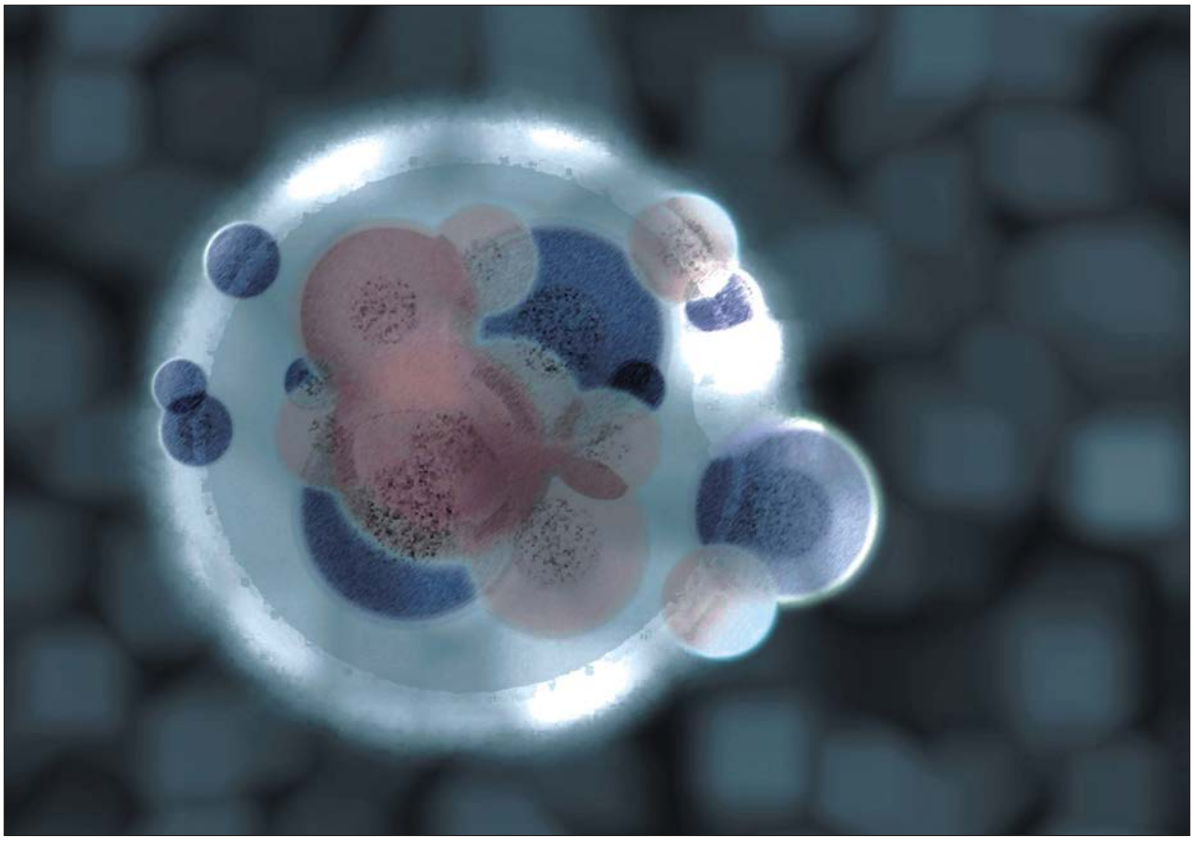

Journal of Biological Sciences

ISSN 1727-3048

science alert

ANSInet
an open access publisher
http://ansinet.com

Journal of Biological Sciences 9 (6): 633-636, 2009
ISSN 1727-3048

Survival and Sex Ratio of a Planted Rattan *Calamus palustris* Griff. Population: Implication to Seed Production and Management

C.Y. Choong, R. Wickneswari and S. Fatimah
School of Environmental and Natural Resource Sciences, Faculty of Science and Technology,
Universiti Kebangsaan Malaysia, 43600 Bangi, Selangor, Malaysia

Abstract: *Calamus palustris* Griff. is a dioecious rattan species of commercial importance for its canes. The sex of *C. palustris* can only be identified from the morphology of the inflorescence. In this survey, the sex ratio of *C. palustris* planted in 2001 in an experimental plot at Universiti Kebangsaan Malaysia, was studied. The survey was conducted from September 2003 to July 2006. A total of 46 male and 43 female plants were identified from the 140 surviving plants in the plot. This gave a ratio of female to male as 1:1.1 with no significant difference compared to an even ratio 1:1. The survival percentage of the planted population was 93.3%. The female plants had 1-7 stems per clump, while the male had 1-10 stems per clump with an average of 4 stems per clump for both the sexes. The even sex ratio of the planted *C. palustris* population might indicate absence of post zygotic sex selection and unbiased sex selection during seed germination.

