Biodiversity in Replanted Mangrove Forests: A Study in the Southern Viti Levu Island Mangrove Ecosystem in Fiji

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Abstract

The biodiversity level of mollusks and environmental conditions in replanted as well as natural mangrove forests were investigated to determine the restoration level in replanted mangroves. This study was performed in 2 replanted and 2 natural mangrove forests in 2003 and 2004 in Viti Levu Island, Fiji. The ages of the trees in each replanted mangrove were 1-3 and 7 years old. The main mangrove tree species replanted in both areas was *Rhizophora stylosa*. The mangrove trees in the natural forest were between 5 m and 20 m in height. However, those in the forests replanted 1-3- and 7 years previously were from 1 m to 1.5 m and from 3 m to 4 m in height, respectively. Trees near the landside were taller than those on the seaside in all of the mangrove forests examined. Salinity in the regions of the replanted mangroves was about 3% but that in natural mangrove forests was from 0.2 to 3%. The older mangrove forests had neutral pH but younger forests were alkaline. About 10 mollusks were counted in natural forests but the replanted mangrove forests contained only 2 to 3 mollusks. Each quadrate showed a different frequency of observed mollusks. *Littorina scabra* was the dominant species in the 1-3-year-old mangrove forest. *Nerita planospira* and *Littorina scabra* were the dominant species near the landside but only *Littorina scabra* were dominant near sea side in the 7-year-old replanted mangrove. Environmental conditions and biodiversity levels in replanted mangrove forests were different from those in natural mangrove forests. However, the 7-year-old mangrove forest showed a slightly higher biodiversity level than 1-3-year-old forest and environmental conditions similar to those of the natural forest.

Key words: biodiversity, Fiji, mollusks, replanted mangrove, Viti Levu Island

Introduction

Biodiversity is very high in mangrove forests and coastal reefs. Mangrove forests provide protection from predators and habitat for juveniles. Accumulation of detritus and leaf material in mangroves might also provide an enhanced food source for macrofauna, *e.g.*, detritus feeders and filter feeders. Although the mangroves provide a complex habitat that provides spaces for juveniles to escape from predators, these forests are also good environments for predators because of the presence of many small and juvenile animals. Moreover, there are many

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industrially important species in these forests.

Mangroves formerly occupied about 75% of tropical coasts and inlets (Farnsworth & Ellison, 1997). However, more than 50% of the world's mangroves have been lost (World Resources Institute, 1996) due to population pressure, wood extraction, conversion to agriculture and salt production, tin mining, coastal industrialization and urbanization, and conversion to coastal aquaculture (Ong, 1995; Macintosh, 1996). These mangrove losses have resulted in a reduction in biodiversity and a decrease in the number of industrially important macrofauna.

Habitat rehabilitation has increased in importance over the last two decades and mangroves have been replanted around the world (Field, 1998). Field (1999) suggested that there are 4 main reasons for rehabilitating mangroves: conservation, landscaping, sustainable production, and coastal protection.

The dominant macrofauna in terms of number and species are the crustaceans and mollusks (Sasekumar, 1974; Jones, 1984). Although there have been several studies of mangrove fauna, little information is available regarding the effects of replanted mangroves on the faunal community.

The present study was performed to monitor the biodiversity and environmental conditions in replanted mangroves in comparison with those of natural mangrove forests.

Materials and Methods

This study was carried out in 1 natural (Naikawanqa) and 2 replanted (Korotogo and Namboutini) mangrove forests from August to September 2003 and in 1 natural mangrove forest (Laucala Island) in February 2004 in Viti Levu Island, Republic of Fiji Islands (Fig. 1).

