ESTABLISHMENT, RELEASE AND IMPACT OF MIXED HOST OF SPECIFIC WEEVILS: *Neochetina eichhorniae* (WARNER) AND *N. bruchi* HUSTACHE FOR THE BIOLOGICAL CONTROL OF WATER HYACINTH ON LAKE KAINJI

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ABSTRACT

Neochetina eichhorniae and *N. bruchi*, the two world-wide known host specific populations were obtained from the National Sub-Committee on Water Hyacinth Biological Control Insectary at Ibadan and International Institute for Tropical Agriculture, Field Laboratory at Cotonou in Benin Republic, respectively. These were multiplied separately and between 1995 and 1997 over 20,000 adult weevils of both species in addition to adult plant impregnated with high population of larvae and eggs were used to inoculate mats of fresh water hyacinth communities throughout the Kainji Lake. The tri-monthly monitoring of six selected sites between 1996 and 1999 showed that the weevils infested more than 90 per cent of the individually assessed plants within the first 2 years of releases. The impact of the two weevils indicated a high positive correlation ($r = 0.67$) between feeding scars and dead leaves. Also, a negative correlation ($r = 0.63$) was found between feeding scars and daughter plants development. Although no significant changes were noticed in the reduction of Kainji Lake water hyacinth populations so far, the results of the weevils impact assessment indicated a high potential for their use in water hyacinth infested areas of Nigeria.

INTRODUCTION

Water hyacinth [*Eichhorniae crassipes* (Martius) Solms] is a free-floating aquatic plant, native to South America but has become naturalized in many tropical countries (Nathan Kham, 1927). The plant has become the most pernicious aquatic weed throughout the world (Obeid and Seed, 1976).

In Nigeria, the occurrence of water hyacinth in the coastal area was first reported in 1984 (Akinyemiju, 1987). Since then, the area covered by the weed continued to expand while fresh ones are added annually (Akinyemiju, 1994). Few years after the report, water hyacinth surge was also reported hinterland especially in the River Niger system including Kainji Lake. The surge with the attendant adverse economic and ecological implications and its threat to hydro-electric power generation necessitated an articulated control programme at National Institute for Freshwater Fisheries Research (NIFFR) in collaboration with other Institutions to stem the menace of the weed (Ayeni *et al*, 1996).

Based on field diagnostic surveys of the presence and associated problems of water hyacinth infestation, an integrated control approach to eradicate the weed was chosen. Among the measures was biological control. Biological control though gradual is considered as the "only cost effective permanent and environmentally friendly method" (Greathead and Groot, 1993). Nevertheless, Jayanth (1988) confirmed that monitoring biological control agents takes several years before their impact can be documented. However, notable successes in Argentina, Australia, India, Sudan and USA (Harley, 1990; Julien, 1992) using *Neochetina* *eichhorniae* and *N bruchi* have been reported. Water hyacinth has been brought under good biological control in a number of countries including the Nile River systems in Sudan.

This paper is aimed at providing results on impact of weevils on water hyacinth infestation of Lake Kainji and potential use of weevils in the control of water hyacinth in other Nigerian infested water bodies.

MATERIALS AND METHODS

Weevils Acquisition and Culturing

Cultured adult weevils both *Neochetina eichhorniae* and *N. bruchi* were collected from the National Sub-Committee on Water Hyacinth Biological Control Insectary at National Institute for Horticulture Research (NIHORT), Ibadan and International Institute for Tropical Agriculture (IITA) Field Laboratory in Cotonou, Benin Republic, respectively. Seven hundred weevils of *N. eichhorniae* were harvested from the water hyacinth insectary at NIHORT, Ibadan and transferred to Yauri field insectaries in Kebbi State. The three insectaries each measuring 3 x 4 x 3m were used for the culture of the insect in-situ. Populations of 199 weevils were stocked in a location opposite market square, 198 weevils around Fisheries Department of Kebbi State and 298 released into the insectary behind the Institute (NIFFR) Guest House, Yauri. Five weevils (0.71%) were dead on arrival at Yauri.

In March 1995, 250 adults of *Neochetina bruchi* were acquired from IITA Benin Republic and cultured successfully in the renovated laboratory insectary at NIFFR. On arrival of the weevils, only 3 (1.2%) were dead but the rest were used in pairs to inoculate three individual water hyacinth plants in 20 litre plastic container (adopted from Van Thielen *et al*, 1996). The water level of culturing plastic container was maintained by consistent topping and dilution of highly destroyed container due to weevil activities with fresh uninfected water hyacinth plants.

