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INTEGRATED MANAGEMENT OF *CHROMOLAENA ODORATA* EMPHASIZING THE CLASSICAL BIOLOGICAL CONTROL

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ABSTRACT

Chromolaena odorata, Siam weed, a very important weed of Java Island (Indonesia) is native to Central and South America.

In the laboratory it showed rapid growth (1.15 g/g/week) in the first 8 weeks of its growth. The biomass was mainly as leaves (LAR : 317.50 cm'/g total weight). It slowed down in the following month as the biomass was utilized for stem and branch formation. This behavior supported the growth of C. *odorata* into a very dense stand. It flowered, fruited during the dry season, and senesced following maturation of seeds from inflorescence branches. These branches dried out, but soon the stem resumed aggressive growth following the wet season. Leaf biomass was affected by the size of the stem in its early phase of regrowth, but later on it was more affected by the number of branches.

The introduction of *Pareuchaetes pseudoinsulata* to Indonesia, was successful only in North Sumatera. In Java it has not been reported to establish succesfully. The introduction of another biological control agent, *Procecidochares conneca* to Indonesia was shown to be specific and upon release in West Java it established immediately. It spread exponentially in the first 6 months of its release. Field monitoring continues to evaluate the impact of the agents. Other biocontrol agents *(Actmole anteas* and *Conotrachelus)* wilt be introduced to Indonesia in 1997 through **ACIAR Project on the Biological Control of *Chromolaena* odorata in Indonesia and Papua New Guinea.**

Keywords: Indonesia / North Sumatra / West Java / Biological control / *Chromolaena odorata i Pareuchaetes pseudoinsulata I Procecidochares conneca.*

INTRODUCTION

The nature of *C. odorata* (SIAM WEED) as a weed in agricultural production systems is well recognized (Tjitrosemito 1996; Tjitrosoedirdjo *et al.* 1991) not only for perennial plantation crops (Syamsudin *et al.* 1993), for forest teak plantations in Java island (Setiadi 1989), but recently also for forest plantations outside of Java island. Sagala (1994), for example, pointed out the role of C. *odorata* in providing inflammable fuel, leading to 2-4 m high flames in forest fires. Moses (1996) also emphasized the important infestation role of *C. odorata* in reducing pasture productivity in East Nusa Tenggara in a recent Regional Symposium in Kupang, East Nusa Tenggara.

In Baluran National Park, East Java, the presence of the weed caused a severe reduction in herbage yield in the park, leading to the reduction of population of protected wild animals such as banteng *(Bosjavanicus)* and deers *(Cervus timorensis,* *Muntiacus muncak).* The situation here is quite severe, since the infestation *of Acacia nilotica,* reaching a population of 1337 trees/ha (Alikodra 1987) covered a major part of the grassing land. The park manager, following extensive mechanical control *of A. nilotica* using bulldozers, anticipated the return of native grasses, but *C. odorata* instead dominated the open space.

Another line of approach has recently been explored by the Agroforestry Research Institute. Following the report by Slaats (1995) in Africa, *C. odorata* may be useful as a fallow crop . The report by Kasniari 1996, indicated a high yield of shoot biomass when the soil was fertile (12.44 Mg ha^{-1}), but not as high when the soil was less fertile (9.04 Mg ha^{-1}). When burnt, most of these biomass was reduced (0.77 Mg ha^{-1}). It further stressed the role of *C. odorata* as a weed in agricultural production systems with a very strong competitive power.

The role of *C. odorata* as a weed is particularly severe in the newly planted or established plantations (oil palm, rubber, coconut) particularly in Sumatera and Kalimantan (Sipayung and de Chenon 1995) with quite substantial loss of investment. Various control techniques have been pursued such as physical (manual, mechanical) as well as chemical approaches, and both are costly.

In an attempt to find a better method for *C. odorata* management, biological control of *C. odorata* in Indonesia has been done since 1989 (Sipayung and de Chenon 1985), supported further through the ACIAR project No. 9110: Biological Control of *Chromolaena odorata* in Indonesia and the Philippines from January 1, 1993 to December 31, 1995. *Pareuchaetes pseudoinsulata* Rego Barros (Lepidoptera: Arctiidae) was imported from Guam, and after sufficient testing, this biocontrol agent was allowed to be released in the field in 1992. *P. pseudoinsulata* did establish in North Sumatera, but not in Java. Although it was established, its effect was not as expected and another agent, i.e. *Procecidochares connexa* (Diptera: Tephritidae) was introduced in Indonesia in 1993. Following extensive testing it was allowed to be released in 1995 by the Minister of Agriculture.