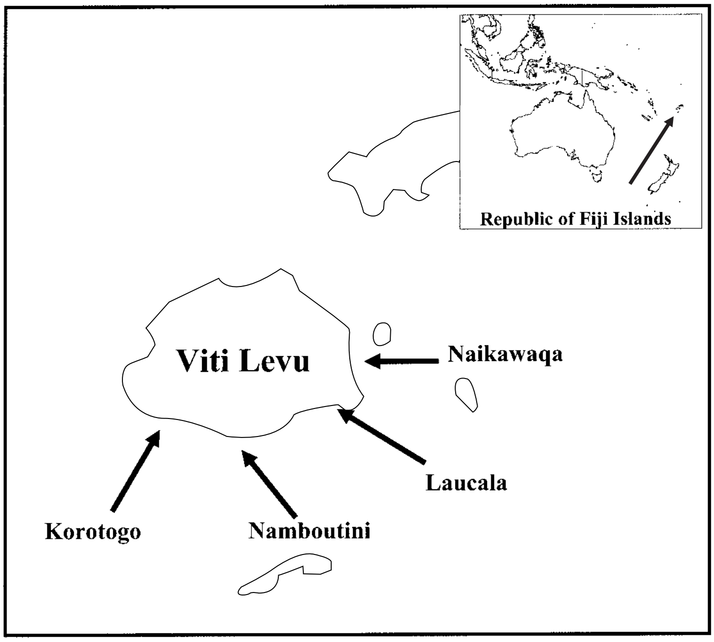

Fig. 1 Map of research area in Viti Levu Island, Fiji.

Mangrove forests in Korotogo and Namboutini were replanted in 2000-2002 and 1997, and therefore the ages of the trees were 1-3 and 7 years old, respectively. The sizes of the replanted areas from landside to seaside were about 40 x 100 m^2 and 100 x 50 m^2, respectively. The replanted mangrove trees in both areas were mainly *Rhizophora stylosa*. Naikawanqa and Laucala Island were rural and city natural forest and the lengths from landside and seaside were 150 m and 250 m, respectively.

One line transect were placed from seaside to landside in each mangrove forest. The line transect was divided equally into 5 intervals and two 2×2 m quadrates were placed at random in each divided area. We monitored the total numbers of snails and bivalves on the trees and on the ground surface in each quadrate. Each species was recorded and the total numbers of each species were counted.

The ground was dug to a depth of 50 cm in each quadrate and the salinity and pH of the seawater exuded from the ground were measured. The heights of the mangrove trees in each quadrate were also measured.

Results and Discussion

The heights of the highest mangrove tree in each quadrate in each mangrove forest are shown in Fig. 2. In the natural forest, the mangrove trees ranged in height from 5 m to 20 m. However,

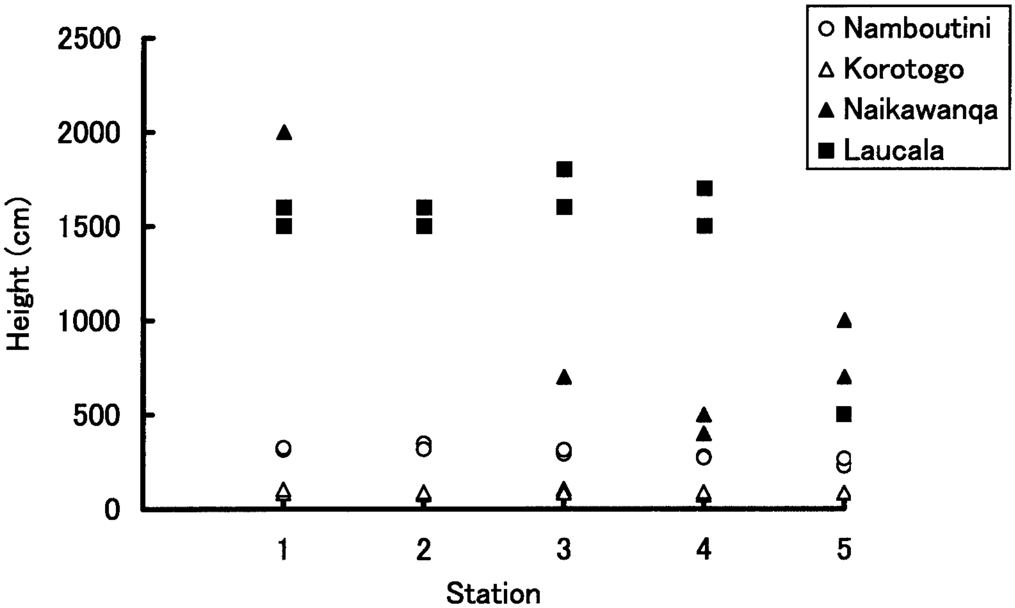

Fig. 2 Height of highest mangrove tree in each quadrate in each mangrove forest.

in the 1-3- and 7-year-old replanted mangroves the trees ranged in height from 1 m to 1.5 m and from 3 m to 4 m, respectively. Trees near the landside were taller than those on the seaside in all mangrove forests.