Releases

Between 1995 and 1997, a total of 15 releases of mixed *N. eichhorniae* and *N. bruchi* were made to cover the infested areas of the Kainji Lake and River Niger system upstream of Lake Kainji. Before releases were made, the local communities were sensitized on weevil activities and assured that the weevils are host specific – only water hyacinth is destroyed. For each release, infested plants, petiole, almost destroyed plants and adult weevils were placed onto mats of healthy water hyacinth plants.

Monitoring Sites

Monitoring of impact of the natural enemies of water hyacinth commenced in 1996 on tri-monthly basis to coincide with the natural life cycle o the weevils. Based on certain criteria, six monitoring sites (Fig. 1) were selected and the criteria used were:

- Accessibility
- Area not frequented by local community
- Constant water and year-round presence of water hyacinth.

At each monitoring site, quantitative parameters on 25 randomly selected individual plants were recorded to detect the effects of the weevils on the weed. The monitoring sites were visited by running a boat into the mat of water hyacinth. For each plant, the following were recorded:

- Number of feeding scars
- Number of dead leaves
- Number of green leaves
- Length of longest petiole
- Length of the leaf of the longest petiole
- Number of daughter plants produced
- Number of green flowers
- Number of dead flowers
- Presence of larval tunnels.

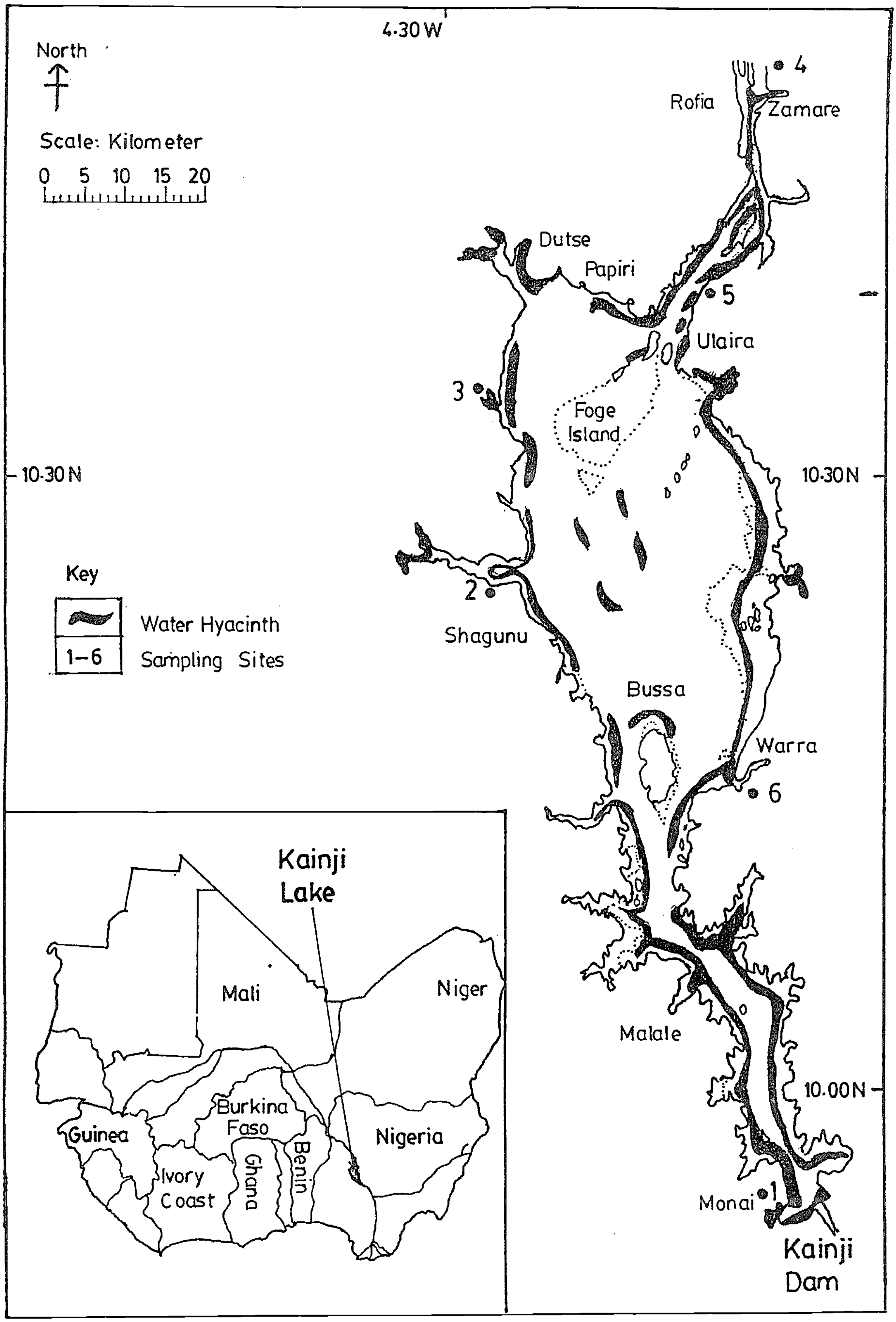

Fig. 1 **Map of Lake Kainji showing water hyacinth infestations and weevils impact sampling sites (1996)**

RESULTS AND DISCUSSION

Between 1995 and 1996, more than 20,000 adult weevils of *Neochetina* spp in addition to several plants heavily ladened with larvae and eggs were harvested and released to infest mats of fresh water hyacinth. Both *Neochetina eichhorniae* and *N. bruchi* were released in 1995. Tri-monthly monitoring commenced in October 1996. More than half of the plants found at monitoring sites showed feeding scars within the first two years of weevil releases. In April 1997, over 90% of the individually assessed water hyacinth plants showed feeding scars. Mean number of feeding scars was 15/plant. Figure 2 shows the trend of feeding scars observed from October 1996 to July 1999. Although the presence of the weevils for individual plants steadily increased, the mean number of feeding holes fluctuated in relation to Lake water level and abundance of water hyacinth plants. The highest mean number of feeding scars was obtained in April 1998 but generally, weevils' impact