

**FRESHWATER PRAWN(SHRIMP) CULTURE
FOR JAMAICA**

IICA-CIDIA

JICA
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-an exploratory report

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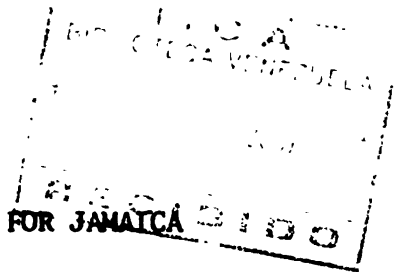
REPORT ON THE PROGRESS OF THE WORK DURING THE YEAR 1907

FRESHWATER FISHES OF THE STATE OF CALIFORNIA

BY DR. J. S. KENNEDY

Miscellaneous Publication #361
Series 1907-1908

FRESHWATER PRAWN (SHRIMP) CULTURE FOR JAMAICA



AN EXPLORATORY REPORT

JUNE 1982

MICHAEL WILES

00000457

INTRODUCTION

The freshwater crayfish, also known as prawn or shrimp is regarded as a local delicacy. Local "production" refers essentially to what has been generated under natural environmental conditions, without intervention by man, and results in the availability of relatively small catches which are sold at high unit prices. The potential production is largely unexploited.

Some attempts have been made through studies to provide information designed to reverse this position, but the results have not been very positive, have remained largely fragmentary and have not been pursued to finality. The necessity therefore exists for the development of a structured husbandry and production programme which could lead to the commercial exploitation of the potential.

The IICA/Jamaica Office in its awareness of this situation has given consideration to the possibility of undertaking a study for formulating and implementing a programme in view of the potential demand for crayfish not only for import substitution but also as a foreign exchange earner, for example in Spain. It has held discussions with the Permanent Secretary Ministry of Agriculture, and the Head of the Zoology Department of the University of the West Indies (Mona campus) and private sector interests. The Prime Minister of Jamaica has expressed a keen interest in this study.

The Pear Tree Bottom River which runs through the Belle Air Estate, St. Ann, a government-owned property, has species of crayfish which have a potential for commercial exploitation. The Permanent Secretary Ministry of Agriculture has made facilities and land available on this property and the collaboration of the Zoology Department of the UWI has been secured through its Head, Professor I. Goodbody. IICA/Jamaica was able to obtain the services of Dr. Michael Wiles, Professor of Biology and Chairman of the Biology Department of St. Mary's University, Halifax, Nova Scotia, on sabbatical leave to identify the project and undertake preliminary work necessary for providing some of the parameters required for undertaking the pre-feasibility study.

11/11/11

Dear Mr. [Name],

I am writing to you regarding the [Topic] of your [Document/Project].

The information provided in your [Document/Project] is [Detailed Description].

It is important to note that [Key Point/Detail].

We have reviewed the [Document/Project] and [Detailed Description].

Based on our findings, we recommend [Action/Conclusion].

Please contact us if you have any questions or need further assistance.

Thank you for your time and cooperation.

Sincerely,
[Signature]

[Name]
[Title]
[Company/Institution]

A number of preliminary investigations have been undertaken, the results of which provide useful inputs for the pre-feasibility study. A number of supportive investigations have been identified and it is the hope that the study when prepared will take Jamaica beyond the present stage of knowledge and will assist in the implementation of an appropriate programme for crayfish production in Jamaica.

The proposals include a research programme, and special studies on the cannibalistic nature of four (4) main freshwater shrimp species namely Macrobrachium acanthurus; M. carcinus, M. faustinum and M. rosenbergii.

The work will be carried out by selected University Graduate students under the direction of a Resident Research Director. The setting up of the project on government-owned land where adequate security at reasonable cost can be established and adequate environment (fresh and sea water) is available are distinct advantages.

It is proposed that the study be a joint GOJ/IDRC/IICA exercise, extending over a period of 3 years.

Percy Aitken-Soux
Director

The first part of the document discusses the importance of maintaining accurate records of all transactions. It emphasizes that proper record-keeping is essential for the success of any business or organization. The text also mentions the need for regular audits and reviews to ensure that all data is up-to-date and correct.

In addition, the document highlights the role of technology in modern record-keeping. It suggests that using digital tools and software can significantly improve efficiency and reduce the risk of human error. The text also touches upon the importance of data security and privacy, particularly in light of increasing regulations and public concern over data breaches.

The second part of the document provides a detailed overview of the various types of records that should be maintained. This includes financial records, such as invoices, receipts, and bank statements, as well as operational records, such as contracts, correspondence, and project files. The text also discusses the importance of archiving and backing up data to prevent loss in the event of a disaster.

Finally, the document offers practical advice on how to implement a robust record-keeping system. It suggests starting with a clear plan, identifying the key areas that need to be tracked, and choosing the right tools and processes. The text also emphasizes the importance of training staff and ensuring that everyone is aware of the importance of accurate record-keeping. The document concludes by stating that a well-maintained record-keeping system is a valuable asset that can provide valuable insights and support the long-term success of any organization.

FRESHWATER PRAWN (SHRIMP) CULTURE FOR JAMAICA

An Exploratory Report

1. Introduction
- II. The Proposed Project Site
- III. Present facilities at the project site
- IV. Suggestions for additional facilities at the project site
- V. Biological research conducted:
 1. Materials and methods
 2. Results
 - (i) Relevant characteristic of the Pear Tree Bottom River System;
 - (ii) Species, composition and relative abundance of crustaceans in samples collected;
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 3. Discussion
- VI. Review of relevant scientific and technical literature
- VII. Recommendations on developing an aquaculture research complex
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- (b) Hydrological and geological data on Pear Tree Bottom River System
- (c) Project Profile submitted to IDRC
- (d) Bibliography of scientific and technical literature on biology and culture of freshwater prawns (shrimps) and related organisms
- (e) Pear Tree Bottom River System, totals and proportions of crustaceans collected by species
- (f) Three year budget (Internal working document of IICA/Jamaica)

THE UNIVERSITY OF CHICAGO

PHYSICS DEPARTMENT

CHICAGO, ILL.

Dear Sir:

I have the pleasure to inform you that your application for admission to the Ph.D. program in Physics has been approved by the Department. You are invited to join the University of Chicago in the fall of 1954. The Department is pleased to have you as a member of its faculty.

Your research interests in the field of quantum electrodynamics are highly regarded, and we believe that the University of Chicago will provide an excellent environment for your work. We are confident that your contributions to the field will be significant.

We are pleased to hear that you have been awarded a Fulbright Fellowship for the year 1953-1954. This is a great honor and we are sure that it will enable you to carry out your research with the highest quality.

We are sure that your presence at the University of Chicago will be a great asset to the Department and to the University as a whole.

I am sure that you will find the University of Chicago a most interesting and stimulating place in which to work. We are sure that you will find many opportunities for collaboration with our faculty members and for participation in the many activities of the University.

Very truly yours,
[Signature]

THE POTENTIAL FOR COMMERCIAL FRESHWATER PRAWN CULTURE IN JAMAICA

IICA OFFICE IN JAMAICA

APRIL, 1982

I. INTRODUCTION

Jamaica's rivers abound the several species of freshwater prawns (or shrimps) of the genus Macrobrachium (L). Some refer to these animals as "crayfish" or even "lobsters", although they belong to neither of these identities, being zoologically, decapod crustaceans of the Family Palaeomonidae. The palaeomonid shrimps grow to a handsome size rather quickly and are sold by the roadside at various locations in Jamaica, as well as being sold by commercial fishermen to the hotel trade on the island. However, Jamaica is a net importer of shrimps for human consumption despite the bounty of them in her natural water-courses.

Worldwide, there is a strong market demand for "cocktail-sized" and "restaurant-sized" shrimps that cannot be met by all the shrimp producers combined. Consequently, the market price for this food commodity is high and stable. Predictably, the price for shrimp can only increase in the future if production increases significantly. Traditional "hunter-gatherer" fishermen cannot by any stretch of the imagination meet this market demand. Over the last 15 years, freshwater shrimp culture has emerged as an alternative to artisanal fisheries, using modern techniques, scientific knowledge and the rapidly developing concepts of the applied science known as aquaculture. This word, if literally translated, means farming of waters and is analogous to agriculture, which means farming the lands. In Jamaica, there are as yet no proven experts in freshwater shrimp culture, although some have tried to develop commercial farms but have failed. These failures are probably attributable to a lack of scientific knowledge of the general biology, physiology and ecology of the organisms in question on the part of those who have attempted to culture them commercially in this country.

Now IICA at the request of the Prime Minister, has commenced a scientific and technical study of freshwater shrimp farming with a view to implementation of commercial aquaculture when the necessary knowledge, experience and expertise have been acquired. Specifically, a site which comprises government-owned land on the north coast of Jamaica has been identified as having considerable potential as a future shrimp farm. Already, scientific investigations of the geology, hydrology and pedology at this location have been carried out, and primary biological studies have recently been conducted by a Canadian aquatic ecologist who has been in Jamaica for three months while on sabbatical leave from his home university. Results of these efforts show clearly that this site is suitable for development into an applied research facility for study of three indigenous Macrobrachium species and one exotic species of the genus.

CONFIDENTIAL - SECURITY INFORMATION

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The purpose of the research facility is to carry out the scientific and technical trials needed to compare these several species under local conditions, in order to find out which one would be the most successful in terms of productivity at the commercial scale of aquaculture. Ancillary efforts would be in training of Jamaicans in aquaculture and in developing some arrangements, if possible, with local small land holders, for shrimp grow-out activities for the domestic market.

The purpose of this report is to summarise the geological, hydrological and pedological data on the proposed culture site and to present in detail the results of biological research conducted at three localities in Jamaica on the indigenous freshwater populations of Macrobrachium in rivers. This report culminates in several recommendations for development of a commercial shrimp farm in Jamaica based on sound scientific, technical and economic principles.

II. THE PROPOSED PROJECT SITE

The site of interest for shrimp culture is part of the old "Belle Air" Estate, St. Ann, Jamaica, through which flows Pear Tree Bottom River. At least 50 ha of the bottom land is swamp (Class IV land) surrounded by perhaps 150 ha of flat (Class V) land which can readily be flooded by controlling river water flows through a network of channels. Inland of the swamp and bottom land, there rises a limestone escarpment, from which freshwater issues at 18 springs or "blue holes" to collectively form what is known as Pear Tree Bottom River. This river consists of a normally dry gully through the lower part of the escarpment inland (which collects surface runoff after rainfall) and a series of ill-defined channels through the bottom land that converge to form a coastal swamp. The freshwaters drain to the sea through three main outflows which are located between Discovery Bay and Runaway Bay, St. Ann. The most westerly outlet is known locally as Parson's Creek, the central one has the greatest flow and is known as Main Outlet, and the most easterly outlet is called Grassy Creek. About 70% of the water in this system comes out of one large spring called the Main Blue Hole, with a diameter of about 15 m. and two main outlet channels of variable position. The land, purchased by the Government of Jamaica in 1978, was once a cattle ranch with coastal mangrove swamps on its shoreline. The mangroves were cleared out, the land partly drained and channelled, and coconuts planted on raised banks between the channels. This venture failed. Later, the coconuts became infected with a mycoplasma that causes lethal yellowing disease, and the plantation was virtually abandoned. Today the land is derelict.

The property is ideally located for freshwater shrimp culture for there is easy access to both freshwater and saltwater, the latter being required for the earlier larval phases in the life cycle, and the former being the medium for growth of juveniles and adults. The bottom land could be modified inexpensively to contain ponds in which the shrimps could be cultured and protected from predators. Fencing the property to prevent praedial larceny would be effected at modest cost.

The freshwater on the property is unpolluted, clear and abundant. As its source is underground it is little affected by rainfall. The hydrological data show that its flow is practically constant throughout the year at about $7 \times 10^6 \text{ m}^3/\text{month}$. The qualities of this water are ideal for shrimps, the total dissolved solids levels being in the optimal range of 150-22 mg/l, with highest amounts in the blue holes and lowest ones in the river channels themselves. The hardness range of the spring waters is 140-160 mg/l which is an ideal level for a domestic water supply because it is low enough for water softening equipment to be unnecessary. The freshwaters are affected by seawater influxes close to the coast where levels of sodium, chloride and sulphate are much higher than further inland. Consequently, total dissolved solids near the river outlets approach 1,000 mg/l, and total hardness levels exceed 300 mg/l. For shrimp culture, seawater encroachment like this provides an optimal environment for the growth and moulting of the first 6 or 7 larval phases in their life cycle, for these have an obligatory requirement for saline waters after hatching and before metamorphosis into juveniles. River water temperatures vary little over the year, the range being 22 to 25°C, which is optimal for shrimp growth. Thus, biological production proceeds on a constant, year-round basis in this system and so could shrimp culture based on this water supply. Ground water levels fluctuate, yet they do so in response to withdrawals or additions of water, not to rainfall (although the rainy season in April-May causes a general, pronounced rise). Heavy rains cause turbid water to appear at seepages and in the main surface drainage gully, but at the same time spring water from the blue holes remains clear. Overall, the spring waters in this area are remarkably clear. Thus the freshwater supply is ample and dependable for drinking, domestic and laboratory use, and for shrimp culture. However, clearing out the vegetation in the swamp channels would be necessary to use this resource effectively. To maintain acceptable water levels in the swamp thereafter, a regular programme of vegetation removal would have to be carried out.

The Main Blue Hole is the obvious spring to use as a source of freshwater for the building (including laboratories and living quarters) and the shrimp culture facilities. Its discharge varies little through the year, the range being 13 to 17 m/sec. and the mean 15 m/sec., while the change in the height of a gauge installed in it for about 3½ months was less than 3 mm in one day. This spring provides about 0.7 of the water in Pear Tree River Bottom system. The rest comes from at least 17 other blue holes, 9 of which have had their water flows measured (their flows are constant too), and from limestone seepage. The second largest blue hole has a constant discharge rate of 4.5 m/sec. Some water flow data for the three main discharge channels flowing into the sea (and subject to tidal backwater) have been collected. Mean values reported are 28.5 m/sec. in March, 30.3 m/sec. in June and 23.4 m/sec. in October. Impedence of freshwater flow into the sea by tidal seawater is overcome by an increased flow rate from the blue holes at high tide, the freshwater flow and tidal flow maxima co-inciding quite precisely. Whereas there is reason to think that the tidal rise reduces underground out-flow of freshwater into the sea, it apparently interferes little with the above surface flow so that saline water intrudes only a very short distance into the Pear Tree River Bottom system.

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Infrared photography has revealed offshore discharge points for freshwater at Pear Tree Bottom River which carry away excess groundwaters from the system and probably contribute to the constancy of the above surface freshwater flows through the swamp.

III. PRESENT FACILITIES AT THE PROJECT SITE

The Pear Tree Bottom area of the Belle Air Property, having once been a livestock farm and coconut plantation, already has certain facilities, albeit in a state of disrepair. There are at present dirt access roads with gates and fencing so that motor vehicles can easily reach the swamp and plantation areas, as well as the existing buildings. There is a house that, after renovation, could serve as both an office facility and a residence for the Resident Research Director and his family. A long cement block building nearby that served as living quarters for several field hands could be converted into laboratories, dormitories and storage facilities.

A pumping and water distribution system once operated on this property. This system could be repaired and used as a water supply system for buildings and shrimp culture facilities.

The waterways on the property, after being cleared of vegetation, can be easily travelled by boat for conducting of in situ ecological research on spatial and temporal changes in the indigenous freshwater shrimp populations. In this way, an analysis of the structure of, and the rates of recruitment of juveniles into the natural population of each species of Macrobrachium in this system could be carried out. These studies would constitute valuable information usable for assessment of the biological productivity (the rate of formation of new biomass) of each species.

The land planted in coconut, or adjacent pasture lands, could be used for construction of the necessary nursery and culture ponds. The exact site for the ponds will be determined by characteristics of the soil and of the topography. There is probably sufficient diversity in the soil and in slope values to encompass a substrat of about 28% clay and a natural or man-made slope of 5°.

IV. SUGGESTIONS FOR ADDITIONAL FACILITIES AT THE PROJECT SITE

If it is not possible to accommodate hatchery facilities within an existing building, then it would be necessary to construct a hatchery building serviced by water, compressed air, electric power and drainage pipes.

It is imperative that the research and culture complex be effectively fenced off and the property protected from praedial larceny by guard dogs and handlers, who should be present all the time. Without such security, it would be impossible for the planned research and development work to develop satisfactorily.



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V. BIOLOGICAL RESEARCH CONDUCTED

1. Materials and methods

Collections of freshwater prawns were made from three Jamaican Rivers, the Black River in St. Elizabeth, the Martha Brae River in Trelawny, and Pear Tree Bottom River System in Saint Ann. Samples from Black River were of two kinds; hand net samples from submerged vegetation on the west bank at Pentio Pen Farm (E2580 N4120), collected between 0730 and 1000 hours on March 17 and 18, 1982; commercial samples of shrimp caught in pots by local fishermen and purchased live at Middle Quarters (E2620 N4370) at 1230 hours on February 23, 1982 and at 1100 hours on March 18, 1982. On both days the commercial samples consisted of 2lbs. (0.91kg.) of shrimp, all water removed; the February sample contained 90 animals, the March sample 70, the hand net samples consisted of 1,082 small specimens.

Shrimp were collected from the Martha Brae River, about 300 m. from its source near Windsor Great House (E3250 N5275), from 1200 to 1400 hours on March 14, 1982, 45 specimens being collected in all with hand nets.

In the Pear Tree Bottom River System (E4260 N5646) nine representative sampling sites were established at various locations (Table 1); Map 1. Both hand nets and small mesh seines were used to recover 120 specimens of Macrobrachium (Table 2). Collecting was done from 0700 to 1100 hours each day from February 16 to 20, 1982. Crustaceans other than Macrobrachium were also obtained (Table 2), for a total of 553 specimens.

All specimens were fixed in 10% formalin (4% formaldehyde) while still alive. After several days in fixative, the formalin was discarded and the specimens washed in 30% ethanol; the shrimp were then stored in 70% ethanol. Identification of species were carried out against white and black backgrounds by studying anatomy and morphology of the animals under a Bausch and Lomb stereoscopic microscope at magnifications ranging from 7 x to 30 x and with strong reflected illumination. The relevant dichotomous keys in Chace and Hobbs (1969) - 'The freshwater and terrestrial decapod crustaceans of the West Indies with special reference to Dominica United States National Museum Bulletin 292, Smithsonian Institution, Washington, D.C. (pp. 48-51, 56-57, 66-70, 76-79, 81-99 and 102-106) were used to determine the specific identification of all specimens in the collections. Specimens other than Macrobrachium species were present in the samples. These too were identified and included in the analyses of the compositions of the decapod shrimp populations of the three rivers investigated in this survey. Macrobrachium larvae and postlarvae were collected from a large blue hole (Crater Lake) on land owned by Kaiser Aluminium Corporation.

The earliest phases of the life cycle from this lake were examined with a compound microscope. Details of the results of the investigation of Crater Lake, as compiled by Dr. Donald McQueen, of York University, Toronto, Ontario, Canada as well as the author, are given in Table 3.

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1. The first part of the report deals with the general situation in the country. It is noted that the economy is in a state of depression and that the government is unable to meet its obligations. The report also mentions that the population is suffering from widespread poverty and that the government is unable to provide for their basic needs.

2. The second part of the report deals with the political situation. It is noted that the government is unable to carry out its policies and that the country is in a state of political instability. The report also mentions that the government is unable to maintain law and order and that the country is in a state of chaos.

3. The third part of the report deals with the social situation. It is noted that the population is suffering from widespread poverty and that the government is unable to provide for their basic needs. The report also mentions that the government is unable to provide for the education and health care of the population.

4. The fourth part of the report deals with the economic situation. It is noted that the economy is in a state of depression and that the government is unable to meet its obligations. The report also mentions that the government is unable to provide for the basic needs of the population.

5. The fifth part of the report deals with the military situation. It is noted that the government is unable to maintain law and order and that the country is in a state of chaos. The report also mentions that the government is unable to provide for the basic needs of the population.

6. The sixth part of the report deals with the international situation. It is noted that the country is in a state of political instability and that the government is unable to carry out its policies. The report also mentions that the government is unable to maintain law and order and that the country is in a state of chaos.

7. The seventh part of the report deals with the future of the country. It is noted that the country is in a state of political instability and that the government is unable to carry out its policies. The report also mentions that the government is unable to maintain law and order and that the country is in a state of chaos.

A search and review of the scientific and technical literature on the biology and culture of freshwater shrimp (prawns) have been carried out to establish a sound background of information on these potentially valuable organisms. Emphasis in this search has been on the scientific journals Aquaculture and Crustaceana, and the technical publications of the United Nations Food and Agricultural Organisation (FAO). However, relevant articles in several other organs have also been gathered together. A useful bibliography on freshwater prawns has been compiled and deposited in IICA files for future reference. It is also appended to this report (Appendix D).

All specimens collected in this investigation are preserved in 70% ethanol and stored in the Department of Zoology, University of the West Indies, Mona Campus, Kingston, Jamaica, under the custodianship of Professor Ivan Goodbody, Head of the Zoology Department.

2. RESULTS

(i) Relevant characteristics of the Pear Tree Bottom River System

Geologically, this short (5km) river system, which rises in a limestone plateau near Orange Valley, St. Ann, is dominated by

- (a) the Montpelier Family of the Tertiary White Limestone Group with flints, dating from the late Miocene through mid-Eocene geological epochs, and located on the escarpment of the hinterland of the system, bounded to the south by the Duanvale Fault; and
- (b) the Coastal Group of limestone, overlain by alluvial till composed of limestone debris, flint pebbles and boulders brought down from the plateau. The land on the coast is ex-mangrove swamp (remnants of the mangrove trees are still present), and rises sharply immediately to the south of the swamp but less sharply further inland up to the limestone plateau.

The swamp itself extends over about 50 ha and surrounding it on three sides are about 150 ha of flat land that could serve as the pond construction area. The permanent freshwater flow comes from springs at the base of the limestone escarpment and from general seepage, so that there is very little variation in flow rates through the year. By the coastline the water is brackish so that a salinity gradient exists between the sea and the river proper. This constitutes an excellent environment for the completion of the life cycle and for the growth to adult sizes of freshwater Macrobrachium prawns.

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5. The fifth part of the document discusses the importance of data governance and the role of various stakeholders in ensuring that data is used ethically and in compliance with relevant regulations and standards.

6. The sixth part of the document provides a summary of the key findings and recommendations. It emphasizes the need for a holistic approach to data management, one that integrates data collection, analysis, and governance into the organization's overall strategy.

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(ii) Species compositions and relative abundance of crustaceans in samples collected

Table 1 gives samples site numbers and codes, names of sites and bottom types for Pear Tree Bottom River System and Crater Lake, while Table 2 gives specie compositions and relative abundance of species of crustaceans recovered during the sampling programme at the Black, Martha Brae and Pear Tree Bottom Rivers and Crater Lake. In Table 3 details of the sampling of plankton and benthos at Crater Lake are shown.

These data indicate that 0.89-0.91 of crustaceans at the lower reaches of Black River, St. Catherine (Pontio Pen Farm), amongst the bank vegetation as juveniles are Jonga serrei and only 0.075-0.112 of samples are of species of Macrobrachium. A mere 0.0055-0.010 of the decapods are Xiphocaris elongata in this part of the river.

In contrast to these specie proportions in the river bank vegetation samples, are the compositions of the two samples of shrimps, purchased at Middle Quarters, consisting of commercial fishermen's catches from lower Black River. In these shrimp pot catches, Macrobrachium is the only genus represented, M. acanthurus being 0.57-0.84 of the catch, M. carcinus 0.02-0.13 and M. faustinum 0.03-0.41 of the samples. The only consistent fact is the dominance of M. acanthurus in Black River commercial shrimp catches.

In Martha Brae River, the dominant crustacean in the sample is Micratypoeyi, representing 0.56 of the collection. Macrobrachium species made up 0.33 of the catch and Potimirim mexicanan 0.11 of the total.

The Pear Tree Bottom River System collections yielded a preponderance of Xiphocaris elongata at 0.56 of the total specimens recovered. Next in relative abundance was Jonga serrei which comprised 0.22 of the collections. Of the Macrobrachium species represented, M. carcinus was most common, constituting 0.14 of the samples. Prevalances of both M. acanthurus and M. faustinum were low, being only 0.13 and 0.07 of the samples, respectively.

In Crater Lake a most interesting situation seems to prevail. A large proportion of the benthic samples (0.89) consisted of Macrobrachium carcinus, while only 0.01 and 0.01 of the collections were M. acanthurus and M. faustinum, respectively. These proportions by species are quite different from those in Pear Tree Bottom River System (Table 2). Benthic crustaceans other than Macrobrachium were quite insignificant in the Crater Lake samples. However, of greatest interest is the presence in the plankton of phase II and later phases of Macrobrachium larvae, and of juveniles. Even though the Macrobrachium larvae and juveniles were minor components in the samples (Table 3), being much less numerous than the copepods, and less common than both rotifers and ostracods, the existence of these early life cycle forms of Macrobrachium in the lake indicates that conditions are suitable for reproduction and growth of freshwater prawns. This is plausible because there is a surface layer of freshwater one to two meters deep (1.25 m near shore and deeper towards the middle),

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below which there is water of a salinity of 19-21 ppt. which extends down to near the lake bottom (McQueen, 1982 MS report). Freshwater springs issue from the limestone bed of the lake. Thus a wide range of salinities is found in this system. The abundant copepod naupii could serve as a food source for developing Macrobrachium larvae.

(iii) Ecological details on crustaceans recovered in samples collected

"The majority of the West Indian freshwater and terrestrial decapod crustaceans are known to be tolerant of salinities approaching that of seawater, many actually invading the ocean or having larval stages that typically occur in the sea". (Chace and Hobbs, 1969, p. 32.

Jonga serrei and Macrobrachium acanthurus are found in estuarine and subestuarine habitats, being restricted to sluggish waters near the mouths of streams. They are progressively less abundant as stream gradient increases, normally being restricted to above sea level elevations of less than 150 feet (45 m). They are normally absent in streams that reach the coast with their beds above high tide level. Macrobrachium acanthurus seems to be most abundant in sluggish streams over muddy bottoms. It is restricted to quiet pools near the mouths of streams and rivers at or below sea level and lacking riffles. During the day it can be found among debris and roots of shoreline plants exposed in the waters. After dark, they move to the tops of debris accumulation or into open water.

Macrobrachium carcinus ascends streams from the sea up to elevations of about 2,000 ft. (600 m) or more, living in pools or under large stones in larger rivers. In subestuarine conditions it finds shelter among littoral debris. It can also be found in rapidly flowing drainage ditches beneath large stones in swift portions of streams and under stones at pool margins of even the smallest creeks. It is basically nocturnal. It leaves its cover during the night and moves around, even crossing riffles in travelling from one pool to another. There is thought to be a direct relationship between size of a pool and the number of M. carcinus populating it. About 15 to 20 square feet of bottom is required by an adult M. carcinus as its territory. The largest specimen in a single pool containing several individuals is the master of that pool. Dominance is linked to size in this species.

Macrobrachium crenulatum is found from almost sea level up to elevations of about 1,300 ft. (390 m), preferring the stream bed of pools in smaller streams and quiet littoral microhabitats of shallow riffles in larger streams.

Macrobrachium faustinum is found in quiet pools and protected littoral areas of larger streams, from subestuarine conditions, where it co-exists with M. acanthurus and Jonga, to elevations as high as 500 ft. (150 m.), but is primarily an inhabitant of the lower reaches of streams. It shelters beneath stones, trunks of water-logged trees or larger pieces of debris. It is believed that this species seldom enters riffles.

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Macrobrachium heterochirus appears to be confined to riffles from about 2,500 ft (750 m.) down almost to sea level.

Macrobrachium jelskii occurs in habitats similar to those of Jonga serrei and M. acanthurus, ranging quite far inland from the coast.

The usually epigean Potimirim mexicana, M. carcinus and M. faustinum have also been reported from caves, as has X. elongata in Puerto Rico. M. carcinus has been reported to be flushed out of underground passages into river pools, from which it was then recovered.

Xiphocaris elongata occurs from elevations of about 1,200 ft. (360) right down to sea level, preferring pools, though this species can move through the fastest currents as adults. Juveniles are mostly restricted to stream margins in moderate currents. Most specimens are to be found in pools at low elevations. Adults may be restricted to elevations about 150-200 ft. (45-60 m). M. faustinum and M. carcinus and X. elongata are the most widespread shrimp in Jamaica, according to Hunt (1976), having been collected by him from parishes bordering the four coasts of the island. M. acanthurus, J. serrei and P. mexicana were collected only from western and southwestern parishes. The eastern and northeastern parishes are mountainous, whereas the western and southwestern ones are relatively low lying and flat. The E and NE rivers tend to be high gradient streams, with shallow, clear, cold and fast-flowing waters with a high O₂ content and stony bottoms with little vegetation. The W and SW rivers are mostly low gradient water courses with deep, turbid, warm, slowflowing waters, low O₂ content and muddy bottoms with abundant vegetation.

The most important ecological factor in the successful completion of the life cycle, from fertilised egg to sexually mature adult, is the level of dissolved salts in the water at the different phases of this cycle. The larvae need to be hatched in relatively high salinity water. Optimum salinities for larval development have been investigated experimentally by several workers with the following results:

Species	Family	Dissolved salts Concentration	Reference
<u>Atya innocuous</u>	Atyidae	30 ppt ¹	Hunt (1976)
<u>Atya lanipes</u>	Atyidae	20 ppt	Hunt (1976)
<u>Atya scabra</u>	Atyidae	Not known	-
<u>Jonga serrei</u>	Atyidae	20 ppt	Hunt (1976)
<u>Macrobrachium acanthurus</u>	Palaeomonidae	15-20 ppt	Choudhury (1976)
<u>Macrobrachium carcinus</u>	Palaeomonidae	(66% sea water) 14-18 ppt	Lewis & Ward (1965)
<u>Macrobrachium faustinum</u>	Palaeomonidae	19-20 ppt	Choudhury (1971)
<u>Macrobrachium heterochirus</u>	Palaeomonidae	32 ppt ³	Hunt (1976)
<u>Micratypoeyi</u>	Atyidae	32 ppt ³	Hunt (1976)
<u>Potimirim mexicana</u>	Atyidae	14 ppt	Hunt (1976)
<u>Xiphocaris elongata</u>	Atyidae	Not known	Hunt (1976)

NOTE: 1 ppt - dissolved salts level as parts per thousand of water e.g. 30 ppt = 3 per cent salts, or 3g per 100g of water = 30g per 1000g (=1 liter).

2. These species are flexible in their salinity requirements for the larvae

3. These concentrations are approximately full strength coastal seawater

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2. The second part of the document focuses on the importance of clear communication and collaboration between all stakeholders involved in the process. It stresses that effective communication is key to ensuring that everyone is on the same page and that all necessary information is shared in a timely and accurate manner. This section also discusses the importance of documenting all decisions and actions taken, and the need for regular updates and reports to keep everyone informed of the current status of the project.

3. The third part of the document discusses the importance of maintaining a strong relationship with external stakeholders, such as suppliers, customers, and regulatory bodies. It emphasizes that a strong relationship is essential for ensuring that all parties are satisfied with the results and that any issues are resolved in a timely and effective manner. This section also discusses the importance of staying up-to-date on industry trends and regulations, and the need for ongoing communication and collaboration with external stakeholders.

4. The fourth part of the document discusses the importance of maintaining a strong focus on customer satisfaction and service. It emphasizes that customer satisfaction is a key driver of business success, and that providing high-quality service is essential for ensuring that customers are happy and loyal. This section also discusses the importance of listening to customer feedback and using it to improve the product and service, and the need for ongoing communication and collaboration with customers.

5. The fifth part of the document discusses the importance of maintaining a strong focus on financial performance and profitability. It emphasizes that financial performance is a key indicator of business success, and that maintaining a strong focus on profitability is essential for ensuring long-term growth and sustainability. This section also discusses the importance of monitoring key financial metrics and using them to make informed decisions, and the need for ongoing communication and collaboration with financial stakeholders.

6. The sixth part of the document discusses the importance of maintaining a strong focus on innovation and research and development. It emphasizes that innovation is a key driver of business success, and that investing in research and development is essential for ensuring that the company is always at the forefront of the industry. This section also discusses the importance of fostering a culture of innovation and encouraging employees to think creatively, and the need for ongoing communication and collaboration with research and development stakeholders.

7. The seventh part of the document discusses the importance of maintaining a strong focus on human resources and talent management. It emphasizes that human resources are a key asset of the company, and that investing in talent management is essential for ensuring that the company has the right people in the right roles. This section also discusses the importance of providing ongoing training and development opportunities for employees, and the need for ongoing communication and collaboration with human resources stakeholders.

8. The eighth part of the document discusses the importance of maintaining a strong focus on risk management and compliance. It emphasizes that risk management is a key component of business success, and that ensuring compliance with all applicable laws and regulations is essential for avoiding legal and financial penalties. This section also discusses the importance of identifying and assessing risks, and the need for ongoing communication and collaboration with risk management and compliance stakeholders.

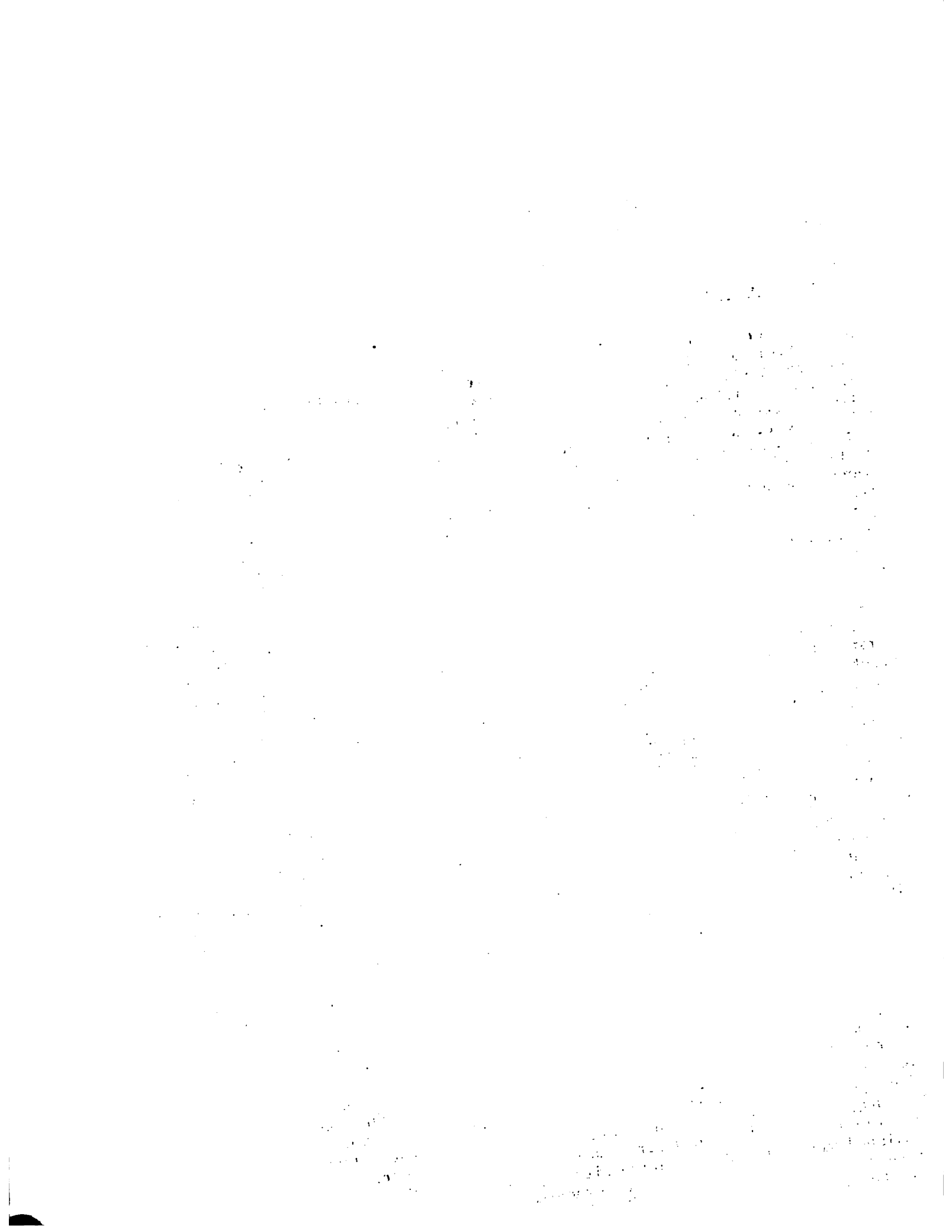
9. The ninth part of the document discusses the importance of maintaining a strong focus on sustainability and social responsibility. It emphasizes that sustainability and social responsibility are key components of business success, and that investing in these areas is essential for ensuring long-term growth and sustainability. This section also discusses the importance of setting and measuring sustainability and social responsibility goals, and the need for ongoing communication and collaboration with sustainability and social responsibility stakeholders.

10. The tenth part of the document discusses the importance of maintaining a strong focus on overall business strategy and vision. It emphasizes that a clear business strategy and vision are essential for ensuring that the company is always moving in the right direction and that all activities are aligned with the overall goals and objectives. This section also discusses the importance of regularly reviewing and updating the business strategy and vision, and the need for ongoing communication and collaboration with all stakeholders.

3. DISCUSSION

There is no doubt that the relevant characteristics of the Pear Tree Bottom River System constitute a most suitable situation for a research, testing and development facility for freshwater prawn investigations. Without repeating evidence for this conclusion, which is given in other parts of this report, suffice it to say here that it is hard to conceive of another location in Jamaica that would be better for aquacultural research than the Belle Air property. In addition to the desirability of the site itself for the proposed facility, another advantage is the proximity of the Discovery Bay Marine Laboratory of the University of the West Indies, Mona Campus. Cooperation in research and development with the University could be easily effected in the form of post-graduate student research on the site and use of some Discovery Bay facilities.

The results of analysing the species' compositions and relative abundance of shrimp from the three rivers and one lake sampled, indicate several encouraging possibilities with respect to the current proposal. First, all three of the indigenous Jamaican species of Macrobrachium which are of interest for testing, occur naturally in both Pear Tree Bottom and Crater Lake so that we know conditions are suitable for maintenance of their life cycles there. It has been shown for the first time that M. acanthurus is established in these two systems, although it is uncommon. Second, M. carcinus is relatively uncommon in Pear Tree samples, but strongly dominates the Crater Lake populations, whereas M. faustinum is rare in the lake but dominant in the river system. Thus brood stock of both species is readily available in the region, while abundant berried females of M. acanthurus could easily be obtained from lower Black River, where this species is the dominant type, and transferred to the culture ponds at Pear Tree Bottom, if necessary. Brood stock for experiments on the exotic but widely cultured species, M. rosenbergii, would have to be imported, but this is an inexpensive procedure. Third, M. carcinus is present near the source of the Martha Brae River, which is not far from Pear Tree Bottom, and is found in unpolluted water. Mature males and females and/or berried females could be transferred from Martha Brae River at moderate cost, if required. Fourth, the occurrence of several different life cycle phases of Macrobrachium in Crater Lake suggests that the life history is completed within the lake. This raises the possibility of culturing it by providing suitable holding facilities for adults along the lake's edge, such as meshed boxes to provide a refuge and exclude predators. With proper planning, this lake could be made into a huge incubator - grow out complex using the abundant, clean, constantly replenished lake water. Augmentation of the currently established wild copepod population with copepod eggs might provide an abundant food supply for the Macrobrachium larvae. At the very least, these ideas should be kept in mind if expansion becomes necessary.



