Morphological Factors Responsible For The Great Success Of *Chromolaena Odorata* In Imo State

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ABSTRACT: An investigation into the morphological factors responsible for the great success of *Chromolaena odorata* in Imo State of Nigeria was carried out. Results show that the factors include (a) Production of flowers in capitulum, each capitulum of which contains 56-71 flowers; (b) presence of the average of 20 capitula per –plant; (c) production of 32-51 seeds per capitulum and an average of 813 per plant; (d) reproduction of both sexual and asexual methods which guarantees the high seed output; (e) ability of the plant to perennate; (f) ability of regrowth after accidents; (g) tremendous spread, and; (h) capacity for colonization.
[Ezeibekwe, I.O; Okeke, S.E; Unamba, C.I.N And Mmom, G.A. **Morphological Factors Responsible For The Great Success Of *Chromolaena Odorata* In Imo State**. World Rural Observations 2010;2(2):21-28]; ISSN: 1944-6543 (Print); ISSN: 1944-6551 (Online). http://www.sciencepub.net/rural.

Keywords: Morphological Factor; *Chromolaena Odorata*; Imo State

INTRODUCTION:

Chormolaena odorata (syn. *Eupatorium odoratum*) belongs to the family Compositae. The family is characterized by the capitulum inflorescence of its members. It is largest and most successful family of flowering plant (Benson, 1957). The species is initially an erect herb. Later on, the plants became perennial shrubs. At this stage, some plants become climbers if they can find host plants. Others fall down one on top of another.

Chormolaena odorata is indigenous to Tropical America. It is popularly known as Siam weed. In recent years, the species has been introduced to Tropical Africa and Asia (Adams, 1961, Bennette and Rao, 1968, Biwas, 1934). Although its introduction in the old world tropics is accidental, it has become very abundant in the areas since its arrival. Since its arrival into the country, it has spread to every nook and corner. In South Eastern Nigeria where arable farming is the practice, the species has colonized every fallow land and road figure. The great success of the species has led to the suppression, destruction and disappearance of indigenous shrubs and herbaceous species growing in the same neighbourhood. *Chrormolaena odorata* is thus known to inhibit the growth of other species around it.

Despite its demerits, literature sources e.g Swennen and Wilson, (1984), Cacers *et al*, (1955) indicate that the species has the following economic importance. (a) Its leaf extract is used for blood clotting (b) The leaf extract when mixed with salt are used for the treatment of sore throat and cold. (c) the plants are used as mulch for row crops. (d) Its allelopathic tendencies reduce nematode population that attacks other plant species in the neighbourhood. (e) It adds organic matter to the soil (f) The plant extracts kills neiserra gonorrhea *in vitro*. (g) It is also used to scent aromatic baths.

The above uses of the species are insignificant especially when compared with its harmful effects on the indigenous flora. Studies have revealed significant differences in leaf area, petiole length and internode length when grown in area of different soil moisture conditions (Edwards, 1967). Crawley (1986) believed that competition among seeds for suitable germination sites may be a key factor in determining the successful spread of alien invaders. Almasi (2000) indicated that plants produce large amount of floral resources or make resources available over a long period, may compete successfully for pollinators. Bingello (1999) has shown that the plant has high reproductive capacity and that positive correlation exists between rainfall/relative humidity and rate of germination at sites.

The aim of this study is to determine to what extent morphological adaptations have played a role in the great success of the species *Chrormolaena odorata* in Imo State, Nigeria since earlier studies on this dwelt more on either physiological or ecological.

MATERIALS AND METHODS

Several investigations were carried out partly in the field and partly in the laboratory to determine whether or not morphological factors are involved in the great success of *Chrormolaena odorata.* These studies were carried in the areas of (a) morphology of the plant (b) fruit/seed density (c) flowering period (d) distribution and species density (e) dispersal mechanism (f) methods of reproduction (g) perennation and survival of accidents.

