traced to parasitic disease infection. This discrepancy represents a challenge for those in tropical cattle management, since the tropics have many advantages for bovine production. These include: a potential year-round growing season in the absence of very low temperatures, grass species capable of greater energy capture and dry matter yields than temperate grasses, vast land areas unutilized or underutilized, labour availability with strong animal keeping traditions, many locally adapted breeds that have been selected for production in adverse environments (Andrews *et al.,* 1992). However, these advantages are counteracted by many constraints of which different animal diseases are major causes. Most popular causes of these diseases are viruses, bacteria, protozoa, helminths and arthropods. According to Onah and Chiejina (1986), because of the absence of well-established veterinary diagnostic services, abattoir statistics have become the single most important source of data on diseases of food animals in Nigeria. This is particularly true of those diseases that can only be reliably diagnosed through post mortem examination such as *taeniasis,* fascioliasis etc. They also showed that surveys carried out at a number of abattoirs in northern Nigeria suggest that the infection with parasite like *Teania saginata* cysticercus is very common in Nigerian cattle.

Studies carried out in Imo state, Nigeria, by Okafor (1988) shows that this is especially so during the mid-dry season months (December to February).

The health of Nigerian populace is therefore at risk as long as these diseased cattle are slaughtered and consumed by the people unless appropriate meat inspection policy is adopted to check the spread of these zoonotic diseases. Also of importance is the need to find appropriate chemotherapeutic and control measures for these parasitic diseases.

The main objective of the study is to determine the prevalence of *Fasciola gigantica* and *Cysticercus bovis* and some disease conditions of public health importance in the Nsukka urban abattoir.

MATERIALS AND METHODS

The Study Site and Cattle: The study site was Nsukka urban abattoir. The cattle slaughtered in Nsukka urban abattoir were bought off the Hausa and Fulani herdsmen from the northern part of Nigeria. These herdsmen or their agents brought them down to Nsukka in lorries. However, because the cattle were not slaughtered as soon as they arrived, they were made to trek to places of pasture within Nsukka area.

Examination of the Organs and Tissues for Infections: The study began on 7th November and ended on 8th December 2001. The abattoir was visited twice every week. The inspection of the meat was made possible through the cooperation of the veterinary staff on duty at the abattoir. All the cattle studied were of the White Fulani *(Bunaji),* Sokoto Zebu/gudli and Nigerian Fulani *(Abore)* breed from the northern part of Nigeria. In most abattoirs, meat inspection facilities are inadequate and procedures are not uniform or standardized, and even where reasonably well developed, incision is only limited to certain muscles. The standard that is followed depends on the epidemiological studies that have been carried out in that locality. Each day, the tongue, masseter muscles, heart, lung, spleen, and liver were inspected by viewing, palpating and incising following the routine meat inspection procedures in the abattoir. The livers were examined for *Fasciola* by making length-wise incisions of the ventral side of the liver in such a way that the bile duct is cut open. The examination was then done by pressing the liver with the thumbs while holding it firmly on the slab or bench. The flukes recovered were taken to the laboratory for identification and preservation.

The tongue, masseter muscles, heart, Lung, spleen and liver were carefully viewed, palpated or incised lengthwise for *Cysticercus bovis* infection as well as other disease conditions. The parasites recovered and diseased organs were fixed in 10 % formalin and preserved in the laboratory.

RESULT

Prevalence of Parasites: Of the 150 cattle examined for various parasitic infections and disease conditions, 116 were males while 34 were females. The cattle were a mixture of young and old animals. The only case of *Cysticercus bovis* infection was found in a liver in November. This represented prevalence rate of 0.67%. There were 15 cases of *Fasciola gigantica* (figure 1) infections representing prevalence rate of 10% for the period. Eight (7.48 %) of the infections were detected in November while seven (16.28%) other cases of *Fasciola gigantica* infections were detected in December. The frequency of occurrence of *Fasciola gigantica* infections is shown in Table 1.

Relationship of Parasite Distribution with Sex: This study showed that all the animals infected were males. In November, 107 cattle were examined (79 males and 28 females) out of which 8 males were infected with *Fasciola gigantica* and one male infected with *C. bovis.* The *Fasciola gigantica* infection formed 7.48% with *C. bovis* formed 0.93% of the cattle examined for November. No female was infected. In December, 43 cattle were examined (37 males & 6 females) out of which 7 males (16.28%) were infected with *Fasciola gigantica.* This formed 16.28% of the cattle examined in December. No female was infected. Therefore, the prevalence rate of infections between the sexes examined in this study showed that there was no significant difference in infection between the sexes. (X^2 = 139.3, df = 6, P>0.05).

Prevalence of other Disease conditions in cattle slaughtered in the Abattoir for the Period, November to December: Different types of disease conditions were observed in different organs and muscles of the cattle examined (Table 2). The prevalence rate recorded for jaundice in the study was 1.33% (i.e. two cases). Also, two cases of bronchial

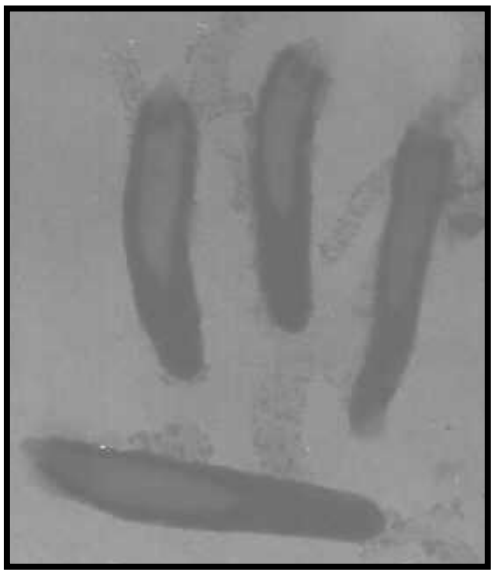

Figure 1: Fasciola gigantica detected from the liver of cattle.

Figure 2: Grossly tubercled lung of cattle.

Table 1: Prevalence of *Fasciola gigantica* and *Cysticercus bovis*

Month	Parasite Detected	Number Examined	Number Infected	Percentage Infection
Nov.	*Fasciola gigantica*	107	8	7.48
	Cysticercus bovis	107	1	0.93
Dec.	*Fasciola gigantica*	43	7	16.28
	Cysticercus bovis	43	0	0%
	TOTAL	300	16	15.33

Table 2: Organ distribution of disease conditions

Disease Condition	Organ infected	Number Examined	Number Infected	Percentage Infection
Jaundice	Skin and internal organ	150	2	1.33
Tuberculosis	Lungs	150	4	2.67
Splenomegaly	Spleen	150	2	1.33
Telangiactasis	Liver	150	2	1.33
Pneumonia	Lungs	150	2	1.33

pneumonia were found (one in a male and one in a female) between November and December. Four male cows were found infected with bovine tuberculosis (figure 2) in November alone. There were no such disease conditions in any cattle examined in December. Three cases of telangiactasis were found (two in males and one in female) in the livers of the cattle in November. There were no such disease conditions in December. The cases of splenomegaly recorded were two (i.e. 1.33%).

DISCUSSION

The purpose of disease surveillance is to use all appropriate epidemiologic and other methods as guide to the control of such disease" (Downs, 1990). This objective was later enlarged to include the evaluation of disease states and provision of data for disease control and health services planning. The first part of the objective is about describing the ongoing pattern of disease occurrence and disease potential. Against this background, the results of this survey should be very relevant in both disease control in cattle and public health controls in the human population. Two parasites were detected in the course of this survey namely *Fasciola gigantica* and *Cysticercus bovis.* These showed prevalence rates of 10.00% and 0.67% respectively. The disease conditions like tuberculosis, pneumonia, splenomegaly, jaundice and telangiactasis were also observed. But there does not seem to be any association

between the prevalence of the helminth parasites and these disease conditions. The occurrence of *Fasciola gigantica* and *Cysticercus bovis* in Nsukka Urban abattoir is not unusual. Ikeme and Obioha (1973) had detected 39% prevalence rate of *Fasciola gigantica* while Onah and Chiejina (1986) detected 2.36% prevalence rate of *Cysticercus bovis* in the same abattoir. Thus this study confirms the persistence of the infection in cattle slaughtered in this market. The prevalence rate of *Fasciola gigantica* (10.00%) in this study is relatively low when compared with the work of Ikeme and Obioha (1973) in the same abattoir where the prevalence rate was recorded as 39%. Also when the prevalence rates found in this study are compared with the prevalence rates in other parts of the world, it is still found to be lower. Although the statistics from the report of Lofti *et al* (1995) for 1987 – 1991 showed a lower prevalence rate of between 4.2 – 6.5% in Assiut abattoir (Egypt). However, other studies cited by Ukoli (1984) show the prevalence rates to vary. For example Gretillat (1961) in Senegal found 30 – 50% while Graber and Outamie (1964) in Niger found 36% and Schillhorn Van Veen *et al; (*1980) in Soba (Zaria rural abattoir) found the rate to be up to 65.4%. This then means that most areas of Africa have prevalence rates much higher than 10.00%. One of the reasons for the low prevalence can be due to the fact that healthier animals now reach the southern market where this study was conducted. The prevalence rate of *Cysticercus bovis* infection is also relatively low. Onah and Chiejina (1986) had earlier reported a higher prevalence rate of 2.36% in Nsukka, Anambra State, Nigeria. Also Okafor (1988) reported a much higher prevalence rate of 26.14% in Imo State Nigeria. The prevalence rates of 19.23% and 17.4% in Bauchi and Borno States of Nigeria reported by Belino (1975) are also higher than the report from this work. Still reports of high prevalence in other parts of the world exist e.g. Aleksic and Miloradovic (1994) reported 2.14% prevalence rate in Poland and Kamparage *et al* (1995) reported 16% prevalence rate in Tanzania. The reason for this drop is not very clear. A drop in exposure due to better management of cattle may not be ruled out. The level of prevalence rate of *F. gigantica* and *C. bovis* infections in this study can be attributed to the age of animals slaughtered. Andrews *et al* (1992) reported that although any age of animal may be susceptible, calves and yearlings are most commonly affected. Quoting Gallie and Sewell (1983), Onah and Chiejina (1986) showed that with increasing age calves develop stronger and more lasting immunity to *T. saginata* metacestode. Therefore, since most of the cattle examined (91.33%) were mature cattle, it may be that this phenomenon is at play. The presence of viable cysts in some of the older animals as reported by Onah and Chiejina (1986) might be as a result of recent infection in animals or persistence from early calf hood infections unaffected by subsequent host immune responses or deviations from the process. The period of this study is another factor that could have influenced the prevalence rate. Egbe-Nwiyi and Chaudrai (1996) reported higher prevalence rate (41.3%) of *Fasciola gigantica* during the rainy season and lower prevalence rate (32.7%) during the post-rainy season periods. Okafor (1988) reported that more cysts of *C. bovis* were isolated during the mid dry season months (December to February) although he attributed this, in the case of rural areas, to a drop in the number of animals slaughtered at these periods of the year. This work which was carried out during the post-rainy season period (November to December) could have been influenced by the season of study. Mode of transportation of the slaughtered cattle from the northern to the southern part of the country could have as well influenced the result. Before 1984, the animals were made to trek to the south from the north. That would mean greater exposure to more grazing grounds and therefore, greater probability of grazing on infected pastures. But with modernized means of transportation in which trailers are used, the cattle are restricted to the rearers choice pasture coupled with their awareness of the economic consequences of leading the cattle to infected grazing grounds.

Finally, the number of veterinary doctors has increased due to increased interest in education which implies that there are now lower ratios of veterinary doctors to the cattle thus giving them better attention medically. This means constant diagnosing and treatment of cases probably accounting for the lower prevalence rates. There was disease conditions also observed during this study which led to partial or total condemnation of carcasses. The prevalence rates of the disease conditions showed that tuberculosis has 2.67% prevalence rate, pneumonia, 1.33%, telangiactasis, 2%, splenomegaly, 1.33%, and jaundice 1.33%. Kamparage *et al* (1995) in a retrospective study (1987-1989) observed that these disease conditions were responsible for the condemnation of whole carcasses and organs in Tanzania. Their work showed higher prevalence rate of some of these disease conditions in the area they studied. The equal prevalence rates

recorded for jaundice and splenomegaly may mean that splenomegaly in the animals may be due to exposure to aetiological agents of jaundice in Nigeria. One of such disease conditions was tuberculosis with prevalence rate of 44%. Konopka (1995) also implicated tuberculosis in the condemnation of carcasses.

CONCLUSION

This work has shown that parasites of zoonotic importance as well as other disease conditions responsible for condemnation of carcasses and organs are prevalent at in cattle slaughtered at Nsukka urban abattoir. Although the prevalence rates of these parasites and disease conditions were moderately low, the public health and economic implications should not be overlooked. It is alarming that unlike in other areas, diseased animal carcasses were not condemned. This situation calls for serious attention of both the veterinary workers and the public health planners in the state. The prevalence of various disease conditions in this abattoir also calls for further studies to determine the remote causes of the disease conditions and to find ways of eliminating them from the cattle slaughtered for human consumption.

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HEAVY METAL CONCENTRATIONS IN A WEST AFRICAN SAHEL RESERVOIR

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ABSTRACT

Heavy metal concentrations were investigated over a period of 12 months in five stations in Alau reservoir, Maiduguri, in the North – east sahel zone of Nigeria. The mean concentrations of zinc, copper, lead, iron and manganese were 0.17 ± 0.02 mg/l (range 0.14± 0.03 - 0.19± 0.02 mg/l), 0.56 ± 0.06 mg/l (range 0.52± 0.01 - 0.64± 0.01 mg/l), 0.56 ± 0.02 mg/l (range 0.54± 0.03 - 0.58± 0.06 mg/l), 0.09 ± 0.02 mg/l (range 0.07± - 0.12± 0.01 mg/l) and 0.19 ± 0.27 mg/l (range 0.04± 0.01 - 0.66± 0.01 mg/l) respectively. Except for lead, mean concentrations varied significantly between stations (P<0.05). The concentrations of heavy metals were below contamination levels and fall within the limits reported for other West African small sahel reservoirs.

Key Words: Heavy metals, Pollutants, Environment, Alau reservoir, Sahel, Enrichment

INTRODUCTION

Water pollutants may be classified according to their chemical characteristics, physical state, environmental compartments in which they are discharged or found, sources and effects on target organisms (Calamari and Chiaudari, 1984).

In natural aquatic ecosystems, metals occur in low concentrations, normally at the nanogram to microgram per litre level. In recent times, however, metal contamination of aquatic ecosystems, especially the heavy metals, has become a problem of increasing concern. This situation has arisen as a result of the rapid growth of population, increased urbanization, expansion of industrial activities, exploration and exploitation of natural resources, extension of irrigation and other modern agricultural practices as well as the lack of environmental regulation (Bincy *et al* 1994) The problems associated with heavy metal contamination of water bodies arising from domestic discharges and agricultural practices have been studied (Forstner and Wittman, 1981; Solomons and Forstner, 1984; Nriagu, 1989). Furthermore, Dejoux (1988) and Philips (1991) provided further information on various environmental problems of heavy metal pollution in African inland waters in particular and tropical aquatic ecosystems in general. These publications showed that the existing information on Africa is scanty.

In spite of the relatively low level of industrial activity in less developed regions of Africa, there is growing awareness of the need for rational management of aquatic resources, including control of waste discharges into the environment (Goldberg, 1976). As Alau reservoir provides portable water for domestic use, it is important to monitor it's metal levels which may be elevated as a result of the other uses of the reservoir in irrigation of farm lands and in watering livestock. This study therefore provides information on heavy metal concentrations in Alau reservoir. This will serve as baseline data for effective water pollution control and management.

MATERIALS AND METHODS

The Study Area: Alau reservoir is located in Maiduguri, Borno state of Nigeria, along Maiduguri-Bama road. The lake lies between longitude 12^0 13^E latitude 13^0-14^E. It is about 20 km long with a total storage capacity of

65.0 km^2 (CBDA 1986). It was constructed in 1987 by damming river Ngadda, which was the first in a series of impoundment's in Borno-state, and it lies entirely within the Nigerian savannah.

Three seasonal periods - dry hot, dry harmattan and rainy season - typical of the North-eastern sahel zone of Nigeria dominate. The seasonal rainfall causes flooding of the lake and this increases the water level during the rainy season. The rainy season lasts from June to September. The dry harmattan season is characterized by low temperature and high harmattan wind, and lasts from October to February. The dry hot season has pronounced high temperature and causes extreme aridity between March and May (Bankole *et al.,* 1994; Odunze *et al*., 1995).

Sampling Methodology and Analysis: Water samples were collected bimonthly at five sites on Alau reservoir, from October 2001-September 2002. Surface water samples were collected using fabricated 2 litre water samplers. Samples were placed in acid washed (10 % HCl) 250 ml polyethylene bottles and taken to the laboratory. In the laboratory, 200 ml aliquot of each original sample was filtered using 0.45 μ membrane filter, for dissolved metal analysis. The filtered sample was acidified with 1 ml of concentrated analytic grade HCl and stored in a polyethylene bottle at 50 ^{0}C. All glass wares, pipettes and filters used in these procedures were rinsed with 10% HCl, deionized water and distilled water. Analysis of concentrations of copper (Cu), iron (Fe), manganese (Mn), lead (Pb) and zinc (Zn) were performed on the filtered, acidified samples (following appropriate dilution or concentration procedures), using a Perkin-Elmer Atomic Absorption Spectrophotometer (Model 403), as described by Olsen (1975), APHA (1976, 1980), Mackereth *et al*. (1978), and Boyd (1979). Comparison of data between stations and sampling periods was made using one-way ANOVA and t-test at 5% level of probability.

RESULTS AND DISCUSSIONS

The heavy metal concentrations in water from the different stations in Alau reservoir are presented in Table 1. The table shows that the concentration of dissolved Zinc (Zn) in Alau reservoir ranged from 0.14 $\pm$ 0.3 mg/l in station 5 to 0.19 $\pm$ 0.02 mg/l in stations 1 and 3. There was a significant difference ($P < 0.05$) between the value recorded in station 5 and all other stations. The values in other stations were not significantly different ($P > 0.05$). The concentration of zinc showed little fluctuation between stations. This may be due to the effect of fertilizers that were applied to the irrigated farm land around the reservoir. The values of zinc observed in this study were lower than those recorded in Jankara reservoir which ranged from 0.8 to 2.10 mg/l (Adeniji and Mbagwu, 1990). Bincy *et al* (1994) reported a higher zinc concentration (2.85 mg/l) for lake Nakuru, Kenya. The values recorded in Alau reservoir exceeded the permissible pollution limit of 0.10 mg/l recommended by Deininger (1980), but was below the WHO limit of 1.5 mg/l (Kaluku *et al*., 1987).

The copper concentration ranged from 0.52 $\pm$ 0.01 mg/l in stations 1 and 3 to 0.64 $\pm$ 0.01 mg/l in station 5. There was no significant difference ($P > 0.05$) between the values in stations 4 and 5, but these were significantly different ($P < 0.05$) from the values recorded in stations 1, 2 and 3. The copper values of this study were lower than 0.95 mg/l recorded in Arizona desert reservoir (Olsen and Sommerfield, 1977) and showed little variation between stations. The significant increase in copper concentration in stations 4 and 5 may be linked to the activities occurring in these stations, such as excessive run off into the water, human navigation activities and washing of fishing equipment directly into the water.

The highest mean value of lead (Pb) was 0.58 $\pm$ 0.06 mg/l recorded in station 4, while the lowest mean value of 0.54 $\pm$ 0.03 mg/l was recorded in station 2. No significant difference was observed between the stations ($P > 0.05$). The value recorded for lead remained stable throughout the study period. This concentration of lead in Alau reservoir was lower than the concentration recorded in Kainji lake where UNIFE (1986) observed a range of 0.16 to 0.87 mg/l. The value recorded in Alau reservoir may be regarded as adequate for photosynthesis and phytoplankton productivity. GESAMP (1988) observed that low concentration of less than 0.02 mg/l may affect photosynthesis, as well as delay embryonic development and reduce growth in adult fish, molluscs and crustaceans. Mombeshora *et al. (*1983).

Table 1: The distribution of heavy metals in different stations in Alau reservoir (mean± SD measured in mg/l)

	STATIONS					
Heavy metals	**1**	**2**	**3**	**4**	**5**	**Mean**
Zinc (Zn)	0.19±0.02[a]	0.18±0.03[a]	0.19±0.02[a]	0.16±0.03[a]	0.14±0.03[b]	0.17±0.02
Copper (Cu)	0.52±0.01[b]	0.52±0.02[b]	0.52±0.01[b]	0.60±0.00[a]	0.64±0.00[a]	0.56±0.06
Lead (Pb)	0.54±0.06[a]	0.54±0.03[a]	0.56±0.04[a]	0.58±0.06[a]	0.57±0.02[a]	0.56±0.02
Iron (Fe)	0.09±0.00[b]	0.07±0.00[b]	0.08±0.00[b]	0.09±0.00[b]	0.12±0.00[a]	0.09±0.02
Manganese (Mn)	0.05±0.01[b]	0.04±0.01[b]	0.09±0.02[b]	0.09±0.01[b]	0.66±0.01[a]	0.19±0.27

The values with the same superscript on the same row are not significantly different at P = 0.05

reported much higher levels of lead in their studies of streams and lakes around Ibadan Increase in lead can be largely due to increase in car washing, high traffic density around the lake, as well as discharges from a local industry, and increased anthropogenic sources especially from automobiles. The mean values for Iron (Fe) ranged between 0.07 ± 0.001 mg/l in station 2 and 0.12 + 0.001 mg/l in station 5. There was no significant difference between the values recorded for stations 1, 2, 3 and 4 ($P > 0.05$) but station 5 was significantly different ($P<0.05$) from these stations. The concentration of iron is consistent with the low solubility of Iron in desert reservoirs (Olsen and Sommerfield, 1977). The fairly stable concentration of iron in Alau reservoir may be due to direct or indirect discharges and run off from soil excavation sites into the reservoir.

The result of the concentration of manganese showed that the lowest mean value of 0.04 ± 0.01 mg/l was recorded in station 2, while the highest mean value of 0.66 ± 0.01 mg/l was recorded in station 5. There was no significant difference ($P>0.05$) between stations 1, 2, 3 and 4, but they were significantly different ($P < 0.05$) from station 5.

The concentration of manganese showed considerable variations within the lake. The highest level of contamination in various stations could be associated with the domestic washing with soap, effect of fertilizers, herbicides and pesticides applied to irrigated farm lands. Odiete (1999) reported that domestic sewage and agricultural effluents have the capacity to precipitate manganese salts which may exact a toxic effect on aquatic organisms. Such effects were not observed in the reservoir. Manganese may also result from sediment transport as observed by Okoye *et al*. (1991), who reported anthropogenic manganese enrichment in the Lagos lagoon and implicated land-based urban and sediment transport as well as industrial sources.

Most stations in Alau reservoir showed low to moderate metal concentrations which clearly indicate low level of pollution. Thus, there is at present no environmental concern for the reservoir. We conclude that heavy metal concentrations in Alau reservoir are comparable with what obtains in other West African sahel reservoirs (Baijot *et al.,* 1997). The little variations in the concentration of heavy metals in the reservoir stations are attributed mostly to the discharge of wastes water from domestic and agricultural activities as well as direct deposition of dry and wet particles by harmattan winds and flood. Based on the results Alau reservoir showed no significant heavy metal contamination.