Appendix B provides an analysis of the available water chemistry, water quality and water flow rates data for Pear Tree Bottom by presenting ranges of values, where appropriate, arithmetic means, standard deviations and standard errors. An examination of these statistics indicates the excellent water chemistry and water quality characteristics of the system with respect to aquaculture of Macrobrachium shrimp. The springs providing good, soft freshwater for adults and the lower channels, where tidal seawater intrudes, offering saline waters for newly-hatched larval development. The water flow rates data on rain recharges, rain outflows and subsurface flows are remarkable for their large standard deviations, due to high variability, and large standard errors caused by small samples. In contrast, spring discharges have low variability, while the constancy of the river system outflow is very striking indeed. Both spring and river flows ensure a reliable water supply of known flow rate.

The ecological information on crustaceans collected in this study which is presented in the results section is of interest to the current proposal because it emphasises the different requirements for living conditions of the individual species in the samples. Amongst the species of Macrobrachium, specifically, we note different physiological optima with respect to salinity, stream bottom type, water current speed and altitude of the three main species under consideration in the present proposal, i.e. acanthurus, carcinus and faustinum. This not only tells us that these species are segregated in nature, so that they do not compete against each other for food and living space, but also that we must be careful to provide each species with the particular condition required for its optimal performance.

There are some relevant points to be raised concerning ecological conditions in the exploitation and rational conservation of aquatic resources at an aquaculture facility. There will co-exist under these conditions two paramount conflicting aspects:

- (1) exploitation, usage and dissipation of resources and energy, leading to losses; and
- (2) conservation, husbandry and rational channeling of energy, leading to maintenance of the integrity of the system, where common effects are thus stability and recycling of nutrients

The cost of (2) is reduced energy utilization rates and economic return rates. Clearly, these conflicts have to be resolved by striking an appropriate balance between them. This can obviously only be done in the context of the objectives which are established in advance for the particular enterprise. The following objectives for an aquaculture facility are proposed here:

- (1) to utilize rationally a natural resource at the same rate that it can replenish itself or at a rate consistent with economically viable, but non-disruptive, subsidy inputs that aid replenishment,



- (2) to avoid environmental degradation in order to prevent the eventual destruction of the resources;
- (3) to avoid pollution, destabilizing nutrient enrichment rates, water flow modifications on a scale conducive to resource deterioration, and harmful stresses resulting from the application of technology,
- (4) to generate information useful for continuing research and development, and that can be basis for advice to governmental and private sector institutions;
- (5) to fulfill practical ends that increase economic well-being, social wealth and the quality of human life.

What is the relative position of aquaculture production of crustaceans when compared to other types of animals that are utilized in this way? In 1975, the level of world aquaculture production was as follows, in round figures.

Animal type	Production (tons)	Percentage of total
1. Finfishes	3,980,000	66.0
2. Seaweeds	1,055,000	17.5
3. Molluscs (oysters, mussels, clams, scallops, cockles etc.)	978,000	16.2
4. crustaceans (shrimps and prawns)	16,000	0.3

We see from these figures that crustaceans constituted an insignificant proportion of world aquacultural production in 1975. This situation is typical of world output of the 1970's and 1980's. However, although crustaceans are a minor component in terms of weight, they are much more important in terms of value because they command a high price in the market per unit of weight. Cultured crustaceans are characteristically a high value commodity of which the price trend is strongly upwards. It is this strong market price that makes prawn aquaculture an attractive and potentially profitable proposition.

Today, freshwater prawn culture around the world is strongly concentrated on Macrobrachium rosenbergii (de Man, 1879) because it is hardy, adaptable and fast-growing. Culture of this species was first achieved in 1962 in Malaysia by Ling (1962) and mass culturing techniques were developed by 1970 in Hawaii (Fujimura, 1966, Fujimura and Okamoto, 1970). Over 20 organizations in the United States alone are involved in studies on the culture of this species. Improvements in larval rearing techniques achieved in Hawaii have made possible the establishment of several commercial shrimp farms there and in various parts of southeast Asia, especially Thailand, in Puerto Rico, Taiwan and Central America

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5. The fifth part of the document provides a detailed overview of the data analysis process. It describes how statistical and analytical techniques are used to identify trends, patterns, and insights from the collected data.

6. The sixth part of the document discusses the importance of data visualization in communicating complex information. It explains how charts, graphs, and dashboards can be used to present data in a clear and accessible manner, facilitating better understanding and decision-making.

7. The seventh part of the document explores the role of data in strategic planning and performance management. It highlights how data-driven insights can be used to set goals, monitor progress, and make strategic adjustments to improve organizational performance.

8. The eighth part of the document discusses the future of data management and analysis. It explores emerging trends such as artificial intelligence, machine learning, and big data, and their potential impact on the way organizations collect, analyze, and use data.

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(Costa Rica and Honduras), by 1980 (Shang 1981). Over 2 million post-larvae were produced in Hawaii by 1974 and annual production capacity at the state hatchery was projected to be 25-30 million postlarvae by 1975 (Shang 1981). Today 27 countries have experimental hatcheries. Emphasis in developed countries is on intensive culture systems, where major economic problems are high cost of formula feeds, and to a lesser extent expensive land and labour.

The costs of Macrobrachium culture using different species constitute one of the most critical factors in this kind of activity. Yet there are few data available which compare different species on a cost basis, so that this matter is still to some extent an open question, one that needs to be investigated further. According to Alston (1981), in I.M.A. (1981) (bibliographic reference No. 83, App. D), an effort has been made in Florida to look at the relative success of a variety of species of Macrobrachium shrimps from several points of view, including the economics of culture under controlled conditions. Some results of this work follow. In Florida, research is on-going on M. acanthurus, M. carcinus, M. rosenbergii and M. ohione, the last-named being considered for production as bait and for polyculture with crayfish (Sic). A very condensed version of the results is shown below:

Comparison of costs of rearing acanthurus and rosenbergii reveals the following

<u>Species</u>	<u>Cost to rear 1,000 larvae to metamorphosis</u>
	US\$
<u>acanthurus</u>	13.42
<u>rosenbergii</u>	3.56

Drawbacks of acanthurus in culture were found to be the following:

- (1) it was less hardy than rosenbergii;
- (2) it did not readily accept ground fish as food;
- (3) it consumed 4 times as much Artemia nauplii as rosenbergii to achieve metamorphosis (nauplii are expensive);
- (4) there was no selected out brood stock available for purchase in starting a culture, non-selected or wild brood stock had to be used; and
- (5) it grew more slowly than rosenbergii

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Although about 12 Macrobrachium species have been investigated for their potential for aquaculture, by 1982 only M. rosenbergii was being produced on a large scale. The only other species to show any farming potential are M. lanchesteri and M. malcolmsonii. However, no studies have been conducted in Jamaica, where conditions for prawn culture are particularly favourable and several species of Macrobrachium are indigenous and are the basis of small scale commercial prawn fisheries in several rivers, such as Black River, Wag Water River and Rio Cobre. Therefore, we propose that in addition to tests of M. rosenbergii in Pear Tree Bottom River system, studies be made of M. acanthurus, M. carcinus and M. faustum, all found naturally in Jamaica. Some examples of culture practices and results with Macrobrachium prawns are given below. Reference: Anon. (1977). FAO Aquacult. Bull 8(2):11.

- (1) Macrobrachium rosenbergii. This species was cultured successfully, for example, at the Prawn-breeding Unit of the Central Inland Fisheries Research Institute, Kakinadam, Andhra Pradesh, India, and described as "the giant freshwater prawn". Newly-hatched larvae were released into earthenware pots holding 30 litres of aged seawater, diluted by 20% and containing a dense plankton component. At larval phase VI, larvae were transferred to round, flat-bottom 10 litre troughs with continuous aeration and water circulation. Larvae of phase VI were fed Artemia nauplii plus minced algae for 7 days, thereafter on nauplii only for another 3 days. After that, the feed was finely-sliced and cleaned Tubifex. Larval rearing was completed with the attainment of larval phase X after 38 days at about 30°C, and with dissolved oxygen levels at 3.95 to 6.55 p.p.m.
- (2) Macrobrachium carcinus. Research on the culture of this species commenced at the Instituto Oceanografico, University of Sao Paulo, Brasil, in April 1975, where it lives in small mountain streams at water temperatures of 17° to 23°C. At the time of reporting this species had not been found in the estuarine zone.
- (3) Procedure. A 92 mm long berried female was placed in a 500 litre concrete tank, 100x60x80 cm, and containing freshwater. On the 5th and 6th days after the female was confined, 5,000 newly-hatched larvae were released from the animal. These were transferred to seawater aerated by compressed air. Larvae were fed Artemia nauplii. Experimental water temperature ranged from 22.7° to 28.9°C, with an average of 26°C, average salinity was 33.5 ppt. Newly-hatched larvae measured 2.1 to 2.2 mm from rostral tip to telson tip. By 20 days larvae averaged 5.8 mm in the phase VIII, by 35 days were 7.6 to 7.8 mm long. Morphology and physiology of this species were being studied.

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SUMMARY OF CHARACTERISTICS DESIRABLE IN AQUATIC ORGANISMS CULTURE FOR
COMMERCIAL SALE

- (1) Successful reproduction in captivity, high hatching success.
- (2) Availability of proven techniques for rearing of larvae; short larval life.
- (3) High growth rate; adaptability to a wide range of temperatures.
- (4) High survival rate, especially amongst juveniles and adults.
- (5) Absence of, or immunity to, major diseases.
- (6) Wide consumer acceptability; high quality meat in terms of taste and texture.
- (7) High market value.
- (8) Technically feasible culture procedures adaptable to the species in question at different locations or in moderately varying conditions.
- (9) Economic feasibility under the local conditions of the venture, using the species of choice.

Of concern in the development of a concept such as is the subject of this report is the maintaining of the momentum established in the early phases of planning into later phases. To help ensure that the idea that a viable freshwater prawn research and culture facility could be functional in the Pear Tree Bottom River System, there follow some lists which should prove useful as the project takes shape. The main value of these lists is that they provide access to relevant information and facilitate the implementation of remedies for problems that may occur in the future as the aquaculture facility goes through its step by step phases of development.

EXPERTS ON CULTURE OF FRESHWATER PRAWNS (SHRIMPS)

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1. The first part of the document discusses the importance of maintaining accurate records of all transactions. It emphasizes that this is crucial for ensuring the integrity of the financial data and for facilitating audits.

2. The second part of the document outlines the various methods used to collect and analyze data. It includes a detailed description of the sampling process and the statistical techniques employed to interpret the results.

3. The third part of the document provides a comprehensive overview of the findings. It highlights the key trends and patterns observed in the data, as well as the implications of these findings for the organization's operations.

4. The fourth part of the document discusses the limitations of the study and the potential for future research. It acknowledges that while the current study provides valuable insights, there are still several areas that require further investigation.

5. The fifth part of the document concludes with a summary of the main points and a final statement on the overall significance of the research. It reiterates the importance of the findings and the need for continued attention to the issues discussed.

6. The sixth part of the document includes a list of references to the sources used in the study. These references provide additional context and support for the findings presented in the document.

7. The seventh part of the document contains a list of appendices, which include supplementary data and detailed calculations. These appendices are provided for the reader's reference and to support the conclusions drawn in the main text.

8. The eighth part of the document is a list of footnotes, which provide additional information and clarification on specific points mentioned in the text. These footnotes are essential for a thorough understanding of the document's content.

9. The ninth part of the document is a list of page numbers, which helps the reader navigate the document and find the specific sections they are interested in.

SOME EXPERTS ON THE NUTRITION AND/OR CULTURE OF CRUSTACEANS
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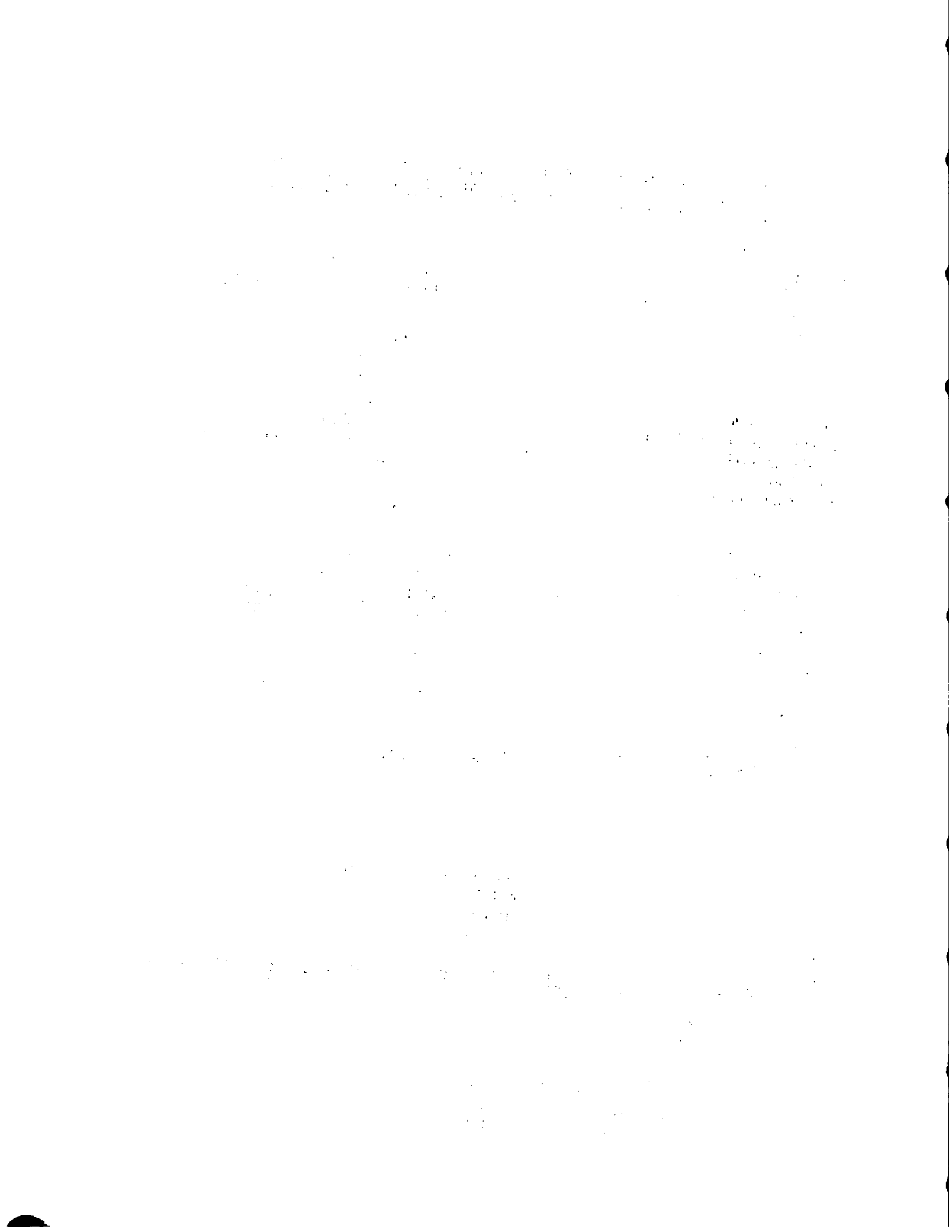
Two sources of literature abstracts on parasites

- (1) Helminthological Abstracts
- (2) Protozoological Abstracts

Published by: Commonwealth Agricultural Bureau
Central Sales Branch
Farham Royal
Slough SL2 3BN England

For control of fungal infestations in aquatic animals - some chemicals and
their effective concentrations

Crystal violet	0.002%
Formalin	0.01%
Hydroquinone	0.04%
Malachite Green	0.5 ppm
Merbronin	0.25%
Neutral red	0.01-0.05%



K ₂ Cr O ₄	0.20%	(potassium chromate)
K ₂ Cr ₂ O ₇	0.1%	(potassium dichromate)
K Mn O ₄	0.02%	(potassium permanganate)
NaCl	1.0%	(Sodium chloride)
'Teepol'	0.04%	(a disinfectant and detergent)

An example of a prepared shrimp food

Experimental Marine Ration 25, Ralston Purina Company, St. Louis, Missouri. This is a water stable high density flake, containing soy meal and soy oil; it is rich in 18:2w6 (linoleic acid), with a crude protein content not less than 25% and fat not less than 7%. However, it contains no shrimp, which some workers would see as a disadvantage.

Proximate analysis

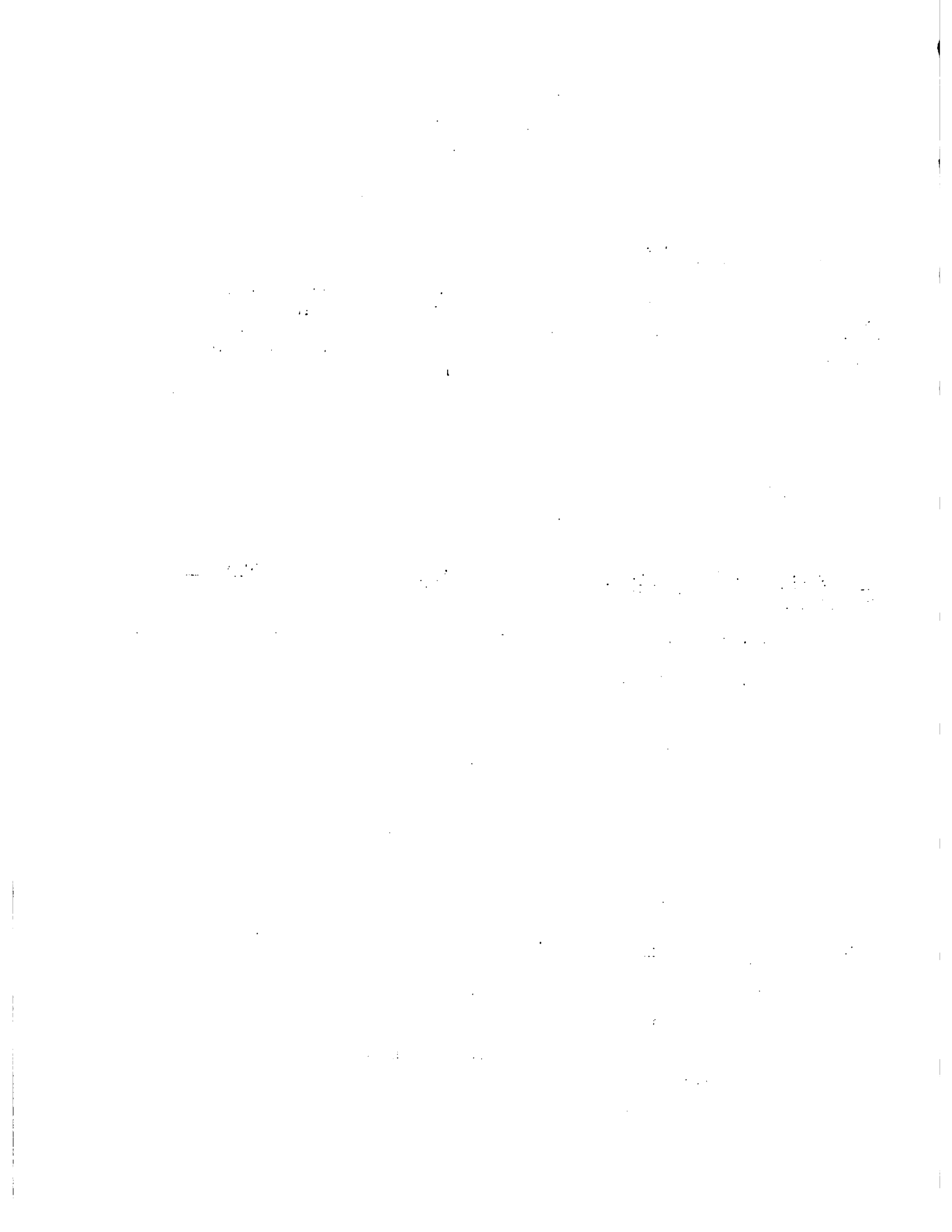
Protein 25.5%; Fiber 4.1%;
Fat 7.3%; Ash 6.7%;
Moisture 11.0%; N-free extract 40.2%

Summary of General Objectives of Aquaculture Development & Coordination for the purposes of Planning and Community Integration

- (1) Provision of multidisciplinary help;
- (2) Strengthening of indigenous research efforts;
- (3) Training of senior aquaculturists,
- (4) Promotion of cooperation at various political unit levels;
- (5) Stimulation of investment;
- (6) Assistance in releases of extra financial help;
- (7) Promoting participation by lower socio-economic persons, e.g. labourers.

Characteristics of small-scale undertakings

- (1) Tropical climate
- (2) Good water supply
- (3) Adequate available land area of non-agricultural value



- (4) Labour intensive, in an area of high unemployment
- (5) Competitive price for the finished product

Infrastructure needed

- (1) Public works for excavations, construction, drainage, etc.
- (2) Joint service for feeds, fertilisers, chemotherapeutics, etc., if required
- (3) Marketing integrated and traditional fisheries, if possible
- (4) Inspectors to regularly check the physical components such as screens, etc.

Possible physical preparations needed

- (1) Installation of screens to keep culture organisms in, competitors out
- (2) Vegetation removal and/or bottom clearing
- (3) Elimination of predators to the extent that that is feasible
- (4) Propagation of natural food, or its protection (e.g. planktonic food)

ALTERNATIVES IN DEVELOPMENT AND USING AN AQUATIC RESOURCE FOLLOWING THE CONDUCTING OF SCIENTIFIC STUDIES

The following methods are feasible options in the exploitation of an aquatic resource

- (1) STOCKING (controversial) and INTRODUCTIONS OF EXOTICS (even more controversial)
- (2) AQUACULTURE:
 - (i) capture fisheries based on cultured young;
 - (ii) capture fisheries based on wild young;
 - (iii) husbandary fisheries

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- (3) COMMUNITY DEVELOPMENT
- (4) ENVIRONMENT ENGINEERING:
 - (i) weeding and brush clearance;
 - (ii) selective poisoning;
 - (iii) water aeration;
 - (iv) nutrient enrichment;
 - (v) dredging
 - (vi) artificial cover;
 - (vii) artificial environment
- (5) CONSERVATION OF INDIGENOUS SPECIES AND NATURAL ENVIRONMENTS, WITH USE OF SUITABLE INDIGENOUS TYPE IN CULTURE

SUMMARY OF REQUIREMENTS FOR INTENSIVE AQUACULTURE

- (1) High water quality
- (2) Plentiful amounts of water
- (3) Industrially prepared feeds
- (4) Effective disease control
- (5) High value per unit weight of marketed product
- (6) Absence of pollution

NOTE World finfish production from aquaculture was estimated by Pillay (1973) to be about 3.6×10^6 tons, 65% of which came from inland or brackish waters. Of this total, only 20,000 tons were produced in the whole of Latin America. Thus, there would appear to be considerable scope for the initiation and rapid expansion of aquacultural activities in Jamaica.

1. The first part of the document discusses the importance of maintaining accurate records of all transactions and activities. It emphasizes that this is essential for ensuring transparency and accountability in the organization's operations.

2. The second part of the document outlines the various methods and tools used to collect and analyze data. It highlights the need for consistent and reliable data collection processes to support informed decision-making.

3. The third part of the document focuses on the role of technology in modern data management. It discusses how advanced software solutions can streamline data collection, storage, and analysis, leading to more efficient and accurate results.

4. The fourth part of the document addresses the challenges associated with data security and privacy. It stresses the importance of implementing robust security measures to protect sensitive information from unauthorized access and breaches.

5. The fifth part of the document provides a detailed overview of the data analysis process. It explains how statistical and analytical techniques are used to identify trends, patterns, and insights from the collected data.

6. The sixth part of the document discusses the importance of data visualization in communicating complex information. It describes how charts, graphs, and dashboards can be used to present data in a clear and accessible manner, facilitating better understanding and decision-making.

7. The seventh part of the document explores the future of data management and analysis. It discusses emerging trends and technologies that are expected to shape the field, such as artificial intelligence and machine learning.

8. The eighth part of the document provides a summary of the key findings and conclusions of the study. It reiterates the importance of data-driven decision-making and the need for continuous improvement in data management practices.

9. The ninth part of the document includes a list of references and sources used in the research. It provides a comprehensive list of academic papers, books, and other resources that have informed the study.

10. The tenth part of the document contains a list of appendices and supplementary materials. These include additional data sets, charts, and tables that provide further detail and support for the findings presented in the main text.

FRESHWATER PRAWN (SHRIMP) CULTURE IN JAMAICA: MAIN REPORT

TABLE: 1 Sample sites established at Pear Tree Bottom River System and vicinity

Site No.	Name of Site	Code	Bottom type
1	Parson's creek, at bridge No. 3	PRSB	Sand
2	Grassy creek, at bridge No. 1	GCSW	Grey mud
3	Swamp Pool A	SPA	Grey mud
4	Lock-Spillway	LS	White mud
5	Rowe's Canal, Coconut Grove	RCCF	Black mud
6	Pear Tree River Main Outlet, at bridge No. 2	PTRMO	Mud, sand
7.	Roger Clarke's Ditch	RCD	Black mud
8	Crater Lake, Kaiser Aluminum	CL	Limestone, mud
9	Pear Tree Bottom River Proper, Lower Reaches	PTBRPLR	Mud sand
10	Row's Canal, Upper Site	RCUS	Black mud

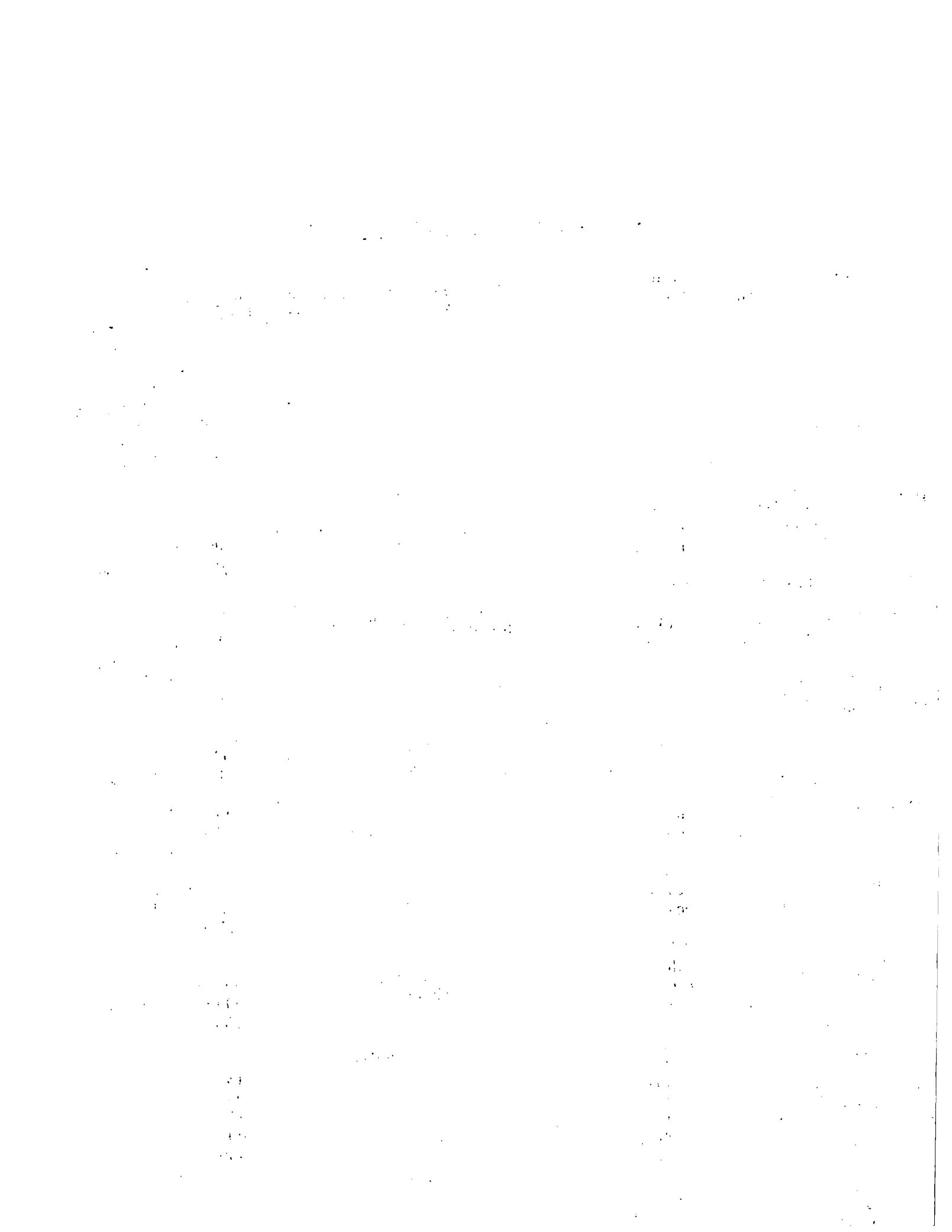
NOTE: Refer to May 1 for the geographic locations of the sample sites

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FRESHWATER PRAWN (SHRIMP) CULTURE IN JAMAICA MAIN REPORT

TABLE: 2 Compositions by species and relative abundance of crustaceans in samples from Black River, Martha Brae River, Pear Tree Bottom River and Crater Lake, Kaiser Aluminum property, Jamaica, February-March 1982

Side Code	Specimen Code	System	Species	Number in Sample	Proportion in Sample	Total in Sample
PPFPI	PPFPI-82-1-ABH	Black R.	Jonga Serrei	443	0.890	499
PPFPI	PPFPI-82-1-D	Black R.	Macrobrachium Acanthurus	25	0.050	
PPFPI	PPFPI-81-E	Black R.	Macrobrachium Carcinus	30	0.060	
PPFPI	PPFPI-82-1-F	Black R.	Macrobrachium Faustinum	1	0.002	
PPFPI	PPFPI-82-3BC	Black R.	Jonga Serrei	532	0.911	584
PPFPI	PPFPI-82-3-A	Black R.	Macrobrachium Acanthurus	24	0.045	
PPFPI	PPFPI-82-3-D	Black R.	Macrobrachium Carcinus	22	0.038	
PPFPI	PPFPI-82-3-E	Black R.	Xiphocaris Elongata	6	0.010	
PPFPI	PPFPI-82-13-ABHBA	Black R.	Jonga Serrei	975	0.9003	1,083
PPFIP	PPFPI-82-13-DA	Black R.	Macrobrachium Acanthurus	49	0.0452	
PPFPI	PPFPI-82-13-ED	Black R.	Macrobrachium Carcinus	52	0.0480	
PPFPI	PPFPI-82-1-F	Black R.	Macrobrachium Faustinum	1	0.0009	
PPFPI	PPFPI-82-3-E	Black R.	Xiphocaris Elongata	6	0.0005	
BRCS-1	BRCS-82-1-BCDG	Black R.	Macrobrachium Acanthurus	51	0.5667	45
BRCS-1	BRCS-82-1-A	Black R.	Macrobrachium Carcinus	2	0.0222	
BRCS-1	BRCS-82-1-EFH	Black R.	Macrobrachium Faustinum	37	0.4111	
BRCS-2	BRCS-82-2-I	Black R.	Macrobrachium Acanthurus	59	0.8429	70
	BRCS-82-2-II	Black R.	Macrobrachium Carcinus	9	0.1286	
	BRCS-92-2-III	Black R.	Macrobrachium Faustinum	2	0.0386	
MBRWGH	MBRWGH-82-1	Martha Brae R.	Macrobrachium Carcinus	10	0.2222	45
MBRWGH	MBRWGH-82-II	Martha Brae R.	Macrobrachium Faustinum	5	0.1111	
MBRWGH	MBRWGH-82-III	Martha Brae R.	Potimirim Mexicana	5	0.1111	
MBRWGH	MBRWGH-82-IV	Martha Brae R.	Micratya Poeyi	25	0.5555	
PTBRS	PTBRS-82-I	Pear Tree R.	Macrobrachium Acanthurus	7	0.0127	553
PTBRS	PTBRS-82-II	Pear Tree R.	Macrobrachium Carcinus	76	0.1374	
PTBRS	PTBRS-82-III	Pear Tree R.	Macrobrachium Faustinum	37	0.0669	
PTBRS	PTBRS-82-IV	Pear Tree R.	Jonga Serrei	122	0.2206	
PTBRS	PTBRS-82-V	Pear Tree R.	Potimirim Mexicana	0	0.0000	
PTBRS	PTBRS-82-VI	Pear Tree R.	Xiphocaris Elongata	310	0.5606	
PTBRS	PTBRS-82-VII	Pear Tree R.	Unidentified	1	0.0018	
CL	CLDM-1-IV-82	Crater Lake	Macrobrachium Acanthurus	2	0.0132	151
CL	CLDM-8-1-82	Crater Lake	Macrobrachium Carcinus	135	0.8940	
CL	CLDM-1-1-82	Crater Lake	Macrobrachium Faustinum	2	0.0132	
CL	CLDM-1-111-82	Crater Lake	Potimirim Mexicana	1	0.0066	
CL	CLDM-28-1-82	Crater Lake	Macrobrachium sp.Larvae	11	0.0728	

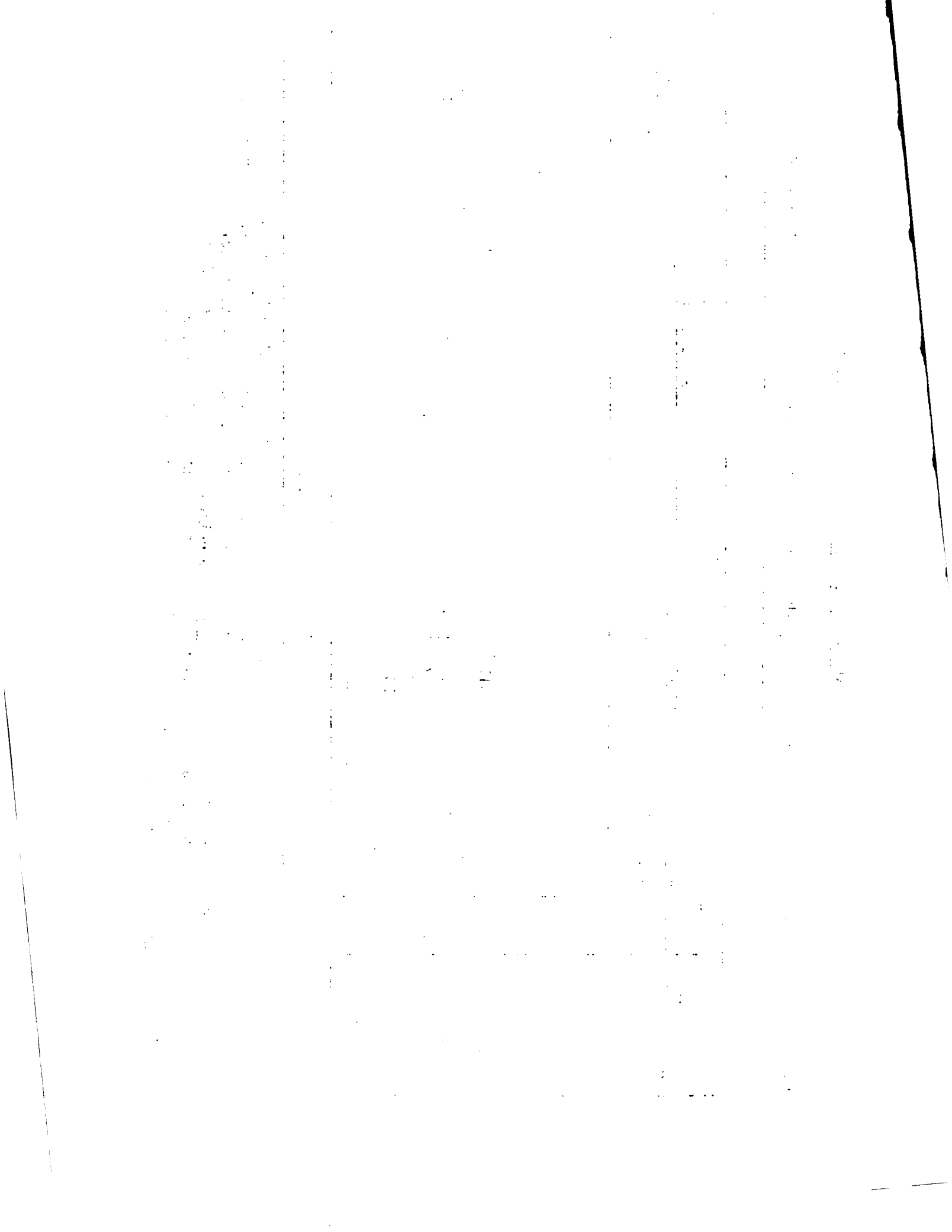


FRESHWATER PRAWN (SHRIMP) CULTURE IN JAMAICA - MAIN REPORT

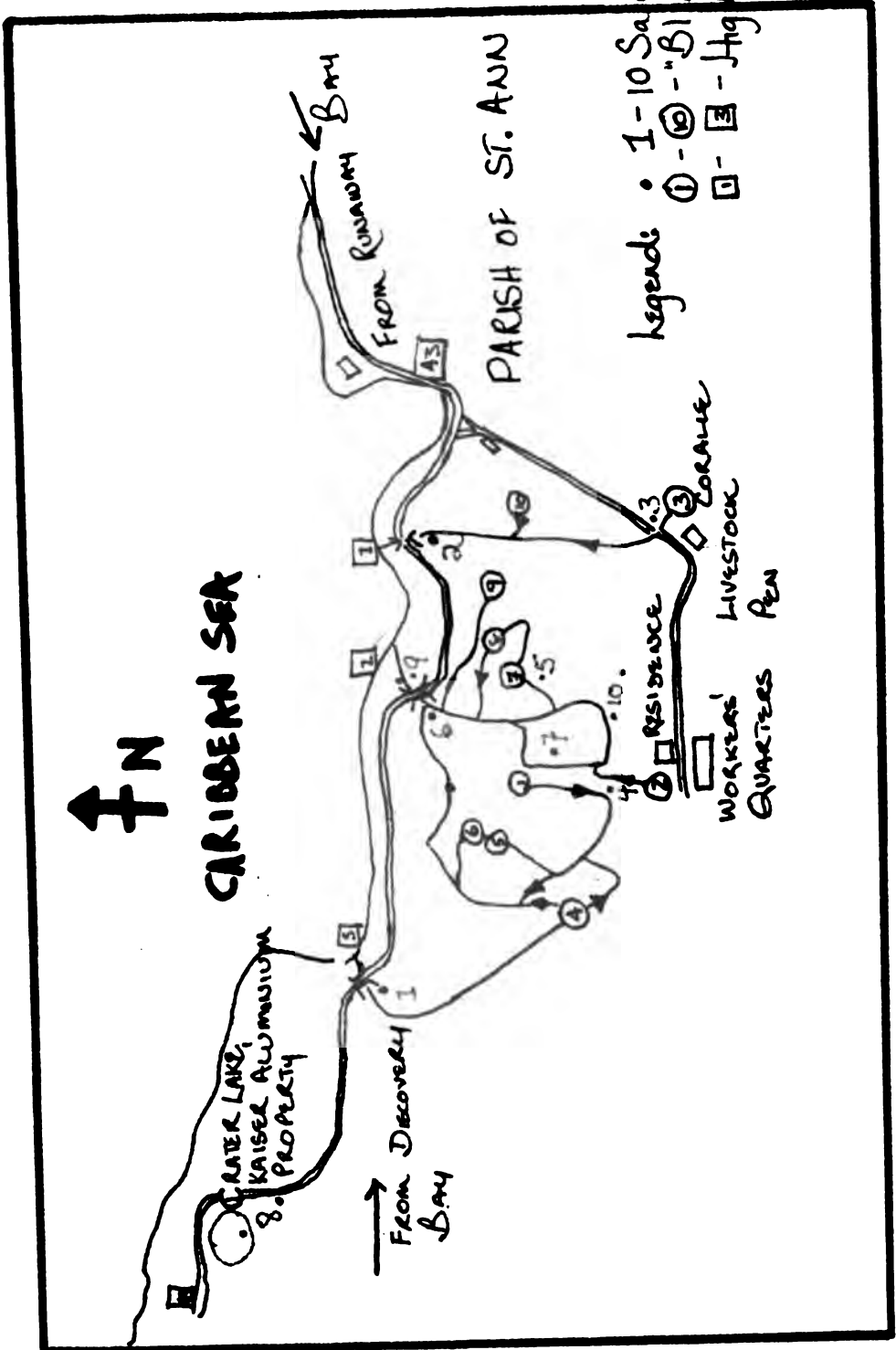
TABLE: 3 Identities and distribution of crustaceans recovered from Crater Lake, Kaiser Aluminum property in February, 1982