The investigations were carried out in ten localities in Imo State on various aspects as follows

a. **Morphology of the plant body**: This was studied partly in the field and partly in the laboratory by means of a morphological chart devised for this purpose. Specimens were collected from the localities and prepared into herbarium specimens both for preservation in the departmental herbarium and for more detailed studies. Hand lenses were used to observe the presence or absence of such tiny features as hairs and glands. Features as stem habit, which cannot be included in the specimens, were studied in the field.
b. **Flowering period:** The month flowers were first observed is usually regarded as the first month of flowering and the month flowers and fruits disappear from the plants, the last month of flowering. The period from the first to the last month of flowering is usually the flowering period of a species. This was recorded for this species in the ten study areas in one season only.
c. **Fruit/Seed density:** The number of fruits/seeds in all the capitula of each of five plants counted per locality. The total number per plant gave the density per plant while the average multiplied by the estimated species density for the locality provided an estimate of the seed density for the locality.
d. **Distribution and density of the species:** The occurrence of a species in an area shows its distribution in the area. This was investigated in just one town of each of the 27 L.G as of Imo State. On the other hand, species occurring in a particular area was studied by clearing a plot 2 x 10m in each of the ten study areas and counting the number of individuals of the species present in each plot. This was done with the cooperation of the natives. The average density provides an insight into what the state density of likely the species would be.
e. **Dispersal mechanism:** The structure of the food was studied. This provided the idea of the likely dispersal mechanism of the fruit. This was confirmed in two of the study area (Ejemekwuru and Okwuofia) during two different windy days.
f. **Methods of reproduction:** The species was tested for the two usual methods of reproduction (sexual and asexual) known among living organisms. For sexual reproduction, observations of flowering and fruit/seed reproduction were carried out in the ten study areas between November, 2003 and April, 2004. Seed germination trials, however were carried out in the Laboratory of Plant Science and Biotechnology Department, Imo State University, Owerri using seeds from each of the ten study areas

Procedure:

Ten Petri dishes were selected, washed with tap water, and arranged in a row on a side bench within the Laboratory. The bottom of each Petri dish was covered with filter paper. By means of a wash bottle, drops of water was introduced into each Petri dish, just enough to wet the filter paper. Twenty mature seeds, from one locality already detached from their capitula, were picked and spread out on one Petri dish. The process was repeated in such a way that eventually one Petri dish contained seeds from one of the ten localities. The setup was allowed to remain for some days while observations of germination were made every two days, starting from 19th January, 2004. The results were tabulated when no further germination were observed for one week.

Asexual reproduction, on the other hand was investigated in two ways. The first was to determine the presence of any underground organs of vegetative reproduction. This trial was carried out by uprooting five fairly old plants from each of the ten study areas. Each underground part uprooted was carefully inspected for the presence of tubers, corms and other propagules.

The second method was test for vegetative multiplication by stem cuttings.

Procedure:

Five stems each about 1m long, were cut from each of the ten localities, each group labeled accordingly. Ten planting beds were made in the Agric Farm of this University. One group of stems was cut into five smaller pieces and all of them planted on one bed. The locality of these stems was labeled against the bed. This process was continued until the ten groups of stems and ten beds were planted up. The planting exercise was carried out on Tuesday, 17th February, 2004. The beds were watered every morning and evening. Weekly observations for sprouting and growth were made. The experiment was dismantled after 42 days.

g. **Perrenation:** This is the ability of a species to survive unfavourable growth periods. In the tropics, dry season is the unfavourable period of plant growth. The effect of the dry season on the species and the way the plants survive this adverse weather condition, was also investigated in the ten study areas from January to April, 2004.
h. **Survival after accidents:** Frequently, individual stems are cut off during land clearing for farm work, brushing of oil palm

plantation and road fingers to reduce over-growth of vegetation. Observation of the regrowth of stumps was also carried out in such cleared areas. This investigation was considered necessary. Since the ability of regrowth is one of the factors ensuring both species and seed densities.

