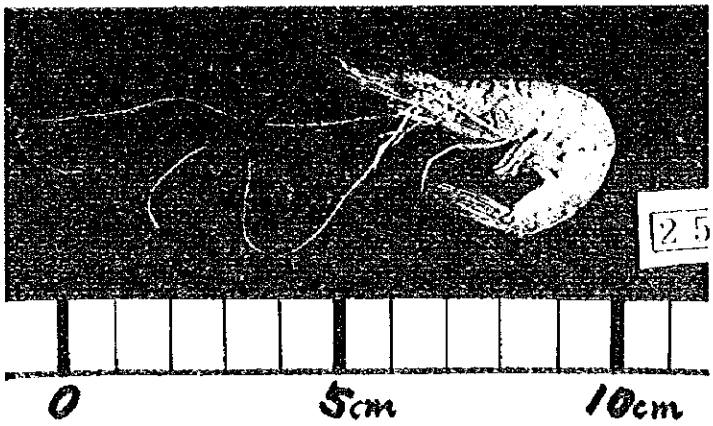


Photo. 7 Penaeus (Penaeus) semisulcatus (Penaeidae)

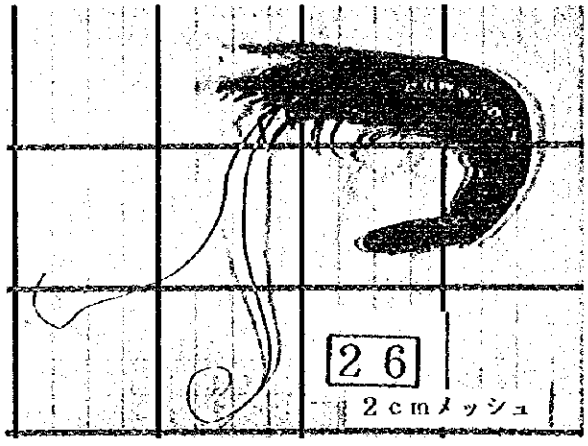


Photo. 8 Metapenaeus moyebi (Penaeidae)

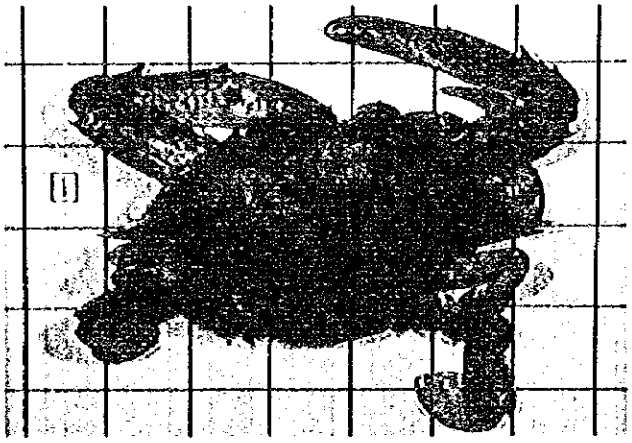


Photo. 9 Portunus (Portunus) pelagicus (Portunidae) Mesh: 2 cm

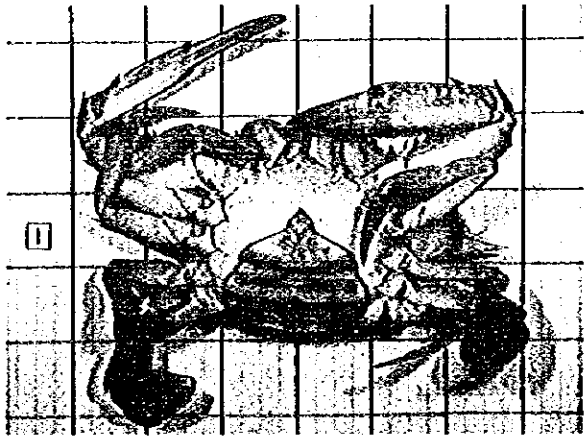


Photo. 10 Portunus pelagicus (Portunidae) Mesh: 2 cm

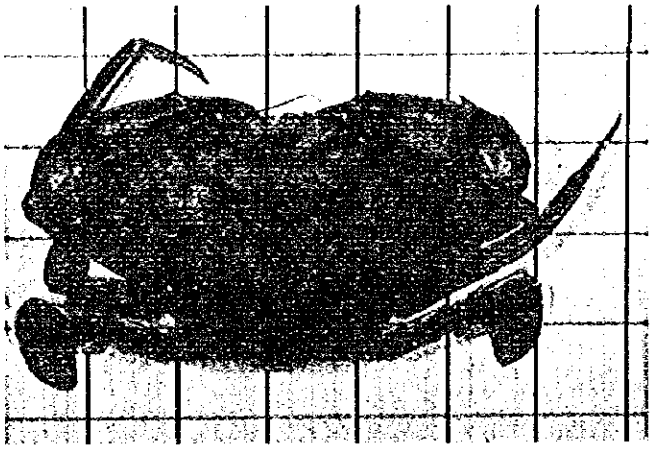


Photo. 11 Female Scylla serrata (Portunidae) Mesh: 2 cm

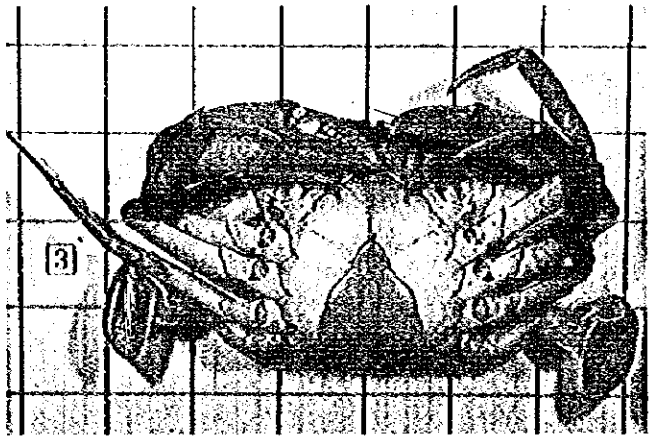


Photo. 12 Female Scylla serrata (Portunidae) Mesh: 2 cm

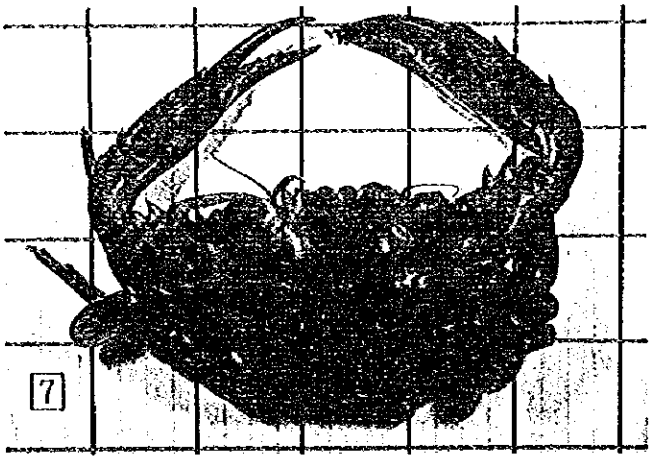


Photo. 13 Thalamita crenata (Portunidae) Mesh: 2 cm

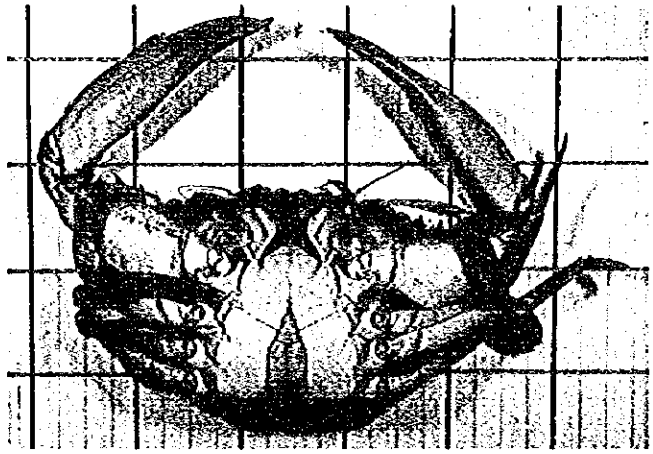


Photo. 14 Thalamita crenata (Portunidae) Mesh: 2 cm

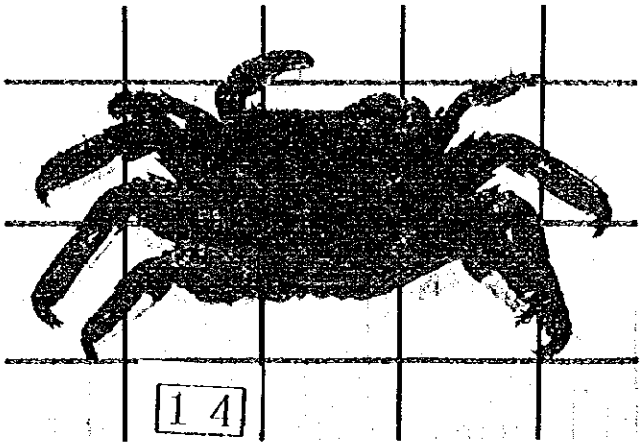


Photo. 15 Metopograpsus latifrons (Gropsidae) Mesh: 2 cm

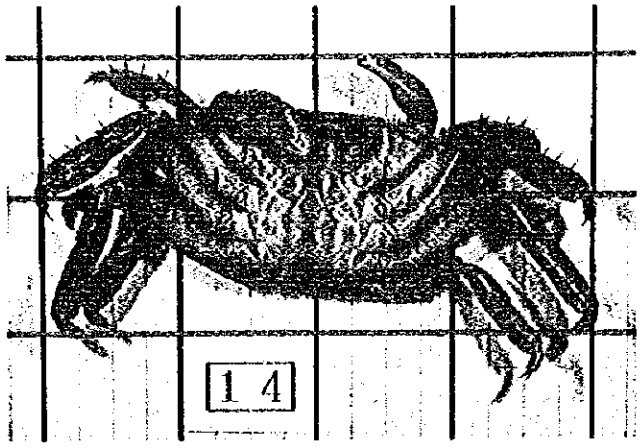


Photo. 16 Metopograpsus latifrons (Gropsidae) Mesh: 2 cm

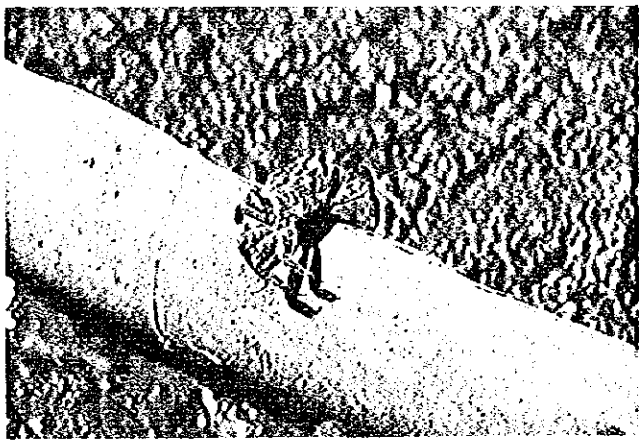


Photo. 17 Sesarmops? impressum (Grapsidae)

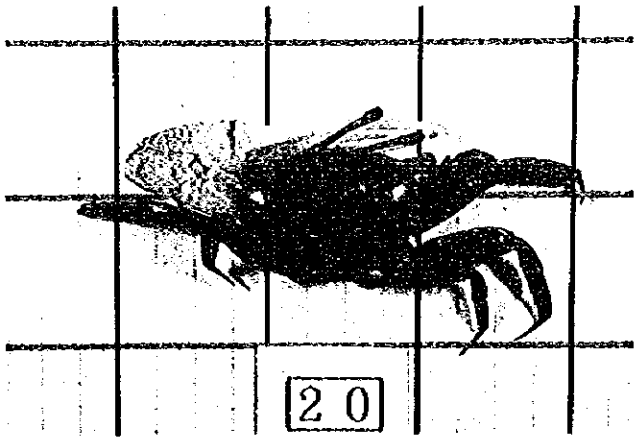


Photo. 18 Uca (Thalassuca) vocans (Ocypodidae) Mesh: 2 cm

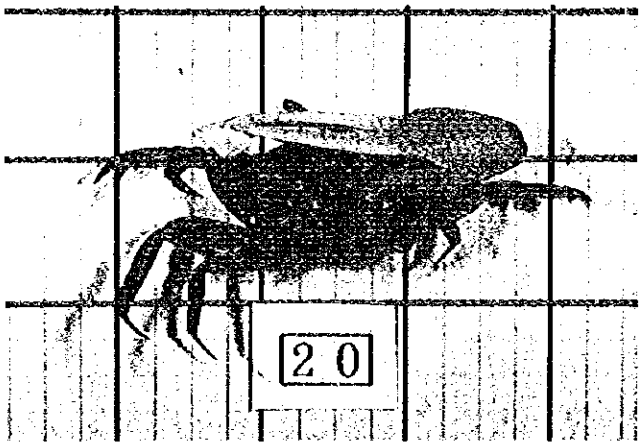


Photo. 19 Uca (Thalassuca) vocans (Ocypodidae) Mesh: 2 cm

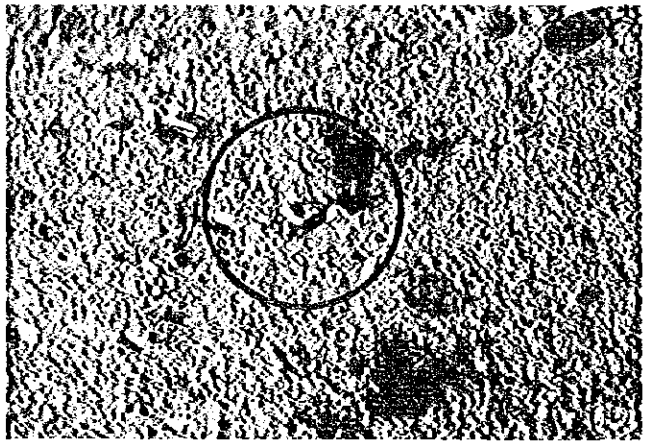


Photo. 20 Female Uca (Deltuca) dussumieri dussumieri (Ocypodidae)

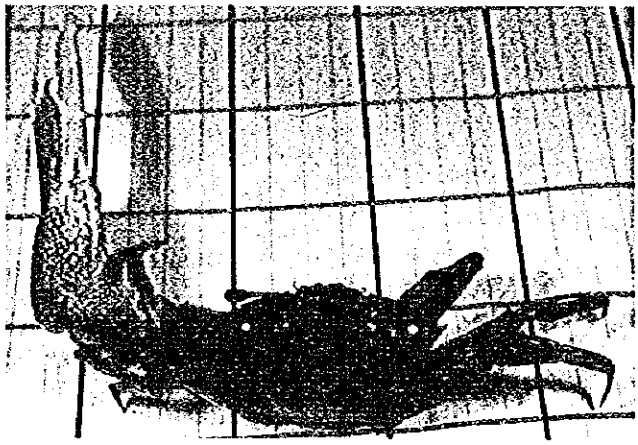


Photo. 21 Male Uca (Deltuca) dussumieri dussumieri (Ocypodidae)

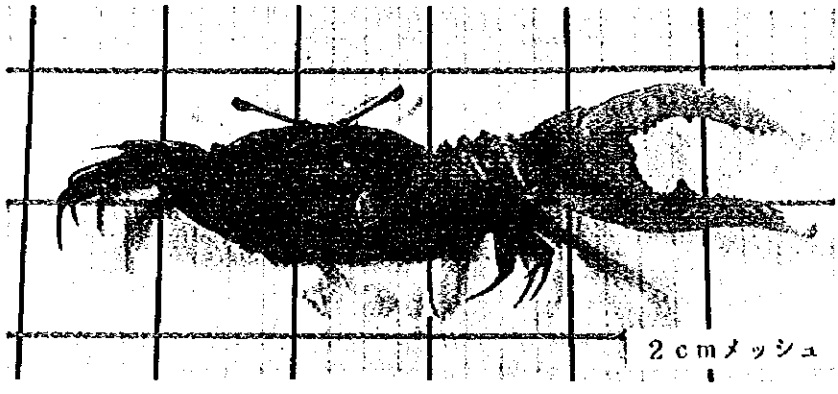


Photo. 22 Male Uca (Deltuca) dussumieri dussumieri (Ocypodidae) Mesh: 2 cm

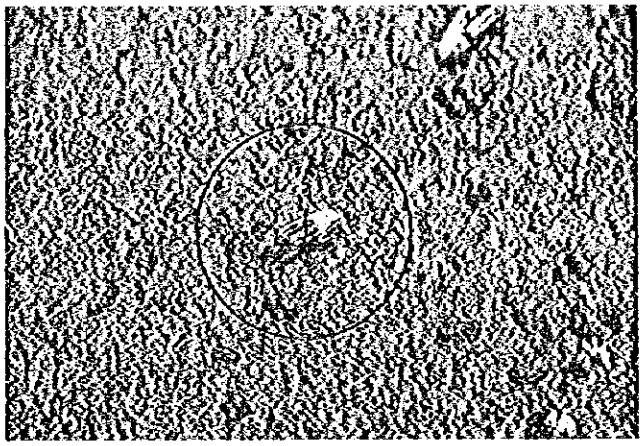


Photo. 23 Uca (Deltuca) coarctata (Ocypodidae)

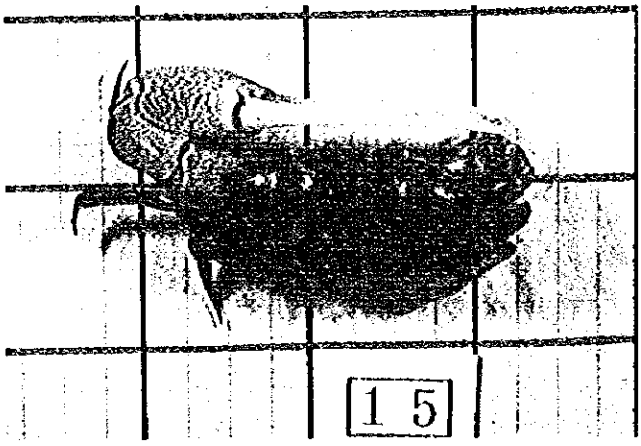


Photo. 24 Uca (Deltuca) coarctata (Ocypodidae) Mesh: 2 cm

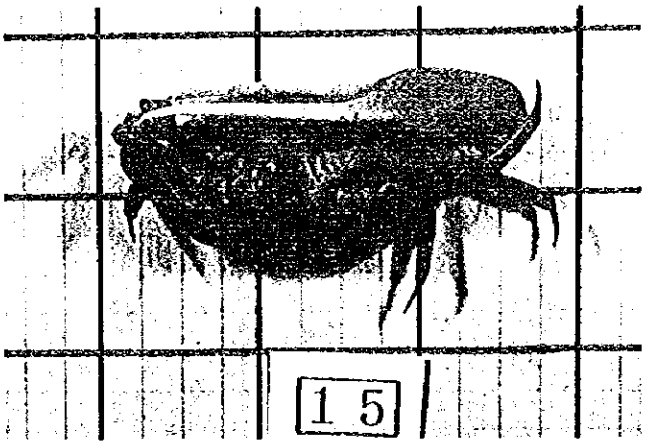


Photo. 25 Uca (Deltuca) coarctata (Ocypodidae) Mesh: 2 cm

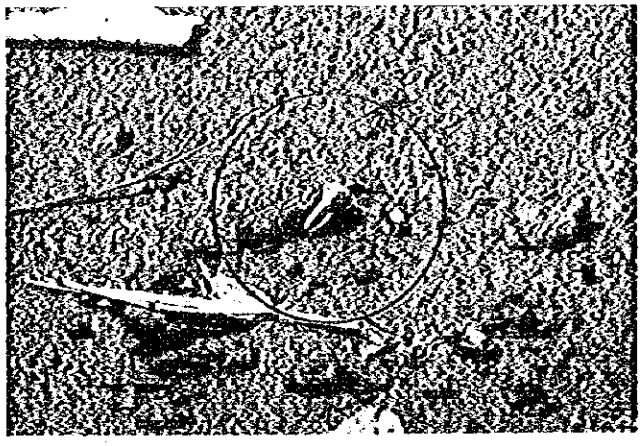


Photo. 26 Uca (Deltuca) demani demani (Ocypodidae)

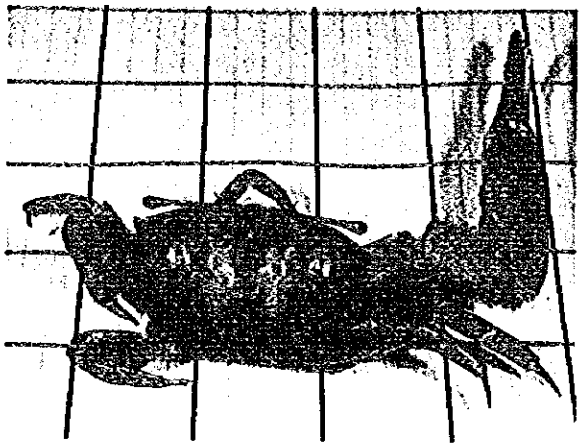


Photo. 27 Uca (Deltuca) demani demani (Ocypodidae)

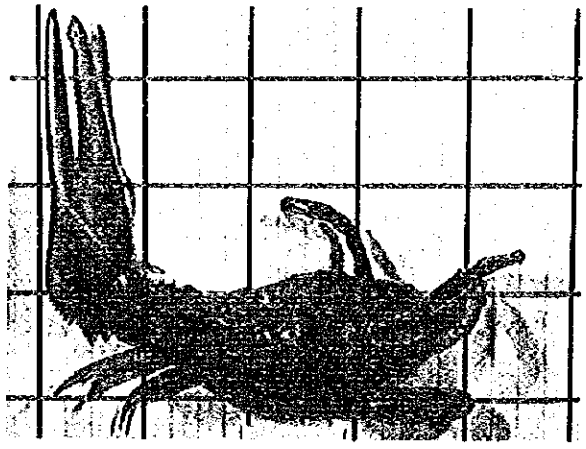


Photo. 28 Uca (Deltuca) demani demani (Ocypodidae)

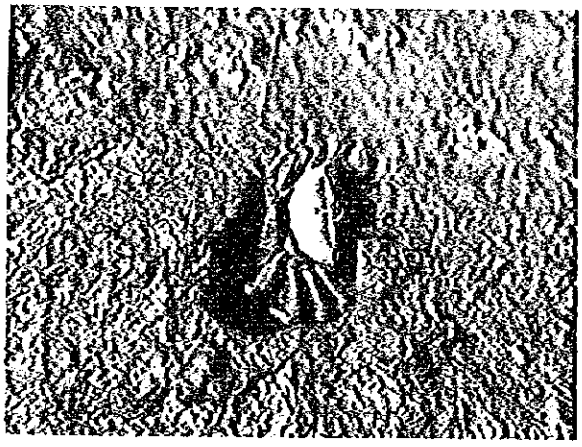


Photo. 29 Female Uca (Australuca) bellator bellator (Ocypodidae)

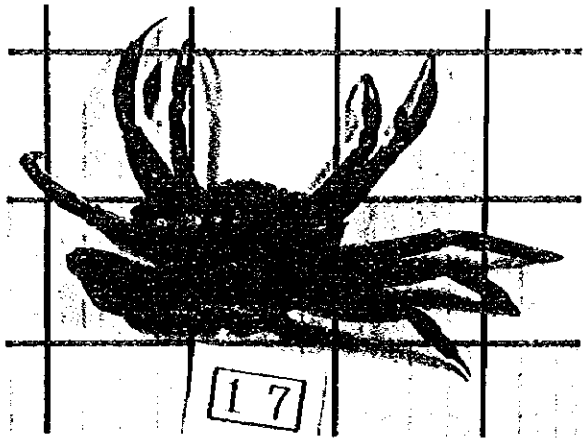


Photo. 30 Female Uca (Australuca) bellator bellator (Ocypodidae)