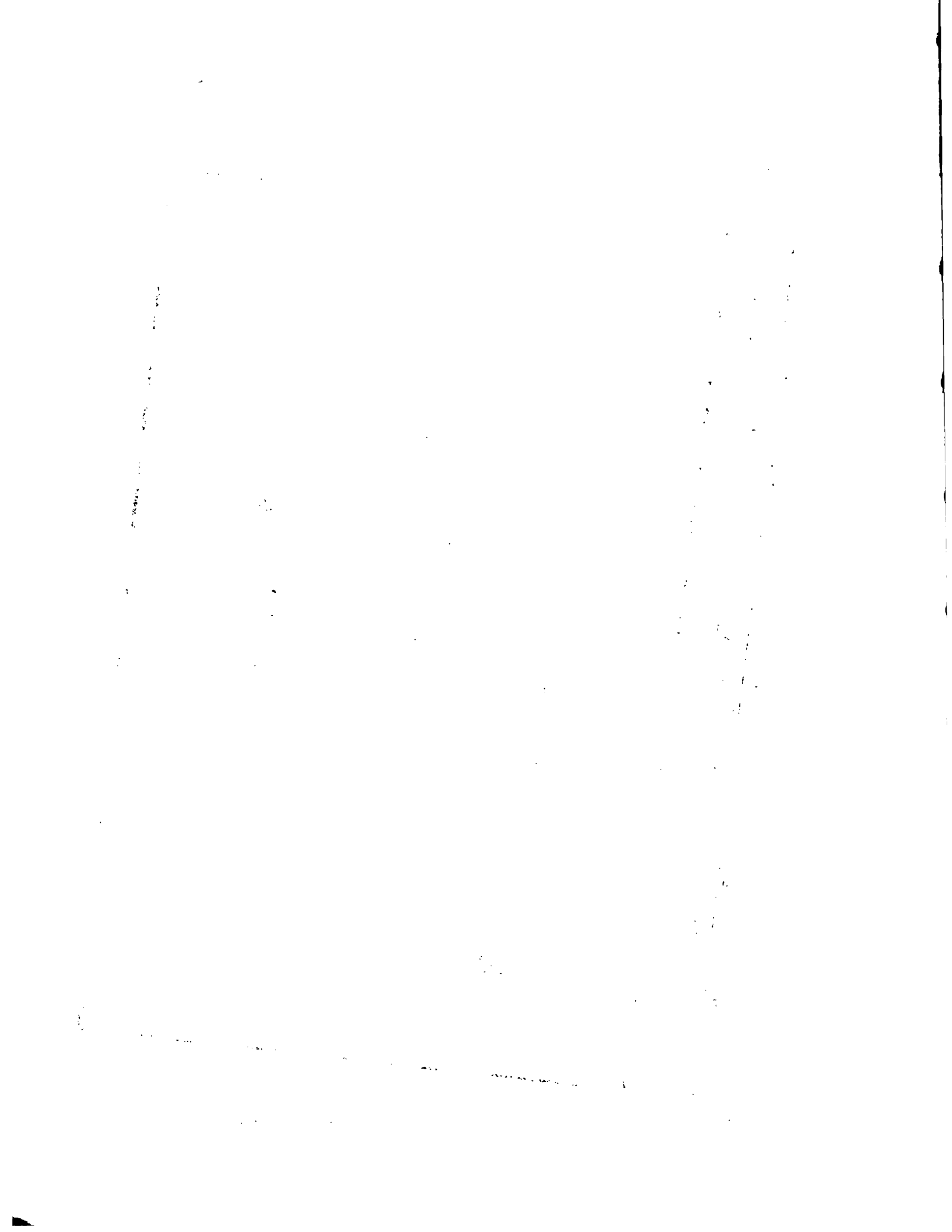
Depth below water surface (m)	Copepods (Cyclops spp) ^{1,2} Number per L of Lake water ⁴					Macrobrachium juveniles ³	Macrobrachium larvae ²	Ostracods ²	Rotifers (Brachionus sp.) ²
	Males		Copepods - lids	Nauplii	Eggs ⁵				
	Females								
0.1	0	0	0	0	0	139	0	0	0
1.0	0	0	1	1	0	0	0	0	0
2.0	17	45	75	183	2(15)	0	0	0	0
3.0	17	37	137	462	2(7)	0	1	0	0
4.0	30	38	168	418	10(27)	0	1	0	0
5.0	103	120	445	517	20(50)	0	4	0	0
6.0	25	55	215	493	13(37)	0	0	0	0
9.0	38	83	182	497	32(97)	0	1	5	25
12.0	78	87	203	517	25(70)	0	1	8	28
15.0	23	58	112	282	5(15)	0	1	0	0
20.0	30	85	138	237	22(70)	0	2	8	5
30.0	35	73	67	125	23(52)	0	0	0	5
35.0	40	40	112	228	7(22)	0	0	3	2
Total	436	721	1,855	3,960	162(462)	139	11	24	65

- NOTES:
1. The cyclopid copepods have not been identified yet, but they are all one species
 2. Planktonic forms of life caught by a 201 Schindler trap attached to a 75 um mesh plankton net
 3. Benthic form of life caught by long-handled dip net from around a floating dock
 4. All counts except those for Macrobrachium juveniles are number per liter of lake water. The number of juveniles caught at 0.1 m is the total caught by dip net (139)
 5. Egg counts are expressed as number of females with eggs, with the number of actual eggs counted in parentheses.



Map. 1. Four Tree Bottom River System and Vicinity, Showing Location of Sample Sites, Blue Holes, waterways and main highway, and Crater Lake, Kaiser Aluminum Property.





VI. Review of relevant scientific and technical literature

The following review is not comprehensive. It selects certain articles that together present the state of the art in freshwater prawn biology and culture. It focuses down on certain cardinal aspects of the scientific and technical literature on freshwater shrimp (prawns). It also deals with the information available on the Pear Tree Bottom River System that has been collected by other workers.

When Ling (1962) first successfully completed in the laboratory the life cycle of Macrobrachium rosenbergii (de Man), the "giant" Mayayan freshwater prawn, the stage was set for commercial aquaculture of this, and possibly other, species of Macrobrachium shrimp. Within a few years of this break-through Ling (1969) was able to report that the culture methods for the Malaysian prawn were standardized and reliable. In the meantime mass culture methods were being developed so that commercial scale culture might become a reality (Fujimara, 1966) and soon thereafter mass culture was a practical proposition whose results were replicatable (Fujimara and Okamoto, 1970). Many studies have been made of M. rosenbergii since these earlier developments. Just a few examples are discussed here.

Wickins and Beard (1974) saw the need for a fast-growing species that would mature and reproduce in captivity. Their study was based on certain observations made on 3 males and 20 females reared from eggs to sexual maturity in captivity, so that conditions required for maturation, mating and production of viable larvae of M. rosenbergii would be known, with measured yields as added information. Newly-hatched larvae were recovered, counted and measured. Adults were measured too and the following details were recorded: frequency of molts; number of times mated; number of times spawning; fate of eggs; and first signs of femal maturity. Mating occurred within 24 hours of the pre-spawning female's molt if a male was left with her 1-4 hours. Some results of their experiments were as follows:

- (1) No. of larvae hatching from each brood ranged from 50 to 98,100 (mean 24,000)
- (2) There was a correlation ($r=+ 0.480$, $df.=21$, $p < 0.05$) between larval size at hatching and size of the female parent.
- (3) There was a trend, once experimental conditions were under control and more suitable, for there to be a relationship between no. of larvae hatched and size of the female parent.

1. The first part of the document discusses the importance of maintaining accurate records of all transactions and activities. It emphasizes that proper record-keeping is essential for transparency and accountability, particularly in financial matters. This section also touches upon the legal implications of failing to maintain such records, which can lead to severe consequences for individuals and organizations alike.

2. The second part of the document delves into the specific requirements for record-keeping, including the types of documents that must be retained and the duration for which they should be kept. It provides a detailed overview of the various categories of records, such as financial statements, contracts, and correspondence, and outlines the best practices for organizing and storing these documents to ensure they are easily accessible when needed.

3. The third part of the document addresses the challenges associated with record-keeping, particularly in the context of digital information. It discusses the risks of data loss, corruption, and unauthorized access, and offers strategies to mitigate these risks. This includes the use of secure storage solutions, regular backups, and access controls to protect sensitive information.

4. The fourth part of the document focuses on the role of record-keeping in legal proceedings. It explains how well-maintained records can serve as crucial evidence in court cases, helping to establish facts and support legal arguments. It also discusses the importance of preserving records in their original form or as certified copies to ensure their admissibility in court.

5. The fifth part of the document provides a summary of the key points discussed and offers final thoughts on the importance of record-keeping. It encourages individuals and organizations to take a proactive approach to record-keeping, recognizing it as a fundamental aspect of good governance and operational efficiency.

- (4) Growth of the females was arithmetic rather than geometric, males grew faster than the females, which is to be expected.
- (5) In females when conditions were not under control mean intermolt period was significantly longer in oviferous than in non-oviferous specimens, as shown below:

Water Conditions State of female	Length of inter-molt period (days)	S.E.	d.f.	p for ts
Not Controlled Oviferous	38	±1.63	43	<0.05*
Not Controlled Non-oviferous	31	±1.64	60	
Controlled Oviferous	43	±2.799	14	<0.05
Controlled Non-oviferous	46	±3.200	13	n.s.

When water conditions were under control, there was no difference between the mean lengths of the intermolt periods of oviferous and non-oviferous individuals.

- (6) For females producing larvae, time interval between hatching and the next moult ranged from 9 to 37 days, being longer when eggs were spawned at the following molt than when spawning did not occur, as shown below:

State of female	Interval between hatching and next moult (days)	S.E.	d.f.	p for ts
Eggs spawned at following molt	38	±1.26	3	<0.05*
Eggs <u>not</u> spawned at following	16	±3.13	5	

The moulting delay may be due to oocyte development in the ovaries.

- (7) Incubation period ranged from 19 to 22 days ($\bar{x}=19.0 \pm 0.134$ S.E., d.f.=31); 18 brood hatched in 1 night, 13 others took 2 nights for completion; larvae ranged in size 1.9-2.1 mm ($\bar{x}=2.0$ mm) total length of hatching, mean no. of larvae (brood was c.2,600), the range being 100 to 79,852

1. The first part of the document discusses the importance of maintaining accurate records of all transactions. It emphasizes that proper record-keeping is essential for the integrity of the financial system and for the ability to detect and prevent fraud.

2. The second part of the document outlines the specific requirements for record-keeping, including the need to maintain original documents and to keep copies of all supporting documents. It also discusses the importance of ensuring that records are stored in a secure and accessible manner.

3. The third part of the document discusses the importance of regular audits and reviews of records. It emphasizes that audits are a key component of the internal control system and are essential for ensuring the accuracy and reliability of the financial statements.

4. The fourth part of the document discusses the importance of training and education for all personnel involved in the financial system. It emphasizes that ongoing training is essential for ensuring that all personnel are up-to-date on the latest regulations and best practices.

5. The fifth part of the document discusses the importance of transparency and accountability in the financial system. It emphasizes that all transactions should be clearly documented and that all personnel should be held accountable for their actions.

- (8) Successful matings resulted in viable larvae about 20 days after copulation.
- (9) Growth of males was arithmetic, with no significant correlation of increment and total length; the mean length increment over the period of the experiment was 13 mm during each moult.
- (10) Growth of females was arithmetic, with a mean increment of 13.89 mm during each moult, which is not significantly different from the mean increment of the males.
- (11) Mean intermoult period was 41.9 days \pm 9.89 S.E., d.f. = 17, and was independent of prawn size ($r=0.0408$, d.f. = 1b; $p > 0.1$).
- (12) Mean brood size increased significantly after environmental conditions were brought under control, as was the no. of times females spawned; also the rate of egg loss by females declined after the controls were effected.
- (13) Females could lay eggs twice within five months, and probably can spawn 3 to 4 times in one year in nature.
- (14) Control of the environment improved growth rate and mean length increment at moult values (7.2 of 13.6 mm; $P < 0.05^*$).
- (15) \log_{10} no. of larvae = $3.01036 = 3.34477 \log_{10}$ female length; e.g. a 200 mm female produces 48,530 (hatched) eggs and a 160 mm female 23,010 eggs (larvae).
- (16) Females grew from 115 to 205 mm and males from 145 to 250 mm total length.
- (17) 3 females spawned more than 4 times in successive intermoult period and 1 female five times in succession.
- (18) 2 males sired viable larvae 4 and 7 times respectively during one intermoult period.

There are various techniques for raising prawn larvae to juveniles. Problems in doing this commercially are **failure** to ensure a constant production of juveniles and operational management mistakes. For an example of the latter, many hatcheries use a static water system with replacement and require large amounts of sea water, so that if the site is far from the sea, operational costs are high due to sea-water transportation charges.

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Three culture techniques were compared by Menasvata and Piyatitativokul (1980) with respect to survival of prawn larvae; effects on water quality; effect of stocking density on survival of juveniles; economics. The three techniques are:

- (1) static system with partial replacement;
- (2) closed recirculator with separate subsand filter; and
- (3) closed recirculator with subsand filter in the rearing tank. Brood stock for the experiment were reared in an earthen pond and in cement tanks inside a shed.

Selected berried females were taken from the brood stock holding tanks and put in larval hatching tanks. Hatched larvae were placed in 20.L plastic buckets for counting to get brood size of each female. Larvae were counted in 10x100 ml aliquots. Larvae were then transferred to rearing tanks.

Density showed a linear inverse relationship with survival. It was found that the recirculators keep nitrite levels down because phytoplanktons grow well in such systems. Labour and operational costs are lower for recirculators than for static systems because water use is reduced and labour in changing water is eliminated. System (3) is cheaper to run than system (2) because there is no need to use labour to clean up food residues and wastes, and it also had a larger rearing volume than system (2). Fujimura and Okamoto (1970) reported that an increase in rearing tank volume from 1,000 to 18,000 L. cut production costs by 0.71.

Survival is not a good indicator of larviculture success. A better datum is postlarval yield/l. Best stocking density was found to be 20 larvae/l.

Limpadanai and Tansakul (1980) conducted larviculture experiments with M. rosenbergii in a small reservoir in Thailand. They pointed out that larval survival rates vary widely from facility to facility. Further their growth is dependent on Artemia nauplii. Another problem is the capital investment required. For example, in Thailand, in 1976, to produce 16×10^6 juveniles per annum, fixed cost input was US\$20,350, non-expendable supplies cost US\$13,200 and running costs were US\$32,150, for a production costs of US\$2.50/1000 juveniles. This is low, but the capital outlay is high for a country with a per capita income in 1976 of US\$250. Thus expansion of prawn farming among small fish farmers is difficult. However, the advantage of the freshwater prawn is its high market value. The paper investigates semi-controlled prawn culture in small reservoirs, where the life cycle is completed by returning berried females to a hatchery using controlled salinity for spawning, hatching and larval rearing. Postlarvae are released into the reservoirs. Also considered is the support for subsistence fishermen in the reservoir basin by studying cost effectiveness of this system.

1. The first part of the document discusses the importance of maintaining accurate records of all transactions. It emphasizes that proper record-keeping is essential for the integrity of the financial system and for the ability to detect and prevent fraud.

2. The second part of the document outlines the various methods used to collect and analyze data. It describes the use of statistical techniques to identify trends and anomalies in the data, and the importance of using reliable sources of information.

3. The third part of the document discusses the role of the auditor in the process. It explains that the auditor's primary responsibility is to provide an independent and objective assessment of the financial statements. This involves a thorough review of the records and a comparison of the results with the applicable accounting standards.

4. The fourth part of the document discusses the importance of communication in the auditing process. It explains that the auditor must maintain clear and open communication with the client throughout the process. This includes providing regular updates on the progress of the audit and discussing any issues that arise.

5. The fifth part of the document discusses the importance of documentation in the auditing process. It explains that the auditor must maintain a complete and accurate record of all work performed. This includes the audit plan, the audit program, the audit working papers, and the final audit report.

6. The sixth part of the document discusses the importance of ethics in the auditing process. It explains that the auditor must adhere to a strict code of ethics and maintain the highest level of integrity and objectivity. This is essential for the public's confidence in the financial system.

7. The seventh part of the document discusses the importance of continuous learning in the auditing process. It explains that the auditor must stay up-to-date on the latest developments in the field and seek out opportunities for professional development. This is essential for the auditor to provide the highest quality of service to the client.

8. The eighth part of the document discusses the importance of teamwork in the auditing process. It explains that the auditor must work closely with the client's staff to ensure that the audit is completed efficiently and effectively. This involves clear communication, collaboration, and a shared commitment to the success of the audit.

9. The ninth part of the document discusses the importance of risk management in the auditing process. It explains that the auditor must identify and assess the risks associated with the audit and take appropriate steps to mitigate those risks. This is essential for the auditor to provide a high level of assurance to the client.

10. The tenth part of the document discusses the importance of transparency in the auditing process. It explains that the auditor must be open and honest about the results of the audit and the reasons for any findings. This is essential for the client to understand the true state of their financial affairs and to make informed decisions.

Juveniles were stocked in the reservoir in 5x5 and 10x10 m pens made of polyethylene netting of 2 cm and 0.5 cm mesh sizes, respectively. Stocking rates were as follows:

Pen No.	Pen size (m)	Mesh size (cm)	Stocking density prawns/m ²	Characteristics of stock		Prawns Age (days)
				Avg.l (cm)	Av. Wt. (g)	
1 and 2	5x5	2.0	10.0	11.24	19.42	150
3 and 4	5x5	2.0	10.0	3.94	5.51	90
5 and 6	10x10	0.5	10.0	2.45	-	70

Natural conditions were simulated in the pens in terms of hiding places and prey-predators, in order to examine the effect of stocking the reservoir with prawns, and not of intensive pen culture. No food supplement was given.

Some of the conditions in the water during these experiments were:

Water quality: T°=26-30°C; dis. O₂=6-8,g/l, diss CO₂=0-5 mg/l, pH=7-8;

Biota: Fish - Puntius sp.; Rasbora sp.; Tilapid sp.; Cyprinus sp., Clarius sp., Ophiocephalus striatus; Trichogaster sp.

Invertebrates - Macrobrachium lanchesteri, chironomid larvae. Prawns stocked at a mean length of 2.45 cm had total mortality. Those at 11.24 cm reached 14.30 cm in 7 months and matured in the 8th month; those at 3.94 cm reached 11.20 cm in 8 months and matured in the 9th month. This growth rate is slow compared to what can be reached in intensive prawn culture (e.g. from 4.37 to 15.0 cm in 6 months (Piyat-isatitivokul, 1978), but this requires more labour and capital input.

Prawns stocked at length 3.94 cm grew faster than those started off at 11.24 cm. It seems that prawns of 2.45 cm and 11.24 cm are not suitable for stocking in natural waters. The former suffer predator attack and cannot tolerate certain environmental changes; the latter require too long in nursery ponds. Prawns 3-5 cm long are appropriate for natural waters because nursery time is shorter and subsequent growth is faster.

Survival rates for 11.24 cm prawns at a density of 10/m² were, an average, 0.48, and for 3.94 cm animals at 20/m² were 0.22. These results suggest that prawn density under certain natural water conditions adjusts itself to not more than 5/m², a level high enough for extensive, successful culture practices. It would be appropriate to stock juveniles at a density 5/m². If 1,000 juveniles cost US\$2.50, these animals, being equivalent to 300g. of market-size prawns (about 3 whole animals), leads

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to the calculation that, if survival is 0.01, 10 will grow to market size, and if 0.60 of these (i.e. 6 prawns) reach the fisherman's gear at market-size, then 100% profit will be achieved (at a market price of US\$5.00/lb). In the experiments, survival was at least 0.22, which would provide a handsome profit if achieved by commercial culturists. Funds for juvenile production from public expenditure are, thus, easily justified.

Dense phytoplankton populations (100-500 mg.m⁻³ Chl.) are kept up in Hawaiian prawn ponds to shade out benthic macrophytons, assimilate waste products from pond animals and help maintain desirable oxygen levels yet a problem arises if many of the plants die because of decomposition reducing O₂ levels. Dense populations can also be problematic on calm nights because of their respiratory demand for oxygen. We need a quantitative understanding of the relationship between algal density, rates of oxygen production and consumption, nutrient assimilation rates and algal physiological state. Laws and Malecha (1981) looked into these problems by using a growth model to investigate phytoplankton growth, which was mainly controlled by light under the prevailing conditions because the water was saturated with dissolved plant nutrients. The light levels in turn can be affected by water clarity and mixing, so indirectly controlling phytoplankton growth. This study showed that phytoplankton populations in prawn ponds should be kept between 150 and 400 mg./m³ chlorophyll in order to prevent anoxia in worse case situations, should they occur, such as calm nights. There was a negative correlation between light-limited growth rates and chlorophyll as levels are raised about 2g./m³. There was also, actually, a negative correlation between photosynthesis and chlorophyll a concentration at values greater than 5g./m³. This ideally, even 1 meter deep ponds should be operated with chlorophyll a concentrations less 2g./m³. Success of this light-limited model in describing data from both mono specific continuous culture systems and from diverse populations in prawn ponds suggests that the model may have wide applicability in mass algal culture systems.

Much of the literature on Macrobrachium is concerned with larviculture. Some of the earliest work was actually carried out in Jamaica, by Choudhury (1970; 1971c), on M. acanthurus (whose larval development was also studied) and by Chouldhury (1971a; 1971b), on M. carcinus (again, development was also described). Larval development in M. carcinus had earlier been investigated by Lewis and Ward (1965), whereas Dobkin (1971) looked at M. acanthurus development. Lee and Fielder (1981) studied the effect of salinity and temperature on the larvae of M. australiense in Australia, and found them to be important for proper development.

Monaco (1974) was the first to rear larvae of M. americanum in the laboratory. He used a self-contained life support system based on "Instant Ocean" sea salts at a salinity of 15 ppt and a temperature of 29.5°C. Diet was sifted fish (see Ling (1969) and Artemia nauplii prefed for 48 hours on Chlamydomonas coccoides. Postlarvae appeared 53 days into the experiment and eleven distinct larval phases were noted prior to metamorphosis. Further details on M. americanum life history were given by Monaco (1975). A breeding pair was obtained from the Syntex facility in Mazatlan, Mexico, consisting of one male, 155 mm., 140., and one female, 125 mm., 110g. The male was introduced to the female's aquarium three hours after the completion of her pre-spawning oviferous molt. He responded instantly to her and copulated with her within 45 sec. pause, and another lasting 12 secs. Egg laying was

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then completed within 24 hours, the extruded eggs being fertilised in the brood pouch. Hatching occurred after 15 days incubation, about 80,000 larvae being collected; eggs hatched in freshwater of $27 \pm 0.5^\circ\text{C}$ and $\text{pH}=6.70$. Larvae were acclimatised slowly to 15 ± 0.1 ppt salinity, and $29.5 \pm 0.5^\circ\text{C}$ with a pH of 8.29, over a 2 hour period in a water bath to regulate temperature. These conditions were maintained until metamorphosis, with the pH ranging from 8.01 to 8.31.

Postlarvae were transferred to a self-contained, life support-system designed by Monaco and McCarty of Syntex, using Instant Ocean salts. Daily readings were taken of temperature, pH and salinity and weekly readings of NH_4^+-N , NO_2-N and NO_3-N .

Larvae were fed 3 times daily on sieved fish flesh and live Artemia nauplii. The fish were sprayed with hot water to wash away lipids and denature the protein to render it less water-soluble. Then the flesh was forced through a #12 mesh sieve with cold water to produce an appropriate food particle size. Nauplii were prefed for 48 hours on Chlamydomonas coocoides.

Newly-hatched larvae measured 1.99 mm total length, on average. Eleven larval phases before metamorphosis were recognised. Development to metamorphosis required 53 days at $29 \pm 0.5^\circ\text{C}$. The first juvenile post-larvae measured 15.6 mm., on average. Larvae swim backwards with ventral surfaces up and are positively phototactic. Postlarvae swim forward with dorsal surface up and are negatively phototactic. Their movements are less random, and more directed, than those of larvae. Evasion is effected by a very rapid backwards movement powered by the telson.

Larval deaths occurred from phase VI on, with high mortalities from phase VII on, possibly because of nutritional insufficiencies for ecdysis.

The 15 ppt. salinity chosen may not be optimal for M. americanum. This value was selected because it is a known optimum for M. rosenbergii. The role of both algae and Artemia in M. rosenbergii larviculture were investigated by Cohen, Finkel and Sussman (1976), using ^{14}C labelled algal cells. Radioactivity counts of larvae were negative, so negligible amounts of algae are directly ingested. Experiments with Artemia nauplii, on the other hand, showed they assimilated and digested considerable quantities of algae.

Algae quickly removed ammonia added to the medium even at levels toxic to the shrimp larvae 10.6 mg/l. Yet high density (20/ml/) population of Artemia caused ammonia accumulation even when algae were present, because of an increase in their metabolic rate when algal-fed. Removal of Artemia resulted in a drop in ammonia levels.

Tilapia was seen to be beneficial in shrimp larviculture only if algae were present and, in fact, larval mortality increased in water that had supported Tilapia growth in the absence of algae. Thus algae enhance shrimp growth indirectly by removing toxic ammonia. If ammonia can be removed by other means, the algae can be dispensed with.

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The following table shows the results of the survey conducted in the year 1998. The data is presented in a tabular format, with columns representing different categories and rows representing specific data points. The table is organized into several sections, each corresponding to a different aspect of the survey. The first section deals with the demographic characteristics of the respondents, including their age, gender, and education level. The second section focuses on the respondents' attitudes towards the issue being studied, and the third section examines their behavioral intentions. The data is presented in a clear and concise manner, allowing for easy comparison and analysis. The results of the survey indicate that there is a significant correlation between the variables being studied, and that the findings have important implications for the field of research. The data is presented in a way that is easy to understand and interpret, and it provides a comprehensive overview of the survey results. The table is organized into several sections, each corresponding to a different aspect of the survey. The first section deals with the demographic characteristics of the respondents, including their age, gender, and education level. The second section focuses on the respondents' attitudes towards the issue being studied, and the third section examines their behavioral intentions. The data is presented in a clear and concise manner, allowing for easy comparison and analysis. The results of the survey indicate that there is a significant correlation between the variables being studied, and that the findings have important implications for the field of research.

In Jamaica, Hunt (1976) studied the culture of larvae of the indigenous species M. faustinum. Mating was in the laboratory, berried females then being isolated one to an aquarium with constantly aerated freshwater, and fed chopped fish and oats. Hatching occurred during early night hours, usually in two batches on consecutive nights. The best diet was found to be Artemia nauplii and "Tetramin" particles. Optimum salinity was 20 ppt. Cannibalism was infrequent, only occurring with starved animals. Hunt (1976) also worked with M. heterochrus larvae, and found the optimum salinity for them was 30 ppt., which is adaptive for the high salinity levels in river mouths in E and NE parishes, to which this species is restricted. For M. acanthurus, restricted more or less towards SW parishes, the larvae have optimal response at 15-20 ppt., adaptive for the lower salinities of the large estuaries of the rivers in the W and SW of the island. M. carcinus and M. faustinum larvae have optima at 14-18, and 19-20 ppt., respectively, but both spp. are very flexible and can tolerate higher levels, which fits with their island-wide distribution.

In M. faustinum Hunt (1976) found that metamorphosis to juveniles occurs at a length of 9--1.5 mm at 19-20 ppt but there was no transformation at 18 ppt. This suggests that larval development occurs in the sea and estuaries but not in the rivers themselves. Specimens of juveniles measuring 10-13 mm are found at river mouths and migrating upstream, which is extra evidence that the river is the habitat for the entire post-larval part of the life cycle. The smallest berried females are 26-28 mm, after about 6 months of postlarval growth. Spawning occurs throughout the year, but is heavier in January and February and between June and November, especially. These peaks precede or coincide with heavy rainfall, to increase changes of newly-hatched larvae being swept out to sea for further development. They also coincide with periods of maximum diurnal temperature changes around a 9°C range, an observation also made by Dugan and Frakes (1972). Temperature range experiments shows that berried females are non-migratory. Their fecundity is directly proportional to their weight, there is a heavy incubation mortality in brood pouches (18.2%) and there are no seasonal changes in either fecundity or incubation mortality. Most larvae are produced by 38-44 mm females at an age of about 1½ years. Juvenile recruitment peaks between about September and February, and usually especially in December, these animals being derived from the spawning peak of June to November, the larval life span being about ninety days.

There is evidence that M. faustinum juveniles can survive in the sea for long periods before they contact their river water and migrate upstream. The males then grow faster than the females in the rivers and reach adult size sooner. The total life span is 2½ to 3 years. Sexual differences become detectable at a length of about 27-29 mm. when the animals average about 7 months old.

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Growth follows a sigmoid curve for length, and an asymmetrical sigmoid for weight. Instantaneous growth rates tend to decline with age, although irregularities occur, due to the discontinuous nature of the growth process in molting organisms. The growth data fit the van Bertalanffy equation well, with L.O. values for males of 79.5, and for females 55.4, mm., with respective K values of 0.027 and 0.019.

Larval mortality consists of general mortality plus net larval migratory loss and it added up to the very high level of 99.8%. Post-recruitment mortality is high at early ages $z=0.13$ at age 2-3 months, $z=0.14$ at 3-4 months, $z=0.13$ at 4-5 months, $z=0.09$ at 5-6 months, etc). In the age range 7-22 months (28-46 mm.), growth equals mortality resulting in a constant sub-population biomass over time. After 22 months, biomass declines because mortality is greater than growth.

In Cave River, M. faustinum eats predominantly detritus, plus mineral particles, higher plant tissue remains and filamentous algae. This species is a particular feeder which uses its chelipeds extensively for this purpose. It feeds at night. In his work on Macrobrachium shrimps in Jamaica, Hunt (1976) suggested that the following ecological niche separation of nonspecifics on the island occurs commonly. M. heterochirus prefers high altitudes; M. carcinus has a predilection for intermediate altitudes; and both M. faustinum and M. acanthurus choose low altitudes. Nevertheless, there are concurrences amongst these species.

Some interesting special apparatus has been developed for use in larviculture studies of Macrobrachium. An apparatus to separate post-larvae from larvae was devised by Smith and Hopkins (1977). The apparatus is a cylindrical tank with concentric inner and outer water chambers, interconnected by narrow slit passageways. From a centre drain water is pumped in the outer chamber and a circular flow pattern is thereby set-up in both outer and inner chambers. The latter contains the mixed population of larvae and postlarvae. The postlarvae, which exhibit a strong positive rheotaxis, swim through the passageways to become concentrated in the outer chamber. In contrast, larvae are planktonic and hence weak swimmers, and so they are retained in the inner chamber. Mean efficiencies of separation achieved were 0.79 over an operation time of 30 mins., and 0.93 after 60 mins, with 8,400-13,800 and 14,800-16,600 animals, respectively.

This apparatus is designed to allow rapid harvesting of post-larvae at any time. Maintenance of individual larval rearing tanks is a relatively inefficient management practice which involves costly manual separation of larvae from postlarvae, which in addition, can injure these delicate animals, resulting in a decreased development rate for several days after handling.

The main tank was 45 cm deep x 117 cm diam., with a 62 cm diameter polyethylene cylinder, attached to its centre, but modified by having cut in it 3 evenly-spaced vertical openings 5 mm wide along its sides and a 5 mm wide opening around its base, serving as water and postlarvae passageways. Water is pumped from the bottom of the drain below and injected at the surface of the outer chamber to produce a circular flow pattern. Curved sections of 13 mm internal diameter PVC pipe act as

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water deflectors to enhance movement of water into the inner chamber. Water is also injected into the water surface of the inner chamber to strengthen the circular water flow. Prevention of re-entry of postlarvæ into the inner chamber is prevented by a 30 mm high polyethylene barrier ring attached on the bottom of the circular tank 5 mm from the outside of the bottom horizontal passageway. A circular air line around the base of the screened drain cover causes larval dispersion away from the centre drain. Cost of construction of this apparatus in 1977 was US\$170.

Peebles (1974) developed an elegant method for molt staging of M. rosenbergii. Examinations causing little or no stress to the animals were needed to determine their phase of the ecdysial cycle. The technique involves microscopic examination of an exopodite of one of pleopod once every 7 days for 6 weeks. The exopodite is cut at the base mounted in freshwater for microscopy, for examination of external pigmentation changes in the pleopod. These external changes in pigment correlate well with internal pleopod morphology changes. States A and B are post-molt, C is intermolt and late D is premolt. These stages are readily distinguishable by degree of hardness of exoskeleton. Transition phases are difficult to identify, histology being needed for this. Other pointers help identify transitions, namely:

- (1) State A - animals cannot raise their chelae if held out of water;
- (2) State A - rostrum is easily bent;
- (3) State A - pleopods setae lack an internal cone;
- (4) State B - Chelae are operative;
- (5) State B - rostrum cannot be bend, exoskeleton is pliable;
- (6) States A and B - pigment retraction from rostral and abominal plates margins has not started;
- (7) State C - exoskeleton is hard, there is little pigment retraction;
- (8) Early State C - most pleopod setae have an internal cone, no epidermal pigment retraction from the exoskeleton;
- (9) Later State C - pigment retraction begins, being observable first at margins of dorsal surface of abdominal somites;
- (10) Early state D - epidermal pigment retraction in pleopods (apolysis) - phase D₀;
- (11) Early premolt (states D₀ and D₁) - extensive pigment retraction, at lateral margins¹ of exoskeletal abdominal somites;

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3. The third part of the document focuses on the role of technology in modern data management. It discusses how advanced software solutions can streamline data collection, storage, and analysis, thereby improving efficiency and accuracy.

4. The fourth part of the document addresses the challenges associated with data security and privacy. It stresses the importance of implementing robust security measures to protect sensitive information from unauthorized access and breaches.

5. The fifth part of the document explores the ethical implications of data collection and analysis. It discusses the need for transparency in data practices and the importance of obtaining informed consent from individuals whose data is being collected.

6. The sixth part of the document provides a summary of the key findings and recommendations. It reiterates the importance of a data-driven approach and offers practical advice for organizations looking to optimize their data management processes.

7. The final part of the document includes a list of references and a glossary of key terms. This section is intended to provide additional context and resources for readers interested in the topics discussed in the document.

- (11) State D - complete pigment retraction at margins of lateral abdominal plates (pleura);
- (12) Substates D_1^{1-11} and D_2^{1-111} requires microscopy with unstained and stained pleopods, as does differentiation of D_0 from D_1 , because pigment retraction is variable;
- (13) State D_1 - new setae start to develop and appear as a "tube within a tube";
- (14) State D_2 - secretion of new cuticle begins, accompanied by extensive pigment retraction on both lateral and dorsal abdominal surface, and lack of visible setae development within antennal scales;
- (15) Early state D_3 - barbel development on pleopod setae and an epicuticle or exocuticle layer over the epidermi also setal development in the internal scale begins and pigment retraction starts along the margin of the dorsal surface of the rostrum; later, the exoskeleton becomes flexible (D_3^{111}).

Possible factors which affect the length of the molt cycle are as follows:

- (1) Size, sex and water chemistry are ~~known~~ significant factors;
- (2) Density, food type and quantity, shelter and temperature are other candidates for effects but they have not been studied directly.

A common failure of aquaculture ventures is unpreparedness for dealing with pests, parasites and diseases. Often the sheer inability to recognise the causative organism is enough to cause loss of all cultured animals. In recent years these agents of disaster have been taken much more seriously than previously. Some examples of both unexpected effects of contamination of culture facilities with the lowly hydrozoan coelenterate were made by Sandifer, Smith and Colder (1974). These authors uncovered some interesting information on these pests, as is shown by the following account of this work.

The larval prawns Palaeomonetes vulgaris, Macrobrachium ohione and M. rosenbergii were brood stock and juveniles. Closed systems, though promising, are not "problem-free". The paper describes population explosions of three brackish-water and marine hydrozoan contaminants, Moerisia lyonis, Stylactisarge and Clytia gracilis, which established themselves on the Macrobrachium prawns in their larval phases. These

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3. The third part of the document addresses the challenges associated with data security and privacy. It discusses the potential risks of data breaches and the importance of implementing strong security protocols to protect sensitive information. The text also touches upon the legal implications of data handling, particularly in light of various data protection regulations that require organizations to be transparent about how they collect and use personal data.