Findings from the above investigations were finally collated. Tables were prepared where necessary. Illustrations were also produced in some cases.

RESULTS

The results of the various aspects of this study are presented below

a. Morphological: This is presented hereunder in taxonomic order.

Distribution: Occurs in every L.G.A in Imo State, densely in some parts sparsely in others

Stem habit: Initially erect herbs, later on climbing (where they can find host plants) or drooping shrubs, each with 2-4 pairs of branches, and each branch subtended by a pair of branches, and climbing members many strangulate their hosts. Drooping shrubs eventually fall down and trail. Others also fall on the first group and trail. This situation continues as long as their growth is unchecked by man. Finally, they develop into a dense, impenetrate bush of interwoven stems, and foliage (fig 1). Consequently, they suppress the growth and development of other herbaceous and shrubs species in the area. Hence it becomes the dominant species wherever it is fully established.

Leaves: sparse per plant, glabrous, simple, petiolate, ovate, serriate, alternate, rounded with reticulate veination.

Inflorescence: In 15-25 capitula per plant, each 1-15cm long and each of which seems at first glance to be an individual flower (fig 2a). Each capitulum is surrounded by a series of green involucral bracts (Fig 2a).

Flowers: 56-71 disc-flowers present per capitulum, all arising from a compound receptacle (fig 2b) and each about 0.5-1cm long (Fig 2c). Ray flowers absent.

Calyx: Reduced to numerous bristle like pappi (fig 2c)

Corolla: Cream, five, tubular, becoming free towards the apex (fig 3c)

Androecium: made up of five stamens adnated to the corolla. Filaments short, anthers elongated and connate (fig 2c).

Ovary: Inferior, two-chambered. One ovule in basal placentation present per chamber.

Style: elongated and protrudes from the apex of the coalescent anthers (fig 2c) branched into two towards the apex (fig 2d).

Stigma: Two, each towards the apex of the style branch (fig 2d)

Fruit: A small dark, cypsela, 4-6mm long (fig 2e).

Floral formula: ⊕ ♂ K0 C(5) A(5) G(2)

b. Fruit/seed density: The estimate of average density of fruit/seeds in a plot of $20m^2$ is 1153 (Tables 1 and 2).

c. Flowering period: Flowering within the species is from November to April.

d. Distribution and species density: The species was recorded in fallow farms, gardens, cleared project sites abandoned for sometime, road fingers and plantations. It was also observed occasionally on the top of roots of shaded buildings and as epiphytes especially on oil palm trees.

The average density of the species recorded in plots of $200m^2$ is 27 (table 3). The density is lower in such L.G.As (e.g Oguta and Ohaji/Egbema) where farmlands are covered by such fallow crops as *Anthonata macrophylla, Dactyladenia bacteri* and *Dialum guineense* during fallow periods. It is also low in such L.G.As as Oguta, Ohaji/Egbema and Ngor Okpala where secondary forests established on farmlands soon after harvest. It is however every high in farmlands with high density of oil palm trees, great number of open fallow farms and unmaintained road fingers.

e. Dispersal mechanism: Wind dispersal trials proved positive for this species. The lightweight of the fruits made tem easily shaken off from their dry, shattered capitula by wind. The bristle-like structures on top of the fruits (pappi, fig 2e) made it possible for them to be easily shaken off from their dry, shattered capitula and be easily carried by the wind over both short and long distances. The fruits finally dropped down at their new sites with the ceassation of the wind.

