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A Preliminary Study of Two Village Tanks (Reservoirs) in the Polonnaruwa Area with Biological Notes on these Reservoirs in Ceylon

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INTRODUCTION

The dry zone of Ceylon is closely dotted with small irrigation reservoirs popularly called village tanks. Fernando (1967) has made a few remarks on the nomenclature of tanks. According to Abeywickrema (1956) there are about 10,000 tanks in Ceylon, presumably working and abandoned reservoirs. Of these only about 30 are over 1000 acres at full supply level. The vast majority fall into the category of small tanks *i.e.* less than 100 acres. The distribution of tanks in Ceylon is given by Abeywickrema (1956). The extent of their concentration in some areas is very great. Anon (1955) gives the figure of 1,014 working tanks and 434 abandoned tanks for the Malwatu Oya drainage basin of 1,026 sq. miles.

Small tanks serve a variety of purposes. They provide drinking water for man and beast and cater to his bathing needs. Defaecation sites are often chosen close to them because of the ready water supply. Many tanks are temporary in that they retain water in any quantity during part of the year only. Some dry out completely. Others retain small pockets of water often reduced to liquid mud during the dry season. The variability of these habitats in regard to the fish fauna and their general productivity and spectrum of plant and animal life is dependent on a number of factors including their situation, water supply (rain, river or stream, large reservoir), permanence, physical factors, chemical factors in the watershed and pollution.

No study has hitherto been made of the biology of a small tank in Ceylon although Fernando (1965) and Mendis (1965) included two such reservoirs in their survey of 21 lakes in Ceylon. In India on the other hand a number of rather detailed studies have been made on similar habitats (see George 1966). There is of course a wealth of work in temperate and not so temperate areas on the subject of small lake (large pond) biology. Some noteworthy papers are those of Nygaard (1949,) Elgmork (1964) and Straskraba, Korinkova and Postolkova (1967). There is a considerable literature on the biology of fishponds in tropical regions both in Asia and Africa but these habitats are more controlled (or perhaps interfered with) by man e.g. Colombo lake studied by Mendis (1964).

The present study was initiated in conjunction with a project to utilize some of these small tanks as fishponds by introducing desirable species like *Tilapia mossambica* Peters and harvesting them at the end of a single season which may vary from 4–8 months depending on the reservoir.

Two reservoirs Timbirigaswewa and Dalukanawewa were chosen for this study. Both of these are in the Polonnaruwa area (Fig. 1). Timbirigaswewa (Fig 4) is a s mall rain fed tank of about 30 acres while Dalukanawewa (Fig. 2) is stream fed with an acreage of just over 100.

MATERIALS AND METHODS

Seven visits were made to the two tanks during 1963–1965. On each visit plankton and bottom samples were collected. The former with a 20 meshnet and the latter with an Ekman dredge. On the last three visits general observations were made on the water levels, vegetation and the drainage area. Samples of water were also collected for microscopic study.

Fish were collected with a pond net and with cast nets. Fish catches made by the villagers were examined and the species determined. Aquatic vegetation was collected during the last three visits and together with terrestrial vegetation invading the dry bottom were preserved for study. Vertebrates other than fish were identified by observation.

During the dry season the tank bottom was examined for evidence of *Tilapia* breeding sites.

Description of habitats

The two reservoirs studied namely Timbirigaswewa and Dalukanawewa are ancient irrigation reservoirs. Both belong to the category of small village tanks which perhaps one could limit to reservoirs below 100 acres (" mean area "). The location of the two tanks is shown in Fig. 1. Timbirigaswewa lies in close proximity to the village of Habarana off the Road from Habarana to Polonnaruwa Dalukanawewa is about 5 miles off the main Polonnaruwa–Batticaloa road, South East of Polonnaruwa. It is close to a settlement of Veddahs now intermingled with more recent settlers or colonists. Dalukanawewa has been recently expanded by the building of a new spill and a raised bund.

Timbirigaswewa (Fig. 4)

This is a small village tank not more than 30 acres when spilling. It consists essentially of a shallow valley dammed by a simple earthen bund. The high ground surrounding the tank at the shallow margins consists of low forest. There are no perennial streams draining into the tank. During floods however this tank is probably connected to large streams and reservoirs in the area. Below the bund is a small acreage of rice fields. This tank dries up completely in August or September and is filled again during the Monsoon rains in November.

