IDRC-210e

Fish Quarantine and Fish Diseases in Southeast Asia

Report of a workshop held in Jakarta, Indonesia, 7-10 December 1982

UNDP/FAO
heries Development
rogram (Philippines)
l Development
anada)

The International Development Research Centre is a public corporation created by the Parliament of Canada in 1970 to support research designed to adapt science and technology to the needs of developing countries. The Centre's activity is concentrated in five sectors: agriculture, food and nutrition sciences; health sciences; information sciences; social sciences; and communications. IDRC is financed solely by the Parliament of Canada; its policies, however, are set by an international Board of Governors. The Centre's headquarters are in Ottawa, Canada. Regional offices are located in Africa, Asia, Latin America, and the Middle East.

Postal Address: Box 8500, Ottawa, Canada K1G 3H9
Head Office: 60 Queen Street, Ottawa, Canada

UNDP/FAO South China Sea Fisheries Development and Coordinating Program, Manila PH
IDRC, Ottawa CA

IDRC-210e

Fish quarantine and fish diseases in Southeast Asia : report of a workshop held in Jakarta, Indonesia, 7–10 December 1982. Ottawa, Ont., IDRC, 1983. 79 p. : ill.

/Fish/, /animal diseases/, /disease control/, /quarantine/, /South East Asia/ — /fishery research/, /research programmes/, /fishery policy/, /regulations/, /pests of fish/, /parasitic diseases/, /disease vectors/, /list of participants/, /recommendations/, bibliography.

UDC: 639.2.09 ISBN: 0-88936-376-5

Microfiche edition available

Editing: F. Brian Davy and Amy Chouinard

Photo credits: Mohd. Shariff bin Mohd. Din, pages 10, 13, 14, 32, 33; Gilda Lio-Po, page 15.

IDRC-210e

FISH QUARANTINE AND FISH DISEASES IN SOUTHEAST ASIA

REPORT OF A WORKSHOP HELD IN JAKARTA, INDONESIA, 7–10 DECEMBER 1982

COSPONSORED BY THE
UNDP/FAO SOUTH CHINA SEA FISHERIES
DEVELOPMENT AND COORDINATING PROGRAM
(PHILIPPINES) AND THE INTERNATIONAL
DEVELOPMENT RESEARCH CENTRE (CANADA)

Résumé

Le commerce du poisson vivant — alevins pour la pisciculture — augmente rapidement, attendu que les coûts de la pêche sont à la hausse et que les rendements diminuent. L'aquaculture moderne repose sur l'approvisionnement en alevins dont l'introduction, telle que pratiquée aujourd'hui, compromet la survie des espèces (souvent une seule par élevage) cultivées de façon intensive. Déjà, des épizooties signalées en Asie du Sud-Est sont attribuées aux nouveaux stocks et ces incidents risquent de se reproduire si les gouvernements de la région ne réglementent pas la circulation des poissons vivants afin de n'autoriser l'entrée qu'aux populations exemptes d'agents parasitaires ou pathogènes. Cette situation existant dans plusieurs pays, des experts en maladie des poissons d'Indonésie, de Malaisie, des Philippines, de Singapour, de la Thaïlande ainsi que des consultants du Royaume-Uni, du Canada et de l'Australie, se sont réunis à Djakarta, du 7 au 10 décembre 1982 pour examiner la question et faire part de leur expérience. L'Indonésie imposera incessamment une quarantaine à tous les stocks de poissons vivants importés ou transportés d'une île à l'autre, dans le pays. L'isolement est de 14 jours et comprend l'analyse d'échantillons en laboratoire pour détecter la présence de parasites, d'infections bactériennes, etc, ainsi que des symptômes ou signes pathognomoniques. La période de quarantaine, qui est de même durée en Australie, suffit à obtenir les résultats des laboratoires, à identifier la plupart des symptômes et des maladies et à garantir l'importation de sujets exempts de pathogènes humains. Singapour applique cette mesure à titre expérimental et les autres pays étudient divers moyens de contrôle. Cependant, la pénurie de personnel et de locaux pour effectuer les diagnostics et les traitements fait obstacle a l'établissement de services appropriés.

Resumen

El tráfico de peces vivos —larvas para las operaciones de cría— aumenta rápidamente a medida que se elevan los costos de la pesca y disminuyen sus rendimientos. Este movimiento de peces es esencial para la acuocultura moderna, pero, bajo los procedimientos actuales, representa un serio riesgo para las grandes cantidades de pescado (a menudo una sola especie) que se cultivan en pequeñas áreas. En el Sudeste Asiático varios epidiontes pueden ser ya vinculados a la introducción de peces importados, y tales incidentes pueden volverse cada vez más comunes si los gobiernos de la región no toman medidas para controlar el tráfico de peces y asegurar que los cargamentos están libres de patógenos y plagas. Muchos de los países han reconocido el problema, e investigadores en enfermedades de los peces, procedentes de Filipinas, Indonesia, Malasia, Singapur y Tailandia, así como consultores del Reino Unido, Canadá y Australia se reunieron en Yakarta del 7 al 10 de diciembre de 1982 para discutir el problema y compartir experiencias. Ellos señalaron que Indonesia está en proceso de introducir la cuarentena obligatoria para todas las especies vivas de peces que se importen al país o sean transportadas entre las islas que lo conforman. La cuarentena es de 14 días durante los cuales las muestras del cargamento son sometidas a exámenes de laboratorio en búsqueda de parásitos, infecciones bacterianas, etc, y observadas en cuanto a signos y síntomas de enfermedades. La duración de la cuarentena, igual a la propuesta recientemente en Australia, asegura que no se importan patógenos humanos con los peces, que se obtienen los resultados de laboratorio y que los síntomas de la mayoría de enfermedades alcanzan a aparecer. Singapur está ensayando procedimientos de cuarentena y los otros países estudian las opciones de control. Sin embargo, la escasez de personal y la carencia de instalaciones para diagnóstico y tratamiento de las enfermedades constituyen una limitación seria al desarrollo de servicios apropiados.

CONTENTS

FOREWORD

Interest in fish farming continues to grow throughout Southeast Asia where extensive areas potentially suitable for aquaculture remain unexplored. Rising fuel costs place fish harvested from distant waters among the most expensive sources of edible protein.

Intensive fish culture calls for high stocking densities, nutritious supplementary feeds, control of water quality, and systematic management. Though there is interest in polyculture — the simultaneous cultivation of several non-competitive species — monoculture is much more common. High concentrations of single species encourage the spread of infection and infestation. Preference among nations for relatively few attractive species has stimulated international trade in fish seed with the concomitant hazard of spreading infectious diseases. In Indonesia, several disease outbreaks have been tentatively traced to imports of live fish for cultivation. Consequently, the Indonesian government has initiated measures to protect the fish within its waters from not only the introduction of disease agents from foreign countries but also the transfer of agents from one island within the country to another. A quarantine system that includes comprehensive examination of transported fish has been proposed and is in the process of being implemented. Indonesia was therefore considered a particularly suitable site for a discussion of fish quarantine and fish diseases in Southeast Asia.

In 1978, when growing interest in fish diseases was evident in the region, IDRC sponsored a meeting of research workers at Cisarua, Bogor, Indonesia, to discuss the state of knowledge and to plan future efforts. It was then recommended that a fish-quarantine meeting be held as soon as one could be arranged.

The meeting described in this report was held from 7 to 10 December 1982, sponsored by UNDP/FAO South China Sea Fisheries Development and Coordinating Program and IDRC, and was attended by research workers from the Asean countries.

It is hoped the recommendations recorded in this report will be examined seriously and sympathetically by all interested agencies and persons responsible for their implementation.

The sponsors wish to extend their sincere thanks to the Government of Indonesia and to its Agency for Agricultural Research and Development and Director of Fisheries for hosting the meeting and making local arrangements for the field trip. Particular acknowledgment is made to H.R. Rabanal, Ronald J. Roberts, T.P.T. Evelyn, and T. Bergin for their valuable assistance as rapporteurs.

E. OSWALD AND J.H. HULSE
UNDP/FAO SOUTH CHINA SEA FISHERIES DEVELOPMENT AND COORDINATING PROGRAM; AND
INTERNATIONAL DEVELOPMENT RESEARCH CENTRE

WORKSHOP SUMMARY

RECOMMENDATIONS

Evidence indicates that the uncontrolled entry of live fish into countries of Southeast Asia has at times resulted in the transfer of pathogenic parasites and microorganisms that pose a great economic and ecological threat to the valuable and vulnerable fish stocks. A rational and economically viable scheme of control is considered essential within Southeast Asia to protect the stocks of ornamental and food fishes, both cultured and wild, and to protect the human populations from *Vibrio cholerae* and *Salmonella* sp., which are not important as fish pathogens but can be carried by fish and are potential human-health risks.

It is, therefore, *recommended* that the following disease agents and pests be recognized as major risks to aquaculture in the Asean region because they currently either are absent from the region or are found only in restricted areas:

- Viruses: viral hemorrhagic septicemia (VHS), infectious pancreatic necrosis (IPN), infectious hematopoietic necrosis (IHN), spring viremia of carp (SVC), channel catfish virus (CCV), lymphocystis, and the unisolated viruses currently suspected of being responsible for fish epizootics;
- Bacteria: *Aeromonas salmonicida* (two varieties), *Vibrio* spp. (forms pathogenic to fish), *Mycobacterium* spp.;
- Parasites: Myxosporia, Microsporia, *Clinostomum* spp., and parasitic crustaceans;
- Fungi: *Lagenidium* spp., *Aphanomyces* spp., *Branchiomyces* spp.; and
- Pests: Backswimmers (Notonecta).

The only practical means of preventing the entry or spread of these disease agents and pests is the institution and implementation of appropriate quarantine measures.

It is, therefore, *recommended* that each country implement a system of fish quarantine incorporating:

- A requirement for specific certification by the exporting country;
- Inspection of imported fish, including laboratory examination of fish samples;
- Treatment and observation of fish in quarantine;
- Safe disposal of imported water and the accompanying pests;
- Sanitary surveillance of fish farms; and
- Penalties for noncompliance.

Although the economic importance of fish diseases is well recognized, at present there is only limited information available on the diagnosis, prevention, and treatment of the diseases.

It is, therefore, *recommended* that priority be given to upgrading existing facilities for fish-disease diagnosis in each country; to the standardization of diagnostic procedures among facilities; and to preparation of an inventory of fish-disease agents present in the region along with efforts to develop an understanding of their epizootiology.

Viruses pose a particularly potent risk, and, at present, there is a total lack of facilities for virus detection and isolation in the region.

It is, therefore, *recommended* that the highest priority be given to the early establishment of a fish-virus diagnostic and research laboratory within the Asean region and that, in the interim, an arrangement be sought for a laboratory outside the region to carry out viral diagnosis and provide advice on the establishment of the laboratory.

Establishing and upgrading diagnostic facilities must be complemented by the training of staff to service them and to link them effectively to the aquaculture industry.

It is, therefore, *recommended* that priority also be given to training for researchers and extension workers and that education of fish farmers and handlers about the value of quarantine to their industry be regarded as essential.

Information on courses offered in particular countries should be shared widely, perhaps through a regional newsletter, to prevent duplication. Exchange of information about diseases is the most important form of sharing because it is a vehicle for prevention of disease spread.

It is, therefore, *recommended* that arrange-

ments between appropriate national agencies in the region be made so that they are notified immediately of the presence or suspected presence of serious fish pathogens. Similar bilateral arrangements should be sought outside the region.

STATUS OF FISH-DISEASE RESEARCH AND LEGISLATION

The fisheries industry is essential to the food supplies and national economies of the members of Asean. Recently, aquaculture, as a component of the industry, has been accorded high priority in the national development programs of these countries to compensate for the increased operational costs of capture fishing, the declining catches from national waters, and, for some, reduced access to foreign waters brought about by extended fisheries jurisdictions.

Aquaculture is not new in the region; in fact, it has a long history. Varying somewhat in the levels and types of development in the different countries, it has progressed gradually and has been innovative. Concomitant with development, intensification and greater movement of resources have become a necessity. The recent trends have resulted in new problems, such as a rise in disease occurrence, accompanied by unintentional transfer of pathogens among and within countries.

The potential for aquaculture in the region is still high, and accelerated development of this industry at present is propitious. There are still vast areas for expansion of culture, and the rearing of new and more resources is being demonstrated.

As the industry progresses, technology to improve culture techniques and eliminate constraints that are just beginning to emerge will be required. The increasing prevalence of diseases and the need to prevent and control their transfer require concerted efforts by the countries in the region.

INDONESIA

Fish production through aquaculture, both in fresh and in brackish water, in Indonesia contributes significantly to the country's economy. Of the estimated annual production of fisheries (1.82×10^6 t), about 11% comes from aquaculture. The main cultured species in fresh waters are common carp, small cyprinids, gouramy, and tilapia. In brackish waters, milkfish and penaeid shrimps are the main species, whereas culture of bivalve species such as oysters and mussels in open areas and cage culture of finfish are also beginning to develop. The culture sites include ponds, rice fields, open waters, etc.

Serious epizootics of fish diseases that caused considerable damage to the Indonesian aquaculture industry have occurred within the last 3 decades: for example, in 1951 an outbreak of *Myxobolus pyriformis*; in 1953, *Lernaea cyprinacea*; and in 1980 an unidentified species believed to be *Aeromonas* sp., which caused losses of 125 t of carps, including 30% of the brood stock. These incidents cost millions of rupiahs, and the disease agents were suspected to have been introduced with imported fish.

The outbreaks focused government attention on measures to prevent similar occurrences in the future. Initial facilities for quarantine and the study of fish diseases were established at the Inland Fisheries Research Institute of the Central Institute for Research in Fisheries of the Agency for Agricultural Research and Development in the Ministry of Agriculture. Research facilities were improved in various universities in the country, with the main one being the fisheries faculty of Bogor Agricultural University.

At the highest levels of officialdom, it was recognized that live-fish traffic, both international and intranational, had to be controlled if accidental introduction of disease agents were to be avoided. The most feasible method of disease control, without impeding the traffic in fish, was considered to be quarantine. Holding and examination facilities and government units for the work were set up, and a series of ministerial directives provided the legal underpinnings. However, because the work is new for the country and there is limited local knowledge and experience, the initial facility is small, probably inadequate to handle all the live fish entering the country. Expansion of the program is anticipated, as is upgrading of the facilities. A main fish-quarantine station has already been established at the national airport in the capital city, and six provincial stations have been installed in strategic places in the country. With government

Spores of Myxobolus *sp., the two prominent polar filaments are at the anterior of the spore. The introduction of* Myxobolus *in Indonesia caused serious losses of fish in culture.*

awareness, the agencies and facilities for the work are expected to expand and improve.