Table 1: Estimate of Fruit/Seed Density of *Chrormolaena odorata*

Localities		Plants per plot			Total per plot	Average per plot
		1	2	3		
1	S/C	32	41	50	123	41
	S/P	640	820	1000	2460	820
2.	S/C	40	33	39	112	37
	S/P	800	660	780	2240	747
3.	S/P	35	45	43	123	41
	S/C	700	900	860	2460	820
4.	S/P	42	36	51	129	43
	S/C	840	720	1020	2580	860
5.	S/P	38	45	43	126	42
	S/C	760	900	860	2520	840
6.	S/P	31	41	34	106	35
	S/C	620	820	680	2120	707
7.	S/P	29	43	41	113	38
	S/C	580	860	820	2260	753
8.	S/P	41	38	43	122	41
	S/C	820	760	860	2240	813
9.	S/P	43	41	39	123	41
	S/C	860	820	780	2460	820
10	S/P	42	37	43	122	41
	S/C	840	740	860	2440	813

Explanation of symbols
S/C = Seed per capitulum
S/P = Seed per plant

Note: Average number of capitula per plant (15-25 divided by 2 = 20) is based on the above morphological description of the species

Table 2: Density of *C. odorata* in each of the ten plots studied.

S/N	PLOTS	NO. OF PLANTS
1.	Ogbor	6
2	Okwuohia	5
3.	Umuezeala	4
4.	Izombe	3
5.	Ihitte Ogeda	5
6.	Inyiogwugwu	5
7.	Ejemekwuru	3
8.	Umuokanne	3
9.	Umuneke	4
10	Uzoagba	5
	Total	43
	Average	4.3

Table 3: Germination trials of seeds of *C. odorata*

Petri Dishes	No. Planted	No. Germinated	% Germination
1.	20	15	75
2.	20	12	60
3	20	18	90
4.	20	18	90
5.	20	14	70
6	20	16	80
7.	20	15	75
8.	20	18	90
9.	20	20	100
10.	20	14	70
		Average % Germination	**80**

f. Methods of reproduction: Sexual reproduction was obvious as the species flowered profusely (fig 1b) and produced numerous fruits and seeds (cypsela) in the ten sites studied. Also, seed germination trials produced 60-100% germinations after two days. Also seed germination trials produced 60-100% germination after two days (table 3) to prove the viability of seeds of the species.

Secondly, the asexual reproduction trials showed that the species also reproduces vegetatively. All the five stem cuttings planted in each of the ten beds sprouted and commenced growth after 23-35 days. Furthermore, natives of some of the study areas confirmed that vegetative reproduction was a common occurrence in the farmlands as stem cuttings buried during tillage of the soil farming sprouted and grew up soon after.

g. Perennation: Vegetative growth of the species takes place in the rainy season (fig 1). But from the early part of the dry season, the leaves begins to dry and fall gradually. By the middle of this season, all leaves dry up and fall off. By this time, the plants appear as if they are completely dead. However, the branches and stems begin to die progressively downwards. By the end of the dry seasons, greater portions of the stems are dead. But from the beginning of the rainy season, death of the stem stops. Therefore, the surviving lower portions commence sprouting. Before the next one month, vegetative growth becomes very noticeable. Two or three months later, full vegetative growth is established. By the next dry season, the same process repeats itself. In this way, the same plants are able to live for many years.

h. Survival from accidents: When portions of the stems are cut off from any point, sprouting and regrowth soon take place a little below the affected region. The young branches grow and regain full size with time.

In the case of fire attack, the portions earlier affected by drought are burnt down. Portions not affected by drought are burnt down. Portions not affected by may be more or less affected by the five attack. When the rainy season comes, the surviving stem portions commenced sprouting and regrowth until full size is attained. In this way also, the same plants are able to live for many years.