The bottom is clayey with little organic plant material. Its bed is covered during the dry season with a variety of terrestrial and semiaquatic plants. A small band of soft mud near the bund however remains uncolonized by plants. The maximum depth of the tank is about 12–15 ft. This region is the area in immediate proximity to the sluice.

Dalukanawewa (Figs. 2 and 3)

This tank is much larger in area than Timbirigaswewa. It has a spread of just over 100 acres when spilling (Fig. 3). Its water supply comes mainly from streams draining a ridge and a hill of considerable size (Gunners Quoin). The main stream draining the ridge and hill forms the deepest portion of the tank. The dam is earthen but strenthened by granite boulders. A newly constructed spill of concrete and an old spill carry away excess water during floods. This tank is in a sense perennial but most of the bottom is exposed for 3–4 months prior to the monsoonal rains in November. About 100 acres of rice fields are irrigated by water from Dalukanawewa.

The bottom consists mainly of soft mud and sand. A considerable deposit of organic material accumulates from plant material washed down from the high ground. The bottom is invaded by a rich variety of terrestrial and semi-aquatic vegetation during the dry season. When the tank is full most of the surface is covered by aquatic vegetation. The maximum depth is 20–25 ft.

Zooplankton

The species recorded are given in Table 1. True planktonic forms were relatively few in both tanks. The smaller zooplanktors would be missed with the net used. Cyclopoids and rotifers were common in a few of the samples but in no case were they numerous. On a few occasions vast numbers of *Euglena* sp. were noted colouring the water green (red at midday). In general it can be said that the zooplankton was meagre. This is probably due to the lack of a defined limnetic zone of any great area. Also Hasler and Jones (1949) have demonstrated the antagonistic action of higher plants on algae and rotifers.

Mendis (1965) recorded 3 species of phytoplankton and 7 of zooplankton in a single sample from a similar tank. George (1966) found 81 species of algae and 50 species of zooplanktors in five fish tanks in Delhi. The vegetation (higher plants) were meagre in these habitats.

Benthic and Littoral fauna

The benthic and littoral fauna recorded is given in Table 2. The shallowness of the tanks during most of the year means that the littoral with its rooted aquatic vegetation extends to all but the deepest portions. True benthic forms are few in species. Chironomid larvae were the only benthic forms found in any numbers. The rich organic material on the bottom of Dalukanawewa was covered with larval cases of chironomids.

The littoral fauna was well represented in species. They included a variety of aquatic insects and larvae, crustaceans (mainly *Caridina*) and *Indoplanorbis exustus*. The smaller invertebrates like Ostracoda and Annelida were not collected. Numerically *Micronecta* was at the head of the list while *Caridina* was very common amongst weeds.

Little is known about the dynamics of the littoral fauna in small tropical lakes. Michael (1963) found the weed fauna of a tropical fishpond to be most abundant from November to March. In the tanks studied the fluctuations in numbers seem very great with changes in the water level. It is durng the dry season that large numbers of littoral animals can be captured because of their crowding.

Fish fauna

The fish fauna recorded from the two tanks is given in Table 3. Timbirigaswewa had 12 species which are typically marsh and pond inhabitants. In Dalukanawewa on the other hand a more varied fish fauna consisting of 18 species was found. This includes " lake " and stream forms like *Ompok bimaculatus*, *Etroplus suratensis*, *Labeo dussumieri*, *Puntius dorsalis* and *P. sarana*. Fernando (1965*a*) pointed out that since there are no natural lakes in Ceylon there has been no evolution of typical lake fishes. The recruits to lakes came from river and marsh dwelling species. *Tilapia mossambica* which was introduced into these two tanks in 1963 had a breeding population in Dalukanawewa.

The small cyprinids constitute the most abundant group. They provide food for the varied predatory species like *Ophiocephalus striatus*, *O. punctatus*, *Glossogobius giuris* and *Ompok bimaculatus*. The omnivores are represented by *Anabas testudineus*, *Clarias teysmanni*, *Mystus vittatus*, *M. keletius*, *Etroplus suratensis*, *E. maculatus* and *Heteropneustes fossilis*.