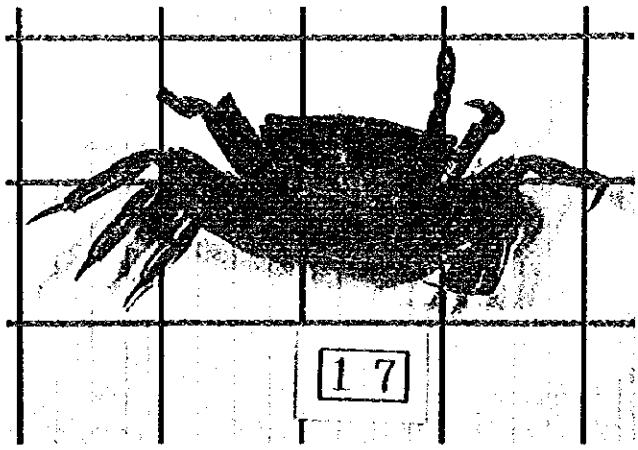


Photo. 31 Female Uca (Australuca) bellator bellator (Ocypodidae)

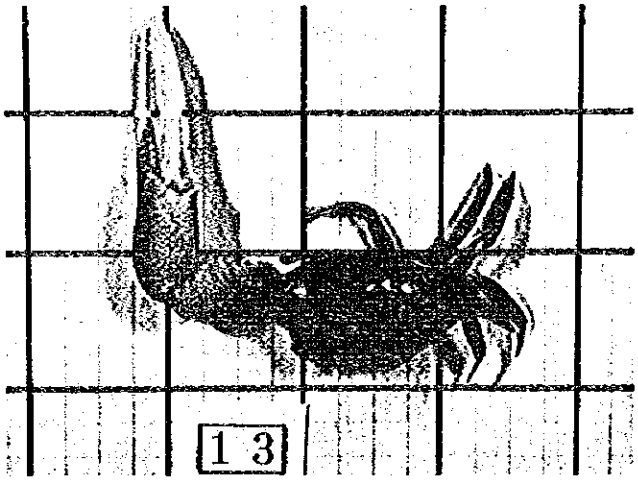


Photo. 32 Male Uca (Australuca) bellator bellator (Ocypodidae)

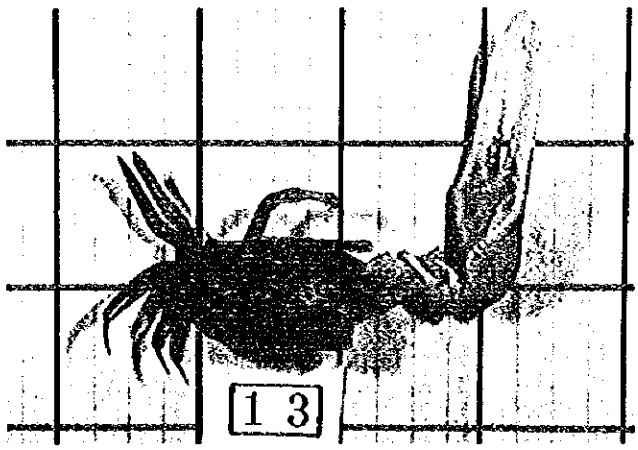


Photo. 33 Male Uca (Australuca) bellator bellator (Ocypodidae)

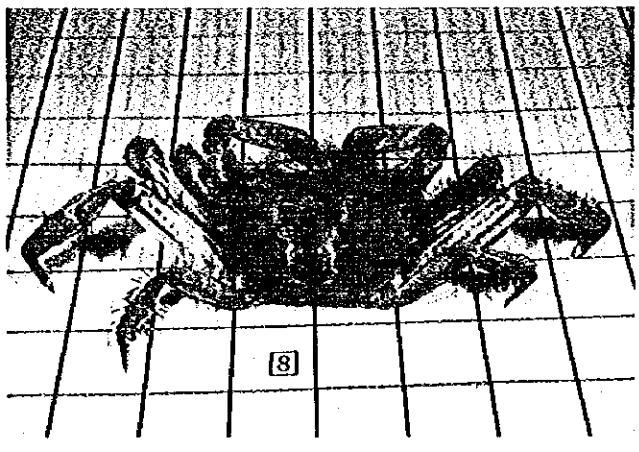


Photo. 34 Macrophthalmus (Venitus) latreillei (Ocypodidae) Mesh: 2 cm

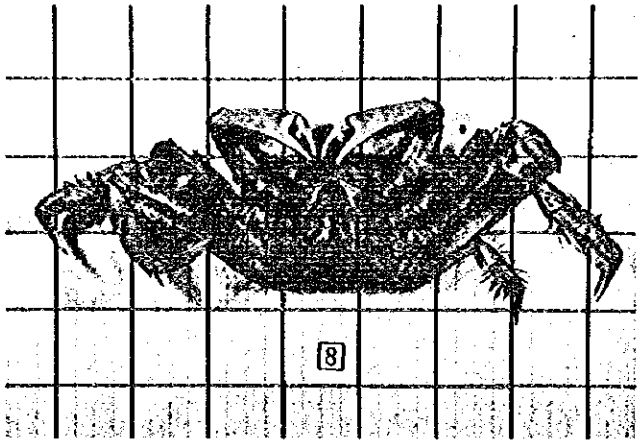


Photo. 35 Macrophthalmus (Venitus) latreillei (Ocypodidae) Mesh: 2 cm

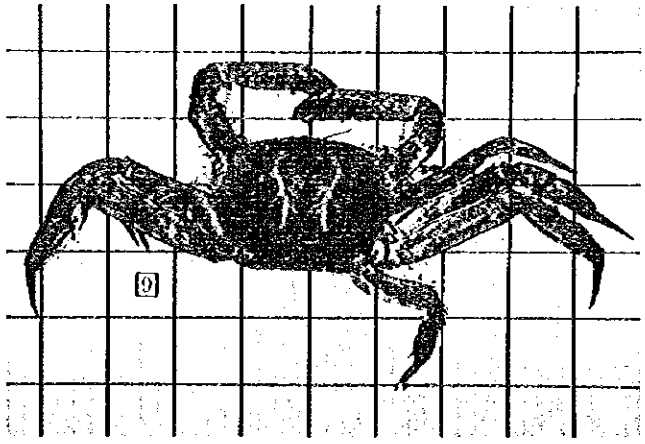


Photo. 36 Macrophthalmus (Venitus) latreillei (Ocypodidae) Mesh: 2 cm

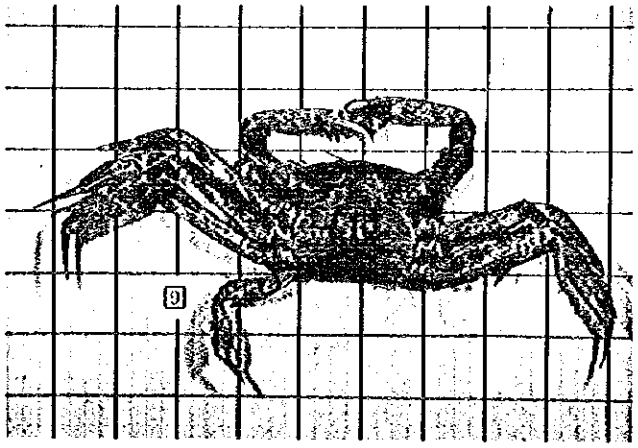


Photo. 37 Macrophthalmus (Venitus) latreillei (Ocypodidae) Mesh: 2 cm

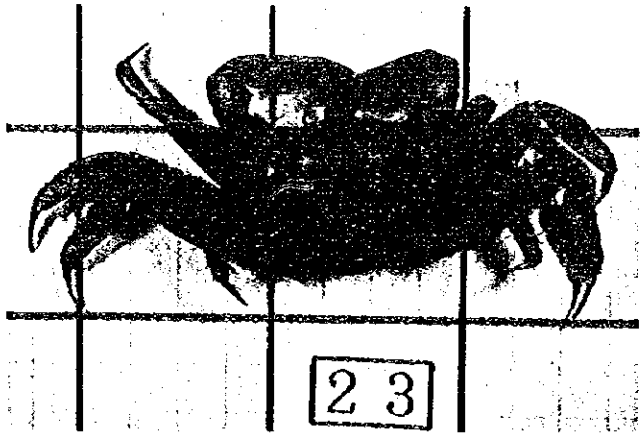


Photo. 38 Macrophthalmus (Mareotis) pacificus (Ocypodidae) Mesh: 2 cm

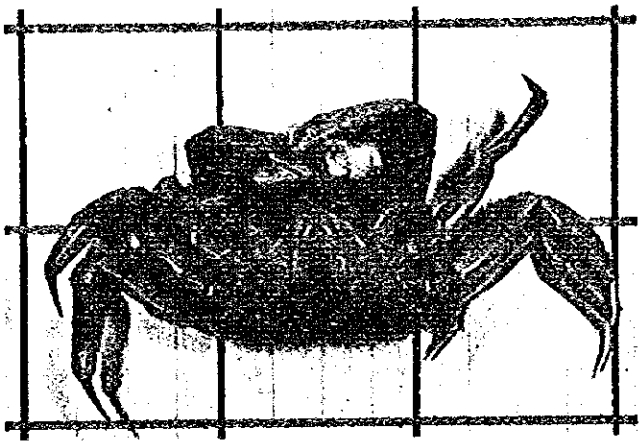


Photo. 39 Macrophthalmus (Mareotis) pacificus (Ocypodidae) Mesh: 2 cm

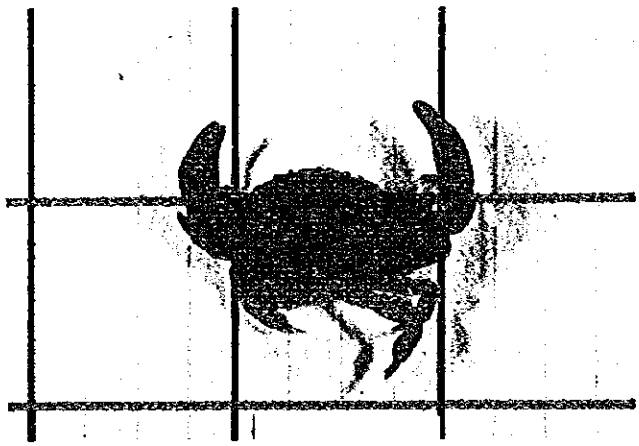


Photo. 40 Xanthidae (not identified) Mesh: 2 cm

Photo. 41 Xanthidae (not identified) Mesh: 2 cm

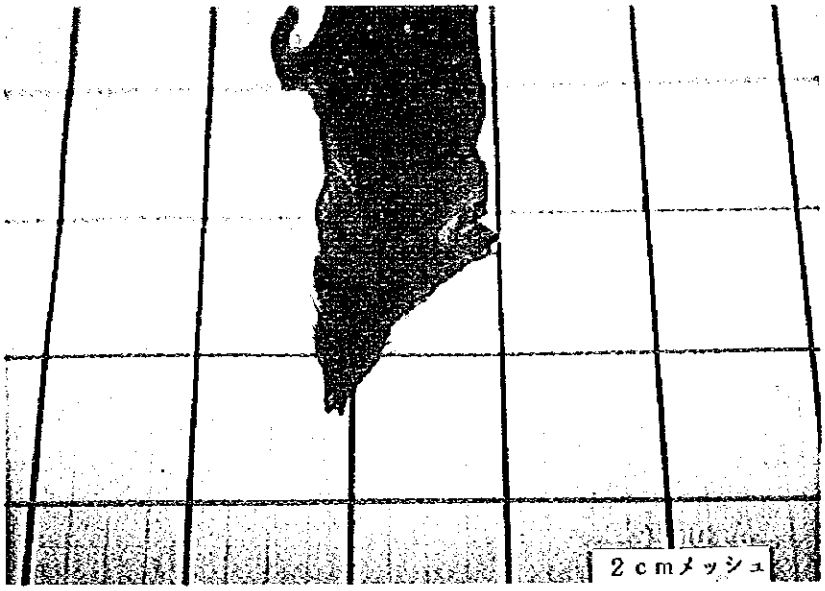


Photo. 42 Rat (in natural forest, nursery) Mesh: 2 cm

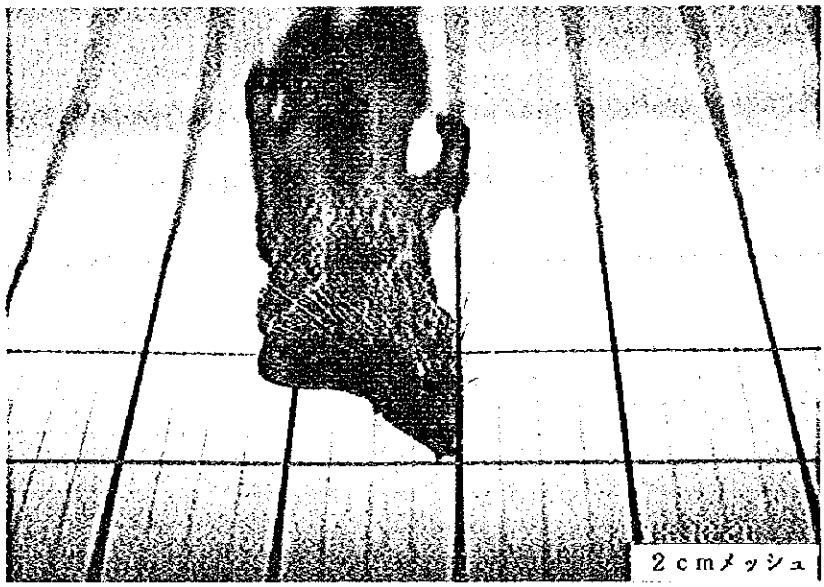


Photo. 43 Rat (in natural forest, nursery) Mesh: 2 cm

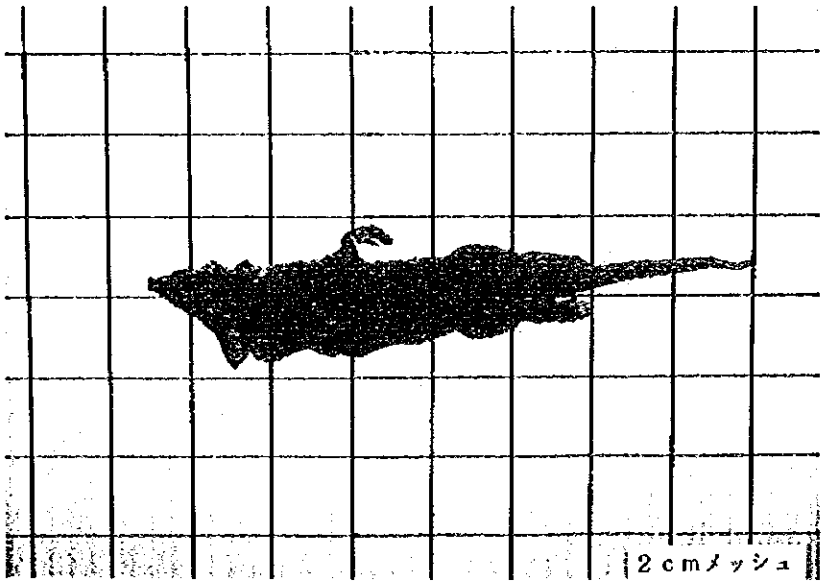


Photo. 44 Rat (in natural forest, nursery) Mesh: 2 cm

Rat (in natural forest, nursery) (Photos. 42, 43, 44)

Monkey (in Gili Sulat Island)

7) Study on pest and biological damages

This survey will be performed by short-term specialists. Long-term specialists communicated with persons in charge of nursery and afforestation projects when any damage occurred. Then, the long-term specialists only took photographs and caught them to make specimens.

Harmful insects and animals that damage natural forest and nursery are supposed to be much more than those recorded until now. The harmful insects and animals reported this time are mainly those active in daytime. Almost no record was made for species that pose damages via activities in night time.

Significant degrees of damage were induced by 3 insect species (amber ant, small soldier bug, and small beetle) and 4 crab species (Metopograpsus latifrons, Neoepisesarma (Neoepise sarma) lafondi, and Cardisoma carnifex).

As for other insect or disease damages, damages by scal es have been reported both in natural forest and in nursery.

A) Damage by insect

a) Damage in natural forest

The following 7 species of insects were recorded to induce damages:

Amber ant (common name)
Middle ant
Small ant
Large soldier-bug
Middle soldier-bug
Small soldier-bug
Small beetle

Amber ant (common name)

It gives the largest eating damage in natural forest. It is a common ant also found in inland areas. It is very aggressive. It is about 10 mm in body length and amber (reddish brown) in color. It curves up the bottom at attacking and blows liquid from the tip of bottom. Surrounding ants of the sam species reacts with the liquid to show the attacking posture simultaneously. When bitten, it is very aching and sometimes

swollen. The ant lives on a tree and can live in an island with no dry land. Using any kind of mangrove trees, it makes a ball shaped nest by drawing several leaves together. It seems to prefer trees with large leaves. A *R. mucronata* tree frequently possesses as many as about 30 nests of the amber ant. Damages made by the amber and are as follows:

- Withering of leaves by formation of nest
- Making flowers, new buds, and young viviparous seeds the farms of scales by transferring them. Many flowers, new buds, and young viviparous seeds clung by scales are shrunken by absorption of nutrients and fall during the course of growth.

They also fell during the course of growth after being covered with black mold-like substance as is the case of SUSUBYO.

Middle ant

They are small in number. The ant is about 6 mm in body length and glossy black in color. It makes a hole in the fruit of *S. alba* and eats inside of it.

Small ant

It is about 3 mm in body length and glossy black in color. The body is flat and the legs are short. It makes a hole in the fruit of *S. alba* and eats or makes a nest inside of it.

Large soldier bug

It is 14 mm in body length and the body glows like cloisonne. The head is green, the back is green and red patterns fringed by black lines, the abdomen is red, and the legs are green. A group of large soldier bugs cling to young leaves and branches of *S. alba* and suck the sap (Photos. 45, 46).

Middle soldier bug

It is 10 mm in body length and brown in color with black patterns on the back. It sucks the sap from leaves of *S. alba* and *A. marina*. Similar damages were also seen in nursery.

Small soldier bug

It is 7 mm in body length and brown in color with no pat terns on the back. It sucks the sap from leaves of *S. alba* and *A. marina*. Outbreak of small soldier bugs occurred in August, 1993. Via the sucking mouths, the leaves were invaded by mold or any

other diseases, showed yellow spots, and were finally with ered. Similar damages were not seen in nursery.

Small beetle

Damage by the small beetle was not yet confirmed in natural forest. However, in natural forest of *R. apiculata*, there were eating damages with the same form seen in nursery which was ascribed to this small beetle. The damage in nursery was significant. In natural forest, the small beetle was supposed to induce the eating damages. In details, see the following section

b) Damage in nursery

The following 8 species of insects were recorded to induce damages:

Longicorn
Grasshopper
Small ant
Middle soldier-bug-like insect
Middle soldier-bug
Small beetle
Small rice insect
Small moth

Longicorn

The longicorn was caught in August, 1994. It is 50 mm in body length and black in color with no patterns on the back. There are white lateral lines on the abdomen. It clung to a leaf of *B. gymnorrhiza*. It was unknown whether the longicorn ate the leaf. Only the single one caught was observed (Photos. 47, 48).

Grasshopper

The grasshopper was caught in September, 1994. It is 30 mm in body length and pale brown in color with no patterns on the back. There are 2 blackish brown spots on the dorsal surface of the femurs of hind leg. It clung to a leaf of *B. gymnorrhiza*. It was unknown whether the grasshopper ate the leaf. Only the single one caught was observed (Photo. 49).

Small ant

The small ant was observed in September, 1994. It is 4 mm in body length and

glossy black in color. The body is somewhat flat with no patterns on the back. A seed of *S. alba* was planted in a pot placed in a simple nursery. Then, the small ant made a hole in the seed before germination and ate inside of it. Furthermore, the small ant brought away the seed.

Middle soldier bug like insect

The middle soldier bug like insect was caught on August 15, 1994. It is 13 mm in body length and pale brown in color with a black portion on the bottom of SEBA. The black antennas are about 9 mm in length and the black sucking mouth is as long as about two-thirds of the body length. A group of middle soldier bug like insects cling to young leaves and branches of *S. alba* (Photo. 50).

Middle soldier-bug

Outbreak of middle soldier bugs occurred in August September, 1994. It is 10 mm in body length and brown in color with black patterns on the back. It sucks the sap from leaves of *S. alba* and *A. marina*. Though no group is formed, the number is many. It is also found in natural forest (Photo. 51).

Small beetle

It appeared in July-August, 1994. It is 3-4 mm in body length and pale brown in color with patterns on the wings.

It is considered to be a king of gold beetle. Eating damage by the imago has not yet been confirmed. However, it is considered to make holes of about 5 mm in diameter in leaves of *B. gymnorrhiza*. It clings to a leaf of *B. gymnorrhiza* night and day. Its larvae lives in the core of an unopened leaf of *B. gymnorrhiza* and eats it (Photo. 52).

By these damages, the growth of *B. gymnorrhiza* is retarded, though no death is induced. Almost all the seedlings are subjected to the eating damage.

Small rice insect

The small rice insect was caught in September, 1994. It is 6 mm in body length and pale brown in color with white abdomen of the bottom. It clung to a leaf of *B. gymnorrhiza*.

Small moth

The small moth was caught in about May, 1994. It is 15 mm in body length and scale-like silver white in color. The imago does not produce any eating damage.

However, the larvae hides in the pot as YATOCHU and makes the eating damage during night. The temporary nursery with no night light was not damaged. At the nursery in the Center, the imagos may approach to the light and lay eggs.

B) Damage by crab

a) Damage in nursery

The following 4 species of crabs were recorded to induce damages (Photos. 53, 54, 55, 56):

Metopograpsus latifrons

Cardisoma carnifex

Neoepisesarma (Neoepisesarma) lafondi

Sesarmops impressum

Metopograpsus latifrons

It is a semi-terrestrial crab and becomes about 7 cm in the width of the shell. In natural forest, it sticks downw ard to 30 cm above the margin of ground on the root of mainly *S. alba* and catches Periophthalmus and prawn moving on the ground. In the site of old farm, it sticks downward on the sluice near the surface of water and catches fishes going through the sluice. Since it is omnivorous, it seems to make the eating damage to leaves of mangrove trees.

Cardisoma carnifex (Photos. 53, 54)

It is a terrestrial crab and becomes about 15 cm in the width of the shell. It is not found in natural forest. It lives in a den of about 10 cm in diameter in the banks of the site of old farm and nursery as well as grassland near the site of old farm. Since it is omnivorous, it makes the eating damage to leaves of mangrove trees.

Neoepisesarma (Neoepisesarma) lafondi

It is a semi-terrestrial crab with similar habits to those of Cardisoma carnifex. It lives in a den in the banks of the site of old farm and nursery as well as grassland near the site of old farm. Since it is omnivorous, it makes the eating damage to leaves of mangrove trees.

Sesarmops impressum (Photos. 55, 56)

It is a small crab in the nursery. It climbs seedlings and makes the eating damage to the leaves.