Meanwhile, national legislation to establish a national fish-quarantine unit, closely linked with the existing plant- and animal-quarantine agencies, has been drafted and is now in Parliament for action.

MALAYSIA

Aquaculture is an expanding industry in Malaysia and has been given high priority in the economic development program of the country. Cockle culture in open marine waters and pond culture of various freshwater species are relatively well developed, and cage culture for marine finfish and pond culture in brackish water are just being initiated. Of the total fish production of 7.0×10^5 t, an estimated 6.5×10^4 t or 9.3% (1979) comes from aquaculture.

Some studies on diseases occurring in pond-cultured freshwater species have been made. Although no mass mortalities have been traced to introductions of fish from foreign countries, the rapid adoption of intensive methods of culture (for example, cage culture of marine fish) and increased imports of various fish seeds to support the industry make the country vulnerable to disease outbreaks. Live-fish traffic is almost completely uncontrolled, although the country's law-making body is considering legislation that would provide the Ministry of Agriculture with the authority to introduce fish-quarantine measures as well as any other controls it considered essential.

The country, at present, lacks trained personnel and facilities for fish-disease study, but a national committee has been designated to undertake fish-disease work under the Ministry of Agriculture, with membership from the Division of Fisheries, Malaysian Agriculture Research and Development Institute (MARDI), and Universiti Pertanian Malaysia. With

increased handling and entry of fish for culture in the country, the establishment of an agency responsible for fish-disease control appears imperative.

PHILIPPINES

Aquaculture, mainly of milkfish in brackishwater ponds, is well established in the Philippines. Of the total annual fish production (1.6×10^6 t), about 9% (1979) comes from aquaculture; the water resources within the country could support intensification and expansion of the industry to increase production.

Some studies on fish diseases have been conducted, but no institution or agency is dedicated solely to such work. The Aquaculture Department of the Southeast Asian Fisheries Development Center (SEAFDEC), a voluntary, regional organization of several countries in Asia, has set up a unit and facilities for identification of fish parasites and bacterial infections. Various universities, especially those with a fisheries faculty, also undertake related studies, with the Bureau of Fisheries and Aquatic Resources (BFAR) coordinating and monitoring the activities. Some epizootics among the main cultured species, the milkfish, have been noted (for example, isopod parasites, bacterial infections), and serious fungal infections of larval and postlarval *Penaeus monodon* (the main species for shellfish culture) have occurred. Microbial infections in other cultured fish (tilapia, catfish, and carps) have, likewise, been reported, and parasitic diseases affecting various species have been identified (mainly by workers in the universities).

Although the Philippines has a national policy to protect and conserve fishery resources, there is no specific policy or activity yet for control of fish diseases through certification and quarantine. With increased movement of live fish and intensification of culture techniques, stricter measures to prevent the introduction and spread of fish diseases will be necessary.

SINGAPORE

Singapore is a major importer of live food and ornamental fish for farming and for transshipment. The demonstration of the technical and economic feasibility of cage culture of marine fish has resulted in a phenomenal increase in the country's import of live fish seeds. By October 1982, imports for the year had totaled about one-half million marine foodfish fingerlings, worth millions of Singapore dollars.

Some studies on fish diseases have been undertaken for the species being cultured, and the major pathogens have been identified. The increasing volume of activities in handling live fish puts the country at serious risk of introducing epizootics, and the government is taking initial steps to quarantine fish imports into the country. The Primary Production Department of the Ministry of National Development is the responsible agency.

THAILAND

Thailand has a well-developed and diversified aquaculture industry. Freshwater and brackishwater pond and cage culture exists, and freshwater and saltwater hatcheries in the country produce finfish, shrimp, and prawn seeds for local fish farms as well as for export to foreign countries. These activities result in extensive movement and handling of fish.

Total fishery production in 1979 amounted to 1.95×10^6 t. Of this, 1.5×10^5 t or about 8% was produced through aquaculture.

Some studies on fish diseases have been conducted in the country, and a few serious disease outbreaks have been reported, one of which was with cultured freshwater catfish. Although mortalities were attributed to disease, heavy stocking densities and poor water quality were also major factors.

Fish-disease studies are being conducted by units of the Department of Fisheries, mainly the National Inland Fisheries Institute for freshwater species and the National Institute of Coastal Aquaculture for euryhaline and marine species. Universities with fisheries and marine-sciences faculties also contribute to these studies.

Quarantine and fish-health services are not yet available, but, as the country is a major exporter of live fish, especially cultured food fish, a reliable certifying agency should be a priority for the fisheries industry.

OUTSIDE THE REGION

The policies and approaches to imports of live fish by potential clients outside the Southeast Asian region are noteworthy. For example, a fish-quarantine system is being implemented in Australia to protect the local fish and human populations against dangerous disease agents. The system requires the licencing of both exporters and importers, with importers being obliged to construct holding facilities to be monitored by the responsible government agency. Results of the quarantine procedures will be transmitted to the importer as well as to the exporting authority.

In Canada, the USA, and the United Kingdom, cold-water species, the salmonids, are

emphasized in the legislation governing live-fish traffic. However, the tropical ornamental fish trade and the increasing use of warm-water effluent from cooling plants for aquaculture may eventually produce problems similar to those in tropical waters and necessitate regulations to govern shipments of warm-water fish in such areas. In Canada, the provinces control all fish transfers within their borders unless, as is the case of the maritimes, the federal government has chosen to retain this responsibility. However, with respect to live, cultured salmonids; live eggs of salmonids; and certain products of dead, cultured salmonids; minimum federal standards have to be met before the products can be imported into Canada or shipped across provincial boundaries. Such shipments have to be accompanied by a permit indicating that they are derived from a source that has been inspected and found to be free of certain disease agents. Details of the inspection procedures required and on the disease agents that must be absent if a salmonid source is to receive certification are contained in Canada's *Fish Health Protection Regulations Manual of Compliance*.

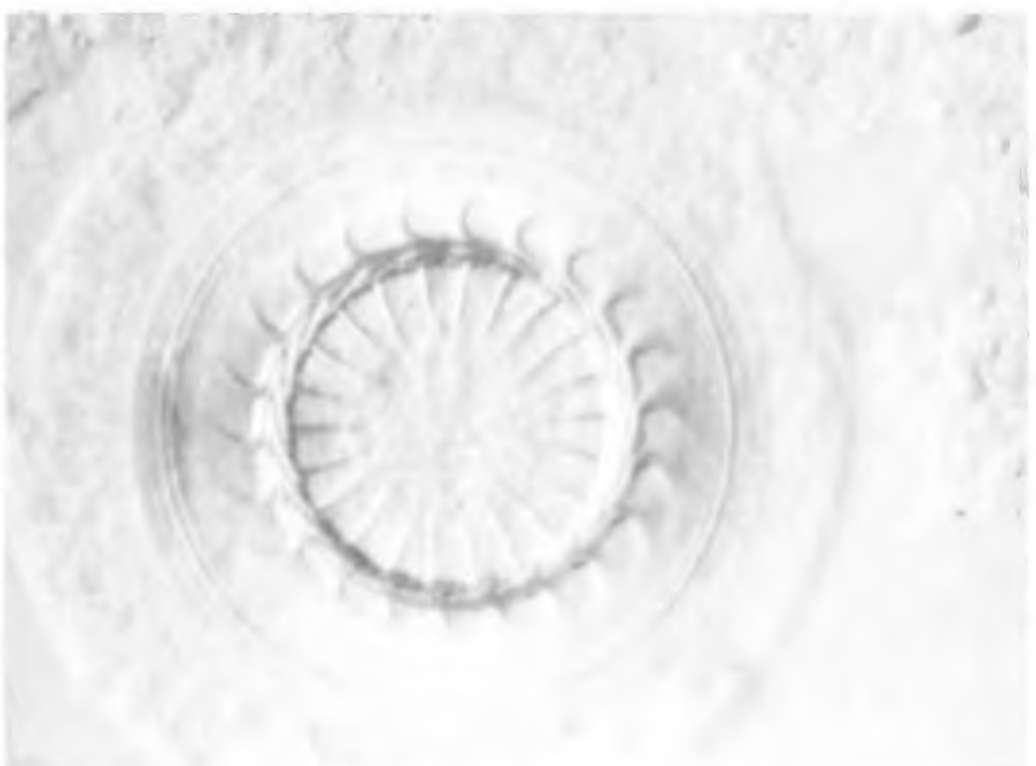
In the UK, the import of live salmonids is forbidden. The certification system relates to salmonid eggs, which are allowed entry only from certified farms and are disinfected on entry. Import of live cyprinids is forbidden for culture or stocking but is allowed under a separate section of the law for ornamental fish, such as goldfish and koi. Other tropical, ornamental fish trade is also covered by this separate mechanism.

FISH-DISEASE AGENTS AND HOSTS

In any consideration of pathogens and their relative importance in fish, whether ornamental or edible, the microorganisms must be placed in the correct context in relation to the two factors controlling their significance: the status of the host and the nature of the environment. All scientists working in Asean agree that healthy, well-maintained fish, in good environmental conditions, rarely succumb to the regular range of disease conditions that are encountered in their normal environment. It is only when the inherent resistance of the fish is lowered by some environmental factor, such as transportation, traumatic handling, poor-water quality, or inadequate nutrition, that the microorganisms normally present in the water or on the skin, gills, or in the intestinal tract of the fish are able to produce clinical disease. However, pathogens that do not currently exist within the normal environment of the fish in an area, if introduced with imported fish or water, may cause epizootics of major financial and ecological significance as they spread through a naive (i.e., vulnerable because of the lack of immunity) population.

Thus, a particular pathogen may be important to a country's industry for a variety of reasons:

- It may cause economic losses through mortality, reduced growth rates, or, in aquarium



Trichodina *sp., a protozoan, can cause mortalities among fish under stress during transport and handling.*

Chilodonella *sp., once known as a cold-water parasite, is now commonly found in fish in the tropics.*

fish, inadequate colouring, fin shape, or other morphological features;

- It may reduce sales because it is a risk to human health; or,
- It may, if introduced to naive fish, result in major epizootics.

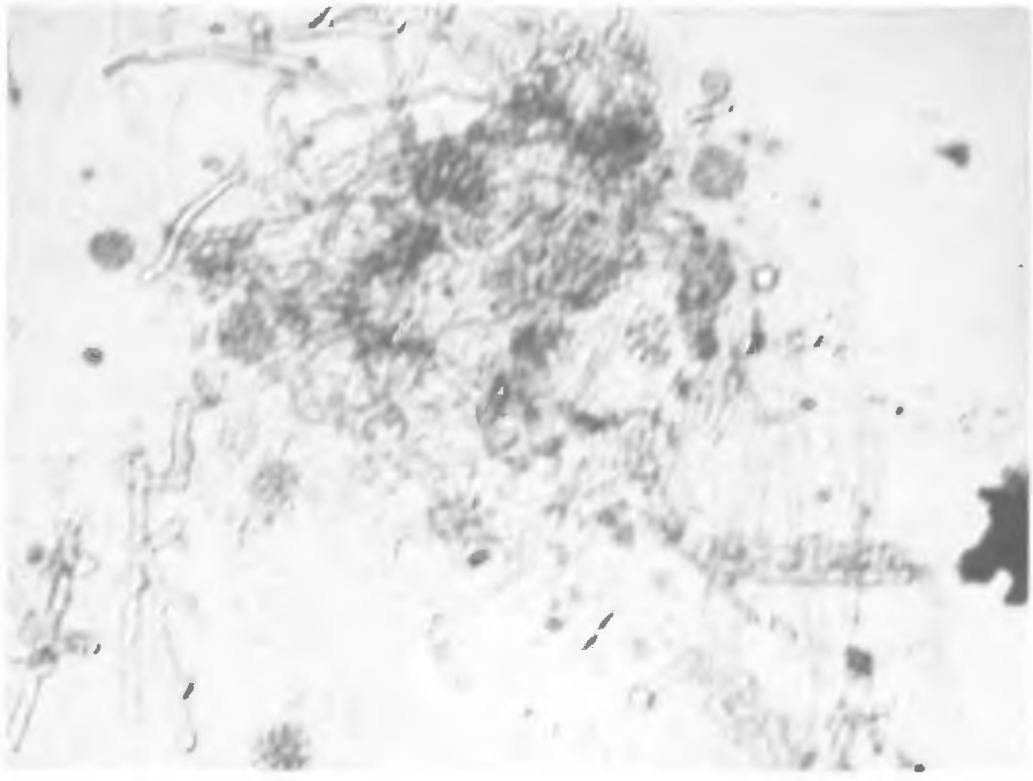
Any one of these three effects is especially important in relation to exports. The first group of pathogens, even if they are already widely dispersed in a recipient country and, therefore, unlikely to be a direct threat (e.g., *Saprolegnia*), may well kill fish during or after transport or make the fish unattractive to end purchasers. If they are not present in the consumer's country, then they put the stocks at risk and are, thus, likely to curtail further exports.

The second group are more significant because risks to human health are usually considered unacceptable by governments and are minimized by strong controls in importing countries. If found among imported live fish, this group could seriously limit an exporter's market for the future.

The last group of pathogens are the most important, in national terms, and, thus, it is in the national interest to take steps to avoid introducing them.

In doing so, one must bear in mind that movement of fish also involves movement of water, itself an excellent medium for the incidental transfer of human pathogens, such as cholera or typhoid bacteria, and other undesirable biota, such as insects, snails, unwanted fish species, and water weeds. In the countries of Asean and in the tropical and subtropical developed countries, such as Australia and the US, major markets for Asean aquarium fish, the water in which fish are moved is a hazard.

In Asean, although to date only limited facilities and trained staff are available, there is already ample evidence that the risk of importing the third group of pathogens is significant. For instance, in Indonesia, *Ichthyophthirius* sp. was introduced, with tragic consequences in 1932, *Lernaea* sp. in 1953, *Myxobolus* protozoa in 1978, and an undiagnosed microbe responsible for a major epizootic in 1980. All of these agents have caused untold harm to the fish-culture industry in the country and could, for the future, close entry to some overseas markets.