was more noticeable during the low lake water level due to lower abundance of water hyacinth plant coverage. Apart from removal of water hyacinth plants in some beaches, the lake hydrology allowed plants to be stranded, dried and burnt. Thus, during the low water level, these combined activities reduce water hyacinth population appreciably. Conversely, at high water level, new mats of water hyacinth from the neighboring countries ingressed into the lake resulting into dilution effect such that weevil populations were dispersed over a wide area and consequently lowering the numbers of feeding scars. Bashir and Bennett (1985) observed similar trend on the Nile River.

In general, more weevil activities were observed on water hyacinth plants in the creeks and river tributaries than those found along the beaches and open water. This is because weevils have better chance to gather and breed in the relativey shielded area than in open water where continuous current, wave action and drifting regularly occurred. During the yearly low water level period, April to August, up to 5 – 9 leaves (50 – 70%) usually turned brownish and senescent resulting into dead leaves (Fig. 2). The combined effects of plant desiccation and reduction of photosynthetic area due to insects feeding on the leaves accounted for high number of dead leaves. The impact of the two weevils indicated a high positive correlation between feeding scars and dead leaves ($r = 0.67$). Goyer and Stark (1984) reported a comparable result on the dynamics of dead leaves of water hyacinth infested with these weevils. The damage caused by *Neochetina* spp is mainly attributable to the larvae. Larvae tunnel internally through the petioles and into the crown of the plants causing them to rot, die and submerge.

The number of green leaves was not only strongly influenced by insect damage but also by plant density ($r = 0.82$). High insect damage and plant density decreased leaf production (Fig. 3). The inability to produce leaves at rates necessary to compensate for losses due to heavy insect damage results in reduced plant vigour, as noticed at some monitoring sites. Several authors observed that the number of green leaves diminished as a result of *Neochetina* infestation, leading to the loss of buoyancy (Centre et al, 1989; Grodowitz et al, 1991).

Generally, the number of green leaves counted when monitoring started was higher than in the subsequent monitoring periods, though not significantly different ($P > 0.5$). A negative correlation was obtained between the green and dead leaves.