There is abundant food in the form of filamentous algae for species like *Puntius vittatus* (Fernando 1956). *Puntius dorsalis* is a plankton feeder as shown by the work of Fernando (1956) and Geisler (1967). A number of omnivores feed on macrophytes both fresh and in the decaying state. *Etroplus suratensis* and *Heteropneustes fossilis* feed on molluscs, the former during the breeding season (Authors unpublished data) and the latter regularly (Fernando 1956 *b*).

The fish fauna appears to be diverse in both tanks in regard to food requirements. The question is whether the main types of food available are being utilized sufficiently. The present authors suggested introducing other species of *Tilapia* which are predominently macrophyte feeders (Fernando 1965*a*, Silva 1965). The presence of a number of large predators also indicates that species introduced annually for culture should be of a fairly large size if mortality is not to be too high.

Since these small tanks are likely habitats for fish culture, we would like to discuss the feasibility of introducing various species either annually or once. *Tilapia mossambica* has already been introduced with success into small tanks. The returns in terms of enhanced fish catches seem to warrant continuing this introduction annually or once in the case of perennial tanks. *Chanos chanos* has also been introduced but none seem to have been subsequently harvested. The expense involved and the poor return of this species indicates that it should not be used for introductions which must inevitably be annual since no breeding occurs in freshwater. The common carp *Cyprinus carpio* L. has also been introduced into small tanks. The returns if at all have been negligible. Fernando (1965*a*) suggested that the introduction of this species into low country tanks should be halted. Its introduction is contraindicated by the damage it causes to *Tilapia* breeding sites (Bont and Hulot 1950). Maar (1960) has however asked for a reexamination of this suggestion.

The recommendation that the common carp be excluded from small tanks in Ceylon is based on a number of very sound reasons. The common carp is not a fish in high demand. It has been introduced into a large number of low-country reservoirs since 1948 without any visible return. No breeding populations* have been established in any of these reservoirs as far as it is known. The likely damage to the breeding sites of *Tilapia mossambica* might be considerable if such sites are

* Mr. H. H. A. Indrasena, Superintendent of fresh water fisheries has subsequently informed me that breeding populations have been established in some tanks in the Southern Province.

restricted. The author has found that in some tanks *Tilapia* breeding sites are restricted. Damage to these sites by digging may reduce the population to levels which are low even for *Tilapia mossambica*. In the short period of a single season *Tilapia* could be raised to an economic size from large fry caught wild. Common carp on the other hand have to be bred and kept in nursaries, a much more expensive undertaking. If indigenous species are desired *Labeo dussumieri* could be collected from large reservoirs as fry using a small mesh beach seine. (Fernando 1967). However *Labeo dussumieri* is not a macrophyte feeder.

Other Vertebrates

Birds constitute the most numerous of this group by far. Nine species were recorded from Timbirigaswewa, 12 from Dalukanawewa. The commonest species were *Amaurornis phoenicurus phoenicrus*, *Ardeola grayi* and the sandpipers. Large numbers of *Phalacrocorax niger* were seen on a few occasions in Dalukanawewa. This species is probably the most important predator of fish in this tank (see Fernando 1965).

The " Aquatic " bird fauna was in general rather poor in numbers. Dalukanawewa had both a greater variety and a far more numerous population of birds.

The other vertebrates besides birds included the common soft tortoise *Lissemys punctata* whose numbers have been greatly reduced due to a recently acquired taste for its meat. Various Ranidae were noted but were not by any means common. *Crocodilus palustris* has been found in Dalukanawewa though the number present was small. This reptile could become an important predator of fish. Also they can hinder effectively the use of gill nets.

General Remarks on biology of small tanks

The actual number of small tanks in Ceylon is probably near the figures given by Abeywickrema (1956) in his map indicating the distribution. The line of division between a small tank and a large tank is somewhat arbitrary to say the least. The number of " working " tanks is dependent to some extent on how long they retain water, the state of the bunds in any particular year and the pattern of rainfall during the year. If any serious consideration is to be given to the culture of fish in these tanks a more careful look has to be taken at them from the biological, chemical and physical angles.