Close up of Lagenidium *sp., a fungal pathogen that has created problems for shrimp culture in the region.*

Disease conditions existing outside the region that cause grave concern among Asean scientists working in the field include the systemic mycoses of non-Asean crustacea, exotic myxosporidians, a wide range of viruses from America and Europe, such as infectious pancreatic necrosis, viral hemorrhagic septicemia, herpes virus of channel catfish, and spring viremia of carp, as well as the bacterium *Aeromonas salmonicida*. Except for *A. salmonicida*, which was reported in west Java during the 1980 epizootic in common carp, none of these has yet been diagnosed in Asean countries, and there is reason to believe that they currently do not occur. However, the region is wide open to their importation, and this would probably mean serious losses to fish farmers. If found, some of them would also certainly result in the complete closure of certain markets, including the US, UK, and Australia, to Asean live fish.

Several important agents have been recognized in individual countries in the region, but their status in the countries as a group is currently unknown. They probably do not exist in the other countries and should be considered members of the third group of agents. Examples of these are the microsporidians causing white-ovary disease in penaeid shrimps in the Philippines and the agent responsible for acute abdominal dropsy in cultured catfish in Thailand.

Proper facilities for the isolation and diagnosis of Asean fish pathogens and for research on their prevention and treatment do not yet exist. For instance, there is not yet one operating fish-virology facility in the region. Disease facilities could, as well as fulfilling their primary objective, offer individual farmers and the industry information and extension services. They could investigate serious disease losses and advise on proper control and therapy. Upgrading disease-diagnosis standards and improving control of international movement of fish pathogens are essential; if they are not implemented soon, the many unique advantages for fish culture enjoyed by Asean will be negated by epizootic transfers. Once a disease agent has been introduced, it is impossible to eradicate because of the ubiquity of waterways and wild fish in most Asean countries.

FISH QUARANTINE AND CERTIFICATION

A viable industry in ornamental fish and in fish cultured for food entails considerable movement of live fish, both intranationally and internationally. This movement carries with it the danger that infectious agents will be transported with the fish to areas previously free of them.

Efforts to minimize the risk of inadvertently transporting dangerous parasites and microbial pathogens with shipped fish have basically followed three strategies: fish-farm certification, inspection of particular shipments, and quarantine. In countries with culture of cold-water species, health certification of production facilities is considered more effective and expedient than attempting to test and certify each shipment of fish made from a facility. Once a facility has been certified — a process that, in Canada, for instance, may take 2 years and four satisfactory inspections — the operator of the facility may make as many shipments a year as desired on the basis of two satisfactory annual inspections. This health-certification scheme is justified because salmonids have been well studied, and knowledge about the pathogens that they carry is fairly complete. Consequently, it is possible to specify which disease agents must be absent from a production facility without too great a risk that a dangerous, unknown pathogen will be present.

In tropical and subtropical waters, however, the number of fish species is large, and knowledge of the infectious agents is fragmented or incomplete. It is extremely doubtful that a health-certification system like the one described for salmonids could be relied on to provide the needed protection against the fish-associated spread of disease agents. Indeed, although it would be desirable to have information on the parasites and microbial pathogens present in the establishments operated by individual fish farmers and dealers, a review of the laboratory facilities and trained personnel available in the Asean indicates that the collection of such data would be beyond the present capability of the region.

At present, many of the countries are approving the import and export of particular shipments of fish on the basis of cursory, visual inspections. It is almost impossible for customs or fisheries officers to judge the health of fish by such measures. Without prolonged observation, the individual shipments of fish cannot be declared pathogen-free with any degree of certainty. In the countries where visual inspection is the practice, the live stocks are at considerable risk, their only protection being the inherent good health of the majority of imports.

Clearly, a quarantine system should be considered for adoption. As a result of unpleasant and costly experiences with imported parasites and pathogens, Indonesia has opted for quarantine. The authorities set up a quarantine system to prevent the import and export of parasites and pathogens with fish being shipped into and out of the country. Fish are held for observation and testing (parasitological and bacteriological) for at least 10 days and are treated for external parasites. The idea is that, in the warm climate, infected (carrier) fish will have exhibited clinical signs of disease within this time. During quarantine, samples of fish are tested for the presence of bacterial and parasitic infections. The system is flexible, allowing, for instance, for increases in the quarantine time as a substitute for some of the lethal examinations on very expensive fish. The system appears to be gaining acceptance among fish farmers and dealers.

At present, only one other Asean country, Singapore, is experimenting with quarantine: the operation is restricted to the short-term holding and bath treatment of imported marine fish destined for mariculture in Singapore.

If and when controls are introduced, they should include a system of feedback to fish suppliers. Singapore and Australia have found that fish farmers need to know what disease agents are found in their shipments. Australia has also stressed mutual trust between trading partners, encouraging a notification system for disease outbreaks.

FUTURE PLANS AND PROGRAMS

Quarantine of fish is a complex problem. In many countries, it involves input from at least three separate areas of government administration: quarantine, fisheries, and veterinary services. The system must be structured to protect the species farmed in a particular country from exotic diseases carried by imported fish. The personnel and facilities that each nation can allocate to the task of fish quarantine must also be taken into account. Legislation must be framed, and its adoption may take many years in some countries. It should provide controls on movement of live fish not only internationally but also intranationally, especially in countries that comprise many islands. The successful containment of an outbreak of disease caused by an unidentified agent in 1980 in Indonesia indicates that quarantine measures between islands can be quite effective. Implementation of a fish-quarantine service requires staff training, research, and new or expanded facilities.

Most countries need to draft an inventory of the diseases found within their borders, as well as a list of diseases that have not been identified in their waters so that they can devise methods of avoiding their introduction. The degree of risk posed by some temperate-water fish viruses has not as yet been assessed; however, consumer nations are likely to avoid purchases from any country reporting the presence of major cold-water fish viruses. Thus, such viruses should be classified as high risk until more is known about their ability to survive in the region. One virus, infectious pancreatic necrosis, can survive in tropical fish, and a north-European fish parasite (*Clinostomum* sp.) has been reported to have caused epizootics in diverse climates, for example in the United Kingdom and Bangladesh. Furthermore, serious problems with one parasite (*Lernaea* sp.) have been reported from as divergent habitats as the countries in Southeast Asia and the waters of the Australian snow fields.

The diagnostic and research requirements of a fish-quarantine system can partially be ascertained from services existing elsewhere. The acute shortage of funds for such purposes in the Asean countries, however, indicates that nations in the region have to convert and possibly expand existing facilities rather than aiming for the construction of new ones. For similar reasons, upgrading of, for example, veterinary-services staff would be cost effective.

The universities' role in training would be significant. Compulsory inclusion of a fish-pathology course within the existing curriculum of fisheries-degree programs would be an initial step. Training of future aquaculture-extension workers on the significance of fish diseases and their prevention is a priority. Also, university authorities should plan to integrate the study of fish infections and prevention in future training courses for aquaculture.

Indonesia is offering training courses for researchers, extension workers, and fish farmers. At the Regional Centre for Tropical Biology in Bogor, a fish-diseases training course has been given top priority in the 1983–88 plans. The Asean members could share resources and minimize duplication if they notified one another of planned courses. In Malaysia, a short national course in fish diseases has been conducted at Universiti Pertanian Malaysia, and the Philippines is interested in suitable courses for fish farmers.

One major constraint to fish-disease study is the complete lack of a fish virologist in the region; a reference centre for the region and a virus facility are also considered essential.

COUNTRY REPORTS

INDONESIA[1]

RUSTAMI DJAJADIREDJA[2], T.H. PANJAITAN[3], AKHMAD RUKYANI[2], ADI SARONO[3], DARTI SATYANI[2], AND HAMBALI SUPRIYADI[2]

Indonesia has a multitude of fishery resources, and fish is the main source of animal protein for human food. Because of its high productivity, aquaculture is considered the most feasible means to increase the supply of high-quality protein for food for the growing population.

About 4.4×10^5 t of fish are produced at present from 1.4×10^7 ha of open waters (natural lakes, reservoirs, rivers, swamps, etc.), brackish water, and fresh water. Of this total surface area, only 28% of the freshwater, 9% of the brackish-water, and 46% of the open-water resources have been utilized for fish culture, with freshwater-fish culture accounting for the highest production. Common carp (*Cyprinus carpio*), java carp (*Puntius javanicus*), nile tilapia (*Sarotherodon niloticus*), and giant gouramy (*Osphronemus gouramy*) are the economically important freshwater species being cultivated in the country. The low production from aquaculture, despite great potential, in Indonesia may be attributed to the insufficient supply of fry, environmental stresses, disease outbreaks, etc.

During the last few years, fish farming in Indonesia has been widely promoted, particularly through national and regional intensification of aquaculture programs; one result of these efforts has been increased traffic of live fish, both between the islands within Indonesia and between Indonesia and other nations. In 1980, Indonesia exported 4.4×10^5 t ornamental fish at a value of US$ 135 934. In the same year, it imported exotic food and ornamental fish, which, unfortunately, introduced serious disease agents into many regions of the country. The history of such introductions is long.

In 1932, serious epizootics of *Ichthyophthirius multifillis* occurred in west and central Java, causing great losses to fish farmers. The parasite was encountered first in aquaria at Bogor, probably introduced with ornamental fish from the United States and Europe.

In 1951, an epizootic of *Myxobolus pyriformis*, a sporozoan parasite, killed thousands of Java carp fry in Central Java (Sachlan 1952). The parasite, which was thought to be imported, has caused serious losses annually ever since. However, the infection is seldom found on common carp or other species. Like most other sporozoan parasites, *M. pyriformis* is very difficult to control because cysts form around the spores and protect them against chemical baths.

Lernaea cyprinacea, which was accidentally introduced into Indonesia from Japan in 1953, caused a serious epizootic in economically important fish species such as common carp, java carp, kissing gouramy, giant gouramy, etc. The parasite rapidly spread to other regions and destroyed about 30% of hatchery production in the main hatchery centres of Java, north Sumatra, and north Sulawesi. This means that, in Java, a total of 1.48 billion fish fry were lost during the epizootic, equivalent to 7.4 billion rupiahs (US$ 1 = 650 rupiahs). Studies of the biology, ecology, and control methods of *Lernaea* were carried out under the Fish Parasite Project, supported by the International Development Research Centre (IDRC) from 1975 to the present, and a number of effective control measures resulting from the studies have been recommended to fish farmers.

During the project, two new parasites belonging to the myxosporidian group were recorded in west Java, causing considerable losses of common carp fingerlings. One of the parasites, first detected in 1974 and identified as *Myxobolus* sp.,

[1]This paper is an edited version of two papers; the cooperation of the authors in agreeing to a single country report is gratefully acknowledged.

[2]Research Institute for Inland Fisheries, 1 Jalan Sempur, Bogor, Indonesia.

[3]Directorate General of Fisheries, Jalan Salemba Raya 16, Jakarta, Indonesia.

produces tumour-like swellings on the gills of fish. The other parasite was recorded in 1978 and preliminarily identified as *Myxosoma* sp. The infected fish exhibited swollen body muscles. Both of these parasites appear to be confined to common carp, and, during epizootics in carp fingerlings, have resulted in mortalities as high as 60–90%. Information on how to control the parasites is limited, and, to date, no treatment has been successful. How they were introduced into Indonesia is unclear, but imports of common carp from Japan are suspected.

In late 1980, a large number of fish died in west Java from an outbreak of bacterial disease. The epizootic was the most serious ever recorded in Indonesia, with 125 t of common carp dying, including 30% of the existing brood stock. This loss not only adversely affected present production but also curtailed expansion of fish culture in the country. A particularly virulent strain of *Aeromonas* sp. is believed to have been the causal agent, probably introduced with imports of common carp from Taiwan.

Although curative measures are pertinent and essential, the Indonesian government is considering measures that emphasize prevention through quarantine, because preventive measures are more economical and effective than curative measures.

Aspects of fish quarantine, its organization, and certification procedures were discussed at a regional workshop on tropical fish diseases, held in Cisarua, Bogor, in November 1978. The workshop was hosted by the Indonesian Directorate General of Fisheries (DGF) and Agency for Agricultural Research and Development (AARD) in collaboration with IDRC.

INSTITUTIONS FOR FISH-DISEASES STUDY AND TRAINING

The study of fish diseases in Indonesia is still in its infancy, and there is a lack of specialists and laboratory facilities for carrying out this work. For a number of years, however, institutions, such as the Inland Fisheries Research Institute (IFRI) and the faculty of fisheries, Bogor Agricultural University (BAU), have been carrying out some studies. The diagnostic laboratories available in these institutions provide modest support for parasitological and bacteriological examinations. IFRI, under the Ministry of Agriculture, has closely cooperated with the faculty of veterinary medicine, BAU, and the Animal Disease Research Institute, particularly for viral diseases. DGF collects information on fish diseases in the field, monitors fish mortalities and morbidities, and provides data to the laboratories. Since the 1980 epizootics, the laboratories now have become better equipped, particularly for bacteriological studies.

The first training course on fish diseases and parasites in Indonesia was held by Biotrop, the Regional Centre for Tropical Biology, in 1980; 12 people from the Asean were trained for 6 weeks in the identification and control of fish and shellfish diseases.

In 1974, Indonesia, through DGF, developed a fish-quarantine service at six main ports, and, since 1977, 86 staff from the provincial fisheries services have been trained in a 2-month fish-quarantine training course at Ciawi, Bogor. Training was made possible through the cooperative efforts of DGF, the Agriculture Agency for Education and Extension, BAU, and IFRI. Through the IDRC-funded, fish-parasite project, four people, representing IFRI, DGF, BAU, and the Animal Disease Research Institute, were trained abroad in practical fish bacteriology, parasitology, and virology and have since rejoined their institutes. Not a single fish pathologist is available at present for work in the fish-quarantine service.

NATIONAL POLICY

Along with the recent increase in live-fish traffic in the country has come increased risk of introduction and distribution of fish pathogens throughout the country. Past and recent disease outbreaks among cultivable fish as well as wild fish have prompted the government to carry out a program in the control of diseases and protection of fishery resources through regulation and legislation. At present, the Fish Quarantine Service in Indonesia is being set up. An agriculture-quarantine law that covers plants, animals, and fish has been drafted by the government for endorsement by Parliament. A manual on fish quarantine, which has been circulated, serves as a guideline for quarantine officers at the fish-quarantine stations throughout the country.