4. The final section provides a summary of the key takeaways and offers practical recommendations for organizations looking to optimize their record-keeping practices. It stresses the need for a proactive approach to data management, where regular audits and updates to policies are conducted to stay current with best practices and regulatory changes. The document concludes by encouraging organizations to embrace a culture of data integrity and continuous improvement.

coelenterates are both predators on the larval prawns and competitors of them for food. Clytia gracilis is a common colonial hydroid of the west Atlantic coast from New England to Argentina, Gulf of Mexico and South Pacific, which release small medusae. Iylactisarge is a mesocond polyhaline species recorded from Chesapeake Bay and Woods Hole, whose degenerate medusae live for only one day and do not feed. Moerisia lyonsi medusae grow up to 8.4 mm diameter, but can have gonads when as small as 1.1 mm. Fertilized egg develops into a planula which later settles to become a polyp-polyps, produce medusae or can reproduce sexually by producing frustules that transform into new polypo which are oligoor meso-haline, reported from Egypt (Lake Qurum), Virginia, Maryland and Delaware Bay, besides the South Carolina records in the present study. M. lyonsi was the most troublesome of the three hydrozoan species encountered.

The coelenterates were probably introduced on detritus mixed in with live prawn collections. Within a month, their populations soared from a few medusae to 25/1 in several 120-1,800 l culture tanks, on their bottoms and sides, but especially in the filter beds of calcareous gravel. In one instance the top few mm of the gravel filter beds were covered with a mass of brownish-red M. lyonsi polyps, budding off medusae. M. lyonsi and S. arge thrived at 25-28.5°C and 1b ppt., while C. gracilis required 35 ppt. salinity so was not present in Macrobrachium tanks. These hydrozoans competed with prawn larvae for Artemia nauplii food, but they ate the larvae too, especially M. lyonsi medusae as small even as 1-2 mm diameter, which devoured up to stage IV larvae. In one 1,800 l tank, these medusae ate several thousand M. rosenbergii larvae in a few days. In another tank, medusae stung to death with nematocysts over 90% of the phase IX-XI M. rosenbergii larvae over three days.

Two hydrozoan groups were identified; polyps on filter beds and medusae with polyps in culture tanks. Chemical treatment would probably adversely affect the filter's bacterial flora and its water quality maintenance ability, and retention of chemicals might subsequently affect larvae, which after all, are human food organisms. However, some trials with chemotherapy were ran. Treatment with 50-100 ppm formalin for 30-60 mins. stopped medusae swimming with subsequent settling out. However, >50% recovered within 24 hours in clean, brackish water. None recuperated within 24 hours of a 60 minutes treatment with 250 ppm formalin, and prawn larvae were not adversely affected.

The best control is prophylaxis, by use of treated or artificial seawater, and exclusion of all hydroid-carrying material, or their sterilisation. Once hydroids invade, the best course of action is sacrifice of infected cultures by draining, scrubbing with hot water, and rinsing of tanks and materials with very hot water. Following these treatments with complete drying for several days, back flush infected filter beds and treat as were the tanks.

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2. The second part of the document outlines the various methods used to collect and analyze data. It describes the use of statistical techniques to identify trends and anomalies in the data, and the importance of using reliable sources of information.

3. The third part of the document discusses the role of the auditor in the process. It explains that the auditor's primary responsibility is to provide an independent and objective assessment of the financial statements, and to ensure that they are prepared in accordance with the applicable accounting standards.

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5. The fifth part of the document discusses the importance of communication in the audit process. It explains that the auditor must maintain open and effective communication with the management of the organization, and with the board of directors, to ensure that the audit is conducted in a transparent and collaborative manner.

6. The sixth part of the document describes the various types of reports that can be prepared by the auditor. It explains that the auditor's report is a key document that provides the management and the board of directors with the auditor's findings and conclusions.

7. The seventh part of the document discusses the importance of the auditor's independence and objectivity. It explains that the auditor must be free from any conflicts of interest, and must maintain a high level of professional skepticism throughout the audit process.

This paper shows how organisms harmless in nature can wreak havoc in a culture system. Therefore, the golden rules are:

- (1) Set and maintain rigid water quality control,
- (2) Prevent introduction of parasites, diseases, predators and competitors;
- (3) Maintain vigilance over the matter of good water management,
- (4) Treat culture water by an appropriate anti-pathogen method, such as UV irradiation, to effect prevention of contamination

Agriculturalists have learned not only to detect and identify diseases and pests but also to fight back. Chemical control of a protozoan ciliate pest on M. acanthurus, for example, was investigated by Roegge, Rutledge and Guest (1977). These workers made the following observations:

- This stalked ciliate caused heavy mortalities on larval shrimps in a 40L tank lacking filtration, with a stocking density of 300/1. Although shed with larval exuviae during the molting, reinfection occurred. Ten preparations were used to test efficacy against Zoothamnium, using 10 infected larvae per treatment with replicates, and 20 infected ones as the control, with 10 in each of 2 batches. There was a minimum of 2 replicates per treatment, with the exception of malachite green at 0.5 ppm where 10 replicates were used. Tests were run in 0.5L containers in aerated, artificial sea water of 15 ppt salinity.

Compounds tested were: nitro-furazone - no effect on Zoothamnium or the ciliate but killed of the larvae.

CuSO_4 , Dylox, methylene blue and Combiotic had little effect on Zoothamnium but larvae were in poor condition;

Roccal killed the ciliate, but 40% of larvae too; 0.5 ppm Malachite green killed 90-100% of the parasite and 10-80% of the larvae;

Terramycin and KMnO_4 killed <5% of the ciliates but wiped out 100 and 80%, respectively, of the larvae;

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4. The fourth part of the document addresses the challenges and risks associated with data management and analysis. It discusses the importance of data security, privacy, and integrity, and provides recommendations for mitigating these risks through robust governance and security measures.

5. The fifth part of the document concludes by summarizing the key findings and recommendations of the study. It reiterates the significance of data in driving organizational success and provides a clear roadmap for future data management and analysis efforts.

Formalin at both 50 and 67 ppm killed all the parasites but none of the larvae, which remained in good condition at the end of the experiments.

Biological filtration prevents the entry of these parasites into culture facilities. However, any outbreaks of it on M. acanthurus can be treated effectively with 50 ppm formalin for 24 hours.

Rather detailed and sophisticated studies have emerged recently on surface pests of M. rosenbergii. In South Carolina, Smith, Sandifer and Manzi (1979) dealt with some epibionts of the Malaysian prawn, as follows:

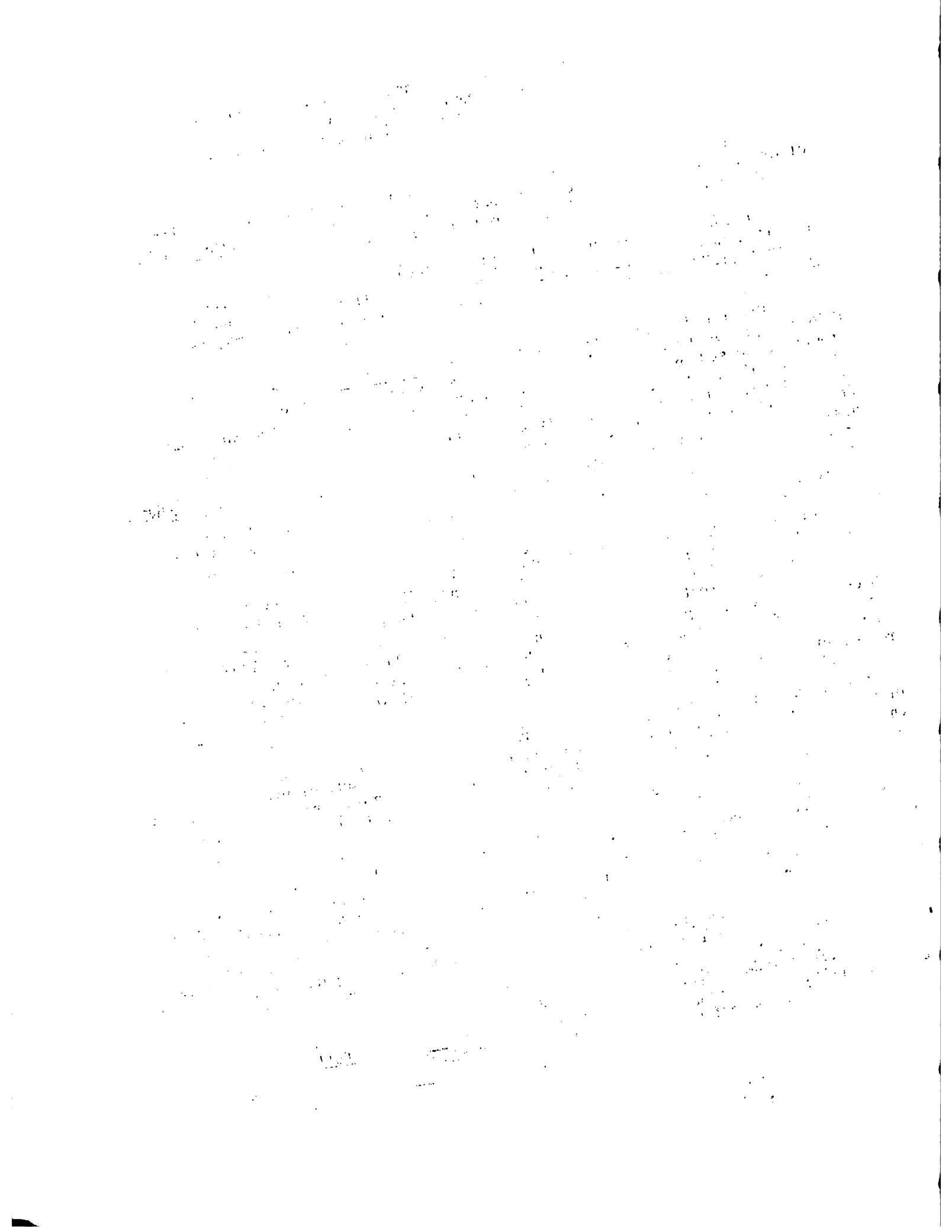
Previously unreported epibionts on M. rosenbergii were noted in 1976 for prawns reared in an out door brood stock pond. Dense algal growths composed of about 90% of the chlorophyte Cedogonium crassiusculum and about 10% by the cyanophyte Lynabua, were observed on the carapace in 58.3% of the males in the tanks (mean weight 47.1 g.), but were absent from all the females. Infected prawns are sluggish, and some cases of blindness were recorded where the eyestalks were physically covered by the growths. When infested animals were moved to indoor culture tanks the algae were lost and the behavior of the previously infested animals returned to normal.

Eggs of the water boat man Samphocouxa acuminata, were recorded on 52.5% of the females in the brood stock pond, their mean wt. being 78.0 g, and were observed on 5.9% of the males at harvest. Distribution of these eggs was restricted to the carapace and/or the 1st. and/or 2nd abdominal somites. Eggs were not seen on 84,000 smaller prawns distributed amongst six adjacent rearing ponds. They appeared to do no harm to their "hosts", and they disappeared just after infested animals were returned to indoor laboratory tanks.

Studies have advanced to consideration of disease proper and one of the earlier considerations of this important aspect of aquaculture was that of Delves-Broughton and Poupard (1976), who were particularly concerned with British recirculation systems. These workers took the following approach.

Whenever possible, moribund prawns were examined alive, or were fixed in 10% formol-saline or Bouins, or kept on ice for bacteriological examination. Live animals were killed in ice-cold water and examined under a stereoscope for gross symptoms. Presence of parasites was checked from smears of haemolymph, hepatopancreas, gut, gills, muscles and exoskeleton. By these means, some valuable information was gathered and presented in this publication on the diseases of culture prawns.

Sometimes sudden disaster due to disease can overwhelm an aquaculture facility. For example, a sudden mass-kill of M. rosenbergii reared in ponds was reported by Green, Richards and Singh (1977).



A trial culture was involved which resulted in death en masse of 45% of the prawns in a 0.19 ha. pond fed by a stream carrying waste water from a dormitory building in Malaysia. The pond had a slope of 2% and a depth of 1.5 m at the outlet end. At its inlet was a sand-gravel filter to prevent entry of fish eggs and fish. The pond was dried out and limed with 10 kg of Ca(OH)_2 and 10 cm water added. The pond was re-drained and dried for 4 weeks till grass covered the bottom, and then it was re-filled and left to stabilise for 2 weeks. This pond was stocked with 200 juvenile prawns, mean $1.23.9 \pm 5.4$ mm. A food supplement at a rate of 5% of dry weight was added each day, starting 2 weeks after stocking. Stocking density was $4/\text{m}^2$.

Some 36 days after stocking the massive kill occurred. Water was murky and there was a bloom of phytoplankton. Dead prawns were recovered over the next 3 days and refrigerated. On the first day of mass die-off, pH, diss. O_2 , temperature, conductivity and light penetration were measured from 0630 to 170 hours.

The pH was 7.5-9.8, diss. O_2 0.5-16.7 mg/l. and $T^\circ 27-32.6^\circ\text{C}$. Factors causing the mass kill were surmised to be as follows. These were over fertilisation with phosphate, nitrate and additional nutrients caused an algal bloom, lack of rain resulted in a reduced water supply; then a sudden, severe storm the day before the kill caused a rush of water into the pond, which stirred up the organic material from the sediments and put them into suspension. This encouraged bacterial growth. Combined algal and bacterial respiration that night reduced dissolved oxygen levels drastically even down to 0-0 mg/l. This killed the prawns.

Another form of fighting back against disease is disinfection, and an effective way of doing this in aquatic environments involves the use of ultra-violet irradiation (UVR). For filtered water, this is effective, with 99.9% or more reduction in viable bacterial cells being on record in some instances. Fungi are also killed by UV irradiation. The best approach is to filter the culture facility water supply and then pass it through the UVR emitting unit. Brown and Russo (1979) conducted experiments. They give some specifications on their set-up.

- (a) 2 μ orlan filter
- (b) aqualine Aluminum SL-1 steriliser, producing up to 30,000 $\mu\text{W}/\text{sec}/\text{cm}^2$ at a flow rate of 321/min. At a flow rate of 4L/min. the radiation dosage rate becomes 93.312.520 $\mu\text{W}/\text{sec}/\text{cm}^2$, depending on the power of the UV lamp

The pathogens were:

- (1) Twenty pseudomonad types: seeded in the experiments to a level of 10^5 cells/ml at 26°C

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- (2) Three vibrio types: seeded in the experiments to a level of 10^5 cells/ml. at 26°C

They found that sea water contaminated with any of the test bacteria at 10^5 cells/ml. was detrimental to the development of fertilised oyster eggs.

UV treated seawater proved satisfactory for rearing fertilised oyster eggs. Oyster larvae reared in irradiated water had a significantly higher survival rate during their first seven days of life larvae raised in non-irradiated seawater; in the irradiated trials, survival was 78% compare to 60% in non-irradiated trials, although there was no significant difference in mean size of larvae in the two treatments. Spontaneous disease occurred in 6 out of 10 non-irradiated cultures and in only 2 of the irradiated ones.

It was determined that UVR was bactericidal to the strains of bacteria used in this study. A dosage of about $80,000 \text{ uW/sec/m}^2$ is required to effect reliable efficacy in destruction of pathogenic bacteria at a flow rate of 4L/min.

Sources of bacterial contamination were seawater, fertilised eggs, and food. Another study of note that has added to the armoury of prevention against disease is that of Burns, Berrigan and Henderson (1979), who looked at the fungus Fusarium in M. rosenbergii, and described this so that culturalists could be aware of this affliction if they encounter it in their facilities.

One approach to deal with disease is chemotherapy. Just two studies will be considered here. A new class of synthetic compounds effective in treatment of a wide variety of diseases of aquatic organisms has been invented in recent years. Delves-Broughton (1974) undertook some exploratory work of the effectiveness of one of these compounds, Furanace, in the cure of prawn diseases.

Furanace, a broad spectrum chemotherapeutic for fish diseases is also called p-7138, nifurpirinol or 6-hydroxymethyl-2(2) (5-nitro-2-furyl) vinyl) pyridine. Effective against a wide range of Gram-positive and Gram-negative bacteria pathogenic to fish and shellfish, and against Saprolegnia (a fungus) this compound is now coming into common use in the battle against disease in aquaculture facilities.

Absorption by tissues and excretion of the drug are rapid. Administerable orally or by bathing, in the latter case absorption is through gills and skin. It inhibits macromolecular synthesis of DNA and is non-toxic at bactericidal concentrations. Delves-Broughton (1974), did some careful work on this drug. He used a 10% active ingredient preparation of Furanace. Minimum inhibitory concentrations (M.I.C.) from 25 to 0.003 mg/l were determined against bacteria by the tube dilution method, using 0.1% yeast extract, 0.1% peptone and 0.5% NaCl broths, although the NaCl level was raised to 2% for Vibrio

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3. The third part of the document addresses the challenges associated with data management. It points out that as the volume of data grows, it becomes increasingly difficult to organize and retrieve information. The text recommends implementing robust data management strategies, such as regular backups and secure storage protocols, to mitigate these risks. Additionally, it stresses the importance of training staff to use these systems effectively.

4. The final section discusses the legal and regulatory requirements for record-keeping. It notes that various industries and jurisdictions have specific rules regarding the retention and disposal of records. Organizations must stay informed about these regulations to avoid penalties and ensure compliance. The document advises consulting with legal counsel to develop a clear record retention policy that meets all applicable requirements.

anguillarum and to 7% for V. parachaemolyticus. Gaffkya hamari was tested in tryptone soy broth. M.I.C. against fungal zoospores was tested by the plate dilution method using the following medium: 1% glucose, 0.5% soluble starch, 0.3% yeast extract, 0.6% Na₂ (HP)4.12H₂O, 0.2% KH₂ PO₄, 1.5% algae, incubated at 25°C, to produce zoospore cultures by inoculum. Water-autoclaved hemp seeds were then added and the culture left for 2 days, by which time the hemp seeds were covered by the mycelium of the fungus. The seeds were then transferred to sterile water in plastic dishes, where the hyphae developed sporangia and release zoospores. The fungal media, in a series containing a range of concentrations of Furanace from 25 to 0.003 mg./l, were inoculated with zoospores, incubated at 25°C and fungal growth recorded daily.

Toxicity of Furanace to M. rosenbergii was tested by baths of both high concentration-short exposure and low concentration-long exposure regimes, using 5 or 6 prawns each time, and holding the prawns in bath at 27°C in 45L tanks fitted with their own gravel biological filters. Prawns were fed daily and checked for deaths, stress and ecdysis. The experimental design was as follows:

High concentration-short exposure regime

Furanace conc. (mg/l)	5			10			15			20			0
Exposure time (min.)	5	10	15	5	10	15	5	10	15	5	10	15	Control

After treatment in this regime, prawns were kept under observation for seven days.

Low concentration-long exposure regime

Furanace conc (mg/l)	1.33	2.5	5.0
Exposure time (days)	7	7	7

Ammonia levels were monitored in all prawn tests to assess any effect of Furanace on nitrification by the Nitrosomonas-Nitrobacter complex in the biological filters. Haemolymph, gill tissue, abdominal segment and exoskeleton levels were measured by the cup-plate method using Bacillus Subtilis as indicator organism. Prawns were killed in ice-cold water, haemolymph was collected by breaking haemocoel and transferred to McCartney bottles coated with tri-sodium citrate to prevent coagulation. To extract Furanace from tissues, organs were frozen with dry ice acetone then ground tissue was treated with 0.5 ml dimethylsul toxide and then 1.5 ml distilled water. This fluid was then assayed.

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For the study of the uptake of Furanace by prawn tissue the following experimental design was used. The experiments were run at 25°C. Furanace levels in haemolymph, gills abdominal segment and exoskeleton were measured immediately after bathing.

Furanace conc. (mg/l)	10			20		
Exposure time (min.)	10	20	30	10	20	30

In order to investigate excretion of Furanace from prawn tissue the experimental desing was as follows: The concentration of furanace used was 20 mg./l at 25°C.

Exposure time to furanace (min.)	30	30	30	30	30	30	30
Bathing time in fresh water, no furanace (hr)	0	0.5	1.0	1.5	2.0	2.5	3.0

After treatment, prawns were killed in ice-cold water and furanace levels were then assayed.

The results of the experiments on invitro antimicrobial activity showed that vibrios were all inhibited by $<1\text{mg/l}$ (0.1-0.4 mg/l) concentrations. Aeromonads and Cytophaga spp. were inhibited by 3.1 and 0.4-3.1 mg/l levels, respectively. Beneckea spp. succumbed to 3.1, 6.2 and 12.5 mg/l values, for each sp., respectively. Pseudomonads and Gaffkya homari did not succumb even to levels > 25.0 mg/l and so can be said to be resistant to furanace. All Sparolegnia spp. tested succumbed to 0.8-1.55 mg/l levels, except S. ferax which was resistant even at > 25 mg./l.

Achyla diffusa succumbed at M.I.C. 3.1 mg./l. In investigating the invivotoxicity of furanace, the high concentration-short exposure tests showed 3-5 g prawns could tolerate 20 mg./l furanace for 20 minutes with no deaths in 7 days. A 20 mg/l treatment for 30 minutes caused stress in 4 out of 7 animals tested. The low concentration-long exposure regime indicated that 3.5 g animals could tolerate 1.33 and 2.5 mg./l levels for 7 days. At 5 mg./l, all 5 prawns in the test died on the 4th day.

Nitrifying bacteria were inhibited as ammonia levels in the 1.33 and 2.5 mg./l tests went up significantly.

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The uptake and excretion of furanace by prawn tissue was studied for prawns treated with 10 mg./l for 20 minutes and 20 mg./l for 30 minute. The furanace levels in several tissues was as follows: (nd means not detectable)

Furanace level (mg./l	10	20
Exposure time (min.)	20	30
Tissue (Haemolymph	0.4-0.5	0.5-0.68
Levels (Gill	0.1-0.25	0.45
(mg./l (Abdominal segment	0.5-0.7	0.6
(Exoskeleton	nd	nd

Results of experiments involving 'self-washing' in pure water after treatment in furanace baths of 20 mg./l for 30 minutes are shown below.

Time after bathing (h)	Furanace levels (mg./l)		
	Haemolymph	Gill	Abdominal segment
0	0.68	0.45	0.60
0.5	0.092	nd	0.12
1.0	0.047	nd	0.075
1.5	0.043	nd	nd
2.0	0.013	nd	nd
2.5	0.011	nd	nd
3.0	nd	nd	nd

Thus, M. rosenbergii both rapidly takes up and rapidly excretes Furanace. Advantages of Furanace are:

- (1) non-toxic,
- (2) water soluble;
- (3) absorbed inactive form;
- (4) is rapidly excreted;
- (5) has wide-spectrum anti-pathogen activity;
- (6) has low antinitrifying bacteria activity in low concentrations, and
- (7) is degradable

The best treatment is a long exposure-low concentration regime, which not only kills the pathogens in the animals but also eradicates it from their environment.

The danger with Furanace is its suppression of the nitrifying bacteria complex in biological filters. Recommended is 2.0 mg.l in a constant bath. The Furanace will degrade with a half life of c. 3 days, under 40w illumination.

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7. The seventh part of the document discusses the impact of external factors on the organization's performance. It analyzes the influence of market conditions, regulatory changes, and global events on the business environment.

8. The eighth part of the document provides a summary of the key findings and conclusions of the study. It reiterates the importance of a holistic approach to business management that integrates all aspects of the organization's operations.

9. The ninth part of the document includes a list of references and sources used in the research. It provides a comprehensive list of academic journals, books, and industry reports that support the findings and conclusions of the document.

10. The tenth part of the document is a concluding statement that expresses the author's appreciation for the support and assistance provided by the organization's management and staff throughout the research process.

Further information on chemotherapeutics actions in crustaceans is given by Hanks (1976), for penaeid shrimps.

Another extremely important aspect of prawn aquaculture is nutrition and diet. A consideration of a few selected publications on the topic will be presented here. One of the earliest studies was that of Lewis, Ward and McIvor (1966) on reproductive behaviour, growth and feeding in M. carcinus. However, it remained for Balazs, Olbrich and Tumbleson (1974) to do a biochemical analysis of the effects of diet in Shrimp, by investigation of their serum constituents. M. rosenbergii was studied by these workers. The following were measured: Cl⁻, Ca⁺⁺, Pi, glucose, cholesterol, urea N, total bilirubin, creatinine lactic dehydrogenase, alkaline phosphate and glutamic-oxaloacetic transaminase. Baseline serum values were determined by sequential multiple autoanalysis. Male prawns were found to have higher cholesterol levels than females, while females had higher urea N, creatinine and lactic dehydrogenase values than males. Females were smaller, on average, in both total weight and carapace length than males. Feeding habits of M. rosenbergii in nature and in captivity were studied by Balazs and Koss (1976). They pointed out that, in the wild, this species appears to be omnivorous, taking grass roots, detritus, insect nymphs and fishes. In captivity the Macrobrachium prawns that have been studied accept a variety of foods. Best growth results from use of molluscan and crustacean flesh, although in most places such foodstuffs would be too costly, often unavailable and difficult to store. According to nutrition research that has been conducted, protein is likely the most limiting nutrient for growth, and feed costs are directly proportional to their protein content.

Feeding was at a level of 5% of prawns body weight, once daily after noon initially, and thereafter adjusted according to the amount uneaten after 24 hours. Eventually, the animals were being fed as much as they would consume. Dead animals were removed. Feeding and controls were continued for 244 days. Water temperatures ranged from 22 to 27.6°C.

Growth rates, feed conversion ratios and survival rates were determined. Water stable diets were used at 15, 25 and 35% levels. Principal protein source combinations were either soybean and tuna meal, or soybean, tuna and shrimp meal. Higher protein content produced larger prawns ($p < 0.01$), but differences between feed conversion ratios (range 1.36-1.72) or survival rates (range 90.3-93.6%). Trials with soybean and Tilapia meal and copra and Tilapia meal combination (25% protein) showed that growth rate was lower on these diets than on those mentioned above, although conversion ratios and the survival rates were the same.

For the controls, which received no formulated diet, growth and survival seemed dependent on natural algae being consumed by the prawns.

Mean prawn length after 244 days on 35% protein soybean and tuna meal (the best diet) was 73 mm.

An interesting diet study was carried out on M. rosenbergii by Sandifer and Joseph (1976). Experimental Marine Ration 25, Ralston Purina Company was impregnated with 3% by weight oil extracted from head of Penaeus setiferus, resulting in reduction of level of 26 fatty acids and an increase in the proportion of W3 and of saturated acids.

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The diet complex was fed for 12 weeks to juveniles, the unmodified ration 25 being used as a control. Prawns fed on the augmented ration grew significantly larger than those on the control feed, this being apparent by the 6th week of the study. Final mean biomass/unit area and food utilisation efficiency were both also significantly higher than in the control group, by a factor of about two in each case, in fact. Survival rates differed little - 71% in augmented diet group and 60% in control group.

Results indicate the prawns conserve or synthesize W3 fatty acids and catabolise 18.2W6 (linoleic acid) as an energy source. Augmented diet animals also had about 15 times more carotenoid pigments than the controls. A main conclusion is that W3 fatty acids are important to M. rosenbergii and so prawn diets should benefit from adding waste shrimp head oil to their diet as a good, cheap source of W3 and pigments.

A most valuable review paper of diet and nutrition studies on shrimps was published by New (1976). This article is so useful to the present proposal for shrimp culture that is described here at some length, as follows:

Commercial rearing as an industry is predicted to expand in both developed and developing countries, e.g. in the U.S., consumption of farmed shrimp was 2×10^6 lbs in 1973 and this expected to expand to 245×10^6 lbs/yr by 1982 with a projected value of $> US\$134 \times 10^7$ at 1975 prices (US\$5.47/lb). At a food conversion ration of 2%, the annual shrimp feed demand could exceed 220,000 metric tonnes.

This paper collates papers on feed and nutrition for both marine and freshwater shrimp, but excludes publications on use of live feed, for shrimp larvae, effect of environmental factors upon ingestion, use of compounded diets in pond culture, use of fertilisation and natural feeding in ponds, and stomach contents of wild animals. The review is restricted to studies of diets under controlled laboratory conditions.

The review contains the following main sections:

- (1) palatability and physical dietary structure;
- (2) lipids and sterols;
- (3) protein;
- (4) carbohydrate;
- (5) minerals;
- (6) vitamins;
- (7) larval foods
- (8) discussion;
- (9) conclusions

Only direct references to Macrobrachium are noted here:

1. Palatability and physical dietary structure

Pioneer Ling (1969) simply cut fresh animal material into pieces and supplemented this with pre-soaked for $\frac{1}{2}$ hour, dired animal material

1. The first part of the document discusses the importance of maintaining accurate records of all transactions and activities. It emphasizes that proper record-keeping is essential for the transparency and accountability of the organization. This section also outlines the various methods and tools used to collect and analyze data, ensuring that the information is reliable and up-to-date.

2. The second part of the document focuses on the implementation of internal controls and risk management strategies. It details how these measures are designed to prevent fraud, reduce errors, and protect the organization's assets. The text also addresses the role of management in overseeing these processes and ensuring that they are effectively integrated into the organization's operations.

3. The third part of the document discusses the importance of communication and collaboration between different departments and teams. It highlights how clear communication and teamwork are crucial for the successful execution of projects and the achievement of organizational goals. This section also provides guidance on how to foster a culture of open communication and mutual respect within the organization.

4. The fourth part of the document addresses the need for continuous improvement and innovation. It discusses how the organization can stay ahead of the competition by regularly reviewing its processes and seeking out new and better ways to do things. This section also emphasizes the importance of investing in research and development to drive growth and innovation in the organization's products and services.

5. The fifth and final part of the document discusses the importance of ethical behavior and corporate social responsibility. It outlines the organization's commitment to high ethical standards and its efforts to contribute positively to the community and the environment. This section also provides guidance on how to ensure that all employees understand and adhere to the organization's ethical principles.

to achieve a suitable final moisture content in the compounded preparations which he used in culture of M. rosenbergii.

Macrobrachium zoea are able to rupture the walls of food microcapsules with cross-linked nylon-protein walls by physical mastication (Jones et al 1974).

2. Lipids and sterols

The biochemical composition of M. rosenbergii juveniles was worked out by Sze (1973), who reported that the dry weight lipid level was 15.8% of the body composition. It is thought, based on the work of others, that shrimp require a specific fatty acid composition in the diet, W6 being inhibitory and W3 types being stimulatory, so that diet lipids with a high W3: W6 fatty acid ratio are required by these animals. Shrimp head oil is an excellent source of W3 polyunsaturated fatty acids. Joseph and Williams (1975) found that M. rosenbergii fed for 3 weeks on a commercial shrimp chow containing 7.3% lipid, mainly from linoleic acid-rich (18.2W6) soy oil, but with 3% shrimp head oil, contained 6% more W3 and 6% less W6 fatty acids than control animals which were fed a diet not supplemented with shrimp head oil. Although levels of W3 fatty acids paralleled those in the diet in both groups, significantly lower levels of W6 fatty acids were found in tissue than in dietary lipid. The conclusion from these results is that W3 fatty acid are annihilated and therefore retained, while W6 fatty acids are catabolised for release of energy. Sandifer and Joseph (1976) confirmed these results. Those shrimp fed diets augmented with 3% shrimp head oil had 15 times more carotenoid pigment than the control animals.

Sick and Beaty (1974) determined the caloric budgets of M. rosenbergii. Balazs et al (1973), in initial trials with M. rosenbergii (where algae may also have been injected), an all soy bean protein source diet gave better results than a fish-soy bean diet, but was inferior to a fish-soy bean-shrimp based diet, even though all 3 diets were 35% protein. Shrimp of different ages, however, require different protein levels and sources in their diet, higher protein levels being required at earlier growth phases, early juveniles requiring >35% protein, although lower proportions may be optimal with a favourable amino acid balance.

Suitable major sources of protein for shrimps are squid, soy bean meal, shrimp meal and fish meal, but the most promising are chitin - containing crustacean wastes such as shrimp protein derived from cannery effluents (Toma and Meyers, 1975), the optimum protein level being 27-35%, the lower levels being acceptable if the amino acid balance is favourable, or if lipid levels are raised, where lipid may substitute for some of the dietary protein (the W6 fractions) in energy supply, so sparing the protein for tissue formation (Andrews et al, 1972). The most important task is to determine the quantitative amino acid needs of each commercially important shrimp species, in order to be able to formulate economically efficient diets.

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4. Carbohydrate

Crustaceans digest carbohydrates and have carbohydrases including α and β amylase, maltase, saccharase, chitinase and cellulase, the last 2 originating in bacterial gut flora. Carbohydrates are important in the kreb's cycle, glycogen storage, chitin synthesis and steroid and fatty acid anabolism. There is strong carbohydrase activity in the herbivore, M. dayarum (Tyagi and Prakash, 1967).

Efficiency of utilisation of carbohydrates by shrimp varies according to source. Partial digestion of cellulose is carried out, and extra cellular chitinases digest chitin in the diet or in the shrimps' own cast exoskeletons. Ability to digest specific carbohydrate sources varies between species, starch in general protein from chitin synthesis to permit a shunt of the protein into tissue synthesis.

5. Minerals

Literature references to minerals in shrimp nutrition are sparse. Sze (1973) reported ash content of M. rosenbergii to be as high as its lipid level at 15.9% dry weight. There have been some studies on Ca^{+} - PO_4^{-} ratios in shrimp but their overall mineral requirements are poorly known. Some species can presumably acquire Ca^{++} , K^{+} , Na^{+} and Cl^{-} from seawater by active osmo-regulation, but they cannot get PO_4^{-} in this manner.

6. Vitamins

Vitamin requirements of shrimp are virtually unknown. There is a little information on vitamins A and C. Most of the B group vitamins are needed by crustaceans, plus C and E. Vitamin D may be partly injected but can also be synthesised from ergosterol, while K may even be inhibitory. The precursors of A may be needed but not the vitamin itself, e.g. β -carotene in phytoplankton can serve as a source of synthesis of A. Vitamin C supplements speed penaeid growth rates, but in excess can inhibit growth, the optimum inclusion level being about 0.2%. Yet application of vitamin mixes to diets without knowledge on requirements may not only waste money but may also be dangerous as excess levels may be given.

7. Larval food

Few papers on artificial larval foods are published. In developing such diets the main problems are to devise food in a form and particle size acceptable to larvae. Further, the food must be in the same part of the water column as the larvae, and protected from leaching. Microencapsulation is a promising answer to these difficulties.

Respiration and injection of larval M. rosenbergii was studied by Sick and Beaty (1975) to measure the amount of food needed for growth sustenance at each larval phase, using several compounded diets, as well as Artemia naupii. The 20% alginate gel and freeze-dried foods were very porous and therefore floated, though near-neutral buoyancy was attained

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by extrusion followed by rolling into flakes. Six diets with different combinations of fish, soy bean and shrimp meals, with cellulose as a filler plus vitamin and mineral supplements, soaked in a linseed-menhaden oil mixture. Two rations had 15% or 30% Artemia meat added, two had 5% and 15% of albumin. Diets were prepared alternatively in freeze-dried, gel and dry flake forms. For all forms, diets with Artemia were incorporated at higher rates than others. Highest ingestion by phase VII-VIII larvae was a freeze-dried diet with 15% Artemia. With a 4:1 starch: albumin ratio larvae ingested more food than those fed any other diet except those containing Artemia. Only larvae fed 5.5 mm rather than 0.7 mm nauplii, or freeze-dried catfish, or the freeze-dried diet with Artemia, ingested sufficient calories to provide for growth plus respiration. Artemia nauplii, and freeze-dried catfish diets were more efficient than the formula feed plus Artemia meat, and they produced stage VII larvae in the shortest time. Yet, combination of a diet of 5.5 mm nauplii plus freeze-dried catfish, and a diet of freeze-dried formula feed plus Artemia meat both gave an excellent result of 57% survival to stage VIII larvae in 19 days.

8. Discussion

Balazs and Ross (1975) reported a food conversion ratio of 1.46:1.00 over 244 days for a soy-tuna shrimp diet fed to M. rosenbergii. This ratio must be used in calculation of feed costs.

The great importance of nutrition in shrimp maturation was stressed by Clark (1976). Basic studies linking actual rather than calculated chemical composition of diets with parameters like respiration, blood chemistry and tissue analyses are essential for success in culture that is other than empirical.

A standard measure of performance should be adopted such as specific growth rate, where $S.G.R. = \frac{\log_{10} \text{ final wt.} - \log_{10} \text{ initial wt.}}{t \text{ (days)}}$

Research must take into account and standardise the following variables:

- (1) selection of optimum environment;
- (2) inherent variability in animals;
- (3) selection of feed form and ingredients;
- (4) data presentation in a suitable form for both scientists and commercial culturists

Shrimp are aggressive, territorial and competitive, so stocking density bears on growth and survival rates. Interactions between animals may either increase or decrease feeding intensity. When testing diets, replicates of individually housed shrimp, rather than populations should be used to eliminate inter-animal effects.

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1. The first part of the report deals with the general situation in the country. It is noted that the economy is in a state of depression and that the government is unable to meet its obligations. The report also mentions that the population is suffering from a lack of food and clothing.

2. The second part of the report discusses the political situation. It is noted that the government is weak and that there is a lack of unity among the different political groups. The report also mentions that the military is a powerful force in the country.

3. The third part of the report deals with the social situation. It is noted that there is a high level of unemployment and that the standard of living is very low. The report also mentions that there is a lack of social services and that the health care system is in a state of collapse.

4. The fourth part of the report discusses the international situation. It is noted that the country is isolated and that it has few friends in the world. The report also mentions that the country is a target of international aggression.

5. The fifth part of the report deals with the future of the country. It is noted that the country needs a strong and stable government and that it needs to be able to meet its obligations. The report also mentions that the country needs to be able to provide for the needs of its population.

6. The sixth part of the report discusses the role of the military. It is noted that the military is a powerful force in the country and that it has the potential to be a stabilizing force. The report also mentions that the military needs to be reformed and that it needs to be able to provide for the needs of the country.