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EFFECTS OF TEMPERATURE AND pH ON THE OXYGEN CONSUMPTION RATE OF *Sudanonautes* (*Convexonautes aubryi*) *floweri* (DE MAN) (CRUSTACEA: DECAPODA)

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ABSTRACT

The oxygen consumption rate of a freshwater sub-terrestrial crab, Sudanonautes floweri in relation to different temperatures and pH was investigated. The average temperature and pH of the crab's peaty stream habitat were 29.5^{0}C and 7.5 respectively. The lethal temperatures at pH 7.0 recorded for the species were 14.5^{0}C and 34.5^{0}C respectively. The oxygen consumption rate (Q) within the temperature range of 21^{0}C – 31^{0}C increased with temperature but decreased in the zones of temperature stress ($\leq$ 16^{0}C and $\geq$ 31^{0}C). There was no significant difference (P>0.05) between weight specific oxygen consumption (QW^{-1}) of the male and female crabs. The oxygen consumption rate was positively correlated with the body weight of the crabs (r = 1.0); but was inversely related to the unit weight of the crab per hour (r = -0.95). The average oxygen consumption of the animal at 30 ^{0}C and pH 7.0 was 53.1 $\mu g\ O_2\ g^{-1}\ h^{-1}$.

Key words: Temperature, pH, Oxygen consumption, *Sudanonautes floweri*

INTRODUCTION

Factors affecting the metabolic rate of invertebrates can be either endogenous (body size, respiratory surfaces, activity, nutritional status and state of reproductive cycle (Newell *et al.,* 1979) or exogenous (temperature, salinity, hydrogen ion concentration (pH), photoperiod and oxygen concentration among others). These factors affect the life pattern and activities of animals in a particular ecosystem. Temperature is a measure of "hotness" and "coldness" in an animal's body. It is usually a function of the rate of molecular agitation which is controlled to a large extent by the rate of physico-chemical reactions in the body of the animal (Hardy, 1979). Since crabs are poikilotherms, it is expected that temperature will grossly affect their metabolic rates. Though metabolic rate of an animal tends to increase with increasing temperature, Aldrich (1975) noted that because of the complex interactions of environmental, demographic and physiological factors it may not be surprising to notice individual variability of oxygen consumption rates in some crustaceans. Lagler *et al.* (1977) stated that there is similarity of effects of oxygen carrying capacity of the blood by carbon (IV) oxide (CO_2) tension and pH. Thus, respiratory rate is generally expected to increase with increasing hydrogen ion concentration.

Bell *et al.* (1970) defines metabolism as the total chemical changes occurring in the cell or in the body. Metabolic rate in an animal can be quantified from the rate of food consumption, energy released as heat or the amount of oxygen consumed in its oxidation processes to obtain energy. Of these three methods, the third is more widely used because it is easy and technically accurate. Thus, metabolic rate conventionally means or represents the rate of oxygen consumption.

Information on the metabolic rates of animals is of basic importance in defining the energy budget of animals. Such information is useful for the establishment of aquaculture facilities and for the evaluation of the aquaculture perspectives of the species involved (Buesa, 1979).

The relationship between oxygen consumption (Q) and the unit body weight oxygen requirement (QW^{-1}) is a well documented phenomenon in the animal kingdom and is most evident in animals weighing from one gram (1 g) to 1000 grams (1 kg). Though metabolism in poikilotherms generally varies with the environmental temperature, it is also influenced by size (Bell *et al.,* 1970). So for strict quantitative purposes

metabolic rates expressed by the rate of oxygen consumption are satisfactory only when individuals of one species population and of about the same sizes are compared (WolveKamp and Waterman, 1969).

While a number of studies have been done on the ecology and aspects of the biology of macruran – Natantia crustaceans in Nigeria, particularly on the important commercial species (Adetayo, 1980, 1983; Ajayi and Adetayo, 1980; Powell, 1982; Marioghae, 1982; Inyang, 1984) not much attention has been given to the brachyuran crustaceans in spite of the fact that many crabs are used as food condiment in some parts of Nigeria, especially along the coast and the riverine areas. In some places crabs are fermented and used as spice in special Nigerian dishes (Inyang, pers. comm.). Crabs also occupy a strategic position in maintaining the ecological balance between the wet – land and aquatic ecosystem. They are also good bioindicators in drilling and exploitation of minerals on the soil-water interphase.

Out of about 42 species of crabs so far identified in Nigeria (Egborge, 1993), *Sudanonautes* species are the most common in freshwaters. *Sudanonautes floweri (= Convexonautes aubryi)* (De Man) is a sub-terrestrial crab that lives in burrows in river banks and crawls out slowly from its burrow only making brisk dashes either to grab a prey or avoid a predator. They are subject to temperature and pH variations in their natural environment.

Information on the biology of freshwater crabs of South Eastern Nigeria are few (Ejike, 1972; Okafor, 1988; Okpala, 1998; Oputa, 1998). The present study is to investigate the effect of temperature and pH variations on the oxygen consumption rate of *S. floweri* in the laboratory as a contribution to the biology of the species.

MATERIALS AND METHODS

Collection and Acclimation of Crabs: About 70 crabs (*S. floweri)* with average weight of 25.5 g, carapace width of 4 - 6 cm were collected from the banks of a peaty stream at Lokpanta, Okigwe, Imo State, Nigeria, during the months of April and May, 1998. At collection, the average temperature, pH and percentage oxygen saturation of the stream were recorded. The crabs were transported immediately after collection to the laboratory at the University of Nigeria, Nsukka in baskets. They were acclimated for eight days in an aquarium (70 x 30 x 30 cm) under laboratory temperature (26^0C – 28^0C). In the aquarium, rocks and stages on which the crabs could climb and stay out of water were provided. The water in the aquarium was changed every other day. The crabs were fed daily on small and immature grasshoppers before the water was changed. The aquarium water was aerated with an air pump continuously.

Experimental Set Up: The modern method of determining the rate of respiration in aquatic animals is by the use of continuous flow recording respirometer (Brown, 1954) which has the advantage of taking readings for a long period without adding an extra environmental stress (low oxygen tension) to the system. In the absence of such a facility a modification of Gilchrist (1959) respiratory chambers were used for short periods (60 minutes) of recordings. Six respiratory chambers (10 X 10 X 10 cm) (A – F) in the water – bath (70 X 40 X 20 cm) with a thermostatically set temperature control (0^0C – 120^0C) were used. The chambers were filled with water and left open until their temperature equilibrised with the thermostatically set temperature of the water bath.

Temperature Experiment: Based on a test-run of the lower and upper lethal temperatures, the selected temperatures of the experiment were 16^0C, 21^0C, 26^0C, 31^0C and 32^0C. At the required temperature at a constant pH 7.0, water sample was siphoned from chamber A (control chamber) into an oxygen bottle and fixed for oxygen determination. The mean value of the oxygen so obtained was taken as the initial oxygen concentration for all the respiratory chambers. The crabs were then removed from the acclimation aquarium, weighed (g), sexed and introduced into the respective chambers (B – F). The water-bath was then closed, making the chambers air-tight and bubble-free. After 60 minutes (1 hour), water samples were siphoned from each of the chambers and fixed for oxygen determination. The difference between the value obtained after 60 minutes and the initial value of oxygen in control chamber was regarded as the amount of oxygen consumed by the crabs per hour (Q = mg O_2 $crab^{-1}$ h^{-1}), while the weight-specific oxygen consumption (QW^{-1} = μg O_2 g^{-1} h^{-1}) was calculated as the amount of oxygen consumed by a unit body weight of the crab per hour. Each temperature trial had two replicates.

Effect of size/weight on oxygen consumption: Different sizes and weight of crabs ranging from 44.0 – 110.0 g respectively were subjected to the same treatment as in the temperature experiment at 30 ^{o}C and pH 7.0. The experiment was replicated with crabs of approximately the same size and weight.

Hydrogen Ion Concentration (pH) Experiment: The pH values used were 4, 6, 8 and 10 at a constant temperature of 28 ^{0}C. The pH values were altered by adding some drops of 1.0 M citric acid or 0.5 M potassium hydroxide (KOH) solution along with a buffer solution of 0.5 M sodium hydrogen phosphate ($NaH_2 PO_4. H_2O$). The values of the pH were cross-checked with a pH meter. The experimental procedure was the same as in temperature experiment. Each pH value trial had two replicates.

Lethal Temperature and pH: The determination of the lower and upper lethal temperatures was a modification of those described by Evans (1948). Young specimens were used for this experiment. Temperature of the respiratory chambers was varied by 1 ^{0}C every two minutes from 10 ^{0}C – 35 ^{0}C by setting the temperature of the bath to the required temperature. Ice water was added to lower the temperature when necessary. The specimens were observed for 60 minutes at each temperature. The time and temperature at which death occurred in all the crabs were noted. The pH values were altered every 5 minutes by adding some drops of 1.0 M citric acid or 0.5 M potassium hydroxide solution along with a buffer solution of 0.5 M sodium hydrogen phosphate ($NaH_2PO_4.H_2O$) to the chambers. A pH meter was used to monitor the pH values. The pH values used were 3, 4, 6, 8, 10 and 12. Specimens in the various pH values were observed, and the time and the pH at which death occurred were noted.

Oxygen Determination: The oxygen concentration of the water sample was determined titrimetrically (Winkler's method) according to Stainton *et al.* (1977) and expressed as mg O_2 h^{-1}.

Analysis of Data: A sample t-test was used to compare the data where necessary (Bailey, 1974).

RESULTS

The temperature and pH of the crab's peaty stream habitat were 29.5^{0}C and 7.5 respectively. The percentage oxygen saturation of the stream was 98.7%.

Lethal Temperatures and pH: At 14.5^{0} C the crabs fell into stupor and died after 30 minutes. They started to float in the water after 45 minutes. Heat coma which preceded death occurred at 34.5^{0}C and actual death of the crabs occurred after 25 minutes later. Prior to the heat coma, the crabs became restless and erratic in behaviour with uncoordinated movements.

At a pH of 3.5, the crabs also became restless after 30 minutes and death occurred later after 80 minutes. The upper lethal pH value was 11, at which all the crabs died after 2 ½ hours.

Effect of temperature on the rate (Q) and weight-specific oxygen consumption (QW^{-1}) of *S. floweri:* Table 1 shows the rate of oxygen consumption (Q) and the weight-specific oxygen consumption (QW^{-1}) of the crabs. The rate of oxygen consumption by the crabs decreased from 1.62 $\pm$ 04 at 16 ^{0}C to 1.22 $\pm$ 0.03 mg O_2h^{-1} at 21 ^{0} C. It then rose sharply to 3.27 $\pm$ 0.03 at 26 ^{0}C reaching a peak (3.88 $\pm$ 0.02) at 31.0 ^{0}C. At 32.0 ^{0}C the rate of oxygen consumption fell to 3.22 $\pm$ 0.01 mg O_2h^{-1} (Table 1).

The weight-specific oxygen consumption followed the same trend as Q with a peak also at 26 ^{0}C (84.3 $\pm$ 0.77 μg O_2 g^{-1} h^{-1}). The QW^{-1} dropped sharply to 56.9 $\pm$ 0.22 at 31 ^{0}C before rising again to 72.6 $\pm$ 0.30 μg O_2 g^{-1} h^{-1} at 32 ^{0}C (Table 1). Death of the crabs occurred at 34.5 ^{0}C.

Sex influence on the oxygen consumption of the crabs: Weight-specific oxygen consumption per hour (QW^{-1}) was used to compare the oxygen consumption of the male and female *S. floweri* at different temperatures. The result is shown in Table 2. The rate of oxygen consumption (metabolic rate) within the temperature range of 21 ^{0}C – 26 ^{0} C was slightly higher in the female than in the male. The reverse was the case at the zones of thermal stress (16 ^{0} C and $\geq$ 31 ^{0} C). However, there was no significant difference ($P > 0.05$) in the overall oxygen consumption of the male and female specimens ($t = 0.096 < t_{0.05} = 2.77$).

Table 1: Influence of temperature on the rate of oxygen consumption (Q) and weight-specific oxygen consumption (QW^{-1}) of *S. floweri* (n = 60, mean weight = 25.5 ± 10.59 g)

Temperature (^{0}C)	Q ($mg\ O_2\ h^{-1}$)	QW^{-1} ($\mu g\ O_2\ g^{-1}\ h^{-1}$)
16	1.62 ± 0.04	32.6 ± 0.81
21	1.22 ± 0.03	25.5 ± 0.59
26	3.27 ± 0.03	84.3 ± 0.77
31	3.88 ± 0.02	56.9 ± 0.22
32	3.22 ± 0.01	72.6 ± 0.30

Table 2: Influence of sex on oxygen consumption at different temperatures

	QW^{-1} ($\mu g\ O_2\ g^{-1}\ h^{-1}$)	
Temperature (^{0}C)	Male	Female
16	38.7	30.5
21	34.0	37.0
26	60.6	62.0
31	60.0	57.5
32	67.7	62.2
N	Mean weight (g)	Weight range
Male 22	25.0 ± 0.70	(24 – 26g)
Female 14	24.5 ± 5.16	(15 – 30 g)

Table 3: Influence of size/weight on oxygen consumption at 30 ^{0}C

Wet weight (g)	*Q* ($mg\ O_2\ h^{-1}$)	*QW^{-1}* ($\mu g\ O_2\ g^{-1}\ h^{-1}$)
44	2.90	65.9
50	3.03	60.6
60	3.20	53.3
80	3.98	49.8
90	4.15	46.1
110	4.73	43.0
Average	3.66	53.10
Correlation coefficient (r)	1.01	-0.95

Table 4: Effect of pH on oxygen consumption of *S. floweri (n = 14, weight range = 24.0 – 27.0 g, mean weight = 25.1 ± 1.0 g)*

pH	Q ($mg\ O_2\ h^{-1}$)	QW^{-1} ($\mu g\ O_2\ g^{-1}\ h^{-1}$)
4	3.08 ± 0.02	57.0 ± 0.31
6	4.51 ± 0.01	92.1 ± 0.25
7	3.79 ± 0.03	75.7 ± 0.49
8	3.05 ± 0.01	61.0 ± 0.04
10	2.63 ± 0.01	54.8 ± 0.27

Effect of size/weight on oxygen consumption of *S. floweri:* The rate (Q) and weight-specific oxygen consumption (QW^{-1}) of crabs of different weight at 30 ^{0}C are shown in Table 3. While the rate of oxygen consumption increased with increase in weight and size of the crabs, the weight-specific oxygen consumption decreased with weight (Table 3). The rate of oxygen consumption was strongly and positively correlated with the weight of the crabs (r = 1.01). A negative inverse relationship (r = -0.95) between the rate of oxygen consumption and the unit weight of the crabs was obtained. A regression analysis of the relationship between the oxygen consumption and the weight of the crabs gave the following equation:

$O_2 = -0.308W^{0.469}$ (O_2 = oxygen consumption; W = weight (g)). The average oxygen consumption per unit weight (g) per hour was 53.1 μg O_2 g^{-1} h^{-1}.

Effect of pH on oxygen consumption: The rate of oxygen consumption increased sharply from 3.08 ± 0.02 mg O_2 h^{-1} at pH 4 to 4.51 ± 0.01 at pH 6. It then decreased to 3.79 ± 0.03 at pH 7 and to 3.05 ± 0.01 and 2.63 ± 0.01 at pH 8 and 10 respectively. Death occurred at pH 11.5 after 30 minutes.

The weight-specific oxygen consumption (QW^{-1}) followed the same trend as Q with a peak value of 92.1 ± 0.25 μg O_2 g^{-1} h^{-1} also at pH 6 (Table 4).

DISCUSSION

It is well known that poikilothermous animals survive within definite temperature ranges. For *S. floweri* the survival temperature range was between > 14.5 ^{0}C and < 34.5 ^{0}C. Thermal death occurred at 14.5 ^{0}C and 34.5 ^{0}C respectively. Thermal death according to Schmidth-Nielson (1977) could be because of inactivation of enzymes at rates exceeding their formation rate or the depletion or accumulation of certain intermediary metabolic products whose formation and transport are temperature dependent. Wolvekamp and Waterman (1969) also stated that high temperature reduces the binding capacity of copper containing blood pigment (haemocyanin), thus depriving the animals of sufficient oxygen to survive. It is therefore possible that death at the upper lethal temperature (34.5^{0}C) could have been due to asphyxiation. Death at the lower thermal temperature (≤ 14.5^{0}C) could be due to the inactivation of enzymes and accumulation of toxic metabolic products in the body of the animal, making it impossible for the crabs to survive.

Effect of Temperature: The metabolic rate of crustaceans depends on a number of internal and external variables. Temperature is one of the external factors that influences the life pattern of poikilothermous animals. It influences the animals directly and indirectly. Johnson *et al*. (1954) interprets the direct effect of temperature on organisms in terms of activation energies of key biochemical reactions. Te mperature affects the organisms indirectly through its effect on the metabolic rate of the organism. A change of external temperature results in a change of oxygen consumption (metabolic rate). In *S. floweri* oxygen consumption was positively correlated with temperatures between 16 ^{0}C and 31 ^{0}C. At 31 ^{0}C the oxygen consumption was about 2.4 times greater than at 16 ^{0}C. The relationship between oxygen consumption and temperature has been attributed to the physiological processes and reactions taking place in the animal's body. Mc Mohon *et al.* (1978) also explained the pattern of increase of metabolic rate with temperature as a result of branchial water flow to supply extra oxygen demand in the crab, *Cancer magister.*

The average temperature coefficient (Q_{10}) of 1.0 recorded at 30 ^{0}C for *S. floweri* was less than those of other tropical crabs studied: *Sesarma ricordi* (1.6 – 2.2) and *Uca mordax* (2.0 – 2.5) at 25^{0}C – 35^{0}C respectively (Scholander *et al.,* 1953). This may be due to the habitats of the crabs, since according to Ayers (1938) the rate of oxygen consumption in several estuarine crabs studied increased as the habitat became more terrestrial. While *Sesarma recordi* is a terrestrial crab, *Sudanonautes floweri* is a sub-terrestrial freshwater crab and *U. mordax* is an estuarine/marine crab. Husain and Alikhan (1979) explained that the higher rate of oxygen consumption in terrestrial species may be a reflection of the increased energy required to carry the mass of the animal in a less buoyant medium.

Oxygen Consumption and Body Weight: The dependence of the rate of oxygen uptake upon animal size is well documented in crustaceans (Zeuthen, 1953; Bertalanffy, 1957; Hart, 1980). The oxygen consumption of *S. floweri* conformed to the general rule of metabolism in poikilotherms which stipulates that metabolism increases with size (Table 3). The oxygen uptake per unit time by crustaceans as in other animal groups can be expressed as $O_2 = aW^b$, where a and b are coefficients in the logarithmic expression. For most crustaceans the b value is generally between 0.67 and 1.0 (Wolvekamp and Waterman, 1969). In *S. floweri* the b value obtained was 0.45. According to Ellenby (1951), body shape of an animal can change the value of b from the Rubner's 0.67 rule. This probably accounted for the deviation of our result from the 0.67 - 1.0 rule.

Sex Influence: The oxygen consumption rate of the male crabs was not significantly different from that by the female. The result agrees with

what Husain and Alikhan (1979) observed for *Porcellio laevis.*

pH Effect: Increase in pH value increases the rate of oxygen consumption in animals. The maximum oxygen consumption rate for *S. floweri* at 30 ^{0}C was at pH 6, beyond which the oxygen consumption decreased. The increase and decrease in the oxygen consumption of the crabs with almost equal gradients on either side of pH 6 (pH 4-6 and pH 6-8) is a consequence of the alteration of the partial pressure of oxygen reducing the half-saturation (P = 50 % saturation) of the haemocyanin with oxygen. At pH values lower or higher than the optimum value, the mucus in the gills become coagulated and this may account for the reduction in the oxygen consumption (Cameron and Randall, 1972) as the gills cannot function properly.

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LOCAL DISEASE PERCEPTION AND TREATMENT OF ONCHOCERCIASIS IN UZO-UWANI LOCAL GOVERNMENT AREA, ENUGU STATE, NIGERIA

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ABSTRACT

Local disease perception and treatment of onchocerciasis were studied in Uzo-Uwani Local Government Area of Enugu State, Nigeria. The objectives of the study were to ascertain the level of understanding of the aetiology of onchocerciasis and the management of the disease in the area. Different sampling methods including cluster sampling and random sampling were used in the selection of the sample units. Data collection methods included the use of questionnaires and interviews. From the study, it was found that the people of the area are aware of the presence and nuisance value of Simulium flies, commonly called the blackly, but do not associate the bite with the manifestations of onchocerciasis which are common in their communities. It was discovered that ignorance was at the root of many problems associated with Onchocerca volvulus disease such as discrimination against people with oncho-rashes, lack of proper treatment of the disease and abuse of the choice drug for treatment of onchocerciasis (ivermectin). Poverty is also a contributory factor to lack of adequate treatment of the disease in the area. The result also showed that nodulectomy is a common and accepted treatment method in the area for Onchocerca nodule. On the basis of the result, it is recommended that enlightenment programme is needed in the area together with a campaign for nodulectomy. In the enlightenment programme, use should be made of Community Directed Distributors already trained by World Health Organization (WHO) for the distribution of ivermectin under the African Programme for Onchocerciasis Control (APOC).

Key words: Onchocerciasis, *Onchocerca volvulus, Simulium*, disease perception, treatment, Uzo-Uwani.

INTRODUCTION

Human onchocerciasis, commonly called 'River blindness' is usually a chronic parasitic disease caused by the filarial nematode, *Onchocerca volvulus*. Onchocerciasis is essentially a focal disease within its endemic areas with new foci still being discovered in remote places (WHO, 1997). It is a disease of warm tropical environment in which the flies that transmit it live under conditions favourable for their development all year round (Crosskey, 1990). The impact of the disease in social, economic and cultural terms in Nigeria has been shown to be enormous as it affects the productivity, social life and sexual life of the sufferer due to blindness or other debilitating effects (Nwoke, 1990). According to him, the socio-economic and cultural disabilities associated with human onchocerciasis in the devastated endemic communities in West Africa are damaging especially among the farming population, which produce the bulk of our food and industrial raw materials.

Nwoke *et al.* (1992) are of the opinion that the assessment of local disease perception and treatment in any onchocerciasis endemic area is significant in effective planning and mobilization of communities for control programmes and in ascertaining whether local treatment is of any chemotherapeutic potential.

Few studies have been carried out on the local disease perception and treatment of onchocerciasis in different parts of Nigeria. Nwoke *et al.* (1992) for example, assessed the local disease perception and treatment in Jos, Plateau State. In northwestern Nigeria, Edungbola (1982) carried out similar studies in Ile-Ire district of Kwara State; Edungbola *et al* (1983) and Edungbola and Asaolu (1984) did similar works in Babana district of Kwara State. In the east, Amazigo and Obikeze (1991) carried out a similar study in Ette in the northern fringes of Enugu State. The Pan African study

group on onchocercal skin disease worked in Awka and Nike among others (WHO,1995).

Edungbola (1982) reported that the natives of Ile-Ire district of Kwara State were aware of the nuisance of the blackfly locally called "Amukuru" and knew onchocerciasis locally called "Inaru" but were not aware of the association between them. They attributed onchocerciasis manifestations to old age, familial traits or enemies. The treatment is, therefore, misdirected towards appeasing enemies or devils.