Before the outbreak of *Lernaea* in 1974 (when DGF established the six fish-quarantine services within the provincial fishery services), fish quarantine was under the Animal Quarantine Service. Some laws had already been passed to protect fishery resources. For example, the Ministry of Agriculture Decree 214/Kpts/Um/V/1973 prohibited transfer or export of certain fishery products, including *Anguilla* elvers, *Chanos chanos* seedlings, the ornamental fish *Botia macracanthus* (longer than 15 cm), and the seedlings of

Macrobrachium rosenbergii. Also, imports of *Serrasalmus* sp. (piranha) had been prohibited (DGF Decree E.1.5/8/8/1973). More recently, seven dangerous species — *Vandelia* sp., *Lepisosteus* sp., *Silurus glanis, Esox masquinongy,* electric eel, *Tetraodon* sp., and *Serrasalmus* sp. — have also been declared illegal by Ministry Decree 179/Kpts/Um/3/1982 and are to be destroyed in any area where they already exist.

Since the outbreak of bacterial disease in west Java in 1980, all imports of live fish require a permit from the Ministry of Agriculture and are only allowed entry via the Jakarta airport (Ministry of Agriculture Decree 819/Kpts/Um/11/1980). The imported fish have to be treated and quarantined. To prevent the spread of communicable-disease agents from Java to other parts of the country, a Ministry of Agriculture Decree (425/Kpts/Um/6/1982) requires that freshwater fish from Java be quarantined before being shipped elsewhere.

FISH DISEASES

In Indonesia, parasitic diseases have been imported since 1920 and are encountered more often than are bacterial diseases, which have only just begun to be reported. Sachlan (1974) reported the presence of 13 species of ecto- and endoparasites on fish fry and adult fish in the country. Most are ectoparasites, which commonly attack fish fry: *I. multifillis, Trichodina domerguei, M. pyriformis, Dactylogyrus* sp., *Gyrodactylus* sp., *Clinostomum* sp., *Argulus indicus,* and *L. cyprinacea*. Two species of fungus, i.e., *Saprolegnia* sp. and *Achlya* sp., were also noted as important.

However, since 1974, a number of new parasites have been found, mainly in west Java, including Glochidia of *Anodonta woodiana* (freshwater clam), *Myxobolus* sp., *Myxosoma* sp., *Ergasilus* sp., and *Henneguya* sp. Among these new parasites, *Myxobolus* and *Myxosoma* are highly pathogenic to fish. No fish mortalities have been associated with the other three. *Henneguya* sp. was first detected on the gills of giant gouramy in 1978 and *Ergasilus* sp. detected on the gills of nilem (*Osteochilus hasselti*) also in 1978. According to Sachlan (1978), the Glochidia were accidentally introduced from Taiwan.

Reports of bacterial diseases before 1980 were rare, but, during that year, *Aeromonas* sp. was isolated from diseased fish. These bacteria are known to be opportunistic pathogens and cause infections in fish with impaired resistance. Impaired resistance may have been caused by a virus, but a virus has yet to be detected. Thus, fish mortalities are being attributed to the bacteria.

There are four major communicable diseases causing great losses to the freshwater-fish culture industry today: myxoboliasis, myxosomiasis, lerneosis, and a bacterial disease. Their importance derives from the fact that a considerable effort has been made to control them, but with only partial success, while fish kills continue.

Lernaea cyprinacea is the causal agent of lerneosis. The parasite belongs to the crustacean group and is known as "anchor worm." It is one of the most important species because of its wide distribution and ability to exist on many species of fish. The adult stage (female) of the anchor worm protrudes from the body of fish and is difficult to control by chemical treatment. Some organophosphate pesticides such as Dipterex and Sumithion at 0.5 ppm are effective against the larvae. Sand-gravel filters, which remove the infectious stages of the parasite from the water supply, are commonly used to prevent infestation.

Myxoboliasis and myxosomiasis are caused by *Myxobolus* sp. and *Myxosoma* sp., respectively, which are both spore-forming Myxosporidia. These parasites are confined to young common carp, the former producing tumour-like swellings (spore-laden cysts) of spores on the gill filaments and the latter causing the body muscle to swell. Identification of these parasites is based on the morphology of the spore. The spores of *Myxobolus* are pyriform in shape, and the sporoplasm contains iodinophyllic vacuoles, whereas *Myxosoma* spores are oval and lack iodinophyllic vacuoles. Spores of both parasites contain two polar capsules. There is no satisfactory means to control the parasitism. Liming the pond with 100–200 g/m^2 and strengthening the fry with nutritious feed, to some extent, reduce the rate of infestation. Also, as is the case with *Lernaea*, fish reared in ponds with sand-gravel filtration systems seem to be protected.

A number of bacteria were isolated from infected fish during the disease outbreak of October 1980. Most of the pathogenic bacteria were identified as *Aeromonas hydrophyla* (IFRI 1980b) and *A. salmonicida* (Sumawidjaja et al. 1981). The disease caused death within 3–4 days. The first disease sign was a loss of appetite, followed by heavy loss of body mucus, hemorrhaging on the skin, damage to gills and fins, loss of equilibrium, and, finally, death. The clinical signs were similar to those for motile *Aeromonas* septicemia (MAS). Large common carp and brood stock appeared to be more susceptible to the disease than are fingerlings or fry. About 3

months after the first outbreak on common carp in Indonesia, the disease was suspected in mass mortalities of walking catfish (*Clarias batrachus*) in west and central Java. Some treatments have proved effective. Potassium permanganate ($KMnO_4$), at 20 ppm, as a bath, controls external lesions, but more effective control is provided by injections of Terramycin (oxytetracycline hydrochloride) at 25 mg/kg body weight. Terramycin can also be administered orally, incorporated in the feed daily for 7–10 days at a rate of 5–7 g/100 kg of body weight. This recommended treatment is being applied throughout Indonesia by the fishery extension service (DGF) to affected farms (IFRI 1980a).

Fish are examined for parasites, according to the methods outlined by Fernando et al. (1972). At least 25 specimens are sampled from each species of fish, and, although the preferred method is to examine live or fresh fish, in most cases, the samples have been preserved in 5% formalin or 70% alcohol, depending on the purpose of the examination. Identification keys by Bykovskaya-Pavlovskaya et al. (1964) and Hoffman (1967) are commonly used.

The procedures for identification of bacterial disease are those published by the American Fisheries Society (1975) and by Environment Canada (1977). Biochemical tests are based on Bergey's (1974) manual. Only simple, standard procedures are carried out, with serological testing seldom being done because of the lack of facilities and trained personnel.

Neither IFRI nor the faculty of fisheries at BAU has facilities for viral-disease studies, and the little that has been done to date has been accomplished through cooperation with the animal and veterinary laboratories in Bogor.

FISH QUARANTINE AND CERTIFICATION

Quarantining live fish that are being moved from one area to another is an effective means of disease control. It has been required since 1974 in several airports, enforced by the fish-quarantine services of the provincial governments. However, before the serious disease outbreak in 1980, disease diagnosis by quarantine officers was normally through superficial examination and observation of fish behaviour. Lack of qualified personnel and laboratory facilities made proper diagnosis impossible. Now, in Jakarta, the fish-quarantine procedure, which has been adopted by the governor and formalized by Decree D.V. 7819/c/10/75, involves the inspection of species and issuance of health certificates for fish to be imported or exported through Jakarta international airport:

- All live fish must be accompanied by a health certificate (Appendix 1), issued by the governor of Jakarta;
- All fish must be quarantined during inspection;
- If dangerous (prohibited) species are found in the consignment, they must be seized as government property or used for research purposes; and
- If the fish are suffering from communicable diseases, they must be treated before being released. If the disease is impossible to treat effectively, the fish must be destroyed.

Importers and exporters not complying with this decree are subject to penalty.

The outbreak of disease in 1980 in west Java prompted a joint effort between IFRI and DGF to enable the fish-quarantine service in Jakarta to conduct more intensive and effective controls at the port of entry.

Would-be importers must request a permit (with quantity of fish and time limits specified) from Jakarta's fisheries service, which passes the request to DGF for approval. If DGF approves the request, the fish are placed in quarantine for at least 2 weeks and samples are examined at the IFRI laboratory. Imports of live fish must be accompanied by the special permit issued by DGF, and international trade is only allowed through the Airport of Halim Perdana Kusuma, Jakarta, where arriving and departing fish are inspected.

Fish are dispatched only after being declared free of parasitic and bacterial disease, for which a health certificate is issued by the fish-quarantine station.

IFRI accepted the responsibility for conducting postentry quarantine services at Pasar Minggu, Jakarta, and provides a diagnostic laboratory, fish-holding equipment, and personnel for disease examination; IFRI also carries out disinfection of imported fish at the port of entry and issues the fish-health certificates. There are two kinds of certificate issued by IFRI, i.e., one for disease-free fish (Appendix 2) and one for diseased fish (Appendix 3). Two fish pathologists from IFRI are involved in these quarantine activities, and they carry out the gross pathological examinations as well as the parasitological, bacteriological, and histopathological examinations, using standard procedures. The fish are held in isolation tanks and aquaria for a minimum of 2 weeks, after which they are released if they have not exhibited signs of disease. During qua-

rantine, the physical, behavioural, and clinical manifestations of disease are observed. The fish, if necessary, are treated with chemicals and antibiotics, such as $KMnO_4$, formalin, malachite green, and Terramycin. The methods of treatment include immersion (dipping, short bathing — 1 h, and long bathing — 6–24 h), systemic treatment (injections and feeding with antibiotics), and swabbing. Immersion may be repeated two to three times at 3-day intervals (shorter intervals cause undue stress).

In summary, fish-quarantine activity includes:

- Fish identification (Table 1), carried out either in Pasar Minggu or at IFRI in Bogor, although other institutes may be consulted.
- Fish-disease identification (Tables 1 and 2), carried out either in Pasar Minggu or at the laboratory of fish diseases at IFRI, Bogor.
- Treatment and disinfection of fish for which diseases or parasites are detected. Plastic bags or holding containers for fish transportation are carefully disinfected or are destroyed.

During 1980–82, the bacterial and parasitic disease agents detected at IFRI laboratory were those already known to be present in the country (Djajadiredja 1982). Only one case of imports of prohibited fish species (10 specimens of piranha from Singapore) was detected. These fish were seized by the government, then killed, and preserved in formalin. However, in the same year,

Table 1. Procedures used in the identification and treatment of fish diseases found during quarantine (2 weeks–1 month) at Pasar Minggu, Jakarta.

Disease agent	Method of examination	Treatment
Ichthyophthirius	Microscopy	Bathe (12–24 h) in malachite green (0.1 ppm), formalin (25 ppm)
Trichodina	Microscopy	Bathe (1 h) in formalin (0.25–0.33 ppt)
Costia	Microscopy	Bathe (1 h) in formalin (0.25–0.33 ppt)
Glossotella	Microscopy	Bathe (1 h) in formalin (0.25–0.33 ppt)
Scyphidia	Microscopy	Bathe (1 h) in formalin (0.25–0.33 ppt)
Epistylis	Microscopy	Bathe (1 h) in formalin (0.25–0.33 ppt)
Myxobolus	Microscopy	Destroy fish carrying the parasite; increase quarantine time for those suspected of being infested
Myxosoma	Microscopy	Destroy fish carrying the parasite; increase quarantine time for those suspected of being infested
Thelohanellus	Microscopy	Destroy fish carrying the parasite; increase quarantine time for those suspected of being infested
Plisthophora	Microscopy	Destroy fish carrying the parasite; increase quarantine time for those suspected of being infested
Henneguya	Microscopy	Destroy fish carrying the parasite; increase quarantine time for those suspected of being infested
Hexamita	Microscopy	Incorporate cabarsone in food (0.2%) for 4 days
Lernaea	Microscopy	Bathe in organophosphates (0.1 ppm) for duration of quarantine or dip in organophosphates (1%) for 2–3 min
Argulus	Microscopy	Reverse salinity of bath
Achteres	Microscopy	Bathe (1 h) in formalin (0.25–0.33 ppt)
Salmincola	Microscopy	Bathe (1 h) in formalin (0.25–0.33 ppt)
Ergasilus	Microscopy	Bathe (1 h) in formalin (0.25–0.33 ppt)
Gyrodactylus	Microscopy	Bathe in organophosphates (0.1 ppm) for the duration of quarantine or dip in formalin (1%) for 2–3 min
Dactylogyrus	Microscopy	Bathe in organophosphates (0.1 ppm) for the duration of quarantine or dip in formalin (1%) for 2–3 min
Clinostomum	Microscopy	Destroy fish carrying the parasite; increase quarantine time for those suspected of being infested
Diplostomum	Microscopy	Destroy fish carrying the parasite; increase quarantine time for those suspected of being infested
Diphyllobothrium	Microscopy	Bathe (1 h) in formalin (0.25–0.33 ppt)
Ligula	Microscopy	Bathe (1 h) in formalin (0.25–0.33 ppt)
Echynorhynchus	Microscopy	Bathe (1 h) in formalin (0.25–0.33 ppt)