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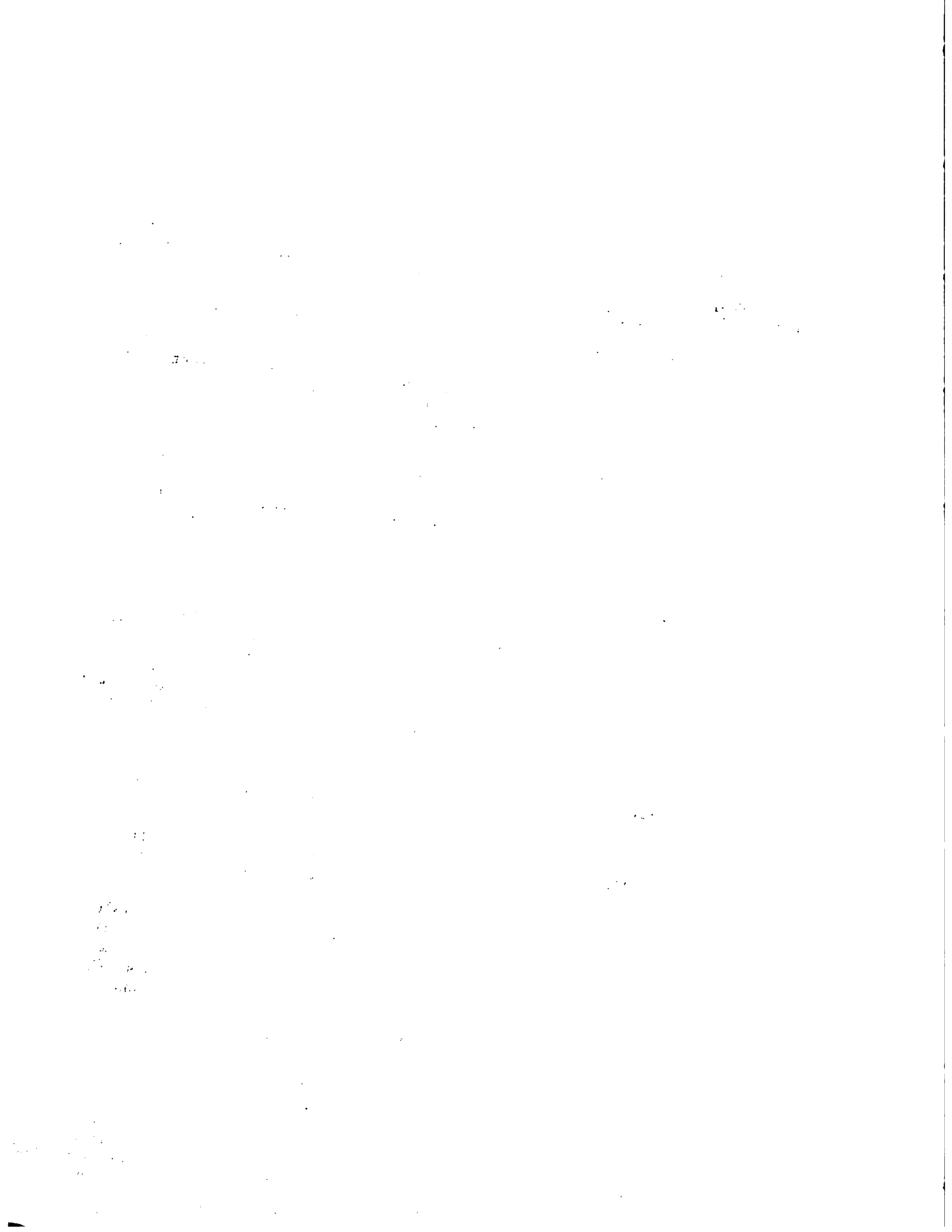
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9. Conclusions

Proposal for standardisation of experimental conditions for dietary trials with Macrobrachium rosenbergii

<u>Aspect of expt.</u>	<u>Recommendations</u>
Origin of animals	From defined strain reared in standard conditions; at least known parental and larval history; larval life 30 d., initial experiment wt. 0.2 g.
Trial length	Min. 98.3., preferred is 350 d., or until animals of 1 treatment average 35 g.
Measurement technique	Individual wt. by standardised blotting total and carapace lengths, using post margin eye orbit.
Measurement frequency	Approximately 21 days.
Pre-trial maintenance	House communally 7 d. at trial, environment conditions, select by wt. randomise to individual tanks; feed control diet a further 5 d.; gradual, complete, water change and starve 48 hours before trial; weigh and measure 1 d. before experiment diets given.
Trial environment	28±0.2°C; 2% S, 75% Diss O ₂ ; pH 7-08.5; 16hL fluorescent light at 108 lux water surface: 8hD
Replication	Diets randomised to give 6 replicates on each of 2 recirculation systems, reverse treatments during trials
Food	Make 1 batch, store in bulk at 15°C, weigh enough for 7 days for each individual tank, and keep at 0 _N , reweigh and discard unused; % of biomass feed daily, fr. of feeding, coll. and measurement of unused food, faeces and exuviae will vary acc. to experiment.
Data Collection	Maintain records on and report parameters of relevance

A very detailed study of the effect of using formulated feeds on the productivity of M. rosenbergii in culture was undertaken by Fair and Fortner (1981). What is the power for growth of supplemental feeds, compared to pond fertilization is the question they posed. Intense organic and inorganic pond fertilization increases fish yields and in many cases has replaced conventional feeds, but the extent to which this is effective in



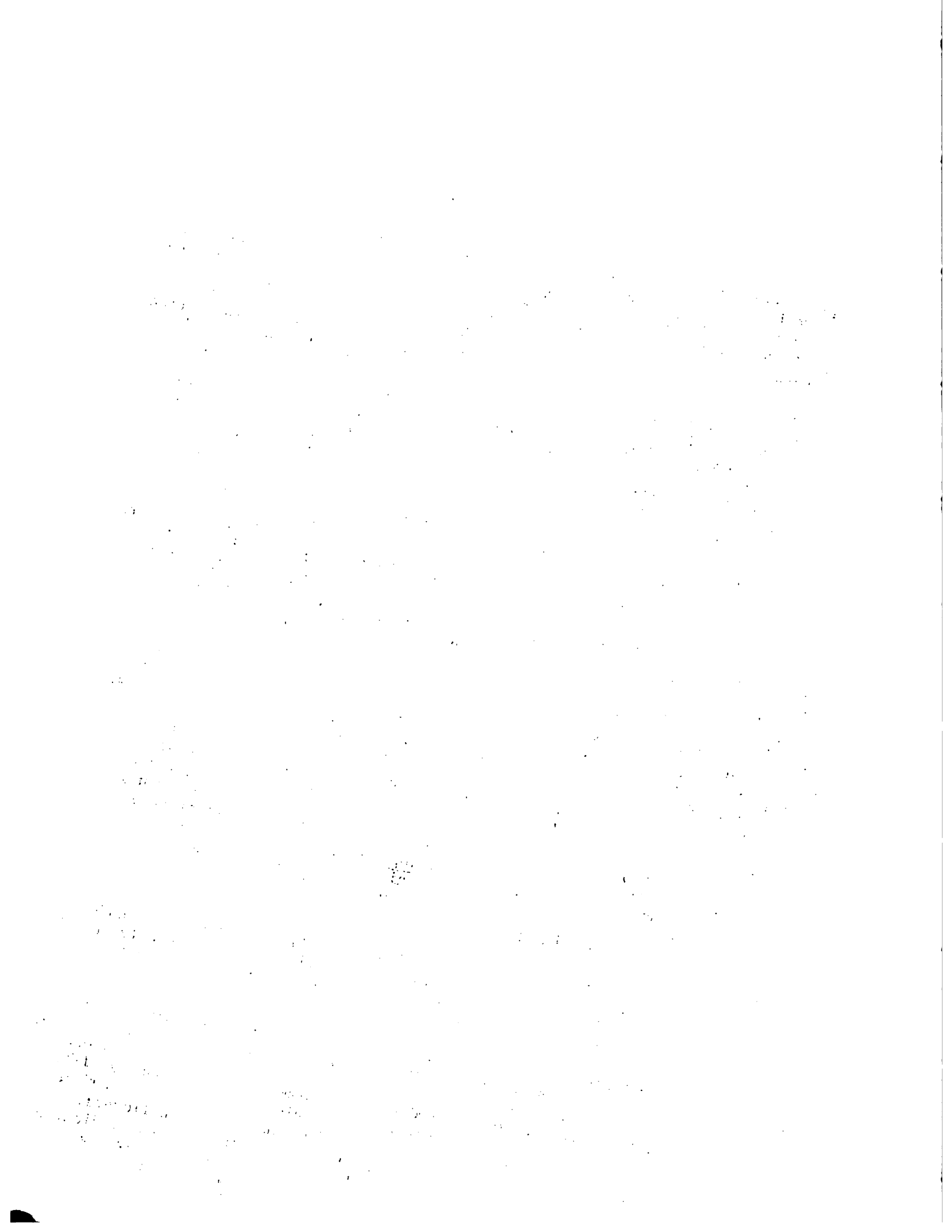
prawn culture was unknown. What are the direct and indirect roles of formula feed in the growth of prawns? Are the nutrients in these feeds directly available and utilised by the prawns, or do the feeds disintegrate and mostly just fertilise the water medium, so stimulating the primary productivity of the system? What is the role of an organic fertiliser used to supplement a pelletised feed? A Purina Marine Ration (33% protein, 5% nitrogen, 11% fat, 11.5% ash, 3% calcium and 1.5% phosphorus) was compared with a commercially composted cow manure (no protein 1%N, no fat, 51% ash, 1% Ca and 0.2%P). Postlarvae were acclimated for thirteen weeks on Purina Marine Ration plus frozen, minced fish. The experiments used four treatments, no feed, no manure (NF NM), formula feed (AF), supplementation with non-available, pulverised formula feed (NAF) and manure (M).

The formula feed was found to be directly available to, and was used for growth by the prawns. Prawns in the AF treatment grew significantly ($P < 0.05$) faster than those in the NAF, M and NF, NM treatments. After 12 weeks, the highest mean weight gain (4.8 g) was achieved by prawns 1.5 g. The mean weight gain for NM, NF prawns was only 0.2 g. Survival after 12 weeks in the M treatment ponds was 0.53, that in AF treatment 0.54, whereas the figure for NAF ponds was 0.84 and that for NF, NM ponds was 0.79.

Total dry wt. feed offered: total wet wt. increase in biomass ratios for AF treatment averaged 1.7 ± 0.11 compared with a NAF mean of 1.3 ± 0.13 and an M mean of 192 ± 22.5 . These ratios are not directly comparable because of physical and chemical differences between formulated feeds and manure. If one uses instead the utilisation of available nitrogen to make a comparison, one finds that manure is at least 38 times less efficient than either the AF or NAF treatments. General pond productivity in the NM treatment was lower than in the other treatment groups. Pelagic and benthic organisms were present in all treatments, especially numerous copepods of Cyclops sp., rotifers, paramecia, cladocerans, ostracods and ceriodaphnia. The macro benthos was poorly represented in all pools, but there were some dipteran larvae of Chironomus sp. and Chaboborus sp.

Apparent direct ingestion of formula diet resulted in growth rates by week 12 twice those of prawns fed pulverised, relatively unavailable feed, and three times those cultured under a natural productivity regime fertilised with manure.

Concerning the relation between growth rates and survival rates, AF and M treatments had low survival figures 0.54 and 0.53, respectively, while NAF and NM treatments had higher values (0.84 and 0.79, respectively). As survival rate was not related to final prawn biomass, density effect on growth was not a major factor in determining prawn growth. Although survival rates were low for both AF and M treatments, significantly higher growth rates were attained by prawns fed formula feed, indicating an independent effect of feed on growth rate. Cannibalism may have caused the higher mortality rates seen in the AF and M treatments. Further, lower growth rates in the M treatment might have been due to starvation.



Feed conversion ratios, based on total N, show that manure fertilisation is less effective for prawn growth than is pulverised formula feed. It is assumed that a major portion of pulverised feed is not ingested directly by prawns, then it follows that pulverised feed is a better pond fertilizer than manure. Yet the relation between fertilization with formula feed and manure is a function of nitrogen composition and rate of application of both feed and manure, qualities in the pond (especially resident flora and fauna), chemistry and physics of the pond water, and the type and number of the species cultured.

Other evidence suggests that natural foods in either fertilised or non-fertilised ponds are nutritionally as beneficial as pelleted formula feeds. Yet the current study shows that ponds not supplemented with formula feed, pulverised feed, or manure, produced insufficient food either directly or via natural productivity, to promote substantial growth among juvenile prawns.

The differential factor may be a micronutrient, rather than available energy level. Probably, both dietary energy and essential nutrients are equally important for optimal freshwater prawn growth. Growth rates of Macrobrachium could be improved by supplementation of high feed conversion diets in pellet form. However, feed costs constitute the larger single operating expense in prawn culture, so what is the importance of applied feeds as a direct source of nutrition? To what extent can natural productivity be augmented by indirect, additive stimulation of naturally occurring pond organisms? If formula feed is not merely an expensive fertilizer, but is directly ingested, as Fair and Fortner (1981) showed, it should become an important component in commercial prawn culture. However, these questions have not yet been answered definitively and more research is needed.

In recent years, some much-needed physiological studies have been conducted on Macrobrachium. Sandifer, Hopkins and Smith (1975) reared M. rosenbergii from eggs hatched in the laboratory and used these to study their salinity tolerance and osmoregulation. Larvae were cultured in a recirculating system using artificial seawater at c. 16‰ (Instant Ocean), and a temperature of c. 28°C in a controlled environment room; feeding was on Artemia nauplii and chopped fish daily, postlarval development required 30-40 days; after metamorphosis, postlarvae measured 8-10 mm, at which time they were transferred to 40L glass aquaria at selected salinities, postlarvae were fed a Ralston Purina experimental ration.

Mortalities occurred at salinities around 25 ppt., increasing rapidly at levels \geq 30 ppt., acclimation increased survival time at 36 ppt., significantly.

Freezing point depressions of blood in postlarvae and juveniles at various salinities from 0‰ to c. 35‰, showed blood values hyperosmotic to the medium for the range 0 to 17-18‰, and hypoosmotic at salinities higher than 18‰. Postlarvae kept blood concentration constant at a freezing point depression of $-0.89 \pm 0.13^\circ\text{C}$ over the salinity range 0 to 27-30‰, the osmoregulation falling at values \geq 30‰. Juvenile blood

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3. The third part of the document discusses the challenges and limitations of data collection and analysis. It highlights issues such as data quality, bias, and the potential for misinterpretation. The text suggests that researchers should be aware of these challenges and take steps to minimize their impact, such as using multiple data sources and conducting pilot studies to test the reliability of the methods.

4. The fourth part of the document provides a summary of the key findings and conclusions. It states that the research has shown that while data collection and analysis can provide valuable insights, it is not a straightforward process. It requires careful planning, attention to detail, and a deep understanding of the underlying concepts and methods. The document concludes by emphasizing the importance of ongoing research and collaboration in the field of data analysis.

concentrations (FPD=0.88±07°C) at 0 to c. 15% resemble those of post-larvae. Osmoregulation in M. rosenbergii resembles generally that of other brackish water species, yet as it can hyperosmoregulate effectively in freshwater, it comes close to resembling freshwater species. It seems that M. rosenbergii can conserve salt in dilute media by producing blood-hypoosmotic urine.

Osmotic work and energy consumption should be minimal for an organism in an iso-osmotic medium and the maximum number of organisms should be culturable per unit of volume of work. Singh (1980) investigated some of the literature on growth at various salinities and the osmoregulation physiology of M. rosenbergii.

Adults hyperregulate their serum osmotic concentration at a value of 397±43 mosm dm⁻³ between salinities of 0 and 17% (0.440 mosm dm⁻³). Above 17% regulation ceases and the animal is iso-osmotic with the medium so we conclude the iso-osmotic point is about 17%. Animals transferred abruptly as newly metamorphosed postlarvae from freshwater to salinities > 18% survive for only about 24 hours. Gradually acclimated larvae can survive values higher than 18%, being able to osmoregulate in the range 0 to 27% hyperegulation occurring below 17.5% and hyporegulation in the range 17.5 to 27%. Above 27%, regulation ceases and postlarvae conform in a hypoosmotic state. Osmotic concentration value of haemolymph in the regulatory condition ranged from 330 to 490 mosm dm⁻³ according to salinity of the medium. Thus, the regulatory range is wider in acclimated postlarvae than in the adult. However, with slow acclimation, the range of adults can also be increased, to almost as wide as that of postlarvae. So, salinity tolerance is almost the same in slowly acclimated postlarvae and adults as is the iso-osmotic point at 17 to 17.5%. With respect to growth at different salinities, some previous studies have shown that maximum growth of postlarvae and juveniles of M. rosenbergii occurs in the salinity range 0 to 2%, which is far from the iso-osmotic range of 17 to 17.5%.

Here are some representative results from Perdue and Nakamura (1976).

<u>Treatment</u>	<u>Growth rate (over 49 days)</u>
0%	0.47 Thus, the iso-osmotic growth
2%	0.47 concept does not hold for
8.5%	0.39 <u>M. rosenbergii</u> , probably
15%	0.25 because, in the range 0 to 2%,

the prawns can more readily take into their tissues the large amount of water needed at ecdysis to stretch the new shell, this water later being replaced by tissue in the intermolt phase. In fact, prawns reared in freshwater contain 4.5% more tissue water than those raised in salinity of 15% and higher.

In commercial culture of any animal, the reproductive behaviour of the adults is an important aspect of their biological production. It is therefore not surprising that there have been a number of studies of this aspect of Macrobrachium biology (Lewis, Ward and McIvor, 1966; Wickins

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and Bread, 1974, for example) A particularly interesting publication on breeding behaviour is that of Smith and Sandifer (1979), an account of which is given below. These workers described the construction and use of breeding depression on the bottom of the culture ponds by M. rosenbergii.

This is the first published report on the occurrence of such depressions among cultured M. rosenbergii stock, although they have not been reported for wild populations. They were constructed by males in eastern culture ponds in South Carolina at 4 widely separated locations in the state. Detailed observations and measurements were taken at 150x 17 m (0.25 ha) ponds at one location. Males here were of mean weight 147.1g, females, mean wt. 78.0 g. Before drainage, depressions were seen along dikes and in shallows, there being 1 male in each at night plus up to 4 ripe females within or on the periphery of depressions. Ten were observed and measured after drainage. All were elliptical or circular and deepest at their centres. Size range was 38x38 to 94x53 cm depths 7 to 15 cm. Maximum ratio of diameter to depth was 8:1, and ratio of major to minor axes ranged 1.1 to 1.8.1 (Sic). (i.e some were ellipses, some circles).

Differences in water quality and in soil type had no influence on the establishment of breeding depressions at various localities in South Carolina. Major factors controlling size and number of depressions are size and density of the male prawns. The larger the prawn, the larger its depression. Shallow and middle centre sections of ponds contained most depressions, with least being found at shallow ends of lateral sections (dykes) and an intermediate number occurring in deeper parts of the dykes.

Depressions may result in lowered productivity as they are made and occupied by large, dominant males that no longer grow rapidly and that utilise feed less efficiently. Further, during selective harvesting with seines, males in depressions can escape capture. The importance of these breeding depressions to the species is unknown. In indoor tanks, males readily mate with females in absence of depressions.

One problem that arises in culture facilities is predation on the stock by wild species, but surprisingly this phenomenon is little reported in the literature. When it is discussed, it tends to be in the context of some other aspect of aquaculture, so it seems there is a need for some careful studies of this potentially serious effect on cultured animals. At the same time, freshwater prawns are themselves predators in their own right. However, again this aspect of their biology has not been subjected to detailed studies. One article on predation by prawns was discovered during the carrying out of this literature review, that of Sukumaran and Kutty (1979) who investigated prey vulnerability to Macrobrachium malcolmsonii, a large south Indian species with good potential for polyculture and mass culture. Vulnerability of four pre-species was studied - a weed minnow, Aplochilus lineatus, fry of 2 exotics, Tilapia mossambica and Cyprinus carpio (Bangkok strain), and tadpoles of a frog, Rana cayanophycis. All prey individuals tested were selected in the size range 1.1-1.6 g; these were placed in a glass tank

The first part of the document discusses the importance of maintaining accurate records of all transactions. It emphasizes that every entry should be supported by a valid receipt or invoice. This ensures transparency and allows for easy verification of the data.

In the second section, the author details the various methods used to collect and analyze the data. This includes both manual and automated processes. The goal is to ensure that the data is as accurate and reliable as possible.

The third section provides a comprehensive overview of the results obtained from the analysis. It highlights key trends and patterns that have emerged from the data. These findings are crucial for understanding the underlying dynamics of the system being studied.

Finally, the document concludes with a series of recommendations based on the findings. These suggestions are intended to help improve the efficiency and accuracy of the data collection and analysis process in the future.

24x15x15 in. or 61x38x38 cm., with continuously recirculated water via a subsand gravel filter, at a temperature of 26.5° to 29°C. In each test 20 prey individuals of a given species were offered to one prawn, and the number consumed per day noted until only one remained uneaten. Then 19 of the same sp. were added to bring the number back to 20 for a second test. In this way starvation became impossible. Several prawns were tested in this way, and their 0.5 and 0.95 mean predation time were calculated at PT_{50} and PT_{95} , also calculated were mean weight of prey consumed by species per prawn and mean number of prey consumed by species per prawn. These three indices constituted measures of vulnerability.

Results were that the vulnerability scale was as follows in order of decreasing susceptibility to predation:

V frog tadpole > V minnow > V carp fry > V Tilapia fry

Taking V frog tadpole = 1.0, then using 0.5 predation times:

V minnow = 0.59; V carp fry = 0.77; V Tilapia fry = 0.36

Changes in prey density and satiation levels render all these indices imperfect, but serve as guides. For example, using weight of prey consumed per day and setting the index of V_f tadpole = 1.0, then V minnow = 0.45, V.c. fry = 0.48 and V Tilapia fry = 0.23

Vulnerability may be determined by behaviour and form of the prey and predator's innate inclinations. Tadpoles are sluggish, soft and non-spinous, so their high vulnerability is not surprising. Previous conditioning did play a role because these prawns had been raised on Tilapia fry, and yet they proved to be the least vulnerable in the experiments.

Most aquaculture facilities have to filter their culture water and the most common type of filter in use is the biological one.

A biological filter's most important function is to oxidise NH_4OH to NO_2^- by use of nitrifying bacteria because NH_4OH is the main excretory product of aquatic organisms, and it is toxic at low concentrations. Forster (1974) described experiments on nitrification in biological filters using seawater. Factors affecting nitrification were investigated in laboratory-scale biological filters supplied with dilute (1-2 mg./l. ammonia nitrogen) solutions of ammonium sulfate water at $26 \pm 2^\circ C$. Increase of hydraulic loads from 10-25 to $246 m^3/m^3/day$ caused the total quantity of NH_4OH oxidised by the filter to increase, although the proportion oxidised relative to influent concentration decreased. Decreased pH adversely affected nitrification, which stopped altogether at pH 5.5. Nitrification was inhibited at diss. O_2 values below 0.6-0.7 mg./l. Percolating (downflow) filters performed about as well as media submerged (upflow) filters. Time to onset of nitrification varied, but allowing at least 4 weeks at $26 \pm 2^\circ C$ before the filter is assumed to be fully active is recommended. (Note: Hydraulic load is

1. The first part of the document discusses the importance of maintaining accurate records of all transactions and activities. It emphasizes that proper record-keeping is essential for transparency and accountability, particularly in financial matters. The text notes that without clear documentation, it becomes difficult to track expenses and revenues, which can lead to misunderstandings and disputes.

2. The second section focuses on the role of technology in modern record-keeping. It highlights how digital tools and software solutions have revolutionized the way data is stored, accessed, and analyzed. These technologies not only improve efficiency but also reduce the risk of human error and data loss. The document suggests that organizations should invest in reliable digital systems to ensure their records are secure and easily retrievable.

3. The third part of the document addresses the legal and regulatory requirements surrounding record-keeping. It explains that various industries and jurisdictions have specific rules regarding the retention and management of records. Organizations must stay up-to-date with these regulations to avoid penalties and legal complications. The text provides a general overview of these requirements, encouraging readers to consult with legal counsel for more detailed guidance.

4. The final section discusses the importance of regular audits and reviews of records. It states that periodic audits help identify any discrepancies or areas where records may be incomplete or inaccurate. This process is crucial for maintaining the integrity of the data and ensuring that all records are properly maintained and up-to-date. The document concludes by emphasizing that a strong record-keeping system is a cornerstone of effective organizational management.

the flow rate measured as m^3 water/ m^3 filter volume per day). Failure of biological filters can be quite serious for when oxidation of ammonia is faulty nitrite is often the by product and this is very toxic to aquatic animals too. Armstrong, Stephenson and Knight (1976) reported the acute toxicity of nitrite to M. rosenbergii larvae and observed heavy mortalities because of it. Thus it is important to maintain any biological filters in the culture carefully.

Filters become particularly important in recirculation type systems. A very elegant system was built and described by New, Scholl, McCarty and Bennett (1974). This system is potentially of great value for the Pear Tree Bottom project as the basis for the experimental aquaria that we propose be included in the facility, and so it will be described here in some detail.

The compact, self-contained recirculation unit consists of 36 10 gal. acrylic sheet ($1/8''$ on bottom and three sides, $3/16''$ on back, sides strengthened with $4'' \times 3/16''$ across top rear, with side strips $1\frac{1}{2}''$ wide, top front being unstrengthened so as not to interfere with animal handling) tanks, measuring $12'' \times 18'' \times 12''$, manufactured by View-Rite Aquariums, Burlingame, Calif. A $1''$ diameter water inlet hole is bored centrally in a top-mounted back plate, $3/4''$ from back of tank; air inlet hole, $1/8''$ diameter, in back plate accepts air supply tubing, outlet hole, $1''$ diameter, is bored high in front of tank to give $10''$ depth of water. Low-level outlet with stopcock can be fitted if varying water depth is required. Tanks are covered by a $13'' \times 14''$ piece of $\frac{1}{2}''$ acrylic sheet. Tanks are mounted on a Dexion 225/S angle iron and $\frac{1}{2}''$ plywood shelf unit, with each $96'' \times 40''$ shelf supporting 12 tanks, 6 on each side; there are three such tiered double shelves, with shelf heights at $14''$, $38''$ and $62''$ above ground level. Angle iron legs are extended up to $84''$ to support air and water systems with temperature and flow rate controls. A pump, filter and heater are located on the end of the rack. Total floor area needed is 36 ft^2 . Pumped water pipes are not permanently attached, to permit tank substitutions etc.

A low pressure, high volume (Cyclonair #CHE-2, Rostron Inc., Woodstock, N.Y.) blower pump is used and can supply over 400 tanks. A pressure drop in the air system is sensed and activates a switch to turn on an emergency blower automatically. Blowers' capacity is $42 \text{ ft}^3/\text{min}$ at 0 "water pressure, with $28 \text{ ft}^3/\text{min}$ flowing at $12''$ pressure. A $3/4''$ PVC pipe controlled by a ball valve takes air from the main air supply to a $1\frac{1}{2}''$ PVC pipe controlled by a ball valve takes air from the main air supply to a $1\frac{1}{2}''$ PVC header pipe (schedule 80). Needle valves are present in the header supply pipe for each pair of tanks, mounted above and between each tank row. Tygon tubing ($1/8''$ and $3/16''$ I.D.) connects each needle valve to a glass aeration tube ($3/16''$ O.D.) inserted through the top of each tank.

Water flows by gravity from filter to $2''$ PVC water header pipes mounted above and between the 2 rows of tanks on each shelf and controlled by threaded gate valves. A constant $4''$ head of water is supplied to each tank by a $2''$ semi-circular weir cut from acrylic sheet and bonded with silicone cement into the levelled header pipe at the opposite end to

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the gate valve. A 1" hole is drilled on top of the elbow, downstream of the weir to allow observation of the water flow and its control with its gate valve. A $\frac{1}{2}$ " PVC pipe, threaded into the 2" header pipe, supplies each pair of tanks with water via a T-piece, two elbows and threaded end caps with orifices drilled in them. Water flow rates to each tank can be varied by putting on end caps with different orifice diameters. Average flow with a $\frac{1}{8}$ " orifice is about 500 ml/min, giving an 85% turnover in each tank per hour.

Water leaves each tank via a male nylon hose adapter, $\frac{3}{4}$ " diameter, attached to the tank with a PVC nut and sealed with silicone cement. Polyethylene mesh in the adaptor will prevent loss of small organisms. A flexible $\frac{3}{4}$ " vinyl tube connects the adaptor with a second hose adaptor screwed into an ABS/2" collection pipe (schedule 80). Two waste water collection pipes, one for each tank row, are needed on each shelf. One of the waste pipes also carries overflow from the header-pipe weir. At the end of each side of the rack, all waste pipes from each shelf join into one vertical pipe which empties into a control pump at floor level at the end side of the rack.

The pump is a 18" 24"12" high #R10M (J.T. Reyerson and Sons, Emeryville Calif.) polyethylene tank. Evaporation and siphoning losses are replaced via a $\frac{1}{8}$ " PVC float valve rated at 80 p.s.i. (1 p.s.i. = 0.070 kg/cm²), connected to domestic water supply. Water is pumped from pump to filter by a Model # 4E-34NR submersible pump (Little Giant Pump Co., Oklahoma City, Ok.), which can deliver 725 gal/hr. (1 gal. US=3.785 L.) at a head of 6 $\frac{1}{2}$ ". A PVC, $\frac{1}{2}$ " supply pipe (Schedule 40) to the filter has a ball check valve in it immediately above the pump, to prevent water draining from the filter into the pump in the event of pump or power failure. A $\frac{1}{2}$ " ball valve reduces flow rate to about 450 gal./hr., to provide complete turnover of all the water in the 36 tank system every hour.

The filter vessel is a 30 gal., circular, Nalge #54100, polyethylene tank. Entering water is distributed throughout the whole cross section of the filter media via a Schedule 40, $\frac{1}{2}$ " PVC pipe grid, which has $\frac{3}{16}$ " holes drilled in its horizontal surfaces at 1" intervals. The 15 gals of filter media consist of:

- (1) 4" layer of $\frac{3}{4}$ "-1" crushed rock at the bottom;
- (2) 8" layer of $\frac{1}{8}$ "- $\frac{1}{2}$ " pea gravel in middle;
- (3) 2" layer of #2 (0.05-1.0 mm) fine sand; and
- (4) 1" layer of $\frac{1}{2}$ " Dolomite

Water leaves the top of the filter vessel through a 2" overflow and distributed through the water supply header by gravity. The filter vessel is 18" in diameter and 29" high. The water level is 24" from the bottom of the vessel. The filter can be flushed with an air-water mixture supplied via a T-piece inserted in the pipe between pump and

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filter, just above the control valve, which connects up to a separate air supply system. This air line is protected by a $\frac{1}{2}$ " threaded ball check valve, controlled by $\frac{1}{2}$ " PVC needle valve, and connected to a mobile diaphragm pump (Duraise pump; Bell and Gossett-Leiman Bors., Monroe, Louisiana), producing 1.1 ft³/min. at 5 p.s.i. Upward flow filtration requires no manual attention because flushing with a water-air mixture makes the filter media lift slightly and dislodges accumulated debris. Seed new filters with gravel from an old filter, and allow some food to decompose in the system. If this is done, you can stock with animals after three days.

If salinity changes are needed, set up a second set of supply and waste pipes for each shelf, supplied by a separate filter and recirculation unit to carry seawater while the first supply set carries fresh water. Each tank should be fitted with two water inlet pipes, one of which is always sealed. To change salinity, cap the freshwater inlet and place an end cap with an orifice on the seawater inlet; detach the flexible outlet pipe from the freshwater waste pipe and connect it to the brackish water waste pipe. If a constant salinity level is required, regulate the freshwater and saltwater flow rates accordingly until the required salinity value is achieved.

For siphoning waste food and faeces, use a peristaltic tubing pump, e.g. Master flex #6005-015; Cole-Parmer, Chicago, III., capable of removing 880 ml./min.

In the final analysis, economics exerts the iron laws that determine success or failure of commercial aquaculture enterprises, although in modern society these rules are "tempered" by socio-culture consideration and political overrides. Just one example of the economic approach will be given in this review, to illustrate what can be included in the analysis. Shang and Fujimura (1977) highlighted the main components of concern in farming Hawaiian freshwater prawns. Their study embodied three sections, cost of production, realities of production and profit.

Under costs they emphasized that site selection and pond construction are the most critical factors in prawn farming, the crucial aspects thereof being water quality and water quantity, soil type and topography. Soil for earthen ponds needs to be quite impermeable to water, and pond bottoms should be fertile and productive, flat land being ideal.

Pond design is important for ease of harvesting and pond control. Use of selective seining harvesting requires ponds of 1-2 acres (0.4-0.8 ha), with a well compacted bottom and a slope of about 0.5% ($\frac{6''}{100}$)¹. A depth of 3 to 4 ft. (1.0 to 1.3 m) is ideal, with an elevation of 1.0 to 1.5 ft. above the water for the pond berm and a width of 10-12 ft. An outflow silt gate is required for rapid water discharge as needed for water level control and easy maintenance. Pond banks should have terrestrial vegetation to reduce erosion, give shelter and a habitat for macroscopic organisms.

1. The first part of the document discusses the importance of maintaining accurate records of all transactions and activities. It emphasizes that this is essential for ensuring transparency and accountability in the organization's operations.

2. The second part of the document outlines the various methods and tools used to collect and analyze data. It highlights the need for consistent data collection procedures and the use of advanced analytical techniques to derive meaningful insights from the data.

3. The third part of the document focuses on the role of technology in data management and analysis. It discusses how modern software solutions can streamline data collection, storage, and analysis processes, thereby improving efficiency and accuracy.

4. The fourth part of the document addresses the challenges associated with data management, such as data quality, security, and privacy. It provides strategies to mitigate these risks and ensure that the data remains reliable and secure throughout its lifecycle.

5. The fifth part of the document concludes by summarizing the key findings and recommendations. It stresses the importance of continuous monitoring and improvement of data management practices to stay ahead in a competitive market.

Construction cost varies with slope, soil and clearing-out required. Average cost in Hawaii in 1977 was US\$4,750/acre, including design, access road and drainage system. In addition, about 10.5×10^6 gals. of water/acre/year are required. Water pumped from a well at about 700 gals. per minute with a 10 H.P. motor can supply about 10 acres, and a 1,500 gpm, 20 H.P. motor 25 acres.

Equipment cost includes pumps, nets, truck and freezer, Equipment cost per acre decreased from about 6,100 for a 1 acre farm to about \$600 for a 100 acre farm.

Operating cost mainly involves labour, feed, cost of juvenile prawns and interest payments, which can add up to 0.7 of the total operating expenses. Labour and feed can be 0.5 of the total. Annual operating cost per acre decreases with increase in farm size, especially the labour costs.

Labour cost is high because harvesting and feeding are manual operations. In Hawaii, labour accounts for 0.42 of total operating costs for a 1 acre farm and 0.23 for a 100 acre farm as labour efficiency increases with farm size. About 0.25 man years per acre is needed for a 1 acre farm and 0.1 man years per acre on a 100 acre set-up. Harvesting takes about 0.48 of the total labour time and feeding about 0.23 of it. Other tasks were weeding, bank repairs and silt pumping, accounting for, respectively, 0.17, 0.07 and 0.05 of labour time. In Hawaii, feed costs account for about 0.13 of total annual cost for a 1 acre (Cf) relates to production per acre (Q), conversion ratio of feed to prawn (R) and feed price, by the expression:

$$Cf = Q.R.Pf$$

Chicken broiler starter has been the basic prawn food in Hawaii, its price being 12¢ a lb. in 1977. With a current feed conversion ratio of 3.3:1, feed cost is 40¢ per lb. of prawn harvested. Broiler starter is optimal neither in nutritive value for prawns nor in cost effectiveness, so that a feed formulated on the basis of knowledge of prawn nutritional needs is very desirable for more efficient prawn farming.

The cost of juveniles is an extra cost to those farmers who buy juveniles from a hatchery. The cost of production of the juveniles at a hatchery is about \$6.00 per 1,000. A good juvenile stocking rate is about 2 per ft² of water surface area. With continuous harvesting and stocking, with a mortality of 0.5, about 70,000 juveniles are needed per acre per year.

The electricity cost consists of costs for light, power tools, machines and pumps. About 10.5×10^6 gals. of water/acre/year are required. In Hawaii in 1977, cost of electricity was 7¢/KWH.

Other operating costs will include about 9% interest on construction costs in 1977, depreciation costs based on physical life of facilities and equipment, and miscellaneous costs.

1. The first part of the report deals with the general situation in the country and the position of the various groups. It is a very good summary of the situation and gives a clear picture of the various groups and their interests.

2. The second part of the report deals with the economic situation and the various measures that have been taken to improve it. It is a very good summary of the economic situation and gives a clear picture of the various measures that have been taken.

3. The third part of the report deals with the social situation and the various measures that have been taken to improve it. It is a very good summary of the social situation and gives a clear picture of the various measures that have been taken.

4. The fourth part of the report deals with the political situation and the various measures that have been taken to improve it. It is a very good summary of the political situation and gives a clear picture of the various measures that have been taken.

5. The fifth part of the report deals with the cultural situation and the various measures that have been taken to improve it. It is a very good summary of the cultural situation and gives a clear picture of the various measures that have been taken.

6. The sixth part of the report deals with the foreign relations and the various measures that have been taken to improve them. It is a very good summary of the foreign relations and gives a clear picture of the various measures that have been taken.

7. The seventh part of the report deals with the future of the country and the various measures that have been taken to improve it. It is a very good summary of the future of the country and gives a clear picture of the various measures that have been taken.

Production mainly affected by stocking, survival, growth and harvesting rate. About 0.03-0.05 of the pond's prawn population reaches market size (c. 10 animals/lg.) about 7 to 8 months after stocking. Harvesting can be undertaken every 3 weeks, yielding about 175 lbs./acre/harvest. Restocking is done as the population decreases. Total production of about 3,000-3,500 lbs marketable prawns/acre/year can be attained, the common mortality rate being about 0.5.

Profit depends on production, operation costs and market price. Production level and costs depend on management skill, farm size and level of technology applied. Price is determined by demand.

Market segments for prawns:

- (1) wholesale market
- (2) restaurants and hotels
- (3) retail markets (stores, supermarkets)

Farm price is US\$3.00/lb (whole) to wholesalers and US\$3.50/lb. to restaurants and retailers. Profit and rate of return increase with increase farm size and with increase in level of production. Rate of return on investment ranges from 0.6% for a 1-acre farm to 75% for a 100-acre farm when annual production reaches 3,000 lbs/acre, but increases to 11% and 96%, respectively, at 3,500 lbs/acre. A fairly economical starting size appears to be a 10-20 acre farm. When enough experience has been gained at this level, expansion to 100 or more acres becomes desirable.

Areas for which improvement and further research are needed:

- (1) Pond design;
- (2) Harvesting techniques
- (3) Pond management;
- (4) Cost-effective feed;
- (5) Genetic improvement;
- (6) Processing of market product

Some other general figures:

- (1) Given an annual market demand of 10^6 lbs., about 330 acres of ponds would be needed, and 23×10^6 juveniles must be available to stock these ponds
- (2) A country would gain an edge in competing in the world market if it had access to the following:

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consistently warm weather year round, inexpensive land and cheap labour.

- (3) Hawaii is faced with very expensive land costs, unavailability of land for production, and high labour costs, and because of these disadvantages is facing cost difficulties for world market penetration. Consequently, Hawaii's production in 1977 was all sold in the State.

These general characteristics of Hawaiian freshwater prawn farming for profit had not changed much by 1980. Shang (1981) summarized the situation there and concluded that profit still related to farm size and that small (1-5 acres) farm could be viable only as family ventures with virtually free labour. In addition, Hawaii has experienced inordinate inflation rates, raised energy costs and wage increases, inflated land prices and water use restrictions by government. Suffice it to say here that Jamaica is favourably situated, in comparison on all these counts except the last-mentioned. However, at Pear Tree Bottom River, water shortage is non-existent. Also, Hawaii recently has experienced a cost-prize squeeze where production costs in 1976-1980 increased 37% and prawn farm prices rose by only 30%. Of interest here is that even into 1981, in Hawaii climate, labour and land costs combined to exclude the State from the world export market. Jamaica feeds none of these restrictions so prawn aquaculture should support a valuable export industry.

