BIOTROPIA No. 12, 1999 : 19-24

THE ESTABLISHMENT OF *PROCECIDOCHARES CONNEXA* IN WEST JAVA, INDONESIA : A BIOLOGICAL CONTROL AGENT OF *CHROMOLAENA ODORATA*

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ABSTRACT

Kirinyu *(Chromolaena odorata* (L.) R.M. King and H. Robinson) was reported for the first time in 1934 from Lubuk Pakam North Sumatera. It grows vegetatively during the wet season, flowers and sets a high number of fruits at the end of the wet season, and senesces during the dry season. It may be controlled manually by uprooting the weed or by slashing, and chemically by spraying with herbicides. However, this has not been successful. Recently a biological control agent, *Procecidochares connexa* was introduced at Parung Panjang, West Java, as a biological control agent of *C. odorata.* This paper reports the successful establishment of *Procecidochares connexa.* Two releases of *P. connexa* colonies were made in Parung Panjang at the end of 1995. The colony was able to survive through a harsh dry season of 1997. When *C. odorata* was swept by fire, the emerging shoots soon were attacked by *P. connexa.* The population of C. *odorata* went down to 37.2% with 31.8% of its emerging shoots attacked by *P. connexa* in a 2-year period. When twigs were attacked by *P. connexa,* the production of cypsellas was reduced by about 50% in one season. However, the survival of emerging flies was also affected by the death of twigs upon maturation of the cypsellas.

Key words: Biological *controUChromolaena odoratalProcecidochares connexa*

INTRODUCTION

The first herbarium record in Indonesia of *Chromolaena odorata* was from Lubuk Pakam, North Sumatera, reported in 1934 (Tjitrosoedirdjo 1990). The specimen was identified as *Eupatorium repandum,* but re-identified by van Steenis as *Eupatorium odoratum,* and is now called *Chromolaena odorata.*

It is a shrub, capable of growing up to 7 m tall when a tree is available to climb on. Normally it forms a thicket of branches of 1.5-3.0 m height. When cut the stem will regrow. Being a member of the Compositae, flowers are arranged into clusters consisting of 30-35 uniform flower units, with 3-5 composit flowers at one terminal point. In an established community, flowers may number 3200/m^2, to yield a total of 960 000/ha flowers at one time, so in one season 1 ha of *C. odorata* may produce more than 10 billion seeds. As a result *C. odorata* will spread very fast. Gauitier (1993) estimated that the weight of each dried fruit is approximately 0.2 mg. With its long papus, this fruit will be able to float and reach a very high altitude as reported by White (1970) and at 500 m it will be able to spread as far as 5 km from its point of origin.

C. odorata was shown to have a high Relative Growth Rate (RGR), although it has low Net Assimilation Rate (NAR) (Tjitrosemito 1996). NAR is a physiologica index indicating the plant's efficiency in converting solar energy for the reduction of CO_2 to carbohydrate. This low NAR was more than compensated for by a high value of Leaf Area Ratio (LAR). It shows that, although the NAR is low, the carbohydrates produced are utilized to produce leaves. Therefore, it has a very high RGR. *Ischaemum timorense,* being a C_4 photosynthetic plant has a high efficiency for its physiological activities, but a low RGR, because most of the photosynthate was used for the generation of stolon, a plant part which is not very productive.

In Java the common method of controlling *C. odorata* in plantation is by uprooting the weeds and placing the stem upside down above the soil, because if it contacts the soil, it will regrow. Other methods are either chemical control or slashing conducted at prohibitively high cost (Tjitrosemito 1996).

Considering the characteristics of *C. odorata,* it seems that biological control agents that attack leaves, branches, and flowers may be a good approach to control this weed. Accordingly, the biocontrol agent *Pareuchaetes pseudoinsulata* was introduced. However, despite its successful establishment in Sumatera, it does not do well in Java. On the other hand another biocontrol agent, *Procecidochares connexa* established more readily, and since its release in 1995 survives in West Java.

Rearing of *P. connexa* has been reported elsewhere (Tjitrosemito 1996). Release was also readily achieved and spread in terms of areas covered by recorded galls, occurred logarithmically. It showed an intrinsic rate of increase in the area covered as r = 1.3. This paper reports the establishment *of P. connexa* and its impact on the population growth of C. *odorata.*

METHODOLOGY

Population *of Procecidochares connexa*

The population of *P. connexa* was estimated by taking samples using line transects starting from the center of the field, drawn in 4 cardinal directions. Along each of the line transects at intervals of 20 m, quadrants measuring 2 x 2 m^2 were established. In each quadrant, the number of shoots and galls were counted. A sample of 20 shoots taken at random was obtained from each quadrant, brought to the laboratory and the presence of eggs was recorded under a binocular microscope. Monitoring was carried out at 2 monthly intervals. The extent of population spread was estimated by the presence of galls. From the release sites, a line was followed to the farthest distance covered by the gall and this distance was used as the measure of spread in October 1997.

Impact *of P. connexa* on the *Chromolaena odorata* population

To evaluate the impact of *P. connexa* on *C. odorata,* the population of C. *odorata* in the permanent plots was counted and compared with that at the time of release, including the number of galls found on the plot. The effect of galls on seed production was measured by randomly selecting 65 *C. odorata* plants free of *P. connexa* and compared to another batch of 65 plants selected at random from those attacked by *P. connexa.* The number of twigs, flowerheads and cypsellas were recorded.