continued

Table 1 concluded

Disease agent	Method of examination	Treatment
Phomphorinchus	Microscopy	Bathe (1 h) in formalin (0.25–0.33 ppt)
Camallanus	Microscopy	Bathe (1 h) in formalin (0.25–0.33 ppt)
Saprolegnia	Microscopy	Dip (1 min) or bathe (1 h) in malachite green (67 ppm or 1–2 ppm, respectively) or swab lesions directly with malachite green (1%)
Achlya	Microscopy	Dip (1 min) or bathe (1 h) in malachite green (67 ppm or 1–2 ppm, respectively) or swab lesions directly with malachite green (1%)
Ichthyophonus	Microscopy	Destroy fish carrying fungus; increase quarantine time for those suspected of being infested
Branchiomyces	Microscopy	Destroy fish carrying fungus; increase quarantine time for those suspected of being infested
Aeromonas	Culture	External infection: bathe (0.5 h) in $KMnO_4$ (15–20 ppm); systemic infection: incorporate daily into food (g/day, 50 kg body weight) conventional sulphonamides (5–10 g); nitrofurans (5 g); potentiated sulphonamides (2.5 g); or antibiotics (3.5 g) for 10 days
Pseudomonas	Culture	External infection: bathe (0.5 h) in $KMnO_4$ (15–20 ppm); systemic infection: incorporate daily into food (g/day, 50 kg body weight) conventional sulphonamides (5–10 g); nitrofurans (5 g); potentiated sulphonamides (2.5 g); or antibiotics (3.5 g) for 10 days
Mycobacteria	Culture	External infection: bathe (0.5 h) in $KMnO_4$ (15–20 ppm); systemic infection: incorporate daily into food (g/day, 50 kg body weight) conventional sulphonamides (5–10 g); nitrofurans (5 g); potentiated sulphonamides (2.5 g); or antibiotics (3.5 g) for 10 days
Corynebacteria	Culture	Destroy fish carrying bacteria; increase quarantine time for those suspected of being infected
Columnaris	Culture	External infection: bathe (0.5 h) in $KMnO_4$ (15–20 ppm); systemic infection: incorporate daily into food (g/day, 50 kg body weight) conventional sulphonamides (5–10 g); nitrofurans (5 g); potentiated sulphonamides (2.5 g); or antibiotics (3.5 g) for 10 days
Flexibacter	Culture	External infection: bathe (0.5 h) in $KMnO_4$ (15–20 ppm); systemic infection: incorporate daily into food (g/day, 50 kg body weight) conventional sulphonamides (5–10 g); nitrofurans (5 g); potentiated sulphonamides (2.5 g); or antibiotics (3.5 g) for 10 days
Myxobacteria	Culture	Bathe (1 h) or dip (1 min) in furanace (0.5 ppt) or $CuSO_4$ (0.5 ppt)
Edwardsiella	Culture	Destroy fish carrying bacteria; increase quarantine time for those suspected of being infected
Infectious pancreatic necrosis	Clinical signs	Destroy fish exhibiting symptoms; increase quarantine time for those suspected
Channel catfish virus	Clinical signs	Destroy fish exhibiting symptoms; increase quarantine time for those suspected
Spring viremia of carp	Clinical signs	Destroy fish exhibiting symptoms; increase quarantine time for those suspected
Infectious dropsy	Clinical signs	Destroy fish exhibiting symptoms; increase quarantine time for those suspected
Viral hemorrhagic septicemia	Clinical signs	Destroy fish exhibiting symptoms; increase quarantine time for those suspected
Viral hematopoietic necrosis	Clinical signs	Destroy fish exhibiting symptoms; increase quarantine time for those suspected
Swim bladder inflammation	Clinical signs	Destroy fish exhibiting symptoms; increase quarantine time for those suspected

Table 2. Imported fish identified at Pasar Minggu after 1980, their origin, the disease agents detected, and treatments.

Origin of shipment	Species of fish	Disease agent (problem)	Quarantine period (days)	Treatment[a]	Results[b]
Japan	Crucian carp	—	10	$KMnO_4$ (20 ppm, 0.5 h)	+
Thailand	Catfish (*Pangasius* sp.)	—	15	$KMnO_4$ (20 ppm, 0.5 h)	–
Singapore	*Symphysodon discus*	*Trichodina* sp.	15	$KMnO_4$ (20 ppm, 0.5 h)	–
Singapore	Catfish (*Pangasius* sp.)	*Trichodina* sp.; *Ichthyophthirius* sp.	16	$KMnO_4$ (20 ppm, 0.5 h)	–
Ujung Pandang	Rainbow	*Gyrodactylus* sp.	16	$KMnO_4$ (20 ppm, 0.5 h)	–
Jambi	Botia (*Barbus* sp.); *Labeo bicolor*	*Epistylis* sp.; *Trichodina* sp.	15	$KMnO_4$ (30 ppm, 0.5 h)	–
Singapore	Grass carp; *Barbus* sp.; *Labeo* sp.; *Pangasius* sp.	*Pseudomonas* sp.	15	Nitrofurans (10 mg/kg body weight) in food	–
Menado	*Forcipiger* sp.; *Centropyge* sp.; *Paracanthurus* sp.; *Amphiprion* sp.	*Aeromonas* sp.; *Pseudomonas* sp.	13	Terramycin (50 mg/kg body weight) in food	+
Japan	Fancy carp (*Cyprinus carpio*)	(injured)	23	Terramycin (50 mg/kg body weight) in food	+
Singapore	Guppy (*Poecilia* sp.)	*Dactylogyrus* sp.	10	Formalin (25 ppm, 24 h)	+
Singapore	*Pangasius* sp.; *Labeo* sp.; *Policentropsis* sp.	*Gyrodactylus* sp; *Trichodina* sp.	16	Formalin (25 ppm, 24 h)	+
Singapore	*Hypessobrycon* sp.; *Pangasius* sp.; *Symphysodon* sp.; *Labeo* sp.	*Trichodina* sp.; *Saprolegnia* sp.	18	Formalin with malachite green (25 ppm, 0.15 ppm, 24 h)	+
Singapore	*Symphysodon* sp.; *Gnathonemus* sp.; *Serrasalmus* sp.	*Ichthyophthirius* sp.	14	Formalin with malachite green (25 ppm, 0.15 ppm, 24 h)	+
Singapore	*Symphysodon* sp.	*Ichthyophthirius* sp.	15	Formalin with malachite green (25 ppm, 0.15 ppm, 24 h)	+
Thailand	*Pangasius* sp.	*Saprolegnia* sp.; *Dactylogyrus* sp.	15	Formalin with malachite green (25 ppm, 0.15 ppm, 24 h)	+
Singapore	*Labeo* sp.; *Barbus* sp.; *Pangasius* sp.; *Danio* sp.	*Saprolegnia* sp.	17	Malachite green (0.15 ppm, 24 h)	+
Thailand	*Pangasius* sp.	*Saprolegnia* sp.	16	Malachite green (0.15 ppm, 24 h)	+
Singapore	*Cyprinus carpio*	*Saprolegnia* sp.	12	Malachite green (0.15 ppm, 24 h)	+
Taiwan	*Rana catesbiana*	(swollen)	15	Terramycin (25 mg/kg body weight) injection	–
Singapore	*Pangasius* sp.; *Labeo* sp.	*Trichodina* sp.; Trematoda	15	Formalin (25 ppm, 24 h)	+

[a]Bath, unless otherwise noted.
[b] + = fish recovered; – = no recovery.

another prohibited species, electric eel, was reported to have been illegally introduced.

The species to be quarantined are live food and ornamental fish, both marine and freshwater. Imports consist mostly of ornamental fish such as discus, neon tetra, botia, and *Pangasius* sp.; carp are the main food fish. Commodities other than fish — crustaceans, molluscs, reptiles, amphibians, aquatic mammals, coelenterate and aquatic plants — may shortly also come under the quarantine regulations.

The fish-quarantine services are located in Jakarta, Medan, Den Pasar, Pontianak, Jambi, and Palembang, of which only three are still functioning as ports of entry. Since 1980, imports of live fish have only been allowed entry through

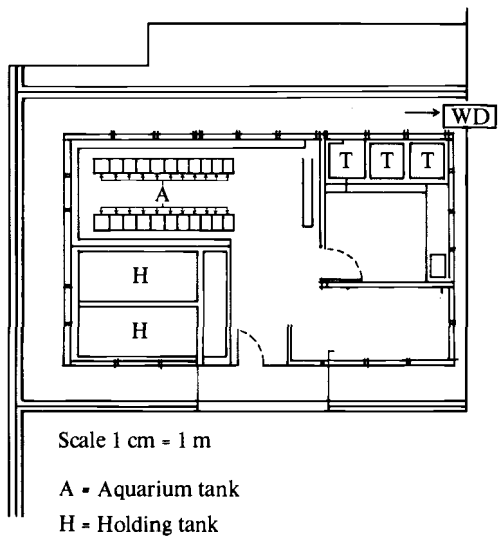


Fig. 1. Floor plan of pilot-scale quarantine station.

Halim airport in Jakarta so that live-fish traffic from outside the country can be carefully controlled.

The quarantine unit is generally provided with both fresh (groundwater) and salt water (seawater). After being used, the water is flushed into underground storage or septic tanks.

It is important to note that quarantine stations should be established not far from ports of entry. The site of the station must be isolated, located far from fish-culture centres, and must have limited contact with the outside world. Most essential is that the effluent must not reach public waters. The effluent must be disinfected and released via an underground septic system.

Fish holding can be done indoors or outdoors. A series of small tanks of 0.40–1.00 m wide and 1.00–2.00 m long is needed. These tanks can be made of concrete, fiberglass, or glass. Larger tanks of approximately 6–20 m^3 capacity are also needed to hold large numbers of fish. Each tank must have its own water supply and a drainage device. It is also necessary to supply each tank with one or more nozzle for air supply (Fig. 1). Besides fresh water, it is advisable to have a series of tanks supplied with seawater. Based on the experiences gained at Pasar Minggu, the quarantine station must be capable of holding 200 000 fish. The station should also have a well-equipped laboratory, with facilities for fish identification, disease diagnosis, treatment of diseases, etc:

In the establishment of the quarantine service, factors such as regulation and legislation, personnel, laboratory facilities, location, etc. have to be considered. Because Indonesia consists of many islands, having only one port of entry is not realistic, from an enforcement point of view. A more effective operation would be based on:

- Legislation and regulations issued and enforced for all interisland or international fish traffic;
- Fish quarantine for all live-fish traffic, coordinated by the central government;
- Complete laboratory facilities for disease diagnosis at the ports of entry, with fish-health specialists using uniform procedures for fish examination;
- As many ports of entry as possible with the available laboratory facilities and trained personnel;
- Disease inventories and records of distribution throughout the country as a step toward defining efficient and effective diagnostic procedures for quarantine services; and
- Coordinated action by institutions, such as customs, other quarantine services, etc., with input from research institutes and universities, particularly in identifying unknown disease agents.

FUTURE ACTIVITIES

Steps should be taken to formulate plans and policies for long-range activities in disease control through the quarantine system. Some activities that need to be considered now are:

- Finalizing the fish-quarantine law, which is now at the ministry level, and, when enacted, will back up the quarantine services, providing a basis for enforcement;
- Finalizing the establishment of a fish-quarantine organization, which would make one agency responsible for quarantine measures;
- Drafting a technical manual of uniform, effective, and practical procedures for identification and diagnosis of disease in aquatic animals;
- Developing an adequate training program locally for competence in diagnostic procedures, supported by overseas training for fish-health specialists where possible;
- Upgrading fish-quarantine services with appropriate diagnostic laboratories and

qualified personnel, both at the headquarters and at the ports of entry;

- Establishing a national recording centre for disease data and encouraging exchange of such information through periodic meetings of fish pathologists and fish-quarantine specialists from national and international agencies; and
- Defining an effective institutional mechanism for quarantine activities.

REFERENCES

Agency for Education and Agricultural Extension Training. 1977. Silabus latihan karantina ikan (Syllabus of fish-quarantine training). Ciawi, Bogor, Badan Penelitian dan Latihan Penyutunan Pertanian (in Indonesian).

American Fisheries Society, Fish Health Section. 1975. Suggested procedures for the detection and identification of certain infectious diseases of fish. Washington, D.C., USA, U.S. Fish and Wildlife Service.

Bergey, D.H. 1974. Bergey's manual of determinative bacteriology, 8th edition. Buchanan, R.E., and Gibbons, N.E., ed., Baltimore, Maryland, USA, Williams and Wilkins.

Bykovskaya-Pavlovskaya, I.E., Gusev, A.V., Dubinina, M.N., Izyumova, N.A., Smirnova, T.S., Sokolovskaya, I.L., Shtein, G.A., Shul'man, S.F., and Epshhtein, V.M. 1964. Key to parasites of freshwater fish of the USSR. Jerusalem, Israel, Israel Program for Scientific Translation.

DGF (Directorate General of Fisheries). 1982. Guidelines for fish-quarantine procedures. Jakarta, Indonesia, Direktorat Jenderal Perikanan. 25 p. (in Indonesian).

Djajadiredja, R. 1982. Report on the execution of fish quarantine at the Inland Fisheries Research Institute, Pasar Minggu, Jakarta. Bogor, Indonesia, Balai Penelitian Perikanan Darat (in Indonesian).

Djajadiredja, R., and Koesoemadinata, S. 1982. Konsep tentang Pedoman Pelaksanaan Pengiriman Ikan Hidup Keluar Wilayah Pulau Jawa (Guidelines for live-fish transportation from Java to other islands). Bogor, Indonesia, Balai Penelitian Perikanan Darat (in Indonesian).

Djajadiredja, R., Koesoemadinata, S., and Supriyadi, H. 1979. Implementasi Teknis Parkarantinaan Ikan di Indonesia Lokakarya tentang Rancangan Undang-Undang Karantina Pertanian (Technical considerations in the implementation of fish quarantine: workshop on the proposal of agriculture quarantine laws in Indonesia). Jakarta, Indonesia, Departemen Pertanian (in Indonesian).

Environment Canada, Fisheries and Marine Service. 1977. Fish health protection regulations, manual of compliance. Ottawa, Canada, Environment Canada, Miscellaneous Special Publication 31.

Fernando, C.H., et al. 1972. Methods for the study of freshwater fish parasites. Waterloo, Canada, University of Waterloo, Biology Series 12.

Hoffman, G.L. 1967. Parasites of North American freshwater fishes. Berkeley, California, USA, University of California Press.

IFRI (Inland Fisheries Research Institute). 1980a. Initial steps for controlling bacterial diseases of common carp. Bogor, Indonesia, Balai Penelitian Perikanan Darat (in Indonesian).

1980b. Report on the research activities in the control of disease epidemics. Bogor, Indonesia, Balai Penelitian Perikanan Darat (in Indonesian).

Oka, Ida Nyoman. 1978. Fish quarantine service in Indonesia. Paper prepared for a workshop on Diseases of Fish Cultured for Food in Southeast Asia, Cisarua, Bogor, Indonesia, 28 November–1 December.

Sachlan, M. 1952. Notes on parasites of freshwater fishes in Indonesia. Jakarta, Indonesia, Central Inland Fisheries Research Station 2, 1–59.

1974. Parasites, pests and diseases of fish fry. Lecture notes prepared for the Training Course in Induced Fish Breeding Techniques. Bogor, Indonesia, Regional Centre for Tropical Biology.