Fig 1: Habit of *Chromolaena odorata*

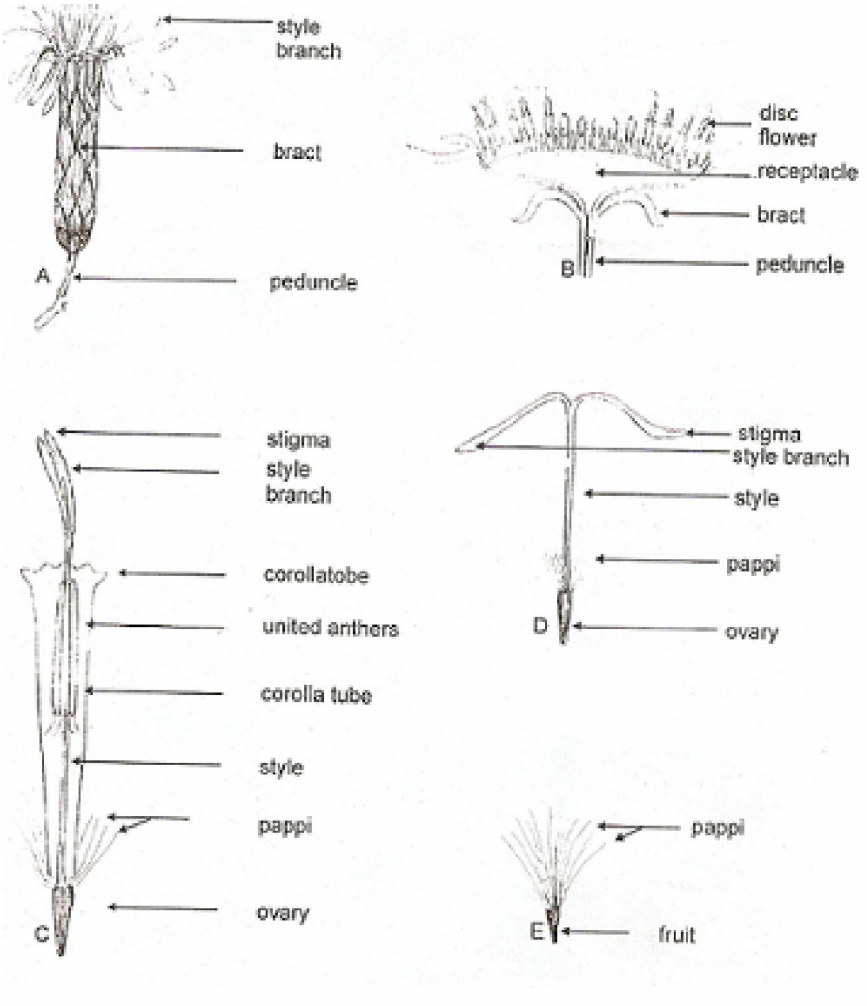

Fig 2: Capitula and Flowers parts of *C. odorata,*
(a) One capitulum (b) L/S capitulum (c) a flower (d) Pistil (e) fruit bearing pappi

DISCUSSION:

The results of this study reveal that *Chrormolaena odorata* possesses numerous morphological features responsible for its great success. These are broadly grouped into three, as follows:

a. High reproductive ability
b. Tremendous spread, and
c. The extensive colonization of the species

Features involved in each of the above adaptations are listed orderly below.

a. High Reproductive Ability: This is made possible by
   - The production of flowers in capitula, each capitulum of which contains 56-71 flowers. Benson (1957) observed that the crowding of numerous flowers into one capitulum leads to perhaps, the most efficient, most effective and most precise method of pollination as numerous flowers are pollinated at one sitting of the visiting insect. This is therefore considered as the first step towards the high reproductive capacity of the species. Since this cannot occur in the absence of an accompanying efficient pollination method.
   - The presence of an average of 20 (15-25) capitula per plant (table 1). This guarantees high seed density and thus high species density.
   - The production of 32-51 seeds per capitulum and an average of 813 (620-1020) per plant (table 1). This appears to be the highest seed output per plant among flowering plants.
   - The high density of 4 plants per 1m2 which also leads to high seed output (table 2).
   - Reproduction by both sexual and asexual methods. This quarantees the high seed output and the high density of the species.
   - Ability of the plants to perennate. This sustains the high density of the species as well as the high seed output.