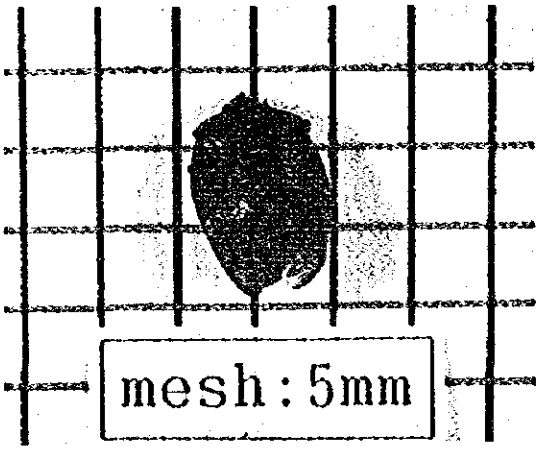


Photo. 45 Large soldier-bug

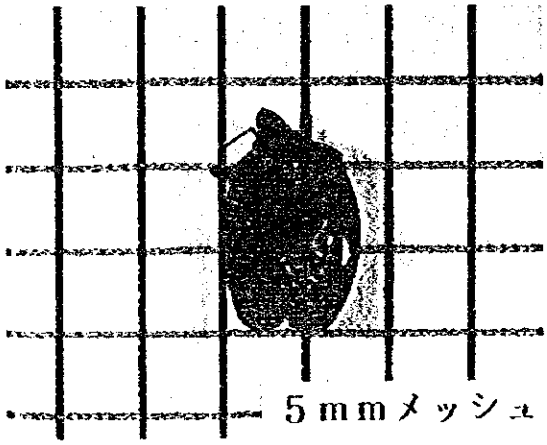


Photo. 46 Large soldier-bug
Mesh: 5 mm

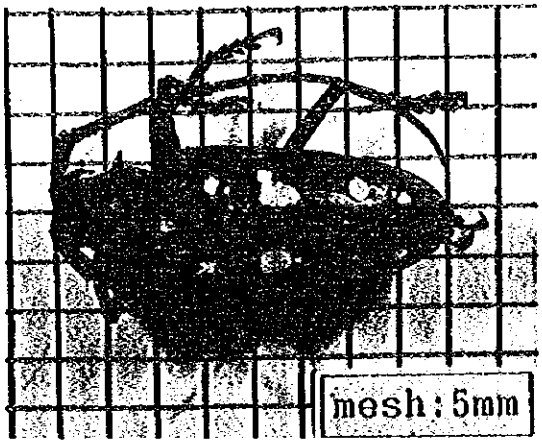


Photo. 47 Longicorn

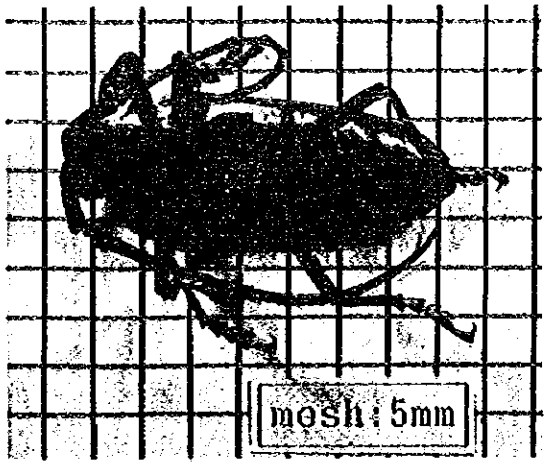


Photo. 48 Longicorn

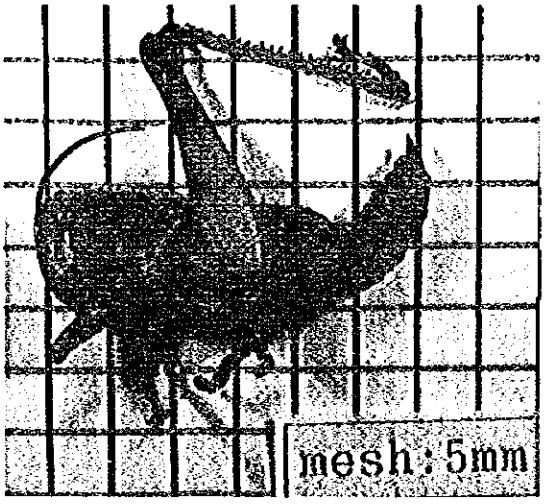


Photo. 49 Grasshopper

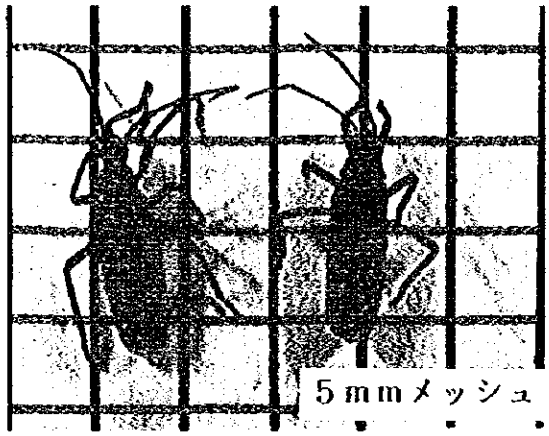


Photo. 50 Middle size insect like soldier–bug Mesh: 5 mm

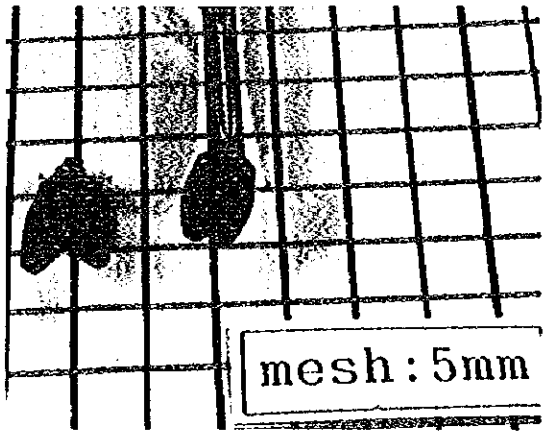


Photo. 51 Middle size soldier–bug

Photo. 52 Middle size beetle

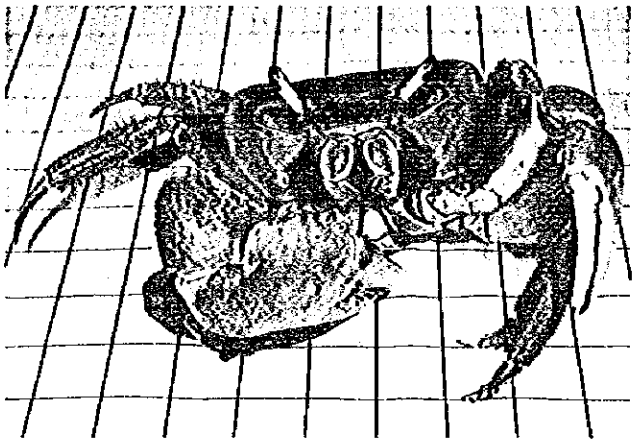


Photo. 53 Cardisoma carnifex
(Gecarcinidae)

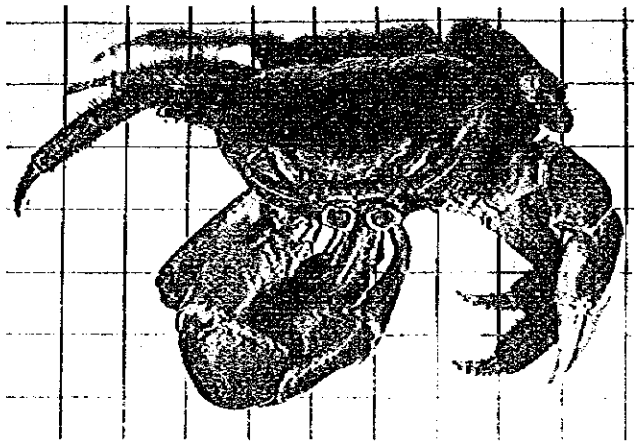


Photo. 54 Cardisoma carnifex
(Gecarcinidae)

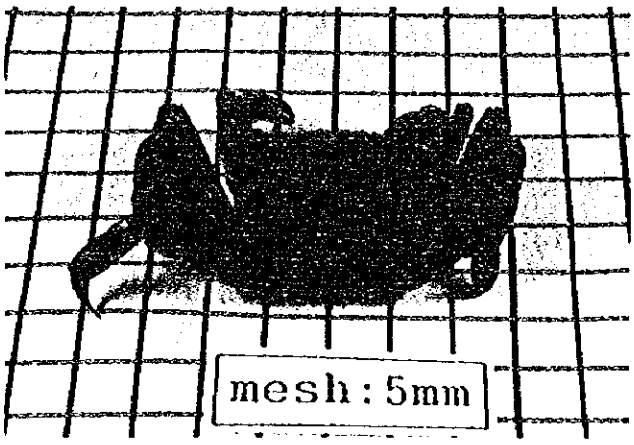


Photo. 55 Sesarmops impressum
(Grapsidae)

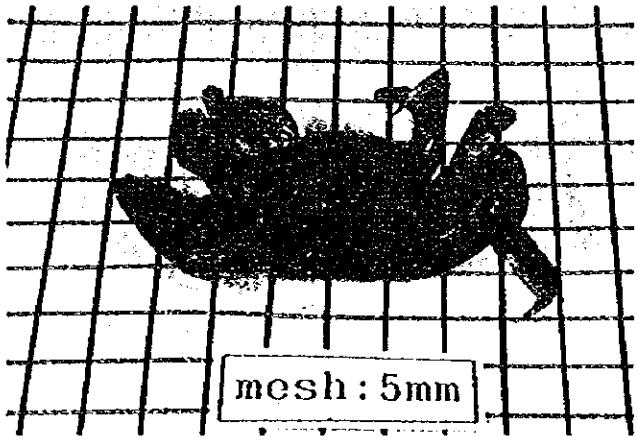


Photo. 56 Sesarmops impressum
(Grapsidae)

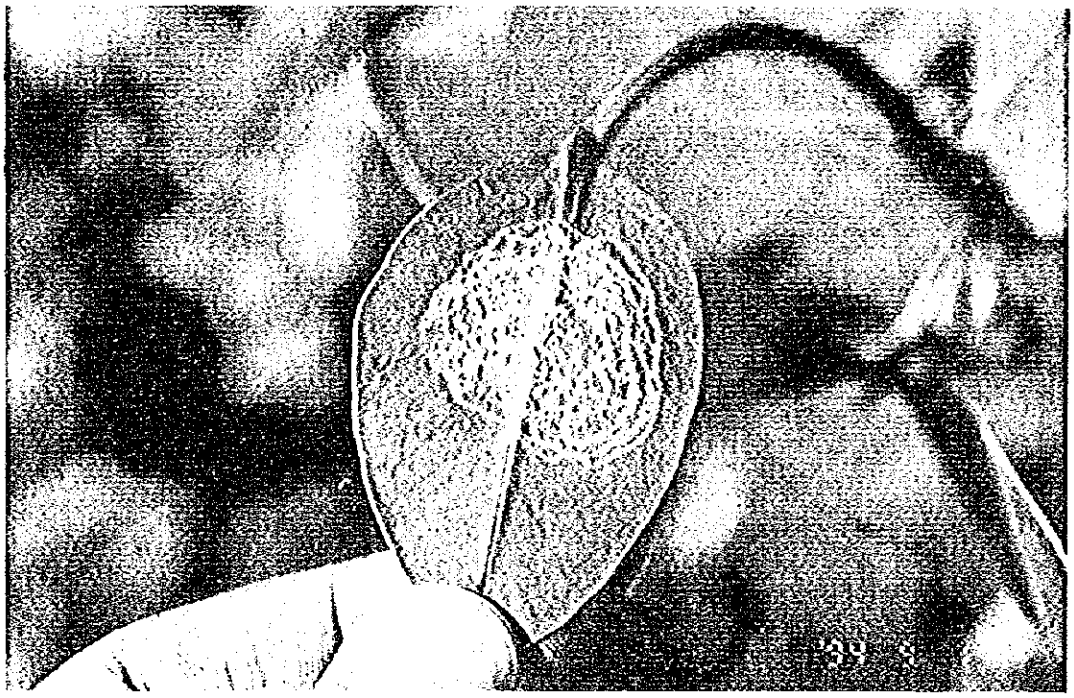


Photo. 57 Scale

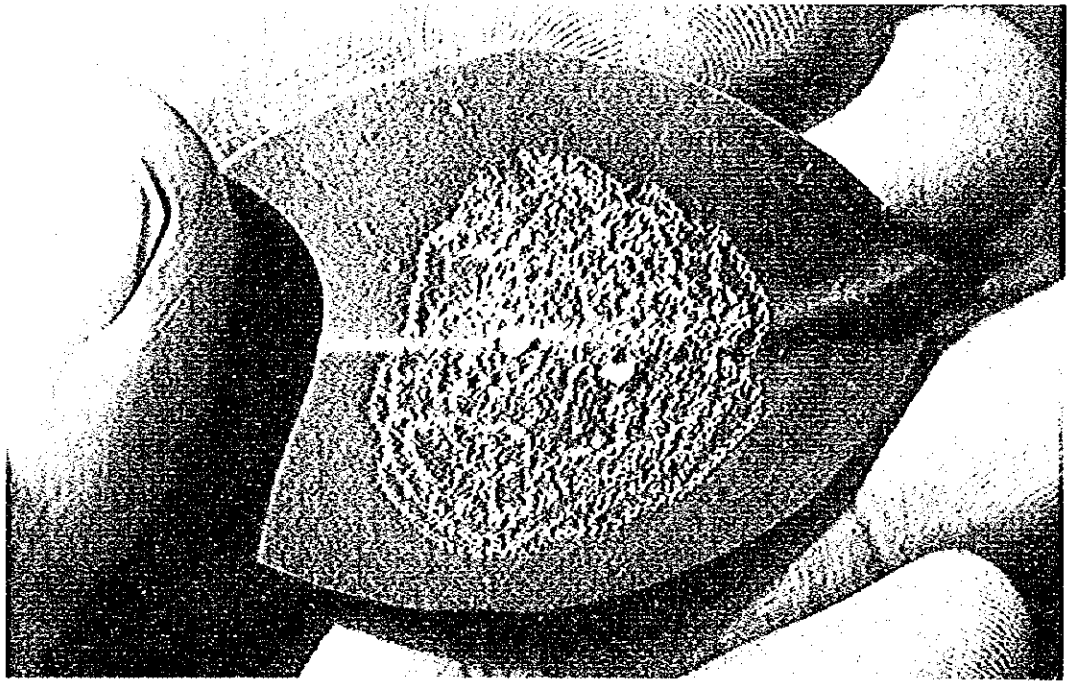


Photo. 58 Scale

C) Damage by scale

There has not been any damage ascribed to scale in the afforestation sites of this project. There are some places with severe damages in the site of old farm subjected to afforestation by State Forestry Department in 1991 and shows favorable growth. In details, refer to the report prepared by Mr. Nakamura, a short-term specialist in the field of afforestation. Condition of the damages are recorded in Photos. 57 and 58.

8) Study on phenology of main (selected) species

The observation was performed for the cycle from appear ance of buds, blooming, fruition, maturation, to fall of seeds. Since many flowers fell during the observation period, continuous observation of one flower was difficult for some species. In such cases, data obtained from flowers at different stages were joined together to suggest the process. Therefore, the obtained data included errors. From the viewpoint of project, this kind of error was considered to pose no problem.

The observation required many human power and time. Species selected were those with strong requirement from the nursery and with sample trees locating near the Office for easy observation.

Results:

Rhizophora apiculata

The period from formation of bud to fall of fruit of this species was very long. So, continuous observation of one flower was not taken for this species. Data obtained from flowers at different stages were joined together to suggest the process.

Even now, there are flowers under observation initiated from the stage of bud. The errors in the obtained data may be corrected in future.

The observation results are summarized in Fig. 2-3-21.

They are summarized as follows:

1. It takes about 21.5 months from the appearance of bud from the bract leaf, fruiting, maturation, to fall.
2. During the period described in the above item 1, it takes about 5.5 months from blooming, fruiting, maturation, to fall.
3. Flower bud has been already formed in bract leaf. At its appearance from the bract leaf, the flower bud is small and not conspicuous. When compared with the flower bud of *R. mucronata* emerged from the bract leaf, it is very small. The size ranges

about 2–4 mm according to individual trees.

4. The life span of a leaf is about 16 months.
5. A joint is formed at about 3–month interval with the opening of leaves.
6. There are about 8–10 leaves on the tip of each shoot.
7. At the time of maturation of viviparous seed, leaves of the floral axis had already been fallen. The phenomenon coincides to the above results 4, 5, and 6.
8. The growing process of viviparous seed is as follows:

Young root emerges from the fruit. Then, young stalk is pushed away from the fruit. The part, once goes outside of the fruit, does not scarcely elongate, though enlargement is achieved. It elongates in the fruit. It enlarges both in the fruit and out of the fruit.

9. The viviparous seed elongates to the direction of the longitudinal axis of the fruit. Small viviparous seeds adheres at a right angle to the branches. According to the maturation of viviparous seeds, the fruits gradually become downward. Some are not become completely vertical. This is the reason of the existence of viviparous seeds with bent or straight head.

At maturation of viviparous seed, the seed leaf appeared at the lower part of the fruit becomes red or pale yellow in color.

During the observation, the following points were found:

- The peak of blooming seems to be June–August. However, blooming is seen throughout the year. Referring to the above result 2, about February of the next year is said to be the season of seeds.
- Branches with viviparous seeds were seemed not to be related to the direction. It is considered that any branch is exposed to similar light since the test site locates at 8 degrees of south latitude.
- Numbering by direct marker writing is favorable to decrease mistakes for flowers, fruits, and leaves.

Rhizophora mucronata

Since very many flowers of this species fall during the ob servation period, continuous observation of one flower is diffi cult. Though observation has been continued from the early phase of arrival at the post, the long–term specialist has not yet obtained sufficient data. It is left as a future problem.

The observation results are summarized in Fig. 2–3–22.

They are summarized as follows:

1. Using 5 samples trees at different places and at different time, a total of 51 flowers

were observed. All fell during the observation period. Even the ratio of formation of mature viviparous seeds was not identified.

2. Based on the results obtained by the observation, a part of the process of growth is estimated. It takes about 14 months from the appearance of inflorescence from the bract leaf, fruiting, maturation, to fall.
3. During the period described in the above item 2, it takes about 3.5 months from the appearance of inflorescence from the bract leaf to blooming.
4. During the period described in the above item 2, it takes about 10 months from blooming, fruiting, maturation, to fall.
5. Inflorescence has been already formed in bract leaf. At its appearance from the bract leaf, the inflorescence is pale green in color and 30–40 mm in length. On the tip of the inflorescence, calyx tube of about 3 mm in diameter covered with bract is already formed. The calyx becomes about 8 mm in diameter, about 12–14 mm in length, and cream in color. Then, blooming occurs.
6. One inflorescence possesses 4–8 flower buds. But, as described in above item 1, all the flowers fall from almost every inflorescence.
7. At the time of maturation of viviparous seed, the seed leaf appeared at the lower part of the fruit becomes pale green or pale yellow in color.
8. The order of growth of viviparous seed is the same as that of *R. apiculata* described in the above section. Namely, young root emerges first from the fruit. Then, young stalk is pushed away from the fruit. The part, once goes outside of the fruit, does not scarcely elongate. It elongates in the fruit and enlarges both in the fruit and out of the fruit.

Ceriops tagal

Since this species is used only for the afforestation of exhibition forest and simple data of maturation of seed is described in "The Botany of Mangrove" (by Thomlinson), the observation will be performed in later years. At the time of maturation of viviparous seed, the seed leaf appeared at the lower part of the fruit becomes yellow in color.

Bruguiera gymnorrhiza

The period from formation of flower bud to fall of fruit of this species was relatively short. So, continuous observation of one flower was performed.

The observation results are summarized in Fig. 2–3–23.

They are summarized as follows:

1. It takes about 8.5 months from the appearance of inflorescence from the bract leaf, fruiting, maturation, to fall.
2. It takes about 6.5 months from blooming, fruiting, maturation, to fall.
3. Inflorescence has been already formed in bract leaf. At its appearance from the bract leaf, inflorescence is large and conspicuous. The size is 17 mm in length of peduncle, 20 mm in length of calyx tube, and about 3–4 mm in diameter of calyx tube according to individual trees. It has yellow and red spots.
4. The life span of a leaf is about 12 months.
5. A joint is formed at about 1.5–month interval with the opening of leaves.
6. There are about 15–18 leaves on the tip of each shoot.
7. At the time of maturation of viviparous seed, leaves of the floral axis are still remained. The phenomenon coincides to the above results 4 and 5.
8. The growing process of viviparous seed is as follows: Young root emerges from the fruit. Then, young stalk is pushed away from the fruit. The part, once goes outside of the fruit, does not scarcely elongate, though enlargement is achieved.
9. Among 12 flowers observed, 9 fell during the maturation process.

Sonneratia alba

The period from formation of flower bud to fall of fruit of this species was relatively short. However, flowers tended to fall during the observation period. So, data obtained from some flowers were joined together.

The observation results are summarized in Fig. 2–3–24.

They are summarized as follows:

1. It takes about 3.5 months from the formation of flower bud, blooming, fruiting, maturation, to fall.
2. It takes about 10 weeks from blooming, fruiting, maturation, to fall. For this point, the relation to 9) Survey on production amount of seed of 7 kinds of tree as described later is investigated. There were no data clearl indicated that the period between blooming (dispersion of stamen) and fall of matured fruit was 10 weeks. Further investigation is required on this point.
3. Flower blooms when the calyx tube becomes 37 mm in length and about 19 mm in diameter. In the previous data, the period from calyx tube of 3 mm in diameter to blooming was 35 days. It took 72 days in another sample tree. There may be a mistake in the observation. It remains as a problem to be clarified in the next

survey.

4. Matured fruit fell at an average diameter of 40–50 mm.

   When many fruits were found in a tree, their diameters were seemed to be larger than the average one. It is difficult to distinguish mature fruits from immature ones because the fruit is solid after stoppage of growth. Maturation probably occurs just before the fall.

5. Fruits fell after maturation left "calyx" to the branch.

   When enough water is at the falling point, the fruit dissolves for 15–30 minutes and seeds are floated and dispersed. If there is no water, seeds are dispersed after being eaten by crabs.

Xylocarpus granatum

Since very many flowers of this species fall during the observation period, continuous observation of one flower is difficult. Though observation was started after confirmation of fruiting, no sufficient data has been obtained yet. It is left as a future problem.

The observation results are summarized in Fig. 2–3–25.

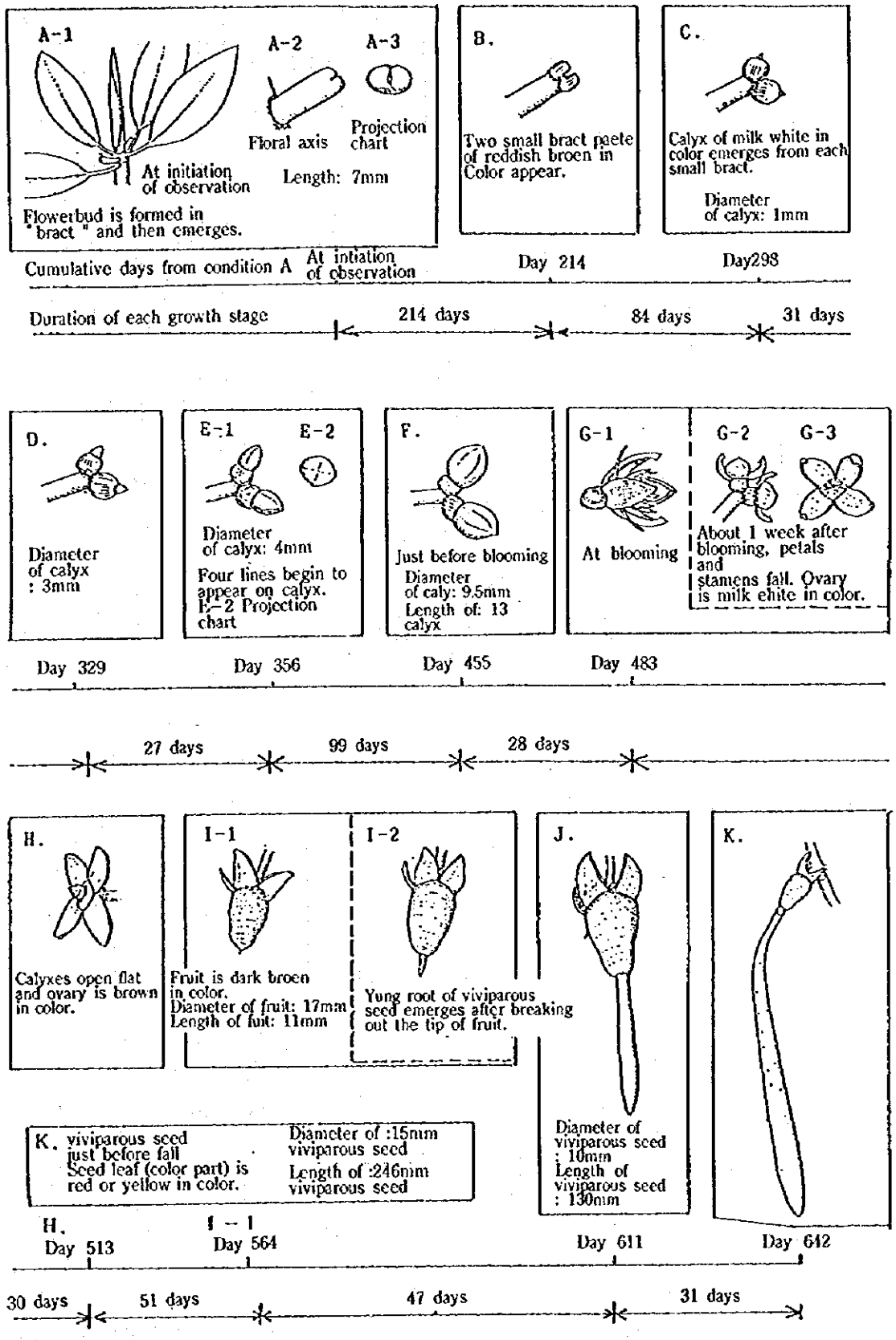
They are summarized as follows:

1. Based on the results obtained by the observation, a part of the process of growth is estimated. It takes about 9 months from the condition of inflorescence to be about 13 mm in length of the floral axis, fruiting, to fruit of 101 mm in diameter. The fruit of 101 mm in diameter is supposed to be still immature. The fruit observed fell at that time, but general mature fruits are about 150 mm in diameter. In another fruit of the same sample tree, it takes about 2 months to become about 150 mm in diameter. Based on this observation result, it takes 11 months until maturation. Additional observation should be performed in the next blooming time.
2. Trees in the same site tend to bloom simultaneously. Blooming is seemed to occur 2 times or more in a year.
3. One inflorescence possesses 6–10 flower buds. One–2 fruits mature in an inflorescence. However, as described above, almost every inflorescence fall during maturation.