1978. Parasites, pests and diseases of fish fry. Paper prepared for a workshop on Diseases of Fish Cultured for Food in Southeast Asia, Cisarua, Bogor, Indonesia, 28 November–1 December.

Sumawidjaja, K., Eidman, M., Hardjosworo, S., and Angka, L. 1981. Haemorrhagic disease of fish: epizootic. Report of the team for disease control. Bogor, Indonesia, Bogor Agricultural University.

APPENDIX 1: FISH-HEALTH CERTIFICATE, FISHERIES SERVICE

PEMERINTAH DAERAH KHUSUS
IBUKOTA JAKARTA
DINAS PERIKANAN
I N D O N E S I A

JAKARTA CAPITAL CITY GOVERNMENT
FISHERIES SERVICE
I N D O N E S I A

KETERANGAN KESEHATAN

HEALTH CERTIFICATE

No.

Nama barang
This is to certify that _____

Jumlah
Number _____

Jumlah dan model kemasan
Number and type of packaging _____

Kode Kemasan
Code of packaging _____

Nama pemilik
Owned by _____

Alamat
Address _____

Dikapalkan dengan
To be shipped by _____

Tanggal pengapalan
Date of shipment _____

Negara tujuan
Destination _____

Telah diperiksa pada tanggal
Has been inspected on _____

Berdasarkan pemeriksaan, ikan-ikan tersebut diatas ternyata sehat dan tidak menunjukkan tanda-tanda penyakit menular.
Examination indicates that the fish in this shipment are not suffering from infectious or contagious diseases and are healthy.

Jakarta, ...

KEPALA DINAS PERIKANAN DKI
CHIEF OF FISHERIES SERVICE:

_____

APPENDIX 2: QUARANTINE SERVICE CERTIFICATE FOR HEALTHY FISH

DEPARTMENT OF AGRICULTURE
AGENCY FOR AGRICULTURAL RESEARCH AND DEVELOPMENT
RESEARCH INSTITUTE FOR INLAND FISHERIES

FISH HEALTH CERTIFICATE FORM A
No. _____

Country/city of origin of shipment _____

Country/city of destination of shipment _____

Name and addresses of shipper _____

To be shipped by _____ No._____

Date of shipment from country/city of origin _____

Date of arrival at country/city of destination _____

Species, size, and number of fish _____

The undersigned certifies that on the basis of parasitological examination and inspection, the fish constituting the present shipment have been found to be free from:

Ichthyophthirius, Costia, Trichodina, Dactylogyrus, Gyrodactylus, Lernaea, Argulus, Ergasilus, Saprolegnia, Achlya

Furthermore, based on observation during _____(quarantine period), the fish showed no clinical evidence of bacterial, viral, or myxosporidian diseases or other contagious diseases.

Issued in _____
on (date of issue)_____

Director:

_____

Fish Health Inspector:
1. _____
2. _____

APPENDIX 3: QUARANTINE SERVICE FORM FOR UNHEALTHY FISH

DEPARTMENT OF AGRICULTURE
AGENCY FOR AGRICULTURAL RESEARCH AND DEVELOPMENT
RESEARCH INSTITUTE FOR INLAND FISHERIES

FISH HEALTH CERTIFICATE FORM B
No._____

Country/city of origin of shipment _____

Country/city of destination of shipment _____

Name and addresses of shipper _____

To be shipped by _____ No._____

Date of shipment from country/city of origin _____

Date of arrival at country/city of destination _____

Species, size, and number of fish _____

The undersigned certifies that on the basis of parasitological examination and inspection during _____ (quarantine period), the fish in this shipment were found to be unhealthy and show clinical signs of disease, namely: _____

_____

_____

_____

_____

Issued in _____
on (date of issue)_____

Director:

Fish Health Inspector:

_____ 1._____

2._____

MALAYSIA[1]

SUHAIRI BIN ALIMON[2], ADRIAN FRANCIS VIJIARUNGAM[3], TING THIAN MING[4], MOHD. TARMIZI BIN MIOR YAHYA[5], AND MOHD. SHARIFF BIN MOHD. DIN[6]

Fish diseases are at present not emphasized in Malaysia because aquaculture itself is still a relatively young industry and is not yet intensive. Nevertheless, freshwater fish ponds are becoming popular, particularly in Sabah, and demand for fish fry is rapidly increasing. Mass mortalities in public waters or in fish ponds are not common, although isolated cases have occurred in government fish-breeding stations. The common causal agents are *Ichthyophthirius multifillis, Lernaea* sp., *Argulus* sp., *Dactylogyrus* sp., and *Trichodina* sp., primarily affecting fish fry (Shariff 1982c). Mass mortalities in public waters have resulted more from factory effluents and insecticide contamination than from diseases.

Mortalities have not been monitored or documented. Qualified personnel and adequate facilities for fish-disease study are lacking, but a subunit within the Fisheries Department is to be launched soon, headed by a fisheries officer who will coordinate national efforts on fish diseases and pollution. Systematic documentation and follow-up (including treatment) will be done when there are any reports of fish mortalities. This will enable researchers to determine the distribution of various fish diseases in the country.

The department has no established policy on quarantine; live fish are freely imported and exported without certification of health. In 1980, 4.8 million fry (US$ 118 000) were imported by Peninsular Malaysia, and about 38 000 were exported. In Sabah, imports comprised more than 290 000 aquarium fish and about 60 000 Chinese carp fry. The potential risks of disease introductions from such live-fish traffic have been recognized by the department, which has drafted import/export regulations (Fisheries Act) for the sanitary condition of fish imported or exported. At the state level, regulations in Sabah require that all importers and exporters apply for approval from the Department of Fisheries, and visual inspection is carried out occasionally, although there is no quarantine service.

In most cases when sick fish are observed, they are isolated from the others; if the disease is serious and widespread, the fish are destroyed and the ponds treated with lime.

DISEASES

The three most common parasites in Malaysian freshwater-fish culture are *Argulus* sp., *Lernaea* sp., and *I. multifillis*. *Argulus* sp. and *Lernaea* sp. have been reported in fish from some of the government breeding centres, from private farms, and from the freshwater Fish Research Centre in Malacca. *Lernaea piscinae* has been found only in bighead carp and has been controlled by bathing the affected fish in Dipterex, 0.25 ppm. *Ergasilus* sp. has also been reported in freshwater fish (MARDI 1981).

Myxobolus sp. has been identified frequently from Japanese koi and goldfish (Shariff 1982a). The protozoan *I. multifillis* was reported from a breeding centre in Perak several years ago, with many fry and fingerlings of *Puntius gonionotus* and *Cyprinus carpio* dying as a result. The water supply was the suspected source of infection;

[1]This paper is an edited version of two papers; the cooperation of the authors in agreeing to a single country report is gratefully acknowledged.

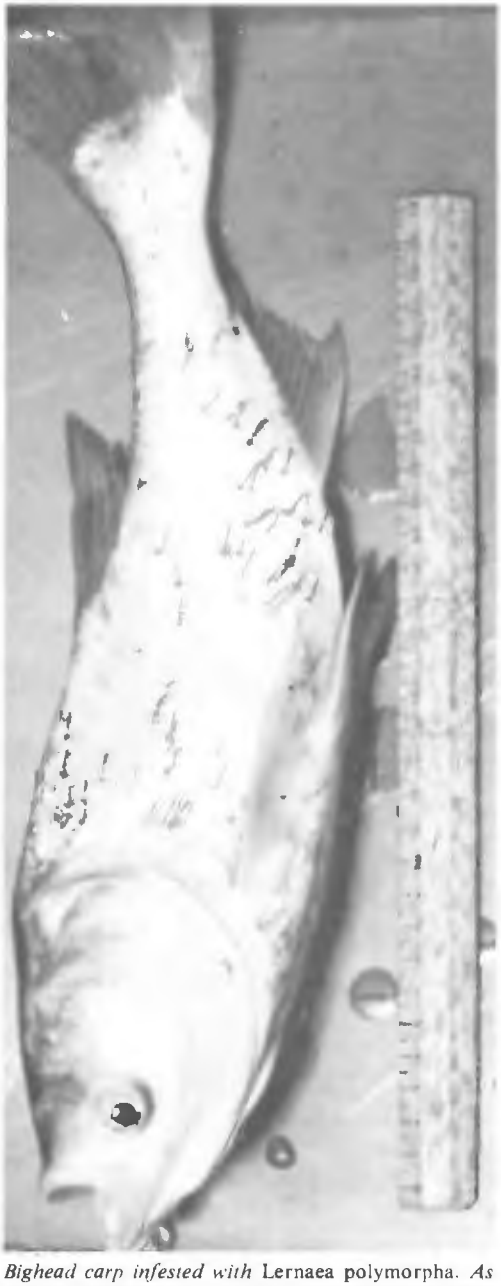
[2]Fisheries Research Institute, Glugor, Penang, Malaysia.

[3]Fisheries Division, Ministry of Agriculture, Swettenham Road, Kuala Lumpur, Malaysia.

[4]Department of Fisheries, Mail Bag 107, Kota Kinabalu, Sabah, Malaysia.

[5]Projek Penetasan, Majuikan, Fisheries Development Authority, Tanjong Dawar, Kedah, Malaysia.

[6]Faculty of Fisheries and Marine Science, Universiti Pertanian Malaysia, Serdang, Selangor, Malaysia.



Bighead carp infested with Lernaea polymorpha. *As many as 400 parasites have been found on a single fish.*

bath treatment with formalin, 25 ppm, was effective. Many freshwater fish including *Ctenopharyngodon idellus, Hampala macrolepidota, Pangasius sutchi, P. gonionotus,* and *Tilapia mossambica* have been infested with *Trichodina* sp. (MARDI 1981), and *Oodinium* sp. has been isolated from *Rasbora heteromorpha* and *Trichogaster leeri.*

From the marble goby (*Oxyeleotris marmoratus*), *Henneguya* sp. has been isolated and *Chilodonella hexasticha* has been isolated from *Aristichthys nobilis* (Shariff 1982b).

In 1963, the *Acanthogyrus partispinus* was found in *H. macrolepidota* (Furtado 1963). *Pallisentis gaboes* is also reported as a parasite to *Ophicephalus striatus* in Malaysia (Fernando and Furtado 1962). Other cestodes that have been isolated from freshwater fish are *Senga malayana, S. parva, S. pytiiformis, Lytocesthus parvulus, Camallanus fehi,* and *C. longitridentatus.*

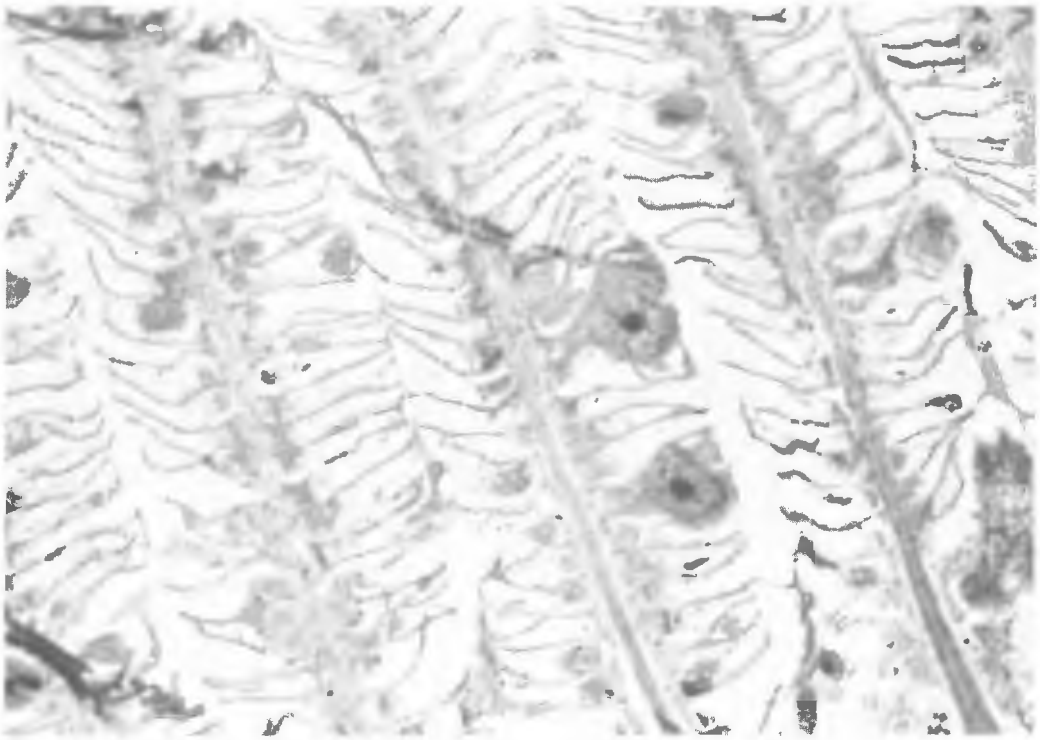
Diseases that are being imported by aquarium fish are monogenetic trematodes, *Costia* sp., *Chilodonella* sp., *Trichodina* sp., *Lernaea cyprinacea,* and *Argulus* sp. (Shariff 1980). *Aeromonas* sp. and *Pseudomonas* sp. have been isolated from wild freshwater fishes, but these bacteria were probably secondary invaders of lesions and skin irritations caused by excessive use of fertilizer on nearby farms.

Fungal infections were observed in prawn hatcheries in Malacca in 1974, and many *Macrobrachium rosenbergii* larvae died. Three fungi were isolated: *Penicillum* sp., *Pullularia* sp., and *Aspergillus* sp. However, it was not clear whether these fungi were the primary cause of death (Shariff et al. 1978).

Filamentous bacteria, perhaps *Leucotrix* sp., have been observed frequently on the larvae of *M. rosenbergii* in the Fisheries Research Institute, Penang. The infected larvae look weak and pale. In one episode, the bacteria were found in decaying organic matter in the culture tank. Thus, changing the water and frequently removing the excess food might have prevented the disease. Protozoans, tentatively identified as *Epistylis* sp. and *Zoothamnium* sp., have also been observed in giant freshwater prawns from this hatchery.

Ectoparasites have been observed on fish cultured in floating net cages in Malaysia and in the Tungku Abdul Rahman Aquarium. Isopoda, *Narocila sundacea*, were frequently isolated, and *Gnathia* sp. has also been found.