Both replanted mangrove forests showed salinity of about 3% continuously from seaside to landside. However, in both natural mangrove forests the salinity decline from seaside to landside, and this trend was more marked in Naikawanqa than in Laucala Island (Fig. 3). The older mangrove forests had neutral pH, while the younger forests were alkaline (Fig. 4).

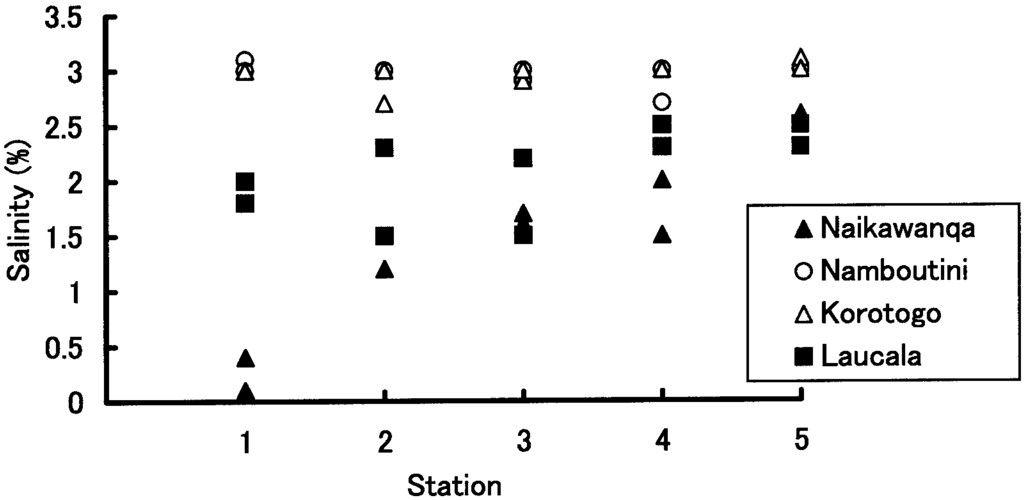

Fig. 3 Salinity level in each quadrate in each mangrove forest.

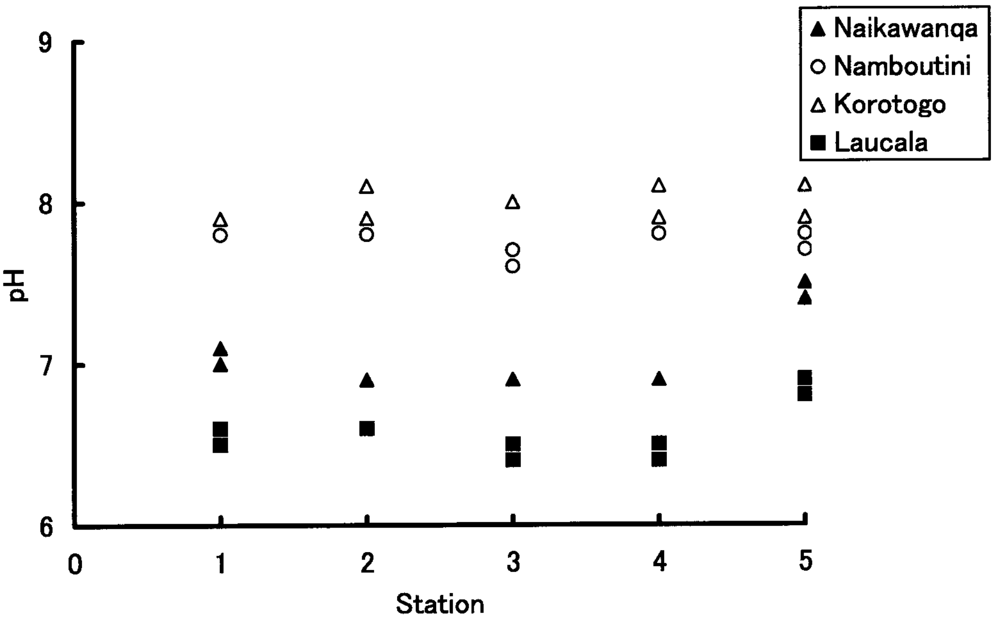

Fig. 4 pH in each quadrate in each mangrove forest.