Avicennia marina

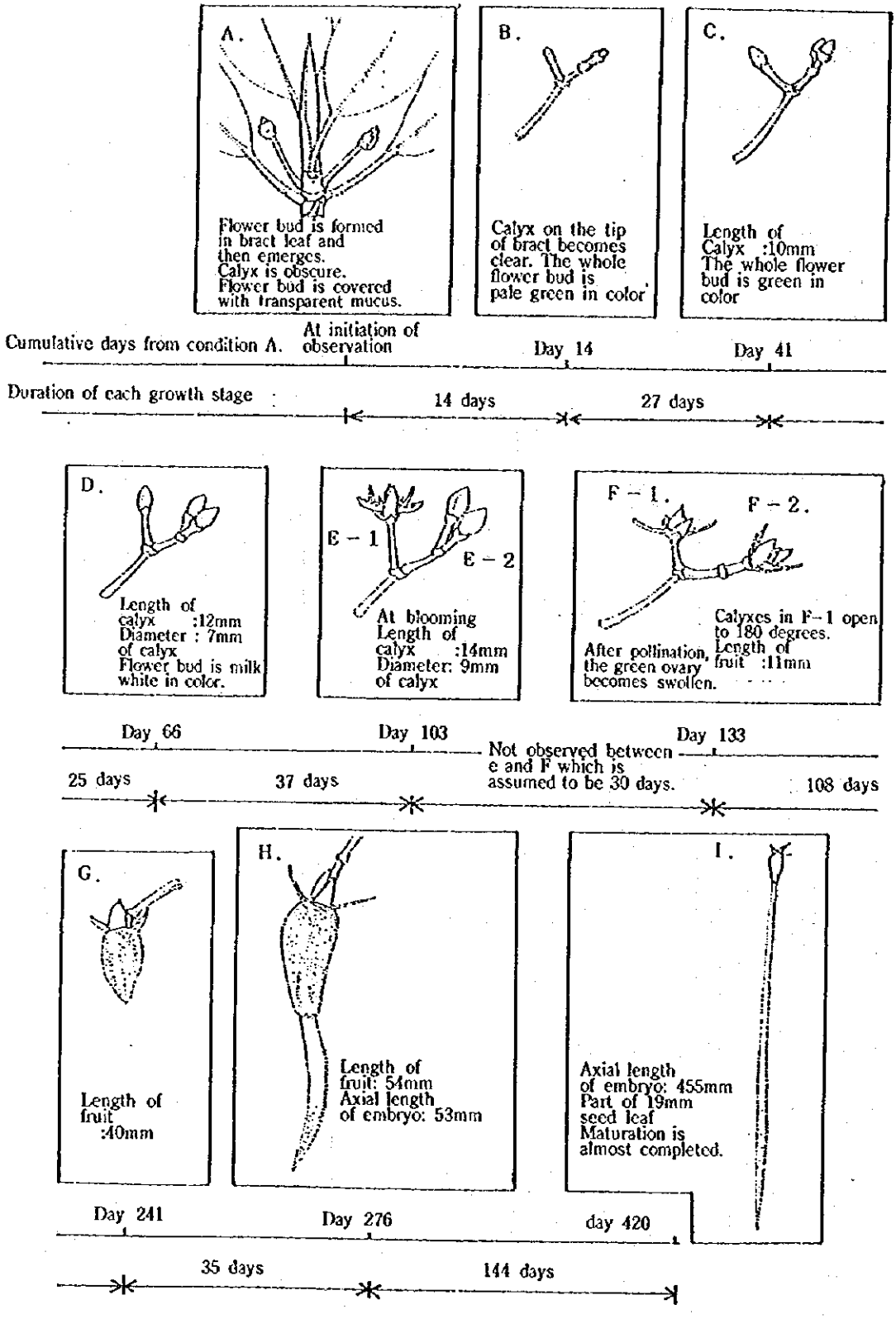
Very many flowers of this species fall during the observation period due to a disease like SUSUBYO. Even after fruiting, almost all fruits fall during maturation due to the

same disease as seen in the flowers. During the observation period from March, 1993 to October, 1994, there was only one time of observa tion of maturation of many seeds. So, continuous observation of one flower is difficult and no sufficient data has been obtained yet. It is left as a future problem.



(Note): There are errors in periods observed since they are prepared based on data obtained from several flowers.

Fig. 2-3-21 Process of maturation of viviparous seed of *Rhizophora apiculata BL.*



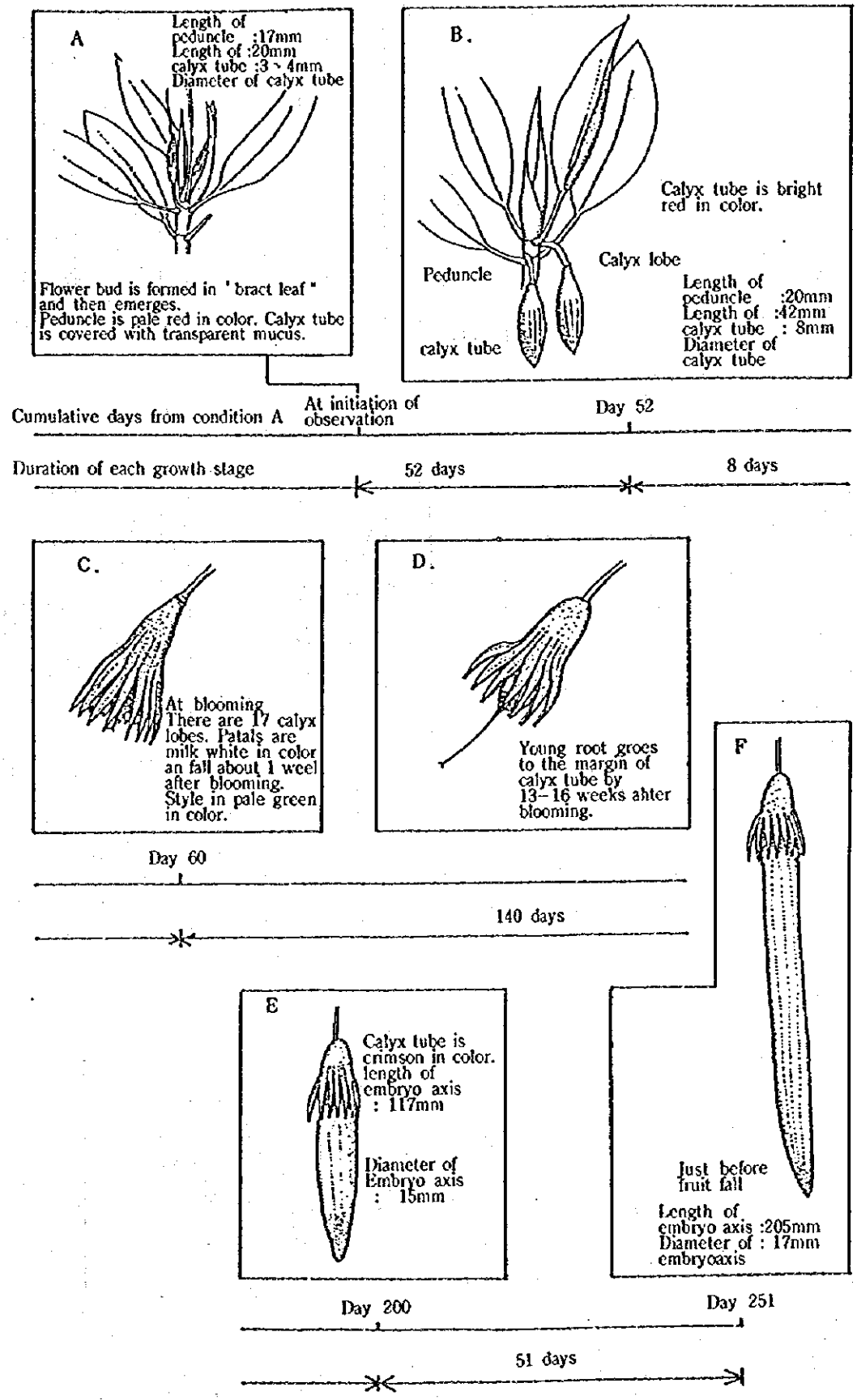
(Note): Periods observed; A–E, F–I.

There are errors in periods observed since they are prepared based on data obtained from several flowers.

Period not observed; E–F.

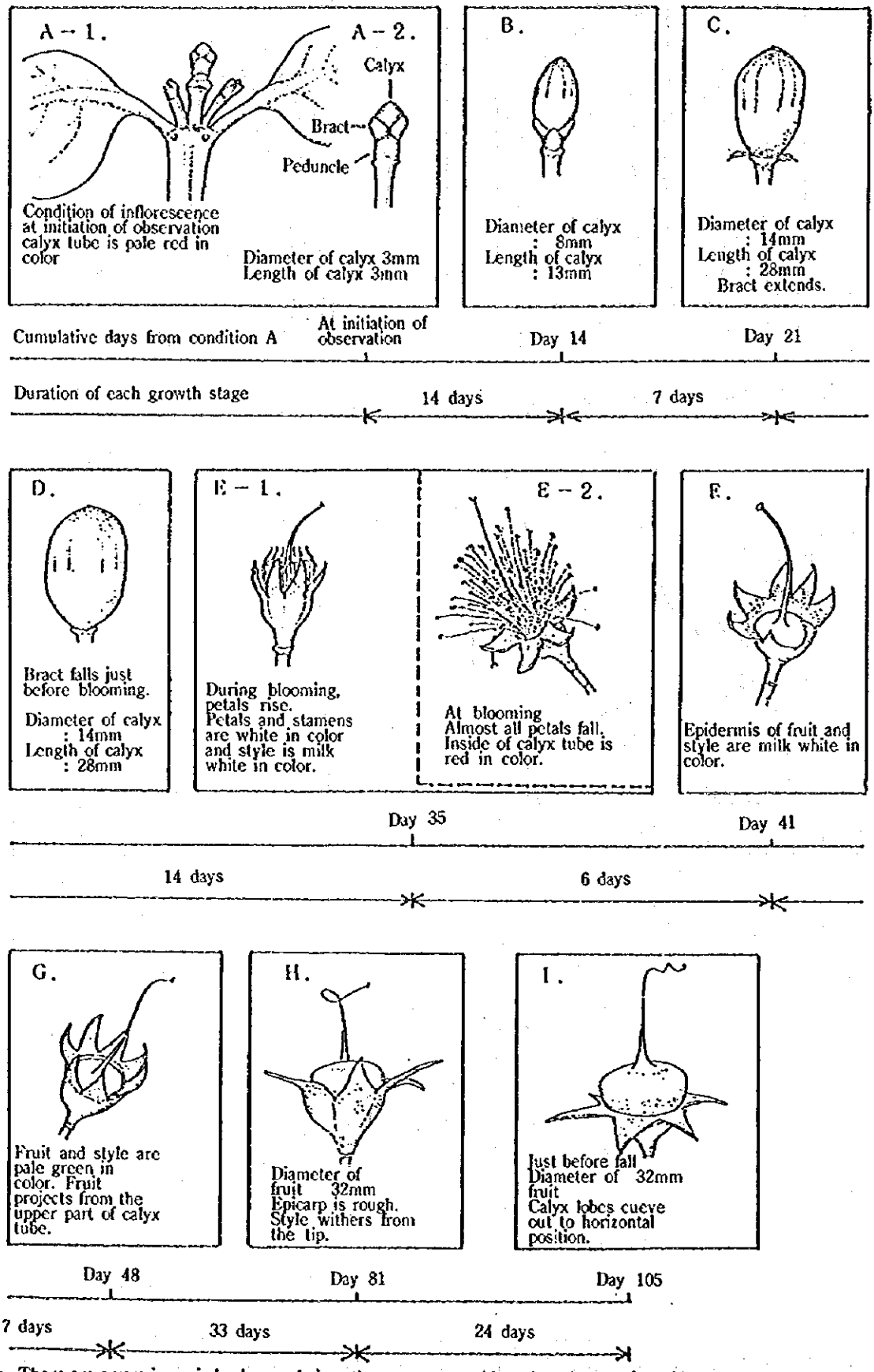
Duration of the period not observed is assumed based on experiences.

Fig. 2–3–22 Process of maturation of viviparous seed of *Rhizophora mucronata Lamk*



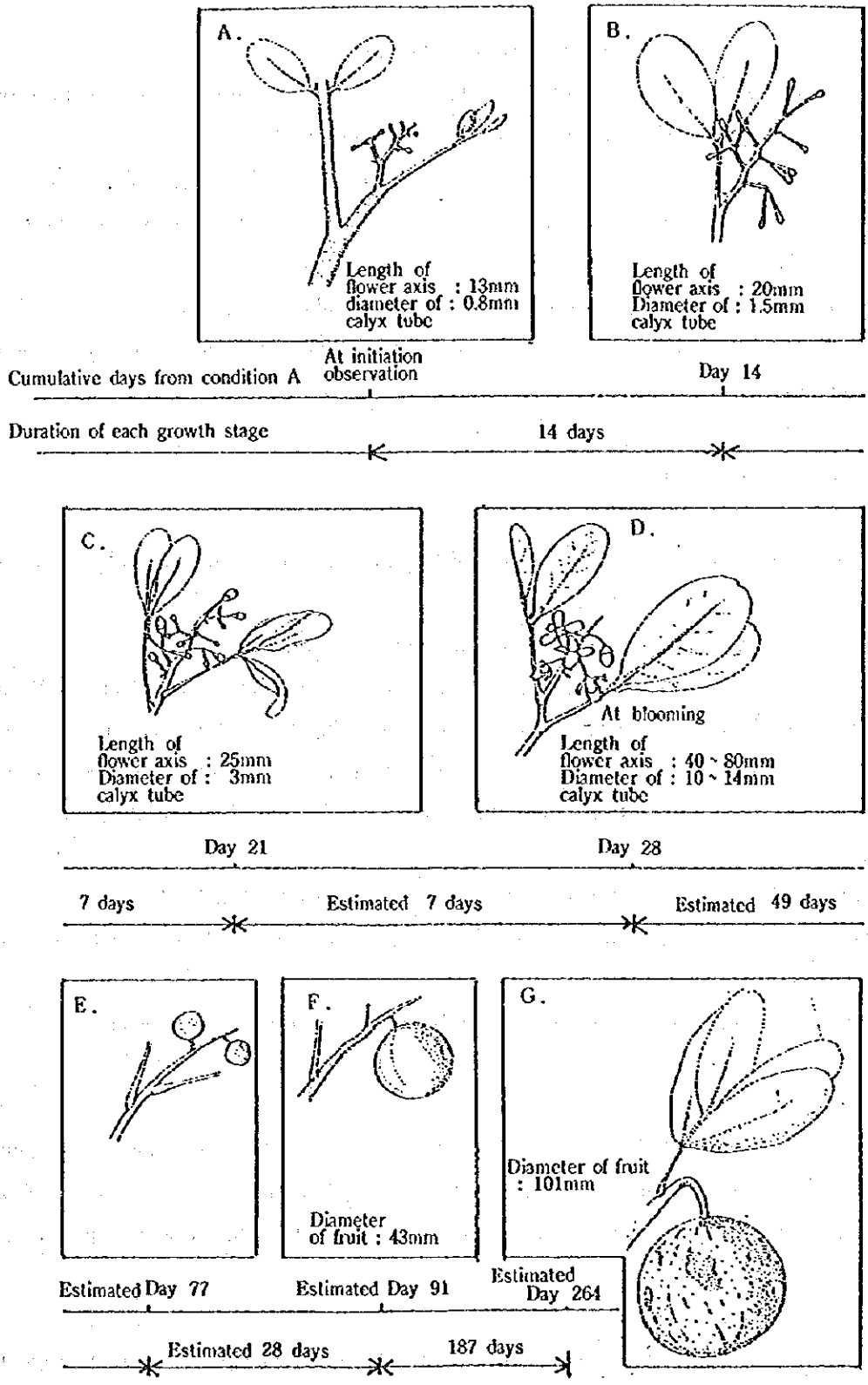
(Note): There are errors in periods observed since they are prepared based on data obtained from several flowers.

Fig. 2–3–23 Process of maturation of viviparous seed of *Bruguiera gymnorrhiza (L.) Lamk*



(Note): There are errors in periods observed since they are prepared based on data obtained from several flowers.

Fig. 2－3－24 Process of maturation of viviparous seed of *Sonneratia alba J. Smith*



(Note): Periods observed; A–C, F–G.

There are errors in periods observed since they are prepared based on data obtained from several flowers.

Periods not observed; C–D, D–E–F.

Durations of the periods not observed are assumed based on experiences.

Fig. 2–3–25 Process of maturation of viviparous seed of *Xylocarpus granatum Koenig*

The observation results are summarized as follows:

1. About 100 flowers were observed. There was no flower processed to maturation of seeds. All fell during the observation due to disease, etc.
2. Trees in the same site tend to bloom simultaneously. Blooming peaks are observed for several times in a year. However, there are trees out of the synchronization of the other ones.
3. One inflorescence possesses 6–50 flower buds. Some fruits mature in an inflorescence. However, as described above, almost every inflorescence fall during maturation.

9) Study on seed production

Collected viviparous seeds were distinguished to be mature or immature by the color of seed leaf appeared from the fruit.

Those of red in color were mature and the others immature.

- The peak season of production of seed is not clear. There are loose peak from January to March and down from May to June (Fig. 2–3–26). The results almost coincided to the results of above described section 8). Namely, the loose peak of blooming was from June to August and it took about 5.5 months from blooming to fall of mature fruit.
- In Gili Sulat Island, the peak season was from March to April in 1994.
- There were many immature fruits in the collected ones. It occupied 35% of all collected by the trap.
- Production amount of mature seed was 0.3333/ m^2 .day in the peak season.

Rhizophora mucronata

The pure forest of *Rhizophora mucronata* was apart of the Center and it was difficult to settle a trap at the site. In addition, a small amount of seeds was collected throughout the year other than the peak season. So, the survey will be performed in later years.

Other observation results:

- According to the observations until now, the peak season was from August to November. A small amount of seeds was also produced in the other time of the year.
- In Gili Sulat Island, however, the peak season was from October to December in 1994. And no seed was collected from March to April.

Ceriops tagal

Since this species is used only for the afforestation of exhibition forest, a small amount of seeds is required. In Lombok and Bali Islands, the seeds can be collected at any time when the places are selected. So, the survey will be performed in later years.

Other observation results:

- According to the observations until now, there are peak season of seed production in individual districts or groups.
  However, there are some trees with many seeds at time other than the peak season of the group.
- From 1 tree, 30–50 seeds can be collected.

Bruguiera gymnorrhiza

Since there is no pure forest of this species in BENOA Bay, one tree that grows near the Center was observed for the change of numbers of viviparous seeds (Fig. 2–3–28).

Other observation results:

- The number of adhering seeds fluctuated seasonally. One peak was supposed to be in a year. The peak season was from October to December. A small amount of seeds was also produced in the other time of the year.
- With respect to one tree, there was a period with no seed.
  However, when considering the whole area of BENOA Bay, collection of seeds is possibly throughout the year.
- In the above section 8) as shown in Fig. 2–3–23, it was confirmed that "Young root emerges from the viviparous seed 13–16 weeks after blooming. The seeds matured and fell about 6 months after blooming." Applying the results, the peak of blooming started from August to September, namely, 3–4 months before the initiation of increase in number of adhering fruits (early December) to 3–4 months before observation of constant number of adhering fruits (late April)(Fig. 2–3–28). The peak persisted for 4–5 months and ended from December to January.
- At initiation of survey, namely, from November to January, there were many trees during blooming and just after blooming. A small number of blooming trees were also observed throughout of the year.
  In the survey, the number of seeds produced by each tree was not able to be

confirmed. So, a waiting net is settled on the margin of ground of the sample tree for the survey of production amount.

Sonneratia alba

In the pure forest of Sonneratia alba, 10 traps of seeds were settled and 4 traps were settled in the margin of the forest. In the early phase after settlement, collected seeds were recovered 1–3 weeks of interval. Then, weekly data had been accumulated. Collected fruits were distinguished to be mature or immature by the existence of calyx on the fruits. Those without calyx were mature and those with calyx immature.

- There are seasonal changes in production amount of fruits.
  In the peak season, 0.3878/m2.day of mature fruits fell.
- By the 18–month observation until now, there seemed to be peaks in May and October. However, the production amounts in the same October differed among years.
- There was a period with no production of seeds. At that time, almost all trees in a district stopped production of seeds.
- Though not accurate, the observation results indicate that the sizes of fruits differed among peak seasons. They were tended to be large at large peaks and small at small peaks.

Xylocarpus granatum

This species is used only for the afforestation of exhibition forest and all trees in BENOA Bay grow singly without forming pure forest, and a small amount of seeds is able to be obtained throughout the year due to somewhat difference in maturation times among trees. So, the survey will be performed in later years.

Other observation results:

- Individual trees showed different timing of seed production.
  As for a group, a very loose peek was supposed to exist.
  From late October to early November in 1994, all trees showed blooming at a time. However, there were somewhat differences in blooming among individual trees and among districts.
- From a tree of 2–5 m in height, 5–15 fruits were collected.
- The sizes of mature fruits varied. Small ones were about 8 cm in diameter and large ones about 15 cm. The former contained about 7 seeds and the latter about 15 seeds.
- Each tree had many flowers at a time but less than 1% of the flowers were processed to mature fruit.

Avicennia marina

A group of Avicennia marina of low height with crown opened was selected for the settlement of seed traps. The survey is now in progress and will be summarized in later years.

Other observation results:

- There might be a loose peak of production of seeds. But it was obscure.
- There was a large peak about September, 1993. Large mature seeds were collected at that time. Until then, no mature seed was obtained. There was a possibility of existence of top year and bottom year.