Vibriosis or red-pest disease caused by *Vibrio* sp. is the most important disease in the rearing of grouper in floating cages in Malaysia (Chua and Teng 1977). The groupers contact this disease through injuries during handling or overcrowding or after being parasitized. Near Kota Kinabalu, grouper fry are caught from the wild and stocked in ponds at 10/m^2. No mass mortalities



General view of gill tissue infested with Ichthyophthirius multifillis. *The parasite is large and is found under the epithelial lamellar cell.*

have been reported in this operation, but annual losses from disease are about 5%. Fin rot, skin lesions, and abdominal inflation have also been observed in cage culture.

In June and August 1982, 100% mortalities were experienced with 10-day-old sea bass larvae reared in Majuikan hatchery, Kedah. Bacterial infection was suspected and might have been introduced with *Brachionus plicatilis* used as feed. In September 1980, 80% mortalities at the third zoeal stage of *Penaeus monodon* were caused by an unidentified bacterial disease. In spite of abundant food, fresh specimens, examined microscopically, had empty guts, indicating loss of appetite.

Heavy infections caused by ciliated protozoans, *Trichodina* sp. and *Zoothamnium* sp., were diagnosed on fresh specimens of *P. monodon,* third major and early postlarvae. More than 60% of the larvae died.

DISCUSSION

The three major institutions involved with fish diseases at the national level are the Fisheries Research Institute, Penang, the Agriculture University at Serdang, Selangor, and the Science University, Penang.

To date, no details of a quarantine system have been worked out, but fish quarantine is likely to become increasingly important as fish farming gains acceptance. Even at present, the country is not self-sufficient in fry production and needs certification procedures to reduce the risk of importing diseases. However, trained personnel, equipment, and disposal systems for wastewater are lacking.

REFERENCES

Chua, T.E., and Teng, S.K. 1977. Floating fishpen for rearing fishes in coastal waters, reservoirs and mining pools in Malaysia. Kuala Lumpur, Malaysia, Ministry of Agriculture, Fisheries Bulletin 20.

Fernando, C.H., and Furtado, J.I. 1962. Some studies on helminth parasites of freshwater fishes. Paper prepared for the First Regional Symposium on Scientific Knowledge of Tropical Parasites, University of Singapore, 5-9 November.

Furtado, J.I. 1963. New caryophyllaeid Cestoda, *Lytocesthus parvulus* nov. from a Malayan catfish. Annals and Magazine of Natural History, 6, 13. 97 p.

MARDI (Malaysian Agriculture Research and Devel-

opment Institute). 1981. Annual report, 1981. Batu Berendam, Malacca, Malaysia, MARDI, Freshwater Fish Section.

Shariff, Mohd. M.D. 1980. Occurrence and treatment of ectoparasitic diseases of aquarium fishes in Malaysia. Malaysia Veterinary Journal, 7, 48–59.

1982a. *Henneguya shaharini* sp. nov. (Protozoa: Myxozoa), a parasite of marble goby, *Oxyeleotris marmoratus* (Bleeker). Journal of Fish Diseases, 5, 37–45.

1982b. Occurrence of *Chilodonella hexasticha* on bighead carp *Aristichthys nobilis* (Richardson) in tropical waters of Malaysia. Molecular and Biochemical Parasitology, supplement (abstracts of the Fifth International Congress of Parasitology, Toronto, Canada, 7–14 August 1982), 403–404.

1982c. Penyakit ikan di Pusat Pembiak Ikan Tapah dan Syor-Syor untuk mengatasi masalah tersebut. Serdang, Selangor, Malaysia, Faculty Perikanan dan Sains Samudra, Universiti Pertanian Malaysia.

Shariff, Mohd. M.D., Tajuddin, Z.A., Hambal, H. 1978. Parasite impact on fish culture in Peninsular Malaysia: problems and possible preventive measures. Paper prepared for a workshop on Diseases of Fish Cultured for Food in Southeast Asia, Cisarua, Bogor, Indonesia, 28 November–1 December.

PHILIPPINES[1]

G.D. LIO-PO[2], J.P. PASCUAL[3], AND J.G. SANTOS[3]

The aquaculture industry in the Philippines has grown considerably in the past 5 years: inland fishery statistics indicate that production increased 86% for fish and 185% for molluscs, yielding a total of 2.85×10^5 t of fish and shellfish in 1980 (BFAR 1980). Culture systems include freshwater, brackish-water, and marine species in ponds, tanks, pens, cages, etc. Prawn culture, particularly, has gained popularity as a lucrative enterprise for the export market. Currently, however, only one-third of the available swamplands is utilized, and potential areas for fish-pond development remain vast. The major fish and shellfish species cultured include *Chanos chanos, Tilapia* spp., *Clarias* spp., *Cyprinus* spp., *Penaeus monodon, Crassostrea* spp., *Mytilus* spp., and *Perna* spp. Small-scale culture of *Macrobrachium rosenbergii* and *Scylla serrata* also exists. Although extensive rearing methods are generally practiced by most fish farmers, some have advanced to semi-intensive stocking. To maximize land and water use for fish production, intensive methods will eventually have to be adopted.

One deterrent to successful aquaculture is the occurrence of fish kills among stocked fish. Mortalities, in most cases, have been reportedly caused by deteriorating environmental conditions because of dissolved gases, acidic water, pollution from pesticides or from excess food, extreme changes in temperature and salinity, turbidity or precipitation after a flood, and stress after handling or transport. Documented reports of fish infections have been few. Because diagnostic facilities are inadequate and often inaccessible, most farmers fail to report epizootics experienced in their ponds.

FISH DISEASES

For lack of viral diagnostic facilities, information on existing viral fish infections in the Philippines is practically nil. An occurrence of lymphocystis among marketable siganids at Batan Bay was diagnosed in 1978 (P.M. Hine, personal communication). Another instance of infection, possibly of viral origin, was in *Clarias macrocephalus* fingerlings (IFP 1975). Infected fish developed inflammation or sloughing of skin and fins, abdominal swelling, and blood-filled kidneys. Neither bacteria nor parasites were isolated from the sampled fish.

Among pond-reared prawns, recent tests confirmed the prevalence of light-to-moderate infections of the hepatopancreas by *Baculovirus* (MBV) among randomly sampled *P. monodon* weighing 1.5–17 g (D. Lightner, personal communication). Infected shrimps appear healthy, but significant mortalities can occur under conditions of stress or crowding.

Bacterial infections of fish and shellfish almost always result in serious mortalities. These act either as primary invaders or as secondary invaders after parasitic infestations produce lesions at sites of attachment that eventually serve as vital ports of entry for the pathogens. Most bacterial pathogens of cultured fish in the country consist of gram-negative bacilli. Gram-negative bacteria also appear to be involved in infections of less consequence, such as the opaque-eyed *Chanos chanos* (K. Muroga, G. Lio-Po, and C.L. Pitogo, unpublished report) and dropsy-like infections of catfish (Hara 1977).

The loss of more than 100 000 milkfish fingerlings within a week after stocking in fish pens was reportedly caused by an unidentified bacterial infection (IFP 1976). In two disease outbreaks among milkfish, fin inflammations or erosions were associated with large numbers of bacteria

[1]SEAFDEC contribution 123.

[2]Pathology Project, Aquaculture Department, Southeast Asian Fisheries Development Center, 6th Floor, Triumph Building, 1610 Quezon Avenue, Quezon City, Philippines.

[3]Department of Natural Resources, Bureau of Fisheries and Aquatic Resources, 860 Quezon Avenue, Quezon City, Philippines.

and pond mortalities (IFP 1973, 1975). No treatment or control methods were cited.

At the SEAFDEC Aquaculture Department, experimental batches of hatchery-reared and wild milkfish fry experienced sporadic occurrences of mass mortalities. Patches of reddish sediment were found at the bottom of rearing tanks or aquaria holding affected fish. No parasites were seen microscopically, but bacteria from weak fry were isolated and identified as *Vibrio* sp. and *Beneckea* sp. Reinfection experiments indicated that *Vibrio* sp. exerted inconclusive pathogenicity among healthy fry. The bacteria were also associated with *Brachionus plicatilis* used as feed for the fry (G.D. Lio-Po and R.C. Duremdez, unpublished report).

A 90% kill among *C. macrocephalus* within 48 h after stocking was reported (IFP 1975). Saddleback lesions developed in the body, characterized by gray, necrotic centres and inflamed borders, necrosis and erosion of skin with crater-like excavations into inflamed muscle tissues, and partial to complete erosion of fins and caudal peduncle. Surviving fish had similar lesions. Typical myxobacteria, possibly *Flexibacter columnaris*, were isolated from the kidney. The fish had a history of stress from excessive handling, crowding in cages, and poor nutrition. Other fish stocked at the same time, with a different history, did not exhibit the infection. Furanace treatment was tried, but results were inconclusive.

Cases of severe infections and massive fish kills, involving more than 80% of fish stocks, were observed by Hara (1977) while rearing *C. macrocephalus* fingerlings for a seed-production project in Tanay, Rizal. Infected fish developed gray spots that gradually turned to white lesions along the area of the lower jaw and body. Dorsal and caudal fins started to decay. Fingerlings and preadult stages were affected in ponds and concrete tanks. Reference books on eel diseases were consulted, and the clinical signs paralleled an infection caused by *F. columnaris*. To arrest the disease, early detection was necessary. Treatment methods that proved effective included the use of either sulfamonomethoxine daily (50–200 mg/kg fish) or tetracycline daily (20–100 mg/kg fish) in feed for 3–7 days. Severely affected fish, however, did not feed.

Catfish can also suffer from a bacteria-like infection characterized by red spots on the belly, anal swelling, and congestion at the base of the pectoral fins. Mortalities as high as 10% have been observed at one time. The infection is similar to *Aeromonas*-caused bacterial infections among eels. Treatments with tetracycline or sulfamonomethoxine, again, proved effective (Hara 1977).

There have been reports also of massive mortalities among tilapia: 2-week-old, tank-reared *Sarotherodon niloticus* fry died at the rate of 15% daily until almost all stocks were lost. Affected fish manifested increased pigmentation, wasting, lesions, surface swimming, and anorexia. Death followed within 24 h of the development of clinical signs, which started as soon as the yolk sac was absorbed. Preliminary treatment with oxytetracycline and sulfonamides (5% feed weight) was given. *Pseudomonas fluorescens* was identified from samples of diseased fry. Reinfection experiments proved the bacterium's pathogenicity at 0.1 mg/100 g fish (G.D. Lio-Po and E. Sanvictores, unpublished data). The bacterial pathogen was shown to survive in various types of freshwater sources for more than 150 days (Duremdez 1982).

Information on a bacterial infection among *Tilapia mossambica* and *T. zilli* has been recorded (IFP 1975). Clinical signs include petechial hemorrhage, heavy pigmentation of skin, erosion of skin as well as fins, and abnormal swimming behaviour. Unidentified gram-negative rods were recovered from the kidneys, skin, and fins in 100% of sampled fish.

In a private venture with Japanese investors, eel farming was started in Bataan in 1973. The operations, according to F. Palisoc (personal communication), were hampered by diseases. High mortalities were usually caused by bacterial infections from *Aeromonas* sp. and *Pseudomonas* sp. Clinical signs included red or inflamed fins and hemorrhagic spots on the abdominal portion of the fish. *Flexibacter columnaris* was also reported to cause infections characterized by gray to white patches on the skin, sloughing of affected skin, and degeneration of the gills. An almost total kill occurred despite antibiotic treatments with erythromycin, sulfa drugs, or furanace. As standard procedure before stocking, elvers were dipped in a methylene-blue solution as prophylactic treatment. The project was eventually terminated (1977).

Penaeus monodon larvae, as early as the zoeal stages, often suffer from bacterial infection. One of several cases involved infection detected at the first zoeal stage. The larvae were lethargic and showed progressively increasing mortalities until the third zoeal stage. In most instances, the dead larvae had empty guts, indicating loss of appetite in spite of abundant food. More than 90% of the larvae died. Bacterial aggregates were seen microscopically in live larvae. Subsequent isola-

tion and identification tests showed the bacterium to be a *Vibrio* sp. (C.L. Pitogo and G.D. Lio-Po, unpublished data).

R.C. Duremdez and C.L. Pitogo (unpublished data) reported heavy infections with a filamentous bacterium in *P. monodon* postlarvae. The bacterium was probably a *Leucotrix* sp. and covered 25–100% of the body and sometimes the gills. Prevalence rates in four tanks, on the 1st day, amounted to 10–40% of 20 postlarval samples examined microscopically and, on the 2nd day, increased to 60–80%. After the onset of the infection, associated mortalities ranged from 17% to 50%.

Experience indicates that fungal infections are more significant among invertebrates, such as shrimp and crab larvae, than among fish. In most instances, fungal attack on the former results in heavy mortalities within 2 days. Also, among invertebrates, fungi usually act as primary invaders, whereas, in fish, they develop as secondary pathogens taking advantage of lesions produced by parasites or by handling.

Three percent of milkfish fry obtained from Iloilo fry dealers developed fungal infection (IFP 1973). In another case, in a milkfish-stocked pond, with 62.5 ppt salinity, fungal infection was detected on the eye membranes of fish. A dense, white rhizoid growth on the eye membrane resulted in clouding and dense white spots in peripheral regions. The infection began at the eye periphery and moved to the centre, over the pupil. Vascularization was evident and mortality was 8% after 3 weeks. One or both eyes were affected (IFP 1973–74).

The fungal pathogen *Lagenidium* sp. has killed hundreds of thousands of penaeid larvae in various hatchery runs (Gacutan et al. 1976; Baticados et al. 1977; Vicente et al. 1979). Infections were detected at naupliar, zoeal, myses, and postlarval stages of *P. monodon* and *P. indicus*. The fungus invaded the internal tissues of its host until a complete replacement of the host tissue was effected by the growth of hyphae. Under such conditions, the host dies. When naupliar and zoeal stages were infected, hyphal elements penetrated through the exoskeleton, extruding a hyphal structure that gave rise to a discharge tube. Asexual reproductive processes were initiated with the development of a spore-enclosing structure called a vesicle. Biflagellate zoospores subsequently formed and were released into the surrounding water when the vesicle ruptured. The zoospores swam around in the water until another host was found. Germination into hyphal structures was again initiated to begin another life cycle for this fungus. To control the pathogen, several fungicides have been tested (Lio-Po et al. 1982). One such chemical, Trifluralin, at 0.005 ppm, allowed vesicle formation but not zoospore development. Subsequent in-vitro tests indicated that even a 0.01 ppm dose could be safely applied to *P. monodon* zoeae and myses (G.D. Lio-Po and E. Sanvictores, unpublished manuscript). Spawner treatment with Treflan, at 1–5 ppm, proved equally effective (SEAFDEC 1977, 1978).

