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Useful Potentials Of Eartworm Activities To Control Erosion And Desert Encroachment In The Low And Short Rainfall Zones Of Nigeria

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Abstract

Earthworm casting can be a very significant antidote against wind – and water – dependent sheet erosion. This study investigated the geographic and edaphic feature of the region of Nigeria characterized by low annual rainfall and short duration. The following earthworm species were identified : Eminoscolex steindachneri, Ephyriodrilus afroccidentalis, Eudrilus eugeniae, Eutoreutus abinsianus, Iridodrilus preussi, Keffia nigeriensis and Keffia variabilis. The species E. afroccidentalis tops the list in terms of suitability for the purposes both of transplanting and the type of cast characteristics that could resist sheet erosion. It was recommended that the battle against erosion and desert encroachment should be started very urgently.

Introduction

Three of the nine isohyets recognized in the country, ranging between 250 and 4000mm, have an annual rainfall of 750mm or less which is the low and short rainfall. This level of rainfall is insufficient to support wooded forests. Rather, the vegetation is largely grass with scattered shrubs and trees, thereby making this zone prone to wind erosion and desertification. Since it is important to resist ecological disasters in this zone and all efforts so far have met with failure, there is then the need to find other means. One such method is by facilitating soil aggregate formation which is mainly as a result of action of soil animals, chief among which are the earthworms. It is therefore of first importance to know which earthworm species are naturally adapted to that low and short rainfall zone.

In that zone, as a result of the combination of both low annual rainfall and the short duration (less than 3 months) the grasses are dried by the end of November, when the drying harmattan wind blows over them. By December the unfortunate yet predictable annual bush burning takes place on a colossal scale. This leaves the soil surface exposed to wind erosion. The latter leads to transportation of soil nutrients away from the zone, thus impoverishing the soil over time.

Due to the long dry months in the zone, the factors such as wetness of the soil, vegetation cover, soil compaction and the amount of soil aggregate formation, which could resist wind erosion are at their lowest.

While it is desirable to reduce wind erodability of the soil, little control is possible on the rainfall regime. Similarly, unsuccessful efforts have been made both by education and legislation to control bush burning. While efforts in this directions should be intensified, there is a possibility of facilitating soil aggregate formation which has hitherto received little attention, perhaps because man appears unable to help in what looks purely like a function of soil organisms.

The abundance of earthworms in this zone is low compared to national average or compared to the temperate region of the world. As such in order to manipulate and encourage their activities of large aggregate formation, it is important first to take an inventory of what earthworm species are naturally adapted to that zone and to study the nature of their cast and soil aggregate formation. Only then are we in a position to select and selectively breed eartworm species for distribution and transplantation.

The objective of the present study was to identify what species of earthworm naturally occur in that low rainfall zone, their abundance and to determine what geographical and edaphic factors prevail in the zone. The resulting information is then used to guide in screening for what earthworms to focus on as the best candidate for selective breeding and distribution to that geographical zone, in order to improve its resistance against erosion.

Material s and Methods

This study focuses on the zone of Nigeria characterized by (a) rainfall ≤750mm and (b) number of rainy days <90.The justification for this selection was that soils within such a zone must be water – stressed. Its soil animals must be adaptable to water stress, short reproductive cycle and open grass environment. High insolation and direct exposure to high energy solar radiations are other factors that soil animals must be adapted to, and these guided the choice of that zone for this study. From a data bank built up from 1984 to date, 13 locations were selected which matched the criteria stated above. The geographic data related to those locations were obtained from Barbour *et al.* (1). Ten replicate quadrats, 0.5m x 0.5m (i.e., $0.25m^2$) each were dug around each of the sampling locations. Earthworms collected from each quadrat were preserved in a separate bottle filled with formo acetic alcohol (FAA). The earthworms were identified using original descriptions of the earthworms (2 – 5). They were weighed on a top loading Mettler balance.