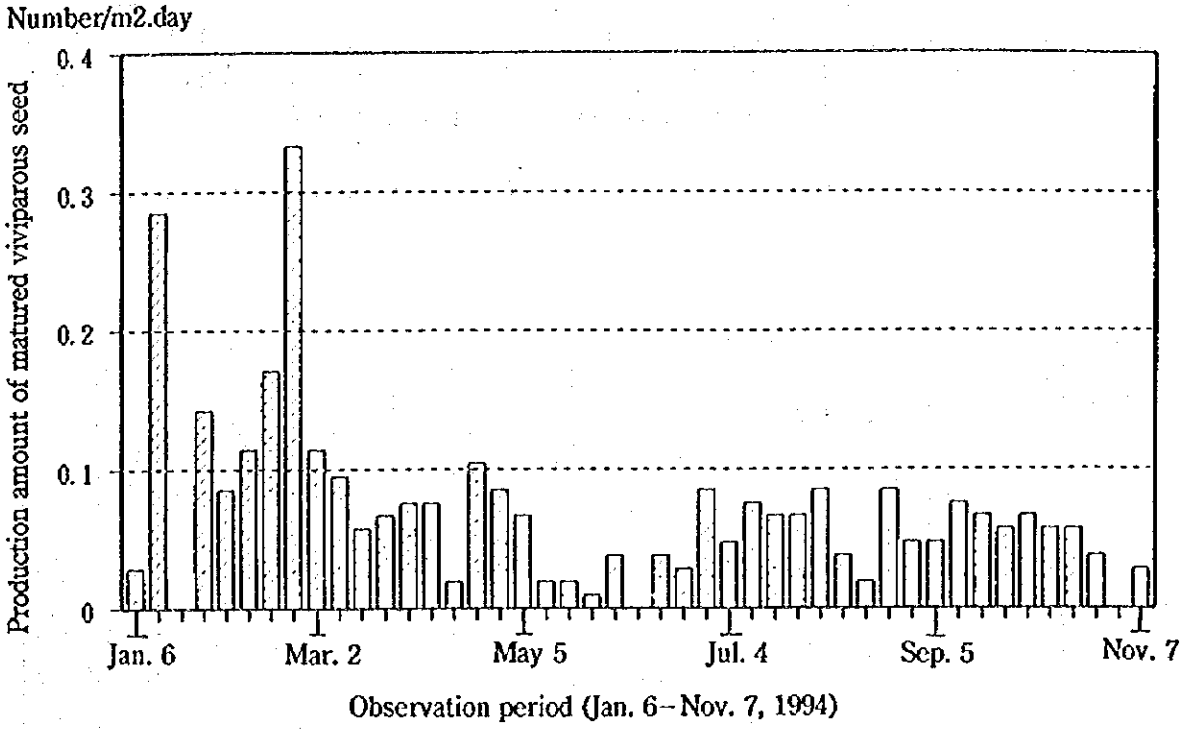


Fig. 2–3–26 Production amount of matured viviparous seed of *Rhizophora apiculata BL*

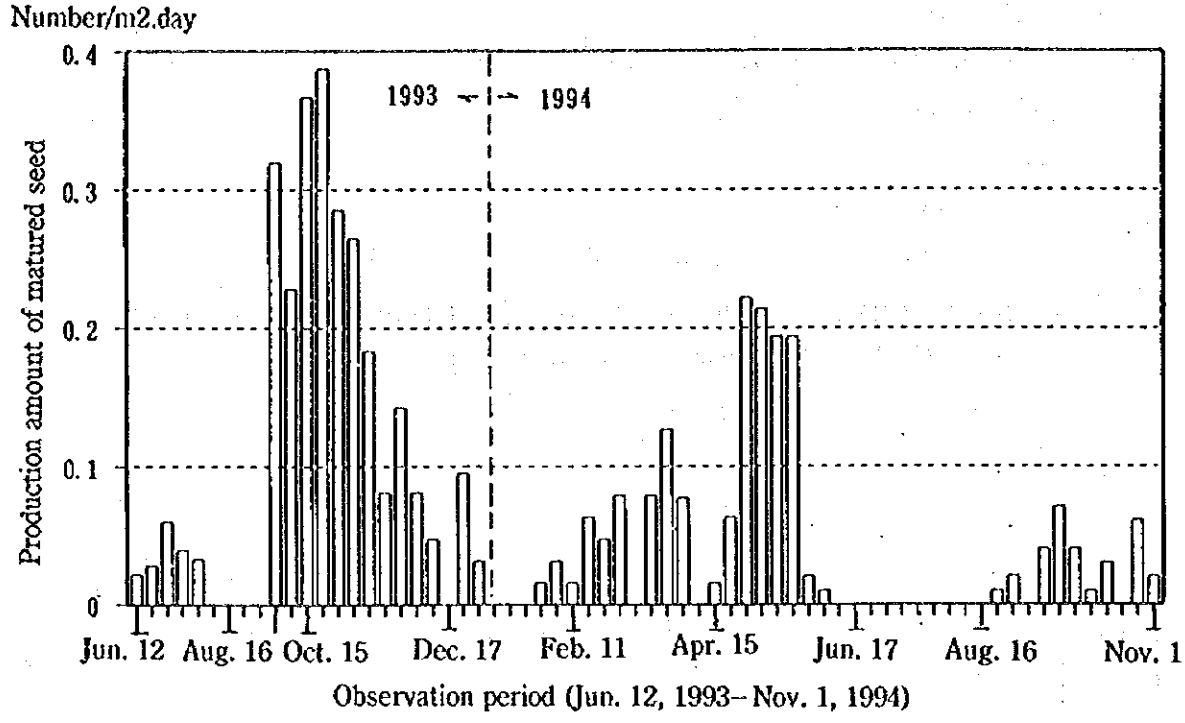


Fig. 2–3–27 Production amount of matured seed of *Sonneratia alba J. Smith*

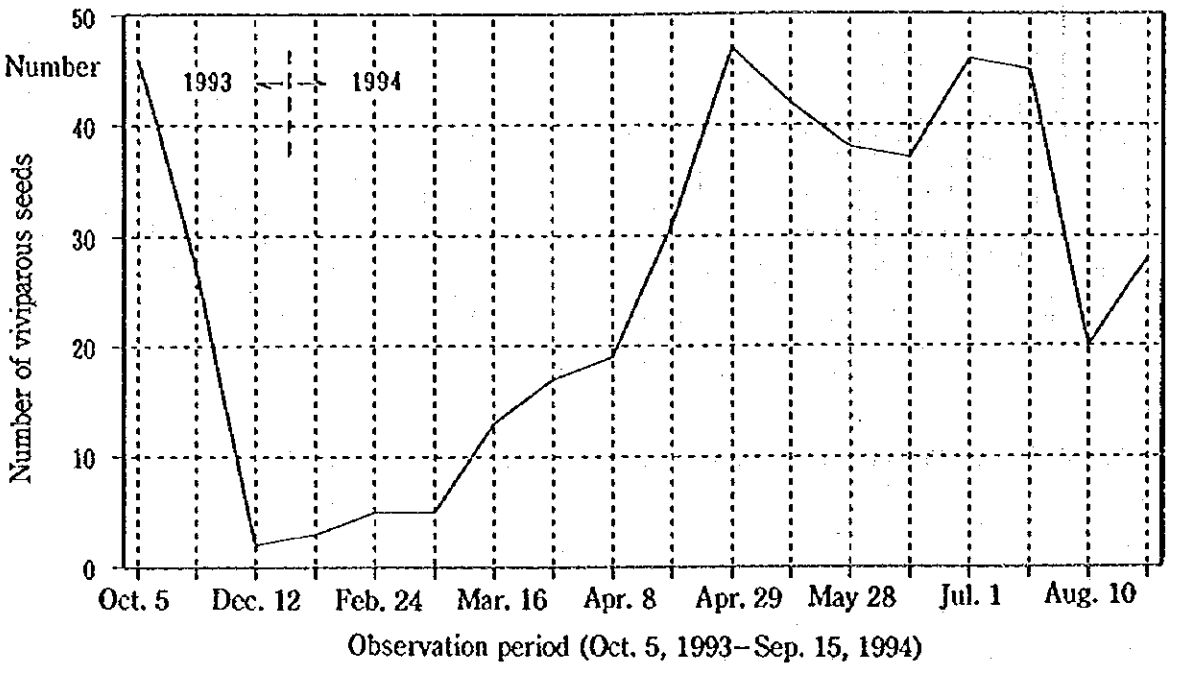


Fig. 2–3–28 Change in number of viviparous seed adhering to one tree of *Bruguiera gymnorrhiza (L.) Lamk*

IV . Report on Forest Management

1. Progress of the Study

(1) Study Plans

The purpose of the project is to make a general model of mangrove afforestation by collecting and processing reference data, which will be needed when a private enterprise plans to invest in mangrove afforestation.

The concrete items which should be executed by the mangrove forest management section in the project term can be summarized as follows:

1) Collecting various data, maps and records which are needed for mangrove forest management, and pigeonholing them,
2) Investigating the working processes and the labor efficiency in seedling culture and afforestation, recording the expenditures, and estimating the cost,
3) Selecting sites for cropping investigation and measuring the yield of growth with the purpose of preparing data required for the crop forecast,
4) Studying mangrove charcoal, the main product of mangrove material to make better use of it,
5) Establishing a method for inhabitants to participate in mangrove afforestation, and
6) Making a model for mangrove forest operation on the basis of the results of the works shown above and various projects and tests concerning to seedling culture, afforestation and echological research.

Dividing the project term into three periods, the project has been planned to adopt mainly the items 1), 2) and 3) in the first period, the items 3) and 4) in the second period, and the items 2), 5) and 6) in the third period.

(2) Progress

1) The following materials were prepared to facilitate forest management:

A map of small divisions of a forest, where each Tambak is taken as division unit

A map of divisions showing the year of return the land ownership to the government.

A Forest survey record based on the survey of the present situation (under preparation)

2) Survey on the labor efficiency and the cost

The labor efficiency in the seedling culture processes in a temporary seedling bed and the cost of the seedling culture were surveyed.

The man-days for some parts of afforestation work were clarified.

3) Survey for preparation of a yeild forecast table

Fourteen survey sites for yeild forecast were selected in man-made and natural forests,

and every tree on the survey sites was examined.

4) Charcoal production

The lay-down burning method of charcoal production and the situation of industrial charcoal production was examined.

5) Social and economical survey --- not started.

6) Model making for mangrove forest operation --- not started.

7) Others

Basic tests for seedling culture in an experimental seedling bed, and survey for siting were conducted.

(3) Problems

1) Since the growing speed of mangroves planted in tambaks is quite low in the early stage of growing, technical development to accelerate initial growing seems to be required.

Also the growing speed of mangroves differs significantly depending on the growing location and the soil conditions. Consequently, technical development of a soil grading method may also be required to facilitate afforestation management.

2) Although information on the forest age or the age of trees is necessary for yeild forecast, the age of trees not only in natural forests but also in man made forests is often unknown. Therefore the forest age or the age of trees should be estimated by selecting cropping survey sites and measuring the amount of annual growth. Since there have been very few reports on yeild forecast, the number of the survey sites should be increased to obtain more accurate data.

3) The original program for improvement of charcoal production technology consists of two parts: tests of cahrcoal prodution from mangroves trees and improvement of charcoal production technology. On Bali and Lombok, however, since all the mangrove forests are designated as reserved forests, and mangrove felling is prohibited, mangrove charcoal has not been produced at all, and actual tests of charcoal production is difficult to conduct. Therefore the contents of the program were modified, so that the present situation and the problems of charcoal production in Indonesia and other countries (e.g. Malaysia) were studied from litereture, and on-site inspections were conducted to point out problems of charcoal production.

2. Survey and research plans, and accomplishments

(1) Survey and research plan

The survey and research plans on management are described as follows:

Project plan	Survey item	priority
Estimation of the cost of mangrove afforestation	Study on efficiency of nursing work	A
	Study on efficiency of planting work	A
	Analysis on nursery cost and afforestation	A
Consideration of social and economical benefits to forestry and fishery communities	Analysis on socio-economic elements regarding Mangrove afforestation	B
Formation of a model of mangrove forest operation	Making documentation on forest condition	A
	Preparation of yeild tables	A
Development of technology for utilizing products from mangrove forests	Improvement of charcoal making technigues	B
	Analysis on socio-economic elements regarding Mangrove afforestation	B

1) Study on efficiency of nursing work

Item	Contents
1. Purpose, expected results	Conduct survey on the labor efficiency for each process of seedling culture of various species, and determine the standard working processes of mangrove seedling production.
2. Sample, plot location, amount, sampling method	Seedling beds and relating working sites
3. Method of measurement	Record the labor efficiency for each kind of work
4. Time for measurement	Conduct measurement when appropriate work is being done.
5. Anlysis method	Dependence on the type of work, dependence on the working environment, dependence on the species, and others
6. Time for reporting (Midterm, final)	Midterm — in the third year, final —— in the fifth year

2) Study on efficiency of planting work

Item	Contents
1. Purpose, expected results	Conduct survey on the labor efficiency in each process of afforestation of various species, and determine the standard working processes of mangrove afforestation.
2. Sample, plot location, amount, sampling method	Seedling beds, afforestation sites, and relating working sites
3. Method of measurement	Record the labor efficiency for each kind of work
4. Time for measurement	Conduct measurement while afforestation work is underway.
5. Anlysis method	Dependence on the conditions of the working environment, direct management or work by contract, dependence on sex, and others
6. Time for reporting (Midterm, final)	Midterm —— in the third year, final —— in the fifth year

3) Analysis on nursery cost and afforestation

Item	Contents
1. Purpose, expected results	Conduct survey and analysis of the cost of seedling production and afforestation to facilitate future projects of seedling production and afforestation.
2. Sample, plot location, amount, sampling method	
3. Method of measurement	Record and analyze the income and expenditure whenever seedling production or afforestation is conducted.
4. Time for measurement	In April or May of each year, analyze the cost of seedling production and afforestation conducted in the previous year.
5. Anlysis method	Trial estimation of the cost of seedling production Trial estimation of the income and expenditure for afforestation
6. Time for reporting (Midterm, final)	Midterm —— at the end of the third year, final —— at the end of the fifth year

4) Making documentation on forest condition

Item	Contents
1. Purpose, expected results	Discuss the contents of the forest survey record, which should help mangrove afforestation management.
2. Sample, plot location, amount, sampling method	
3. Method of measurement	Conduct a brief note survey in February or March every year.
4. Time for measurement	Accumulate data in the present-state forest survey records.
5. Anlysis method	How to divide into subterms, determination of survey items, how to prepare a summary table, consideration of detabase formation
6. Time for reporting (Midterm, final)	Midterm —— in the second year, final —— in the fifth year

5) Preparation of yield table

Item	Contents
1. Purpose, expected results	Prepare a yeild forecast table to predict the amount of crop obtained from an man made mangrove forest
2. Sample, plot location, amount, sampling method	Man-made forests and natural forests
3. Method of measurement	Measure the amount of annual growth of trees, which should depend on the tree height.
4. Time for measurement	Measure on each of the stationary survey sites once a year.
5. Anlysis method	Prediction of the amount of growth for each year
6. Time of reporting (Midterm, final)	Midterm —— in the third year, final —— in the fifth year

6) Improvement of charcoal making techniques

Item	Contents
1. Purpose, expected results	Collect information on mangrove charcoal utilization, and discuss methods of utilizing favorable material wood.
2. Sample, plot location, amount, sampling method	Sites of mangrove charcoal production and mangrove charcoal markets
3. Method of measurement	
4. Time for measurement	In July and August
5. Anlysis method	Study techniques of mangrove charcoal producdtion and indicate points to be improved. Analyze the market structure in areas where charcoal is produced and consumed.
6. Time for reporting (Midterm, final)	In the fourth year

7) Analysis on socio-economic elements regarding mangrove afforestation

Item	Contents
1. Purpose, expected results	Conduct survey and analysis of social and economical effects of mangrove afforestation, and seek for measures to control and make sustainable use of mangrove forests
2. Sample, plot location, amount, sampling method	
3. Method of measurement	Analysis using exsisting survey data, and research on some of actual conditions
4. Time for measurement	In September and October
5. Anlysis method	1. Techniques to organize inhabitants of the surrounding area so that they can participate in the afforestation project 2. Analysis of the effects of the afforestation project on the life style of inhabitants involved and in the area as a whole. 3. The effects of the afforestation project on fishery
6. Time for reporting (Midterm, final)	In the final fiscal year

(2) Results of the Survey and Research

1) Study on efficiency of nursing work

Tables 2-4-2 and 2-4-3 summarize the process of making a temporary seedling bed and the labor cost and the cost of supplies which had been required for making the bed, and the number of man-days and the labor cost which had been required for seedling culture in the temporary seedling bed.

The data for a project's nursery were collected in the period from October 1993 to March 1994.

The results of analysis will be discussed in the next report.

Table 2-4-1 Seedling Culture Plan in Fiscal 1993

Species	Number of seedlings planned to be raised	Amount of planned production
S. alba	24, 200	(3, 600) 17, 900
B. gymnorrhiza	24, 200	(3, 600) 17, 900
R. apiculata	24, 200	(3, 600) 17, 900
R. mucronata	24, 200	(3, 600) 17, 900
A. marina	24, 200	(3, 600) 17, 900
C. tagal	5, 000	(700) 3, 800
X. granatum	3, 300	(500) 2, 500
TOTAL	129, 300	(19, 200) 95, 800

(4) Note: The numbers in ( ) show the numbers of replanted trees.

Table 2--4--2 The Labor Cost and the Cost of Supplies Having been Required for Making a Temporary Seedling Bed

Kind of work	Man-days	Amount of work	Amount of work per man-days
Trimming	0.750	100 m	133.0 m
Laying sandbags	6.125	4 m^2	0.65 m
Weeding	8.125	320 m^2	39.4 m^2
Partitionig	4.000	2,016 m^2	504.0 m^2
Constructing and maintaining a waterway	102.500	2,166 m^2	21.13 m^2
Clieaning	2.000	4,000 m^2	2,00.0 m^2
Bed making	74.500	1,008 m^2	13.5 m^2
Land preoaration	9.000	1,008 m^2	112.0 m^2
Making and driving piles	68.000	1,008 m^2	14.8 m^2
Demokition of a waterway	4.000	20 m	5.0 m
Total	279,000 X 4,500 = Rp 1,255,000		
Night watch	16,000 X 4,500 = Rp 72,000		
Construction of a storehouse	Rp 79,750		
The cost of supplies	Rp 1,875,400		
Total	Rp 3,282,650		

Table 2-4-3 The Cost of Supplies having been required for Construction of a Storehouse in the Temporary Nursery (1)

Item	Amount	Unit cost (Rp)	Payment for a month (Rp)			
			February	March	April	Total
Sandbag	110	180 400	19,000	9,000		28,000
Chinese hoe	10	4,750 8,500	51,250			51,250
Reap hook	2	2,500	5,000			5,000
Whetstone	1	1,500	1,500			1,500
Shovel	14	12,250 12,500	122,750	50,000		172,750
Sheet	1	26,000	26,000			26,000
Nylon string	3 rolls	750	2,250			2,250
Metal cutting saw	1	6,000	6,000			6,000
Saw blade	2	400	800			800
Board	9	16,500 24,000	35,500	138,000		173,500
Bamboo rod	8	1,512	12,100			12,100
Electric driver	1	88,500	88,500			88,500
Pile pipe	4	6,975	27,900			27,900
Nylon rope	1 roll	19,600	19,600			19,600
File	1	4,000	4,000			4,000
Sand	4 m^3	20,000		80,000		80,000
Partitioning rope	1 role	9,000		9,000		9,000
Oil tank	1	4,500		4,500		4,500
Gasoline	10 l	700		7,000		7,000
Bucket	10	4,250		42,500		42,500
Boots	23 pairs	8,086		186,000		186,000
Doctor's fee for treatment of an injured worker				8,000		8,000
Total			422,150	534,000		956,150

Table 2-4-3 The Cost of Supplies having been required for Construction of a Storehouse in the Temporary Nursery (2)

Item	Amount	Unit cost (Rp)	Payment for a month (Rp)			
			February	March	April	Total
Bent scale	1	3,000		3,500		3,500
Board	19	11,500 -25,000		328,000		328,000
Asbest	20	11,500		230,000		230,000
Nail	6 kg	3,125		18,750		18,750
Thread	1 role	500		500		500
Key	1	3,500		3,500		3,500
Plywood board	22	8,500		187,000		187,000
Rafter	10	12,800		128,000		128,000
Hinge	1	2,500		2,500		2,500
Nylon tape	1 role	3,000		3,000		3,000
Total				904,750		904,750

Table 2-4-4 The Number of Man-days and the Cost having been required for Seedling Culture in the Temporary Nursery

Man- days for a month

Type of work	March	April	May	June	July	August	September	October	Subtotal
Gathering and transportaion of soil	13.0	77.0							90.0
Seed gathering	3.0	19.0	13.0	63.0	59.5	47.0	61.0	11.0	276.5
Preparing pots		163.0	88.0						251.0
Transportation and arrangement		44.5	68.0	6.0				13.5	132.0
Draining		3.0							3.0
Seeding			15.0		17.0	13.0	28.0	17.0	90.0
Sprinkling water		4.0	3.0						7.0
Gathering Seedlings		4.5							4.5
Planting cuttings			43.0	25.0	9.5	14.5	15.0	8.0	115.0
Seedling selection			4.0						4.0
Shading from the sun			18.0	43.0	27.0	27.0	25.0	10.0	150.0
Cleaning			1.0		1.0				2.0
Repair of the bed ground				6.0					6.0
Seedling Bed making					4.0				4.0
Transplanting					7.5	10.5			18.0
Removing the sunshade						0.5	7.0		7.5
Pump operation							2.0		2.0
Subtotal	16.0	315.0	253.0	143.0	125.5	112.5	138.0	59.5	1,162.5

Unit labor cost (1993) Rp 4,500 Subtotal Rp 5,757,750

Night watch									
Subtotal					62.0	62.0	60.0	176.0	360.0

Unit labor cost (1993) Rp 2,250 Subtotal Rp 805,500

Total	16.0	315.0	253.0	143.0	187.5	174.5	198.0	235.5	1,522.5

Total labor cost Rp 6,563,250

Conversion rate 1 dollar = 2,100 Rp

Table 2--4--5 The Cost of Supplies having been required for Seedling Culture in the Temporary Nursery (1)

Item	Amount	Payment for a month (Rp)								
		March	April	May	June	July	August	September	October	Total
Germination box	390	1,175,000			1,950,000	56,000	220,000	660,000		4,061,000
Sieve (large)	3	60,000								60,000
Sieve (small)	3	24,000								24,000
Box for seedling transportation	129	425,000					435,000	257,000		1,117,000
Vinyl pot	177,500	2,109,250					54,000			2,163,250
Bamboo rod	760	804,000		108,000	43,000		144,000			1,104,000
Compost	6	540,000								540,000
Pruning shears	6	36,000								36,000
Vinyl string	16	19,750					1,000	1,000		20,750
Gasoline for pumps	70		21,000	28,000						49,000
Bucket	20		30,000	18,500						48,500
Shovel	9		110,250							110,250
Rope	4		60,000							60,000
Reward for seed gathering				105,000						105,000
Seed gathering B. gymnorrhiza	3,460			34,600						34,600
Seed gathering X. granatum	3,100			31,000						31,000
Seed gathering R. apiculata	4,620			46,200						46,200
Seed gathering R. mucronata	2,350			40,200						40,200
Gasoline for cars	686			163,000	49,000					212,000
Mobile	1			8,000						8,000
Electric torch	1			14,700						14,700
Wire	94			48,700	156,000	3,000				207,700
File	1			2,000						2,000

Table 2--4--5 The Cost of Supplies having been required for Seedling Culture in the Temporary Nursery (2)

Item	Amount	Payment for a month (Rp)								
		March	April	May	June	July	August	September	October	Total
Whetstone	2			2,500						2,500
Scoop for transplantation	3			5,500						5,500
Watering pot	3	9,100			4,250					13,350
atap	554				314,800	240,000				554,800
Paint	3				11,250					11,250
Balance	2				24,750					24,750
Fertilizer	1				62,500					62,500
Nail	2				4,000					4,000
Board	30				210,000					210,000
Rectangular timber	5				36,000					36,000
Subtotal		5,202,100	221,250	655,900	2,624,550	299,000	853,000	918,000		10,773,800
Oil tank	10				20,000		17,500			37,500
Indication board	70					420,000				420,000
Screw	140						28,000			28,000
Pushpin	2						4,000			4,000
Stemmin	50							70,000		70,000
Scale	1							5,000		5,000
Rattrap	4								2,880	2,880
Rat paste	2								4,760	4,760
Subtotal					20,000	420,000	49,500	75,000	7,640	572,140
Total		5,202,100	221,250	655,900	2,644,550	719,000	902,500	993,000	7,640	11,345,940

Table 2-4-6 Seedling Culture Plan in Fiscal 1994

Species	Number of seedlings planned to be raised	Amount of planned production unit: number of trees
S. alba	57, 100	(8, 446) 42, 333
B. gymnorrhiza	57, 100	(8, 446) 42, 333
R. apiculata	57, 100	(8, 446) 42, 333
R. mucronata	57, 100	(8, 446) 42, 333
A. marina	57, 100	(8, 446) 42, 333
C. tagal	5, 000	(750) 3, 750
X. granatum	3, 300	(500) 2, 500
TOTAL	293, 800	(43, 500) 217, 915

Note: The numbers in ( ) show the numbers of replanted trees.