Edungbola *et al.* (1983) and Edungbola and Asaolu (1984) reported that although most subjects of Babana district of Kwara State were aware of the blackfly locally called "Kusena", they were ignorant of its association with the various manifestations of onchocerciasis. For this reason, no attempts were made by the subjects to seek appropriate remedy, as reflected in the finding that all the infected individuals interviewed, except two teachers, had never been treated for onchocercal infection.

Nwoke *et al.* (1992) studied local disease perception in Jos area and found out that villages in endemic communities were aware of the menace of the blackflies, locally called "Bekin Kuda", because of the bite and accompanying intense itching especially during the farming season. However, they were not aware of any association between the blackfly bites and onchocerciasis. They attributed the manifestations to various causes including old age, familial traits, affliction from enemies or the gods. As a result, majority did not attend hospitals but consulted oracles and appeased gods for help.

At Ette, Amazigo and Obikeze, (1991) reported that the villagers knew the blackfly locally called "Ita" but had no knowledge of its association with the manifestations of onchocerciasis, which they attributed to other causes. They treated the disease with local herbs.

In the present study, the local disease perception and treatment of onchocerciasis were investigated in the 16 communities that make up Uzo-Uwani Local Government Area of Enugu State, based on a previous report of the presence of onchocerciasis in part of the area (Amazigo *et al.*, 1993). The objectives of the study were to ascertain whether the farming communities associate the disease with *Simulium* flies and to determine how, if at all, they treat it. This, it was hoped, would help in recommending appropriate intervention strategies to help these agricultural communities.

MATERIALS AND METHODS

The Study Area and Study Population: The study area was Uzo-Uwani Local Government Area of Enugu State (Figure 1) which, belongs to the forest-savanna mosaic zone of Nigeria (Crosskey, 1981). It lies between longitude 6^0 $30^/$ and 7^0 $00^/$ East and between 6^0 $55^/$ and 7^0 $15^/$ North. The area is traversed by many rivers and streams, which belong to the Anambra river system identified by Crosskey (1981) to be part of the breeding sites for *Simulium damnosum* in Eastern Nigeria. Most of these rivers are clean and rapidly flowing, which encourage the breeding of *Simulium* in these rivers. Uzo-Uwani Local Government Area consists of 16 communities divided into four health districts namely:

i. Umulokpa district consisting of Umulokpa (headquarters), Nkume, Adaba and Ukpata
ii Nkpologu district made up of Nkpologu, Uvuru and Akpugo
iii Ogboli district consisting of Adani, Asaba, Igga, Ojjor and Ogurugu
iv Nimbo district comprising Nimbo, Abbi, Ugbene-Ajima and Nrobo.

Uzo-Uwani Local Government Area is inhabited by two ethnic groups namely the Ibos and the Igallas but the latter are in the minority being part of only three communities (Igga, Ojjor and Ogurugu). The inhabitants of all the communities that make up this local government area engage in agriculture as their major economic activity, cultivating mainly yams, cassava, maize and rice. The level of engagement in farming activities in the area is so high that almost every adult, including the civil servants, are involved. The study population comprises the inhabitants of the 16 communities that make up the local government area.

The Study Sample and Sampling Procedure: The study sample consists of 1958 randomly selected primary school pupils, secondary school students and adults from the sixteen communities that make up the local government area (Table 1). Different sampling methods were used in the selection of the sample. This included purposive sampling, cluster sampling and random sampling methods (Eboh, 1998). Uzo-Uwani Local Government Area was purposively selected for the study

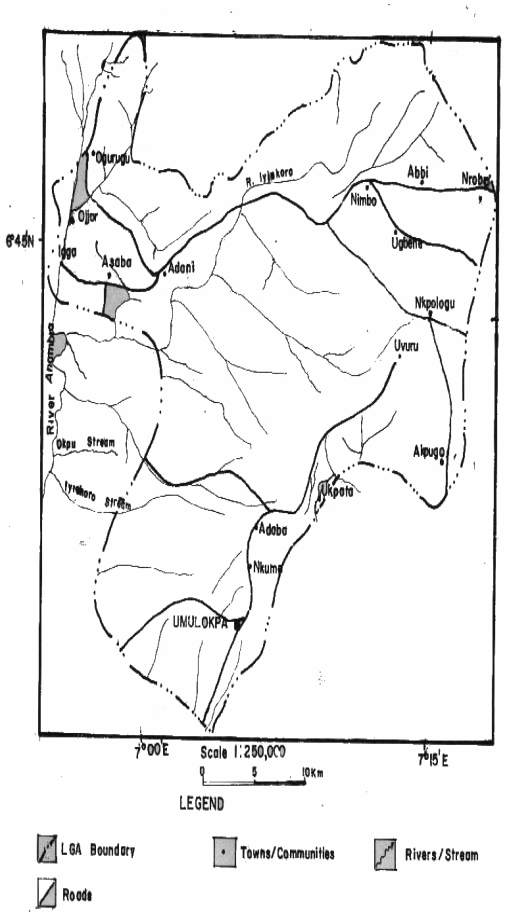

Fig. 1: Map of Uzo-Uwani Local

Table 1: Respondents according to study group and sex

Group	*M*	*F*	*Total*
Primary School Population	469	383	852
Secondary School Population	273	206	479
Adult Population	430	197	627
Total	**1172**	**786**	**1958**

because of previous knowledge of the presence of onchocerciasis in the area (Amazigo *et al*., 1993). The subjects were selected in clusters – the primary school pupils, the secondary school students and the adults of the individual communities. Within each cluster, subjects were randomly selected.

Data Collection: A structured and pre-tested questionnaire was administered to the selected secondary school students in face to face encounters. The questionnaire schedule was also used as a guide to interview the primary school pupils, some indigenous teachers and some adults of each community to find out their knowledge and beliefs about onchocerciasis including the vector (blackfly) and various visible manifestations of the disease and local treatment methods for these manifestations.

Data Analysis: In each community during the interview, the majority opinion was taken as representing the opinion of the community. The questionnaires were coded and analysed using percentages and the answer with the highest percentage in each question was accepted as majority opinion.

RESULTS

Knowledge of the blackfly and the various manifestations of onchocerciasis as well as treatment methods are presented for different health districts in Uzo-Uwani Local Government Area (Table 2). Although there were similar knowledge and beliefs in most communities, some communities had their own peculiar beliefs. Respondents in all communities knew the blackfly and the various manifestations of the disease, which each community called different names. However, the extent of knowledge varied from one community to another depending on how common the blackfly and the disease manifestations were in that community (Table 2). It was, however, observed that communities in the same health district had similar names for both the blackfly and the various manifestations (Table 3) and their beliefs about these were also closely related.

The people generally believe that the blackfly bites mostly in the mornings and evenings especially around farms, bushes and rivers/ streams, bites everybody and on all exposed parts of the body. However, they do not associate the bites with any of the manifestations of onchocerciasis such as oncho-rashes, palpable nodules and Leopard Skin. They do not also have universal method of preventing the bites of the blackfly, although few people use palm oil as repellent, some use smoke while others use plant branches to drive them away.

There was a general belief, among the youth, that oncho-rashes are caused by dirty habits and can be passed from one person to another either by direct contact or through common use of personal materials such as towels, bedding, clothes e.t.c. They also believe that these rashes can be prevented by avoiding such contacts. Some elders, on the other hand, believe that oncho-rashes result from nodules and are not contagious. Treatment methods were more or less similar e.g. oncho-

Table 2: Abundance of blackflies in relation to its knowledge and manifestation of onchocerciasis in the communities especially among the youth

Community	Abundance of blackfly from community response	Knowledge by youth	Manifestation of disease in youth
Umulokpa District			
Umulokpa	Abundant	Known	Present
Nkume	Abundant	Known	Present
Adaba	Abundant	Known	Present
Ukpata	Abundant	Known	Present
Nkpologu District			
Nkpologu	Abundant	Known	Present
Uvuru	Abundant	Known	Present
Akpugo	Abundant	Known	Present
Ogboli District			
Adani	Abundant	Known	Present
Asaba	Not Abundant	Not Known	Absent
Igga	Abundant	Known	Present
Ojjor	Abundant	Known	Present
Ogurugu	Abundant	Known	Present
Nimbo District			
Nimbo	Not Abundant	Known	Present
Abbi	Not Abundant	Known	Present
Ugbene-Ajima	Not Abundant	Known	Present
Nrobo	Not Abundant	Not Known	Absent

Table 3: Names of blackfly and manifestations of onchocerciasis in Uzo-Uwani local Government Area

S/No	Community	Blackfly	Rashes	Nodules	Leopard skin
A	**Umulokpa District**				
1	Umulokpa	Nta oji	Iti	Akpurukpu	Ukpo ocha
2	Nkume	Nta ipo	Iti	Akpurukpu	Ukpo ukwu
3	Adaba	Nta	Iti	Akpurukpu	Ukpo ocha
4	Ukpata	Nta	Etu	Akpurukpu	Ukpo ukwu
B	**Nkpologu District**				
5	Nkpologu	Nta	Etu	Akpu	Akpaala
6	Uvuru	Nta	Akpu	Akpurukpu	Akpaala
7	Akpugo	Nta	Korugaba	Akpurukpu	Nchaba ukwu
C	**Ogboli District**				
8	Adani	Nta nkwuisi	Akpu	Akpurukpu	Akpaala
9	Asaba	Ijiji ndi Fulani	Iti	Akpu	Akpaala
10	Igga	Ita\ Ijiji ndi Fulani	Etiri	Okpo	Akpaala
11	Ojjor	Ijiji ndi Fulani	Etiri	Okpo	Akpaala
12	Ogurugu	Ita oloko	Ifoo\Kachuabeg	Okpo	Akpaala
D	**Nimbo District**				
13	Nimbo	Nta akpurike	Akpu	Akpurukpu	Akpaala
14	Abbi	Nta akpurike	Akpu	Mkpo	Akpaala
15	Ugbene-Ajima	Nta akpurike	Etu	Akpu	Akpaala
16	Nrobo	Nta akpurike	Etu	Akpu	Akpaala

rashes were commonly treated with herbs while *Onchocerca* nodules were commonly treated by removal.

DISCUSSION

The studies on the local disease perception and treatment reveal a high level of ignorance of the aetiology of onchocerciasis in the 16 communities that make up Uzo-Uwani Local

Government Area of Enugu State, Nigeria. All these communities are aware of the presence of the blackfly and its nuisance in terms of its bites but they are not aware that the bites are associated with any disease. Consequently, there is no serious effort to prevent them from biting. It was also obvious that the blackfly is not equally abundant in all the communities and that the level of the knowledge of the blackfly in a community, especially among the younger members of the community is closely related to its abundance in that community, for example, the two communities where the primary and/or secondary school children did not know the blackfly (Asaba and Nrobo) were among the communities in which their elders accepted that the *Simulium* flies are not abundant. When compared with studies on the prevalence of onchocerciasis (Ubachukwu, 2001), it was noted that the abundance of the blackflies (from the responses) in a given community correlates, largely, with the prevalence of onchocerciasis in that community. The communities where the blackfly was claimed not to be abundant and not well known, at least among the younger members of the communities, had the least manifestations of the disease especially among the youth, for example, at Asaba and Nrobo. The fact that the blackfly bites everybody implies that in every community where *Simulium* flies exist and especially where they are abundant, everybody is at the risk of infection with *Onchocerca volvulus*. Again, the fact that the blackfly bites on all exposed parts of the body means that the larger the area of the body exposed, the higher the man-fly contact and so the greater the risk of getting *Onchocerca volvulus* infection.

Every community in Uzo-Uwani Local Government Area knows papular onchodermatitis (oncho-rashes) called various names in different communities. It was observed that the communities in the same health district tend to use similar names to describe these manifestations. Except in a few communities whose elders believe that these rashes result from the presence of nodules, majority of the people of Uzo-Uwani Local Government Area attribute onchodermatitis to various causes such as dirty habits or poor hygiene, inheritance, etc while many do not have any idea or opinion about the cause. Because of this erroneous belief, most people of this area think that onchodermatitis can be passed from one person to another through either direct body contact or through common use of personal materials such as towels, bed sheets, clothes, etc. They wrongly believe also that it can be prevented by avoiding contact with infected persons. These wrong beliefs are at the root of the discrimination practiced against people with onchodermatitis in many of these communities (Ubachukwu, 2001). The people believe onchodermatitis can be cured either by use of local herbs, medicated soaps or drugs but they have no idea of the drugs used for its treatment.

The *Onchocerca* nodule is also generally known in Uzo-Uwani Local Government Area and called by various names in different communities. The cause of the nodule as well as any means of its prevention is not known by the communities. The general curative measure for the *Onchocerca* nodule in Uzo-Uwani Local Government Area is removal of the nodule (nodulectomy). This is done either by local excisors or by medical personnel in health posts, health centres or government hospitals. According to the people interviewed, what determines where one goes for treatment of nodule or oncho-rashes is the amount of money available to the person. Most members of the communities know that private hospitals may give better medical care but they cannot afford the cost of treatment. As a result, they go to either local excisors, patent medicine dealers or health centres for treatment. The people do not however, know any drug used in the treatment of *Onchocerca* nodule.

Although leopard skin is common in all the communities studied, no community studied knows of any connection between such a manifestation and any other manifestation of onchocerciasis. They attribute leopard skin to old age or inheritance. Apart form itching, leopard skin is not a source of problem in the communities. It does not hinder them from doing their normal duties neither is it an object of discrimination.

As mentioned earlier, ignorance is at the root of most of the beliefs concerning the manifestations of onchocerciasis. Another area of ignorance is in the treatment of these manifestations. In Uzo-Uwani Local Government Area, it is not generally believed that the manifestations are caused by gods or enemies and so people do not resort to appeasing gods and enemies as reported by Edungbola (1982); Edungbola *et al.* (1983), Edungbola and Asaolu (1984) and Nwoke *et al.* (1992). Yet, due to ignorance of the aetiology of onchocerciasis, people with such manifestations do not take the right treatment for their infection. In Uzo-Uwani Local

Government Area, as well as other endemic areas in the nation, the Ministry of Health in collaboration with World Health Organization (WHO) and non-governmental Development Organizations (NGDO), have been distributing ivermectin (Mectizan) since 1996 under the Community Directed Distribution (CDD) Programme of African Programme for Onchocerciasis Control (APOC) (WHO, 1996). Inspite of this programme, most people of this local government area, apart from few teachers, health officers and the Community Directed Distributors, have no idea of any drug used for treating onchocerciasis. Even those taking ivermectin do not know the disease for which they are taking the drug. Although ivermectin is supposed to be taken for about 10 years without break, many people in this area refused to take it after the first experience because of some observed side effects. As far as such people are concerned, the drug causes disease. They feel more at home with the manifestations of onchocerciasis than with the side effects resulting from the treatment. The side effects are such that in two communities (Adaba and Nkpologu), few people (1 and 2 respectively) died from excessive swelling after taking the drug and as a result, many people prefer to live with the disease than to die from treating it. It should be noted, however, that the root cause of the deaths is ignorance. Some people, such as those with respiratory problems like tuberculosis and asthma, who are not supposed to take the drug, take it and others drink alcohol (which should not be taken) after taking the drug, all due to ignorance. In one community (Uvuru), there was propaganda that the aim of the drug is to reduce the population of their community and so many people refuse to take it.

As mentioned earlier, one other problem that hinders people from taking the right treatment for onchocerciasis is poverty. Many people cannot afford to go to good hospitals to be treated even when they know that they can be treated. Most people testify of people that went to good hospitals and were cured of their manifestations, especially onchodermatitis, which is most dreaded but there are other people still suffering from the same manifestation in the same locality. Some of such people, due to poverty, go to herbalists and patent medicine dealers who are not in a good position to help them.

SUMMARY AND RECOMMENDATIONS

From the results reported in this paper, the people of Uzo-Uwani Local Government Area know the blackfly but do not associate the bites with any disease. They also know the manifestations of onchocerciasis but they do not know the cause. They attribute them to various causes such as poor hygiene, inheritance and old age. Because of ignorance and poverty, the people do not take the right treatment for these manifestations. Even the choice drug for onchocerciasis treatment, ivermectin, which is being distributed free of charge in the local government area, is not taken by many people because of fear and misconceptions.

From their responses, it is obvious that the people are aware of both the diurnal rhythm and seasonality of the blackfly/human contact. Their major problem is inability to associate the bites of these blackflies with the various manifestations of onchocerciasis, probably as a result of the long period between infection and manifestation of the various effects of the disease (1-3 years). With this knowledge, it appears that the most relevant intervention strategy required in this area at the moment is enlightenment. This enlightenment programme can be planned to educate them on the following:

(i) The association between blackfly bites and infection with *Onchocerca volvulus*.

(ii) The length of time taken for the infection to produce the various observable manifestations.

(iii) The fact that onchocerciasis manifestations are not contagious. This will remove the social stigma associated with such manifestations especially rashes.

(iv) The importance of taking ivermectin once a year for at least ten years in order to eliminate the reservoir in man. This will mean that even when the blackfly bites man, there will be no transmission of the parasites.

(v) The safety of ivermectin if taken according to the laid down guidelines (e.g. no alcohol intake, no previous history of respiratory or heart disease etc).

To encourage them to take the drug, emphasis should not be laid on the apparently insidious manifestations of the disease but on the ultimate effect, which is blindness and on the fatal effect of blindness on their future generations.

To implement this enlightenment programme, use will be made of the already existing Community Directed Distributors (CDDs) who are selected members of the individual communities, mostly teachers, trained by World Health Organization (WHO) under the African Programme for Onchocerciasis Control (APOC) for the distribution of ivermectin (WHO, 1996). These people will work hand in hand with the primary health care units in the various communities. It is recommended that WHO, in collaboration with the Ministry of Health and non-governmental Development Organizations (NGDO) remunerate these CDDs who have, hitherto, been left to be remunerated by their individual communities. It was found out during the study that most communities do not give them even transport money to go to the headquarters and collect drugs. As a result, most of them, though willing to work, are frustrated, and may often skip the opportunity to continue the service. Cost recovery as suggested by Amazigo *et al* (1998) and Hopkins (1998) may also be a way of helping to sponsor these CDDs. This involves payment of a token amount by each treated family.

It is also recommended that in addition to the distribution of ivermectin and the enlightenment campaign, WHO should encourage and sponsor nodulectomy as treatment method for the *Onchocerca* nodule in this local government area. The only known hindrance is the cost of removal. When the researchers sponsored the excision of nodules in Ukpata community, most infected people were willing to submit themselves for the exercise (Ubachukwu, 2001).

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DIFFERENCES IN MERISTIC COUNTS OF THE GENUS *Clarias* (PISCES: CLARIIDAE) IN ANAMBRA RIVER, NIGERIA

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ABSTRACT

Specific differences in meristic counts were exhibited in both the anal fin ray count and the vertebral count in the clariids of Anambra river, Nigeria. There was a close numerical relationship between the number of anal fin rays and the number of vertebrae. The present study further justifies the taxonomic importance of anal fin ray count in differentiating Clarias species.

Key words: Meristic Counts, *Clarias,* Clariidae, Anambra River

INTRODUCTION

Congeneric and conspecific variations in fifty-four morphologic characters among *Clarias* species have been reported (Eyo, 2002 a, b). *Clarias ebriensis* and *C. albopunctatus* as well as *C. gariepinus and C. anguillaris* have overlapping morphologic character ranges. Congeneric differences among the clariids occurred in 2 raw and 9 ratio but not easily detected in 6 residual morphologic characters (Eyo, 2002 a). These are key characters which have ecological and taxonomic implications.

Sex discrimination among male and female clariids inhabiting the Anambra river system was evident in 7, 11, 20 and 26 morphologic characters for *C. ebriensis*, *C. albopunctatus*, *C. gariepinus* and *C. anguillaris* respectively. The observed increase in number of sex differentiating characters with clariid definitive size may be connected with variances in specific growth rates (Eyo, 2002 b).

The present study focuses on congeneric and conspecific differences in meristic counts among four *Clarias* species in Anambra River, Nigeria. The specific objectives of the study were (1) to provide taxonomic and descriptive statistical data on the meristic counts within and between *Clarias* species of Anambra river, (2) to evaluate the presence of sexual dimorphism in meristic counts and (3) to validate differences in meristic counts between the species.

MATERIALS AND METHODS

Clarias species were sampled from three locations (Onitsha, Otuocha and Ogurugu) along the Anambra River, Nigeria (Fig. 1). The fish were captured using set nets (mesh sizes 70 mm - 120 mm) and long lines baited with earthworm, pieces of meat and ripe palm fruits. Specimens were also bought from the major landing river port at Otuocha to ensure good representation of all sizes of the catfishes. All specimens were frozen and kept under refrigeration until used.

Fishes were properly identified and classified to their subgeneric level using Teugels (1982). Members of the subgenus *Clarias (Clarias) w*ere identified to the species level using Lowe-McConnel (1972) and Sydenham (1983), whereas those of the subgenera *C. (Clarioides)* and *C. (Anguilloclarias)* were identified using Ezenwaji (1989). The keys relevant to the taxonomy of the Anambra river catfishes of the genus *Clarias* have been presented elsewhere (Eyo, 1997). Data on 7 meristic counts (Fig. 2) obtained from 52 *C. gariepinus,* 56 *C. anguillaris,* 60 *C. ebriensis* and 90 *C. albopunctatus* were analysed.

All fish specimens were dissected and their sexes identified. Males and females of each species were treated separately to demonstrate conspecific differences and then combined to illustrate congeneric differences among studied meristic counts. Caudal fin ray count (CFRC) (the number of all the rays in the caudal fin), anal fin ray count (AFRC) (the number of rays in the anal fin), dorsal fin ray count (DFRC) (the number of the dorsal fin rays), pectoral fin ray count (PFRC) (the number of rays in the pectoral fin), pelvic fin ray count (PeFRC) (the number of rays in the pelvic fin), gill raker count (GRC) (the number of all the gill rakers on the first left gill arch) and vertebrae count (VC) (the

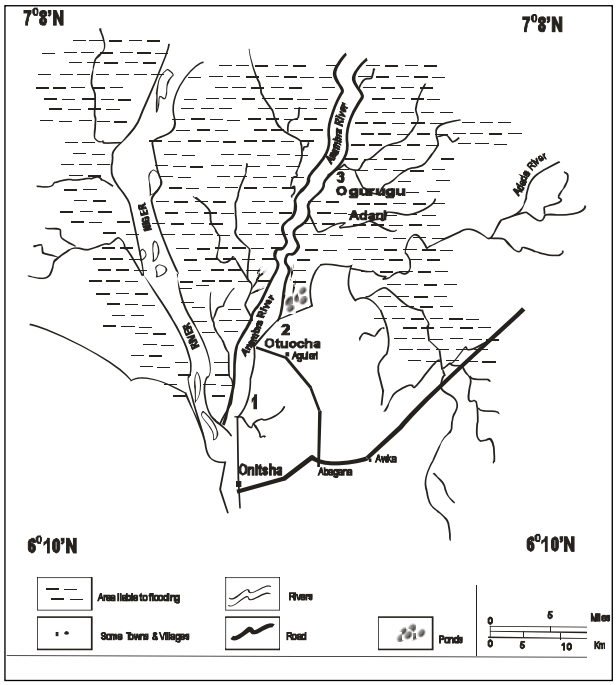

Figure 1: Map of Anambra river basin showing the sampling locations 1, 2 and 3.

number of all the vertebrae from the occipital to the end of the caudals) were carefully recorded. Before the vertebral count, an articulated skeleton of the catfish vertebrae was prepared using hot water maceration method. The fish specimen was defleshed and introduced into 0.01 N boiling solution of NaOH and left for 5 - 8 mins. The resulting soft flesh adhering on the skeletal part was cleared using a soft brush and the skeleton washed in water. The vertebrae were then counted and packaged. Means rather than modal counts were analysed. Mean, rather than modal, counts were analysed.