Figure 4 shows the rate of daughter plants development between October 1998 and April 1999. Further analysis indicated a negative correlation between feeding scars and daughter plants development ($r = 0.63$). As feeding scars increased, the number of new offshoots decreased. Daughter plants that serve as the recruitment potentials of parent plant are usually produced from brittle stolon that grows laterally below the surface. Thus apart from reduced photosynthetic area of the adult plant, the weevil larvae that tunnel through the stolon and rhizome further destroy plant food

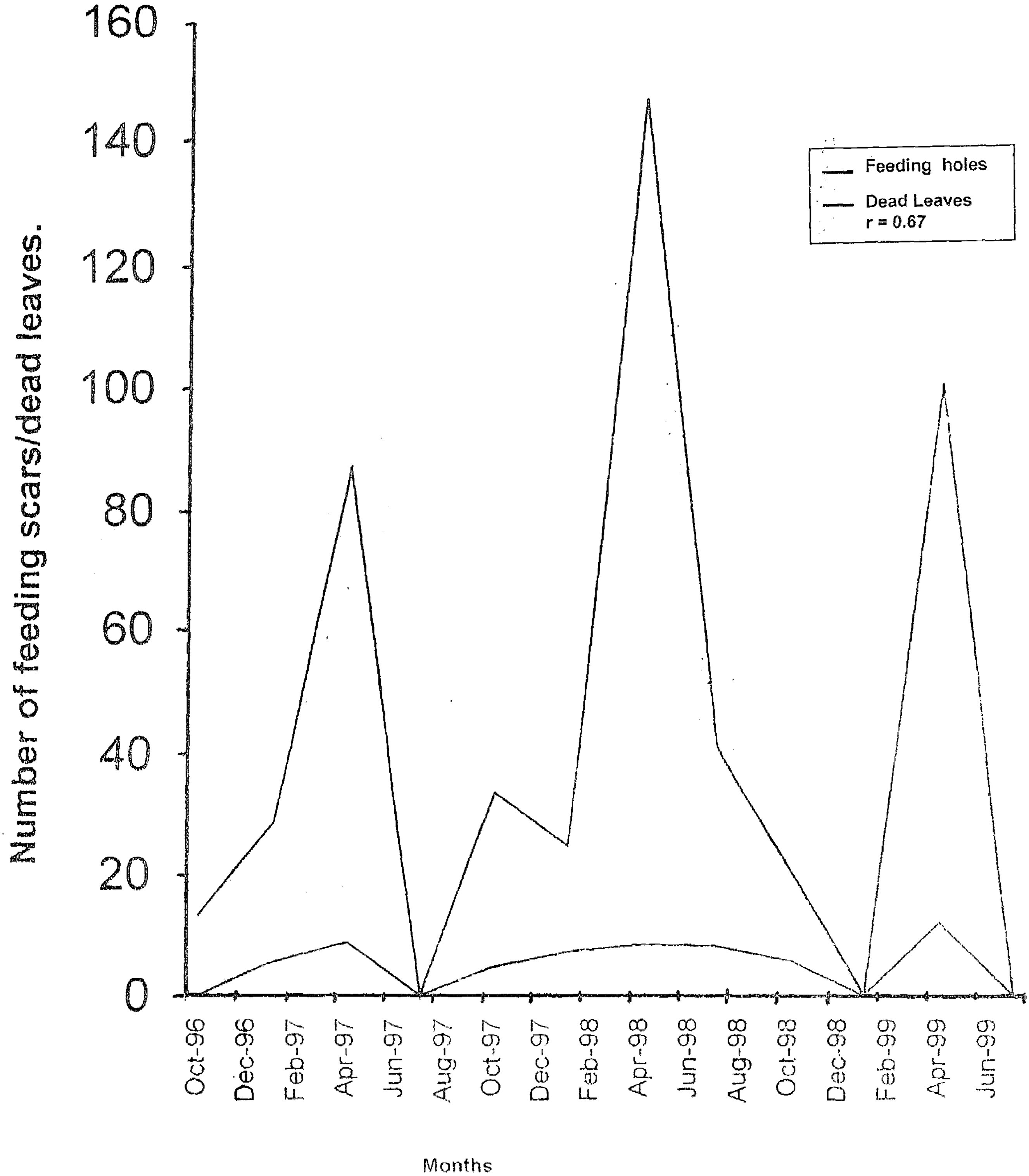

Fig. 2: Weevil feeding activities in relation to water hyacinth leaves desication.