Table 2-4-7 Number of Seedlings Raised during the Period after Construction of the Temporary Nursery and before Switching Over to Operational Seedling Culture, and Number of Seedlings Raised by the End of Fiscal 1993/94

Species	Number of seedlings raised in the term from March 13,1993 to October 1993	Number of seedlings raised in the term from October 16, 1993 to March 31, 1993	Note
		0	Upper – for fiscal 93/94
S. alba	13,000	0	Lower – for fiscal 94/95
		0	〃
B. gymnorrhiza	30,300	43,600	〃
		2,000	〃
R. apiculata	27,400	80,400	〃
		5,400	〃
R. mucronata	21,000	23,900	〃
		0	〃
A. marina	24,000	62,900	〃
		0	〃
C. tagal	12,500	4,700	〃
		0	〃
X. granatum	4,000	1,900	〃
		7,400	〃
TOTAL	132,200	217,400	〃

Table 2-4-8 The Number of Man-days and the Cost having been required for Seedling Culture in the Operational Nursery

	Man-days for a month						
Type of work	October	November	December	January	February	March	Total
Gathering and transportaion of soil	13.0	179.5	218.0	75.0	77.0	55.0	617.5
Seed gathering	2.0	105.0	123.0	12.0	115.0	69.0	426.0
Preparing pots	16.5	159.0	207.0	54.0	134.0	33.0	603.5
Transportation and arrangement	4.5		27.0	15.0		24.0	70.5
Draining							
Seeding	2.0			46.0			48.0
Sprinkling water		5.0					5.0
Gathering seedlings							
Planting cuttings		29.0	90.0	21.0	10.0		150.0
Seedling selection							
Shading from the sun	34.0	79.0	66.0	91.0	19.0	42.0	331.0
Cleaning		2.0	2.0		4.0		8.0
Repair of the bed ground							
Bed making		4.0	4.0	10.0		7.0	25.0
Transplanting	5.0			50.5	21.0	16.0	92.5
Removing the sunshade							
Pump operation							
Partitioning	2.0						2.0

	Man-days for a month						
Type of work	October	November	December	January	February	March	Total
Additional fertilization		2.0					2.0
Breakwater wall			4.0				4.0
Office moving			6.0				6.0
Shed moving			10.0	8.0			18.0
Pot arrangement					28.0	6.0	34.0
Painting						21.0	21.0
Total	79.0	564.5	757.0	382.5	408.0	273.0	2,464.0

Unit labor cost at the time Rp 4,500 Total Rp 11,088,000

Table 2-4-9 The Cost of Supplies having been required for Seedling Culture in the Commercial Operational Nursery (1)

Item	Amount	Payment for a month (Rp)						
		October	November	December	January	February	March	Total
Germination box	178	220,000	1,030,000	550,000				1,800,000
Vinyl pot	355,100	5,078,500						5,078,500
Block	1,650	225,000		2,100,000		900,000		3,225,000
Tap	2	12,500	4,500					17,000
Hose	2	7,800	60,000					67,800
Bamboo rod	1,100	250,000	1,045,000	210,000				1,505,000
Nail	16.5	2,500	2,200	12,500	14,900	3,500	5,000	40,600
Hammer	1	2,500						2,500
Sheet	7		90,000			32,000		122,000
Nylon tape	4		22,000					22,000
Atap	1,240		960,000	6,000				966,000
Freight charge	2		140,000					140,000
Rectangular timber	34			315,000				315,000
Chinese hoe	6		40,000				12,000	52,000
Wire net	6		7,000	7,000	6,000			20,000
Tinman's shears	3		6,000		7,800			13,800
Wire	3		210,000		110,000			320,000
Bucket	50		65,000					65,000
Truck parts	1		9,000					9,000
Doctor's fee			30,000					30,000
Sandbag	10		5,000					5,000
Indication board	165		150,000	180,000	180,000	300,000	180,000	990,000
Hatchet	4		9,000			10,000		19,000
Broad ax	1		6,000					6,000
File	1		4,000					4,000
	4		800		3,000.			3,800
Whetstone	2		2,000		2,000			4,000

Table 2-4-9 The Cost of Supplies having been required for Seedling Culture in the Commercial operational Nursery (2)

Item	Amount	Payment for a month (Rp)						
		October	November	December	January	February	March	Total
Duck shoes	20			80,000		90,000		170,000
Artificial fertilizer	3			122,500			62,500	185,000
	5			75,000				75,000
	20			7,500	6,500			14,000
Canvas hose	1			385,250				385,250
Subtotal		5,798,800	3,897,500	4,050,750	330,200	1,335,500	259,500	15,672,250
Plywood board	10				75,000			75,000
Roof sheet	15				71,250			71,250
Truck repair	1				21,500			21,500
Sand	1				40,000			40,000
Cement	1				10,000			10,000
Hoe grasp	2				5,000			5,000
Key	1				3,000			3,000
Paint	28				20,000	24,000	90,000	134,000
Thinner	1				3,500			3,500
Brush	5				2,100	1,000		3,100
Wire brush	4				3,000	1,500		4,500
Pliers	4				8,300			8,300
Bolt	50				2,500			2,500
Spray	3				9,500	4,500		14,000
Board	33				112,500	265,000		377,500
Rectangular timber	4				40,000			40,000
Boots	25				110,000	161,000		271,000
Scale	2				7,500			7,500
Gimlet	2				1,600			1,600

Table 2-4-9 The Cost of Supplies having been required for Seedling Culture in the Commercial Seedling Bed (3)

Item	Amount	Payment for a moth (Rp)						
		October	November	December	January	February	March	Total
Saw	2					9,000		9,000
Cheesecloth	5					8,400,000		8,400,000
Bonus for the New Year	20						100,000	100,000
Pot							2,120,000	2,120,000
Reap hook	3						6,000	6,000
Shovel	1						12,500	12,500
Oil	1			4,500				4,500
Lever	1			5,000				5,000
Subtotal				9,500	546,250	8,866,000	2,328,500	11,750,250
Total		5,798,800	3,897,500	4,060,250	876,450	10,201,500	2,588,000	27,422,500

2) Study on efficiency of planting work

Man-days for some kinds of work were determined as follows:

Man-days for each kind of work

Existing materials were studied and data was collected to determine the standards of man days for each kind of work to be done in the abandoned shrimp culture ponds and the delta areas on the Bali sites and in the clear-cut areas in the atolls on the Lombok sites.

On the basis of the data collected, the man days for the work of planting new, construction of footways, construction of pathways for working, nursing, and fertilizing were determined, as shown in the following table (the intervals of planting: 2m x 2m):

Table 2-4-10 Standards of Man-days

Item	Type	Division of work	Subdivision	Unit	Bali		Lombok
					Abandoned shrimp culture pond	Delta area	Clear-cut area in an atoll
Renovation	Planting new	Ground preparation	Preparation	ha	–	–	–
			Arrangement		–	– Selection of seeds	0.40(5)
		Planting	Transportation		7.72(2)	7.32(1)	2.05(5)
			Planting		10.42(2)	12.93(1)	5.10(5)
		Planting temporarily			–	–	–
	Replanting	Ground preparation	Preparation	ha	–	–	–
			Arrangement		–	–	–
		Planting	Transportation		–	–	–
			Planting		–	–	–
		Planting temporarily			–	–	–
Pathway required for afforestation	Footway (bridge)	Construction	Width m	m	(Bamboo bridge)	–	–
		Repair	(0.3)	(Number of spots)	0.83(3)	–	–
	Pathway for working (bridge)	Construction	Width m	m	(Log bridge)	–	–
		Repair	(1.3)	(Number of spots)	3.34(1)	–	–
Additional planting		Planting			–	–	–
Nursing		Support pile	Preparation	Piles per day	500(2) (Manufactured)	–	–
			Installation	Piles per day	412(2)		
			Replanting fallen trees	Piles per day	42(2) (Scattered)	–	–
			Cleaning	Piles per day	–	59(1)	–
Fertilization	Fertilization of seedlings		Fertilization	kg	–	–	–
Protection	Prevention of breeding and extermination of blight and noxious insects		Felling		–	–	–
					–	–	–

Note) The figures in ( ) indicate the numbers of samples.

3) Analysis on nursery cost and afforestation

The production cost of one seedling was estimated, as shown in the following.

The results of simple estimation of the cost of raising a seedling in the temporary nursery that in the period after switching over to the operational nursery and before the end of fiscal 1993, and that in fiscal 1993 are shown in Tables 2-4-11, 2-4-12, and 2-4-13.

Table 2-4-11 The Cost of Raising a Seedling in the Temporary Nursery

(unit: Rp)

Item	Amount	Number of seedlings raised	The cost of raising a seedling
The cost of constructing the temporary Nursery	3,282,650		
The labor cost of raising the seedlings	6,563,250		
The cost of supplies for raising the seedlings	11,591,940		
Total	21,437,840	132,200	Rp 162.16

Table 2-4-12 The Cost of Raising a Seedling in the Period after Switching Over to Commercial Seedling Culture and before the End of Fiscal 1993

(unit: Rp)

Item	Amount	Number of seedlings raised	The cost of raising a seedling
The labor cost of raising the seedlings	11,088,000		
The cost of supplies for raising the seedlings	24,722,000		
Total	35,810,000	224,800	Rp 159.29

(The cost of constructing the seedling bed is not included)

Table 2-4-13 The Cost of Raising a Seedling in Fiscal 1993

(unit: Rp)

Item	Amount	Number of seedlings raised	The cost of raising a seedling
The cost of constructing the temporary nursery	21,437,840		
The cost for the period after switching over to operational nursery	35,810,000		
Total	57,247,840	357,000	Rp 160.35

4) Making documentation on forest condition

The following materials were prepared.

(A) Partitioning a Forest into Small Divisions

The Bali site of the project, which extends from west to east and faces Benoa Bay on the north, could be divided into five divisions.

These divisions were called forest divisions, and each Tamback in these divisions was called a subdivision. A forest subdivision map was drawn for each of forest divisions No. 1 to No. 5.

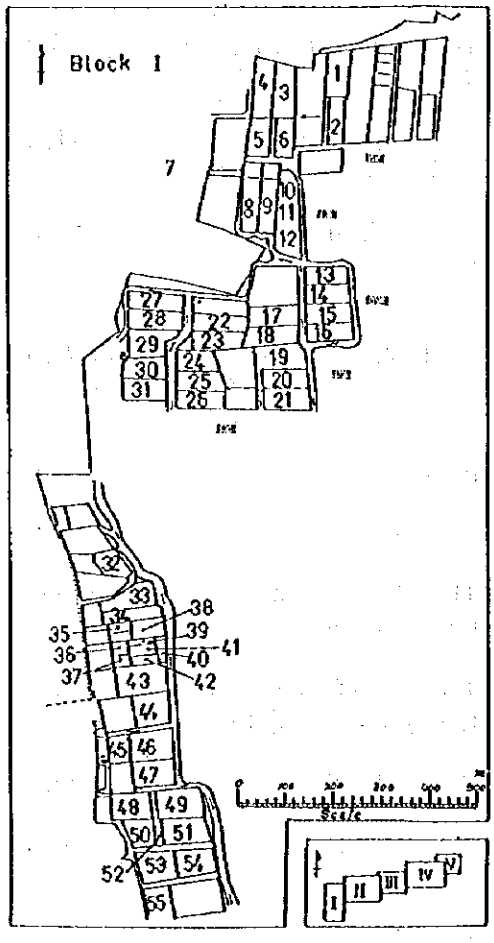


Figure 2-4-1 (1) Forest subdivision map

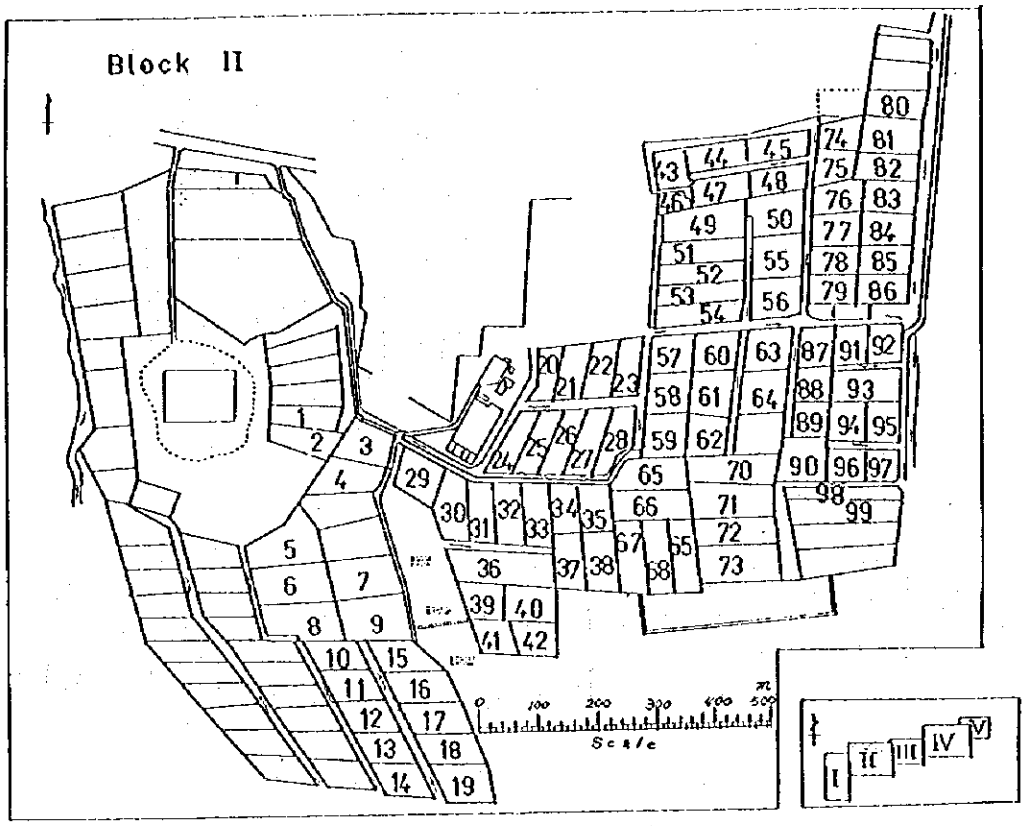


Figure 2-4-1 (2) Forest subdivision map

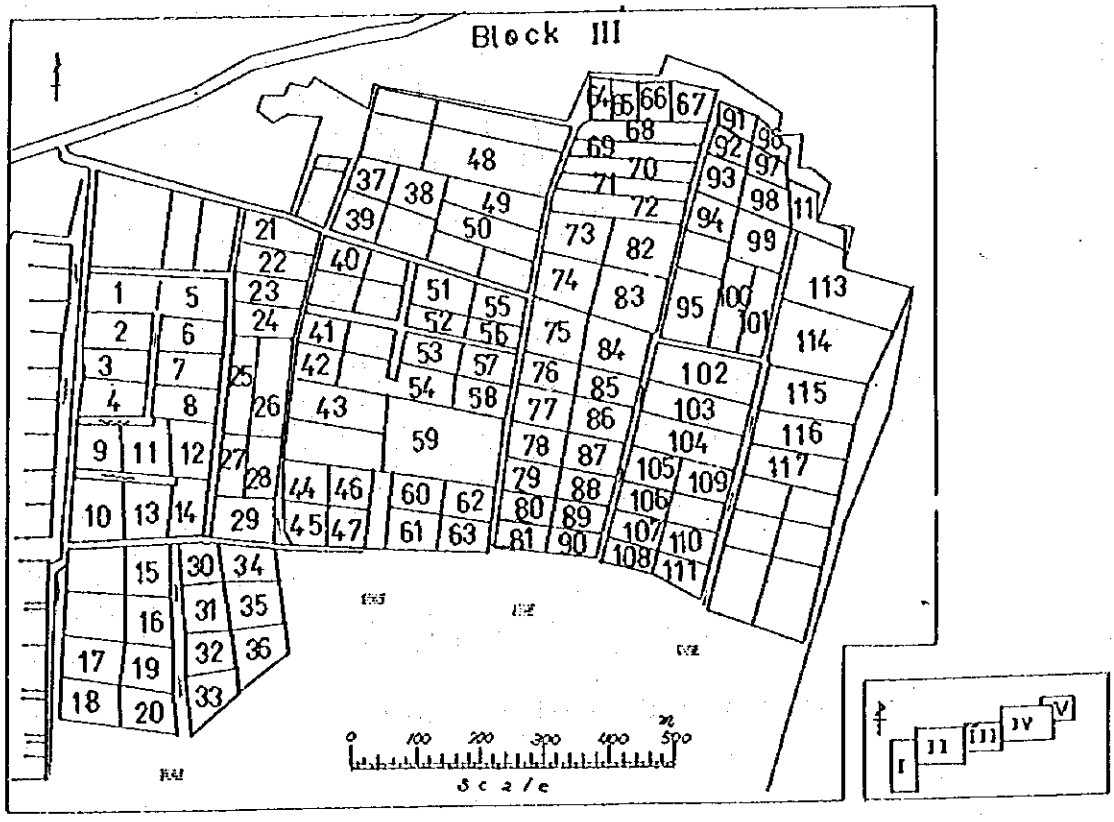


Figure 2-4-1 (3) Forest subdivision map

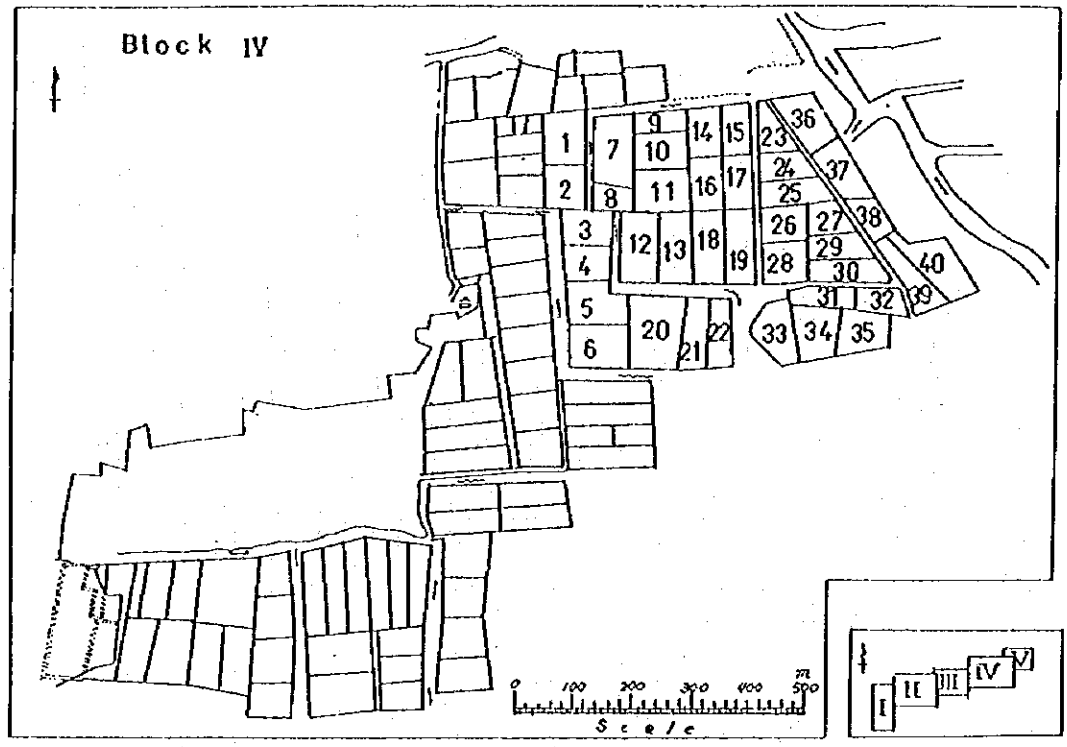


Figure 2-4-1 (4) Forest subdivision map

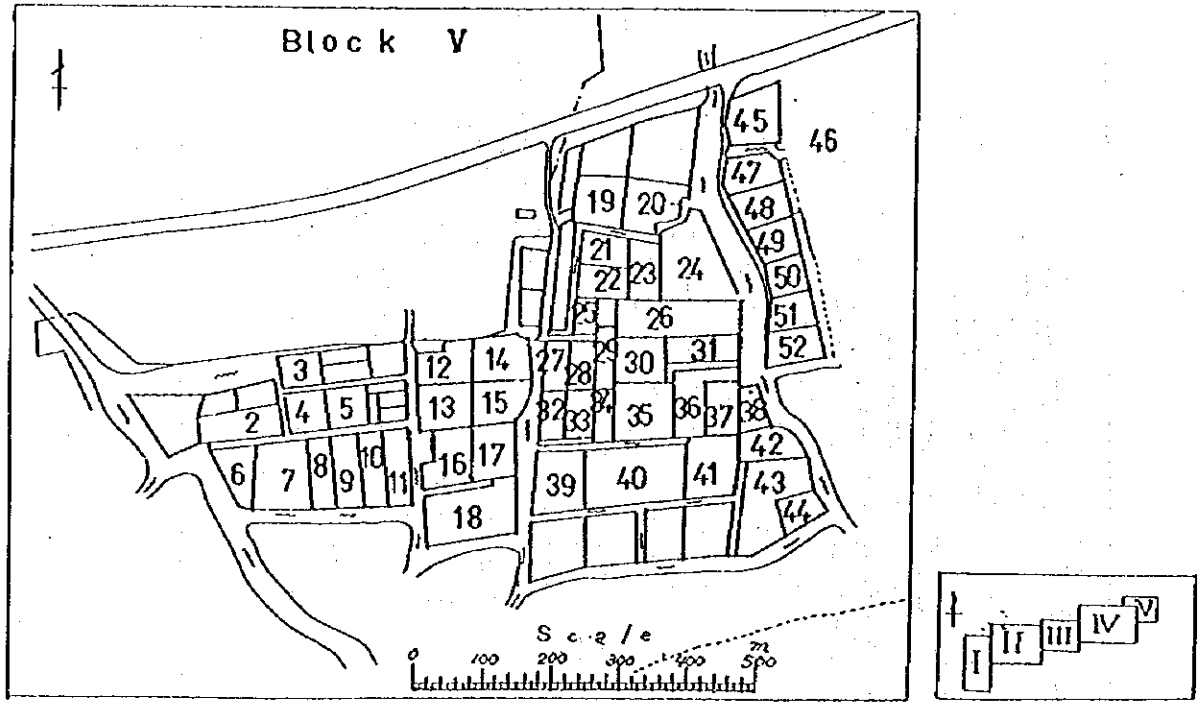


Figure 2-4-1 (5) Forest subdivision map

(B) Drawing of a Partitioning Map Showing the Year of Return

Shrimp culture in the national land was stopped, and the pond was returned to the Ministry of Forestry of Indonesia in three stages(1990/91, 1991/92, and 1992/93). In the returened Tambaks, mangroves were immediately planted by the State Forest Management Beureau (DINAS). Since the species of mangroves planted differ depending on the year of return and the Tambaks changed greatly in one to two years after the return, a partitioning map showing the year of return was drawn on the basis of the data supplied by the Bali LocalForest Administration Bureau (KANWIL).

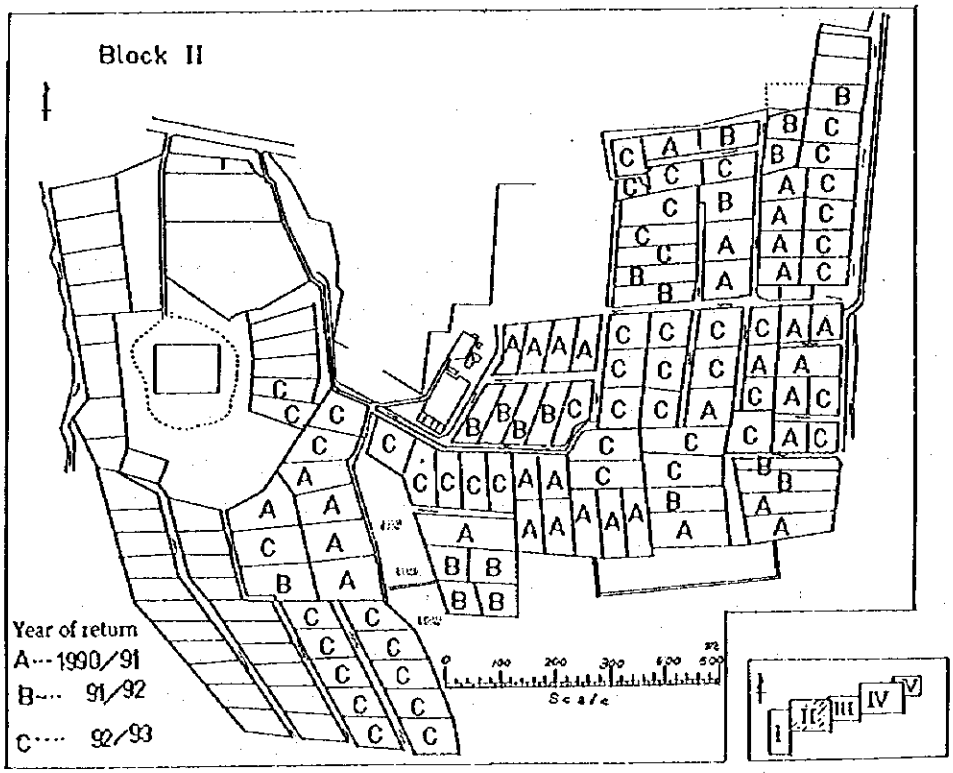


Figure 2--4--2 Partitioning Map Showing the Year of Return

(C) Preparation of a Forest Survey Record Based on the Survey of the Present Situation

The state of soil and forests in Tambaks changes rapidly due to the contaminated soil cleaning effect of the tide level change in the Tambaks , the change of the ground level caused by deposit of soil and sand in the Tambaks and errosion of banks, growing and dying of seedlings of Sonneratia and alba developed from seeds which were brought to the Tambaks by the tidal wave, withering of mangroves being planted and raised, and damage by noxious insects. Consequently, abrief note survey of all the Tambaks is conducted in February or March every fiscal year to know the present situation and the change during the previous year.