Key words: Sex ratio, *Calamus palustris*, rattan, dioecious, planted population

INTRODUCTION

The evolution of sex ratios has long been a focus of scientific interest. Investigation of sex ratios is vital for the understanding of sex ratio deviation in the tropical ecosystem. Sex ratio studies on dioecious plant species are important to predict deviations from an equal (1:1) ratio of male and female plants. Many theoretical studies have shown that an equal zygotic (primary) sex ratio is to be expected in most cases based on the fact that each offspring produced will contain equal gene complements from male and female parents in a dioecious sexually reproducing population. If there is an excess of one sex in the population, the fitness of individuals of the opposite sex will increase through mutation and selection mechanisms, primary sex ratios are expected to be kept in an evolutionary balance near one to one (Meagher, 1981). However, skewed sex ratios have been reported in adult populations for a number of different plant species (Sakai, 1990). The implication of skewed sex ratios in dioecious plant species is especially vital in the planning of seed production areas, studies on genetic diversity as well as on conservation of near-extinct species (Opler and Bawa, 1978). Such deviations could be the result of genetic mechanisms, which bring about unequal numbers of male and female progeny or they could be the result of post-zygotic life history differences between males and females (Meagher, 1981).

Calamus palustris Griff. or locally known as rotan Langkawi is a dioecious rattan species with a limited distribution in the Northern part of Peninsular Malaysia. Its medium size diameter (18 mm) cane is mainly used for making furniture and handcrafts. *Calamus palustris* is a clustering rattan species which produces multi stems from one individual plant. The gender of the plants can only be identified when the plants start flowering at the age of 3-4 years. The male inflorescence from the male plant has only male flowers, while the female inflorescence from the female plant has fertile female flowers but sterile male flowers. Furthermore, the gender identification can also be done by observing the branching pattern of the inflorescence. In the male inflorescence, the second order branching bears flowers. On the other hand, the third order branching in the female inflorescence bears flowers. No conclusive study has been made to determine the *C. palustris* sex ratio in wild populations, mainly due to the difficulty of finding undisturbed populations in the wild and its limited distribution in the Northern part of Peninsular Malaysia. Therefore, the estimation of sex ratio of this and other rattan species could only be made in established plantations and experimental plots (Aminuddin and Nur Supardi, 1993; Chia, 2000). A more conclusive survey would help in understanding the existing sex ratio and the factors influencing the sex determination in *C. palustris*. The understanding of sex

Corresponding Author: Dr. Chee Yen Choong, School of Environmental and Natural Resource Sciences, Faculty of Science and Technology, Universiti Kebangsaan Malaysia , 43600 Bangi, Selangor, Malaysia
Tel: 603-89213848 Fax: 603-89253357

ratio would contribute towards better management of natural stands and the development of seed orchard to ensure efficient seed production for the rattan plantation. Therefore, the study presented here was undertaken to determine the sex ratio of a planted population of *C. palustris* in an experimental plot established in the campus of Universiti Kebangsaan Malaysia, Bangi, Selangor.

MATERIALS AND METHODS

The planted population of *C. palustris* in an experimental plot located at a 45-degree slope in the campus of Universiti Kebangsaan Malaysia was surveyed. A total of 150 *C. palustris* plants were inter-planted with *Acacia* trees (mixture of *Acacia mangium* Willd., *A. auriculiformis* A. Cunn. ex Benth. and the *Acacia* hybrid) in early 2001. The *Acacia* trees provide support for the climbing rattan plants. The *C. palustris* plants were planted in three rows corresponding to the three rows of *Acacia* trees with a distance of 1 m between the rows and 1.5 m within the row. Each rattan plant in a row was separated by an *Acacia* tree. The first sight of flowering of the rattan population was spotted in September 2003.

The field observation to identify the gender of the rattan plants was conducted from September 2003 to July 2006. The gender identification was done based on the morphology of the inflorescence (Raja-Barizan, 1992). In *C. palustris*, inflorescence are produced close to the shoot of the new leaves which are normally located high in the canopy. Therefore, a pair of binoculars was used in the field observation. The number of stems per individual plant was also recorded towards the end of the survey (July 2006). The sex ratio was then calculated and test of goodness-of-fit (χ^2) (Snedecor and Cochran, 1989) was used to test whether the ratio is in agreement with the theoretical value of 1:1.