b. Tremendous spread: This derives basically from the productionof fruits in cypsela (Fig 2e). According to Benson (1957), such features as pappi present on the fruits, and which carry them through the air as if by parachute, are responsible for the rapid dissemination of members of the Compositae over the earth. In otherwords, wind dispersal is the major factor responsible for the tremendous spread of *Chrormolaena odorata* in Imo State and elsewhere. The high reproductive capacity of the species which produces the innumerable seeds for dispersal is a secondary factor.

c. Capacity for colonization: The trailing habit (fig 1) which eliminates herbs and some shrubs account for the dominance and great colonization ability of the species within its habits. The high density and tremendous spread of the species are additional factors.

This study therefore suggests that at least nine morphological adaptations of the species within its habits. The results of this study also reveal the high rate (80% in two days) of seed germination within the species. This confirms the reports of earlier workers (Baker, 1965, Bennette and Rao, 1968; Binlorme, 1979, Crawley, 1968 and Sakari, 1965). It also appears to be the only physiological adaptation recorded by these workers in conection with the great success of the species.

Earlier implication of such ecological factors as soil moisture condition, selective forces of the new environment, and environmental tolerance by Edwards (1969), Allard (1965) and Barker (1965), appear not to be the case. The obvious factors seem to be morphological and physiological as shown above.

Allard (1965) and baker (1965) pointed out that *Chrormolaena odorata* releases substances that kill off indigenous plant species around it thereby creating open space for the spread of the exotic weed. This view was not supported by the result of this study. However, the crowding and trailing habit of the stems (fig 1) appear to bring about the allelopathic tendencies of this weed.

CONCLUSION:

From the above account, the numerous morphological adaptations of this species are more responsible for its great success than factors from any other sources. As it does not yield any substantial economic value, its presence in Imo State is greatly disastrous. The government of Imo State and its agencies should without any delay, initiate actions to control the spread or totally eradicate this species from the State.

REFERENCES:

1. Almasi, K.N (2000). A non-native perennials invades forest. Bioilogical Invasions 2: 219-230.
2. Allard, R.W (1965). Genetic systems associated with colonizing ability in predominantly self pollinated species. Pp 49-75.
3. Adams, S.G (1961). Origin of *Euparotium odorata* in tropical Africa. Pp 312-314.
4. Bingello, K.U (1999). The study of plants flowering behaviour 1: 48-65.

5. Bakar, H.G (1965). Characteristics and modes of origin of weeds. Pp 147-172.
6. Biwas, K.S (1934). Plant pollinators interaction in Tropical Rain Forest. Annual Review of Systematics and ecology. Pp 399-422.
7. Bennettee, F.F and Rao, V.P (1968). Distribution of an introduced weed *Chromolaena odorata/inn* (Compositae) in Asia and Africa and possibilities of its control. Articles and new summaries. See C 14:227,281.
8. Benson (1957). Flowering plants and rates of reproduction in Tropical Africa. Pp 45-48.
9. Crutwell, 1960, Mohan, 1960. The spread of alien species in Africa. Pp 482-490.
10. Caceres et al (1995). A review on the successful spread of *Eupatorum odoratum* in Africa. Pp 412-415.
11. Crawley, M.J (1968). The population biolgy of invaders. Phylolophied transactions of royal Society of London. Series B, 314:711-731.
12. Delome, F.G (1979). The influence of herbicide on the weed *Eupatorum odorata.* pp *54-46.*
13. Loff and Von Holle (1999). Insects as key pollinators of *C. odorata.* Pp 55-51.
14. Sakai, K.I (1965). Contributions to the problems of species colonization from the view point of competition and migration. Pp 215-239.
15. Sheldrick, R.D (1968). The control of Siam weed in Nigeria. *J. Nigeria Institute Oil Palm Res. 5:7-19.*
16. Swennen and wiulson (1984). A review on the successful spread of *C. odorata.* Pp 45-48.

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