RESULTS

The distribution of meristic counts in the *Clarias* species of Anambra river, Nigeria is presented in Table 1. The specific differences in meristic counts among the examined species employing F-LSD are presented in Table 2. The means of the CFRC in males, females and combined sex of *C. ebriensis* and *C. albopunctatus* were identical (18.00 ± 0.00). Slight variations were displayed in the means of this count in males (19.00 ± 1.04), females (18.50 ± 0.89) and combined sex (18.73 ± 0.98) of *C. gariepinus* and in males (18.50 ± 0.94), females (18.38 ± 0.81) and combined sex (18.47 ± 0.86) of *C. anguillaris*. The test for significant differences indicated that the count was statistically similar among the males, females and combined sex of all the species studied.

The means of the AFRC varied in males (61.71 ± 2.69), females (60.23 ± 2.89), and combined sex (61.40 ± 2.54) of *C. ebriensis* and in males (54.50 ± 1.70), females (54.21 ± 1.72) and combined sex (54.30 ± 1.70) of *C. albopunctatus*. Furthermore, the means of the count differed in males (52.93 ± 2.27), females (52.56 ± 2.37) and combined sex (52.73 ± 2.29) of *C. gariepinus* and in males (62.93 + 3.15), females (63.69 ± 3.42) and combined sex (63.33 ± 3.26) of *C. anguillaris.* The F – LSD test for specific differences indicated that the counts were statistically similar in all the *Clarias* species females, different in all the *Clarias* species combined sex and identical among males of *C. ebriensis* vs *C. albopunctatus, C. albopunctatus* vs *C. gariepinus* and *C. albopunctatus* vs *C. anguillaris.*

The means of the DFRC varied in males (78.06 ± 3.15), females (78.85 ± 2.88) and combined sex (78.40 ± 3.00) of *C. ebriensis* and males (70.63 ± 2.19) females (70.36 ± 1.19) and combined sex (70.50 ± 1.90) of *C. albopunctatus.* The count means differed in males (72.36 ± 3.97), females (71.44 ± 2.99) and combined sex (72.07 ± 3.60) of *C. gariepinus* and in males (71.43 ± 2.82), females (71.00 ± 2.48) and combined sex (71.20 ± 2.60) of *C. anguillaris*. The F – LSD test for specific differences indicated not significant differences in males and females of all species, while the combined sex of *C. albopunctatus* vs *C. gariepinus* and *C. anguillaris* were statistically similar.

The means of the PeFRC in males, females and combined sex (6.00 ± 0.00) of *C. albopunctatus*, *C. gariepinus* and *C. anguillaris* were identical. Slight variations were observed in the means of males (6.71 ± 0.99), females (7.08 ± 1.04) and combined sex (7.27 ± 1.25) of *C. ebriensis*. The F – LSD test showed not significant difference among males, females and combined sex of all catfish species studied.

The means of the PFRC for males, females and combined sex of *C. ebriensis* and *C. albopunctatus* were the same (8.00 ± 0.00). Furthermore, the means for males, females and combined sex of C. *gariepinus* and *C. anguillaris* were identical (9.00 ± 0.00). The F-LSD test of significance indicated not significant difference among the males, females and combined sex of all *Clarias* species examined. The means of the GRC varied in males (16.65 ± 1.41), females (16.77 ± 1.30) and combined sex (16.70 ± 1.34) of *C. ebriensis* and males (16.63 ± 0.50), females (16.43 ± 0.51) and

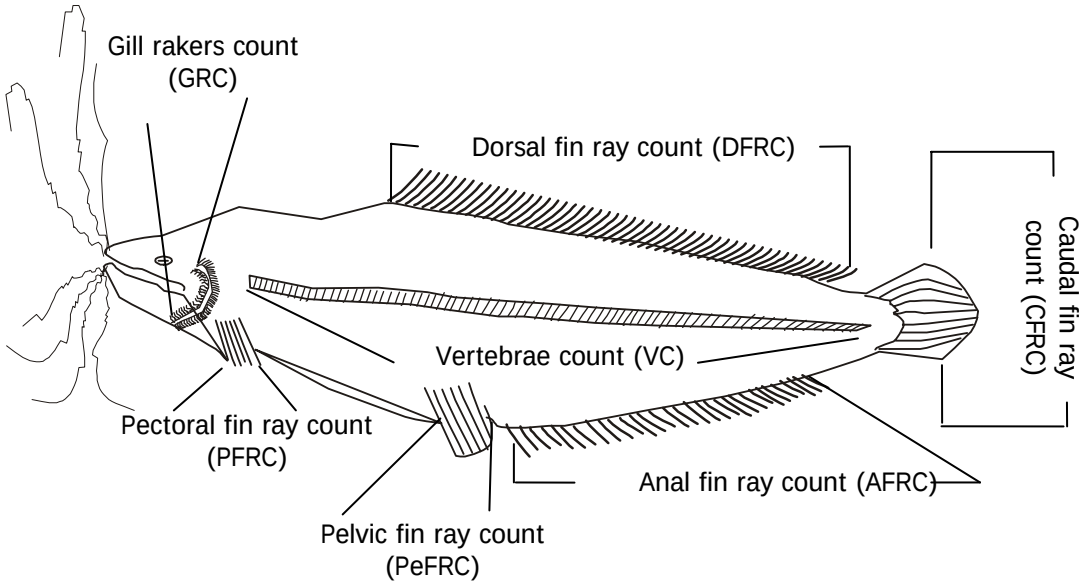

Figure 2: Schematic representation of meristic counts among *Clarias* species of Anambra river, Nigeria.

Table 1: Distribution of meristic counts in the *Clarias* species of Anambra river Nigeria

Meristic	Males			Females			Combined Sex		
Counts	Mean	SD	RV	Mean	SD	RV	Mean	SD	RV
				C. ebriensis					
CFRC	18.00	0.00	0.00	18.00	0.00	0.00	18.00	0.00	0.00
AFRC	61.71	2.69	9.00	60.23	2.89	9.00	61.40	2.54	9.00
DFRC	78.06	3.15	9.00	78.85	2.88	9.00	78.40	3.00	9.00
PeFRC	6.71	0.99	2.00	7.08	1.04	2.00	7.27	1.25	2.00
PFRC	8.00	0.00	0.00	8.00	0.00	0.00	8.00	0.00	0.00
GRC	16.65	1.41	4.00	16.77	1.30	4.00	16.70	1.34	4.00
VC	55.59	1.62	4.00	56.00	1.58	4.00	55.77	1.59	4.00
				C. albopunctatus					
CFRC	18.00	0.00	0.00	18.00	0.00	0.00	18.00	0.00	0.00
AFRC	54.50	1.71	5.00	54.21	1.72	6.00	54.30	1.70	6.00
DFRC	70.63	2.19	5.00	70.36	1.69	5.00	70.50	1.90	5.00
PeFRC	6.00	0.00	0.00	6.00	0.00	0.00	6.00	0.00	0.00
PFRC	8.00	0.00	0.00	8.00	0.00	0.00	8.00	0.00	0.00
GRC	16.63	0.50	1.00	16.43	0.51	1.00	16.53	0.51	1.00
VC	50.94	1.12	4.00	50.71	0.83	2.00	50.77	0.82	2.00
				C. gariepinus					
CFRC	19.00	1.04	2.00	18.50	0.89	2.00	18.73	0.98	2.00
AFRC	52.93	2.27	7.00	52.56	2.37	8.00	52.73	2.29	8.00
DFRC	72.36	3.97	9.00	71.44	2.99	8.00	72.07	3.60	9.00
PeFRC	6.00	0.00	0.00	6.00	0.00	0.00	6.00	0.00	0.00
PFRC	9.00	0.00	0.00	9.00	0.00	0.00	9.00	0.00	0.00
GRC	42.64	1.15	3.00	43.44	1.46	5.00	43.07	1.39	5.00
VC	57.21	1.31	4.00	56.88	1.36	4.00	57.03	1.33	4.00
				C. anguillaris					
CFRC	18.27	0.94	2.00	18.38	0.81	2.00	18.47	0.86	2.00
AFRC	62.93	3.15	9.00	63.69	3.42	9.00	63.33	3.26	9.00
DFRC	71.43	2.82	6.00	71.00	2.48	8.00	71.20	2.60	8.00
PeFRC	6.00	0.00	0.00	6.00	0.00	0.00	6.00	0.00	0.00
PFRC	9.00	0.00	0.00	9.00	0.00	0.00	9.00	0.00	0.00
GRC	35.57	3.16	9.00	36.38	2.47	9.00	35.00	6.63	9.00
VC	59.29	1.49	4.00	59.06	1.53	4.00	59.17	1.49	4.00

Table 2: Specific differences in meristic counts in the *Clarias* species of Anambra river Nigeria employing F-LSD

Meristic Counts	F-LSD Value	*Clarias ebriensis*	*Clarias albopunctatus*	*Clarias gariepinus*	*Clarias anguillaris*
			Males		
CFRC	2.49	18.00	18.00	19.00	18.57
AFRC	7.75	61.71a	54. 50ab	52. 93bc	62. 93bd
DFRC	8.54	78.06	70.63	72.43	71.43
PeFRC	0.79	6.71	6.00	6.00	6.00
PFRC	1.19	8.00	8.00	9.00	9.00
GRC	6.85	16.65a	16. 63ab	35.57d	42.64c
VC	7.37	55.59a	50.94b	59.29d	57.21c
			Females		
CFRC	3.72	18.00	18.00	18.50	18.38
AFRC	11.99	60.23	54.21	52.56	63.69
DFRC	34.50	78.85	70.36	71.44	71.00
PeFRC	1.38	6.77	6.00	6.00	6.00
PFRC	1.69	8.00	8.00	9.00	9.00
GRC	3.08	16.77a	16.43ab	43.44c	36.38d
VC	11.19	56.00	50.71	56.68	59.06
			Combined Sex		
CFRC	2.35	18.00	18.00	18.73	18.47
AFRC	1.35	61.40a	54.30b	52.73c	63.33d
DFRC	1.48	78.40a	70.50bc	72.07c	70.50bd
PeFRC	0.84	6.73	6.00	6.00	6.00
PFRC	1.09	8.00	8.00	9.00	9.00
GRC	2.42	16.70a	16.53ab	43.07c	35.00d
VC	0.61	55.77a	50.77b	57.03c	59.17d

combined sex (16.53 ± 0.51) of *C. albopunctatus*. In addition, the means of the count differed in males (42.64 ± 1.15), females (43.44 ± 1.46) and combined sex (43.07 ± 1.39) of *C. gariepinus* and males (35.57 ± 3.16) female (36.38 ± 2.17) and combined sex (35.00 ± 6.63) of *C. anguillaris*. The F-LSD test for specific differences indicated that all the males, females and combined sex were significantly different except for the male of *C. ebriensis* and *C. albopunctatus*.

The means of the VC differed in males (55.59 ± 1.63), females (56.00 ± 1.58) and combined sex (55.77 ± 1.59) of *C. ebriensis* and in males (50.94 ± 1.12), females (50.71 ± 0.83) and combined sex (50.79 ± 0.82) of *C. albopunctatus*. The count means differed in males (57.21 ± 1.31), females (56.88 ± 1.36) and combined sex (57.03 ± 1.33) of *C. gariepinus* and males (59.17 ± 1.49), females (59.06 ± 1.53) and combined sex (59.17 ± 1.49) of *C. anguillaris*. Their F-LSD test for specific difference indicated that the males of *C. albopunctatus* and *C. gariepinus* differed significantly from the rest of the males while the females were not significantly different among the species. Furthermore, the count among the combined sex was significantly different in all the catfish species.

DISCUSSION

Specific differences in AFRC and VC distribution were exhibited among the clariids. Observation from the present study indicated that there was a close numerical relationship between the number of anal fin rays and the number of vertebrae. Thus, the mean AFRC varied from 53 in *C. gariepinus* to 63 in *C. anguillaris,* whereas the mean VC differed from 51 in *C albopunctatus* to 59 in *C. anguillaris*. Sydenham (1978) reported a modal number of vertebrae for the African *Clarias* species to be 60, with intraspecific variation in the order of 2 – 3 vertebrae. Species of the subgenera *C*. (*Clarias)* and *C. (Allabenchelys)* have VC close to the generic mode ranging from 59 to 63. Species of C. (*Clarioides)* however, show much greater interspecific variation with counts ranging from 50 - 68 (Sydenham, 1978). In *C. agboyiensis* and *C. isheriensis* ranges of 52 to 57 VC have been reported (Sydenham, 1980). Furthermore, in *C. aboinensis,* Sydenham and Olawoye (1981) reported vertebrae range of

between 58 and 60. Teugels and Thys Van Den Audenaerde (1981) reported vertebrae ranges of 59 to 62 in *C ebriensis* and 59 to 64 vertebrae in *C. dahomeyensis.* The VC in the present study falls within the 50 – 68 distribution of vertebrae in the genus *Clarias* (Sydenham, 1978).

Teugels and Thys Van Den Audenaerde (1981), while comparing the original description of two nominal species, *C. ebriensis and C. dahomeyensis,* observed that only the number of the dorsal and the anal fin rays can be indicated as being strikingly different. *C. ebriensis* had 70 - 73 dorsal and 53 - 62 anal fin rays, while they were 80 - 87 and 62 - 75 respectively in *C. dahomeyensis.* Teugels (1980) had already demonstrated that the systematic value of these counts was doubtful because of their wide variation. It is worthy to observe that the rejection of AFRC by Teugels (1980) based on wide variation may be invalid reasoning because all meristic counts examined by Teugels (1980) as well as those examined in the present study exhibited heterogeneous variance within stipulated ranges. Furthermore, species classification using morphological features is not based on one key character but on a wide range of key characters. In *C. angolensis,* Sydenham (1978) recorded 70 anal fin rays. Other numbers recorded for AFRC were 46 - 53 in *C. liberiensis* = *C. buettikoferi, 64 - 66 in C. submarginatus = C. albopunctatus,* 70 in *C. laeviceps,* 57 in *C. walkeri* = *C. camerunensis* and 63 – 71 in *C. longior* (Sydenham, 1978), 66 – 73 in *C. agboyiensis,* 51 – 60 in *C. isheriensis* = *C. agboyiensis* and 59 to 62 in *C. aboinenesis* (Sydenham and Olawoye, 1981). The observed range of the AFRC in all the species falls within the established range of 46 – 73 for the genus *Clarias*. Other authors have strongly supported the systematic values of both AFRC and VC.

Considering the use of meristic counts in differentiating other fish species, the AFRC was a major character in discriminating among *Oryzias* species (Uwa and Parenti, 1988). Similarly, Ferguson and Liskauskas (1995) employed both AFRC and VC in discriminating among populations of the brook charr (*Salvelinus fontinalis*). Thus, the present study further justifies the taxonomic importance of AFRC and VC in differentiating between clariids.

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MAYR'S COEFFICIENT OF DIFFERENCE AND TAXONOMY OF *CLARIAS* (CLARIIDAE – SCOPOLI, 1777)

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ABSTRACT

Coefficient of difference in 54 morphometric characters was studied using 258 Clarias species from Anambra river, Nigeria. There were no differences between C. ebriensis and C. albopunctatus for all the 54 characters studied. The coefficient of difference in morphometric characters of C. ebriensis vs. C. gariepinus indicated that about 90 % of C. ebriensis were significantly different from about 90 % of C. gariepinus in about 34 morphometric characters. Thirty seven differentiating morphometric characters occurred between C. ebriensis and C. anguillaris. Considering the discriminating characters between C. albopunctatus and C. gariepinus, 90 % of C. albopunctatus differed from 90 % of C. gariepinus in about 32 characters. Furthermore, about 90 % of C. albopunctatus differed from 90 % of C. anguillaris in about 35 characters. Differentiating of C. gariepinus from C. anguillaris based on the coefficient of difference was impossible for all the 54 characters studied. The coefficients of difference among all clariids studied were almost identical in 10 characters namely: maximum body depth, pectoral spine height, anal fin base length, inner mandibular barbel length, outer mandibular barbel length, maxillary barbel length, premaxillary teeth band depth, vomerine teeth band depth, prenasal length and nasal - nasal barbel space, with exception of C. ebriensis vs. C. albopunctatus and C. gariepinus vs. C. anguillaris. These characters thus represent "key characters" for differentiating between the "small" and "large" clariids.

Key words: Mayr's Coefficient of Difference, *Clarias,* Clariidae, Taxonomy

INTRODUCTION

Differences in fifty-four morphometric characters among four *Clarias* species Scopoli, 1777 of Anambra river, Nigeria, using F-LSD have been reported (Eyo, 2002 a, b). In the report, *Clarias albopunctatus* and *C. ebriensis* as well as *C. anguillaris* and *C. gariepinus* were shown to have overlapping morphometric character ranges. Differences among the studied *Clarias* species occurred in 2 raw (pectoral fin base length (PFBL) and frontal fontanel width (FFW)), 9 ratio (pelvic fin base length (PeFBL), pectoral spine height (PSH), dorsal fin height (DFH), maxillary teeth band width (MTBW), premaxillary teeth band depth (PmTBD), frontal fontenelle length (FFL), internasal space (INS), pelvic fin – anal fin space (PeAS) and prenasal barbel length (PNBL)) and not easily established in 6 residual (Total length (TOL), prepectoral length (PPL), pectoral fin base length (PFBL), Dorsal fin base length (DFBL), outer mandibular barbel space (OMBS) and eye diameter (EDIA)) morphometric characters. The 2 raw and 9 ratio characters were recommended as important generic and specific key characters in clariid systematics and their ecological and taxonomic implications were reassessed (Eyo, 2002 a).

Similarly, sex differentiating morphometric characters between male and female clariids inhabiting the Anambra river systems employing studentized t -test occurred in 7, 11, 20 and 26 morphometric characters for *Clarias ebriensis*, *C. albopuncatus*, *C. gariepinus* and *C. anguillaris* respectively.

Furthermore, specific differences in the distribution of meristic character among the clariids of Anambra river, Nigeria, utilizing F-LSD, indicated that both the anal fin ray and vertebrae counts were of taxonomic importance. There was a close numerical relationship between the number of anal fin rays and number of vertebrae (Eyo, 2004).

Another univariate statistical tool capable of discriminating 90 % population of species A from 90 % population of species B is Mayr's coefficient of difference (CD) (Mayr, 1969). Thus in the present study, Mayr's

coefficient of difference was employed to test the equality of morphometric character means between the clariid species, the assumption being that if the difference between two mean measurements of populations A and B exceeded the sum of the two standard deviations by 1.28, then about 90 % of species belonging to population A differed from about 90 % of species belonging to population B based on the tested morphometric characters.

MATERIALS AND METHODS

Fish: *Clarias* species were collected from the Anambra River, Nigeria, using set nets (mesh sizes 70 mm – 120 mm) and long line baited with ripe palm fruits. The multiple sampling methods were employed to eliminate gear selectivity and ensure good representation of all sizes of the catfish. Individuals required for morphometric studies were iced and transported to the Department of Zoology, University of Nigeria, where they were kept under refrigeration until used.

The clariids were identified to the genus *Clarias* using (Sydenham, 1983), and to their sub-generic level using Teugels (1982a). The "large" *Clarias* were identified to the species level using (Lowe-McConnell, 1992). The "small" and "large" *Clarias* were identified using (Ezenwaji, 1989) and (Sydenham, 1983) respectively. The keys relevant to taxonomy of the Anambra river catfish of the genus *Clarias* have been catalogued (Eyo, 1997). A total of 52 *Clarias gariepinus*, 56 *C. anguillaris*, 60 *C. ebriensis* and 90 *C. albopunctatus* were analyzed.

Morphometric characters: Prior to the measurement of the morphometric characters, the frozen specimen was allowed to thaw completely and the fresh weight taken to the nearest 0.01 gram using a Mettler PC 2000 electronic balance. Fifty-four (54) morphometric characters were measured per individual fish as listed in Table 1. The description of these characters have been presented elsewhere (Eyo, 2002 a). All measurements were taken on the left side of the fish using a vernier caliper or a pair of dividers or a piece of thread on a scaled fish measuring board, in centimeters to the nearest 0.5 mm.

Analysis: Mayr's coefficient of difference (CD) (Mayr, 1969) was employed to test the equality of means of morphometric characters between the clariid species. If the difference between two mean measurements of populations A and B exceeded the sum of the two standard deviations by 1.28, then about 90 % of population A differed from about 90 % of population B. Coefficient of difference was computed as: mb - ma/SDa + SDb where mb and ma are mean measurements of morphometric character for populations B and A respectively, SDa and SDb are standard deviations of measured character for population A and B respectively, and a and b being specific morphometric characters of the different clariid species respectively.

RESULTS

The coefficients of differences among the clariids are presented in Table 1. From the data, there were no differences between *C. ebriensis* and *C. albopunctatus* in all the 54 characters studied.

Considering *C. ebriensis* vs. *C. gariepinus* about 90 % of *C. ebriensis* were significantly different from about 90 % of *C. gariepinus* in about 34 characters. These characters were: standard length, total length, predorsal length, prepelvic length, preanal length, caudal penduncle length, head height, maximum caudal penduncle depth, maximum head width, pelvic fin base height, pelvic fin base length, pectoral fin base length, anal fin height, dorsal fin height, maxillary barbel space, premaxillary teeth band width, vomerine teeth band width, mouth width and eye diameter. Other characters exhibiting differences were prefrontal fontennelle length, frontal fontennelle length, frontal fontennelle width, preoccipital fontennelle length, occipital fontennelle length, occipital fontennelle width, internasal space, interorbital space, maximum body width caudal fin length, pectoral-pelvic fin space, prenasal barbel length, nasal barbel-orbital space and nasal orbital space.