Knowledge of the water chemistry of any type of waters in Ceylon is meagre. Sirimanne (1952) gives some data on potable and industrial waters and Geisler (1967) gives a few figures from South-West Ceylon. Apart from a very few lakes like the Beira Lake (Colombo Lake) none seem to be " Eutrophic " in the sense of being heavily polluted What data is available indicates that the river waters are relatively unpolluted as yet by any standards. This feature is perhaps something to work towards retaining. A certain amount of " pollution " from cattle droppings occurs in most of the small tanks but the seasonal drying and flushing out during the monsoonal rains alleviates the situation and contributed to a high production of plant life.

Although the authors have no detailed data on biological cycles in small tanks a few remarks can be made based on observations over 10–12 years. The faunal composition is influenced by a number of factors. The duration of water retention during the year is perhaps the most important. Some small tanks e.g. Kesbewa tank (Western Province) retain water throughout the year. Others for 8 months or so e.g. Dalukanawewa, while many dry up in 3–6 months. The species in these tanks therefore can consist of " permanent " residents as active stages throughout the year or aestivate as eggs, larvae or adults, the former being eliminated every year from most of the tanks. Colonization occurs through two routes, (1) Via the river system during floods and (2) Aerially. The former applies mainly to fish and some larger crustaceae and the latter to insects. Aestivation of resistant stages occurs in Algae, Protozoa, Porifera, Rotifera, Annelida, Crustaceae and Mollusca. Many of these resistant stages can withstand considerable drying e.g., Sponge gemmules, resistant eggs of Rotifera and Crustaceae, protozoan cysts, Operculate snails. Some survive in moist mud e.g. beetles, Mollusca, Annelida, but may be eliminated if conditions become too severe.

In some of the tanks which dry up completly the authors have had the opportunity to observe the earlier phases of the fauna and flora. After the early monsoonal rains only those with resistant stages, with aerial modes of colonization or terrestrial habit of adults were found. Subsequently

with the flooding caused by the monsoons, fish and the larger Crustaceae became evident. Many fish of course can survive considerable drying. This applies to species with acessory respiratory organs but is by no means restricted to them. Fernando (1956) noted that *Puntius vittatus* could withstand long periods in a liquid " mud ". Incidentally this species is both widespread and abundant in a variety of habitats.

We know little of the fluctuations in population of different species in the littoral, plankton and benthos. Observations indicate a very rapid development of the faunal and floral components on the waterbecomes available after a dry period. Following on the increase of small plants and animals there is encroachment of the water by higher aquatic plants (if the water is shallow) which had aestivated as underground elements or seeds. The young fish consisting mainly of herbivores dominate the larger fauna together with *Caridina*. The carnivorous fishes gradually crop these as the season progresses often to perish with the drying up of their habitat and predation by birds, reptiles and mammals.

Fisheries in small tanks

Many small tanks contain a fair variety of edible species. A few of these may reach large enough sizes to be sought as food. However coarse fishes constitute the major component of the catch The poverty of the indigenous fauna referred to earlier can therefore be overcome by suitable fast growing species like *Tilapia mossambica*.

In February and March 1963, eight small tanks in the Polonnaruwa area were stocked with *Chanos chanos* and *Tilapia mossambica*. Records of fish catches were made from three of these in September 1963. These tanks were Timbirigaswewa, Dalukanawewa and Moragaswewa. The total catch from the first was around 3,500 lbs. (i.e., over 100 lbs./acre) and from Dalukanawewa about 7,000 lbs. (i.e., 70 lbs./acre), Moragaswewa, a tank of about the size of Timbirigaswewa had a catch of about 3,500 lbs. These figures are given by Balasuriya (1964) and are perhaps on the high side. In 1964 the authors visited Dalukanawewa during the fishing season. Fishing had yielded about 5,000 lbs. in July and August according to the fisherman who had taken a " lease" of the lake This figure was perhaps a little too low. *Tilapia mossambica* which constituted practically the whole catch was iced and sent out by lorry throughout the fishing period.

It is evident that in the tanks where *Tilapia* had been introduced the catch had gone up tremendously. Fishing in small tanks is traditionally of the subsistance type using rod and line, cane baskets " Karak gedi " or cast net. In Dalukanawewa gill nets had been used two years in a row in 1963 and 1964.