On this note, Alston (1981) noted the advantages of the Caribbean area for *Macrobrachium* culture, which he listed as year round ideal climate and proximity to the markets of North and South America. For Jamaica we could add the attributes of clean water and cheap land and labour.

This concludes the survey of the scientific and technical literature that is relevant to the substance of this report.

However, for specific information on Pear Tree Bottom River System, limited as this is, please consult Anon. 1973; Barber, 1968; Donaldson, 1970; FAO-UNDP, 1974; and Inv. Bull., 1978/1979.

VII. Recommendations on Developing an Aquaculture Research Complex

The goal is to use a flowing freshwater and pumped seawater system as a research tool to investigate relative reproduction and production rates of four species of Macrobrachium shrimps.

It is important to plan requirements for types of materials, seawater distribution and filtering, freshwater supplies, services like compressed air and nutrient supply, and quality control testing. The scale of the experiments also has to be decided upon. To be taken into consideration as well are legal, marketing, political and regulatory aspects of the operation of the complex. Later if success is achieved,

1. The first part of the document discusses the importance of maintaining accurate records of all transactions and activities. It emphasizes that proper record-keeping is essential for transparency and accountability, particularly in financial matters. This section also touches upon the legal implications of failing to maintain such records, which can lead to severe consequences for individuals and organizations alike.

2. The second part of the document delves into the specific requirements for record-keeping, including the types of documents that must be retained and the duration for which they should be kept. It provides a detailed overview of the various categories of records, such as financial statements, contracts, and correspondence, and outlines the best practices for organizing and storing these documents to ensure they are easily accessible when needed.

3. The third part of the document addresses the challenges associated with record-keeping, such as the volume of data generated and the risk of data loss or corruption. It offers practical solutions and strategies to overcome these challenges, including the use of secure digital storage solutions and the implementation of robust backup and recovery procedures. Additionally, it discusses the importance of regular audits and reviews to ensure the integrity and accuracy of the records.

4. The final part of the document provides a summary of the key points discussed and offers concluding remarks on the overall importance of record-keeping. It reiterates that maintaining accurate and complete records is not only a legal obligation but also a fundamental aspect of good business practice and responsible management. The document concludes by encouraging individuals and organizations to take proactive steps to ensure their record-keeping practices are up-to-date and compliant with all relevant regulations and standards.

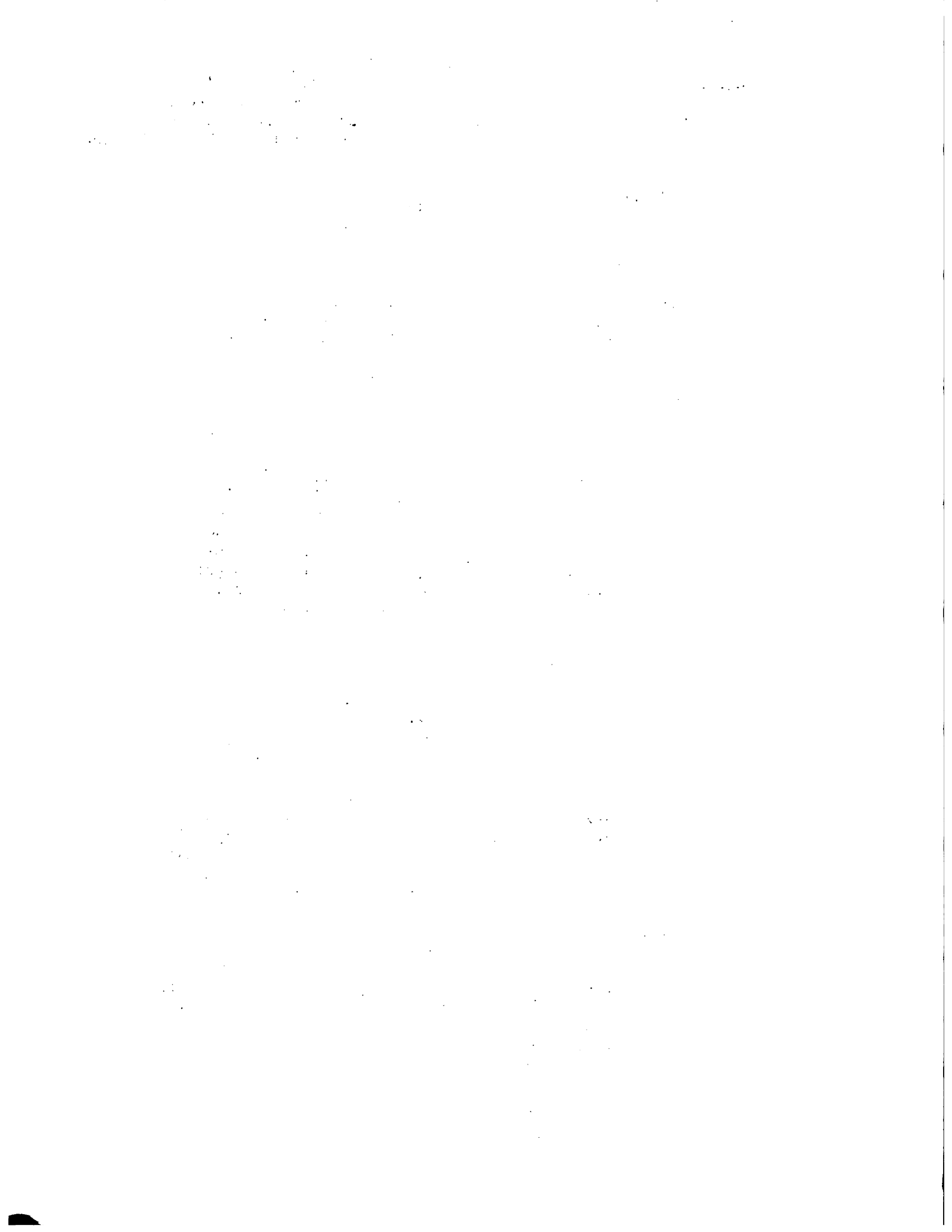
an economic analysis of scaled-up systems has to be conducted. Finally, serious thought should be given to the possibility of developing a multi-species, multi-tropic level system rather than a separated species, single tropic level system.

Much of the basic biological knowledge required for setting up an aquaculture system is unavailable and some design variables have not been adequately investigated or documented. Thus we should test rather small systems first and scale up later, the design process and the scientific programme necessarily proceeding in parallel. The development approach should include:

- (i) collection of information on previous similar endeavours carried out by others
- (ii) small scale testing; and
- (iii) careful, step-by-step refinement of design; the research and the development of the actual facilities must proceed hand-in-hand, with planning horizons at 12-15 months

Some specific design features:

- (1) For flexibility of modification and low cost, keep as much piping as possible above ground level. Centralise the water supply and provide easy access to it wherever possible by passing it through raised channels fitted with removable covers. Cross connections can easily be added, as needed. Thus pipes carrying raw seawater, filtered seawater, freshwater, nutrient supply, electric power, drainage waters, oil-less low pressure air, and sewage will be easy to check, service and repair.
- (2) Design the outdoor ponds to hold a variable depth of water to accommodate changing needs.
- (3) Have drains at both ends of any raceways, and install removable wall baffles so that they can be operated in series as well as in parallel.
- (4) Indoor wet laboratories should be designed for flexibility, with all services overhead. Use plenty of spot drains to keep the floor dry, with a handling capacity sufficient to deal with maximum flow rates, such as occur when the drain plugs of all tanks are pulled open at the same time.
- (5) There should be two, not one, seawater intakes; only one of these should be in operation at any given time, while the other is either being serviced or cleaned, or is simply shut down. The pump station should have two self-priming, non-clog pumps. Install a chlorinator on the discharge line to prevent fouling.



- (6) A continuously operating, biological sand filter that automatically backflushes itself at regular intervals, and consisting of layers of rocks, oyster shells and sand, can be readily installed. Turbidity sensors can be included that switch on the back-flushing mechanism more frequently if the incoming water should become more cloudy.
- (7) If possible, use a gravity flow system where water elevations are controlled with standpipes and overflows. Flow rates can be controlled with calibrated orifices or valves.
- (8) Take discrete water samples and test the water quality regularly.
- (9) Consider the installation of a comprehensive alarm system to monitor water flows, electric power currents, air supply pressures and the like, so that any interruption of normal operating services will result in signals being sent to an alarm panel or to a telephone line attended by a staff member.

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1. The first part of the document discusses the importance of maintaining accurate records of all transactions and activities. It emphasizes that proper record-keeping is essential for transparency and accountability, particularly in financial matters. The text notes that without clear documentation, it becomes difficult to track expenses and revenues, which can lead to misunderstandings and disputes.

2. The second section focuses on the role of technology in modern record-keeping. It highlights how digital tools and software solutions have revolutionized the way data is stored and accessed. These technologies not only improve efficiency but also reduce the risk of human error and data loss. The document suggests that organizations should invest in reliable digital systems to ensure their records are secure and easily retrievable.

3. The third part of the document addresses the legal and regulatory requirements surrounding record-keeping. It explains that various industries and jurisdictions have specific rules regarding the retention and management of records. Compliance with these regulations is crucial to avoid legal penalties and ensure the integrity of the organization's operations. The text provides a general overview of these requirements, encouraging organizations to consult with legal counsel for more detailed guidance.

4. The fourth section discusses the importance of regular audits and reviews of records. It states that periodic audits help identify any discrepancies or inaccuracies in the data, allowing for timely corrections. Additionally, audits provide an opportunity to assess the effectiveness of the record-keeping processes and make necessary improvements. The document stresses that a proactive approach to auditing is key to maintaining high standards of record-keeping.

5. The final part of the document concludes by reiterating the overall significance of record-keeping. It summarizes the key points discussed, including the need for accuracy, the use of technology, adherence to legal requirements, and the importance of regular audits. The text encourages organizations to adopt a comprehensive and systematic approach to record-keeping to support their long-term success and growth.

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1. The first part of the document discusses the importance of maintaining accurate records of all transactions and activities. It emphasizes that this is essential for ensuring transparency and accountability in the organization's operations.

2. The second part of the document outlines the various methods and tools used to collect and analyze data. It highlights the need for consistent and reliable data collection processes to support informed decision-making.

3. The third part of the document focuses on the role of technology in modern data management. It discusses how advanced software solutions can streamline data collection, storage, and analysis, thereby improving efficiency and accuracy.

4. The fourth part of the document addresses the challenges associated with data security and privacy. It stresses the importance of implementing robust security measures to protect sensitive information from unauthorized access and breaches.

5. The fifth part of the document explores the ethical implications of data collection and analysis. It discusses the need for transparency in data handling practices and the importance of obtaining informed consent from individuals whose data is being collected.

6. The sixth part of the document provides a detailed overview of the data analysis process. It describes various statistical and analytical techniques used to extract meaningful insights from large datasets.

7. The seventh part of the document discusses the importance of data visualization in communicating complex information. It highlights how visual representations such as charts and graphs can make data more accessible and understandable for stakeholders.

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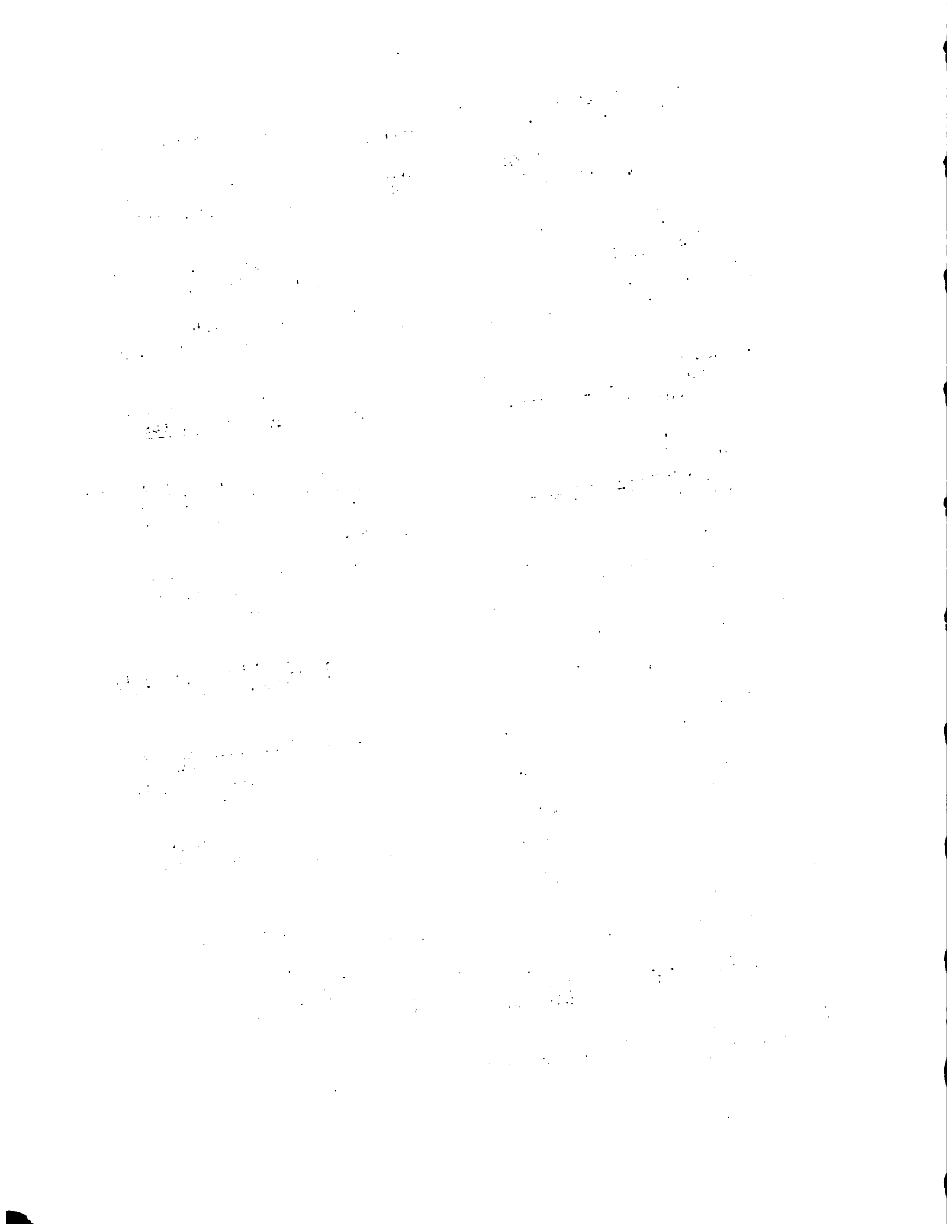
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In the second section, the author outlines the various methods used to collect and analyze the data. This includes both primary and secondary data collection techniques. The primary data was gathered through direct observation and interviews with key stakeholders. Secondary data was obtained from existing reports and databases.

The third section details the statistical analysis performed on the collected data. Various tests were conducted to determine the significance of the findings. The results indicate a strong correlation between the variables being studied, suggesting that the observed trends are not merely coincidental.

Finally, the document concludes with a series of recommendations based on the research findings. These suggestions are aimed at improving the efficiency of the current processes and addressing the identified areas of concern. It is hoped that these measures will lead to a more streamlined and effective operation.

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1. The first part of the document discusses the importance of maintaining accurate records of all transactions. It emphasizes that this is crucial for ensuring the integrity of the financial statements and for providing a clear audit trail.

2. The second part of the document outlines the various methods used to collect and analyze data. It includes a detailed description of the sampling techniques employed and the statistical tests used to evaluate the results.

3. The third part of the document presents the findings of the study. It shows that there is a significant correlation between the variables being studied, and that the results are consistent with the hypotheses.

4. The fourth part of the document discusses the implications of the findings and provides recommendations for future research. It suggests that further studies should be conducted to explore the relationship between the variables in greater detail.

5. The fifth part of the document concludes the study and summarizes the key points. It reiterates the importance of accurate record-keeping and the need for ongoing research in this area.

6. The final part of the document includes a list of references and a list of figures. The references cite the works of other researchers in the field, and the figures provide a visual representation of the data presented in the text.

APPENDIX A

REPORT ON PEAR TREE RIVER BELLE AIR

To: The Director of Inter-American Institute for Co-operation on
Agriculture, Jamaica Office

As instructed by Dr. Aitken I visited the Belle Air property and carried out the survey of that part of the property which has been stated as the site of the Crayfish Farm Project.

The turn off to the site is on a stone/dirt road on the left of the main road to Discovery Bay about $1\frac{1}{2}$ (one and a half mile) from the Brown's Town crossing. There is no visible sign pointing out the turn.

The stone/dirt road is for most of its length on solid ground on the top side of the spring line. After about half ($\frac{1}{2}$) a mile it crosses the swamps via a long culvert. At the end of the culvert it makes a right turn through a large wooden gate opposite some old milking sheds. The road enters the compound after about twenty chains.

The compound as shown on the site plan, sheet 1, is on a sloping ground with the swamp line approximately on the upper neat line. There are two large houses and three(3) support buildings. The main project building, No. 1, is on the left and the caretaker's cottage, No. 5, is on the right. The pump house No. 2 is straight ahead. The kitchen/store-room No. 4 and toilet is off to the right. Fruit trees overhang the compound. Most of the space in between the buildings has been compacted by usage and the addition of stony material over the years. Farm animals - cows, goats, chickens, and pigs move freely from water trough to pasture and so on. They are government caretaker's stock. Elsewhere on the property outsiders graze and water their cattle. There is talk that wild hogs also roam the swamps.

THE BUILDINGS

The main building No. 1, see floor Plan Sheet No. 2, consist of nine (9) rooms. A large utility room R1-1, 51 ft by 22 ft 6 ins; six (6) rooms R1-2A to R1-2F, 14 ft by 11 ft 6 ins; a small room R1-3 6 ft by 10 ft; and the bath/toilet area R1-4A 11 ft by 7 ft, R1-4B 14 ft by 10 ft and R1-4C 10 ft by 18 ft.

This building is approached using a 7 ft long two (2) tred step cut into a concrete landing 11 ft by 90 ft. From the landing one steps unto a verandah area 7 ft 6 ins by 78 ft. The roof of the verandah area is an extension of the main roof and is supported by a 21 in. deep beam with 8 ft 6 ins. 2 in. diameter steel pipes 12 ft on centers. Doors lead the verandah into the rooms. These doors are veneer ply doors 3 ft wide 7 ft high with a fan light 1 foot on top. One steps up five (5) inches into the rooms.

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Room R1-1 is ventilated by five sets of windows as shown on plan and cross-sections. A 'bar' counter 2 ft 6 ins high by 2 ft 6 ins wide, 11 ft from the rear wall spans the room. There is a kitchen style twin sink with 2 ft standing cupboards as well as hanging cabinets at the rear of the room. Two exit doors are also shown. The rest of the room is open. The height of the room slopes evenly from 12 ft at the front to 7 ft 8 ins at the back.

Room R1-2A is entered through a centre door, as before described. They are completely enclosed with a rear window 3 ft 6 ins, 3 ft from the right and a 3 ft Vee jointed door at the left.

Room R1-3 is small, one enters through a centre door as before described. Facing the door is a 2 ft 6 ins louvre window the only glass window, all the rest being metal жалousies.

The bath/toilet area is entered via a small alcove. Room R1-4A contains space and plumbing for five wash basin one of which is missing. Head high walls separates it from R1-4B where there are three (3) water closets cubicles (low wall W.C.) served by a wide L shaped passage.

A two (2) inch step down takes one into R1-4C onto a landing. There is a 2 ft wide shower stall 5 ins below the surface of the 7 ft landing. There is plumbing for a six (6) showers in this open stall. Rear exit is provided by a 3 ft door at the right.

Through this door one steps four inches onto a 10 ft rear landing where all the rear doors from R1-2A to R1-2F and a side door from R1-1 opens. On the outside rear of R1-4C there are four 2 ft by 2 ft wash tubs.

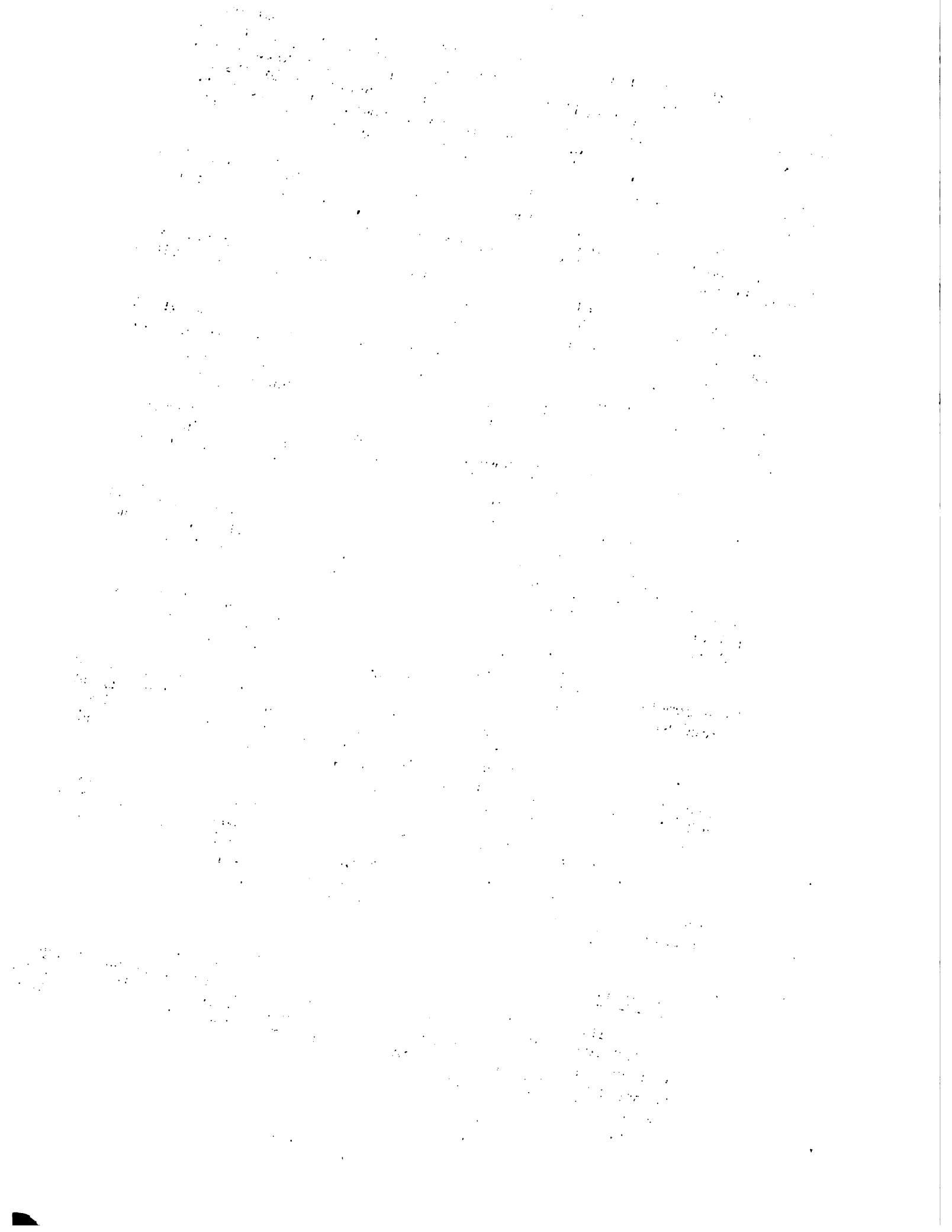
The floor of Building 1 is good concrete slab float finished with cement mortar and blocked. The walls are of concrete blocks reinforced with steel and rendered in and out with cement mortar.

The walls are plated with 2"x4" sills, rafters are 2"x4" spaced 2 ft 6 ins on centers. In R1-1 there are two 8"x12" concrete beams and three (3) 3"x6" wooden beams helping to support the rafters. On the rafters there is 1"x10" sarking onto which a mixture of aluminium and galvanized iron sheets are nailed to complete the roof.

The caretakers cottage No. 5 has two bed rooms. It has wide enclosed verandahs and a shed to the left. It is in need of repairs to walls, roof and floor. The out buildings No. 3 and No. 4 are in good repairs. Building No. 2 is the old pump house - it is derelict. And as it stands, it can only be rebuilt not repaired.

ELECTRICITY

The compound is served by both 120 and 240 volts power lines. The 240 volts goes to the pump house, the 120 to the other buildings. On Building #1 R1-1 is supplied with overhead bulbs 7 ft 6 ins on centres. It has twin wall plugs over 14 ft 20 ins from floor. The main breaker panel is also in the room:



Room R1-2S all have a central roof bulb and twin outlets on the rear wall five (5) ft from the right. Room R1-3 is similarly lit. The bath/toilet areas are also lighted. Switches are on the inside of the entrance doors. The wiring is 'in house' through pipes. It should be possible to increase coverage by rewiring.

WATER

Water is supplied by pump from the well in No. 2. The pumps are not now working. In times past the pumps supplied all the property, it was drinkable, now it can only be used to water cows and land. A new well has been sunk about three (3) chains from the main building. The water has been tested found good and only needs to be harnessed.

The sink in R1-1 the bath rooms in R1-4 and the wash tubs are all supplied by 3/4" pipe from the water tank at the back. It has a head of over 10 ft, when full, it will supply the building adequately.

There is a 4 ft cube water tank for the caretaker area by the kitchen. At the time of the survey there was no water for testing. The plumbing is in place and the pipes take off the water.

There are no telephone services on the compound.

CONCLUSION AND RECOMMENDATIONS

The Building No. 1 is in very good repairs. With modification it can be used for the stated project. Walls can be knocked out or added. More plumbing can be added by cutting walls and or floors. The electrical fittings and supplies can be improved by refishing new wires in and additional ones where needed.

The area between the Buildings could be paved and a chain link fence at least, is a must around the needed perimeter.

Rudolph Brown

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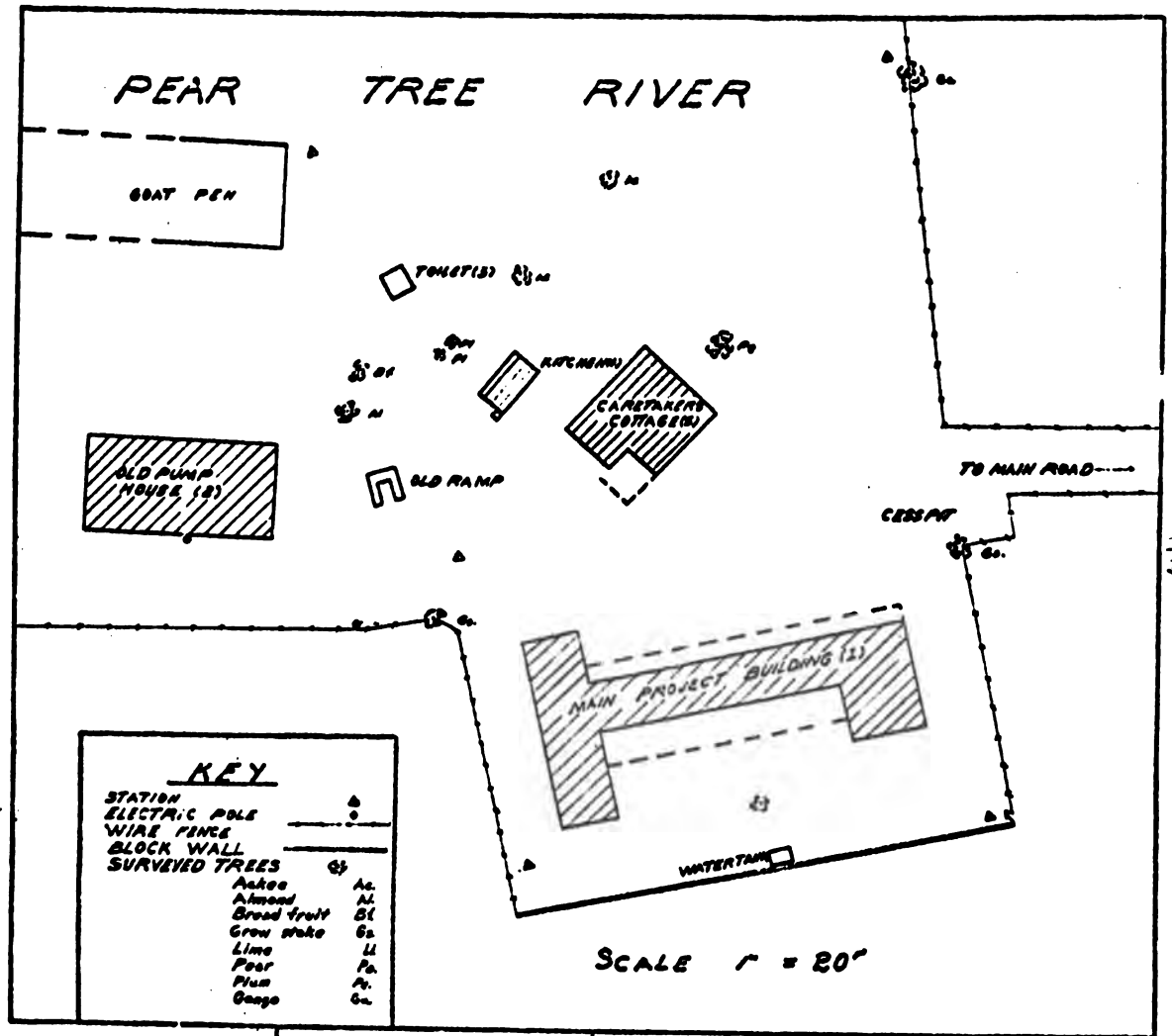
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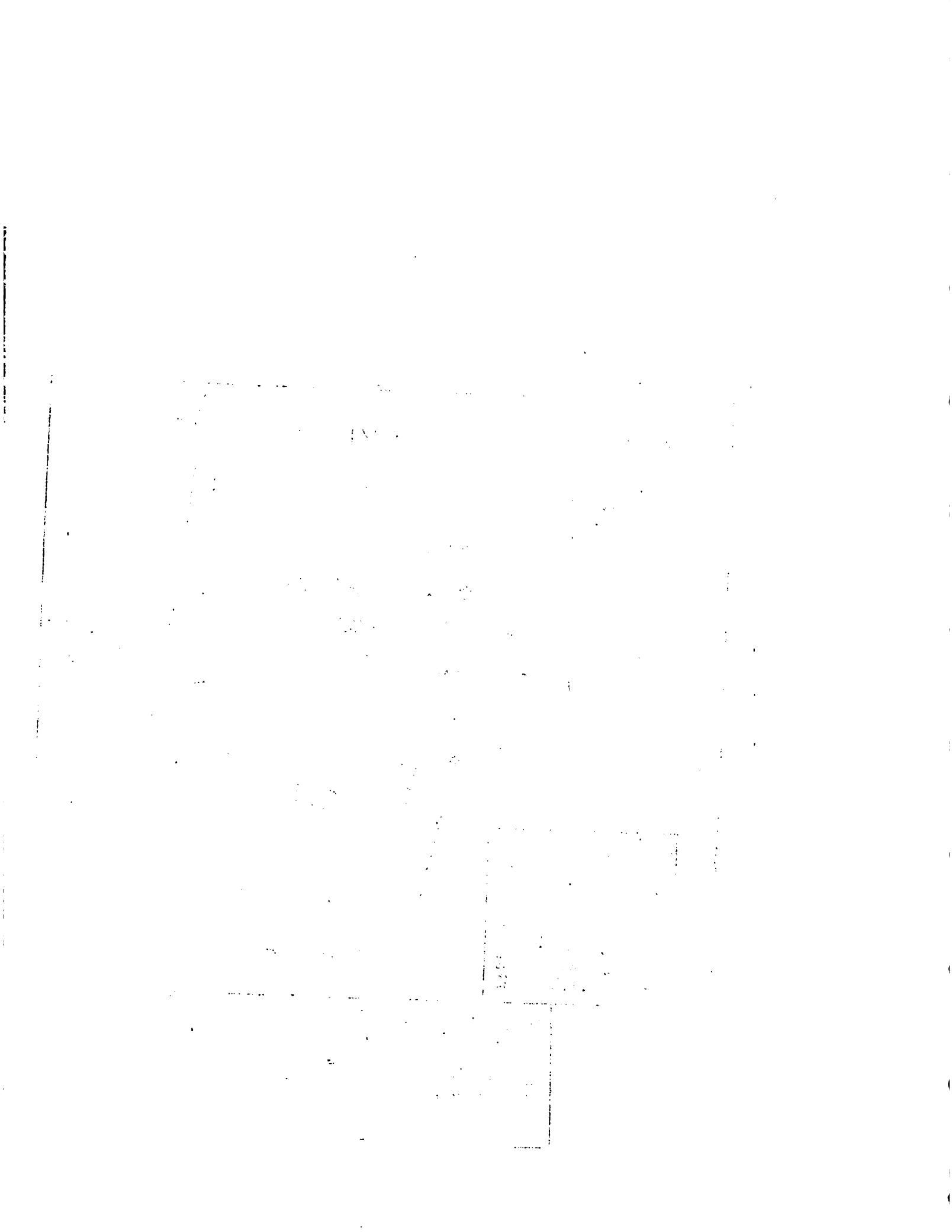
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APPENDIX A

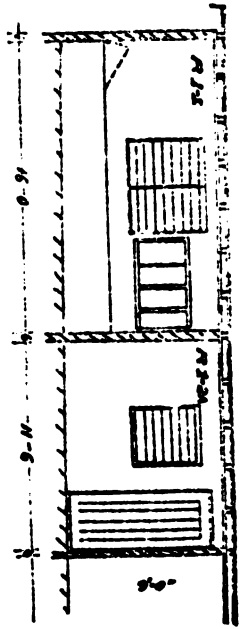


PEAR TREE RIVER
 PART OF
 BELLE AIR ST. ANN
 PREPARED FOR
 I. I. C. A.
 "CRAY FISH FARM
 PROJECT"

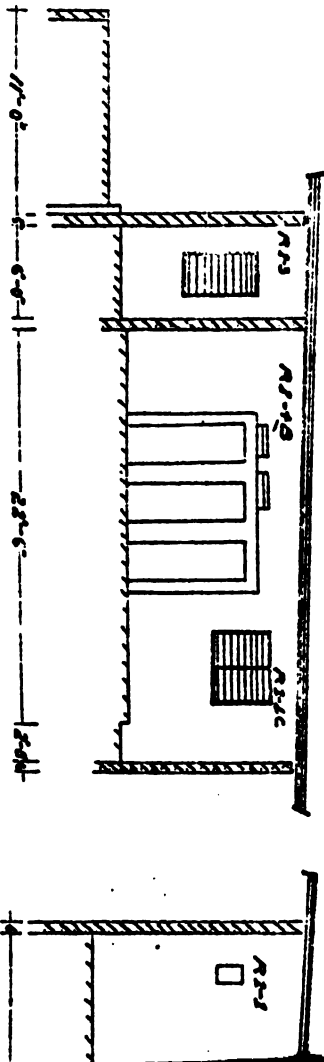
SHEET # 1
 SHEET # 2 OF 3
 SITE PLAN
 SCALE 1" = 20'
 DATE: 15 APRIL 1982
 RUDOLPH F. BROWN
 DRAUGHTSMAN



APPENDIX A



SECTION A - A (REVISED)



SECTION B - B

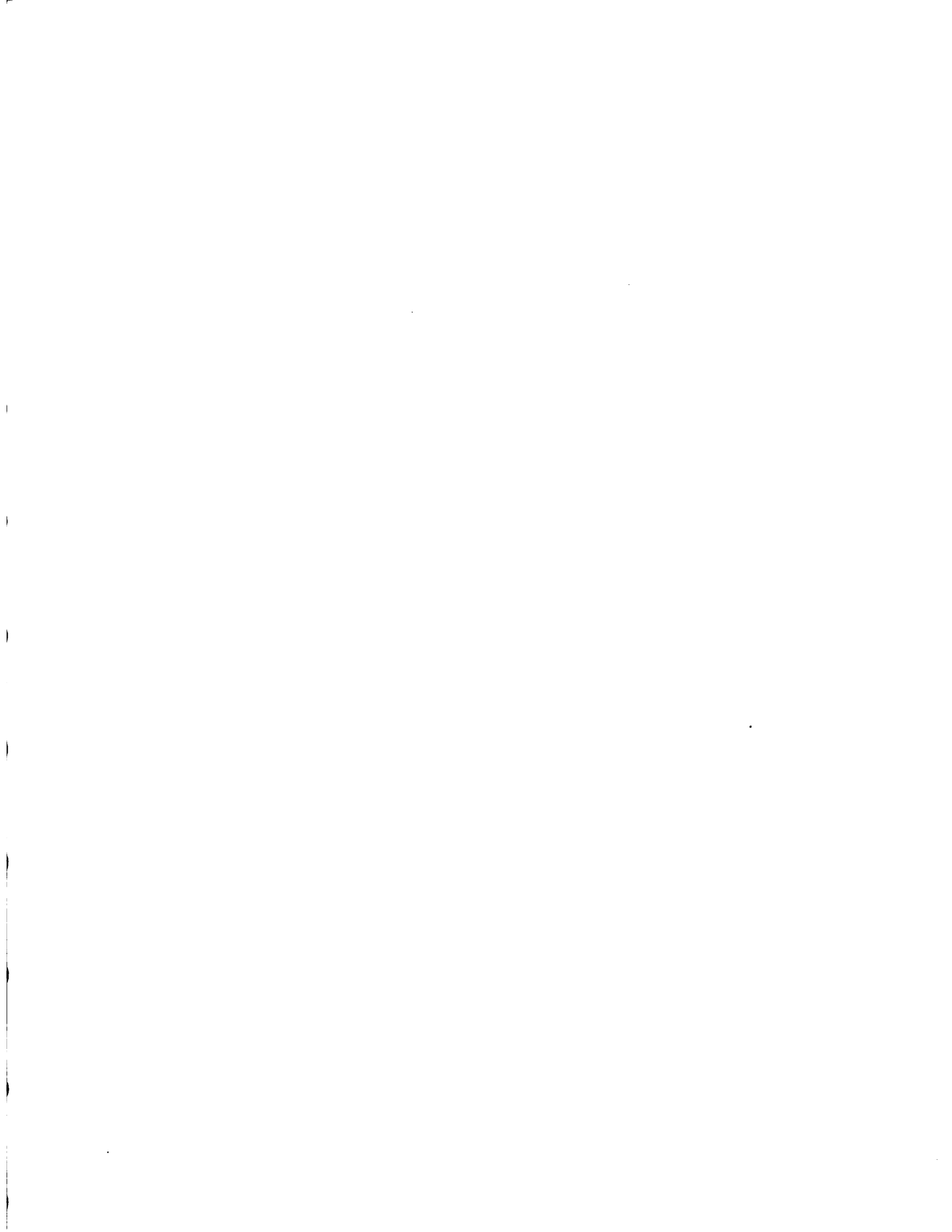
PEAR TREE RIVER
BELLE AIR ST. ANN
I. I. C. A.
CRAY FISH FARM
PROJECT

SHEET #
SECTIONAL VIEWS
SCALE 1" = 4'-0"
DATE: B. APRIL 1982
RUDOLPH F. BROWN
ARCHITECT

1974

1974

1974



Hydrological and geological data on Pear Tree River Bottom System, St. Ann Parish, Jamaica, West Indies¹

1. Hydrological (water chemistry and water quality) data

JAMAICA GRID REFERENCE	ALKALINITY (mg/l)	CALCIUM (mg/l)	CHLORIDE (mg/l)	CARBONATE (mg/l)	COLOUR (S.U.)	HARDNESS (mg/l)	BICARBONATE (mg/l)	MAGNESIUM (mg/l)	NItrate (mg/l)	pH	SULFATE (mg/l)	SPECIFIC CONDUCTIVITY (microhm/cm)	TOTAL DISSOLVED SOLIDS (mg/l)	TURBIDITY (S.U.)
A. SPRINGS AND RIVERS														
152-240	152-240	58.4-108.0 ⁷	14.0-1,7500 ⁷	5.0-52.0 ⁷	15-135	190-550 ⁷	116-240	11.3-68.6 ⁷	2.7-39.9 ⁷	7.0-7.6 ⁷	0.6-100.0 ⁷	360-3,844 ⁷	156-2,231 ⁷	0.7-31.0
188-2526.36	188-2526.36	73.90±15.68	58.33±06.70	23.25±20.19	-	292.00±120.06	177.13±37.59	27.44±22.17	9.45±12.46	-	26.88±2.71	996.25±1,230.29	566.75±719.09	11.19±1.2
9-50	9-50	5.93	43.56	11.66	-	49.38	14.21	8.58	4.71	-	21.35	403.01	277.79	-
NUMBER OF SAMPLES (n)	3	5	7 ⁸	4	8	8	8	8	8	8	8	8	8	8
B. SPRINGS														
176-240	176-240	58.4-82.4	14.0-28.0	16.0-20.0	15-125	190-270	160-240	11.3-17.6	3.1-7.9	7.30-7.35	1.47±0.76	360-502	196-260	0.7-31.0
201.20±23.90	201.20±23.90	70.72±8.81	18.40±5.86	18.00±2.85	-	229.20±34.83	194.00±30.73	14.82±2.87	5.46±2.28	-	0.44	102.80±58.83	239.00±26.49	10.31±1.7
10.69	10.69	3.94	2.62	2.00	-	15.58	13.74	1.28	1.02	-	5	26.76	11.95	-
NUMBER OF SAMPLES (n)	5	5	5	5	5	5	5	5	5	5	5	5	5	5
C. SPRINGS														
152-240	152-240	58.4-108.0	14.0-1,7500	5.0-52.0	15-135	256-550	116-184	20.0-68.6	2.7-39.9	7.00-7.60	30.0-100.0	420-3844	150-2331	1.9-31.0
109.83±16.00	109.83±16.00	79.72±5.76	552.00±546.78	28.50±33.23	-	396.67±147.41	149.00±34.04	48.47±25.35	16.10±20.67	-	65.00±49.50	1959.67±1738.13	1128.00±1,085.87	11.33±1.1
9.24	9.24	14.58	373.12	23.50	-	85.11	19.66	14.64	11.92	-	35.00	1003.51	892.29	-
NUMBER OF SAMPLES (n)	3	3	3	3	3	3	3	3	3	3	3	3	3	3

Footnote follows on page 76



- NOTES:
1. These data are taken from an internal draft report drawn up jointly by several people and using various sources (e.g. FAO/UNDP/survey of Jamaica (1974), Barker (1968), Donaldson (1970) (Compiler), Investigations Bulletin (1978/1979), a copy of this draft report (Anon. 1973) is in IICA files.
 2. S.D., Standard deviation, = $\pm \sqrt{\frac{\sum X^2 - (\sum X)^2/n}{n-1}}$
 3. S.E., Standard Error = $\frac{S.D.}{\sqrt{N}}$
 4. N = sample size
 5. S.I.U., Standard International Unit
 6. $\mu\text{mhos/cm}$, resistance in micro-ohms per centimeter of water.
 7. The upper part of these ranges is the effect of tidal sea-water mixing with river water.
 8. The largest reading (1,250.0 mg/l) was not included in the analysis as it is incompatible with the rest of the data.
 9. Means, standard deviations and standard errors were not computed for colour and pH for these qualities are based on arbitrary and on logarithmic scales, respectively; the variables in both instances, therefore, are not normally distributed so that parametric statistics are inapplicable to them.