The assessment of the differentiating characters between *C. ebriensis* and *C. anguillaris* revealed that 90 % of *C. ebriensis* differed from 90 % *C. anguillaris* in 37 characters. The characters included standard length, total length, predorsal length, prepectoral length, prepelvic length, preanal length, preorbital length, caudal peduncle length, Head length, maximum caudal peduncle depth, maximum head width, pelvic fin height, pelvic fin base length, pectoral fin base length, anal fin height, dorsal fin height, outer mandibular barbel space, nasal barbel space,

Mayr's coefficient of difference among *Clarias* species

Table 1: Mayr's coefficient of difference among *Clarias* species of Anambra River, Nigeria

	Morphometric Characters	Coefficient of difference between two species		
		C. ebriensis vs. *C. albopunctatus*	*C. ebriensis* vs. *C. gariepinus*	*C. ebriensis* vs. *C. anguillaris*
1	**Standard length [STL]**	0.09	1.29	1.36
2	**Total length [TOL]**	0.10	1.41	1.43
3	**Predorsal length [PDL]**	0.33	1.94	1.83
4	**Prepectoral length [PPL]**	0.06	1.22	1.52
5	**Prepelvic length [PPeL]**	0.06	1.47	1.65
6	**Preanal length [PAL]**	0.21	1.71	1.66
7	**Preorbital length [POL]**	0.00	1.20	1.58
8	**Caudal peduncle length [CPL]**	0.49	1.46	1.40
9	**Head length [HEL]**	0.33	2.12	1.91
10	**Maximum head depth [MHD]**	0.15	0.84	1.10
11	**Maximum body depth [MBD]**	0.14	1.01	0.96
12	**Maximum caudal peduncle depth [MCPD]**	0.01	2.03	1.90
13	**Maximum head width [MHW]**	0.22	1.62	1.46
14	**Pelvic fin height [PeFH]**	0.11	1.67	1.61
15	**Pelvic fin base length [PeFBL]**	0.22	1.31	1.56
16	**Pectoral spine height [PSH]**	0.20	1.19	1.24
17	**Pectoral fin base length [PFBL]**	0.43	1.51	1.57
18	**Anal fin base length [AFBL]**	0.12	0.71	0.98
19	**Anal fin height [AFH]**	0.07	2.02	1.63
20	**Dorsal fin base length [DFBL]**	0.08	1.11	1.21
21	**Dorsal fin height [DFH]**	0.35	1.40	1.81
22	**Inner mandibular barbel length [IMBL]**	0.33	1.08	0.92
23	**Outer mandibular barbel length [OMBL]**	0.06	0.77	0.65
24	**Nasal barbel length [NBL]**	0.03	0.44	0.27
25	**Maxillary barbel length [MBL]**	0.09	0.85	0.58
26	**Inner mandibular barbel space [IMBS]**	0.20	0.70	1.25
27	**Outer mandibular barbel space [OMBS]**	0.04	1.23	1.54
28	**Nasal barbel space [NBS]**	0.02	1.50	1.58
29	**Maxillary barbel space [MBS]**	0.07	1.37	1.66
30	**Premaxillary teeth band width [PrTBW]**	0.22	1.62	2.05
31	**Premaxillary teeth band depth [PrTBD]**	0.22	0.51	0.96
32	**Vomerine teeth band width [VTBW]**	0.08	1.79	1.87
33	**Vomerine teeth band depth [VTBD]**	0.17	1.26	0.63
34	**Mouth width [MOW]**	0.19	1.75	2.06
35	**Eye diameter [EDIA]**	0.65	3.56	2.52
36	**Prefrontal fontennelle length [PFFL]**	0.07	1.32	1.56
37	**Frontal fontennelle length [FFL]**	0.40	2.56	2.47
38	**Frontal fontennelle width [FFW]**	0.78	2.52	2.17
39	**Preoccipital fontennelle length [POFL]**	0.35	2.11	1.91
40	**Occipital fontennelle length [OFL]**	0.18	1.60	0.52
41	**Occipital fontennelle width [OFW]**	0.14	1.34	0.12
42	**Frontal fontennelle – Occipital fontennelle space[FOS]**	0.21	1.28	1.47
43	**Internasal space [INS]**	0.24	1.44	1.86
44	**Interorbital space [IOS]**	0.16	1.58	1.67
45	**Maximum body width [MBW]**	0.28	1.56	1.37
46	**Caudal fin length [CFL]**	0.01	2.12	1.76
47	**Pectoral - Pelvic fin space [PPeS]**	0.17	1.63	1.70
48	**Pelvic - Anal fin space [PeAS]**	0.71	2.12	1.78
49	**Occipital - Dorsal fin space [ODS]**	0.20	0.72	1.37
50	**Prenasal length [PNL]**	0.11	0.87	1.26
51	**Prenasal barbel length [PNBL]**	0.26	1.43	1.59
52	**Nasal - Nasal barbel space [NNBS]**	0.18	1.17	1.22
53	**Nasal barbel - Orbital space [NBOS]**	0.32	1.97	1.77
54	**Nasal - Orbital space [NOS]**	0.40	1.96	1.81

Table 1 continues

	Morphometric Characters	Coefficient of difference between two species		
		C. albopunctatus vs. C. gariepinus	*C. albopunctatus vs. C. anguillaris*	*C. gariepinus vs. C. anguillaris*
1	**Standard length [STL]**	1.28	1.37	0.41
2	**Total length [TOL]**	1.40	1.42	0.41
3	**Predorsal length [PDL]**	1.58	1.59	0.44
4	**Prepectoral length [PPL]**	1.40	1.68	0.50
5	**Prepelvic length [PPeL]**	1.47	1.66	0.47
6	**Preanal length [PAL]**	1.54	1.55	0.42
7	**Preorbital length [POL]**	1.21	1.59	0.59
8	**Caudal peduncle length [CPL]**	0.75	1.04	0.63
9	**Head length [HEL]**	1.90	1.77	0.41
10	**Maximum head depth [MHD]**	1.11	1.32	0.44
11	**Maximum body depth [MBD]**	0.93	0.78	0.37
12	**Maximum caudal peduncle depth [MCPD]**	2.20	2.01	0.40
13	**Maximum head width [MHW]**	1.51	1.39	0.41
14	**Pelvic fin height [PeFH]**	1.73	1.65	0.43
15	**Pelvic fin base length [PeFBL]**	1.03	1.34	0.51
16	**Pectoral spine height [PSH]**	1.14	1.21	0.20
17	**Pectoral fin base length [PFBL]**	1.26	1.38	0.34
18	**Anal fin base length [AFBL]**	0.88	1.12	0.41
19	**Anal fin height [AFH]**	2.30	1.79	0.13
20	**Dorsal fin base length [DFBL]**	1.12	1.22	0.44
21	**Dorsal fin height [DFH]**	1.81	1.80	0.03
22	**Inner mandibular barbel length [IMBL]**	0.46	0.46	0.13
23	**Outer mandibular barbel length [OMBL]**	0.77	0.64	0.01
24	**Nasal barbel length [NBL]**	0.44	0.28	0.21
25	**Maxillary barbel length [MBL]**	0.85	0.51	0.13
26	**Inner mandibular barbel space [IMBS]**	0.88	1.42	0.58
27	**Outer mandibular barbel space [OMBS]**	1.28	1.60	0.49
28	**Nasal barbel space [NBS]**	1.31	1.74	0.65
29	**Maxillary barbel space [MBS]**	1.47	1.76	0.51
30	**Premaxillary teeth band width [PrTBW]**	1.81	2.18	0.80
31	**Premaxillary teeth band depth [PrTBD]**	0.83	1.25	0.60
32	**Vomerine teeth band width [VTBW]**	1.89	1.81	0.63
33	**Vomerine teeth band depth [VTBD]**	1.13	0.10	0.59
34	**Mouth width [MOW]**	1.85	2.18	0.46
35	**Eye diameter [EDIA]**	2.41	1.76	0.18
36	**Prefrontal fontennelle length [PFFL]**	1.45	1.66	0.52
37	**Frontal fontennelle length [FFL]**	2.46	2.37	0.25
38	**Frontal fontennelle width [FFW]**	1.50	1.22	0.25
39	**Preoccipital fontennelle length [POFL]**	1.83	1.75	0.49
40	**Occipital fontennelle length [OFL]**	1.37	0.37	0.78
41	**Occipital fontennelle width [OFW]**	0.87	0.01	0.68
42	**Frontal fontennelle - Occipital fontennelle space[FOS]**	0.90	1.13	0.36
43	**Internasal space [INS]**	1.38	1.83	0.61
44	**Interorbital space [IOS]**	1.53	1.61	0.45
45	**Maximum body width [MBW]**	1.52	1.34	0.37
46	**Caudal fin length [CFL]**	2.04	1.71	0.33
47	**Pectoral - Pelvic fin space [PPeS]**	1.45	1.56	0.36
48	**Pelvic - Anal fin space [PeAS]**	1.35	1.17	0.10
49	**Occipital - Dorsal fin space [ODS]**	0.55	1.21	0.61
50	**Prenasal length [PNL]**	0.85	1.26	0.56
51	**Prenasal barbel length [PNBL]**	1.36	1.55	0.65
52	**Nasal - Nasal barbel space [NNBS]**	1.01	1.12	0.44
53	**Nasal barbel - Orbital space [NBOS]**	1.65	1.72	0.47
54	**Nasal - Orbital space [NOS]**	1.62	1.59	0.42

Significantly different coefficients of difference are underlined.

maxillary barbel space, premaxillary teeth band depth, vomerine teeth band width, mouth width, eye diameter, prefrontal fontennelle length, frontal fontennelle length, preoccipital, fontennelle length, and frontal fontennelle-occipital fontennelle space. Furthermore other differentiating characters were internasal space, inter orbital space, maximum body width, caudal fin length, pectoral-pelvic fin space, pelvic-anal space, occipital-dorsal fin space, prenasal barbel length, nasal barbel-orbital space and nasal orbital space. Furthermore, considering the discriminating characters between *C. albopunctatus* and *C. gariepinus*, 90 % of *C. albopunctatus* differed from 90 % of *C. gariepinus* in 32 characters. The characters were standard length, total length, predorsal length, prepectoral length, prepelvic length, preanal length, head length, maximum caudal peduncle depth, maximum head width, pelvic fin base length, anal fin height, dorsal fin height, nasal barbel space, maxillary barbel space, premaxillary teeth band width, vomerine teeth band width, mouth width, eye diameter, prefrontal fontennelle length, frontal fontennelle length, frontal fontennelle width, preoccipital fontennelle length, occipital fontennelle length, internasal space, interorbital space, maximum body width, caudal fin length, pectoral-pelvic fin space, pelvic-anal fin space, prenasal barbel length, nasal barbel-orbital space and nasal-orbital space.

Thirty five characters discriminated 90 % of *C. albopunctatus* from 90 % of *C. anguillaris*. The characters were standard length, total length, predorsal length, prepectoral length, prepelvic length, preorbital length, caudal peduncle length, head length, maximum body depth, maximum caudal peduncle depth, maximum caudal peduncle depth, maximum head width, pelvic fin height, pelvic fin height, inner mandibular barbel space, outer mandibular barbel space, nasal barbel space, maxillary barbel space, premaxillary teeth band width, vomerine teeth band width, mouth width, eye diameter, prefrontal fontennelle length, frontal fontennelle length, preoccipital fontennelle length, internasal space, inter orbital space, maximum body width, caudal fin length, pectoral-pelvic fin space, prenasal barbel length, nasal barbel-orbital space and nasal-orbital space. Discriminating *C. gariepinus* from *C. anguillaris* based on the coefficient of difference was impossible for all the 54 characters assessed. The coefficient of differences among all clariids studies was almost identical in 10 characters namely: maximum body depth, pectoral spine height, anal fin base length, inner mandibular barbel length, outer mandibular barbel length, maxillary barbel length, premaxillary teeth band depth, vomerine teeth band depth, prenasal length and nasal-nasal barbel space.

DISCUSSION

Considering Mayr's coefficient of difference between two species, it was evidently clear that no differences existed between *C. ebriensis* and *C. albopunctatus* considering the 54 morphometric characters. This result is contrary to an earlier report, employing F-LSD, of 2 raw data, 9 ratio data and 6 not easily identified differences in morphometric characters among the clariids of Anambra river, Nigeria (Eyo, 2002a). The observed corresponding increased number of sex differentiating characters with *Clarias* definitive size may not be unconnected with variations in their respective growth rates (Eyo 2002 b). Furthermore, discriminating 90 % of *C. ebriensis* from *C. gariepinus*; *C. ebriensis* from *C. anguillaris*; *C. albopunctatus* from *C. gariepinus* and *C. albopunctatus* from C. *anguillaris* were possible utilizing the standard length, total length, prepelvic length, preanal length, head length, maximum caudal peduncle depth, maximum head width, pelvic fin height, anal fin height, dorsal fin height, maxillary barbel space, premaxillary teeth band width, vomerine teeth band width mouth width, prefrontal fontennelle length, frontal fontennelle space, maximum body width, caudal fin length, pectoral-pelvic fin space, prenasal barbel length, nasal barbel-orbital space and nasal-orbital space. None of these characters exhibited any difference among the clariids when F-SLD of raw, ratio and residual data was employed, except for the ratio data of dorsal fin height and residual of standard length (Eyo, 2002a). In fish taxonomy, the analytical tool employed, may pose biased elements that affect proper differentiation of species. Thus statistical tool with explicit taxonomic objective may become a major problem of the fish taxonomist and researcher, as different statistical tools offer different discriminating characters even when utilizing the same data. Previous workers on *Clarias* taxonomy did not pay attention to Mayr's coefficient of difference between species (Sydenham 1978, 1980, Sydenham and Olawoye1981; Teugels 1980, 1982 a, b, c; Ezenwaji 1986, 1989 and Teugels and Roberts

1987) as no mention of it was made, even though they had employed some of these characters. For instance, Sydenham (1978) in re-describing the specimens of six clariid species from West Africa employed such characters as standard length, total length, preanal length, maximum caudal peduncle depth, pelvic fin height anal fin height and dorsal fin height. These characters were subsequently employed by Ezenwaji (1986) and Teugels (1980, 1982 a, b, c.). These characters thus represent "key characters" for discriminating between the "small" and "large" clariids. From the above, it is clear that with regards to Mayr's coefficient of difference, *C. ebriensis* and *C. albopunctatus* as well as *C. gariepinus* and *C. anguillaris* may be sibling (cryptic) species. Lagler, *et al.* (1977) defined sibling species as those species that are morphologically indistinguishable or very similar but are shown to be fully differentiated by genetical, physiological, ecological or behavioral differences that often produced reproductive isolation.

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QUANTITATIVE PROTEIN AND FAT METABOLISM IN WEST AFRICAN DWARF SHEEP FED MARGARITARIA DISCOIDEA AS SUPPLEMENT

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ABSTRACT

Protein and energy utilization and quantitative retention of protein, fat and energy was investigated with twelve castrated Djallonke sheep averaging (20.0 ± 2.2kg BW) in nitrogen and energy balance trials. Dried leaves of Margaritaria discoidea were offered as supplement at two levels (25% (diet 2) and 50% (diet 3) of DMI), replacing hay in a basal hay diet. The basal hay diet without supplementation was the control. Measurements were performed by means of nitrogen and carbon balances with the use of indirect calorimetry. The digestibility of protein was not influenced by supplementation, while utilization of protein was influenced (P<0.05). Metabolisability of energy (ME/GE) was on the average 46.7 (SEM 1.6) % being not significantly (P>0.05) different between treatment. Diet 3 had a higher (P<0.05) total amount of energy retained in protein and fat (0.28 MJ/d) compared with the control diet. It was concluded that Margaritaria discoidea improved protein utilization and retention in Djallonke sheep.

Key words: Margaritaria discoidea, Protein, Energy, Fat utilization and retention, Sheep

INTRODUCTION

Multipurpose trees provide a cheap source of protein supplement during the dry season, when both the quantity and quality of pasture herbage is limited. They are becoming particularly important in more humid, agriculturally productive areas where the increasing human population has necessitated the cultivation of grazing land. These trees can be integrated into these high potential crop-livestock production systems as live fences, feed gardens, fodder banks, alley farms, wind breaks and multi-strata systems as sources of homegrown supplements for low-quality crop residues during dry season.

Inspite of considerable attention that has been focused on the use of multipurpose trees as feed supplement for small ruminant during dry season (Larbi *et al*., 1993; Osakwe *et al*., 1999; Rittner, 1992), less attention has been paid to the influence of anti-nutritional factors and in particular-condensed tannins on the quantitative protein, fat and energy metabolism. Few experiments with nitrogen and energy balances have been performed with poultry (Steenfeldt *et al*., 1998), pigs (Jorgensen, 1998) and sheep (Osakwe *et al*., 2000, 2003), but no results based on nitrogen and carbon balances with Djallonke sheep can be found in literature. Jackson and Barry (1996) reported that forages with low concentration of condensed tannins could improve the efficiency of nitrogen digestion.

The effect of condensed tannins in *Margaritaria discoidea*, on the utilization and retention of protein, fat and energy has been investigated in the present experiments with Djallonke sheep.

MATERIALS AND METHODS

Sample Collection: Leaves from mature *Margaritaria discoidea* (also called *Phyllanthus discoideus*), Family Euphorbiaceae from the humid/sub-humid zone of Cotonou (Benin) Republic were collected during the dry season, sun dried on a raised wooden platform at the experimental station of ”Direction de la Recheche Agronomique”, Cotonou. The dried leaf samples were then packed in plastic containers and transported to the University of Hohenheim, Germany for analysis and feeding trial.

Hay: The hay consisted primarily of cool-season grasses harvested in mid-October at the Hohenheim University. Grass species composition was predominantly redtop bend grass (*Agrotis stolonifers*). The experiment included twelve Djallonke castrated sheep (BW 20 kg) investigated in balance experiments including measurements of the gas exchange in a respiration chamber. *Margaritaria discoidea* leaves were offered as supplement at two levels (25% (diet 2) and 50% (diet 3) of DMI) replacing hay in the basal diet. The basal hay diet without supplement was used as the control diet.

Four animals each were randomly assigned to the control, diets 2 and 3 respectively. The animals were housed in individual metabolism crates and adapted for 10 days to the experimental diets. This was followed by a 7 days nitrogen balance trial during which feed, faeces and urine were collected daily. After the nitrogen balance trial, the animals were transferred to respiration chambers for another trial during which 24 hr measurement of gas exchange of carbon dioxide, methane and oxygen was carried out.

The gas exchange measurement was carried using an open circuit respiration system with four chambers. The chamber volume is 5,000 cubic litres, each is equipped with air conditioners that maintain a constant humidity of 60-70% (±2%) and a temperature of 20^{o}C (±0.3^{o}C) within the chambers. The animals were put in the chambers for 4x24 hr, for the measurement of their gas exchange and they received the experimental diet and water. About 35,000 litres/day of air is pumped in and out of each chamber. During a measuring period of 24 hr, aliquot sample of the spent/waste air is collected in gas receptors for the analysis of carbon dioxide, methane and oxygen. In addition the air intake was also analysed. The gas analysis was carried out under a standardized condition of 0 ^{o}C, 0 % humidity and 760 mm Hg. Carbon dioxide and methane were measured with Uras 10 using the principle of infrared-absorption-gas-analyser. Oxygen was measured with Magnos 2T using the principle of paramagnetic oxygen-analyser.

In addition to the experimental diet, animals received a mineral premix supplement (10 g/d). Feed was offered twice a day at 0800 and 1600 hr, and water provided *ad libitum.*

Analytical Methods: Feed samples were ground in a hammer mill to pass a 1mm mesh sieve for chemical analysis. Nitrogen content was determined by the Kjeldahl method and ash by burning at 550^{o}C (AOAC, 1990), Crude protein was calculated from N x 6.25. Neutral detergent fibre (NDF), Acid detergent fibre ((ADF), and Acid detergent lignin (ADL) were determined as described by Goering and Van Soest (1970). The difference between NDF and ADF was designated as hemicellulose, and between ADF and ADL as cellulose. Samples of faeces were dried at 65 ^{o}C for 48 h, ground through a 1 mm diameter screen and together with urine were analysed for N (AOAC, 1990). Gross energy of feed and faeces were measured by bomb calorimetry using benzoic acid as a standard (26437 J/g). Analyses of extractable condensed tannins were carried out by the method described by Markkar *et al*., (1993). Total extractable phenol and tannin phenol were analysed by the method described by Singleton and Rossi (1965). Carbon content in feed, faeces and urine was determined according to the principle of electric conductivity by means of a carmograph apparatus (Schiemann *et al*., 1971). Retention of protein (RP), fat (RF) and energy (RE) were calculated by means of carbon and nitrogen balances with the set of constants and factors described by Brouwer (1965): RP, g = Retained Nitrogen x 6.25; RF, g = (carbon balance – carbon in RP)/0.767; RE, kJ = RP, g x 23.86 + RF, g x 39.76.

Analysis of Variance (ANOVA) was used to analyse the data using the General Linear Modelling Procedure (SAS, 1985). Significant treatments were differentiated using Duncan's Multiple Range Test (Duncan, 1955).

RESULTS

The chemical composition and gross energy content of the experimental diets and *Margaritaria discoidea* is presented in Table 1. *Margaritaria discoidea* has a high CP (156 g/kg) and a relatively high GE content (19.3 kJ/kg DM).

Intake of metabolizable energy (ME), digestible protein (DP), digestibility and utilization of protein of sheep supplemented with *Margaritaria discoidea* are summarized in Table 2. The daily intake of ME was lowest in the control diet while intake of DP was lowest in diet 3, but the differences were not significant (P>0.05). The digestibility and utilization (RP/DP) of protein was measured in individual nitrogen balance experiments. The digestibility of protein was not influenced (P>0.05) by supplementation. The utilization of protein was strongly (P<0.05) influenced at the higher level

Table 1: Composition of experimental diets and *Margaritaria discoidea* (% of DM)[a]

Item	Control	Diet 2	Diet 3	*Margaritaria discoidea*
CP	11.5	12.6	13.6	15.6
Ash	9.3	8.8	8.3	7.4
Ether extract	1.5	2.3	3.0	4.6
Crude fibre	30.2	27.2	24.1	18.6
NFE	40.7	44.5	43.2	45.7
NDF	58.9	54.2	49.5	40.2
ADF	34.6	31.8	29.0	23.3
ADL	3.2	3.5	3.8	4.4
Cellulose	31.4	28.3	25.2	18.9
Hemicellulose	24.2	22.4	20.5	16.8
Total phenols [1]	-	1.6	2.13	4.52
Tannin phenol [1]	-	0.3	0.7	1.33
Condensed tannins [2]	n.a.	0.32	0.64	1.28
GE (kJg $^{-1}$ DM)	18.04	18.34	18.65	19.25
Mineral premix [3]	10.0	10.0	10.0	n.a.

[1]As tannic acid equivalent; [2]As leucocyanidin equivalent; n.a.: Not applicable; [3]Composition/kg: vit A 600,000 IU, vit D3 75,000 IU, vit E 300 mg, Zn 3,000 mg, Mn 480 mg, Co 12 mg, Se 10 mg. [a]The values in each column represent triplicate assays per sample

Table 2: Intake of ME, digestible protein, digestibility and protein utilization of sheep supplemented with *Margaritaria discoidea*

Item	Control	Diet 2	Diet 3	SEM
Metabolizable energy [MJ/d]	4.54	4.84	4.62	0.16
Digested protein (DP), (g/d)	46.4	47.1	38.4	2.91
Digestibility (%)	60.8	61.6	62.3	0.36
Utilization (RP/DP), %	23.3	12.7	38.5	3.4

Table 3: Effect of supplementation with *Margaritaria discoidea* on retained protein, fat and total amount of energy retained in protein and fat

Item	Control	Diet 2	Diet 3	SEM
Retained protein (g/d)	10.8	6.0	14.8	2.6
Retained fat (g/d)	-2.6	3.2	2.1	1.6
Energy retained in protein [MJ/d]	0.26	0.14	0.35	0.08
Energy retained in fat [MJ/d]	-0.1	0.13	0.08	0.03
Total Energy retained [MJ/d]	0.156	0.27	0.44	0.09

of supplementation. Supplementation of *Margaritaria discoidea* in diet 3 caused an increment ($P<0.05$) in RP of 4 g/d compared with the control.