This paper reports the results of *Procecidochares connexa* (Diptera: Tephritidae) introduction to Java island and its spread in the field.

MATERIALS AND METHODS

A. THE GROWTH OF C. *ODORATA*

The experiments were carried out in: Parungpanjang, West Java, in a forest area developed for bee farming. The total area was about 1000 ha planted mainly with

Acacia mangium and about 10 ha was planted with kapok trees *(Ceiba petandra)* infested with shrubs of various kinds including *C. odorata, Mimosa invisa, Hyptis* sp., *Melastoma affine, Ficus* sp., with coppice *Schima walichii,* and lianas such as *Meremia* sp., *Mikania micrantha, Passiflora* sp., etc.

EXPERIMENT I: PLANT STRUCTURE

Since October 1995 plots measuring 4 m^2 were slashed at monthly intervals, and the stumps were mapped. The diameter was measured in mm, and recorded. The biomass was separated into leaves and stems, dried at 80°C for 48 hours or until the weight was constant and the weight recorded. The data were analyzed to characterize the plant structure of the established mature *C. odorata* population.

EXPERIMENT II: THE GROWTH OF *C. ODORATA* COPPICE

The growth of coppice was observed at monthly intervals on plots following slashing treatment described in *Experiment I* without destroying the plants. Particular attention was given to emergence of coppice from small diameter stumps. The data were recorded in terms of coppice number and height of each stem, and number and position of branches. The data were analyzed statistically.

B. REARING AND RELEASE OF *PROCECIDOCHARES CONNEXA* **B.l.**

Rearing

a. Gall Collection

The stem cuttings bearing gall were collected from Marihat Research Station, North Sumatera, Indonesia, on My 18, 1995. At BIOTROP, Bogor, the galls were dissected. There were 17 galls altogether producing 48 pupae. The pupae were yellowish white when young and turned dark brown when mature. The pupae were subsequently reared on petridishes lined with moist filter paper and put in a rearing cage made of a wooden frame with fine plastic mash measuring 0.4 x 0.4 x 0.4 m^3 kept in an air conditioned room. From 48 pupae, 38 imago emerged consisting of 19 females and 19 males. Female iinagos were easily differentiated from the males by its conspicuous ovipositor.

b. Oviposition

The emerged imago was soon paired up, in an 8 cm test tube to mate, and released into caged potted *Chromolaena odorata* plants the following day in the green house. The cages of medium size, 0.5 x 0.5 x 1 m, were made of wooden frames with fine plastic mash, housing plastic pots of 51 capacity containing soil mixed with worm casting at 1:1 ratio as medium to support the growth of *C. odorata.* The potted *C. odorata* plant should have at least 20 shooting buds, preferably more, upon which the female fly will oviposit. The cages potted C. *odorata* with the pair of flies were kept approximately one week or until the flies died to ensure that the female oviposits its eggs on the *C. odorata* plant. The potted plants were then immediately removed and put under the sun with plenty of water and fertilizer.

c. Life Cycle

It takes 50 days for the gall to develop and mature. The maturity of the gall was indicated by the appearance of a window opening on the gall, which was still closed by a very thin cover of transparent lining gall epiderm used to allow emerging fly to escape.

When most of the galls showed the window opening, the galls were harvested and dissected. From 19 pairs of flies, 53 galls were produced and after dissection yielded 142 pupae. From 142 pupae, 118 emerged (83%) in a period of 11 days (Sept. 26 - Oct. 6, 1995), with a female to male ratio of 64 : 54.

d Sex Ratio

From 64 females of the first generation in the laboratory, 407 galls were produced yielding more than 1200 flies comprising 640 males and 629 females. In the second generation, the mature galls were not dissected, but the harvested gall-bearing stem cuttings were collected and reared in the rearing cages by dipping the stem cutting in jars of water to keep the cuttings fresh.

e. Mass Production

The emergence took place from December 12, 1995 up to January 12, 1996. Some emerged later. The 3rd generation of P. *connexa* in BIOTROP produced 3232 flies consisting of a female to male ratio of 1646 to 1586. The rearing procedure in the laboratory at BIOTROP was slightly modified and standardized as follows:

The emerging flies were collected by sucking them with a small modified vacuum cleaner and reared for at most 2 days in a rearing cage. The population of images in 2 days can reach 100 pairs of flies. These paired imagos must be released immediately to new potted C. *odorata* plants having at least 20 shooting buds each. The potted C. *odorata* plants were housed in a big cage made of iron frame with a fine plastic screen measuring 2 x 3 x 3 m^3. The plastic screen was lifted one week later, or until all flies died. The potted *C. odorata* plants were provided with adequate water and fertilizer.