THE UNIVERSITY OF CHICAGO
DEPARTMENT OF CHEMISTRY
5800 S. UNIVERSITY AVENUE
CHICAGO, ILLINOIS 60637

MEMORANDUM FOR THE RECORD
SUBJECT: [Illegible]

[Illegible text follows, consisting of several paragraphs of faint, mostly illegible text.]

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II. Geological (water flow rates) data¹

BROWNS TOWN AND VICINITY (7km inland, (approx.))		VICINITY OF FRESHWATER SPRINGS (2.0-2.5 km inland, approx.)		VICINITY OF COASTLINE, UP TO ELEVATION OF 15 m approx. (up to 1 km inland, (approx.))									
INFLOW FROM CRETACEOUS LIMESTONE (mx10 ⁶ /month) (mx10 ⁶ /year)		DISCHARGE OF SPRING NO.1 (MAP 1) SIX OTHER SPRINGS (ft./day)		DISCHARGE OF ALL SPRINGS (ft./day)		CITYFLOW FROM RAIN (mx10 ⁶ /month) ²		RECHARGE FROM RAIN (mx10 ⁶ /month)		RIVER SYSTEM OVERFLOW (mx10 ⁶ /month)		ESTIMATED SUBSURFACE FLOW TO SEA (REMAIN-DER (mx10 ⁹ /month)	
YEAR	Average per month	Annual total	Daily average	Daily average	Daily average	Average per month	Annual total	Average per month	Annual total	Average per month	Annual total	Average per month	Annual total
1970	No data	No data	No data	No data	No data	No data	No data	No data	121	7.00±0.00	84	No data	No data
		78.5±85.5 (S.E.±24.7)								(S.E.±0.00)	(est) ²		
1971	3.67±1.87 (S.E.±0.54)	44	No data	No data	No data	53.58±42.77 (S.E.±12.35)	643	7.16±6.59 (S.E.±1.90)	96	7.00±0.00 (S.E.±0.00)	84	11.50±50.65 (S.E.±11.73)	+138
1972	4.17±2.52 (S.E.±0.73)	50	50.30±3.86 (S.E.±1.93)	22.58±2.00 (S.E.±1.00)	72.88±2.52 (S.E.±1.26)	63.58±47.75 (S.E.±13.79)	763	9.42±8.91 (S.E.±2.57)	113	7.00±0.00 (S.E.±0.00)	84	31.25±45.90 (S.E.±13.25)	+375

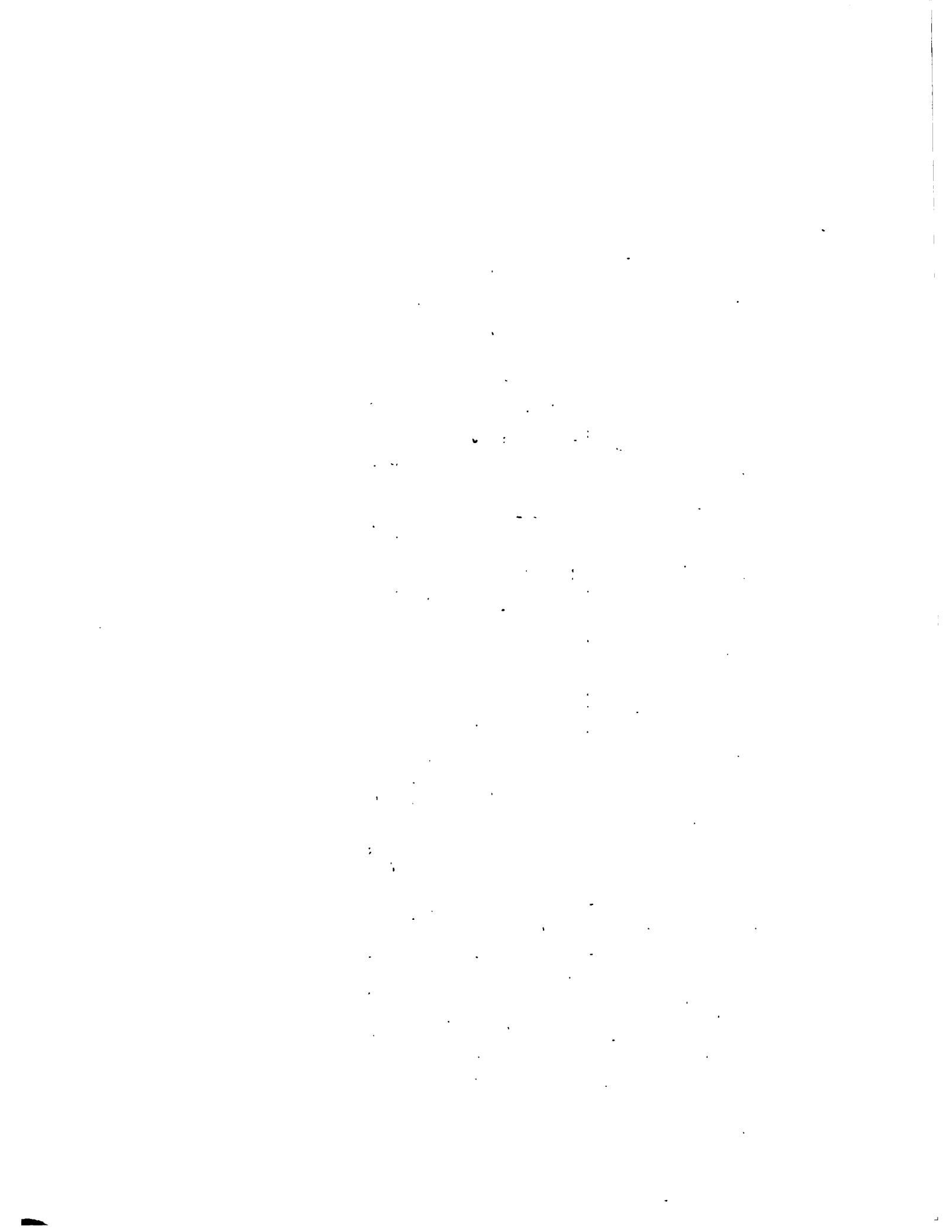
NOTE: 1. These data based on the same internal draft/report from which the data in Part 1 of Appendix B were taken.

2. Meteorological records indicate that this area receives 850-1,000 mm of rain per annum but that it is variable from year to year.

For example an average value of 1966-1978 is 1,445.33±51 mm with a S.E.±298.82. Note the large S.D. and S.E. values. Annual total river system outflow in 1970 is estimated from data or only three months in that year (Oct, Nov, and Dec.).

3. A surface run-off of 65,160 acre-ft/annum has been recorded for this system but this is the sole datum available.

4. A few measured flow rates are as follows: 78, 95, and 101/ft sec, in March, June and October respectively.



Project profile submitted to IDRC

PROJECT: EXPLORATORY WORK ON CRAYFISH PRODUCTION POTENTIAL
AT BELLE AIR (PEAR TREE BOTTOM), ST. ANN JAMAICA

1. The Belle Air Estate, St. Ann, Jamaica which is a government-owned property, includes the Pear Tree Bottom River, in which there are known to exist species of shrimp which have a potential for commercial exploitation.
2. Jamaica imports shrimp and the above exploitation of the potential at Pear Tree Bottom, if found to be successful, could serve the two-fold purpose of providing import substitution (replacement) and export earnings. The Prime Minister of Jamaica has expressed a keen interest in this study and eagerly awaits the results of an evaluation.
3. The IICA/Jamaica Office has obtained the services of Dr. Michael Wiles, Professor of Biology and Chairman of the Biology Department of St. Mary's University, Halifax, Nova Scotia, Canada, presently on Sabbatical leave, to identify the project and undertake preliminary work necessary to provide some of the parameters required for undertaking a pre-feasibility study.
4. In this context, discussions have been held with the Ministry of Agriculture (MINAG), Jamaica and also with Professor Goodbody, Head of the Zoology Department of the Mona Campus of the University of the West Indies, with whom it has been possible to obtain involvement and collaboration.

Preliminary investigations indicate:

- excellent freshwater supply, quantitatively and qualitatively,
- proximity to sea facilities and cheap seawater system for adjustment of salinity and for biological development;
- the existence of three (3) spp. of Macrobrachium viz M. acanthurus, M. carcinus and M. faustinum all of which can be grown to cocktail size in relatively short periods under local conditions.

5. Recommendations

- (i) A research programme to investigate the conditions required for rapid and efficient courtship, mating, incubation, hatching, larval development, ~~notamorphosis~~, development, sexual maturity and adult growth of the Jamaican freshwater shrimp species

1. The first part of the document discusses the importance of maintaining accurate records of all transactions and activities. It emphasizes that proper record-keeping is essential for transparency and accountability, particularly in the context of public administration and government operations. The text notes that without reliable records, it becomes difficult to track the flow of funds, resources, and information, which can lead to inefficiencies and potential misuse.

2. The second part of the document addresses the challenges associated with data collection and analysis. It highlights that while modern technology offers powerful tools for gathering and processing large amounts of data, the quality and consistency of the information can vary significantly. The text suggests that organizations should invest in training and infrastructure to ensure that data is collected systematically and analyzed using standardized methods. This approach helps in identifying trends, patterns, and areas for improvement more effectively.

3. The third part of the document focuses on the role of leadership in driving organizational success. It argues that strong leaders are those who can inspire and motivate their teams, set clear goals, and provide the necessary support and resources. The text also discusses the importance of communication, as effective leaders must be able to convey their vision and expectations clearly to all levels of the organization. Furthermore, it stresses the need for leaders to be adaptable and responsive to changing circumstances, as the ability to pivot and adjust strategies is crucial in today's fast-paced and competitive environment.

4. The fourth part of the document explores the concept of innovation and its impact on business and society. It defines innovation as the process of developing new ideas, products, or services that create value. The text notes that innovation is not just about technological advancements but also encompasses improvements in processes, management practices, and social structures. It emphasizes that fostering a culture of innovation requires encouraging risk-taking, experimentation, and collaboration. Organizations that embrace innovation are better positioned to stay ahead of the curve and address the needs of their customers and stakeholders in a dynamic market.

5. The fifth part of the document discusses the importance of ethical considerations in decision-making. It argues that while the pursuit of profit and growth is a primary goal for many organizations, it should not come at the expense of ethical principles. The text highlights that ethical behavior is essential for building trust, maintaining a positive reputation, and ensuring long-term sustainability. It suggests that organizations should establish clear ethical guidelines and codes of conduct, and hold all employees accountable for their actions. Additionally, it encourages organizations to be transparent about their operations and to engage with external stakeholders in a responsible and ethical manner.

6. The sixth part of the document addresses the issue of diversity and inclusion in the workplace. It argues that diverse teams, composed of individuals with different backgrounds, experiences, and perspectives, are more likely to be creative and innovative. The text notes that creating an inclusive environment where all employees feel valued and respected is essential for maximizing the potential of a diverse workforce. Organizations should implement policies and practices that promote diversity and inclusion, such as providing equal opportunities for advancement and ensuring that all voices are heard in decision-making processes.

7. The seventh part of the document discusses the impact of globalization on business and society. It notes that globalization has led to increased international trade, investment, and cultural exchange. While this has brought many benefits, such as economic growth and the spread of technology, it has also created challenges, such as job displacement and cultural homogenization. The text suggests that organizations should adopt a global perspective and be prepared to navigate the complexities of an interconnected world. This includes understanding the needs and preferences of different markets and building strong relationships with international partners and customers.

8. The eighth part of the document addresses the issue of environmental sustainability and its impact on business. It argues that environmental sustainability is no longer just a niche concern but a critical factor in the success of any organization. The text notes that consumers are increasingly aware of the environmental impact of the products and services they purchase, and they are more likely to support companies that demonstrate a commitment to sustainability. Organizations should therefore integrate environmental considerations into their core business strategies and operations. This can include reducing carbon footprints, conserving resources, and investing in sustainable technologies and practices.

9. The ninth part of the document discusses the importance of continuous learning and development for individuals and organizations. It argues that in a rapidly changing world, the ability to learn and adapt is essential for staying relevant and competitive. The text suggests that organizations should invest in training and development programs that provide employees with the skills and knowledge they need to succeed in their roles. Additionally, it encourages individuals to embrace a growth mindset and seek out opportunities for learning and development throughout their careers.

10. The tenth part of the document addresses the issue of social responsibility and its impact on business. It argues that social responsibility is an integral part of a company's identity and should be reflected in all aspects of its operations. The text notes that socially responsible companies are more likely to attract and retain top talent, as well as build strong relationships with their communities and stakeholders. Organizations should therefore consider the social and environmental impacts of their decisions and actions, and strive to create a positive impact on society through their business activities.

M. acanthurus, M. carcinus and M. faustinum and the exotic M. rosenbergii under prevailing Jamaica conditions.

- (ii) Special studies on the cannibalistic nature of these species, predation by other species, and on other factors likely to affect development of the proposed project.
 - (iii) Comparison of mortality rates, mating successes and growth rates up to commercial marketing sizes.
 - (iv) Profitability of each of the (4) species under projected commercial farming conditions.
 - (v) Determination of cost benefit for each of the four (4) species.
6. The Belle Air property has an area of approximately 400 acres. It has access roads, housing, buildings, etc. suitable for modification for project use, including the siting of research facilities. Support facilities such as electricity, water, drainage and sewage outlet facilities are available.
 7. The project is estimated to last a period of 3 years. Selected University Graduate students will be engaged to work under the supervision of the Resident Research Director. It is desirable that an appropriate local counterpart (professional) be assigned to the project and that provision be made for training both at that level and at that for technicians.
 8. IICA sees the advantages of the proposal and of the site of operation to be:
 - (1) The land is available and is owned by the Government
 - (2) Adequate security at reasonable cost can be established
 - (3) The quantity and quality of freshwater are satisfactory
 - (4) Seawater supply for early life development of shrimps is close by
 - (5) Buildings and basic services are already available
 - (6) Conditions in the Pear Tree Bottom River for the reproduction and growth of shrimps are favourable
 - (7) Existing demand for freshwater shrimps is high
 - (8) Brood stock for the 3 indigenous freshwater Macrobrachium spp. appears to be adequate, but can readily be complemented.
 - (9) Collaboration with UWI is facilitated through the proximity of the site of the Discovery Bay Marine Laboratory of the U.W.I.

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9. It is suggested that if accepted the pre-feasibility study should be conducted as a joint GOJ/IDRC/IICA exercise.
10. The estimated budget over a 3 year period will be US\$651,100 (see details on the Annex to this note).
11. The Government of Jamaica's contribution will consist of land and in-kind provision of buildings and other relevant elements.
12. The detailed budget for this profile is an internal document of work of IICA/Jamaica.

1. The first part of the document discusses the importance of maintaining accurate records of all transactions and activities. It emphasizes that this is crucial for ensuring transparency and accountability in the organization's operations.

2. The second part of the document outlines the various methods and tools used to collect and analyze data. It highlights the need for consistent data collection procedures and the use of advanced analytical techniques to derive meaningful insights from the data.

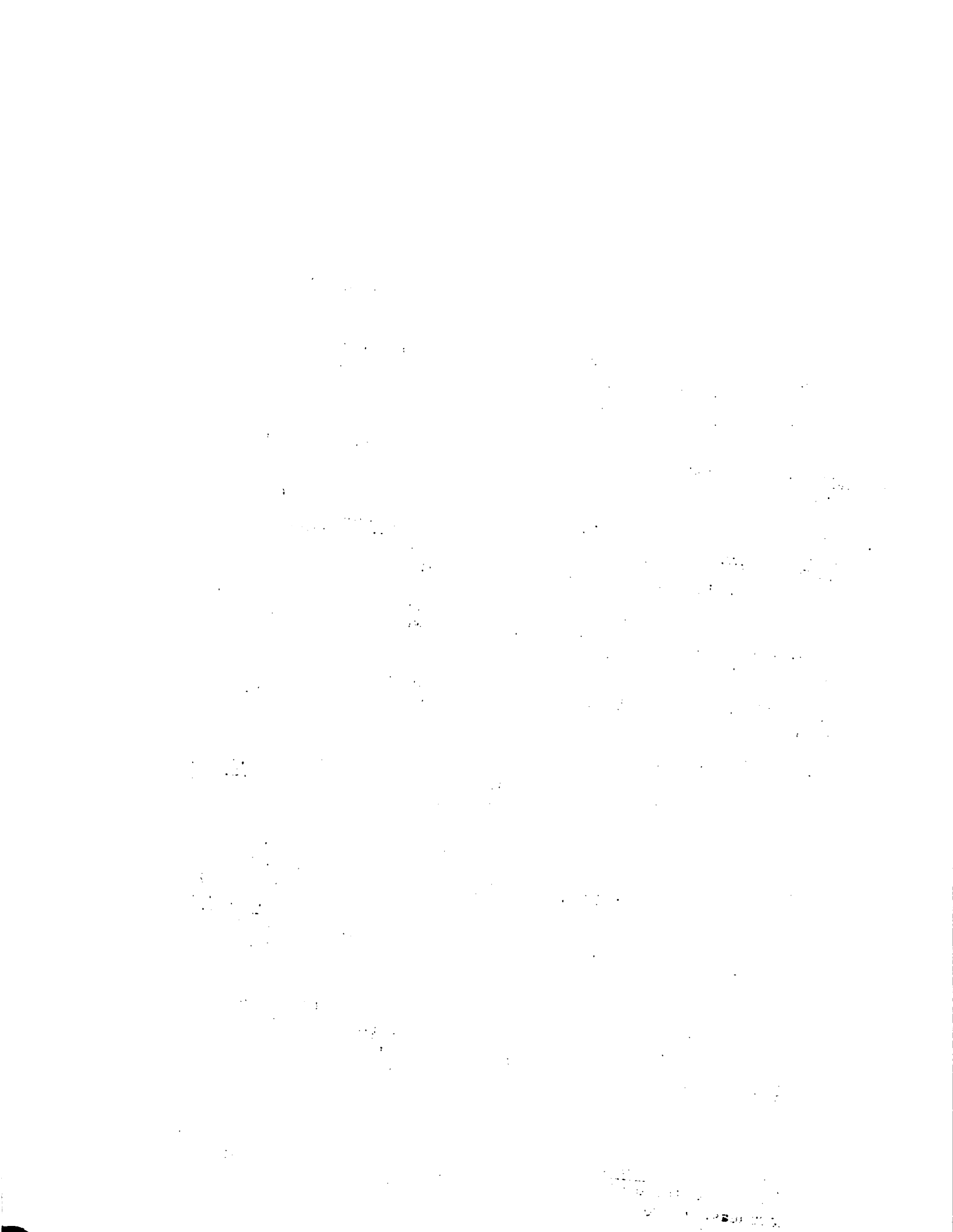
3. The third part of the document focuses on the interpretation of the data and the identification of key trends and patterns. It discusses how these insights can be used to inform decision-making and to develop effective strategies for the organization.

4. The final part of the document provides a summary of the findings and offers recommendations for future research and practice. It stresses the importance of ongoing monitoring and evaluation to ensure that the organization remains competitive and responsive to changing market conditions.

APPENDIX D

Bibliography of scientific and technical literature on
biology and culture of freshwater prawns (shrimps) and
related organisms

1. ACKEFORS, H., and C.G. ROSEN, (1979). Farming aquatic animals. *Ambio*, 8(4): 132-143. (GA).
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13. BALAZS, G.H., and E. ROSS (1976). Effect of protein source and level on growth and performance of the captive freshwater prawn Macrobrachium rosenbergii. Aquaculture, 7(4): 299-313 (ND).
14. BALAZS, G.H., S.E. OLBRICH, and M.E. TUMBLESON. (1974) Serum constituents of the Malaysian prawn (Macrobrachium rosenbergii) and pink shrimp (Penaeus marginatus). Aquaculture 3(2): 147-157. (ND).
15. BALAZS, G.H., E. ROSS, and C.C. BROOKS (1973). Preliminary studies on the preparation and feeding of crustacean diets. Aquaculture, 2(4): 369-377. (ND).
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22. BROWN, C., and D.J. RUSSO. (1979). Ultraviolet light disinfection of shellfish hatchery sea water. I. Elimination of five pathogenic bacteria. Aquaculture, 17(1): 17-23 (D).

1. The first part of the document discusses the importance of maintaining accurate records of all transactions and activities. It emphasizes that this is essential for ensuring transparency and accountability in the organization's operations.

2. The second part of the document outlines the various methods and tools used to collect and analyze data. It highlights the need for consistent data collection procedures and the use of advanced analytical techniques to derive meaningful insights from the data.

3. The third part of the document focuses on the role of technology in data management and analysis. It discusses how modern software solutions can streamline data collection, storage, and processing, thereby improving efficiency and accuracy.

4. The fourth part of the document addresses the challenges associated with data management, such as data quality, security, and privacy. It provides strategies to mitigate these risks and ensure that the data remains reliable and secure.

5. The fifth part of the document discusses the importance of data governance and the role of various stakeholders in ensuring that data is used ethically and in compliance with relevant regulations.

6. The sixth part of the document provides a detailed overview of the data lifecycle, from data collection to data archiving and deletion. It emphasizes the need for clear policies and procedures to govern each stage of the data lifecycle.

7. The seventh part of the document discusses the role of data in decision-making and the importance of providing timely and accurate information to management. It highlights how data-driven insights can lead to better strategic decisions and improved organizational performance.

8. The eighth part of the document discusses the importance of data security and the need to implement robust security measures to protect sensitive information from unauthorized access and breaches.

9. The ninth part of the document discusses the role of data in compliance and the need to ensure that all data handling activities are in line with applicable laws and regulations.

10. The tenth part of the document provides a summary of the key points discussed in the document and offers recommendations for further action to improve data management practices.

23. BURNS, C., and K. HALSCOTT. (1979). Refining selected management techniques for culturing Macrobrachium shrimp. Caml. Rep. Fla. Dep. Nat. Resources, Proj. 2-298 - R: 101 pp. (RD).
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5. The fifth part of the document concludes by summarizing the key findings and recommendations. It stresses the importance of a data-driven approach in decision-making and the need for continuous monitoring and improvement of the data management process.

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1. The first part of the document discusses the importance of maintaining accurate records of all transactions and activities. It emphasizes that proper record-keeping is essential for ensuring transparency and accountability in financial reporting. This section also highlights the role of internal controls in preventing errors and fraud, and the need for regular audits to verify the accuracy of the data.

2. The second part of the document focuses on the implementation of a robust risk management framework. It outlines the process of identifying, assessing, and mitigating various risks that could impact the organization's financial health and operational performance. This includes the establishment of risk registers, the assignment of responsibilities, and the implementation of mitigation strategies to reduce the likelihood and potential impact of adverse events.

3. The third part of the document addresses the importance of effective communication and reporting. It stresses the need for clear, concise, and timely communication of financial information to all relevant stakeholders, including management, investors, and regulatory bodies. This section also discusses the role of financial reporting in providing a clear picture of the organization's financial performance and position.

4. The fourth part of the document discusses the importance of maintaining a strong relationship with external auditors. It emphasizes the need for transparency and cooperation with auditors to ensure the accuracy and reliability of the financial statements. This section also highlights the role of auditors in providing independent assurance and identifying areas for improvement in the organization's financial reporting process.

5. The fifth part of the document discusses the importance of staying up-to-date with the latest regulatory requirements and industry best practices. It emphasizes the need for continuous monitoring and updates to the organization's financial reporting policies and procedures to ensure compliance with all applicable laws and regulations. This section also discusses the role of professional organizations and industry associations in providing guidance and support in this regard.

6. The sixth part of the document discusses the importance of maintaining a strong internal control system. It emphasizes the need for a well-defined and documented system of internal controls that covers all aspects of the organization's financial reporting process. This section also discusses the role of internal controls in preventing errors and fraud, and the need for regular testing and evaluation of the system to ensure its effectiveness.

7. The seventh part of the document discusses the importance of maintaining a strong relationship with the board of directors. It emphasizes the need for regular communication and reporting to the board on all aspects of the organization's financial reporting process. This section also discusses the role of the board in providing oversight and guidance, and the need for the board to be fully informed and engaged in the process.

8. The eighth part of the document discusses the importance of maintaining a strong relationship with investors. It emphasizes the need for transparency and timely communication of financial information to investors to ensure their confidence and support. This section also discusses the role of investors in providing feedback and guidance, and the need for the organization to be responsive to their needs and concerns.

9. The ninth part of the document discusses the importance of maintaining a strong relationship with regulatory bodies. It emphasizes the need for compliance with all applicable laws and regulations, and the need for regular communication and reporting to regulatory bodies. This section also discusses the role of regulatory bodies in providing oversight and guidance, and the need for the organization to be responsive to their requirements and expectations.

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7. The seventh part of the document discusses the role of data in customer relationship management (CRM). It explains how analyzing customer data can help organizations better understand their needs and preferences, leading to improved customer satisfaction and loyalty.

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13. The thirteenth part of the document discusses the importance of data in supply chain management. It highlights how data analysis can help organizations optimize their supply chain operations, reduce costs, and improve delivery times.

14. The fourteenth part of the document concludes by discussing the future of data and its potential to transform various industries. It encourages organizations to stay up-to-date on the latest trends and technologies in data management and analysis.

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1. The first part of the document discusses the importance of maintaining accurate records of all transactions and activities. It emphasizes that proper record-keeping is essential for transparency and accountability, particularly in the context of financial reporting and auditing. The text notes that without reliable records, it is difficult to verify the accuracy of financial statements and to identify any potential discrepancies or irregularities.

2. The second part of the document focuses on the role of internal controls in ensuring the integrity of financial data. It highlights that a robust system of internal controls is necessary to prevent and detect errors, fraud, and misstatements. The document suggests that organizations should implement a variety of control measures, such as segregation of duties, authorization requirements, and regular reconciliations, to minimize the risk of financial misstatements.

3. The third part of the document addresses the challenges associated with data collection and analysis. It notes that the volume and complexity of data have increased significantly in recent years, making it more difficult to manage and analyze effectively. The text suggests that organizations should invest in advanced data management technologies and hire skilled personnel to handle the growing volume of data. Additionally, it emphasizes the importance of ensuring the accuracy and reliability of the data used for analysis.

4. The fourth part of the document discusses the impact of external factors on financial performance. It notes that various external factors, such as changes in market conditions, regulatory requirements, and economic trends, can significantly affect an organization's financial results. The text suggests that organizations should closely monitor these external factors and adjust their financial strategies accordingly to maintain their competitive advantage and financial stability.

5. The fifth part of the document concludes by emphasizing the importance of ongoing monitoring and evaluation of financial performance. It notes that financial performance is not a static concept and that organizations should regularly assess their financial health and make adjustments as needed. The text suggests that organizations should use a variety of financial ratios and metrics to evaluate their performance and identify areas for improvement. Additionally, it emphasizes the importance of maintaining open communication with stakeholders and providing timely and accurate financial information.

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1. The first part of the document discusses the importance of maintaining accurate records of all transactions and activities. It emphasizes that this is crucial for ensuring transparency and accountability in the organization's operations.

2. The second part of the document outlines the various methods and tools used to collect and analyze data. It highlights the need for consistent data collection practices and the use of advanced analytical techniques to derive meaningful insights from the data.

3. The third part of the document focuses on the role of technology in data management and analysis. It discusses how modern software solutions can streamline data collection, storage, and processing, thereby improving efficiency and accuracy.

4. The fourth part of the document addresses the challenges associated with data management, such as data quality, security, and privacy. It provides strategies to mitigate these risks and ensure that the data remains reliable and secure throughout its lifecycle.

5. The fifth part of the document discusses the importance of data governance and the role of various stakeholders in ensuring that data is used ethically and in compliance with relevant regulations and standards.

6. The sixth part of the document provides a detailed overview of the data collection process, from identifying the data sources to implementing the collection mechanisms. It includes a checklist of key steps to follow during this process.

7. The seventh part of the document discusses the various types of data that can be collected and analyzed, including structured and unstructured data, and the specific challenges associated with each type.

8. The eighth part of the document provides a comprehensive overview of the data analysis process, from data cleaning and preprocessing to the final interpretation of results. It includes a checklist of key steps to follow during this process.

9. The ninth part of the document discusses the various tools and software solutions available for data management and analysis, and provides a comparison of their features and capabilities.

10. The tenth part of the document provides a detailed overview of the data governance framework, including the roles and responsibilities of various stakeholders and the key components of the framework.

11. The eleventh part of the document discusses the importance of data security and privacy, and provides strategies to ensure that the data is protected from unauthorized access and misuse.

12. The twelfth part of the document provides a detailed overview of the data collection and analysis process, from identifying the data sources to implementing the collection mechanisms and analyzing the data.

13. The thirteenth part of the document discusses the various challenges associated with data management and analysis, and provides strategies to overcome these challenges.

14. The fourteenth part of the document provides a detailed overview of the data governance framework, including the roles and responsibilities of various stakeholders and the key components of the framework.

15. The fifteenth part of the document discusses the importance of data security and privacy, and provides strategies to ensure that the data is protected from unauthorized access and misuse.

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20. The twentieth part of the document provides a detailed overview of the data collection and analysis process, from identifying the data sources to implementing the collection mechanisms and analyzing the data.

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1. The first part of the document discusses the importance of maintaining accurate records of all transactions and activities. It emphasizes that proper record-keeping is essential for ensuring transparency and accountability in the organization's operations.

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4. The fourth part of the document addresses the challenges associated with data security and privacy. It provides guidelines for implementing robust security measures to protect sensitive information and ensure compliance with relevant regulations.

5. The fifth part of the document discusses the importance of data quality and the need for regular data audits. It emphasizes that high-quality data is crucial for making accurate and reliable decisions, and that regular audits help identify and correct any data quality issues.

6. The sixth part of the document explores the role of data in strategic decision-making. It highlights how data-driven insights can help organizations identify new opportunities, optimize their operations, and gain a competitive advantage in the market.

7. The seventh part of the document discusses the importance of data literacy and the need for ongoing training and development. It emphasizes that all employees should have a basic understanding of data and be able to interpret and use data effectively in their work.

8. The eighth part of the document discusses the role of data in customer relationship management. It highlights how data can be used to better understand customer needs and preferences, and to tailor marketing and sales efforts accordingly.

9. The ninth part of the document discusses the role of data in supply chain management. It highlights how data can be used to optimize inventory levels, improve logistics, and reduce costs throughout the supply chain.

10. The tenth part of the document discusses the role of data in human resources management. It highlights how data can be used to identify talent gaps, improve recruitment processes, and enhance employee performance.