The methods of fishing besides those mentioned earlier is to bale the water out of isolated portions of the habitat. This method is used extensively in Ceylon for streams, ponds and small lakes. It was used in Timbirigaswewa in 1963. Mud fishing, as this method is called, has been referred to by Willey (1910) and Hora (1932). It is a wasteful procedure because the young fish are killed off indiscriminately. In tanks which dry up completely mud fishing can do no additional harm but in " perennial " tanks which retain some water this method should be discouraged.

SUMMARY

A very preliminary study was made during 1963–1965 of the biology of two small tanks. This project was undertaken in conjunction with an effort to utilize them as " fishponds "

Small tanks, which number about 10,000 in Ceylon serve a wide variety of purposes at present Fish production does not constitute an important use of the tanks. Preliminary results howeve indicate that they might be a source of a considerable quantity of fish.

The two tanks investigated were Dalukanawewa and Timbirigaswewa, both in the Polonnaruwa area. The former is about 100 acres and the latter about 30 acres when spilling.

The planktonic fauna is poor due to the small limnetic area and perhaps the antagonistic act ion of higher plants on some plankton. The littoral fauna is varied and the benthic fauna poor in species. The fish fauna consisted of only pond and marsh types in Timbirigaswewa which is rain

fed. In Dalukanawewa stream and " lake " types of fish were found too. The typical lake niches are not filled in Ceylon by indigenous species hence there is perhaps a place for introduced species of a greater variety than at present. Vertebrates other than fish consisted mainly of " aquatic " birds.

Fisheries in small tanks is mainly of the subsistance type. Rod and line, cane baskets (Karak gedi) and cast nets are in common use.

Gill nets were used in Dalukanawewa to catch the abundant *Tilapia mossambica* introduced in 1963.

The fish catches in small tanks is meagre. Introduction of *Tilapia mossambica* has raised the catch to 70–100 lbs. acre/annum for two tanks.

It is suggested that the introduction of *Tilapia* be continued annually into tanks which dry up. Complementary macrophyte feeders could be introduced in addition. A number of other *Tilapia* spp. will fill this role very well. Common carp should not be introduced into small tanks because they are not in much demand, might damage *Tilapia mossambica* breeding sites and are further quite expensive to raise.

A more detailed study of small reservoirs should be made if they are to be used for fish culture.

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TABLE I

PLANKTON COLLECTED FROM TIMBIRIGASWEWA AND DALUKANAWEWA

SPECIES	Timbirigaswewa							Dalukanawewa						
	4.4.63	3.5.63	26.8.63	29.9.63	9.9.64	8.11.64	7.1.65	3.4.63	3.5.63	22.7.63	26.8.63	9.9.64	8.11.64	21.1.65
Protozoa														
Phacus spp.														+
Euglena spp.						+								
Arcella sp.			+											
Vorticella sp.						+								
Other ciliates						+	+				+	+	+	+
Ectoprocta														
Plumutella sp. (Gemmules)							+							
Rotifera														
Asplanchna brightwelli Gosse			+			+								
Keratella tropica Apstein						+						+	+	+
Brachionus quadridentatus Hermann						+								+
Brachionus rubens Ehr.						+								
Trichocerca sp.						+								+
Other Rotifera				+	Dry	+						+	+	+
Cladocera														
Chydorus sphaericus (Muller)							+							
Dunhevedia serrata Daday														+
Pleuroxus levis Sars														+
Other Cladocera						+	+					+	+	+
Copepoda														
Cyclopoids	+	+	+	+		+	+	+	+			+	+	+
Calanoids							+							+
Canthocamptus										+	+			
Diptera														
Chironomidae							+							
Ceratopogonidae	+													
Hydracarina											+			
Organic debris	+		+				+							
Inorganic matter			+				+			+				