The salinity in the 1-3-year-old replanted forest was similar to that of the 7-year-old forest. However, the latter had taller trees and lower pH than the former. These observations indicated that by 7 years after replanting the conditions had begun to return to those in the natural forest.

Ten mollusks were observed in the natural forest but only 2 to 3 were observed in the replanted mangrove forests (Table 1).

Table 1 Observed mollusks species in each mangrove forest.

	Korotogo 1-3 year old	Namboutini 7 year old	Naikawaqa Natural	Laucala Natural
Patelloida sp.				○
Nerita planospira	○	○	○	○
Nerita turrita			○	
Littorina scabra	○	○	○	○
Morula anaxeres				○
Melampus sp.			○	○
Cassidula sp.			○	○
Pythia sp.			○	
Crassostrea mordax		○	○	○
Septifer virgata			○	○

Each quadrate showed a different frequency of observed mollusks. *Littorina scabra* was the dominant species in the 1-3-year-old mangrove forest (Fig. 5). *Nerita planospira* and *Littorina*

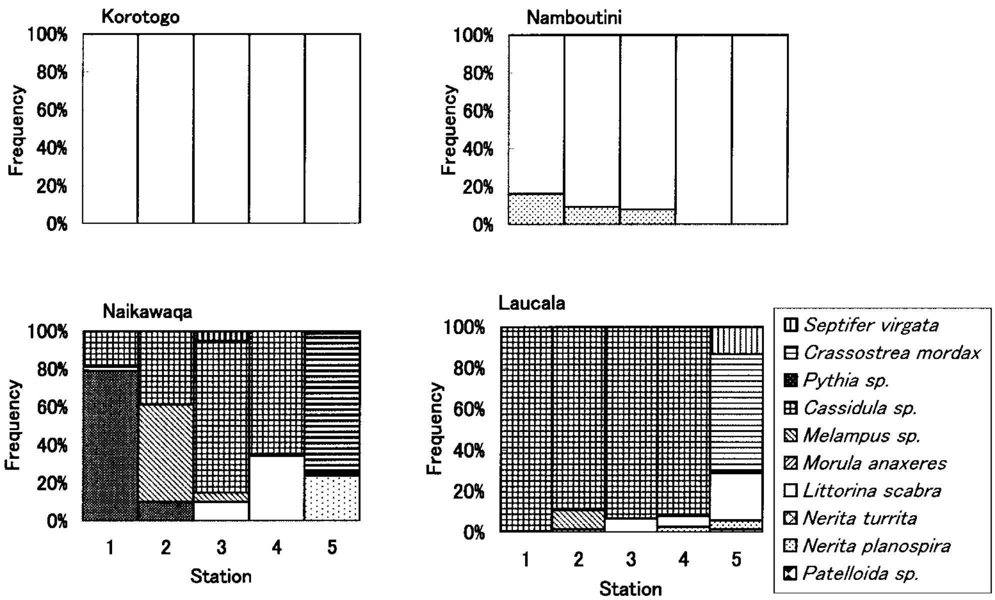

Fig. 5 Frequency of observed mollusk species in each quadrate in each mangrove forest.

scabra were dominant near the landside but only *Littorina scabra* was dominant near sea side in the 7-year-old replanted mangrove. *Littorina scabra* was dominant in both replanted mangroves indicating that *Littorina scabra* was the first species recruited to the newly made habitats in mangrove forests.

The animals beneath the ground were not monitored. The 7-year-old replanted mangrove showed a cline of pH beneath the ground from landside to seaside, although it was not sufficient to recover to the natural conditions. The values of dissolved oxygen, temperature, and pH were closely related to the distributions of the gastropods (Blanco and Cantera, 1999), suggesting that the incline in pH contributed to the complexity of the habitat. Biodiversity in replanted mangrove increased with complexity of habitat conditions, such as pH. The results of the present study revealed both the number and species of mollusks in these forests. However, the dominant animals in mangrove forests are usually crustaceans and mollusks. Local people reported that the numbers of both individuals and species of crustaceans increased in replanted mangroves after 7 years.

This study suggested that both biodiversity and habitat complexity were increased in mangrove forests 7 years after replanting, although they did not show recovery to the natural conditions. Further studies are required to continuously monitor the dynamics of community structure and environmental changes in these forests over time. Moreover, it is also necessary to monitor biodiversity at the DNA level in replanted mangrove forests as well as other environmental factors, such as dissolved oxygen level, temperature, *etc*.

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