The effect of flowerheads on the development of galls for fly emergence

Batches of galls with and without flowers were observed on 8 populations. The numbers of successful emergence of flies from galls were recorded and statistically evaluated.

RESULTS AND DISCUSSIONS

Population *of P. connexa*

The recorded number of shoots carrying eggs of *P. connexa,* and the number of galls are presented in Table 1.

Table 1. The percentage of shoots carrying eggs and noticeable galls

	Time						
	Jan.	Feb.	Apr.	Jul.	Aug.	Oct.	Dec.
Eggs	30.1	27.9	27.4	31.1	52.2	39.5	34.0
Galls	27.1	25.9	17.1	25.7	40.7	34.7	29.2

The precentage of shoot bearing eggs went down slightly from January (30.1%) to April (27.4%), but went up again to reach a peak in August (52.2%). It seems that during the wet season, when growth of *C. odorata* was rapid and shoots were abundantly available, the number of emerging flies was still too low to visit the available shoots, thus accounting for the low precentage of shoot carrying eggs. When the dry season approached *C. odorata* did not produce new shoots, because it began to flower. The percentage of shoot bearing eggs increased to reach a maximum value of 52.2% in August 1997, but went down again to 34.0% in December. It is interesting to note that percentage of galls was always lower than that of eggs.

Population spread

The spread of the population was recorded in October 1997 and is presented in Table 2.

Table 2. The population of galls in a 2 x 2 m^2 quadrant at various distances measured from point or release

release

Distance (m)	Galls per 2 x 2 m2
500	17
1000	23
1500	19
2000	17
2500	11
3000	7
3500	11
4000	4
4500	6
5000	4
5500	1

double the size of the area each month. It was slower than previously reported when it was observed that doubling in size of the infested area occurred each 0.5 month. Since spread is also affected by the availability of *C. odorata* plants, this was not unreasonable.

Impact on *C. odorata*

The permanent plot established in 1995 contained a very dense vegetation of C *odorata*. In 5 x 5 m^2, 145 plants with 2333 shoots were present. The initial releases in December 1995 were made with 75 pairs of flies and repeated again with 100 pairs. In 1997 the site was swept by fire and the population of C. *odorata* became 54 plants/5 x 5 m^2 containing 891 shoots. Although the plot was burnt down, the surviving plants quickly took over, and only 4 new recruits were recorded in the permanent plot, eventhough 90 plants disappeared during a 2-year period. The new recruits were still small in December 1997, and an old surviving stump was able to regrow bearing 74 new shoots (buds) in the plot. The infestation of *P. connexa* remained high, as indicated by the 277 galls recorded on the permanent plot. This meant that 31.08% of all shoots were infected by flies. This was much higher than 5% reported in December 1995. The population of *C. odorata* was reduced leaving only 37.2% of the original population, and the shoot was reduced to the same extent i.e. only 38.2% remained, with 31.08% infested by *P. connexa*. Here, biological control was effective.

The effect of galls on seed production

While the number of twigs did not differ significantly among plants attacked or not by *P. connexa* the flower heads differed significantly in numbers. Formation of galls seemed to draw nutrition from the plants, reducing flower head development from 40.95/plant to 27.7/plant (see Table 3). The reduction of seed production was even more conspicuous, i.e. from 1391.5 cypsellas/plant down to 647.6 cypsellas/ plant, a reduction of about 50%.

Table 3. Cypsellas/plant production as affected by *P. connexa* recorded on 65 plants

Characters	Plants with galls	Plants without galls	Statistical test
Number of plants	65	65	NS
Number of twigs	264	316	NS
Flowerheads/plan	27.7	40.95	P <. 0.05
Cypsellas/plant	647.6	1391.5	P^O.Ol

The effect of flowerheads on the development of galls leading to fly emergence

Comparison of population of galls having flowerheads and those that did not show a very significant difference in gall development at the 1% level. Galls developed on shoots without flowerheads produced 0.8 successful emergences, while galls developing on growing flowerheads produced only 0.3 successful emergences (see Table 4). This is caused by the fact that twigs bearing flowerheads will soon dry up following maturation of fruits.

Table 4. The emergence of flies from galls (8 populations of 20 colonies of galls, with and without flowers)

No.	Colony with flowers	Colony without flowers	Statistical test
1	0.40	0.90	
2	0.30	0.70	
3	0.20	0.80	
4	0.35	0.90	
5	0.30	0.75	
6	0.35	0.90	
7	0.40	0.65	
8	0.40	0.95	
Mean	0.33	0.82	PS 0.01

This finding has a practical implication as the survival of emerging adults is reduced significantly by drying out of the bearing flowerheads. When all twigs are dried up it destroys the colony of *P. connexa.* The condition in Parung Panjang seems to support the perpetuation of the colony of *P. connexa,* since the population has survived the harsh dry season in 1997.

ACKNOWLEDGEMENT

This research has been funded by ACIAR through ACIAR Project No. 9110. Biological Control of *Chromolaena odorata* in Indonesia and the Philippines.

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