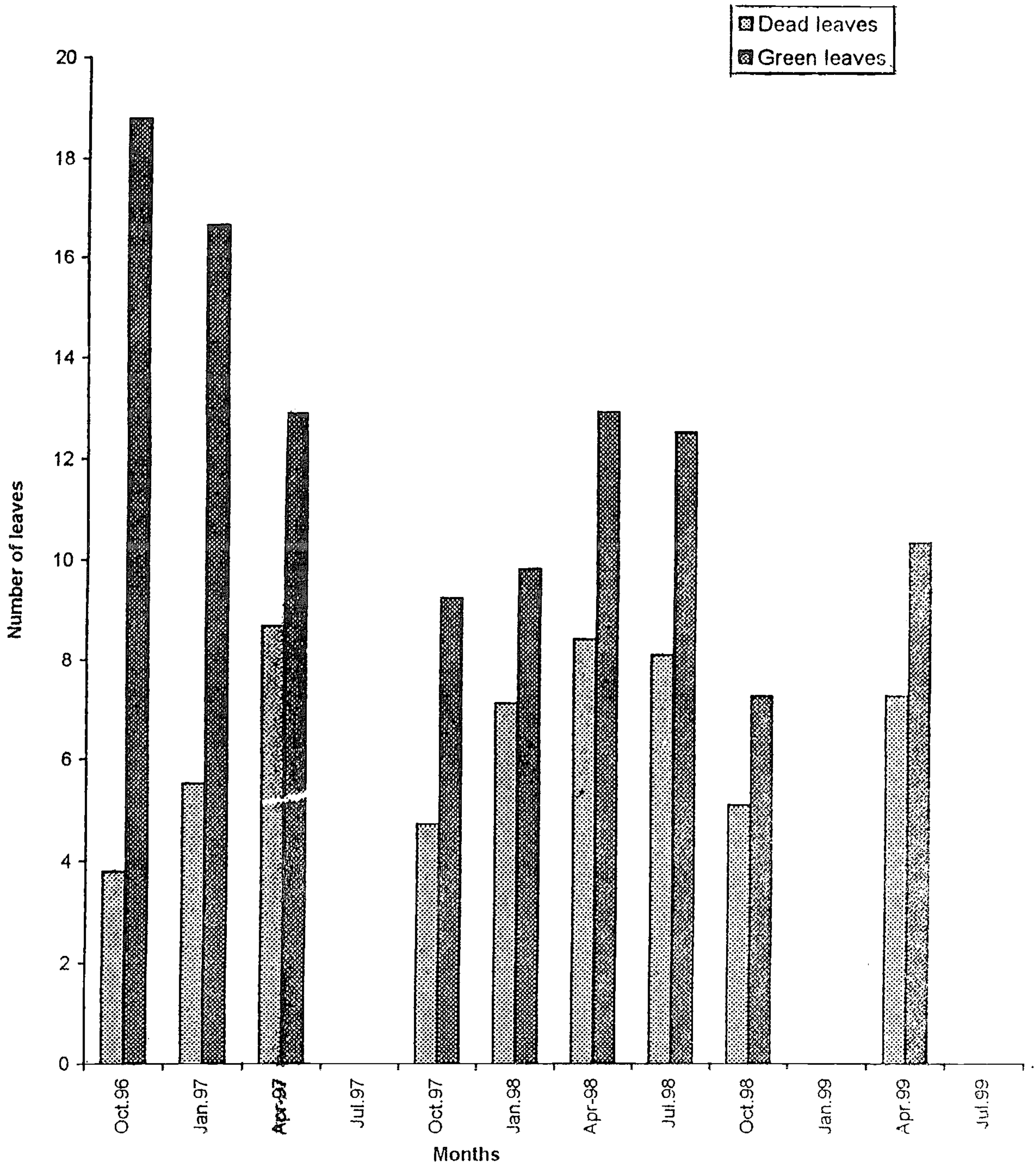

Figure 3: Effects of the two weevils on water hyacinth leaf production (periods without bars indicate when data were not collected).