Soil samples taken from the top, middle and bottom of each of the ten replicate pits were pooled together, air – dried and subjected to standard soil analytical methods (6 – 14).

Results

The geographic and edaphic factors related to the zone are shown (Table 1). The following earthworm species were identified : *Eminoscolex steindachneri, Ephyriodrilus afroccidentalis, Eudrilus eugeniae, Eutoreutus abinsianus, Iridodrilus preussi, Keffia nigeriensis* and *Keffia variabilis* (Table 2). Their abundance are also shown. The species *E.steindachneri, E.eugeniae, I. preussi* and *K. variabilis* were each recovered. The species *E.afroccidentalis* and *K.nigeriensis* were collected twice and the species *E. abinsianus* five times.

Discussion

Integumentary adaptation of the earthworms to the environment : *E.steindachneri* resembles *Eudrilus* in many ways, especially in respect of casting behaviour and cast type (the little mound type). There is an incubating taxonomic thought that the genus *Eminoscolex* is *congeneric* with *Eudrilus*. Most of the ecological characteristics of *Eudrilus* apply to members of *minoscolex* (Table 3). The species *E.eugeniae* has become pantropical, been distributed and successful, even in the USA, far from tropical Africa that is believed to be the origin of the earthworm family, Eudrilidae. It must, therefore, be very versatile and adaptable to many ecological and geographical environments. With the coffee brown integumentary pigmentation, it is melanic. It is little wonder then that it is known to tolerate grassland environment and little vegetable shading. It is the type of earthworm that will survive the exposed grassland environment of the low and short rainfall zone. The *Eutoreutus* and *Keffia* spp. have melanic grey integumentary pigmentation and have been collected in places with low grass cover. *Keffia nigeriensis* has been observed to roam around under late morning sunlight (2 and

3). Very probably, the melanic pigmentation confers on these bearers a significant level of toleration of solar radiation and ability to survive under low vegetation covered soils. The presence of *Iridodrilus preussi* in this environment is surprising and noteworthy, since on the basis of integumentary pigmentation it is ill – equipped for it. There must be some other factors that outweigh integumentary pigmentation.

Table 1. Descriptive statistics of the geographical and edaphic factors related to the low and short rainfall zone of Nigeria

	Mean	SD	N	Range	Minimum	Maximum
Latitude (^{0}N)	11.30	1.28	13	3.87	9.21	13.08
Longitude (^{0}E)	10.74	3.05	13	9.26	4.52	13.78
Altitude (m asl)	452.00	275.89	13	992.00	76.00	1068.00
MAR (mm)	796.23	152.43	13	444.00	445.00	889.00
MAT (^{0}C)	26.69	0.48	13	1.00	26.00	27.00
MMT (^{0}C)	34.31	0.85	13	3.00	33.00	36.00
% Sand	58.72	19.85	11	69.30	14.30	83.60
% Clay	21.99	9.80	11	31.30	10.70	42.00
% Silt	19.37	11.81	11	39.86	3.64	43.60
pH	6.30	0.73	11	2.40	5.40	7.80
OM (%)	2.16	1.24	10	3.89	0.54	4.43
Nitrate (ppm)	26.58	43.07	11	147.50	2.50	150.00
Phosphate (ppm)	20.33	5.15	11	17.90	7.10	25.00
Potassium (ppm)	0.39	0.30	11	0.98	0.02	1.00
Calcium (ppm)	18.77	6.62	11	25.60	0.20	25.80
Magnesium (ppm)	1.31	0.95	11	2.63	0.28	2.91
Sodium (ppm)	0.51	0.12	11	0.43	0.20	0.63
Iron (ppm)	13.29	14.03	11	46.40	1.70	48.10
Manganese (ppm)	20.68	6.14	11	21.00	2.30	23.30
Copper (ppm)	8.18	23.16	11	76.84	1.16	78.00
Zinc (ppm)	11.31	3.06	11	10.30	2.10	12.40
TED	0.32	0.23	10	0.67	0.03	0.70
TEB	0.17	0.26	10	0.78	0.02	0.80
SII	0.15	0.09	10	0.28	0.04	0.32