Approximately 50 days later the emerging flies were sucked with the modified vacuum cleaner as mentioned above. About 250 pairs of flies obtained that way were once more released in Parungpanjang and 32 galls were sent to Yogyakarta.

Since emergence took more than 1 month, between February 26, 1996 and April 7, 1996 at BIOTROP, everyday there were new emerging imagos of *P. connexa.* The 4th generation emerged from May 10, 19% to June 28, 1996. There were more than 3835 galls, producing more than 4000 **flies.**

B.2. Release

EXPERIMENT HI. RELEASE

a. Permanent Plot

Permanent 5 x 5 m plots were made in the area densely populated by *C. odorata,* marked with wooden poles of 4 m at the corner of the plot, delineated with steel wire. Inside the plot individual plants of *C. odorata* were tagged with numbered alluminium tags attached to the base of the plants. The precise location of *C. odorata* plants was plotted on grid paper. The number of plants and their growing shoots were recorded. The permanent plots were made in Parungpanjang and Sukabumi.

b. Release

Release of *P. connexa* was done in the permanent plots at Parungpanjang and Sukabumi.

b.L Parungpanjang

The release was conducted on December 19, 1995 with 75 pairs of mated imagos, and repeated again on December 30, 1995, with 100 pairs of additional mated imagos.

b.2. Sukabumi

The release was carried out directly from the cage containing 100 pairs of mated imagos in the permanent plots on May 28, 1996, and when no gall was observed in the field on June 17, 1996, the following day, an additional 65 pairs of mated imagos were released.

c. Evaluation

The evaluation was carried out by observing the presence of galls in the permanent plots and in the surroundings.

c. 1. Permanent Plots

In Parung panjang every single plant was inspected on December 30, 1995, while in Sukabumi this was done on September 14, 1996. The galls were counted and recorded.

c. 2. Surrounding Permanent Plots

Outside the permanent plots the observation were out using the line transect method. Four lines at four cardinal directions were followed using measuring tape. Along the way any *C. odorata* plants directly under the line was inspected for the occurrence of any galls. The number of galls and the distances were recorded and used to estimate the area infected by *P. connexa* These data indicated the population growth and dispersal of the fly.

c. 3. Data A nalyses

Data on weed growth were analyzed using multiple regression, while the area infected by the fly was analyzed using exponential growth to estimate the rate of spread.

RESULTS AND DISCUSSION

A. THE GROWTH OF C. *ODORA* **A.l.**

The Plant Structure

The data of the mature, well established C. *odorata* community slashed in October were analyzed to see how the leave biomass was affected by other variables (i.e. plant height, shootbase diameter, number of branches, and stem dry weight). Using linear multiple regression analysis with data from 52 plants, the following regression equation was obtained :

$Y= i.2258 - 2.8075 \times 10^{'3} X, + 4.561 \times 10^{'2} X_2 - 3.2034 \times 10^{'3} X_3 + 0.18373 X< (t^2 = 0.7349)$

Where: Y = leaf biomass(g) (= 3.252 g)
Xi = plant height (cm) (=159.100 cm)
X_2 = shootbase diameter (mm) (= 4.981 nun)
X_3 = number of branches (=10.520)
X< = stem dry weight (g) (= 14.000 g)

Further analysis of the regression coefficient indicated that only the X4 variable was significant in affecting the total leaf biomass, because this population of *C. odorata* just sprouted to produce coppice along the denuded stem after undergrowing leaf shading during the dry season following flowering and fruiting. It is interesting to compare the growth behavior of *C. odorata* in the laboratory, where in the first two months of growth most of the photosynthate is utilized to produce leaves Consequently it has a relatively high Relative Growth Rate (RGR) =1.15 g/g/weeks (Tjitrosemito 1996). It seems that this character is consistent whether it grows from seeds or when recovering from drought.