The retention of fat (RF) was calculated from the carbon balances, and the mean values of RF and total amount of energy retained in protein and fat are shown in Table 3. The RF values were higher in the supplemented groups compared with the control that had a negative RF value. The metabolizability of energy (ME/GE) was on the average 46.7 (SEM 1.6) % being not significantly different ($P>0.05$) between treatments. The total amount of energy in retained protein and fat showed an increase ($P<0.05$) of 0.28 MJ/d in diet 3 compared with the control. As the ME intake varied with supplementation, the energy retained in protein and fat was compared with the ME intake (Fig. 1). The RE in relation to ME showed no difference ($P>0.05$) with supplementation.

DISCUSSION

Naturally occurring polyphenols, particularly condensed tannins inhibit utilization of protein and energy from multipurpose trees. In the present investigation, though the mean intake of DP was lowest in diet 3, while intake of ME was lowest in the control diet, the differences were not significant, indicating no depressive effect of

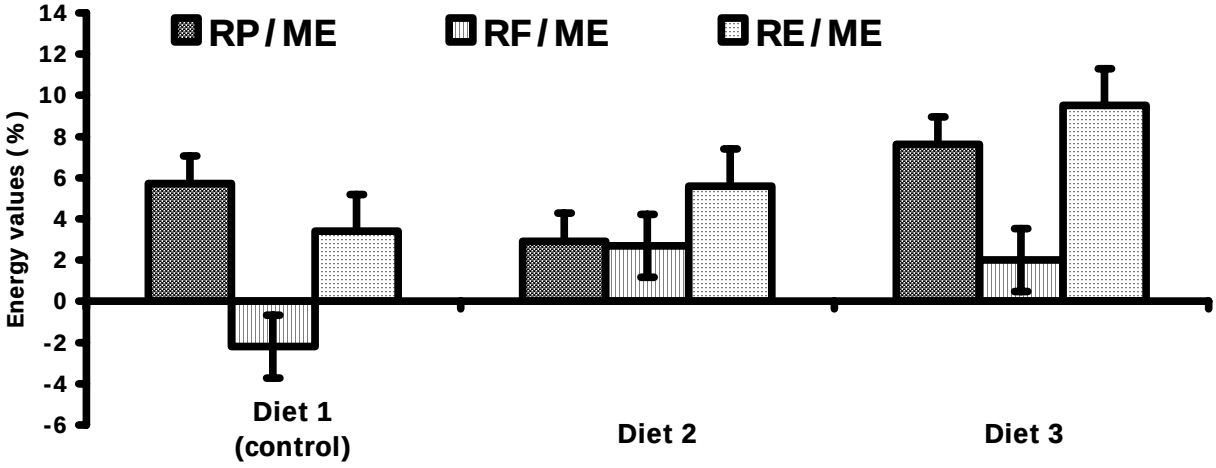

Figure 1: Energy retained in protein (RP), fat (RF) and total (RE) in relationship to ME intake of sheep.

condensed tannins on nutrient and energy consumption. In spite of similar protein digestibility between treatment groups, there were significant ($P<0.05$) differences in protein utilization with diet 3 having the highest value. Improved protein utilization has also been observed as a reduction of urinary nitrogen excretion (ILCA, 1988, Osakwe *et al.*, 2003, Rittner, 1987). It is interesting to note that the higher supplementation level improved utilization in diet 3, consequently, resulting in the highest protein retention in diet 3. On the average RP increased by 27% in diet 3 compared with the control animal. The improved protein utilization and retention in the present investigation is in agreement with the reports of Jackson and Barry (1996) that forages with low concentration of condensed tannin could improve the efficiency of nitrogen digestion. Waghorn*, et al* (1987) and Mangan (1988) reported the possibility of protein protection by condensed tannins leading to improved nitrogen utilization. The finding of this study is in agreement with their reports.

The present study showed that there were no differences ($P>0.05$) in protein digestibility but the utilization of protein was increased ($P<0.05$). Thus at higher level of supplementation, the animals were able to retain more protein in the body not by an increase in digestible protein (DP) but by the improved utilization of the absorbed protein, i.e. by using more protein for anabolism and less for oxidation (Chwalibog *et al*,. 1994). There were no differences in the total energy retention between the control and diet 2 animals, but a shift in energy retention from fat to protein. When comparing the control and diet 2 animals, it is difficult to answer whether the reduction of retained fat (RF) and energy retained (RE) was caused by changes in the intermediary metabolism or caused by the tendency for lower metabolisable energy (ME) intake in the control. However, when expressing energy retention in relation to ME the pattern was the same for absolute values.

CONCLUSION

In conclusion, these findings may indicate that increased protein retention is stimulated by lower concentration of condensed tannins than the reduction of fat retention. It would appear lower concentration of condensed tannins protected the feed protein and made it available at the hind gut where improvement in utilization was observed. The implication of this study to livestock farmers is that farmers engaged in ruminant production can utilize 25% to 50% of *Margaritaria discoidea* leaves as supplement to hay diet during dry season feeding.

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THE EFFECT OF FISH MOISTURE CONTENT ON OVIPOSITION, FECUNDITY AND DEVELOPMENT OF THE HIDE BEETLE, *Dermestes maculatus* DEGEER (COLEOPTERA: DERMESTIDAE)

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ABSTRACT

Oviposition, fecundity and development of Dermestes maculatus in Clarias ebriensis with different moisture contents (14%, 36%, 41%, 56%, 66%, 73%, 77%) were investigated from January to April, 2003. Catfish of different moisture content and a pair of male and female D. maculatus constituted a treatment and each of the seven treatments was replicated thrice. The treatment with fish of 14% moisture content served as the control. Generally, the pre-oviposition period, egg incubation period, oviposition peak, percentage number of eggs hatching to larvae, duration of larval emergence, larval developmental period and duration of pupal emergence were all moisture-dependent. At 29^0 C and 58% RH, fecundity ranged from 54-598 eggs. The eggs measured 3.38±0.44 mm in length. The larvae had five larval instars which measured 3.28±0.71, 6.06±0.82, 8.04±0.75, 10.83±0.97 and 13.0±0.29 mm in length respectively. Larval developmental period was 16-23 days and larvae fed voraciously and bored into the flesh and head capsule of fish. Pupae measured 7.65±0.29 mm in length and adults emerged from ≥ 50% of pupae in all treatments. Total developmental period was 59 days.

Key words: *Dermestes maculatus,* Oviposition, Fecundity, Development, *Clarias ebriensis,* Moisture content

INTRODUCTION

Traditionally cured fish are generally prone to infestation by a variety of beetle pests throughout storage, transportation and marketing. This often results in substantial loss of the economic value and quality of the cured fish. Daget (1966) reports that losses due to beetles may reach 25-30% of the 6000-9000 t per year of dried and smoked fish marketed in the regions of the Middle Niger and Chad basin in West Africa. Osuji (1985) estimates the loss at 30-50%. The major beetle pests responsible for this loss are *Necrobia rufipes* (DeGeer) and *Dermestes* species. At least seven *Dermestes* species – *D. maculatus* DeGeer, *D. ater* Kuster, *D. frischii* Kugelmann, *D. lardarius* Kuster, *D. haemorrhoidalis* Kuster, *D. carnivorous* Fabricius and *D. peruvianus* Laporte de Castelnau – infest cured fish in tropical developing countries (Johnson and Esser, 2000). The first four of these *Dermestes* species have been recorded in tropical Africa (Blatchford, 1962; Green, 1967; Proctor, 1972; Osuji, 1974a, 1975). Of these, *D. maculatus* is cosmopolitan and dominant in sub-saharan countries (Johnson & Esser, 2000).

In Nigeria, some information exist on the biology of *D. maculatus* (Taylor, 1964; Toye, 1970; Osuji 1974a, b, 1975). However, none of these workers considered the effect of different fish moisture contents on the developmental biology of the hide beetle. This paper investigates this and presents data on oviposition, fecundity and development of *D. maculatus* in *Clarias ebriensis* with different moisture contents.

MATERIALS AND METHOD

Adult *D. maculatus* were collected from infested fish bought from the Nsukka main market. The beetles were separated into males and females. The males were readily identified by the presence of a shallow pit with a tuft of erect, dense, golden-yellow hairs on their 4th abdominal sternite (Osuji, 1985).

A total of 42 adult *Clarias ebriensis* (185-222 g) were collected from the Adani fish market and randomly sorted into seven groups

of six catfish each. The six catfish in a group were arbitrarily dried either to moisture content of 14%, 36%, 41%, 56%, 66%, 73% or 77% using the hot-air oven method (AOAC, 1995). In this method, 5 g fish sample was weighed in a previously weighed clean and dry aluminium dish with a Mettler PC 2000. The fish in the aluminium dish was dried in an oven at 100^0 C for 24 h, and then cooled in a dessicator, and weighed. The percentage moisture content of the fish sample was calculated as: b-a/c-a x 100, where a= weight of empty aluminium dish, b= weight of aluminium dish and fish before drying, and c= weight of aluminium dish and fish after drying.

Adult males of *D. maculatus* were paired with adult females. Each pair was provided with two catfish either of 36%, 41%, 56%, 66%, 73% or 77% moisture content in a separate plastic plate and these served as treatment 1, 2, 3, 4, 5 or 6 respectively. The treatment with a pair (a male and a female) of the beetle and two fish of 14% moisture content served as the control. Free water was added by wet cotton wool in each plate because Dick (1937) and Taylor (1964) have shown that this enhances egg production and the period of oviposition. Each plastic plate was covered with mosquito plastic gauze held in place with a rubber band. The gauze facilitated the supply of oxygen to the beetles but prevented contamination with other pests. Each treatment was replicated thrice.

After copulation, the time it took the female in each replicate to start ovipositing, the oviposition period, the number of eggs laid, the number of eggs that died, the number that developed to larvae, the developmental period of the larvae, the number of pupae developing from the larvae and the number of adults emerging from the pupae were carefully recorded in all treatments. The lengths of the eggs, the larval instars and the pupae were measured with an ocular micrometer. The total developmental period of the beetle was recorded. Regression analyses of fish moisture content on peak oviposition, percentage dead eggs, egg incubation period, percentage of eggs hatching to larvae, duration of larval emergence, mean larval development period, percentage dead larvae, duration of pupal emergence, percentage dead pupae and percentage of eggs developing to adults were performed using the straight line curve, $Y = \alpha + \beta X$.

A mercury thermometer and a hygrometer fixed within the experimental laboratory were employed in determining the prevailing temperature and relative humidity conditions between January and April, 2003, which was the period of this study.

RESULTS

The mean temperature was 29.1 ± 0.73^0 C, whereas the mean relative humidity was 58.4±0.41 % throughout the experimental period. There was no significant difference in these climatic factors in the treatments ($P>0.05$).

Oviposition: The pre-oviposition period (that is, the number of days before egg laying) of the females in the control was longer than in the other treatments ($P<0.05$). All female *D. maculatus* in all treatments laid eggs. The females in treatment 6 started oviposition earlier than others, followed by treatment 5 (Table 1). Oviposition peaked on the ninth day in the control and significantly earlier in the other treatments. The correlation between peak oviposition and fish moisture content was strong ($r=0.76$) and significant ($P<0.05$). Oviposition period in the control was longer than in the other treatments in which the oviposition period fluctuated between 6 and 9 days (Table 1). This table also shows that the number of eggs laid by the females ranged from 54 to 598 depending on the fish moisture content. Thus, the number of eggs in treatment 6 was higher than the number in the other treatments ($P<0.05$). Generally, the number of eggs laid by the females increased as the fish moisture content increased.

Freshly laid eggs were white in colour and oval in shape, being bluntly pointed at both ends. The eggs were laid singly or in batches of 2-8; they measured 3.38±0.44 mm in length. More eggs died in treatment 6 than in the other treatments ($P<0.05$), and the correlation between percentage dead eggs and fish moisture content was fairly strong ($r = 0.62$). The incubation period (that is, the time it took the eggs to start hatching after oviposition) lasted from 3 to 5 days and was moisture-dependent ($r = 0.56$).

Larval Development: The percentage number of eggs hatching to larvae decreased as the fish moisture content increased ($r = 0.62$). A higher correlation existed ($r = 0.96$) in the inverse relationship between duration of emergence of the larvae and fish moisture content (Fig. 1). There were five larval instars. The first to the

Table 1: Developmental parameters of *D. maculatus* in different fish moisture levels

Treatments	Fish moisture contents (%)	Pre-oviposition period (days)	Oviposition period (days)	Number of eggs laid	Number of eggs hatching to larvae (%)	Number of larvae developing to pupae (%)	No. of pupae emerging as adult (%)
Control	14	12	20	54	43(79.63)	14(33.56)	10(71.43)
1	36	5	8	164	115(70.12)	29(25.22)	21(72.41)
2	41	6	7	59	39(66.10)	14(35.54)	12(85.71)
3	56	5	9	147	133(90.48)	22(16.54)	20(90.9)
4	66	5	6	97	73(75.26)	28(38.36)	14(50.0)
5	73	4	8	246	102(41.46)	28(27.45)	24(85.71)
6	77	3	8	598	120(20.07)	30(25.0)	20(66.07)

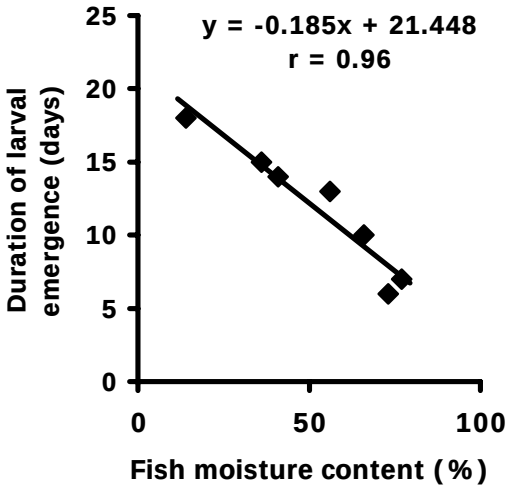

Figure 1: Duration of larval emergence in relation to fish moisture content

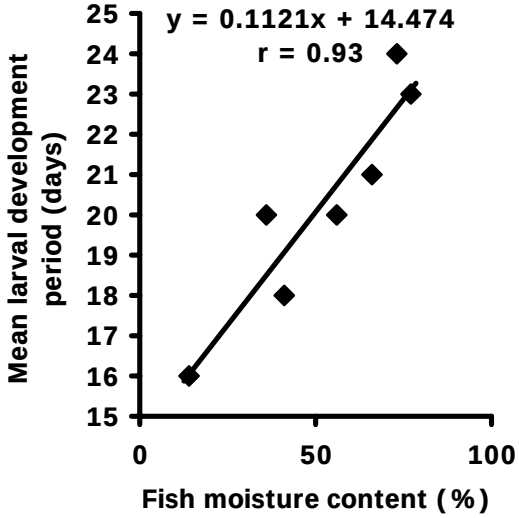

Figure 2: Mean larval development period in relation to fish moisture content

fifth instars measured 3.28±0.71 mm (range 2-4 mm), 6.06±0.82 mm (range 5-7 mm), 8.04±0.75 mm (range 7-9.5 mm), 10.83±0.97 mm (range 10-12 mm) and 13.0±0.29 mm (range 12.5 – 13.5 mm) in length respectively. Thus, the larvae grew bigger as they became older. The larvae bored into the fish flesh and head capsule and fed voraciously, reducing the fish to fragments and powder. The late instar larvae were found mostly in the head capsule. The mean larval developmental period increased with increase in fish moisture content and there was a very strong correlation between them (r = 0.93) (Fig.2). The mean larval developmental period lasted from 16 to 23 days. Over 61% of the larvae in each treatment died and, therefore, did not develop to the pupal stage, though virtually no correlation existed between the percentage dead larvae and fish moisture content (r = 0.23). The pre-pupa stage lasted 2-4 days. It was reached when the late instar larvae stopped all physical activities, such as feeding and movement.

Pupal Development: The percentage of pupae which emerged from the larvae in each treatment was remarkably low. It ranged from 17% in treatment 3 to 38% in treatment 4, though no definite pattern was discerned (Table 1). A strong positive correlation (r = 0.86) existed in the inverse relationship between the time it took all the pupae to emerge and fish moisture content (Fig. 3). The pupae were white in colour and measured 7.65±0.79 mm (range 7-8.6 mm) in length. The percentage dead pupae fluctuated without any definite pattern and showed a total lack of correlation (r = 0.09) with the fish moisture content.

Adult: Between 50 and 91% of adults emerged from the pupae in all treatments (Table 1). The newly hatched adult, often found in the head capsule, had reddish-brown head and yellowish-

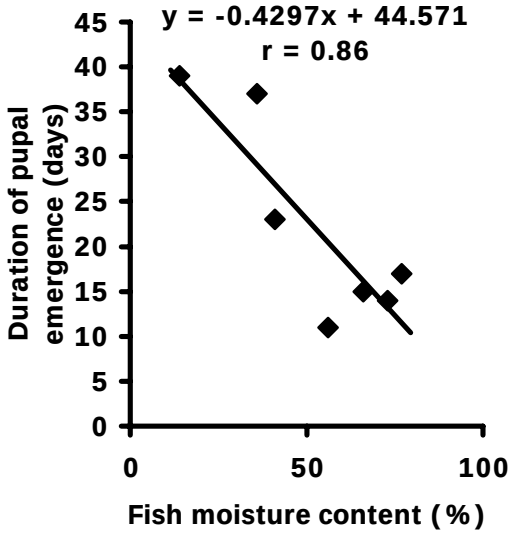

Figure 3: Duration of pupal emergence in relation to fish moisture content

brown elytra, which later became black. The abdomen was white in colour. There was moderate correlation (r = 0.77) in the inverse relationship between percentage eggs which developed to adult and the fish moisture content.

DISCUSSION

The longer pre-oviposition and oviposition periods of *D. maculatus* females in the control are attributed to the low fish moisture content (14%). This level of fish moisture seems to prohibit oviposition by the beetle and probably explains why 'banda', made up of cut pieces of mainly *Clarias* species, is charred and dried to moisture content of 15% before storage (Osuji, 1977). To provide a better condition for egg laying, the fish in the control absorbed moisture from the free water in the plate which then enabled it to became gradually more conducive for egg deposition. This process was undoubtedly accomplished over a period of time, hence the longer oviposition period and the fewer number of eggs (54) laid. Our preliminary investigation before the start of this study showed that dipterans, particularly blow flies, found very high levels of fish moisture content extremely suitable for egg deposition, as also do *D. maculatus* females of this study, which laid very high numbers of eggs on fish with moisture content of 73% and 77%. However, the vast majority of the eggs laid at these high fish moisture levels died resulting in the low percentage ($\leq$ 42%) number of eggs hatching to larvae as against the high percentage ($\geq$ 66%) observed at the other fish moisture levels, which had fewer eggs (Table 1). It is probably this observation that led Osuji (1977) and Johnson and Esser (2000) to assert that fish with moisture content of 32-47% are very suitable for infestation with dermestid eggs.

The fecundity of female *D. maculatus* (54-598 eggs), though extremely variable, compares favourably with that reported for dermestids by Kreyenberg (1928, 198 – 845 eggs), Taylor (1964, 160 eggs), Osuji (1985, 250 eggs) and Michael (2000, 318 eggs). The lower limit of 54 eggs recorded in the control is the lowest dermestid fecundity so far reported. It appears that the eggs laid on the fish with lower moisture content (14-66%) at the warm, dry period of January to April were very viable such that a higher percentage of them survived to adult life. This is consistent with Osuji (1974a,b), Proctor (1977) and Barwal and Devi (1993) who have shown acceleration of development in dermestids during the warm, dry season, given fish with the right moisture level and high lipid content. *C. ebriensis*, as well as other *Clarias* species, has high lipid level of $\geq$ 16.4% (Osuji, 1974b; Ezenwaji, 1989) and this nutritional requirement makes the clariid good substrate for the rapid development of *D. maculatus.* That this is indeed so is collaborated by the short larval developmental stages and period reported here. The larval stages (5 instars) are short, falling into the lower limit reported by Osuji (1975, 1985, 5 - 7 instars) but contrasting with Taylor (1964, 6 - 10 instars) and Michael (2000, 7 - 9 instars). Similarly, the larval developmental period of 16-23 days is considerably less than those reported by these workers (Taylor, 1964, 39 – 46 days; Osuji, 1975, 33.5 days; Michael, 2000, 50 days). The temperature (29^0C) and relative humidity (58%) which prevailed during the warm, dry period also appear to be optimum for dermestid development.

An overview shows that female *D. maculatus* is able to lay eggs on fish with varying moisture levels (14-77%). The eggs at the lower moisture levels (14-66%) survive much better than the eggs laid at higher fish moisture levels. Low moisture levels, the nutritional status of *C. ebriensis* and the climatic conditions enable acceleration of the development of *D. maculatus* in *C. ebriensis*. It may be in this way that high numbers of *D. maculatus* are maintained in dry *Clarias* species marketed in Nigeria resulting in high quality and economic losses.

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EFFECT OF ACTELLIC 25 EC ON THE DIFFERENTIAL LEUCOCYTE COUNTS OF THE CATFISH *Clarias albopunctatus* (NICHOLE & LAMONTE, 1953)

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ABSTRACT

The changes in the total and differential leucocyte count in the fish Clarias albopunctatus exposed to sublethal concentrations of actellic 25 EC (0, 0.3, 0.5, 0.8 and 1.0 μg/l) were studied for 18 days in a static renewal bioassay system. Compared with the control, there was significant leucocytosis (P<0.05) in the actellic -exposed fish. The total leucocyte counts also differed significantly (P <0.05) in the treatment groups. The lymphocytes were the dominant leucocyte subgroup in the blood of the fish. There was significant lymphocytosis in the actellic 25 EC-exposed fish. Decreased eosinophils, monocytopenia and neutropenia were evident in the treatment groups. These observations are indications of the mobilization of the body's defense system due to Actellic25 challenge leading to leucopoiesis.

Key words: Actellic, *Clarias*, Stress, Leucocyte, Differential count

INTRODUCTION

The application of pesticides either to boost food production or in the control of pests, results in environmental contamination especially in the developing countries. These chemicals eventually get to the aquatic habitats either as run-off or directly during aerial spray or while washing of the containers. This would result in changes in the physico-chemical qualities of the water body with attendant effects on the physiological and indeed the health of faunal populations living therein.

The response of the leucocytes to the changes in water quality and chemicals is variable (Nussay et al., 1995; Srivastava and Narain, 1982; Ezzat, *et al.,* 1974). Lecucocytosis was reported in some fish species exposed to pesticides (Mathiessien, 1981; Srivastava and Narain, 1982; Santhakumar *et al.,* 1999; Mgbenka *et al.,* 2003). Oluah and Nwosu (2003) also reported increased leucocyte count in *C. albopunctatus* chronically exposed to Brewery effluent. Leucocytopenia however, was reported in Coho salmon exposed to Kraft pulp mill effluent (Mcleay, 1975). Lymphocytosis accompanied by neutropenia was reported in *Anguilla anguilla* (Krutzmann, 1979) treated with drugs. Neutropenia was also reported in channel catfish during hypoxia (Scott and Rogers, 1981). On the contrary, neurophilia was observed in fish during bacterial infection (Hines and Spira, 1973) and stress (Slicher, 1961).