There are following survey items in the survey record:

Items of the Survey Record

Number for a division of a forest ... Use a number of five figures.
The two digits on the left side show the number for the division, and the three digits on the right side show the number for the subdivision.
Area ... Show in ha down to the third decimal place.
Distance ... Show the distance from the roadway in ha in a straight line.
Depth of water... The level water in cm, measured from the bottom of the concrete gate of the Tambak when the tide level in Benoa Bay is 200 cm
Drainage ... Judging from the percentage of the surface area of the pool at low tide, evaluate the drainage condition as follows:

Good: the percentage of the surface area of the pool
—— lower than 20%
Fair: —— 20% to 50%
Poor: —— higher than 50%

Salinity ... Salinity (in milli percent) of the water in the pool at low tide
Mud depth ... Measure in cm with a boring stick 1.5 m long
Contamination ... Judging from the degree of production of spirogyras or conas, and the condition of rubbish accumulation, evaluate the contamination level as follows:

Level of contamination ... high more than 50% of the surface is covereed by spirogyrus or conas
intermediate —— 20 to 50%

low —— less than 20%

Purpose ... The main purpose of afforestation ——

P: production forest

C: conservation forest

D: demostration forest

Planting ... Year and month of planting —— example, 94.03 —— March 1994

Species ... R. M —— *Rhizophora mucronata* R. A —— *Rhizophora apiculate*

B. G —— *Burguera gymnoriza* S. A —— *Sonneratia alba*

A. M —— *Avicennia marina* C. T —— *Ceriops tagal*

X. C —— *Xylocarpus granatum*

Number of trees ... Number of existing trees

Density .... Dense X, intermediate X, sparse X

Rate of survival ... The rate of survival after three years from the time of planting

Height ... The average height of trees when the rate of survival was surveyed

Replanting ... Year and month of replanting

Replanted species ... Species of replanted trees

J planting ... Planting in the JICA project

1, 2, 3 survival ... The rate of survival after one, two or three years from the time of planting

1, 2, 3 height ... The average height of trees when the above rates of survival were measured

Others ... Note the things observed at the time of survey

Examples: development condition of mantis shrimp mounds, condition of natural renovation of S. alba, damage by noxious insects, damage by blight, change in geographic features, drainage works

5) Preparation of yeild table

To prepare a yeild forecast table, certain survey areas were determined, and all the trees in these areas were measured.

The ages of the forests were unknown, except for some man made forests. To estimate the ages of the forests from annual growth, the diameter was measured in mm, and the tree height in cm.

The results of measurement in each survey area are shown as follows:

Results of Measurement in a Crop Survey Area (1)

Measurement area number: 1
Measurement area: Lembogan, Bali
Species: Rhizophora apiculata
Natural or man made: natural forest
Forest age: unkown
Measured area: 10m × 10m
Number of trees measured: 86
Number of trees per ha: 8,600
Date of measurement: 1994.03.09
Symbol: RaN−1
Method of measurement: diameter —— direct measurement of each tree with a ring scale
tree height —— direct measurement of six representative trees with average diameter using a measuring rod

Measured value

Diameter (mm)

sum	3,597
average	42.3176
variance	700.813
standard deviation	26.4729
coefficient of variation	62.5575

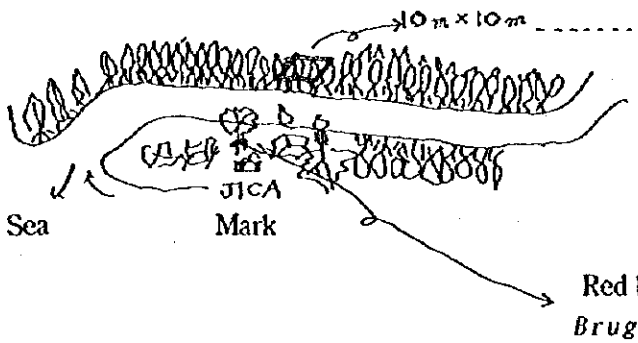
Tree height (cm)

average	818

Frequency distribution table (diameter)

range		frequency
7.000	17.300	14
17.300	27.600	18
27.600	37.900	11
37.900	48.200	12
48.200	58.500	6
58.500	68.800	9
68.800	79.100	4
79.100	89.400	4
89.400	99.700	4
99.700	110.000	3

Sketch of the measured area



A number tape is sticked on each tree
No1 ~ No86

Red band on the trunk
Bruguiera gymnorrhiza

Results of Measurement in a Crop Survey Area (2)

Measurement area number: 2
Measurement area: Lembogan, Bali
Species: Rhizophora stylosa
Natural or man made: man made forest
Forest age: three years old
Measured area: 10m × 10m
Number of trees measured: 26
Number of trees per ha: 2,600
Date of measurement: 1994.03.09
Symbol: RsM−1
Method of measurement: diameter —— direct measurement of each tree with a pair of calipers
tree height —— direct measurement of each tree with a measuring rod

Measured values

Diameter (mm)

sum	418
average	16.0769
variance	62.9538
standard deviation	7.9343
coefficient of variation	49.3524

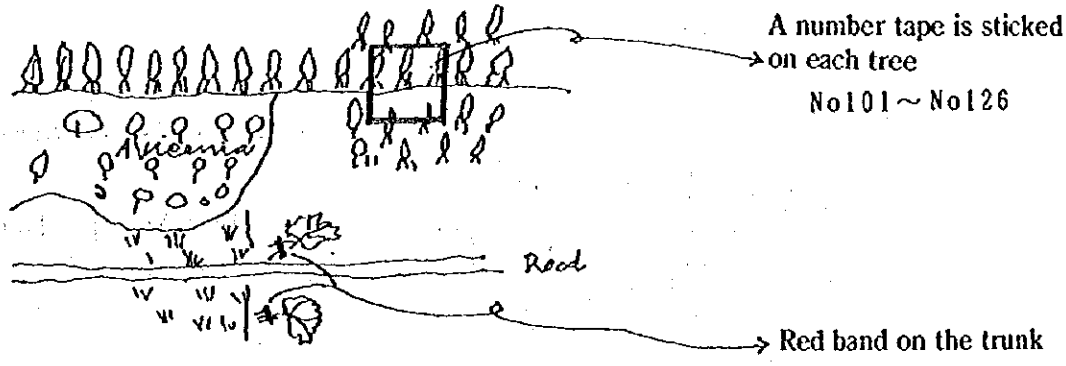
Tree height (cm)

average	230

Frequency distribution table (diameter)

range	frequency
4.000 ..... 8.429	3
8.429 ..... 12.857	8
12.857 ..... 17.284	4
17.284 ..... 21.714	7
21.714 ..... 26.143	0
26.143 ..... 30.571	3
30.571	1

Sketch of the measured area



Results of Measurement in a Crop Survey Area (3)

Measurement area number: 3
Measurement area: Lembogan, Bali
Species: Bruguiera gymnorrhiza
Natural or man made: naturale forest
Forest age: unknown
Measured area: 20m X 20m
Number of trees measured: 13
Number of trees per ha: 325
Date of measurement: 1994.03.09
Symbol: BgN-1
Method of measurement: diameter —— direct measurement of each tree with a ring scale
tree height —— direct measurement of each tree with a measuring rod

Measured values

Diameter (mm)

sum	1,507
average	115.923
variance	1502.08
standard deviation	38.756
coefficient of variation	33.4311

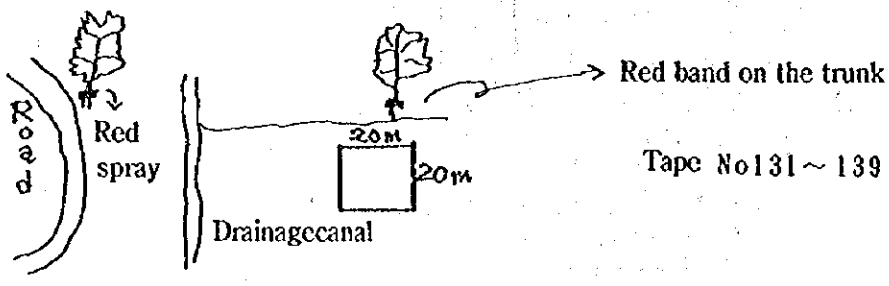
Tree height (cm)

average	617

Frequency distribution table (diameter)

range	frequency
50.0 ..... 61.8	2
61.8 ..... 73.6	0
73.6 ..... 85.4	0
85.4 ..... 97.2	3
97.2 ..... 109.0	0
109.0 ..... 120.8	1
120.8 ..... 132.6	2
132.6 ..... 144.4	1
144.4 ..... 156.2	3
156.2	1

Sketch of the measured area



Results of Measurement in a Crop Survey Area (4)

Measurement area number: 4
Measurement area: Lembogan, Bali
Species: Rhizophora apiculata
Natural or man made: natural forest
Forest age: unkown
Measured area: 10m × 10m
Number of trees measured: 86
Number of trees per ha: 8,600
Date of measurement: 1994.03.08
Symbol: RaN−2
Method of measurement: diameter —— irect measurement of each tree with a ring scale
tree height —— direct measurement of six representative trees with average diameter using a measuring rod

Measured value

Diameter (mm)

sum	3,099
average	36.0349
variance	132.364
standard deviation	11.505
coefficient of variation	31.9273

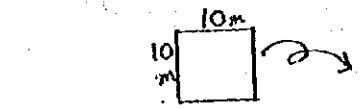
Tree height (cm)

average	545

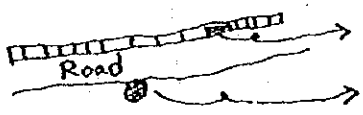
Frequency distribution table (diameter)

range			frequency
11.000	.....	15.636	2
15.636	.....	20.273	6
20.273	.....	24.909	9
24.909	.....	29.546	11
29.546	.....	34.182	9
34.182	.....	38.818	14
38.818	.....	43.455	11
43.455	.....	48.091	9
48.091	.....	52.091	8
52.727	.....	57.364	5
57.364	.....		2

Sketch of the measured area



A number tape is sticked on each tree
No141～227



Red mark at the upper part of the concrete protection wall

Red mark on the stamp of a palm tree

Results of Measurement in a Crop Survey Area (5)

Measurement area number: 5

Measurement area: Subdivision 114 in the block III in Benoa Bey

Species: Rhizophora mucronata

Natural or man made: man made forest

Forest age: unkown

Measured area: 15m × 19m

Number of trees measured: 133

Number of trees per ha: 4,666

Date of measurement: 1994.06.08

Symbol: RmM-1

Method of measurement: diameter —— direct measurement of each tree with a diameter tape measure

tree height —— direct measurement of every tree with a measuring rod

Measured value

Diameter (mm)

sum	7,314
average	54.9925
variance	152.766
standard deviation	12.3598
coefficient of variation	22.4755

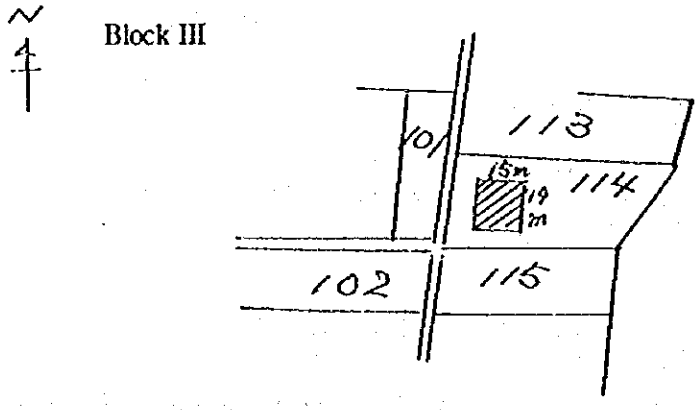
Tree height (cm)

average	644

Frequency distribution table (diameter)

range		frequency
22	31	4
31	40	9
40	49	26
49	58	30
58	67	43
67	76	18
76	85	2
85		1

Sketch of the measured area



Results of Measurement in a Crop Survey Area (6)

Measurement area number: 6

Measurement area: Subdivision 114 in the block III in Benoa Bey

Species: Rhizophora mucronata

Natural or man made: man made forest

Forest age: unkown

Measured area: 20m x 21m

Number of trees measured: 72

Number of trees per ha: 7,200

Date of measurement: 1994.06.08

Symbol: RmM-2

Method of measurement: diameter —— direct measurement of each tree with a diameter tape measure

tree height —— direct measurement of each tree with a measuring rod

Measured value

Diameter (mm)

sum	2,201
average	30.5694
variance	66.8692
standard deviation	8.1773
coefficient of variation	26.7501

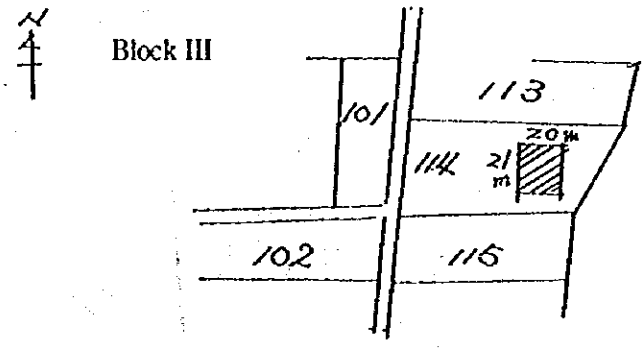
Tree height (cm)

average	344

Frequency distribution table (diameter)

range		frequency
19	27	29
27	35	22
35	43	14
43		7

Sketch of the measured area



Results of Measurement in a Crop Survey Area (7)

Measurement area number: 7

Measurement area: Subdivision 43 in the block III in Benoa Bey

Species: Rhizophora apiculata

Natural or man made: man made forest

Forest age: unkown

Measured area: 20m x 20m

Number of trees measured: 154

Number of trees per ha: 5,133

Date of measurement: 1994.06.09

Symbol: RaM-1

Method of measurement: diameter —— direct measurement of each tree with a diameter tape measure

tree height —— direct measurement of each tree with a measuring rod

Measured value

Diameter (mm)

sum	7,970
average	51.7532
variance	470.447
standard deviation	21.6898
coefficient of variation	41.91

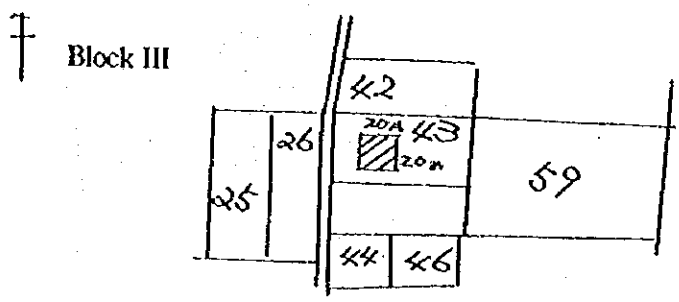
Tree height (cm)

average	445

Frequency distribution table (diameter)

range			frequency
17.000	.....	26.909	10
26.909	.....	36.818	30
36.818	.....	46.727	32
46.727	.....	56.636	29
56.636	.....	66.546	24
66.546	.....	76.455	14
76.455	.....	86.364	6
86.364	.....	96.273	0
96.273	.....	106.182	5
106.182	.....	116.091	1
116.091	.....		3

ketch of the measured area



Results of Measurement in a Crop Survey Area (8)

Measurement area number: 8

Measurement area: Subdivision 47 in the block I in Benoa Bey

Species: Sonneratia alba

Natural or man made: natural renovated forest

Forest age: one year and 4 months

Measured area: 3m × 3m

Number of trees measured: 53

Number of trees per ha: 58,900

Date of measurement: 1994.06.09

Symbol: SaN--1

Method of measurement: diameter —— not measured

tree height —— direct measurement of each tree with a measuring rod

Measured value

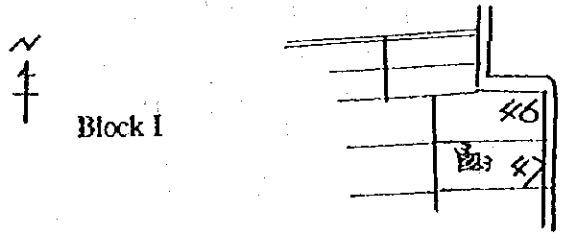
Tree height (cm)

sum	5,894
average	111.208
variance	415.556
standard deviation	20.3852
coefficient of variation	18.3308

Frequency distribution table (tree height)

range		frequency
43.000	53.091	1
53.091	63.182	0
63.182	73.273	0
73.273	83.364	3
83.364	93.455	3
93.455	103.545	10
103.545	113.636	13
113.636	123.727	10
123.727	133.818	5
133.818	143.909	5
143.909		3

Sketch of the measured area



Results of Measurement in a Crop Survey Area (9)

Measurement area number: 9

Measurement area: Subdivision 210 in the block II in Benoa Bey

Species: Sonneratia alba

Natural or man made: natural forest

Forest age: unkown

Measured area: 6m × 6m

Number of trees measured: 38

Number of trees per ha: 10,555

Date of measurement: 1994.06.10

Symbol: SaN−2

Method of measurement: diameter —— direct measurement of each tree with a diameter tape measure

tree height —— direct measurement of each tree with a measuring rod

Measured value

Diameter (mm)

sum	1,277
average	33.6053
variance	175.057
standard deviation	13.2309
coefficient of variation	39.3715

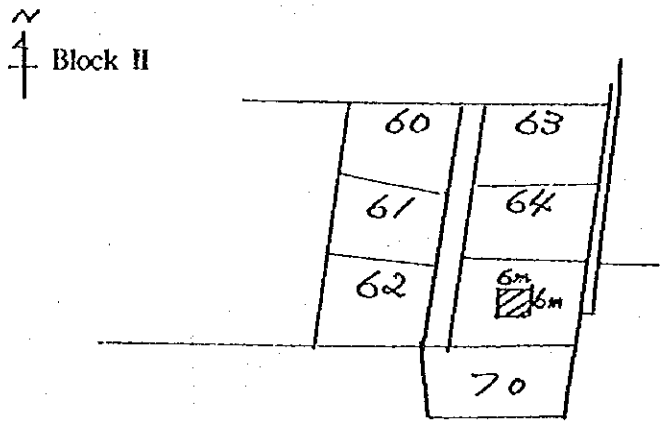
Tree height (cm)

average	355

Frequency distribution table (diameter)

range		frequency
14.000	23.600	
23.600	33.200	
33.200	42.800	
42.800	52.000	
52.400		

Sketch of the measured area



Results of Measurement in a Crop Survey Area (10)

Measurement area number: 10
Measurement area: Gili manuk, Bali
Species: Avicennia marina
Natural or man made: natural forest
Forest age: about 40 years (by hearing)
Measured area: 20m × 20m
Number of trees measured: 84
Number of trees per ha: 2,100
Date of measurement: 1994.07.19
Symbol: AmM--1
Method of measurement: diameter —— direct measurement of each tree with a diameter tape measure
tree height —— measurement of each tree with an infrared range finder and a brumerise height meter

Measured value

Diameter (mm)

sum	10,300
average	122.619
variance	864.848
standard deviation	92.997
coefficient of variation	75.8424

Tree height (cm)

average	847

Frequency distribution table (diameter)

range		frequency
20	66	30
66	112	20
112	158	9
158	204	13
204	250	2
250	296	5
296	342	3
342	388	1
388	434	0
434		1

Results of Measurement in a Crop Survey Area (11)

Measurement area number: 11
Measurement area: Gili manuk, Bali
Species: Avicennia marina
Natural or man made: natural forest
Forest age: about 20 years (by hearing)
Measured area: 10m × 10m
Number of trees measured: 42
Number of trees per ha: 4,200
Date of measurement: 1994.07.19
Symbol: AmN--2
Method of measurement: diameter —— direct measurement of each tree with a diameter tape measure
tree height —— direct measurement of each tree with a measuring rod

Measured value

Diameter (mm)

sum	3,140
average	74.7619
variance	557.261
standard deviation	23.6064
coefficient of variation	31.5754

Tree height (cm)

average	629

Frequency distribution table (diameter)

range	frequency
30.00 ..... 39.09	1
39.09 ..... 48.18	3
48.18 ..... 57.27	3
57.27 ..... 66.36	8
66.36 ..... 75.45	11
75.45 ..... 84.55	3
84.55 ..... 93.64	4
93.64 ..... 102.74	4
102.74 ..... 111.82	3
111.82 ..... 120.91	0
120.91	2

Results of Measurement in a Crop Survey Area (12)

Measurement area number: 12
Measurement area: Gili manuk, Bali
Species: Avicennia marina
Natural or man made: natural forest
Forest age: about 10 years (by hearing)
Measured area: 10m x 10m
Number of trees measured: 75
Number of trees per ha: 7,500
Date of measurement: 1994.07.19
Symbol: AmN-3
Method of measurement: diameter —— direct measurement of each tree with a diameter tape measure
tree height —— direct measurement of each tree with a measuring rod

Measured value

Diameter (mm)

sum	2770
average	36.9333
variance	253.983
standard deviation	15.9368
coefficient of variation	43.1503

Tree height (cm)

average	381

Frequency distribution table (diameter)

range	frequency
20.00 ..... 28.57	20
28.57 ..... 37.14	22
37.14 ..... 45.71	12
45.71 ..... 54.29	10
54.29 ..... 62.86	6
62.86 ..... 71.43	3
71.43	2

Results of Measurement in a Crop Survey Area (13)

Measurement area number: 13
Measurement area: Gili manuk, Bali
Species: Ceriops tagal
Natural or man made: natural forest
Forest age: about 15 years (by hearing)
Measured area: 20m × 5m
Number of trees measured: 15
Number of trees per ha: 1,500
Date of measurement: 1994.07.20
Symbol: CtN-1
Method of measurement: diameter —— direct measurement of each tree with a diameter tape measure
tree height —— direct measurement of each tree with a measuring rod

Measured value

Diameter (mm)

sum	900
average	60
variance	51.4284
standard deviation	22.6778
coefficient of variation	37.7964

Tree height (cm)

average	362

Frequency distribution table (diameter)

range	frequency
40 50	3
50 60	5
60 70	3
70 80	2
80 90	1
90 100	0
100 110	0
110 120	0
120	1

Results of Measurement in a Crop Survey Area (14)

Measurement area number: 14
Measurement area: Gili manuk, Bali
Species: Ceriops tagal
Natural or man made: natural forest
Forest age: about 9 years (by hearing)
Measured area: 10m × 10m
Number of trees measured: 20
Number of trees per ha: 2,000
Date of measurement: 1994.07.20
Symbol: CtN−2
Method of measurement: diameter —— direct measurement of each tree with a pair of calipers
tree height —— direct measurement of each tree with a measuring rod

Measured value

Diameter (mm)

sum	204
average	10.4
variance	9.22106
standard deviation	3.03662
coefficient of variation	29.7708

Tree height (cm)

average	179

Frequency distribution table (diameter)

range	frequency
6.000 ..... 7.875	3
7.875 ..... 9.750	5
9.750 ..... 11.625	8
11.625 ..... 13.500	2
13.500 ..... 15.375	1
15.375 ..... 17.250	0
17.250 ..... 19.125	0
19.125	1

6) Improvement of charcoal making technigues

Research on the actual condition was conducted to collect information, as shown in the followings:

For people living in mangrove growing areas, mangrove forests are closely connected with their daily life. Mangrove wood is widely used not only as construction materials, furniture materials, and materials for boats but also as fuel in daily life in the form of firewood and charcoal. They also use mangroves for food, materials for alcoholic drink, medicine, livestock feed, dyes for fish net, or clothing.