At this time of the year the growth of C. *odorata* was still recovering from drought. The tops of stem and some branches that were carrying inflorescences were dried off following the dispersal of seeds as indicated by the negative sign of the coefficients. The greater the number of branches the lesser the biomass of leaf because those branches did not carry leaves just yet since the top part of those branches were dead. The situation was similar for plant height, as the higher the plant the lesser the leaves, as the top part was still dried off.

The plant size was relatively small having an average height of 159.10 cm with leaf biomass of only 3.253 g/plant and total stem dry weight of 14.00 g/plant. The number of branches was relatively high i.e. 10.520 g/plant, but still small and some were only carrying 2 leaves.

When slashing was done in May, the following regression line was obtained:

$Y = -12.567 + 3.6413 \times 10^{'2} X, + 6.8146 \times 10^{'1} X_2 + 0.9645 X_3 + 2.9480 \times 10^{'2} X4$

Where: Y = leaf biomass (g) (= 5.583 g)
X, = plant height (cm) (=199.1cm)
X_2 = number of branches (= 7.243)
X_3 = stem diameter (mm) (= 5.608 mm)
X, = stem dry weight (g) (= 28.53 g)

Further analysis of regression coefficients indicated that the X_2 variable, i.e. number of branches, was highly significant in affecting the biomass of the leaf. X_3

and X_4 were also significant in affecting the biomass of the leaf. The number of branches represent new growth, where leaves are located. Therefore, the greater the number of branches the higher the biomass of the leaves they carry and the sign is positive. Stem dry weight and stem diameter were indicating the size of the plant. The taller the plant the higher the biomass of the leaves, and the signs are positive. However, the constant carried a negative sign, indicating that the growth of this population was very thick with many leaves at the top of the population so that some leaves at the lower level were shaded and some of them already senesced. This plant structure was different from those in October when the population was still recovering from the drought.

The size of plant already reached a mature stage. Stem dry weight reached 28.53 g/plant with the leaf biomass of 5.839 g/plant, and the average plant height was 199.1 cm. The number of branches stabilized at an average of 7.243 g/plant and these branches were effective viable branches which will bear inflorescences when mature.

A.2. The Growth of *C. odorata* Coppice

The growth of coppice was recorded on all stumps from as small as 2 mm to 10 mm when slashing was done during the wet season, i.e. from October - June, while from July to September regrowth was recorded only on plants with a diameter of 5 mm or greater. At this period, most of seedlings (if seeds happen to germinate) will also die due to the drought. It seems that the regrowth of coppice of *C. odorata* is mostly affected by soil moisture. It was unfortunate that we did not collect data on soil moisture. This information will be collected in future observations.

The above data revealed the plant structure in terms of biomass distribution. To understand the plant structure in physical terms the data on coppice growth was quite revealing. When observations were carried out at 2 and 3 months after slashing (during the wet season) the following data were obtained (average of 78 plants) (Table 1).

At two months after slashing as the space was stil available, the plant utilized its energy for producing branches, reaching a total of 26.07 branches/plant. The plant height varied reaching a maximum of 240 cm but the average was 162.5 cm, while the branches were distributed slightly skewing to the left, i.e. indicating that the plants were still investing their energy for growth. The peak of branch number was observed at a height of 80-100 cm above ground.

At three months after slashing, however, there was a stabilization in number of branches. Leaves of lower branches were shaded out and the branches were sacrificed by the plant, in favor of the new branches at the top of the plants. The plants grew taller reaching a maximum of 300 cm but the average was 220 cm. The branches were distributed slightly skewing to the right since at this time the lower branches and leaves were dying off. The plants formed a population architecture in such a way that most of the leaves were grown on the top branches to harvest sunlight as much as possible at die expense of the lower leaves and branches. This is the final structure when the population will produce flowers. When the time permits and moisture is available the plant will grow to form a very dense thicket of *C. odorata.*

Table 1. The distribution of branches in the *C. odorata* community at different stages of growth

	Harvested 2 Months After Slashing	Harvested 3 Months After Slashing
Plant Height (cm)	162.50	220.600
Total Living Branches	26.07	18.95
Branches from :		
0-20 cm height	0.5714	0.1818
20-40 cm height	1.9290	0.3939
40-60 cm height	8.6790	1.0150
60-80 cm height	17.0000	2.3030
80- 100 cm height	22.4000	3.3940
100-120 cm height	20.7100	6.4550
120-140 cm height	18.2500	9.1360
140-160 cm height	11.9300	12.0000
160-180 cm height	6.8570	12.5200
180-200 cm height	3.0360	13.7000
200-220 cm height	0.9286	10.9500
220-240 cm height	0.4286	7.0450
240-260 cm height	-	2.9090
260-280 cm height	-	0.6364
280-300 cm height	-	0.1212