TABLE 2

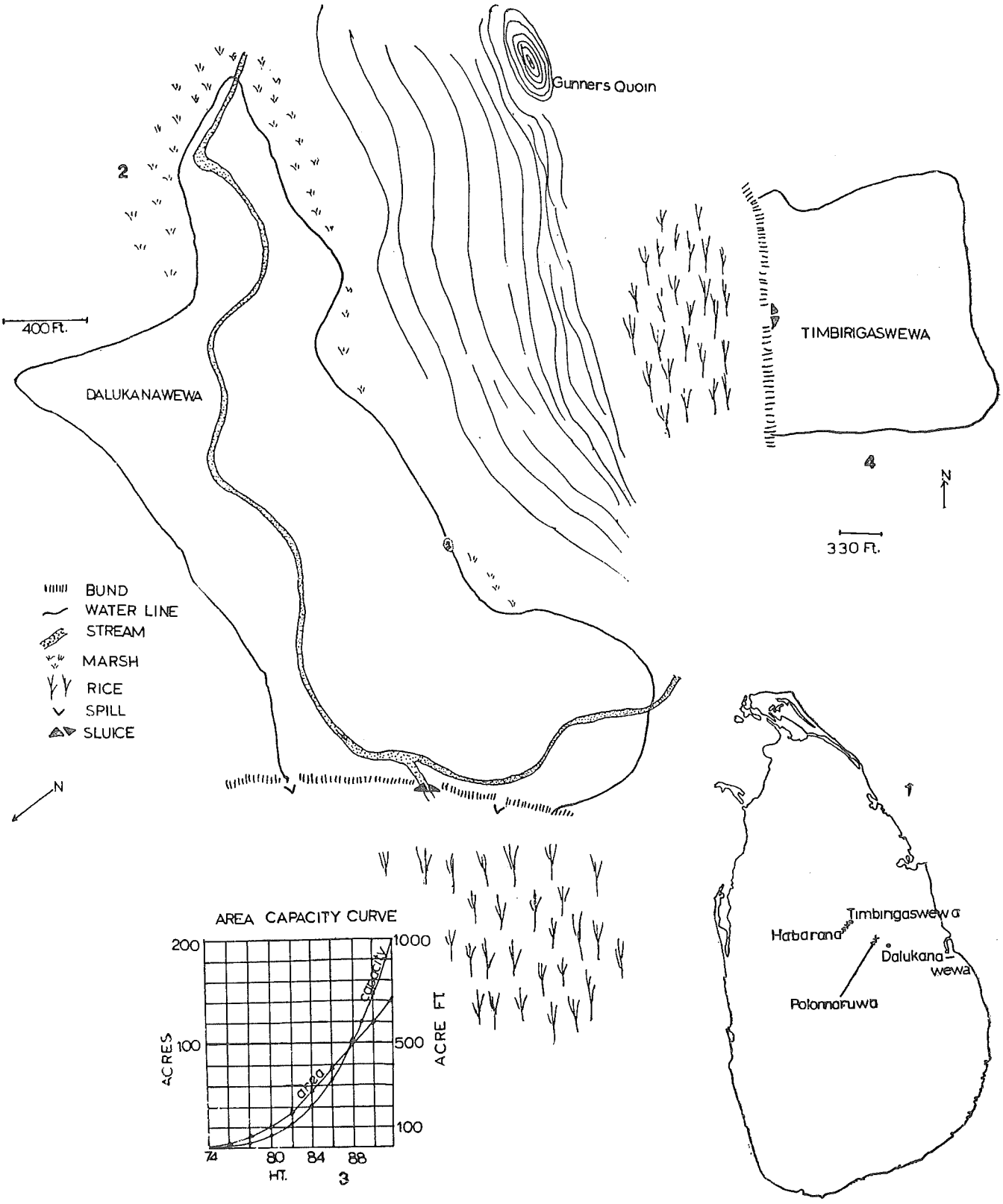
LITTORAL FAUNA COLLECTED FROM TIMBIRIGASWEWA AND DALUKANAWEWA

	Timbirigaswewa							Dalukanawewa						
	4.4.63	3.5.63	26.8.63	29.9.63	9.9.64	8.11.64	7.1.65	3.4.63	3.5.63	22.7.63	23.8.63	9.9.64	8.11.64	21.1.65
Porifera														
Srpongilla sp.			+											
ustacea														
Caridina simoni Bouvier ..	+		+				+		+	+	+			+
Caridina fernandoi Arud. and Costa ..	+		+					+						
Macrobrachium sp.									+					
Paratelphusa bouvieri (Rathbun) ..		+												+
Paratelphusa ceylonensis Fernando ..														
Ephemeroptera														
Caenis sp.		+					+	+	+					+
Odonata														
Anisoptera	+		+	+		+	+	+	+	+				+
Zygoptera	+		+				+	+	+	+				+
Hemiptera														
Micronecta quadistrigata Bredd. ..								+				+	+	
Sphaerodema rusticus (F.) ..		+						+		+				+
Anisops breddini Kirk. ..							+						+	+
Ranatra fikformus (F.) ..	+	+	+	+			+		+	+	+		+	
Cercometus sp.							+							+
Laccotrephes sp.			+	+						+	+		+	
Naucoris scutellaris Stal ..		+		+		+	+							
Plea liturata Kirk.													+	
Mesovelia orientalis Kirk. ..													+	
Limnogonus parvulus (Stal) ..							+							+
Gerris adelaidis Dohrn ..														
Hydrometra greeni Kirk. ..													+	
Coleoptera														
Cybister sugillatus Er. ..	+		+											
Cybister larvae			+	+										
Helochares anchoralis Sharp ..													+	
Berosus indicus Motsch. ..		+												
Amphiops gibbos Ill. ..														
Diptera														
Chaoborus asiaticus Giles ..									+					
Chironomid larvae		+	+					+		+	+	+	+	
Tabanid larvae			+					+		+				
Mollusca														
Indoplanorbis exustus (Desh.) ..	+	+	+	+				+						
Bithynia inconspicua Dohrn ..						+			+					

TABLE 3

VERTEBRATES RECORDED FROM TIMBIRIGASWEWA AND DALUKANAWEWA