Since mangroves in the *Rhizophora* species have particularly high market value as materials for charcoal of high quality, people in the areas can get income by selling mangrove wood and also by being employed for charcoal production.

Indonesia has a long history of mangrove charcoal production. Recently, however, mangrove forests has been decreasing, being converted into rice paddy and shrimp culture ponds. As mangrove conservation movement has been activated,mangrove charcoal production sites have also been decreased. At present, commercial-scale mangrove charcoal production is carried on only in the areas of Riau and Aceh in the north of Sumatra mainly for export purposes.

Since an outline of the situation of production and consumption of mangrove firewood and production and export of mangrove charcoal in Indonesia has already been reported by an short-term expart, Mr. Ota , the following items were studied in the present survey: – ① the lay-down burning method of charcoal production in Bali, – ② the price of charcoal and firewood at various marketing stages in Bali, and – ③ the situation of industrialized charcoal production in the Riau area. In the survey, data on the working processes, the charcoal retrieval rate and the prices were tried to be collected.

① Survey on the lay-down burning method of charcoal production and the situation of firewood production in Bali

Lay-down burning is a simple method of charcoal production, and has been employed by people from the ancient times. In agricultural areas in Bali, the lay down burning method has been used for wood (e.g. from old coffee trees) and coconut husks.

Sawan Village and Taranga City in the north of Bali were chosen as the survey areas.

A. Migratory lay-down burning method of charcoal production

Sawan Village locates in the upcountry mountains, and is a 90 minute drive from Singaraja City. The site is on a hillside inclined at 15 degrees. It lies in a broad leaved forest adjacent to a coffee plantation. Since the surface of the site is covered

with thick volcanic ash, it is easy to dig a hole for lay down burning, which is of bowl shape 1 m in depth and 2m in diameter at the upper end. People migrate to find a suitable burning site where material wood is available and the working conditions are adequate.

Wood of old coffee trees or the root and fossil wood of tall trees called Kayu Kariji by people in the area are used as materials for charcoal. Coffee trees are widely cultivated in the area. They begin to bear fruit in three years after planting, and the level of fruit bearing is lowered in about 20 years. Therefore old coffee trees can be utilized as materials for charcoal.

The actual work of charcoal burning was observed and recorded as follows:

Digging a hole for lay-down burning:

Time required: 15 minutes by three men

Size: Diameter at the upper end	1m 20 cm
Diameter at the lower end	50 cm
Depth	60 cm

Procedures of charcoal production:

1) Lean seasoned coffee tree chips against the side wall of the hole.
2) Pour lamp oil into an ashtray filled with ash, and place it at the bottom of the hole to be used as an ignition agent.
3) Arrange thin sticks in parallel crosses so that space is left at the bottom.
4) Pile thin, a little more thick, and fairly thick material wood rods by turns.
5) Sprinkle lamp oil on material wood a little by little while piling the rods.
6) Fire the ignition agent when the top of the material wood pile gets higher than the level of the hole top.
7) Check that the lower layer wood is completely in flame and that the intermediate layer wood has caught fire.
8) Place banana leaves on the wood pile in the form of a lattice, and cover them with soil.
9) Leave for a night.
10) On the next day, remove the banana leaves and soil, and assort and pack up the charcoal produced.

Although the quality of charcoal of this sort is rather low, it can be used satisfactorily to grill chicken or to cook everyday meals. The delivery on the site price of the charcoal is 500 Rp per kg.

B. Stationary lay down burning method of coconut husk charcoal production

Stationary lay down burning for coconut husk production was observed in the surburbs of Taranga City in the east of Bali, which is one of the most important coconut production areas in Bali.

The size and the shape of the burning holes are similar to those for above-mentioned migratory burning. In this case, however, three holes are digged to be used permanently, and a roof is provided for each of the holes. One of these holes is used by turns.

1) The price of coconut husks (material of charcoal) delivered to the sight is 150 Rp per kg.
2) The ignition method is similar to that for migratory burning. Coconut husks are thrown into the hole in a lump, because the surface curvature of the husks is not uniform.
3) Place a steel sheet with a hole at the center on the hole, and cover it with soil.
4) Leave for a night. On the next day, assort and pack up charcoal produced.
5) the distribution route and the change in the price:

material	producer	middleman	first vendor	second vendor	shop front
Rp. 150	Rp. 500	Rp.700	Rp. 850	Rp. 1000	Rp.1500

② Price at various distribution stages (in Bali)

In the areas of charcoal production in the lay down burning method, firewood is also produced and sold. The kitchen of a private house has a two hole cooking furnace, in which firewood is burned. At a corner of some farmhous gardens, firewood is seen to be piled up. Some of the families cannot gather firewood for themselves, and have to buy it. Stores with firewood piled up in front can be found anywhere in the mountain area, the city area (Singaraja), and the area in between. Firewood used in Bali is taken mostly from coffee trees.

At the production sites, several sticks about 65 cm in length and 3 cm in diameter are bundled, and these are sold at the rate of 5,000 Rp per 60 bundles. In the city area, however, the price of 60 bundles is said to be raised to 9,000 Rp. When firewood is sold by lots, the price of a 4m80cm × 65 cm × 65 cm lotis 35,000 Rp.

In a village near a production site, it is found that a bundle of eight to ten coffee tree sticks 120 cm in length and 43 cm in circumference costed 500 Rp, and that a 50 bundle lot 110 to 120 cm in length and 120 cm in circumference costed 25,000 Rp.

The price of 500 Rp per bundle can be broken down into the price at the production site in the mountain area (300 Rp) and the fee for transporting to the village about 2 km apart (200 Rp).

According to the statistics taken for charcoal by the Bali Forestry Officein fiscal 1990/91, Bali makes its own supply of charcoal, except that 4,200 kg of charcoal is imported from East Jawa. The most part of imported charcoal is of a usual kind, not being made of coconut husks.

Imported charcoal is carried to wholesale dealers in Dempasar in 35 kg bags, and packed into small (1 kg or 2 kg) bags to be sold.

The retail price is 450 Rp/kg for usual charcoal produced in Jawa, and 750Rp/kg for coconut husk charcoal produced in Bali. In the market in Dempasar City, the price of usual charcoal is found to be 500 Rp/kg for usual charcoal, and600 Rp/kg for coconut husk charcoal. There is no standard price of charcoal, and the price varies from area to area.

③ Industrialized charcoal prodution

According to the statistics taken by Ditjen intag, Dephut (Forest Resources Research Bureau) in 1993, the total area of mangrove forests in Riau, Sumatra is 221,045 ha, and mangrove wood, mangrove charcoal and mangrove oval briquets are produced in the area of Riau. The Dinas kehutanan Propinsi Daerah Tingkati Riau Juli 1994 annual report shows data on mangrove products as shown in the following:

Table 2-4-14 Amount of Production of Mangrove Wood, Charcoal and Oval Briquets

Year of production	Mangrove wood	Mangrove charcoal	Oval briquets
1992/93	28,900 m	4,743 ton	345 ton
1993/94	30,022 m	4,282 ton	401 ton

Mangrove charcoal of the highest quality is exported to Malaysia, Hongkong, Singapore (and Japan by way of these contries) to acquire foreign exchanges.

In fiscal 1992/93, 7,571 tons of mangrove charcoal was exported to obtain US $571,281, and in fiscal 1993/94, 7,741 tons was exported to obtain US $621,633, showing a growing tendency of the amount of mangrove charcoal export. The accuracy of these statistical figures, however, is quite questionable, because the amount of exports is much larger than the amount of production shown in the table above.

According to the statistical report of the Sumatra Forestry Office and the Forest

Management Station, the average price of charcoal in domestic distribution was 150.000 Rp per ton in fiscal 1992/93, and 130,000 Rp per ton in fiscal 1993/94, showing a downward tendency. The export price of charcoal shown by the Sumatra Forestry Office was 2,500,000 Rp per ton, which was about eighteen times higher than that of charcoal in domestic distribution. When compared with the price of charcoal in Japan, however, this is still less than one fifth of the price of Bincho charcoal, that is 500 yen/kg (in around 1986) or 700 yen/kg (an estimated figure for the present price).

The area of Riau has a long history of mangrove charcoal production, which started in 1928. They use kilns similar to those found in Malaysia. A kiln of this type has a dome shaped fire room 4.5 to 5.0 m high, whose maximum width is about 7 m. Two types of kilns of almost the same size are used: the Malaysian type, in which bricks are placed on the lower part of the side wall, and the traditional type made only from clay.

In many cases, clay suitable for making a kiln cannot be obtained in the mangrove area, and should be found in other areas and brought to the site. The life time of a kiln is about 30 years. A few persons in charge of charcoal production stay in the site, and other persons living in neighboring villages come to do assorting and packing work. R. apiculata, R. mucronata, B, gymnorrhiza, C. tagal and X. granatum are used for materials of charcoal, while A. marina and S. alba are not used because they are not suitable as charcoal materials.

Mangrove trees with a trunk 7 to 10 cm in diameter are sawed down to make charcoal material wood pieces 4m long. After the material wood is brought to the production site and the number of pieces is checked, it is stored in the mud under sea water, or brought near to the kiln and leant against a wall to dry by natural air. A woodman gets 75 to 150 Rp per piece of material wood at the kiln site, including the cost of sawing, wood production and transportation. Since awoodman can bring 75 pieces of wood per day on average, he can get 5,600 Rp (about 280 yen) to 11,200 Rp (about 560 yen) per day (the conversion rate: 1 yen = Rp 20).

There are seven large kilns on the site, and they can be loaded with 11,000 to 12,000 pieces of material wood 4m long. According to a record of charcoal production in a kiln in fiscal 1993/94, it took 35 to 50 days to complete the processes of material wood loading, heating with steam, ignition, carbonization control, refining, and fire extinguishing. The record did not show the reason forthe difference in the number of days. In comparison with charcoal production in Japan, the size of the kilns is larger, and the time required for charcoal production is much longer (In case of Japan, it takes 211 hours, or about 9 days to complete an entire process of charcoal production).

If a large kiln is used, it gets very difficult to make the quality of charcoal uniform

and also to attain a high charcol retrieval rate. Charcoal taken out of the kilns is brought to a warehouse to store. Later it is classified into charcoal of the first grade, that of the second grade and that of the third grade.

first grade —— completely cabonized whole shaped charcoal for export

second-grade —— incompletely carbonized

third grade —— out of shape

The second grade and the third grade charcoal is consumed domestically.

They say that 90% of charcoal produced can be exported. Since it is not easy to get first grade charcoal at such a high rate, they must have attained quite a high level of charcoal production technology.

Charcoal thus produced is cut to an even length, put into bags and shipped. Women and children from neiboring villages are engaged in the job of weighing and bagging to get pocket money.

Charcoal is put into bags at the rate of 5 kg per bag, and four bags are packed into a larger bag to be shipped. Industrialized charcoal production of this type is carried on by the Forestry Cooperative Association (KOPSILVA), and the shipping price was not disclosed on the site.

Corrugated cardboard boxes filled with charcoal for barbecue parties were seen to be laid on the site. Japanese characters were printed on them, showing that they were going to be carried to Japan. They said that this charcoal was to be exported to Japan by way of Singapore.

In case of charcoal production in a large kiln, since it is difficult to attain uniform burning in the kiln, production of charcoal of equal quality is not so easy. Workers on the site and officers of the Sumatra Forestry Office said that there were no data on the charcoal retrieval rate or carbonization scheduling, and this suggests that charcoal production in this area relies heavily on masterly skills of experienced workers. In order to continue producing charcoal in this way, it is necessary to maintain extensive mangrove forests which can supply sufficient amount of charcoal material wood. In spite of keen necessity for a program for conservation of forest resources, refor estation has hardly been practiced in clear-cut forests.

Further upgradeing of charcoal quality and the improvement of charcoal retrieval rate can be pointed out as technical problems in developing the charcoal industry while conserving forest resources in the area of Riau. To solve these problems, it is necessary to make a schedule for achieving better carbonization in a standard kiln of large scale.

7) Analysis on socio-economic elements regarding mangrove afforestation

Mangrove afforestation technology is still in a development stage. The present afforestation project is in the stage of basic experimental research on culture and transplantation of healthy seedlings, and analysis and survey of socio-economic factors has not been started.

8) Appendix

Survey on the Present Situation of Environmental Factors for Manfroves Growing on the Project Site

Purpose:

The present situation of environmental factors for mangroves growing on the project site is studied to evaluate the feasibility of forest operation and to estimate the afforestation cost.

Method and Results:

Starting in the fourth quarter of fiscal 1992, the rooting and growing conditions of mangrove seedlings tranplanted in 383 areas in abandoned shrimp culture ponds were observed. Even if trees replanted a year after afforestation were taken into consid eration, among 106 shrimp culture ponds, 70 ponds (65%) showed a seedling survival rate of 20% or lower, while only 13 ponds (12%) showed a survival rate of 60% or higher. The Bali Forestry Office plans to replant Rhizophora mangrove seedlings. In this plan, however, environmental conditions such as the effect of sea water have not been taken into consideration, or technical measures such as soil improvement and selection of species suitable for the soil conditions have not been taken. The mangrove growing conditions are generally affected by water (depth of water, salinity, duration and frequency of floods) and soil (pH, fertility, degree of oxidization or reduction).

According to the results of the survey by the preparatory investigation committee in May 1993 and those of observation by specialists, any particular differences have not been found in the characteristics of various abandoned shrimp culture ponds, except that the number of living mantis shrinp is larger in some areas. Significant areal differences of salinity have not been observed in the project sight, which might have been caused by variation in the degree of mixing with fresh water flowing down a river. It can be generally expected, however, that geographic features of shrimp culture ponds had been considerably changed (e.g. dropping of the pond bottom due to digging, change in the paths of the sea water flowing in and out the pond due to construction of banks),

and this might adversely affect the growing conditions of mangroves. Therefore environmental factors of afforestation were studied and summarized.

On the basis of the result of the above mentioned study, survey in the test areas was carried out as follows:

1) Measurement of the depth of flood water and drawing of distribution maps for various depths of flood water
2) Measurement of the flooding time for various depths of flood water in each pond
3) Measurement of the salinity and drawing of salinity distribution maps
4) Drawing of dead water distribution maps
5) Drawing of soil depth distribution maps
6) Drawing of a distribution map for the Tambaks in which hydrogen sulfide is generated
7) Drawing of a distribution map for the areas where spirogyras or squilla mounds are found
8) Sketching maps based on air photos
9) Measurement of pH of the soil

3. Problems in the Study

For the purpose of preparing forest survey records, we have observed and recorded changes in the soil conditions of the abandoned shrimp culture ponds and the conditions of mangroves growing there for these two years. Due to the ebb and flow of the tide caused twice a day, contaminated soil in the culture ponds has been cleaned, and mud has been carried in and accumulated on the lowered pond bottoms (not measured). Numbers of holes has been made by small creatures such as crabs in the soil, which facilitate the change of water and air. Mangrove sprouts from seeds carried by the wind begins to be observed.

The most important measure for afforestation in abandoned shrimp culture ponds may be to leave the ponds without having seedlings for about two years after shrimp culture is stopped, so that the soil can be restored and various kinds of research study can be conducted in this period.

For the purpose of preparing materials for crop forecast, fourteen stationary survey sites (five in man-made mangrove forests and nine in natural forests)were selected in Bali and Lembogan. The tree hight and the diameter at the breast hight were measured for each tree on the sites, and the number of the surviving trees on the sites was counted.

Estimation of the forest age is indispensable for forecasting the crop. Since the ages of natural forests are unknown, they have to be estimated from data on the annual increase in the trunk diameter and that in the tree height. To get more accurate data, the number of the survey sites has to be increased.

Also a stationary site for the crop survey has to be selected in a representative place where mangroves are transplanted in the present project.

Data for the analysis of the labor efficiency and the cost are being collected for each process of seedling culture and afforestration. These data will be reported in the next report.

Survey on charcoal production was conducted, in which the lay down burning method of charcoal production practiced in Bali, the price of charcoal and firewood in distribution stages in Bali, industrialized charcoal production and the price of exported charcoal were studied. Processes in industrialized charcoal production, the amount of material wood, the charcoal retrieval rate, the cost, the selling price, carbonization control, the quality, production and utilizationof mangrove vinegar, etc were the main themes of the survey.

Development of mangrove forest grading technology seems to be required forfacilitating mangrove forest operation, although it has not been planned in the project.

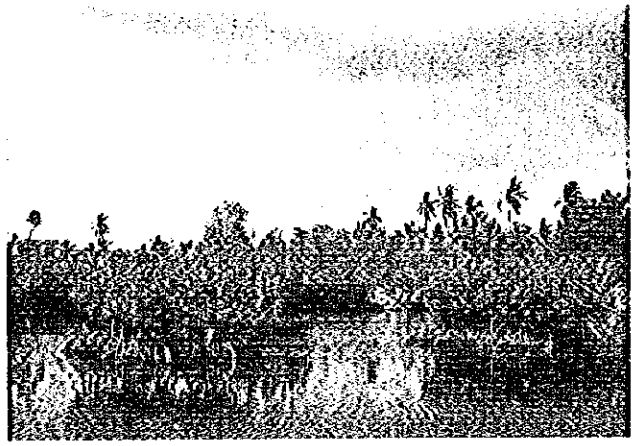


Photo. 1 Tambak in tonpaansari system BlocKI

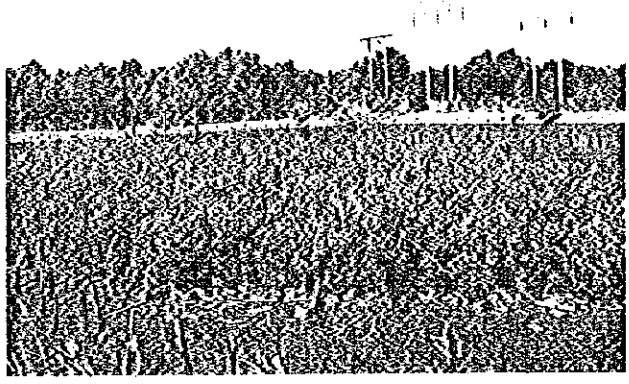


Photo. 2 Natural S. alba renovation area in a Tambak BlocKI

Photo. 3 Natural C. tagal forest where lower branches and leaves are fed to goats Gili manuk, BAL

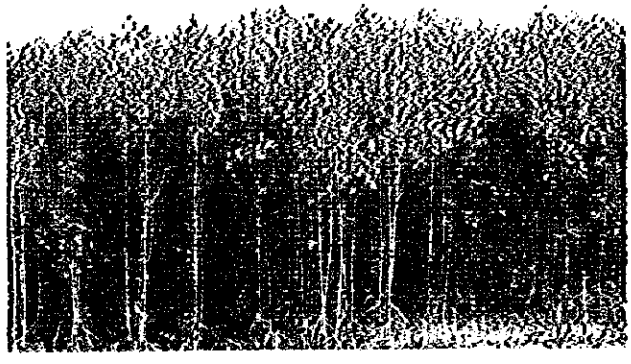


Photo. 4 Overcrowded R. mucronata forest Propobingo, JAWA

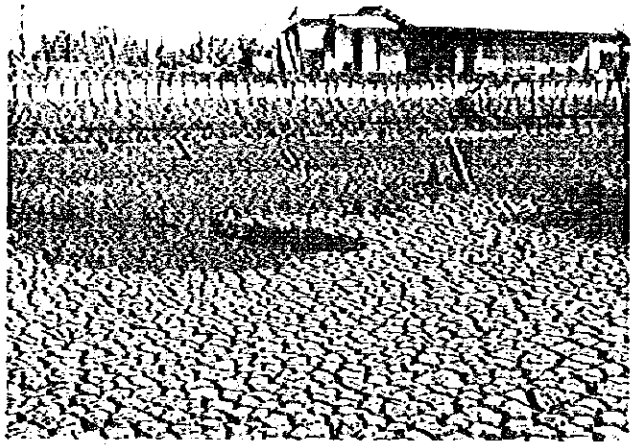


Photo. 5 Sun drying of the bottom soil of a shrimp culture pond, and digging and removing of the surface soil Block – 7

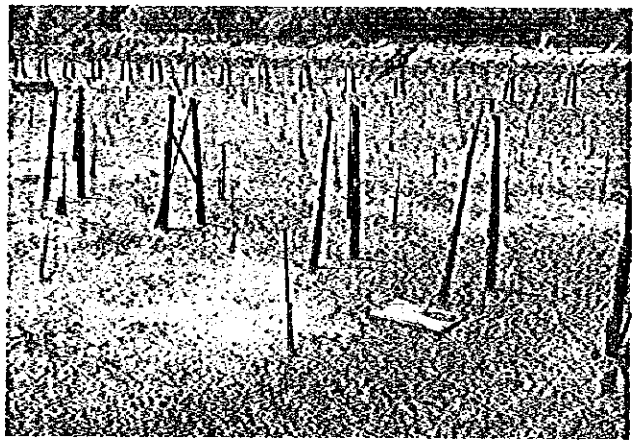


Photo. 6 Contamination of the surface soil in an abandoned shrimp culture pond Block – 8

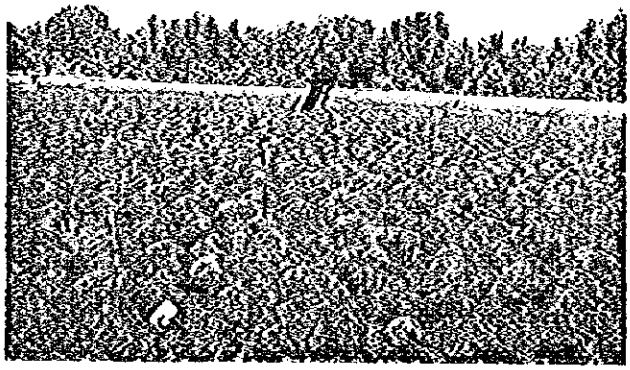


Photo. 7 Tambak where squilla mounds were developed Block – 9

Photo. 8 Mangrove firewood to be used for salt production BALI

Photo. 9 Lay-down burning method of charcoal production

Sawan, BALI

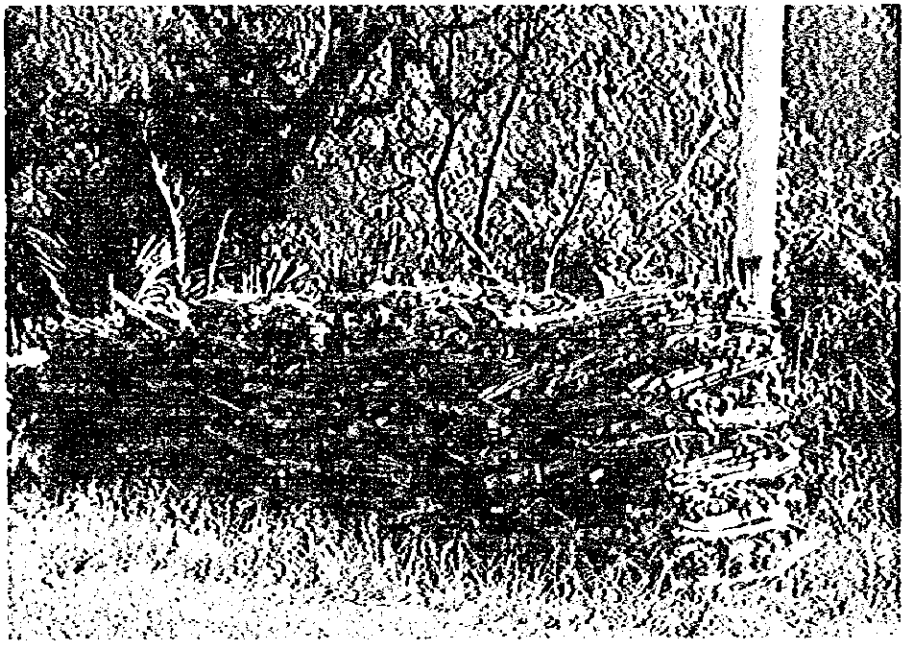


Photo. 10 Firewood for selling Sawan, BALI