B. LABORATORY REARING OF *P. CONNEXA*

From Table 2, it appears that the time of emergence varies considerably from 9-25 days (from pupation/dissection to emergence). The emergence was about 79% with a sex ratio of 1 : 1. So this initial culture of *P. connexa* at BIOTROP was 19 pairs of imago.

Table 2. The emergence of imago of *P. connexa* from pupae

No.	Date of emergence	Total	Female	Male
1.	07-27-1995	3	2	1
2.	-28-	2	1	1
3.	-29-	4	2	2
4.	-30-	3	1	2
5.	-31-	-	-	-
6.	08-01-1995	7	4	3
7.	-02-	-	-	-
8.	-03-	3	1	2
9.	-04-	1	1	.
10.	-05-	-	.	.
11.	-06-	-	.	.
12.	-07-	3		2
13.	-08-	2		1
14.	-09-	3	:	1
15.	-10-	3		2
16.	-11-	2		1
17.	-12-	2		1
	Total :	38	19	19

Assuming that pupae represented the egg laid by a female, each female in generation I, on average, laid 7.5 eggs, this was lower than reported by Sipayung and de Chenon (1995), being 16, and much lower than the total number of eggs that may be laid by a female *of P. connexa* (69 eggs). However, for the following generation the estimated eggs laid was higher i.e. 19 per female. For the initial colony each gall contained about 3 pupae per gall. This was maintained up to generation n at BIOTROP. It dropped at generation III and IV to about 1 pupae per gall. This condition may be attributed to the stage of the plant occurring mostly in the flowering stage at this time of the year (Table 3).

Table 3. The outcome of the rearing in the laboratory

			Emergence	Imago			Remarks
	Gall	Pupa	Period	Total	Female	Male	
Initial colony	17	48	17	38	19	19	Dissected
Generation I	53	142	11	-118	64	54	Stem cutting in jars
Generation II	407	(NR)	30	1269	640	629	Modified vacuum cleaner
Generation HI	3177	(NR)	(NR)	3232	1586	1646	
Generation IV	3835	(NR)	(NR)	4027	2023	2004	

NR: not recorded

C. FIELD EXPERIMENT

C.I. Parungpanjang

The population of *C. odorata* in Parungpanjang, West Java, a permanent plot of 5 x 5 m^2, was 145 *C. odorata* plants with 2333 + 8.7 shoots. The *C. odorata* vegetation had a very dense thicket of shoots.

In the permanent plot of 5 x 5 m^2, on December 30, 1995, 128 galls were found. It is about 5% from the available shoots. This infestation is still low, in terms of the efficiency of controlling C. *odorata.* The spread of *P. connexa* into the surrounding area may be judged from data in Table 4.

Table 4. The distribution of galls in Parungpanjang

Time of Observation	Galls recorded in the direction of							
	N		W		S		E	
	No. gall	Dist. (m)	No. gall	Dist. (m)	No. gall	Dist. (m)	No. gall	Dist. (m)
Dec. 30, 1995	4	5.82	11	78.0	23	13.5	19	7.5
Mar. 29, 1996	14	7.60	28	24.8	39	32.8	19	54.8
June 25, 1996	11	20.00	103	290.0	50	201.0	34	229.0

The northern side of the permanent plot was bordered by a forest of young *Eucalyptus,* mixed with *Calliandra callothyrsus* and *Ceiba petandra.* This forest seems to form a barrier for *P. connexa* to spread.

The rate of spread may be estimated from the distance where galls were recorded. Assuming that the forest on the northern side of the plot constitutes a barrier, the available area of spread was half circular as in Figure 1. So the area is approximately '/i m^2 (where r = distance of galls found).

In the first month, the area covered by the infestation of *P. connexa* estimated from the distance of recorded galls, was about 150 m^2. The following 2 months the spread covered an area of approximately 2203 m^2 and at 6 months after release the area covered was 120 580 m^2. The mode of spread seems to follow an exponential pattern, with relative spread rate of 1.1 in a month.