In recent times, there is increasing interest on the effect of heavy metals and chemicals and or / harmful substances on the haematology of *Clarias* species on the account of their socio-economic importance in the fish food supply in Nigeria.

This study represents part of our continuing contribution to the physio-ecology of the Clariid fishes. The purpose of the study was to investigate the effect of sublethal concentrations of actellic 25 on the leucocyte and differential white blood cell count of the fish *C. albopunctatus.*

MATERIALS AND METHOD

The fish samples were caught from Anambra River Nigeria, using local traps. The fish were transported to the laboratory in a plastic container and thereafter acclimatized for 14 days at water temperature of 28 ^{o}C. The 150 fish (66.3 $\pm$ 2.48 g mean weight) used in the study were randomly divided into five groups of 30 fish each. Each

group was further randomized into three replicates experiments of 10 fish per replicate. The fish in group 1 and 2 were exposed to 0.3 and 0.5 μg/l actellic, respectively. The fish in groups 3 and 4 were exposed to 0.8 and 1.0 μg/l actellic, respectively. The fish in the fifth group which served as the control was exposed to tap water only. The experiment lasted for 18 days in a static bioassay system. The water and the pesticide were changed every 24 hour to maintain constant concentration and avoid the accumulation of waste metabolites and food remains. The feeding regime and blood collection methods were as described by Oluah and Nwosu (2003).The leucocyte count was made using improved Neubauer haemocytometer after diluting the blood 1:100 with Shaw's solution (Shaw, 1930).

The results were analyzed using one way analysis of variance (ANOVA) followed by F-LSD post hoc test. The significance level was taken as $P < 0.05$.

RESULT

The effects of Actellic 25 EC on the total leucocyte and differential white blood cell counts of the fish *C. albopunctatus* are shown in Tables 1, 2, 3 and 4. The result showed that the total leucocyte in the treatment groups were significantly higher ($P < 0.05$) than the control. Also the leucocyte counts in the treatment groups were significantly different ($P < 0.05$).

The result also showed that the lymphocytes, neutrophils, monocytes, eosinophils and the basophils were the recognizable types of white blood cells found in the peripheral blood of *C. albopunctatus*. These were classified as granulocytes or agranulocytes, depending on the presence or absence of granules in their cytoplasm. The lymphocytes are the most dominant leucocyte type in the blood of *C. albopunctatus*. In the control, the leucocytes were significantly higher ($P<0.05$) when compared with the treated groups. Lymphocytosis occurred with increased duration of exposure. The monocytes, which are round cells with oval nuclei with clumped chromatin, are the second agranulocytes in the blood. When compared with the control, there was significant decrease ($P<0.05$) in the monocytes in the Actellic-exposed fish. Monocytopenia occurred with increasing duration of exposure.

The neutrophil, eosinophils and basophils were the granulocytes in the blood of *C. albopunctatus*. The neutrophils were significantly reduced in the treated groups ($P < 0.05$) when compared with the control. The neutrophil was the dominant granulocyte in the fish *C. albopunctatus.* Neutropenia was most pronounced in the fish exposed to 1.0μg/l actellic 25 EC. The second most numerous granulocytes was the eosinophils which decreased significantly ($P < 0.05$) in the treatment group when compared with the control. The eosinophils also decreased with exposure time to Actellic. The least abundant granulocyte in the peripheral blood of *C. albopunctatus* was the basophils.

DISCUSSION

The result of the study showed that Actellic 25 EC had significant effect on the leucocyte and differential white blood cell count in *C. albopunctatus.* According to Nussey *et al.,* (1995), the sustained leucocytosis in the actellic 25 exposed fish represented a physiological response to infection. Earlier studies had demonstrated that leucocytosis was observed in fish subjected to pollution by insecticides (Mathiessien, 1981); Van Vuren, 1986; Santhakumar *et al.,* 1999; Mgbenka et al., 2003), heavy metals (Misha and Srivastava, 1980; Dick and Dixon 1985, Nussey *et al.,* 1995; Oluah, 2001) and Brewery effluent (Oluah and Nwosu, 2003). The increase in the proportion of lymphocytes in the *C. albopunctatus* exposed to actellic agreed with the earlier work of Mgbenka *et al.,* (2003) in the same species exposed to gammalin 20. Srivastava and Narain (1982) also reported increased lymphocyte number in H*eteropneustes fossillis* treated with endrin and nuvacron. Similarly, lymphocytosis was reported in *Ictalurus punctatus* subjected to hypoxia (Grizzle and Rogers, 1976; Scoot and Rogers, 1981). On the other hand, leucocytopenia was reported in Coho salmon treated with kraft pulp mill effluent (McLeay, 1975).

The decreased number of monocytes and neutrpophils in *C. albopunctatus* with exposure to actellic 25 EC and duration agreed with the report of Nussey et al., (1995) on *Oreochromis mossambicus* treated with Copper. Monocytopenia and neutropenia have been reported in *C. albopunctatus* exposed to gammalin 20 (Mgbenka *et al.,* 2003) and brewery effluents

Table1: The mean total and differential leucocyte count *C. albopunctatus* exposed to 0.3 μg/l actellic

Types of leucocytes (%)	*Exposure Period (days)*			
	Control	**6**	**12**	**18**
Agranulocytes(%)				
Lymphocytes	60.50 ± 1.69	64.50 ± 1.38	72.50 ± 1.04	71.00 ± 1.64
Monocytes	13.50 ± 0.82	12.50 ± 0.62	11.50 ± 0.39	9.50 ± 1.03
Granulocytes				
Neutrophils	22.0 ± 1.74	17.5 ± 1.09	16.00 ± 1.17	18.50 ± 1.42
Eosinophils	4.0 ± 0.08	4.0 ± 0.10	_	1.00 ± 0.01
Basophils	_	1.50 ± 0.52	_	_
Total leucocyte	**4.70 ± 1.80**	**11.70 ± 1.75**	**20.5 ± 1.46**	**54.84 ± 1.51**

Table 2: The mean total and differential white blood cell count in *C. albopunctatus* exposed to 0.5 μg/l actellic

Typesofleucocyte(%)	*Duration of Exposure (days)*			
	Control	**6**	**12**	**18**
Agranmcocytes				
Lymphocytes	60.50 ± 1.69	65.0 ± 1.48	81.0 ± 1.92	80.5 ± 1.86
Monocyte	13.50 ± 0.82	16.0 ± 0.66	3.5 ± 0.11	3.5 ± 0.02
Granulocyte				
Neutrophil	22.0 ±1.74	18.0 ± 1.20	15.5 ± 1.09	16.0 ± 1.40
Eosinophils	4.0 ± 0.08	1.0 ± 0.02	-	-
Basophil	-	1.0 ± 0.01	-	-
Total WBC	**4.70 ±1.80**	**15.05 ± 1.03**	**27.60 ± 1.26**	**25.00 ± 1.58**

(*Values are means of 5 determinations*)

Table 3: The mean total and differential white blood cell counts in *C. albopunctatus* exposed to 0.8 μg/l actellic

Leucocyte type	*Duration of Exposed (days)*			
	Control	**6**	**12**	**18**
Agrannulocyte				
Lymphocytes	60.5 ± 1.69	67.0 ± 1.88	82.5 ± 1.56	83.0 ± 1.09
Monocytes	13.50 ± 0.82	15.0 ± 1.06	4.0 ± 0.12	_
Grannulocytes				
Neutrophil	22.0 ± 1.74	17.0 ± 1.09	13.0 ± 1.11	16.0 ± 1.20
Eosinophil	4.0 ± 0.08	_	0.5 ± 0.04	_
Basophil	_	1.0 ± 0.01	_	0.5 ± 0.03
Total leucocyte	**4.10 ± 1.80**	**20.65 ± 1.30**	**32.6 ± 1.74**	**39.9 ± 1.83**

(*Values are means of 5 determinations*)

Table 4: The mean total and differential white blood cell counts in *C. albopunctatus* exposed to 1.0 μg/l

Leucocyte types (%)	*Duration of Exposed (days)*			
	Control	**6**	**12**	**18**
Agrannulocytes				
Lymphocytes	65.5 ± 1.69	72.0 ± 1.98	94.5 ± 1.36	85.00 ± 1.55
Monocytes	13.5 ± 0.82	10.5 ± 0.76	3.0 ± 0.08	_
Grannulocytes				
Neutrophil	22.0 ± 1.74	17.0 ± 1.18	12.0 ± 0.84	10.0 ± 0.66
Eosinophil	4.0 ± 0.08	_	_	0.50 ± 01
Basophil	_	_	_	_
Total leucocyte	**470 ± 1.80**	**31.45 ± 1.19**	**39.70 ± 1.24**	**39.8 ± 1.60**

(*Values are means of 5 determinations*)

(Oluah and Nwosu, 2003). Neutropenia was also reported in *Barbus conchonius* exposed to mercury (Gill and Pant, 1985) as well as in *Pleuronectes flascens* treated with cadmium (Johansen-Sjobeck and Larsson, 1978). Kreutzmann (1977) also observed neutropenia in *Anguilla anguilla* treated with drugs.

On the other hand, neutrophilia was reported in rainbow trout after the administration of adjuvant (Finn and Nielson, 1971) and in *Cyripinus carpio* due to *Ichthyophthirius multifilis* infection (Hines and Spira, 1973). Slicher (1961) also reported neutrophilia in stressed fish.

In this study, the basophil was the least abundant (1 %) leucocytes in *C. albopunctatus*. This agreed with report of Ward (1969) that the basophils constitute about 1% of the leucocytes in the lungfish *Neoceratodus forsteri*. Also, the review by Ellis (1977) showed that the basophils are very few or even absent in some fishes. In conclusion, the observed leucocytosis, hymphocytosis, monocytopenia, and neutropenia are indications of stress and concomitant infection in *C. albopunctatus* exposed to sublethal actellic 25 EC concentrations. With standardization, information on the changes in the white blood cell types in fish could be applied as a diagnostic tool in Ichytho-toxicological monitoring and assessment of aquatic pollution.

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COMMUNITY PARTICIPATION IN THE CONTROL OF PARASITIC DISEASES: THE CASE OF UZO-UWANI LOCAL GOVERNMENT AREA

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ABSTRACT

A study on the epidemiology and effects of human onchocerciasis on productivity and social lives of rural communities in Uzo-Uwani Local Government Area of Enugu State was carried out between 1998 and 2000. The objectives of the study were to assess the level of endemicity of onchocerciasis in the 16 communities that make up the local government area and to ascertain the effects of the disease on the pattern of social interactions and the age of marriage of the infected individuals. The work also involved the local disease perception and treatment of the disease in the area and histopathological studies of the Onchocerca nodules. In the course of the studies, interviews were conducted for individuals and various groups in the communities including the Community Directed Distributors (CDDs) of ivermectin in the area. During these interactions, a number of problems that beset the control of onchocerciasis in the area became obvious. This paper reports on the community participation in the control of the disease, the problems encountered by these rural people in their efforts (which include lack of funds, late arrival of drugs, transportation and communication problems) and makes recommendations on how to overcome some of these problems.

Key words: Epidemiology, onchocerciasis, productivity, Community Directed Distributors, Control.

INTRODUCTION

Control of onchocerciasis had depended largely on the control of vectors by means of insecticides. These are used against *Simulium* larvae in the watercourses where they breed. However, reinvasion of the controlled areas by blackflies from neighbouring and adjoining uncontrolled regions usually occurs (Nwoke, 1992). Ideally, such measures should be reinforced with an attack on the parasite in man by means of nodulectomy or chemotherapy (Duke, 1972). Widespread larvicide applications result in a substantial drop in prevalence over most of the control area but the incidence of the infection in children remains high despite the low vector densities brought about by control. This can be attributed to the migratory reinvasion potential of savanna cytospecies of the *S. damnosum* complex (Garms *et al.,* 1979).

In Nigeria, the strategies and goals for control of onchocerciasis include a combination of health education, large-scale chemotherapy with ivermectin in communities where the prevalence of skin microfilariae is 30 % and above. Large-scale treatment with ivermectin has been given priority because of

1. the proven efficacy and safety
2. the small dosage required (a maximum of two tablets once or twice a year),
3. the convenience of its oral administration
4. its ability to bring about a dramatic reduction in the skin microfilarial load and potentially to reduce the morbidity and
5. the additional benefit of expelling many intestinal worms from persons who are treated for onchocerciasis
6. the fact that the donations of the drugs by the manufacturer- Merck, Sharp and Dohme (MSD) are free
7. the ease with which its distribution can be integrated into the existing high priority Primary Health Care (PHC) programme and
8. the commitment that the distribution, coverage and acceptance will be sustained long enough to reduce onchocerciasis to a level at which it is hoped that the disease will no longer be an important public health problem (Edungbola, 1991).

Onchocerciasis has constituted a major public health problem and an obstacle to socio-economic development in the endemic communities. In West Africa, a control programme was initiated in 1974 and is commonly called Onchocerciasis Control Programme (OCP). It is a joint programme sponsored by World Health Organization (WHO), World Bank, United Nations Development Programme (UNDP) and Food and Agricultural Organization (FAO) with WHO as executing agent. The OCP controls the disease in 11 nations in West Africa, which cover a total

area of 1.3 million km^2. The programme is designed to benefit over 15 million rural West Africans (Nwoke, 1992). The disease has been eliminated as a public health problem from the OCP countries through extensive insecticide spraying of the exposed vector breeding sites in the region, mostly from helicopters. Remme *et al.* (1990) reported that after 12-14 years of vector control, the community microfilarial load (CMFL) was close to zero in all villages they surveyed. Today, some 1.5 million people who were once infected no longer have any trace of the disease. About 10 million children born in the operational area since the programme began are now free of any risk of contracting the disease. Dadzie *et al.* (1990) reported a reduction of the incidence of onchocercal blindness by 40% resulting in lack of onchocercal blindness in children below the age of 20 years. To complement vector control activities, the drug ivermectin is distributed free of charge to more than 2.2 million people in the operational area (De Sole and Remme, 1991; WHO, 1996). Since the WHO Onchocerciasis Control Programme was launched in 1974 in West Africa, more than 1.7 million additional years of productive labour have become available as a result of control measures. An additional 25 million hectares of usable land could be made available for agricultural production. This could feed 17 million more people (WHO, 1996).

A programme to eliminate onchocerciasis as a public health problem in the Americas is being coordinated by the Pan American Health Organization with the support of non-governmental development organizations (NGDO) and the Inter-American Development Bank (IADB). Concerted efforts had been made to control the disease in areas where it is endemic through co-ordination of ivermectin distribution activities. However, a conference held in 1991 resulted in the launching of a regional onchocerciasis elimination programme (Onchocerciasis Eradication Programme of the Americas, OEPA) to reduce morbidity through the mass distribution of ivermectin in Brazil, Colombia, Ecuador, Guatemala, Mexico and Venezuela (WHO, 1996; Etya'ale, 1998).

WHO in 1995 launched a new programme - the African Programme for Onchocerciasis Control (APOC) - in close co-operation with the World Bank, the governments of 16 participating countries where the disease exists but which were not covered by the earlier programme, donors and non-governmental development organizations (NGDO) (WHO, 1996; Benton, 1998). This new programme, which became operational in January 1996, aims to control and eventually eliminate the disease as a public health hazard from the entire African continent by the year 2002. APOC will directly benefit more than 15 million people infected with onchocerciasis and nearly 100 million people estimated to be at risk in these 16 participating countries (WHO, 1996). Fortunately, Nigeria is one of the beneficiaries of this programme and Uzo-Uwani Local Government Area happens to be one of the endemic areas benefitting from the programme

MATERIALS AND METHODS

The Study Area and Population: The study area was Uzo-Uwani Local Government Area of Enugu State, Nigeria. It consists of 16 communities divided into four health districts namely:

1. Umulokpa district consisting of Umulokpa (local government headquarters), Nkume, Adaba and Ukpata
2. Nkpologu district made up of Nkpologu, Uvuru and Akpugo
3. Ogboli district consisting of Adani, Asaba, Igga, Ojjor and Ogurugu
4. Nimbo district comprising Nimbo, Abbi, Ugbene-Ajima, and Nrobo.

Uzo-Uwani Local Government Area lies between longitude 6^0 $30^/$ and 7^0 $00^/$ East and between latitude $6^0 55^/$ and 7^0 $15^/$ North. It belongs to the forest-savanna-mosaic vegetation zone of Nigeria (Crosskey, 1981). The vegetation is a mixture of tall grasses and shrubs with few tall trees. This local government area is generally not hilly when compared with the neighbouring Nsukka, Igbo Etiti and Udi Local Government Areas of Enugu State. Uzo-Uwani Local Government Area, like other parts of Enugu State, has in general 7 months of rainy season (April to October) with a break around July/August and 5 months of dry season (November to March) with harmattan occurring sometime within the dry season months. The weather is usually hot during the dry season especially in Ogboli district. Uzo-Uwani Local Government Area is traversed by many rivers and streams. These include River Adada , River Obina, River Duu, River Eshi and Anambra River in addition to many streams. These rivers and streams belong to the Anambra River System, which had been identified by Crosskey (Crosskey, 1981) as part of the breeding sites for *Simulium damnosum* (blackfly) in Eastern Nigeria.

Most of these rivers are clean, rapidly flowing and with resistant rocks in the river beds at some points while others have been dammed at some points for agricultural purposes. These conditions encourage the breeding of *Simulium damnosum* in these rivers. Most of the rivers are perennial and this makes them suitable for *Simulium* breeding all year round.

The communities within Uzo-Uwani Local Government Area are mostly connected by minor roads while the area is joined to neighbouring local government areas by secondary roads. Road transportation is the major transport system within and out of this area. Majority (about 90%) of the communities in this local government area do not have pipe-borne water and electricity. Each community, however, has a health centre and/or health post. The larger communities like Adani, Umulokpa, Nkpologu, Nimbo, have private hospitals in addition.

The inhabitants of all the communities that make up this local government area engage in agriculture as their major economic activity. Most farmers in Ogboli district cultivate mainly rice and the establishment of Adarice Project by the government in this district is an encouragement to rice cultivation. Some people, in addition to farming, engage in fishing and hunting activities.

Methods of Data Collection: The data was collected using two methods namely questionnaire and interview methods. Structured and pre-tested questionnaire was used to collect information from the secondary school students while group interviews using the questionnaire as a guide were conducted for the primary school children and adults members of the different communities.

Methods of Data Analysis: The information obtained using the questionnaires were coded and analysed using percentages. For the interviews, the most popular opinion on any question was taken to represent the opinion of the community.

RESULTS AND DISCUSSION

Out of the 16 communities interacted with; all (100%) agreed that there was a drug distributed in their communities. This knowledge spanned through all the segments of the different communities primary school pupils, secondary school students and adult members. However, they did not know the name of drug and disease for which it was distributed. All the communities, especially the adult members accepted that nodules were common and the common curative measure was removal of the nodules (nodulectomy).

Interviews with the adult members of the communities also showed that some communities refused to take ivermectin due to reasons discussed later. Also, community participation in drug distribution was beset with a number of problems discussed below.

Areas of Community Participation in the Control of Onchocerciasis in the area

1. Drug distribution: At the time of the study, ivermectin distribution was on in Uzo-Uwani Local Government Area. The person in charge of the distribution at the Public Health Care unit of the Ministry of Health reported that the Community Distributors usually came to collect the drugs for their communities from the headquarters. These distributors were supposed to be sponsored by their communities to cover at least their transportation costs because some of the communities were as far as 50 km from the headquarters. In this effort, therefore, the members of the communities were involved in the disease control.

2. Nodulectomy: Nodulectomy was found to be a very common and accepted treatment method in the whole of Uzo-Uwani Local Government Area. Each community had local excisors who removed the nodules from infected individuals. In addition, health centre superintendents also removed nodules. For example, in Ukpata, where nodules were collected for histopathological studies, the researcher sponsored nodulectomy for 34 patients, the excision was done by the superintendent of the health centre (Ubachukwu, 2001a).

Problems Encountered by the Communities in Their Control Efforts

1. Lack of funds: The community directed distributors interviewed in three of the communities (Ukpata, Adaba and Nkpologu) reported that lack of funds hindered them from their duty of drug distribution. According to

them, their communities did not continue to sponsor their transportation to collect drugs from the headquarters and consequently, some of them got discouraged and stopped the collection. Some of them resorted to charging a token amount to anybody that would like to collect the drug. The members of some communities stopped taking the drugs because they could not afford to pay for them.

2. Late arrival of drugs: One of the problems reported at the headquarters was late arrival of ivermectin. This resulted in delays in delivering the drugs to the community distributors.

3. Communication problems: There was no regular means of communication between the community distributors and the headquarters. Consequently, there was need to continue checking the headquarters from time to time until the drug arrived. As a result of the transportation costs, some got frustrated and stopped further efforts.

4. Transportation problems: Many of the communities are far from the local government headquarters and there are no good roads and no regular means of transport. Many transporters ply Umulokpa (the headquarters) only on their market days. Consequently, it was not easy for the distributors to easily check for drugs in the absence of adequate communication.

5. Ignorance: Most people interviewed in all the communities knew that a drug was distributed to them but did not know the disease for which the drug was distributed. They did not also know all the rules guiding the taking of the drug. In two communities, Adaba and Nkpologu, they recorded one and two deaths respectively after taking the drug. This discouraged many from taking the drug. In one community, Uvuru, there was propaganda against the use of the drug. The allegation was that there was an attempt to reduce their population using the drug.

Recommendations on How to Overcome Some of the Problems

Major recommendations to be made from the results of the studies are shown in Figure 1. These include:

1. Strengthening the ivermectin distribution programme: Since 1996, WHO under the African programme for Onchocerciasis Control in collaboration with the Federal Ministry of Health and non-governmental development Organizations (NGDO) has been undertaking free distribution of ivermectin in Uzo-Uwani Local Government Area. There is need to make the distribution more effective by supplying enough drugs to the area and monitoring its distribution to the various communities. Also, a more effective training of the Community Directed Distributors (CDDs) selected from the individual communities for the drug distribution is required. Cost recovery as reported by Amazigo *et al.* (1998) and Hopkins (1998) is one of the ways of sustaining the distribution of Mectizan in the rural areas. This involves payment of a token fee by every family that receives Mectizan treatment. In a report by the WHO/APOC Community Directed Treatment with Ivermectin (CDTI) Project Evaluation Team in Ekiti State (Akogu *et al.*, 2003), they recommended better planning, monitoring and supervision, training, integration of activities, proper funding and provision of transport both at the state and local government levels to ensure effective distribution of ivermectin.

2. Nodulectomy: Nodulectomy (nodule excision) is a common and generally accepted treatment procedure in Uzo-Uwani Local Government Area. From interactions with the people of the area, they are willing to remove the nodules. Their only hindrance is the cost of the removal (Ubachukwu, 2001a). In the health centres and health posts, the personnel to do the removal are available but the materials to use are not readily available. The people with nodules are expected to provide these materials and many of the people cannot afford them. They, therefore, either go to quacks for the removal or leave the nodules. It is recommended that nodulectomy be sponsored in these communities in addition to the on-going drug distribution. The Ministry of Health should provide these materials to the health personnel in the affected communities.