Timbirigaswewa	*Dalukanawewa*
Pisces	
Puntius ticto (Ham. Buch.)	*Puntius dorsalis*
P. chola (Ham. Buch.)	*P. vittatus*
P. dorsalis Jerdon	*P. sarana*
P. cumingi Gunther	*Rasbora daniconius*
P. vittatus Day	*Danio aequipinnatus* (McClelland)
Rasbora daniconius (Ham. Buch.)	*Labeo dussumieri* (Val.)
Noemacheilus botia (Ham. Buch.)	*Noemacheilus botia*
Ophiocephalus punctatus Bloch	*Mystus keletius* (Val.)
O. striatus (Bloch)	*M. vittatus* Bloch
Clarias teysmanni brachysoma (Gunther)	*Clarias teysmanni brachysoma*
Glossogobius giuris (Ham. Buch.)	*Heteropneustes fossilis* (Bloch)
Anabas testudineus Bloch	*Ompok bimaculatus*
	Ophiocephalus striatus
	O. punctatus
	Glossogobius giuris
	Tilapia mossambica
	Etropluas suratensis (Bloch)
	E. maculatus (Bloch)
Aves	
Egretta alba modesta (Gray)	*Nycticorax nycticorax nycticorax* (L.)
Ardeola grayii (Sykes)	*Egretta alba modesta*
Phalacrocorax niger (Vieillot)	*Ardeola grayii*
Anhinga melanogaster Pennent	*Phalacrocorax niger*
Tringa stagnatilis (Bechstein)	*Anhinga melanogaster*
Actitis hypoleucos (L.)	*Tringa stagnatilis*
Lobivanellus indicus indicus Boddaert	*Limicola falcinellus falcinellus* (Pontoppidon)
Alcedo atthis taprobana Klinschmidt	*Capella gallinago gallinago* (L.)
Amauronis phoenicurus phoenicurus (Pennent)	*Rostratula bengalensis bengalensis* (L.)
	Alcedo atthis taprobanica
	Amauronis phoenicurus phoenicurus
Reptiles and Amphibia	
Lissemys punctata ceylonensis (Gray)	*Crocodilus palustris kimbula* Deraniyagala
Ranidae	*Lissemys punctata ceylonensis*
	Ranidae



1. Map of Ceylon showing location of Timbirigaswewa and Dalukanawewa. Two neighbouring towns are marked namely Habarana and Polonnaruwa.
2. Dalukanawewa.
3. Area capacity curve of Dalukanawewa.
4. Timbirigaswewa.