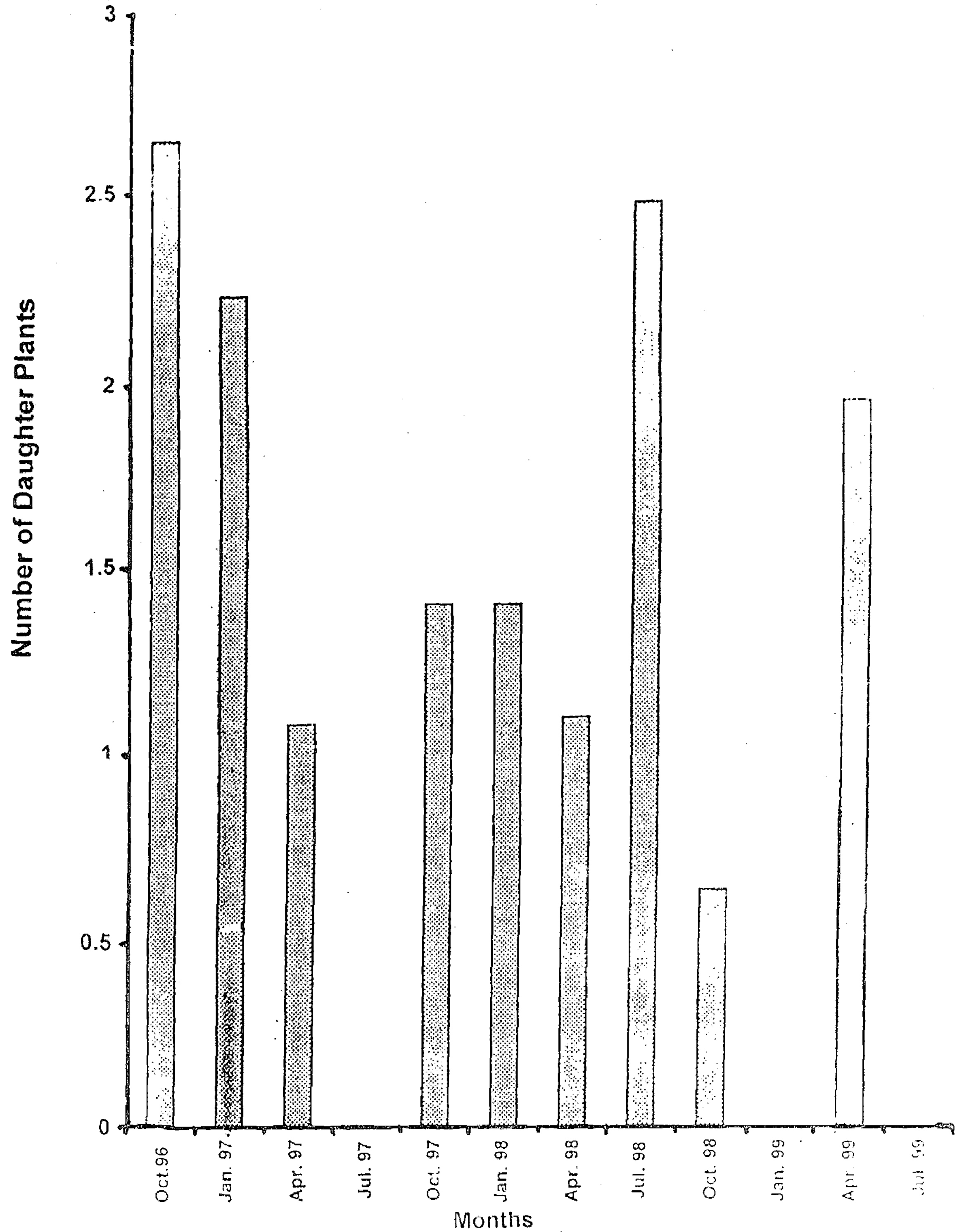

Figure 4: Rate of daughter plant development by the assessed water hyacinth plants (periods without bars indicate when the data were not collected).

reserve resulting in reduced reproductive potentials and consequently die off. The physiological response of the infested water hyacinth plants accounted for the decreased daughter plants.

CONCLUSION

Results from this study have shown that *Neochetina* spp have been fully established on Lake Kainji. Adjudged from the presence of numerous holes caused by *Neochetina* sp on water hyacinth plants affirmed the effectiveness of *N. bruchi* and *N. eichhorniae* as an effective biological control agent for water hyacinth spread.

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