RESULTS

The *C. palustris* population in the experimental plot was planted in the early of 2001. The plants started to bear flowers in September 2003. Therefore, it took the *C. palustris* population in the plot roughly 3 years to start its first flowering. Nevertheless, it was noted that only seven plants (five females and two males) produced inflorescence during the first flowering season.

Of the 150 seedlings planted in the plot, 140 plants survived after 3-4 years of planting. A total of 10 plants died in the early stage of growing when the plants were still in rosette form (plant without elongated stem). This gave a survival of 93.3 % indicating a low mortality of *C. palustris* plants. During the period of observation, a total of 89 plants (63.6 %) had reached their reproductive stage. Of these, 43 individuals were female and 46 were male, giving a ratio of female to male as 1:1.1. Calculated chi-square (χ^2) at one degree of freedom gave a value of 0.044 (Table 1). This ratio was statistically not significant compared to an equal ratio 1:1.

Table 1: Chi-squared (χ^2) test

Number	Male	Female	Total
Observed (O)	46.00	43.00	89.00
Expected (E)	44.50	44.50	89.00
O-E	1.50	-1.50	-
([O-E]-0.5)	1.00	-1.00	-
$([O-E]-0.5)^2$	1.00	1.00	-
$([O-E]-0.5)^2/E$	0.022	0.022	0.044*

*p>0.05

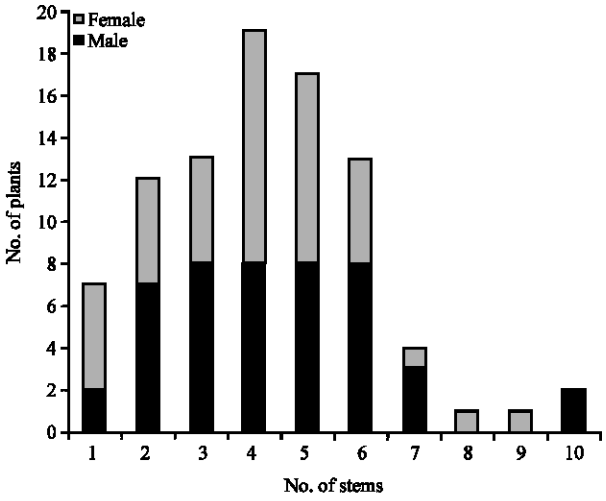

Fig. 1: Comparison of number of stems between male and female plants

At the age of 5-6 years, *C. palustris* could produce up to 10 stems per individual plant (Fig. 1) with an average of 3 stems per individual plant. The numbers of stems per individual male and female plants were 4.3 and 4.0, respectively.

DISCUSSION

The determination of reproductive age is particularly important for plant propagation through seed as plant breeders could estimate the schedule of seed production. The reproductive age varies among rattan species. The first flowering in *C. palustris* generally is close to (2.5 years) *C. subinermis* H. Wendl and Becc. (Chia, 2000), but much earlier than *C. manan* Miq. which usually takes 5-6 years (Raja-Barizan, 1992). However, it should be

noted that the age of first flowering obtained in this study was that of a planted population. It is not clear if wild populations would have similar behaviour to that of planted populations. Nevertheless, the data from planted populations is of much useful to design seed orchard for plant propagation.

The planted *C. palustris* population generally had higher survival (93.3%) than that of other rattan species. Jaya-Kumar *et al.* (2005) reported a low survival (57 %) of a planted *C. manan* population in a secondary forest. *Calamus palustris* is a clustering (multi stems) rattan species whereas *C. manan* is a solitary rattan species. Any damage to the solitary stem of *C. manan* will cause the death of the plant. On the other hand, a dead stem in *C. palustris* will readily be replaced by a new stem. The good number (roughly four) of stems per individual plant of *C. palustris* ensures the survival of *C. palustris* even though a stem is damaged or withered. This could be one of the factors contributing to the high survival rate of *C. palustris* when compared to *C. manan*. Furthermore, the inter-planted *Acacia* trees in the plot were strong and massive to provide good support to the *C. palustris* to reach the canopy. Presence of support trees is important to ensure the survival of climbing rattan species (Aminuddin and Nur Surpadi, 1993). The number of stems per clump in *C. palustris* is also of much interest in planting the rattan species for cane production. Each stem generated from a clump is potential to be harvested to produce cane.

The equal sex ratio had been observed in the planted *C. palustris* population. Natural populations of many dioecious plant species tend to have equal sex ratio (Rottenberg, 1998, 2000) and some may bias in favour of male (Dupont and Kato, 1999). The female biased sex ratio for dioecious plants is infrequent (Stehlik and Barrett, 2005). It is not clear if the equal sex ratio observed in the planted population would also be applied to natural populations. The limited species distribution, the dwindling population due to over harvesting and unclear flowering seasons are among the factors hindering the sex ratio study of natural population of *C. palustris*. Nevertheless, the sex ratio in planted populations is of much interest for the purpose of seed production for rattan plantations. Based on the sex ratio, a proper planting design of seed orchard may be adopted for maximizing the seed production.