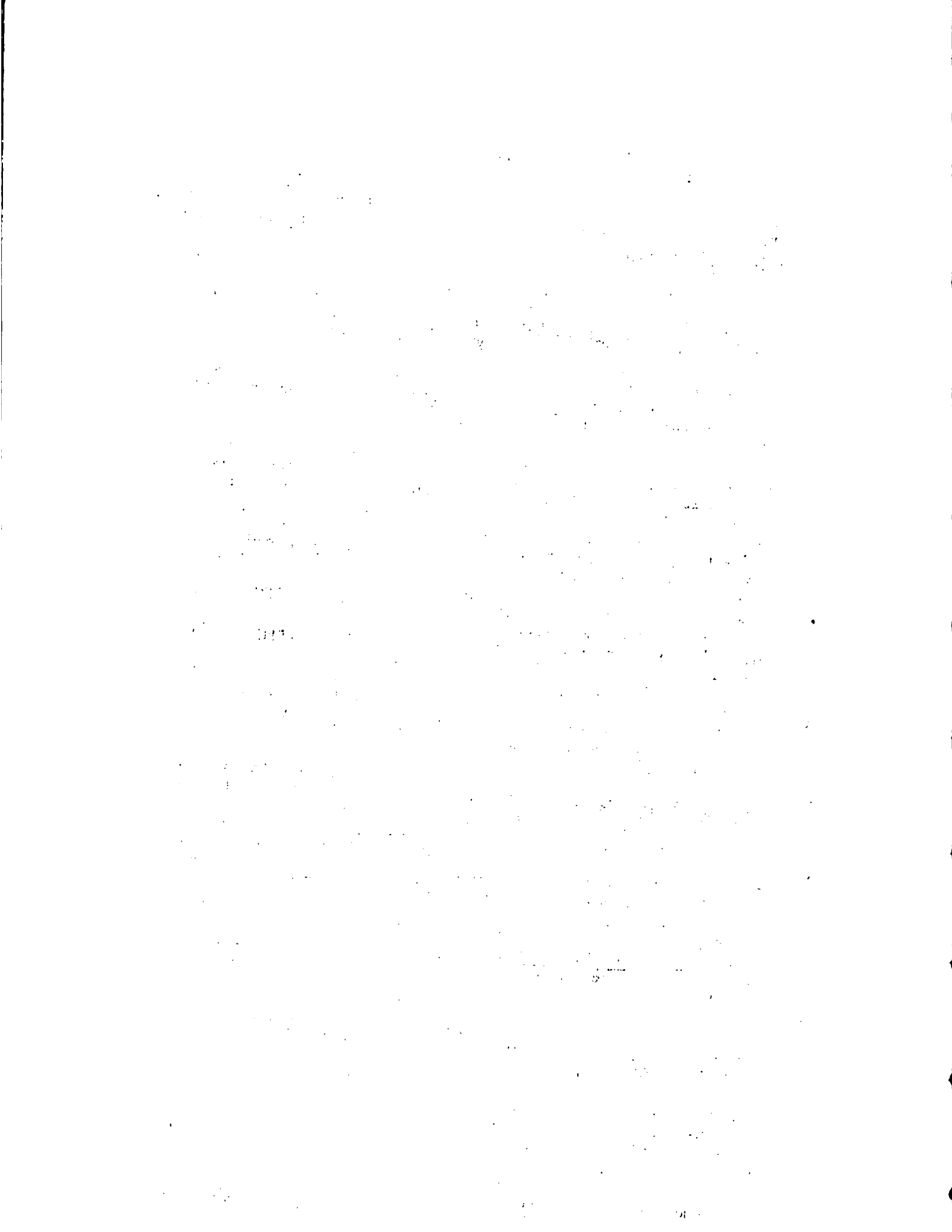
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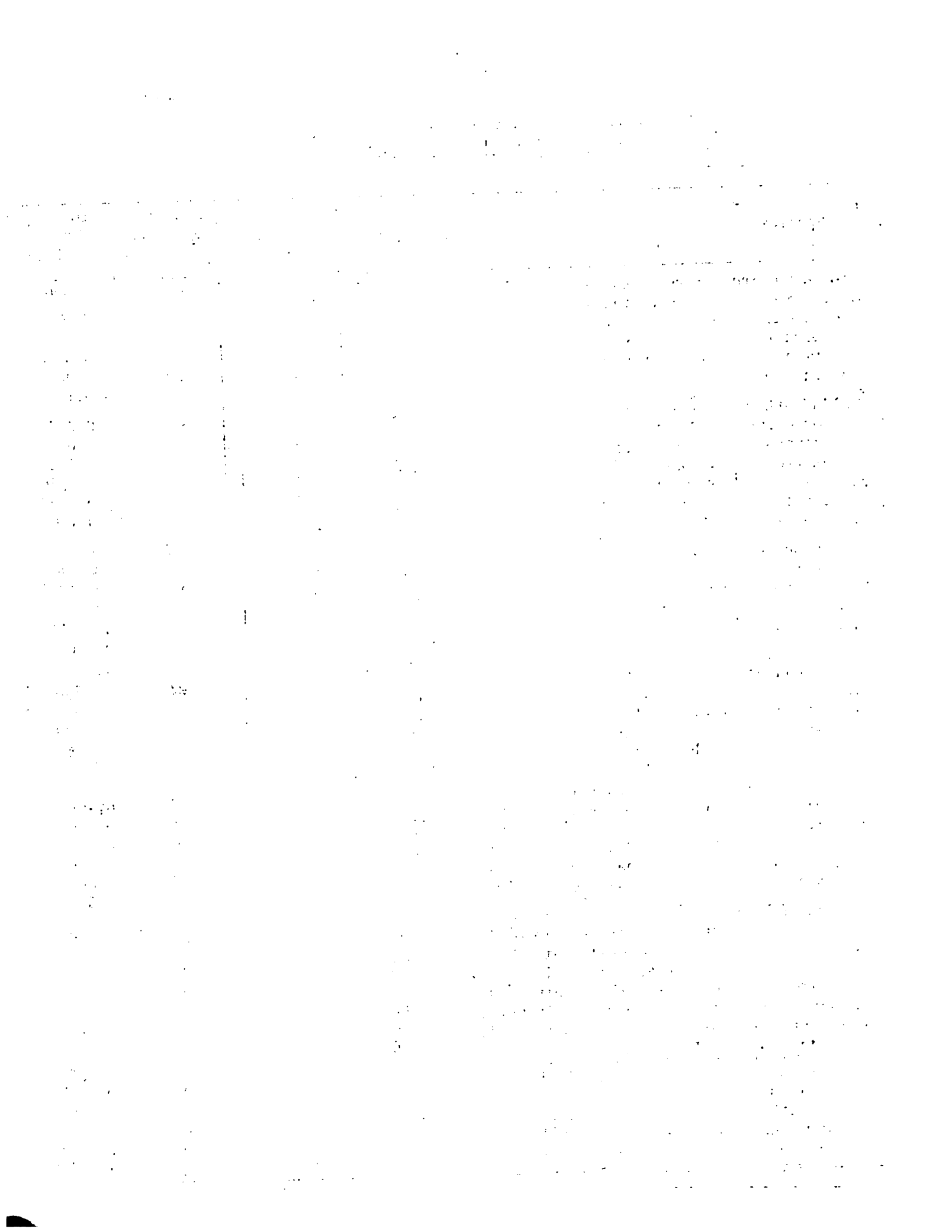
EXPLANATION OF ABBREVIATIONS REFERING TO TOPICS IN BIBLIO-
GRAPHIC REFERENCES GIVEN AFTER EACH ENTRY

- (BE) Bioenergetics
- (BF) Biological filters
- (CP) Commensal and/or parasites
- (CT) Chemotherapy
- (D) Disease
- (E) Economics of production
- (ENG) Agricultural engineering
- (EX) Exotic species
- (FH) Fertilization and Harvesting
- (G) Growth
- (GA) General aquaculture
- (GB) General Biology
- (GM) The genus Macrobrachium
- (GN) Genetics and/or breeding
- (IC) Intraspecific competition
- (JN) Juvenile nursery production
- (LC) Larval culturing
- (LD) Larval development
- (MC) Mass Culturing
- (MM) Moulting and mortality
- (ND) Nutrition and diet
- (P) Physiology
- (PC) Polyculture
- (PLR) Post-larval rearing
- (PM) Biological population models
- (Pr) Predation
- (RB) Reproductive behaviour
- (RCR) Rearing and culturing of Macrobrachium rosenbergii
- (RD) Research and development
- (Ref) A reference work
- (S) Spawning

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Pear Tree Bottom River System, totals and proportions of crustaceans collected by species

Species	Site Name	Site Code	Site Number	Number of Specimens in sample	Proportion of sample by species
M. acanthurus	Parsons Creek	PRBS	1	0	0.0000
M. carcinus	Parsons Creek	PRBS	1	0	0.0000
M. faustinum	Parsons Creek	PRBS	1	19	0.8261
J. serrei	Parsons Creek	PRBS	1	0	0.0000
P. mexicana	Parsons Creek	PRBS	1	0	0.0000
X. elongata	Parsons Creek	PRBS	1	4	0.1739
M. acanthurus	Grassy Creek	GCSW	2	2	0.0870
M. carcinus	Grassy Creek	GCSW	2	0	0.0000
M. faustinum	Grassy Creek	GCSW	2	18	0.7826
J. serrei	Grassy Creek	GCSW	2	0	0.7826
P. mexicana	Grassy Creek	GCSW	2	0	0.0000
X. elongata	Grassy Creek	GCSW	2	3	0.1304
M. acanthurus	Pool Swamp A	PSA	3	0	0.0000
M. carcinus	Pool Swamp A	PSA	3	0	0.0000
M. faustinum	Pool Swamp A	PSA	3	0	0.0000
J. serrei	Pool Swamp A	PSA	3	0	0.0000
P. mexicana	Pool Swamp A	PSA	3	0	0.0000
X. elongata	Pool Swamp A	PSA	3	0	0.0000
M. acanthurus	Lock Spillway	LS	4	2	0.0690
M. carcinus	Lock Spillway	LS	4	23	0.7931
M. faustinum	Lock Spillway	LS	4	0	0.0000
J. serrei	Lock Spillway	LS	4	0	0.0000
P. mexicana	Lock Spillway	LS	4	0	0.0000
X. elongata	Lock Spillway	LS	4	4	0.1379
M. acanthurus	Rowe's Canal Coconut Grove	RCCG	5	0	0.0000
M. carcinus	Rowe's Canal Coconut Grove	RCCG	5	7	0.5000
M. faustinum	Rowe's Canal Coconut Grove	RCCG	5	0	0.0000
J. serrei	Rowe's Canal Coconut Grove	RCCG	5	0	0.0000
P. mexicana	Rowe's Canal Coconut Grove	RCCG	5	0	0.0000
X. elongata	Rowe's Canal Coconut Grove	RCCG	5	7	0.5000
M. acanthurus	Pear Tree River Main Outlet	PTRMO	6	1	0.0039
M. carcinus	Pear Tree River Main Outlet	PTRMO	6	10	0.0394
M. faustinum	Pear Tree River Main Outlet	PTRMO	6	0	0.0000
J. serrei	Pear Tree River Main Outlet	PTRMO	6	20	0.0787
P. mexicana	Pear Tree River Main Outlet	PTRMO	6	0	0.0000
X. elongata	Pear Tree River Main Outlet	PTRMO	6m	222	0.8740
Unidentified	Pear Tree River Main Outlet	PTRMO	6	1	0.0039
M. acanthurus	Roger Clarke's Ditch	RCD	7	0	0.0000
M. carcinus	Roger Clarke's Ditch	RCD	7	0	0.0000
M. faustinum	Roger Clarke's Ditch	RCD	7	0	0.0000
J. serrei	Roger Clarke's Ditch	RCD	7	0	0.0000
P. mexicana	Roger Clarke's Ditch	RCD	7	0	0.0000
X. elongata	Roger Clarke's Ditch	RCD	7	11	1.0000



APPENDIX E (cont'd)

Species	Site Name	Site Code	Site Number	Number of specimens in sample	Proportion of samples by species
M. acanthurus	Pear Tree Bottom River Proper, Lower Reaches	PTBRPLR	8	0	0.0000
M. carcinus	Pear Tree Bottom River Proper, Lower Reaches	PTBRPLR	8	34	0.2.36
M. faustinum	Pear Tree Bottom River Proper, Lower Reaches	PTBRPLR	8	0	0.0000
J. serrei	Pear Tree Bottom River Proper, Lower Reaches	PTBRPLR	8	102	0.6108
P. mexicana	Pear Tree Bottom River Proper, Lower Reaches	PTBRPLR	8	0	0.0000
X. elongata	Pear Tree Bottom River Proper, Lower Reaches	PTBRPLR	8	31	0.1856
M. acanthurus	Rowe's Canal Upper Site	RCUS	9	2	0.0625
M. carcinus	Rowe's Canal Upper Site	RCUS	9	2	0.0625
M. faustinum	Rowe's Canal Upper Site	RCUS	9	0	0.0000
J. serrei	Rowe's Canal Upper Site	RCUS	9	0	0.0000
P. mexicana	Rowe's Canal Upper Site	RCUS	9	0	0.0000
X. elongata	Rowe's Canal Upper Site	RCUS	9	28	0.8750
Unidentified	Rowe's Canal Upper Site	RCUS	9	0	0.0000

REVISIONS

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APPENDIX F

ANNEX TO NOTE

SUGGESTED BUDGET OVER THREE YEARS

FIGURES IN 1982 U.S. DOLLARS

FIRST YEAR

1. <u>PERSONNEL</u>		\$
(i) <u>International</u>		
Resident Research Director, Ph.D in aquaculture or biology; senior scientist with proven record of administration and research.		
Salary and fringe benefits	50,000	
Technical supervisor; MSc or professional technical qualifications and experience in aquaculture		
Salary and fringe benefits	35,000	
(ii) <u>Local</u>		
Professional Counterpart	15,000	
Two clerical assistants (Senior & Junior) with skills and experience in typing, shorthand, speedwriting, filing and reception; full time employees	18,000	
Field trainee; with capacity for outdoor work, including manual labour, inspection and security; full time employee	<u>5,000</u>	
	SUBTOTAL	<u>123,000</u>

1. The first part of the document discusses the importance of maintaining accurate records of all transactions and activities. It emphasizes that this is essential for ensuring transparency and accountability in the organization's operations.

2. The second part outlines the various methods and tools used to collect and analyze data. This includes the use of surveys, interviews, and focus groups to gather qualitative information, as well as the application of statistical software for quantitative analysis.

3. The third part details the process of identifying and measuring key performance indicators (KPIs). It explains how these indicators are used to track progress and evaluate the effectiveness of different strategies and initiatives.

4. The fourth part addresses the challenges and limitations of data analysis. It highlights the need for careful interpretation of results and the potential for bias or error in the data collection process.

5. The fifth part discusses the importance of communication and reporting. It stresses that the findings of the analysis must be clearly and concisely presented to stakeholders in order to inform decision-making and drive positive change.

6. The sixth part provides a summary of the key findings and conclusions of the study. It identifies the most significant trends and insights, and offers recommendations for future research and action.

7. The seventh part includes a list of references and sources used in the document. This provides a clear path for readers who wish to explore the topics in more depth.

8. The eighth part contains a list of appendices, which include additional data, charts, and supporting documents. These are provided for reference and to ensure the transparency of the research process.

9. The ninth part is a list of footnotes and endnotes, which provide further details and context for the information presented in the main text.

10. The tenth part is a list of page numbers, which helps readers navigate the document and find the information they are looking for.

2. COST OF OPERATIONS

<u>Equipment and Supplies</u>	\$ \$
Pumping System renovation	25,000
Pond construction and drainage installation	24,000
Experimental facilities	15,000
Generator	12,000
Office Equipment	10,000
Compound microscope	8,000
Stereoscopic Microscope	6,000
Compressor	6,000
Water Quality testing apparatus	5,000
Salinity, Conductivity, Temperature Meter	3,000
Suspended solids recorder	2,000
Sampling equipment	2,000
Office supplies	2,000
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SUBTOTAL	120,000
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3. GENERAL SERVICES

Automobile; Jeep or 4-wheel drive half ton truck	12,000
Light, power, fuels etc.	10,000
Gasoline and truck maintenance	6,000
Travelling and subsistence	1,000
Rent	5,000
Maintenance	5,000
Insurance	5,000
	<hr/>
SUBTOTAL	44,000
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FIRST YEAR SUBTOTAL 297,000

Administration and Technical Supervision (15%)	43,050
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TOTAL FOR FIRST YEAR \$ 330,050

1. The first part of the document discusses the importance of maintaining accurate records of all transactions and activities. It emphasizes that proper record-keeping is essential for transparency and accountability, particularly in the context of financial reporting and auditing. The text highlights that without reliable records, it becomes difficult to verify the accuracy of financial statements and to identify any potential discrepancies or irregularities.

2. The second part of the document focuses on the role of internal controls in preventing fraud and ensuring the integrity of financial data. It outlines various control measures, such as segregation of duties, authorization requirements, and regular reconciliations, which are designed to minimize the risk of errors and misstatements. The document stresses that a robust internal control system is a key component of an organization's risk management strategy and is critical for maintaining the trust of stakeholders.

3. The third part of the document addresses the challenges associated with data security and information privacy. It discusses the need for organizations to implement strong security protocols to protect sensitive information from unauthorized access, disclosure, or loss. The text also touches upon the importance of data backup and recovery procedures to ensure business continuity in the event of a security incident or system failure.

4. The fourth part of the document explores the impact of regulatory changes on financial reporting and auditing practices. It notes that the evolving regulatory landscape, driven by global standards and local requirements, necessitates continuous monitoring and adaptation of internal processes. Organizations are encouraged to stay informed about the latest regulatory developments and to proactively address any compliance gaps to avoid potential penalties and reputational damage.

5. The fifth and final part of the document provides a summary of the key points discussed and offers recommendations for organizations to enhance their financial reporting and auditing practices. It suggests that a combination of strong internal controls, robust data security measures, and a commitment to regulatory compliance is essential for achieving high standards of financial transparency and accountability. The document concludes by emphasizing the long-term benefits of a well-implemented financial reporting and auditing framework, including improved decision-making and increased stakeholder confidence.

SECOND YEAR

1. PERSONNEL

(i) International Professional (Director)	50,000
International Professional Supervisor	35,000

(ii) Local

Professional Counterpart	15,000
Farm Manager	8,000
Technical Assistant	6,000
2 Clerical Assistants	18,000
Field Trainee	5,500
Field Hands	4,500

SUBTOTAL	<u>142,000</u>
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2. COST OF OPERATIONS

Equipment and Supplies

Fiberglass Tanks	10,000
Experimental facilities extension	10,000
Office equipment	6,000
Water quality testing supplies	2,000
Sampling equipments additions	2,000
Office Supplies	2,000
Harvesting seine nets	2,000
Fiberglass tanks ancillaries	1,000

<u>Scholarships</u>	<u>10,000</u>
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<u>Training</u>	SUBTOTAL	<u>45,000</u>
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CHAPTER 10

Section 10.1

1. The first part of the proof is the same as in the previous chapter. The second part is as follows:

Section 10.2

2. The first part of the proof is the same as in the previous chapter. The second part is as follows:

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Section 10.3

6. The first part of the proof is the same as in the previous chapter. The second part is as follows:

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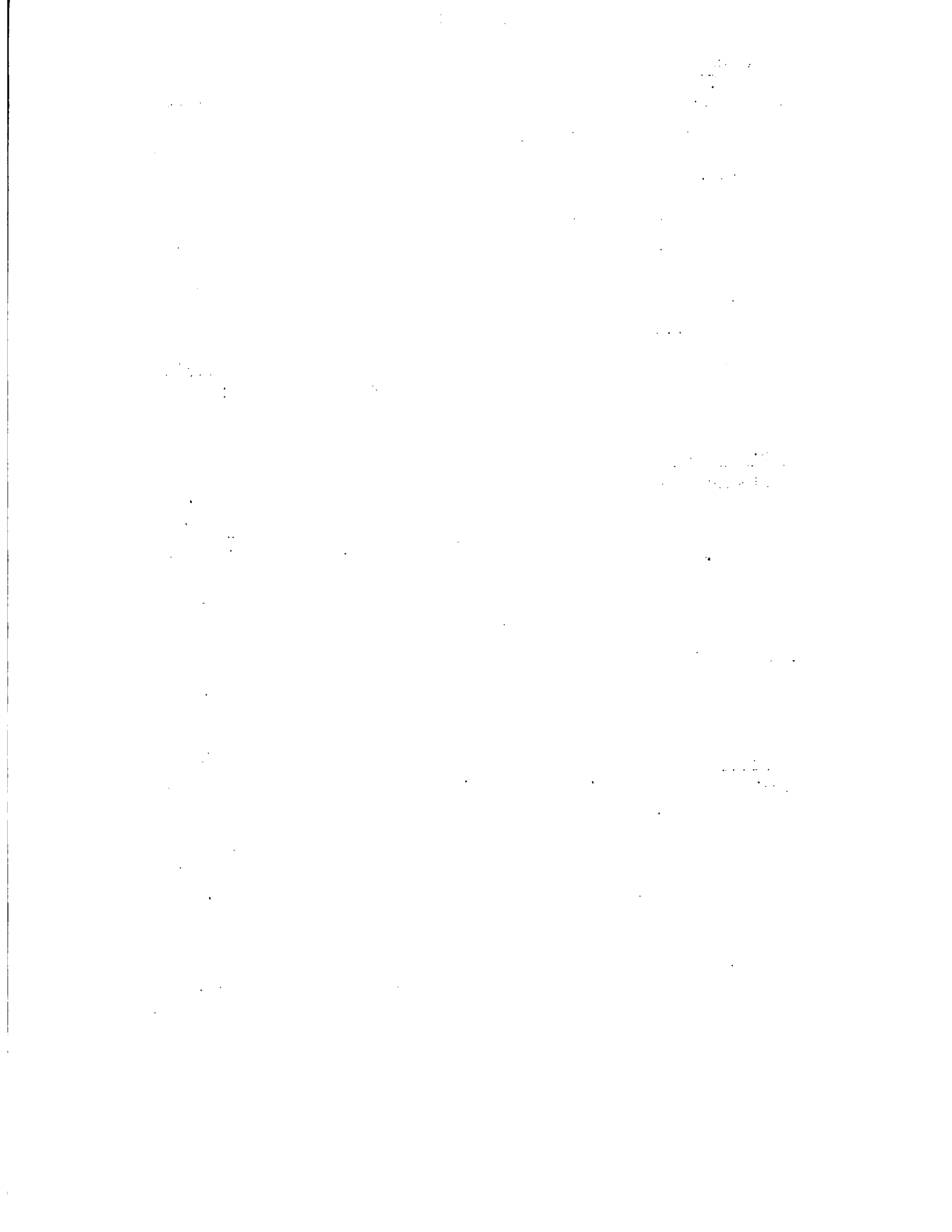
11. The first part of the proof is the same as in the previous chapter. The second part is as follows:

3. GENERAL SERVICES

Light, power, fuels, etc.	10,000
Gasoline and truck maintenance	6,000
Equipment depreciation	5,000
Pond maintenance	3,000
General repairs	3,000
Rent	5,000
Maintenance	5,000
Travelling and Subsistence	1,200
Insurance	<u>5,000</u>
	SUBTOTAL
	43,200
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	SECOND YEAR SUBTOTAL
	230,200
Administration and Technical Supervision (15%)	<u>34,530</u>
	TOTAL FOR SECOND YEAR
	<u>264,730</u>

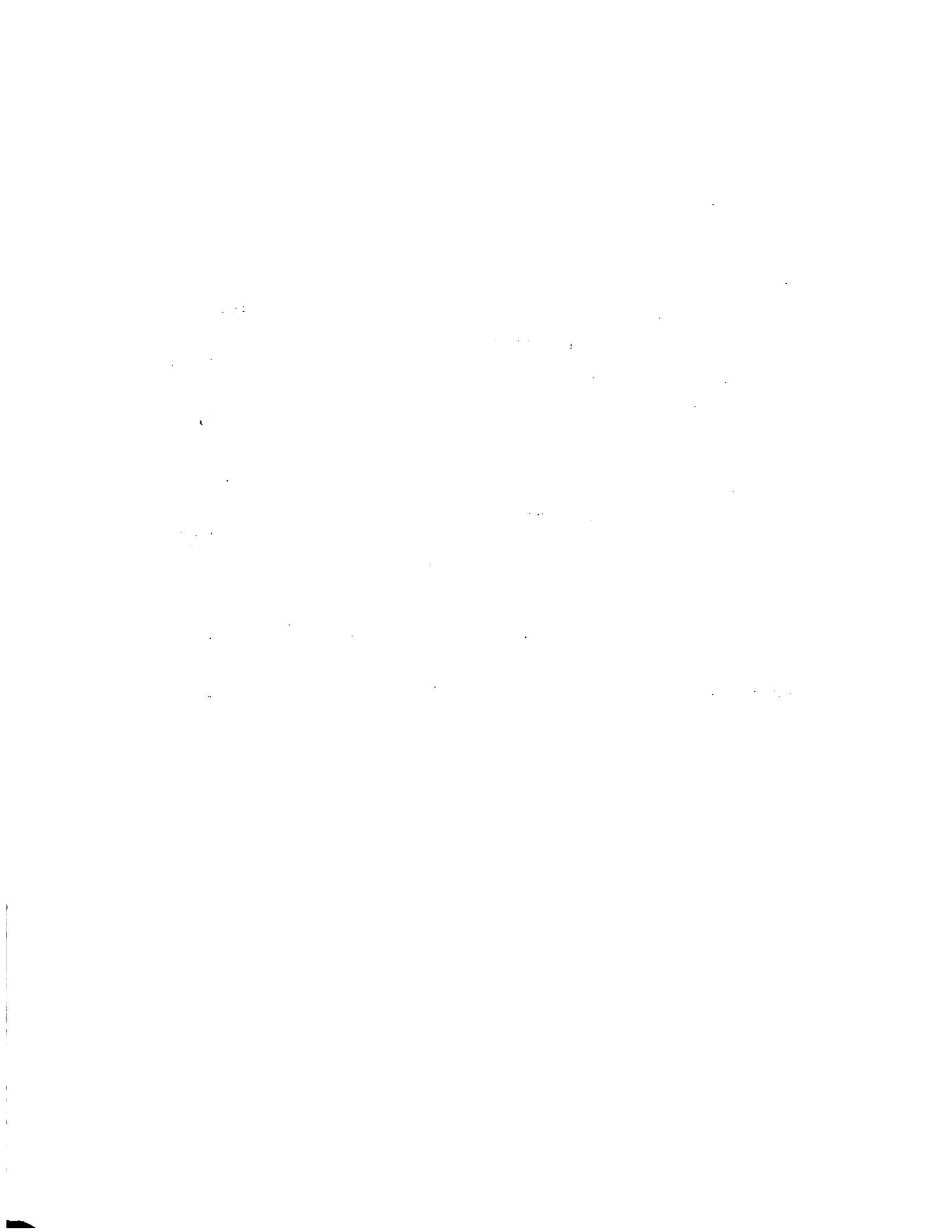
THIRD YEAR

1. <u>PERSONNEL</u>	\$
(i) International Professional (Director)	50,000
International Professional Supervisor	38,000
(ii) <u>Local</u>	
Professional Counterpart	15,000
Farm Manager	8,000
Technical Assistant	6,000
2 Clerical Assistants	18,000
Field trainee	5,500
Field Hands	4,500
	<hr/>
	SUBTOTAL
	145,000
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2. <u>COST OF OPERATIONS</u>	
<u>Equipment and Supplies</u>	
Demonstration facilities for farmers	25,000
Operating experimental supplies	5,000
Office equipment	3,000
Water quality testing supplies	2,000
Sampling equipment	2,000
Office supplies	2,000
Seine nets	1,000
Tank ancillaries	1,000
<u>Scholarships</u>	3,000
<u>Training</u>	5,000
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	SUBTOTAL
	49,000
	<hr/>



3. GENERAL SERVICES

Light, power, fuels etc.	10,000
Gasoline and truck maintenance	6,000
Equipment depreciation	5,000
Pond maintenance	4,000
General repairs	5,000
Rent	5,000
Maintenance	5,000
Travelling and Subsistence	1,400
Insurance	<u>5,000</u>
SUBTOTAL	<u>46,400</u>
THIRD YEAR SUBTOTAL	<u>240,400</u>
Administration and Technical Supervision (15%)	<u>36,060</u>
TOTAL FOR THE THIRD YEAR	<u>276,460</u>



PROPOSED PROJECT BUDGET

EXPENSES	YEAR 1	YEAR 2	YEAR 3	TOTAL
1. Personnel	123,000	142,000	145,000	408,000
2. Equipment & Supplies	120,000	45,000	49,000	214,000
3. General Services	44,000	43,200	46,400	133,600
4. Administration & Technical Supervision	<u>43,050</u>	<u>34,530</u>	<u>36,060</u>	<u>113,330</u>
	330,050	264,730	276,460	868,930

TOTAL COST FOR THREE (3) YEARS US\$868,930

AGRICULTURE IN JAMAICA

Collection of papers of the Office of IICA in Jamaica

1977 - 1978

- No. I - 1 Fritz Andrew Sibbles, "Basic Agricultural Information on Jamaica Internal Document of Work", January 1977
- No. I - 2 Yvonne Lake, "Agricultural Planning in Jamaica", June 1977
- No. I - 3 Aston S. Wood, Ph.D., "Agricultural Education in Jamaica", September - October 1977
- No. I - 4 Uli Locher, "The Marketing of Agricultural Produce in Jamaica", November 1977
- No. I - 5 G. Barker, A. Wahab, L. A. Bell, "Agricultural Research in Jamaica", November 1977
- No. I - 6 Irving Johnson, Marie Strachan, Joseph Johnson, "Land Settlement in Jamaica", December 1977
- No. I - 7 Government of Jamaica, "Agricultural Government Policy Papers", February 1978
- No. I - 8 Jose Emilio Araujo, "The Communal Enterprise", February 1980
- No. I - 9 IICA and MOAJ, "Hillside Farming Technology - Intensive Short Course", Vols. I and II, March 1978
- No. I - 10 Jose Emilio Araujo, "The Theory Behind the Community Enterprise - Seminar in Jamaica", March 1978
- No. I - 11 Marie Strachan, "A National Programme for the Development of Hillside Farming in Jamaica", April 1978
- No. I - 12 D. D. Henry, "Brief Overall Diagnosis of Hillside Farming in Jamaica", April 1978
- No. I - 13 Neville Farquharson, "Production and Marketing of Yams in Allsides and Christiana", May 1978

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- No. I - 14 R. C. E. McDonald, A. H. Wahab, "Fertility Assessment of Newly Terraced Hillside Soils Using the Microplot Technique - the Allsides Case Study", 1978
- No. I - 15 IICA - IDB, "Course in Preparation and Evaluation of Agricultural Projects", Vols. I and II, November 1977
- No. I - 16 Neville Farquaharson, "Production and Marketing of Dasheen in Allsides and Christiana", June 1978

1978 - 1979

- No. II - 1 O. Arboleda-Sepulveda (IICA-CIDIA), "Agricultural Documentation and Information Network in Jamaica", September 1978
- No. II - 2 Victor Quiroga, "National Agricultural Information System", (NAIS-Jamaica) Project Profile, September 1978
- No. II - 3 Joseph Johnson, "A Review on Land Reform in Jamaica for the Period 1972 - 1978", September 1978
- No. II - 4 Neville Farquaharson, "ABC of Vegetable Farming", A Draft High School Textbook, Vols. I, II, III and IV, February 1979
- No. II - 5 Jerry La Gra, "Elements of an Agricultural Marketing Strategy for Jamaica", March 1979
- No. II - 6 D. D. Henry, I. E. Johnson, "Agricultural Extension Service in Jamaica", March 1979

1979 - 1980

- No. III - 1 H. R. Stennett, "Watersheds of Jamaica and Considerations for an Ordinal Scale of their Development", July 1979
- No. III - 2 IICA-MAJ, "Hillside Farming in Jamaica", A Training Seminar, December 1978
- No. III - 3 A. L. Wright, A. H. Wahab, H. Murray, "Performance of Six Varieties of Red Peas (*Phaseolus vulgaris* L.) on a Newly Terraced Ultisol in Jamaica", September 1979
- No. III - 4 IICA/Jamaica Staff, "Agro-Socio-Economic Sample Survey of Allsides - Trelawny, Jamaica", September 1979

1. The first part of the document discusses the importance of maintaining accurate records of all transactions.

2. It is essential to ensure that all entries are supported by appropriate documentation and receipts.

3. Regular audits should be conducted to verify the accuracy of the records and identify any discrepancies.

4. The second part of the document outlines the procedures for handling cash and credit transactions.

5. All cash receipts should be recorded immediately and deposited in a secure bank account.

6. Credit sales should be recorded at the time of sale, and the amount should be tracked until payment is received.

7. The third part of the document provides guidelines for managing inventory and stock levels.

8. Inventory should be counted regularly to ensure that the recorded quantities match the actual stock on hand.

9. Any discrepancies between recorded and actual inventory should be investigated and corrected immediately.

10. The fourth part of the document discusses the importance of maintaining accurate financial statements.

11. These statements should be prepared regularly and reviewed by a qualified professional to ensure their accuracy.

12. The fifth part of the document outlines the procedures for handling tax matters and ensuring compliance with applicable laws.

13. All tax-related transactions should be recorded accurately and reported to the appropriate authorities.

14. The sixth part of the document provides information on the company's financial performance and outlook.

15. This section includes a summary of the company's revenue, expenses, and profit for the reporting period.

- No. III - 5 IICA-MOAJ, "An Approach to Agricultural Settlement of Hilly Lands", October 1979
- No. III - 6 IICA-MOAJ, "Tree Crops of Economic Importance to Hillside Farms in Jamaica", October 1979
- No. III - 7 Canute McLean, "Production and Marketing of Peanuts", November 1979

1980

- No. IV - 1 Joseph Johnson, "Production and Marketing of Red Peas in the Hilly Areas of Jamaica", January 1980
- No. IV - 2 Lyn Snuffer, "Rural Women: An Annotated Caribbean Bibliography with special reference to Jamaica", January 1980
- No. IV - 3 Vincent Campbell, Abdul Wahab, Howard Murray, "Response of Peanut (Arachis hypogaea L.) on a Newly Terraced Ultisol in Jamaica", January 1980
- No. IV - 4 P. Aitken, A. Wahab, I. Johnson, A. Sahni, "Agro-Socio-Economic Survey - Pilot Hillside Agricultural Project 'PHILAGRIP' Southern Trelawny", February 1980
- No. IV - 5 Glenys H. Barker, "Bibliography of Literature relating to Research and Development in the Agricultural Sector of Jamaica 1959 - 1979", March 1980
- No. IV - 6 Milton R. Wedderburn, "Allsides Farmers' Pre-Cooperative A Socio-Economic Assessment", March 1980
- No. IV - 7 Adele J. Wint, "The Role of Women in the Development Process", April 1980
- No. IV - 8 Milton R. Wedderburn, "The Co-operative Input in the Development of the Pilot Hillside Agricultural Project (PHILAGRIP)", April 1980
- No. IV - 9 MOJ/IICA/CARDI, Fruit Trees Seminar - "Research & Development of Fruit Trees", June 1980
- No. IV - 10 Henry Lancelot, "Traditional Systems in Hillside Farming, Upper Trelawny, Jamaica", June 1980

1. The first part of the document discusses the importance of maintaining accurate records of all transactions and activities. It emphasizes that this is crucial for ensuring transparency and accountability in the organization's operations.

2. The second part outlines the various methods and tools used to collect and analyze data. This includes the use of surveys, interviews, and focus groups to gather qualitative information, as well as the application of statistical techniques to quantitative data.

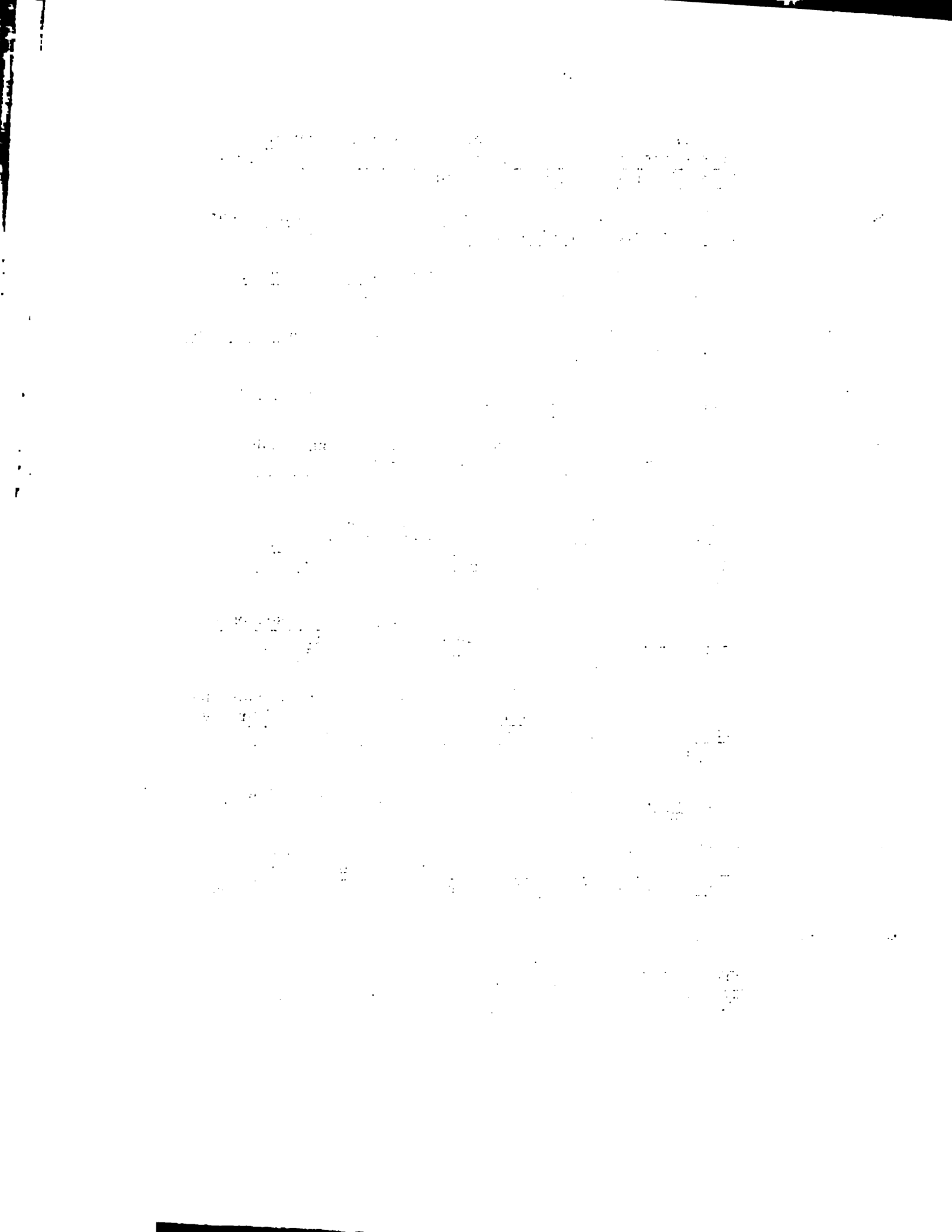
3. The third part of the document focuses on the interpretation of the collected data. It provides a detailed analysis of the findings, highlighting key trends and patterns that have emerged from the research. This analysis is supported by relevant statistics and charts.

4. The final part of the document discusses the implications of the research findings. It identifies the key areas where the organization's performance can be improved and provides specific recommendations for action. These recommendations are based on the insights gained from the data analysis.

- No. IV - 11 IICA/Jamaica, "Pilot Hillside Agricultural Project", (PHILAGRIP), Project Document. Vols. I, II and III, June 1980
- No. IV - 12 A. Wahab, I. Johnson, P. Aitken, H. Murray and H. Stennett, "Highlights of the Pilot Hillside Agricultural Project at Allsides", July 1980
- No. IV - 13 I. Johnson, A. Wahab, P. Aitken, H. Payne, "Benchmark for a Project Profile for Developing a Peanut Industry in Jamaica", July 1980
- No. IV - 14 P. Aitken, A. Wahab, I. Johnson, "The Allsides Post Peasant", August 1980
- No. IV - 15 Norma Munguia, Percy Aitken, Abdul Wahab, Irving Johnson, "Salt Extraction by Solar Energy", A Mini-project, September 1980
- No. IV - 16 Abdul H. Wahab, Percy Aitken-Soux, Irving E. Johnson and Howard Murray, "The Allsides Project in Jamaica - Developmental Potentials of Hillside Agriculture", September 1980
- No. IV - 17 P. Aitken, A. Wahab, I. Johnson, A. Sahney and N. Munguia, "Rural Women Survey", Vols. I, II and III, October 1980
- No. IV - 18 P. Aitken, I. E. Johnson, A. Wahab, "Assessment of Employment Among Small Hillside Farmers of Jamaica", November 1980
- No. IV - 19 IICA/Jamaica "Pilot Hillside Agricultural Project", (PHILAGRIP), Final Project Document. October 1980.
- No. IV - 20 P. Aitken, A. Wahab, I. E. Johnson, Bo-Myeong Woo, "IICA Evaluation of the First Phase FSB Allsides Project", (Internal Document of Work), November 1980
- No. IV - 21 MINAG/IICA/CARDI - "Seminar on Multiple Cropping", December 1980
- 1981
- No. V - 1 N. Munguia, P. Aitken, A. Wahab, I. Johnson, "Smoke Curing of Fish (as a household industry in Rural Jamaica)", January 1981

Handwritten text, likely bleed-through from the reverse side of the page. The text is extremely faint and illegible due to the quality of the scan. It appears to be organized into several paragraphs or sections, but the specific words and sentences cannot be discerned.

- No. V - 2 P. Aitken, A. Wahab, I. Johnson, "Under-employment - It's Relation to the Agricultural Sector and Considerations for its Management", January 1981
- No. V - 3 D. D. Henry, J. R. Gayle, "The Culture of Grafted Pimento (as spice crop for Allsides, Jamaica)", January 1981
- No. V - 4 Abdul H. Wahab, Noel Singh, "Agricultural Research in Jamaica", February 1981
- No. V - 5 P. Aitken-Soux, A. H. Wahab, I. E. Johnson, "Country Level Action Plan (CLAP)", May 1981
- No. V - 6 P. Aitken-Soux, A. H. Wahab, I. E. Johnson, "Overview of Agricultural Development in Jamaica", May 1981
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1982

- No. VI - 1 Vivian Chin, "Rice Research and Production in the BRUMDEC Project State-of-the-Art Review, Identification of Constraints and Interim Recommendations and Budget for Establishing 405 Hectares (1,000 acres) of Rice on the Clay Soils at BRUMDEC", January 1982
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VI

IICA PM-351		FRESHWATER PRAWIN(SHRIMP) CULTURE FOR JAMAICA.
Autor		AN EXPLORATORY REPORT.
Título		
Fecha Devolución	Nombre del solicitante	
17 ENE 1990	Daniel Vertania	



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