SD = Standard deviation MAR = Mean annual rainfall (mm)
MAT = Mean annual temperature (^{0}C) OM = Organic matter (%)
MMT = Mean maximum temperature (^{0}C)
TED = Total earthworm density (in million worms / ha)
TEB = Total earthworm biomass (in ton / ha)
SII = Soil impact index

Table 2. Earthworms of the low and short rainfall zone of Nigeria and their abundance

	Mean	SD	N	Range	Min.	Max.
	Biomass (in ton/ha)					
Eminoscolex steindachneri	0.016	-	1			
Ephyriodrilus afroccidentalis	0.103	0.109	2	0.154	0.026	0.180
Eudrilus eugeniae	0.058	-	1			
Eutoreutus abinsianus	0.238	0.245	5	0.525	0.038	0.563
Iridodrilus preussi	0.440	-	1			
Keffia nigeriensis	0.069	0.034	2	0.048	0.045	0.093
Keffia variabilis	0.440		1			
Eminoscolex steindachneri,	0.964	-	1			
Ephyriodrilus afroccidentalis	1.007	0.726	2	1.027	0.493	1.520
Eudrilus eugeniae	0.467	-	1			
Eutoreutus abinsianus	0.577	0.417	5	1.000	0.240	1.240
Iridodrilus preussi	0.240	-	1			
Keffia nigeriensis	0.390	0.438	2	0.620	0.080	0.700
Keffia variabilis	0.240	-	1			

SD = Standard deviation
Min = Minimum Max = Maximum

Table 3. Comparison of the earthworms with respect to selection of some feactors

Species	TEE	IP	Cost type
Eminoscolex steindachneri,	Unknown	Coffee brown	Little mound
Ephyriodrilus afroccidentalis	Shade loving	Brown	Little mound
Eudrilus eugeniae	Tolerant	Coffee brown	Little mound
Eutoreutus abinsianus	Tolerant	Grey	Little mound
Iridodrilus preussi	Shade loving	Unpigmented	Little mound
Keffia nigeriensis	Tolerant	Grey	Little mound
Keffia variabilis	Tolerant	Grey	Little mound

TEE = Tolerance to exposed environment
IP = Integumentary pigmentation

Cast type and soil binding characteristic : If one were to select a species for multiplication, distribution and transplantation, after thinking of which ones will survive and adapt, one must next consider which ones will best benefit the soil. There are three major types of benefits : the deep soil burrowing that brings soil nutrients to the surface, voracious consumption and breakdown of vegetable matters and large soil aggregate and cast formation that increases that resistance of the soil to wind and low rain speed erosion. Hence, we concerned with the latter. The little mound makers tend to create soil granules that are relatively easy for low rain erosion. The turret – type casr maker (*Ephyriodrilus*), if abundant enough turn the soil surface into heavy casts that have been produced by using mucous secretions from the gut of the earthworms to cement the soil into aggregates. These large aggregates are too heavy for wind erosion and for rain runoff.

Earthworm casting and resistance to desert encroachment : By the nature of their casting, earthworms can protect the soil against sheet erosion by wind. The latter, as at now only creates a vicious cycle loss of soil nutrients, which in turn, leads to poorer vegetation cover, which leads to further exposure of the soil to erosion. Necessary facilities should urgently be put in place for mass production of earthworms for transplantation to this zone. This may be a very crucial step towards breaking the vicious cycle.

Conclusion

Putting all the above factors together, *E. afroccidentalis* is the best candidate earthworm for multiplication and transplantation for soil amelioration of the low and short rainfall zones of the country. It is versatile enough to survive the environment and its cast characteristics are the type required to resist wind and rain sheet erosion.

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