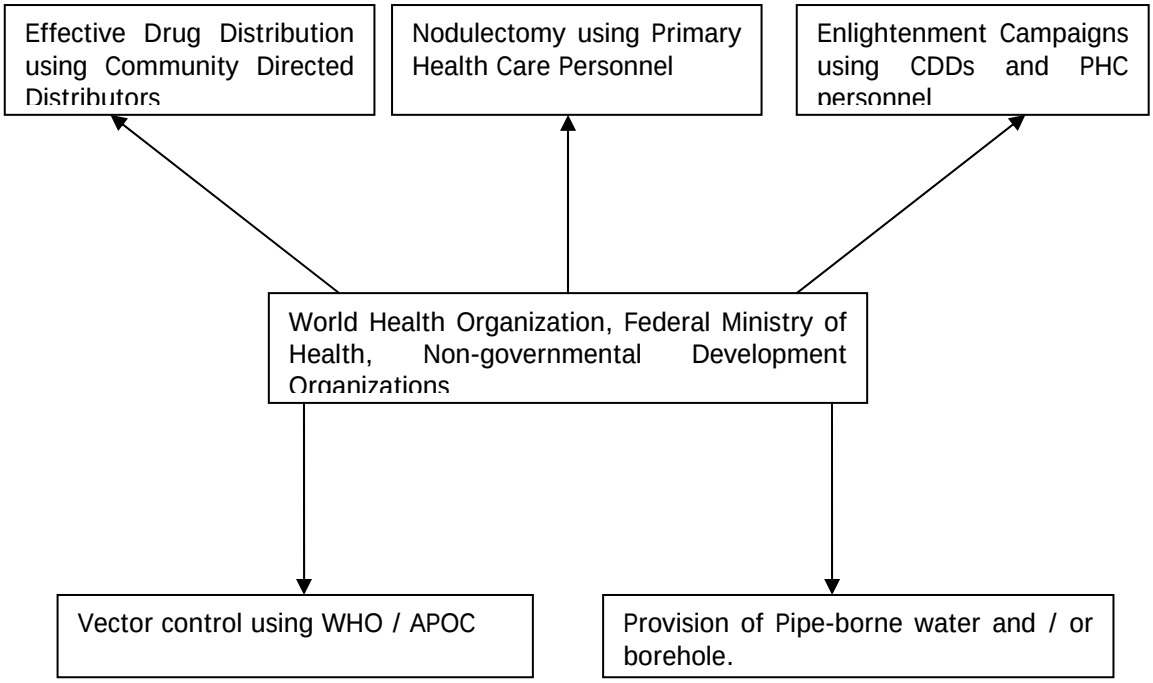

Figure 1: Schematic Representation of Strategies for controlling onchocerciasis in Uzo-Uwani Local Government Area.

3. **Enlightenment campaign:** The people of Uzo-Uwani Local Government Area are largely ignorant of the basic facts concerning the causative agent, vector and common manifestations of onchocerciasis. This ignorance leads to misconceptions of both the cause and symptoms of the disease. One of the misconceptions with serious implications is that oncho-rashes are caused by poor hygiene and are contagious. This belief leads to social discrimination against people with rashes and culminates in the late marriages and limited choice of marriage partners of infected people, especially girls (Ubachukwu, 2001b).

The enlightenment campaign recommended here will make use of the Community Directed Distributors (CDDs) selected from each community for ivermectin distribution in collaboration with the staff of primary health care (PHC) units e.g. health centres and/or health posts in each community. In the existing set up, WHO trains the CDDs on the guidelines for ivermectin treatment. These people go back to their communities to distribute drugs. It is recommended that there should be further enlightenment on the parasite, vector, manifestations and effects of onchocerciasis to enable these community distributors to enlighten their own people. Some of the areas of enlightenment suggested include the aetiology of the disease, onchocerciasis, including what causes it (*Onchocerca volvulus*), the vector (*Simulium damnosum*) and the symptoms (itching, rashes, palpable nodules, visual impairment, leopard skin, lizard skin, hanging groin, scrotal elephantiasis, body pains etc). Also to be included here is where and how they get the infection (mostly near rivers and in farms and through *Simulium* bites), the socio - economic effects of onchocerciasis, the fact that the manifestations, especially rashes, are not contagious. From the little enlightenment carried out during the studies, it is obvious that the communities are willing to learn. Finally, they should be encouraged to try and prevent the bites particularly during the peak biting periods through covering themselves properly while working outdoors, using insect repellents or changing their working habits, taking their break and leave from the farms during the peak biting periods especially the evening peaks (between 5.00 and 6.00 p.m.) which are usually higher (Ubachukwu & Anya, 2001).

Another area of the enlightenment should be on the effective use of the choice drug, ivermectin. The rules guiding the use of the drug and the consequences of not following the guidelines should be stressed to the CDDs during their training before drug distribution. The effect of not taking the drug by the entire community should also be stressed, for example the danger of serious visual impairment and blindness with their long-lasting implications on both the young and old. Again, the rural people have no recorded medical history and this has led to a few tragic cases that discouraged many in the affected communities from taking the drug. It is recommended that the medical

history of each individual be traced and recorded before the administration of the drug. Proper monitoring is also required.

4. Vector control: Boakye (1999) reported some of the successful results of vector control by World Health Organization (WHO) in the Onchocerciasis Control Programme (OCP) areas of West Africa. To be able to eradicate onchocerciasis in Uzo-Uwani Local Government Area, it is recommended that vector control be undertaken in addition to effective distribution of ivermectin drug, nodulectomy and enlightenment campaigns. These strategies, if well co-ordinated will yield the desired result in this area and eliminate onchocerciasis as a public health and socio-economic problem in Uzo-Uwani Local Government Area as has been reported in the OCP areas (WHO, 1996).

5. Use of repellents: There is need to discover an effective repellent that can be used by the people while working outdoors especially at the peak biting periods of the *Simulium* flies.

6. Provision of social amenities: It was observed in the course of this study that all the communities in Uzo-Uwani Local Government Area lack pipe-borne water and therefore depend on streams and rivers as their major source of water supply. Provision of pipe-borne water/ boreholes would help to reduce the man - fly contact arising from going to the river/stream to fetch water for drinking and laundry.

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HELMINTH FAUNA OF *Tadarida (Chaeraphon) nigeriae* (THOMAS, 1913) (MICROCHIROPTERA: MOLOSSIDAE)

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ABSTRACT

A checklist of helminth parasites isolated from Tadarida (Chaeraphon) nigeriae is presented. Out of 857 bats examined 658 (76.78%) were infected by helminth parasites. Details of the taxa presented show that 2 were trematodes; 2 were cestodes; and 5 were nematodes. Observation on the distribution of the worms within the host shows that they were found mainly in the alimentary canal and peritoneal cavity. Rictularia was the predominant helminth parasite of these bats in this study with 49.59% of the bats examined found infected with this parasite. Female bats were found with higher infection rates with the helminths than the males. There are similarities in the type of parasites infecting bats collected from Nsukka and those collected from other places. Significant levels of positive associations exist between the parasites. Food habits based on stomach content analyses revealed that in volume and in actual numbers, beetle (Coleoptera) and moths (Lepidoptera) comprised the major prey items in the diet.

Key words: Helminths; *Tadarida,* Prevalence, Similarities, Associations, Foods.

INTRODUCTION

The prey community on which an organism depends on for its food may be a potential source of health problems for the organism and for other organisms that share its environment. This happens because very often the prey species are stable hosts of the intermediate stages of some parasites. Most helminth parasites of wild insectivorous vertebrates are acquired through prey-predator relationships in the given micro ecological setting. From West Africa there are reports of the occurrence of as many as 106 bat species. Some of these are fruit bats and the others are insectivorous bats (Rosevear, 1965; Aderounmu, 1973; Okon, 1974). Many of the latter are house dwelling while all of the former are predominantly found in the wild. For house dwelling bats, which here is exemplified by *Tadarida,* the prey community from where they source their foods is a great assemblage of arthropod species of different sizes and behaviours. These bats have been known to show some forms of food partitioning according to defined taxonomic groupings (Fenton 1970). This partitioning of food resources limits each bat species to only a certain group of prey species. In *Tadarida* most of its preys are efficient intermediate hosts of helminth parasites. Very extensive literature exists on the parasites of higher vertebrates including bats. Some of the contributions to our knowledge of the parasite fauna of bats include:Watanabe,1950;Douvres, 1956; Yeh, 1957; Hurkova, 1959; Skrjabin, 1961; Rhodes, 1964; Cain, 1966; Riding, 1968; Fenton, 1970; Zdzitowiecki, 1970; Webster, 1971; Kunz, 1973, 1974; Kagei et al 1979, 1985; and Edungbola, 1981. Salem (1971) updated the increasing knowledge of the helminth fauna of bats when he recorded some trematodes from *Tadarida aegypthiaca.* The other bat species that have been examined include *Tadarida brasiliense;Eptessicus fuscus; Nycteris borealis; Myotis lucifugus; M. bocagie; Pipistrellus nanus; P. abramus; Rhinolophus ferrumequinum nippon; R. cornutus; R. malayanus; Nyctalus maximus; Hipposideros Turpis and H. (caffer) tephrus*. In all these and other species of bats all helminth groups have been isolated mostly from the small intestine. A nematode *Spirura Spinicaudata* and a trematode *Maxbraunium nigeriense* were found in the stomach of some Nigerian bat species (Edungbola, 1981) among other parasites..The present study examines *Tadarida (Chaerophon) nigeriae* for helminth parasites. It is aimed at providing a check list of the helminth parasites; and at examining some

of the ecological factors relating to their occurrence in parts of southeast Nigeria.

MATERIALS AND METHODS

Study Area: Location: This study is based on insectivorous ba*ts Tadarida Chaeraphon nigeriae* (Thomas) collected between 1986 and 2003 from Nsukka, Enugu-Ezike, Nnobi and Nsugbe in southeastern Nigeria. The bats were collected from well built houses which they infested.

Climate: The climate of the study areas is the same and is tropical, with heavy rain fall which is seasonal, falling a little more in Nsugbe and Nnobi than Nsukka and Enugu-Ezike.
The rainy season is divided into 2 periods, separated by a short dry period in August. Most of the rains fall between April and July and between August and October. The areas lie within a large belt that experience mean temperature of between 22 ^{0}C to 24 ^{0}C and annual maximum temperature of between 28 ^{0}C to 32 ^{0}C.

Vegetation: The towns are located in the tropical rain forest belt. Some areas have developed into a Guinea Savannah forest mosaic due to human activities. Palm trees abound in these areas and form a major source of revenue for the rural communities.

Capture of bats: The bats were captured alive from residential houses in the 4 towns using long handled large sweep nets. Usually capture is effected as the bats leave the roost or as they return from their foraging flights. Trapped animals were transported to the laboratory where data on sex, age, capture dates, locality, and physical conditions were taken after anaesthesia using chloroform. Aging was done using the method recorded in Mutere (1968).

Examination for helminth parasites: (a) Blood was usually drawn from the branchial artery with a syringe, this is mixed with physiological saline and thick smears made of them. These were used to screen for microfilariae. (b) Anaesthesized animals from which the blood samples had been examined were then dissected and the different portions of the gut isolated and cut from each other. These gut parts were then placed in Petri dishes containing saline. The peritoneal cavity of each was also scrapped into a Petri dish. The gut parts were then cut open and their contents and scrapings from their walls examined microscopically for helminthes (either whole worms or ova). (c) About 2 cm square section of diaphragm of each bat was examined microscopically in a muscle press for *Trichinell*a sp larvae.

Treatment of Collected Helminths: All the helminth parasites collected from each bat were treated similarly. They were first transferred into watch glasses, washed in physiological saline and later killed by placing them in Petri dishes containing warm water at 40^{0C}. These worms die fully stretched. Subsequently the nematodes and trematodes amongst them were fixed in hot 70 % alcohol and then preserved in 5 % formalin. A few drops of glycerin were added to give a concentration of about 5ml of 5% formalin and 0.5 ml glycerin. Cestodes were compressed between two slides and tied up with a cotton sewing thread and in this position fixed in Bouin's fluid for 16 hours. This was later washed off with 70% alcohol. The slides separated and the worms stored in an alcohol, formalin and acetic acid mixture (AFA).

Staining: Nematodes and trematodes were cleared in cotton blue lactophenol for 5 minutes and then stained after washing in Erlich Haematoxylin for 20 minutes, and counterstained with Eosin following the usual procedures for H/E staining. The cestodes were stained with acetocarmine.

Foods of bats: Samples of bats collected upon return from foraging flights were anaesthesized immediately and the stomachs dissected out and preserved in 10% formalin. The contents were later examined in Petri dishes under the microscope after soaking in 50 % isopropyl alcohol for 12 hours. Thereafter, further volumes of 50 % isopropyl alcohol were added and stirred, then left to evapourate. After the alcohol had evapourated the contents were examined under the low power of a microscope. Identification of animal parts was made by comparison of fragments with collections of comparable field materials. Some of the more characteristics parts of the insects e.g. wings, legs, antennae and mouthparts were searched for in the samples. By these comparisons the prey identities were determined. The unidentified objects were classified as 'unidentified matter'.

Table 1: Prevalence of helminth parasites in *Tadarida*

Species of parasite	Number of infected Bats	Prevalence of infection (%)	Total worm load	Mean number of worms per host
Nematodes				
Rictularia chaeraphoni	425	49.59	3846	9.05
Histostrongylus coronatus	295	34.42	1415	4.80
Capillaria annulosa	158	18.44	923	5.84
Cheiropteronema globocephalus	65	7.58	648	9.97
Litosoma pujoli	45	5.25	92	2.04
Trematodes				
Posthodendrium panouterus	30	3.50	266	8.87
Castroia nyctali	22	2.56	64	2.91
Cestodes				
Hymenolepis kerivoulae	15	1.75	29	1.93
Oochoristica agamae	35	4.08	156	4.46

Analysis: The isolated parasites were subjected to analyses with Simpson's index (C =ln (Y/N)), where Y = % hosts infected with each helminth species; and N = the sum of all Y values; and was used to determine the dominant species. Fager's index (Southwood, 1966) was used to determine the level of association between the parasites. Sorensen's Index was used to analyse similarity of fauna in the study areas S = (2j/(An + Bn) where An and Bn are the number of species in areas A and B respectively, j is the number of helminth species common to both areas (Greig-Smith, 1964).

RESULTS

A total of 857 bats were examined these consisted of 429 males and 428 females. The result obtained showed that there is a rich helminth fauna in *Tadarid*a. The frequency of occurrence of the helminth parasites was found to show that *Rictularia lucifigus* is the dominant species. Altogether nine Parasites were isolated and these are presented in Table 1 and Figures 1 - 5. They include 5 nematodes (*Rictularia chaeraphoni; Histostrongylus coronatus; Capillaria annulosa; Cheiropteronema globocephalus; Litomosa pujoli),* 2. Trematodes (Posthodendrium) *panouterus; Castroia nyctali),* and 2 cestodes (*Hymenolepis kerivoulae; Oochoristica agamae).*

The prevalence of these parasites among the examined bats is also shown in Table 1. A total of 658 bats were found infected with helminth parasites giving a prevalence rate of 76.78%. Examinations of the musculature and the blood show no helminth parasites.

Whereas *Rictularia* is the most common helminth parasite of these bats,

Table 2: Sorensen's Indices of similarity used to compare the helminth fauna from the bats in different towns

Towns	Sorensen's Index of similarity
Nsukka and Enugu Ezike	0.876
Nsukka and Nnobi	0.561
Nsukka and Nsugbe	0.379
Enugu Ezike and Nnobi	0.581
Enugu Ezike and Nsugbe	0.439
Nnobi and Nsugbe	0.628

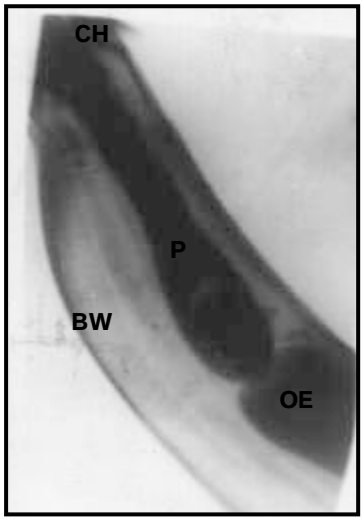

Figure 1: Head region of *Histostrongylus coronatus* showing BW – body wall, OE – oesophagus, P – pharynx and CH – crown of hooks

Cheiropteronema occurs with the highest mean worm load per host (9.97). The infected bats had between 2 to 9 helminth species. Analysis of the result using Simpson's Index for all the helminth species confirm that *Rictularia (C=-0.39)* is the dominant helminth species within the populations of Tadarida.

Table 3: Relationship between sex, age, weight and helminth infections

	Number examined	Number infected	Parasite species prevalence (number infected)								
			Rit.	Hist.	Cap.	Lit.	Chae	Post	Cast	Hyman	00CH
Young bats M	140	29	19	6	-	-	-	2	-	-	2
Young bats F	105	96	65	12	-	-	-	2	5	4	8
Old bats M	289	224	180	72	68	29	11	10	9	4	13
Old bats F	323	319	161	205	90	36	34	16	8	7	12
Total M	**429**	**253**	**199**	**78**	**68**	**29**	**11**	**12**	**9**	**4**	**15**
Total F	**428**	**415**	**226**	**217**	**90**	**36**	**34**	**18**	**13**	**11**	**20**
TOTAL			**425**	**295**	**158**	**65**	**45**	**30**	**22**	**15**	**35**

M =Males; F = F emales; Rict. =Rictularia; etc.

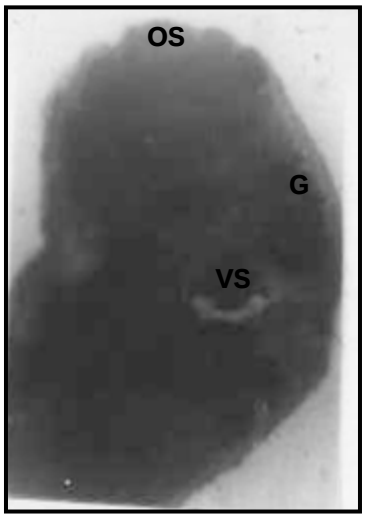

Figure 2: Whole mount of *Postodendrium panouterus* showing VS – ventral sucker, OS – oral sucker and G – Gut caeca

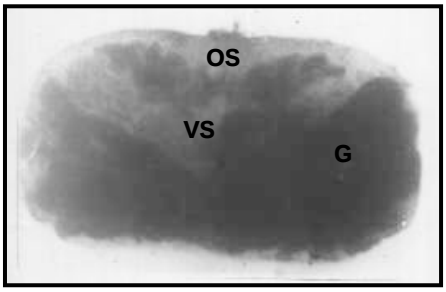

Figure 3: Whole mount of *Castroia nyctali* showing OS – oral sucker, VS – ventral sucker and G – gut.

The cumulative Index was low(C=0.99) indicating a diverse fauna of helminth species. Association between species in terms of frequency of occurrence showed no significant association of the parasites. None significance in terms of occurrence was further confirmed using Fager's Index of association (F=>+1). Calculated Sorensen's Indices of similarity are presented in Table 2.

Table 4: Insect orders isolated from the stomach of bats anaesthesized immediately after foraging flight (80 stomachs examined)

Insect order	Number of stomach in which it is found	% occurrence
Lepidoptera	14	17.50
Hemiptera	11	13.75
Coleoptera	70	87.50
Diptera	48	60.00
Orthoptera	3	3.75
Trichoptera	5	6.25
Siphonaptera	6	7.50
Neuroptera	10	12.50

The Indices in comparing the helminth fauna from different towns reflected similarities between them based on the number of shared species.

Observation on the organs of the bats where the parasites were found showed that the small intestine seemed to be the most preferred site, as most of these worms were found in the duodenum and the jejenum. One trematode *Castroia* was found in the bile duct and another parasite *Litomosa pujoli* was found in the peritoneal cavity. No filarial worm was found in the blood and no *Trichinella* sp was found in the sections of the diaphragm.

Analysis of the prevalence of the worms in terms of each animal's sex, age and weight show that, female Bats had higher percentage of occurrence. Using Chi square test on the raw data presented in Table 3 shows no significant difference in infection between the sexes (Chi square=68.15; P > 0.05). Young Bats had lower infection rates and in those infected a very low worm load per host. The weights of infected bats were not much lower than the weight of bats free of helminth parasites.

Data summarized in table 4 indicate that these bat species eat mainly members of the insect orders Coleoptera, Homoptera, Diptera, Lepidoptera and Hemiptera. The other insects' orders Orthoptera, Neuroptera,

Figure 4: Proglottids of *Oochoristica agamae*

Figure 5: Head region of *Hymenolepis kerivoulae*

Trichoptera, and Siphonaptera, are occasionally found but cannot be the main food items.

DISCUSSION

Bats are generally known to play host to a lot of parasites (Rosevear, 1965). Many factors influence this phenomenon. Prominent among these are climatic factors which favour the existence of parasites and their intermediate hosts. In this case, the long wet season during which insect population is usually preponderant. The result of this survey confirms the incidence of a large number of helminthes in Tada*rida*. The most outstanding observation is that the number of nematode parasites in this bats species is high in the areas studied and this must be related to the high reproductive efficiency ascribed to this group (Anya 1976). The common nematode of this bat species *Rictularia* would also be assumed to have a common insect intermediate host, that is also favoured (by this species) as food organism to achieve the enormous load recorded in this study. Further analysis of these insects would reveal which of them is playing this dual role.

The higher prevalence of helminth infection among the females may be due to the fact that adult females consume greater quantity of food than adult males. Kunz (1973) reported that female consumption of food is greater than that of the male with females able to consume 25-30% of their body weight while males consume only 20 – 25% of their body weight. They achieve this greater quantity and weight by having higher period of foraging activity than the males thus being more exposed to the risk of infection.

The reason for the small intestine containing a higher number of helminthes parasites is understandable from a physiological point of view, as this region is rich in freshly digested food. Thus adequate nutrients and metabolites required for growth, development and maintenance of these helminths are easily available in the small intestine. The occurrence of *Litomosa pujoli* in the peritoneal cavity can not be explained and repeated finding of this parasite in this region rules out contamination or sampling error. Thus further studies on the migratory behaviour and life history of this parasite is required to fully understand what is going on. For the intestine dwelling forms, it has also been shown that the quality and quantity of gases in the intestinal lumen is of particular importance in the distribution of the parasites as it affects their various metabolic pathways (Hirsch and Gier, 1974).

Loss of weight in infected bats recorded here is similar to what happens on other vertebrates. Mettrick and Podesta (1974) attributed this to host nutritional deprivation by parasites. They indicated that the deprivation is both in quality of nutrients and quantity of food.

As for the observation on the different insect orders found in the stomach or freshly fed bats, it only suggests that these bats are opportunistic feeders and they select food from a wide variety of prey species. Their diet seems to reflect the season of feeding, the location of food and diversity of insects (also governed by the two earlier factors). Their feeding ranges also seem to overlap with some other vertebrate insectivores such as *Agama agama* so that it is

not surprising that they also share parasite with this group e.g. *Oochoristica agamae* whose similarity with those isolated from *Agama* has been described in this area (Okafor, 1990).

The closeness of these bats to human beings and the level of contamination of cooking utensils with faecal droppings in infested homes is a potential sources of health risks. Although only a few parasites of bats have been recorded in human zoonoses, it is important to keep monitoring the list with time, and to reduce the bat-human contact as much as possible. Thus these bats could be classified as pests and effort to control them stimulated at every level (i.e. house hold, local government, state and country).

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