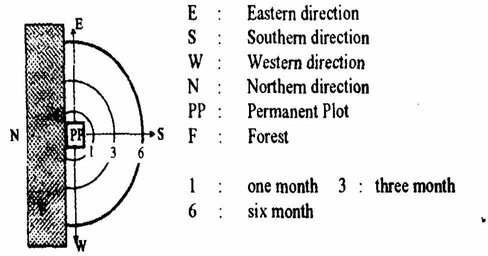

Figure 1. Diagram of the position of the permanent plot in Parungpanjang

C.2. Sukabumi

The population of *C. odorata* in the permanent plot of 5 x 5 m^2, consisted of 82 *C. odorata* plants with 2140 + 18.5 shoots. This *C. odorata* vegetation was under a coconut plantation. It seems that this weed has been neglected for some reason. Although the population was less than that of Parungpanjang, the number of shoots was almost the same. In fact, the average for Sukabumi was 26.1 shoots/plant, higher than that of Parungpanjang (16.1 shoots/plant).

Two weeks after the release in Sukabumi no gall was observed, since *C. odorata* plants were in the process of fruit maturation, where shoots were dried out. So *C. odorata* plants were slashed and *P. connexa* was released again on June 18, 1996 with 65 pairs of flies. On August 8, 19%, 120 galls were recorded. The rate of infestation is about 5%, similar to the infestation rate in Parungpanjang, while the observation outside the permanent plot is still being evaluated.

In contrast to *Pareuchaetes pseudoinsulata, P. connexa* survived and reproduced well at Java island. This result is very encouraging. Although the rate of infestation is still low (5%), it is hoped that with the coming wet season the infestation will be higher. The impact of *P. connexa* on the performance of C. *odorata* such as its growth, seed production and seed viability are still under investigation and it is expected that one or two more biological control agents could be introduced in Indonesia.

REFERENCES

ALDCODRA, H.S. 1987. The Exotic Plantation of *Acacia nilolica* and Its Problem on the Ecosystem of Savana Baluran National Park. Duta Rimba 79/80/XIII/1987: 30-34.

KASNIARI, D.N. 1996. The Role *of Chromolaena odorata* in Increasing soil Fertility in Alang-alang Field. MSc. Thesis. University of Brawijaya, Malang.

MOSES, B.C. 1996. A. Concept of Integrated Agriculture, with Reference to the Subsector of Animal Husbandry. A, paper presented to the Regional Symposium. University of Nusa Cendana, March 26, 1996.

SAOALA, AP.S. 1994. Land Fire Control, Experience from Riam Kiwa Plantation Area Established on Alang-alang Grassland. *In:* Tampubolon *el al.* (eds.) From Grassland to Forest: Profitable and Sustainable Reforestation of Alang-alang Grassland in Indonesia. 97-108.

SETIADI, D. 1989. Notes on Weeds under Teak Forest. Proc. 9*. Indonesian Weed Sci. Conf. Ill : 74-78.

SffAYUNG, A. AND R. DESMIER DE CHENON. 1995. *Procecidocrtares connexa* to control *Chromolaena odorata.* A paper presented to the meeting on Release of *Procecidochares connexa,* July 17, 1995. Research Centre of Oil Palm, Medan.

SLAATS, JJ.P. 1995. *Chromolaena odorata* Fallow in Food Cropping System: an Agronomic Assessment in South-West Ivory Coast. PhD. Thesis. Agricultural University, Wageningen. The Netherlands. 117 p.

SYAMSUDDIN, E., T.L. TOEING AND R.A. LUBIS. 1993. Integrated Pest Management in Oilpalm Plantation in Indonesia. BIOTROP Spec. Publ. 50. 137-145.

TJITROSEMrro, S. 1996. The Management *of Chromolaena odorata* (L.) R.M. KING & H. ROBINSON in Indonesia *In:* Prasad *et al.* (eds.). 1996. Proc. 3rd. International Workshop on Biological Control and Management of *Chromolaena odorata:* Distribution, ecology and Management of *Chromolaena odorata.* Agricultural Experiment Station, Univ. Guam. Mangilao, Guam, USA.: 135-142.

TJmosoEDIRDJO, S., S.S. TJITROSOEDIRDJO AND R.C. UMALY. 1991. The Status *of Chromolaena odorata* (L.) R.M. KING & H. ROBINSON in Indonesia. BIOTROP Spec. Publ. 44: 57-66.