On the contrary, *C. manan* has a different sex ratio compared to *C. palustris* though both the rattan species are closely related. It was reported that planted *C. manan* populations have sex ratio in favour of male (Aminuddin and Nur Surpadi, 1993; Jaya-Kumar *et al*., 2005). The skewed sex ratio (female to male) in *C. manan* was as high as 1:1.55 (Aminuddin and Nur Surpadi, 1993). It was postulated that the high mortality in the *C. manan* populations contributed to the skewed sex ratio (Aminuddin and Nur Surpadi, 1993; Jaya-Kumar *et al*., 2005). Differential mortality rates have been put forth as a factor resulting in male-biased sex ratios in several dioecious plant species (Meagher, 1981). Male plants allocate a lower proportion of their resources to sexual reproduction than female plants. Therefore, male plants may show greater vegetative vigor and hence lower mortality. The female *C. manan* could have higher mortality rate (Jaya-Kumar *et al*., 2005). On the other hand, the number of stems per female individual (4.0) in the *C. palustris* population was lower than that of the male individuals (4.3) indicating by the high tendency of mortality in the female *C. palustris*. The overall survival percentage of the *C. palustris* population may help to counter post zygotic sex selection. Therefore, the equal sex ratio in planted *C. palustris* population is most likely attributed by equal zygotic sex ratio and unbiased sex selection during seed germination.

The equal sex ratio and the age of reaching reproductive stage observed in the planted population of *C. palustris* are crucial parameters for setting up an orchard with suitable design for seed production. However, subsequent surveys of the planted population are important to confirm the observation in this study as the gender of the remaining 36.4% of the surviving plants is not known yet.

ACKNOWLEDGMENTS

This research was supported by Science Fund 02-01-02-SF0404 under the Ministry of Science, Technology and Innovation, Malaysia and Fundamental Research Grant UKM-ST-FRGS0048-2006 under the Ministry of Higher Education, Malaysia.

REFERENCES

Aminuddin, M. and M.N. Nur-Supardi, 1993. A note on the sex ratio of *Calamus manan* planted in a secondary forest. J. Trop. For. Sci., 6: 81-82.

Chia, F.R., 2000. The sex ratio of *Calamus subinermis* planted in a secondary forest and *Acacia* plantation. J. Trop. For. Sci., 12: 185-187.

Dupont, Y.L. and M. Kato, 1999. Sex ratio variation in dioecious plant species: A comparative ecological study of six species of *Lindera* (Lauraceae). Nord. J. Bot., 19: 529-540.

Jaya-Kumar, K., C.Y. Choong, R. Wickneswari and R.S. Raja-Barizan, 2005. A sex ratio survey of *Calamus manan* planted in a secondary forest. Proceedings of the 2nd Regional Symposium on Environment and Natural Resources, 2005, Malaysia, pp: 59-61.

Meagher, T.R., 1981. Population biology of *Chamaelirium luteum*, a dioecious lily. II. Mechanisms governing sex ratios. Evolution, 35: 557-567.

Opler, P.A. and K.S. Bawa, 1978. Sex ratios in tropical forest trees. Evolution, 34: 812-821.

Raja-Barizan, R.S., 1992. Phenology of Rattans. In: A Guide to the Cultivation of Rattan, Wan-Razali, W.M., J. Dransfield and N. Manokaran, (Eds.). Forest Research Institute, Malaysia, ISBN: 983-9595-10-6, pp: 39-46.

Rottenberg, A., 1998. Sex ratio and gender stability in the dioecious plants of Israel. Bot. J. Linn. Soc., 128: 137-148.

Rottenberg, A., 2000. A field survey of dioecious plants in Israel: Sex ratio in seven rare species. Bot. J. Linn. Soc., 134: 439-442.

Sakai, A.K., 1990. Sex ratios of red maple (*Acer rubrum*) populations in Northern lower Michigan. Ecology, 71: 571-580.

Snedecor, G.W. and W.G. Cochran, 1989. Statistical Methods. 8th Edn., Iowa State University Press, Ames, Iowa, ISBN: 9780813815619.

Stehlik, I. and S.C. Barrett, 2005. Mechanisms governing sex-ratio variation in dioecious *Rumex nivalis*. Evolution, 59: 814-825.