Another fungal pathogen, *Haliphthoros philippinensis*, was also isolated from penaeid larvae (Hatai et al. 1980). The life cycle of the fungus was similar to that of *Lagenidium* sp. except for the absence of vesicle formation during the reproductive phase. The zoospores were directly released through a discharge tube. Infection was less serious than that caused by *Lagenidium*, and in-vitro tests with several chemicals showed that Treflan was effective at a mycostatic dose of 5 ppm (Lio-Po et al. 1982).

Crab eggs and larvae, like prawns, can be killed by fungal pathogens. *Lagenidium scylla* has been isolated in the Philippines and identified (Bian et al. 1979). Pathological manifestations are similar to those in penaeid larvae and are one obstacle to successful rearing of crab larvae.

In light infestations, parasites rarely cause fish mortalities, but they can be carriers of microbial pathogens as well as providing ports of entry for secondary microbial infections. Among Philippine fish species of commercial value, reports of parasitism, not associated with fish kills, included *Cryptobia* sp., *Myxosoma* sp. (IFP 1975), *Scyphidia* sp. (IFP 1973), *Costia* sp. (IFP 1976), digenetic trematodes (Table 1), nematodes (Velasquez 1980), and *Acanthocephalus* sp. (Velasquez 1975a). Reports on infestation by *Trichodina* sp. (IFP 1970, 1973, 1975) and monogenetic trematodes (Duncan 1973; Guerrero and Monje 1980) have not established that the parasites were the cause of mortalities. Commensals like *Vorticella, Zoothamnium, Gregarina, Epistylis,* nematodes, and *Ephelota gemmipara* have been reported on *P. monodon* larvae (Gacutan et al. 1976, 1977; Vicente et al. 1979), and, of these, *Epistylis* has been suspected as a cause of mortalities among *M. rosenbergii* (Dejarme et al. 1980).

Ronquillo and Caces-Borja (1980) cited five separate occurrences of isopod infestations among milkfish in 1958–64. The isopods were reported to proliferate after a heavy rain when the salinity dropped to almost nil. Swarms of these crustacean ectoparasites were observed on the base of fins, head, gills, and subopercular

Table 1. Digenetic trematodes of fishes with aquaculture potential in the Philippines (Velasquez 1975a).

Host species	Parasite	Stage of parasite	Habitat
Lates calcarifer	*Transversotrema larveii*	Adult	Under scales of skin
	Prosorhynchus luzonicus	Adult	Intestine
	Pseudometadena celebescncis	Adult	Stomach, small intestine, intestinal ceca
	Lecithochirium neopacificum	Adult	Stomach
Epinephelus bleekeri	*Prosorhynchus mcintoshi*	Adult	Muscle, stomach, intestine
Scatophagus argus	*Waretrema piscicola*	Adult	Intestine
	Procerovum varium	Metacercariae	Muscles
Siganus spp.	*Hemiurus sigani*	Adult	Small intestine
	Gyliauchen papillatus	Adult	Small intestine
	Hexangium sigani	Adult	Stomach, intestine
Ophicephalus striatus	*Opegaster minima*	Adult	Intestine
	Orientocreadium batrachoides	Adult	Intestine
	Clinostomum complanatum	Metacercariae	Eye sockets, pericardium
	Clinostomum philippinensis	Metacercariae	Tissues outside the eyeball between the branchiostegal muscles and linings of the pericardial and opercular cavities, other tissues immediately under the pectoral fins
	Clinostomum brieni	Metacercariae	Gall bladder, gills, opercular cavity
	Euclinostomum multicaecum	Metacercariae	Muscles
	Centrocestus formosanus	Metacercariae	Muscles
	Haplorchis taichu	Metacercariae	Muscles
	Haplorchis yokogawai	Metacercariae	Muscles
	Procerovum calderoni	Metacercariae	Muscles
Clarias spp.	*Opegaster minima*	Adult	Intestine
	Orientocreadium batrachoides	Adult	Intestine
	Clinostomum brieni	Metacercariae	Gall bladder, gills, opercular cavity
Anguilla mauritiana	*Galactosomum anguillarum*	Adult	Intestine
Mugil spp.	*Haplorchis yokogawai*	Metacercariae	Muscles
	Heterophyopsis expectans	Metacercariae	Muscles
	Pygidiopsis marivillai	Metacercariae	Muscles
	Stellantchasmus falcatus	Metacercariae	Muscles
	Procerovum calderoni	Metacercariae	Muscles
	Pygidiopsis genata	Metacercariae	Muscles
Chanos chanos	*Procerovum varium*	Metacercariae	Muscles

membrane vent, as well as on any moving object in the pond, including humans. Apparently, affected fish try to shake off the parasites. Velasquez (1975b) identified an isopod *Rocinella typhus* in another case of fish kills in Iloilo in 1965.

A copepod parasite persistently occurs among tank-reared milkfish brood stock at SEAFDEC, Aquaculture Department, attaching to the skin, fins, and gills of the sabalo. Colonies are readily detached as whitish patches at sites of attachment. Affected fish swim abnormally, rubbing against any solid surface, and may die of asphyxiation. Laviña (1978) identified the parasite as *Caligus* sp. and reported that 0.25 ppm Neguvon bath for 12–24 h was effective in removing it. Repeated treatments at intervals of several weeks were necessary, as the copepod recurred. Other treatment methods tried included 90 ppm formalin for 2 h and 100% freshwater bath for 24 h. Both treatments proved lethal to the parasitic copepod (SEAFDEC 1980), but the host may not be able to tolerate this dose of formalin.

Velasquez (1979) reported a case of mass infection of milkfish by another copepod, *Lernaea* sp. The wormlike parasites were observed protrud-

ing from nostrils, skin, or the fin bases of affected fish. A 3–5% salt solution was found effective for the larval stages of the parasite, but, for destruction of the adult stages, desiccation of ponds and liming were recommended.

Velasquez (1975b) reported a case of *Dactylogyrus* sp. infestation of catfish in Pansol, Laguna, in which 1000 of 5000 fish died in 2 days. Subsequently, other severe cases of infestation occurred in Lumbang and Candaba, Pampanga.

In two studies, *Trichodina* was found responsible for high mortalities among *S. niloticus* fry (G.D. Lio-Po and M.C.L. Baticados, unpublished data) and among *T. zilli* and *T. mossambica* (IFP 1975). Another report, however, indicated that these protozoans may be present in healthy tilapia in association with *Gyrodactylus* and *Dactylogyrus* (Guerrero and Monje 1980).

The fish louse, *Argulus,* has on one occasion caused mortalities of about 20% of stocks of Japanese ornamental carps. The parasite sucks blood or tissue fluids through a tubular piercing organ that injects a toxic substance that appears to facilitate secondary fungal infection. No treatment was tested or recommended (IFP 1976).

Adult *Mugil cephalus* cultured at SEAFDEC, Aquaculture Department, were found infested with *Amyloodinium*-like protozoan parasites. These parasitic dinoflagellates caused gill lesions that ultimately led to lamellar disintegration. The gill lesions may have resulted in the physiological disorders and observed fish mortalities (M.C.L. Baticados and G. Quinitio, unpublished manuscript).

Ichthyophthirius sp. has been implicated in about 20% mortalities of farmed eels in Bataan (F. Palisoc, personal communication). Because of the lesions in the surface of the skin and fins, the disease is commonly referred to as white spot, with 1–2% formalin being a satisfactory treatment.

In 1976, *P. monodon* juveniles from a private pond in Villa were examined at SEAFDEC. Gills were heavily infested with the protozoan *Zoothamnium* sp., which possibly interfered with respiration of the prawns. A mortality of about 70% was observed. The pond experienced a heavy bloom of this protozoan, resulting from the decomposition of frog's meat used as feed (G.D. Lio-Po and A. Llobrera, unpublished data).

DIAGNOSTIC INSTITUTIONS AND PROCEDURES

A major reason that fish farmers fail to report fish diseases is the unavailability or inaccessibility of fish-diagnostic laboratories in the country. However, there are several agencies (Table 2) that could be tapped for this purpose. Since August 1980, SEAFDEC's Pathology Project has adopted a standard procedure for processing specimens referred to the laboratory. Isolation and identification of bacterial, fungal, and parasitic pathogens can be conducted. When necessary, particularly in suspected viral, nutritional, or toxicity cases, histopathologic analyses of the specimens are done. If possible, staff go to the site of the disease outbreak to collect samples and assess the farming conditions. Otherwise, the fish

Table 2. Institutions in the Philippines involved in fish-diseases study.

Name	Address	Investigators	Areas of interest, competence
Pathology Project	Aquaculture Department, SEAFDEC, Tigbauan, Iloilo	M.C. Baticados, E. Cruz, R. Duremdez, R.O. Gacutan, G. Lio-Po,[a] A. Llobrera, F. Palisoc, C. Tamse	Bacteriology, mycology, parasitology, vertebrate and invertebrate pathology, diagnostic and research studies
Zoology Department	University of the Philippines, Diliman, Quezon City	G. Enriquez,[a] N. Lopez, C. Velasquez	Parasitology, vertebrate and invertebrate pathology
Brackishwater Aquaculture Centre	University of the Philippines, Visayas, Leganes, Iloilo	L. Dureza	Parasitology
Freshwater Aquaculture Centre	Central Luzon State University, Muñoz, Nueva Ecija	O. Quines	Parasitology
MSU-IFRO	Mindanao State University, Naawan, Misamis Oriental	H.J. Vicente, F.M. Valdez, S.M. Dejarme	Prawn-hatchery diseases

[a]Leader.

farmer is told how to submit satisfactory specimens. Reinfection experiments are conducted to establish pathogenicity of an isolated bacterium or fungus. For a comprehensive evaluation of the case, information on water quality, feeding, water source, farm conditions, etc., is collected and recorded (Appendix 1). Standard procedures for antibacterial, in-vitro tests are conducted (Bauer et al. 1966). Stock-management procedures and treatment, when necessary, are recommended (Appendix 2).

FISH QUARANTINE

All laws affecting fishing and fisheries in the Philippines are consolidated in Presidential Decree 704, which includes the policy of the state to accelerate and promote the integrated development of the fishery industry and to keep the fishery resources of the country in optimum-production condition through proper conservation and protection. Exports of fish and fishery products are encouraged as a positive contribution to the national economy.

Under the decree, would-be importers and exporters must obtain a permit from the Director of the Bureau of Fisheries and Aquatic Resources or a duly-authorized representative. Before a permit is granted, an inspection for quality control is made on all frozen marine products and live fish. The only criterion applied for the latter is a healthy appearance at the time of inspection.

Quarantine has been a neglected aspect of fish-disease prevention. Visual inspection for signs of disease is the only step taken before imports of live fish are allowed entry. It is not surprising, then, to read reports of imported epizootics.

One such incident involved *Lernaea* sp. (anchor worm), which infested silver carps and common carp brood stock. The parasite attached to the skin, often penetrating deeply into the muscles. Severe hemorrhagic reactions occurred at the sites of attachment, resulting in secondary bacterial or fungal infections and, ultimately, death. When the copepod attached to a site near nerve centres such as the brain or lateral line, the fish exhibited abnormal swimming behaviour. The anchor worm is believed to have been absent in the Philippines before the introduction of infested silver carp (IFP 1976).

Another incident was a disease outbreak causing mortalities among veil angel fishes, *Pyrophythrum scalare*, after several imported discus breeders, *Symphysodon discus*, were introduced. Diseased fish developed lesions and ascites before death. Treatment with a broad-spectrum antibiotic was attempted but proved ineffective. The causative organism was not identified, as no fish-pathology facility was accessible. The infected stock had to be destroyed and the tanks disinfected (Canlas 1978).

Such incidents underline the need for quarantine measures. First, the constraints on the establishment of an effective quarantine service in the country as well as in the region must be identified and removed. The major issues to be considered include establishment of fish-diagnostic centres, sanitary classification of fish farms, and introduction of legislation.

Diagnostic centres are essential in the identification and surveillance of disease problems in the aquaculture industry. For lack of adequate diagnostic facilities, some aquaculturists compare signs of infection with published reports, but this approach is far from reliable, as signs of various diseases overlap. An accurate and prompt diagnosis is the key to disease prevention and control. Hence, an important consideration for a diagnostic laboratory is its accessibility to the fish farmers. However, the shortage of scientific personnel and funds suggests that a modest scheme (Table 3) for a coordinated diagnostic system in the region should be developed. Provincial diagnostic laboratories should be established in major aquaculture areas in the country. Extension workers trained in disease recognition and presumptive diagnosis should staff the labora-

Table 3. Proposed classification, functions, and staffing of diagnostic laboratories for the Southeast Asian region.

Level	Functions	Staff requirements
Regional	Disease diagnosis, pathogen identification, training of fish pathologists, training of extension workers, research, publications, advisory services	Virologist, bacteriologist, mycologist, parasitologist, immunologist, histopathologist or toxicologist, technical support staff
National	Disease diagnosis, training of fish farmers, fish-health certification, research, publications, advisory services, case referral	Fish pathologists, technical support staff
Provincial	Disease diagnosis, advice, case referral	Extension workers with technical background in fish diseases

tory, referring complex cases to a national fish-disease laboratory staffed by people trained specifically in ichthyopathology. The national laboratory, ideally, would be located near main ports of entry, i.e., international airport or port. After examination of specimens submitted by provincial health workers, a health certificate could be issued by the national diagnostic laboratory. A regional fish-disease centre is needed for referral of difficult cases from national centres; for training of fish pathologists; for confirmation of identification of pathogens; and for research on host reactions, epizootiology, diagnostic methods, pathogen and host tolerance to therapeutic agents, as well as disease-prevention techniques.

To certify the health status of a fish batch, one has to consider the rearing establishment. Fish quality in terms of health would, therefore, need to be defined. Such a scheme has been proposed previously (Ghittino and de Kinkelin 1975). The classifications suggested were:

- Fish free of specific pathogenic organisms (SPF). The water supply would have to be completely sterile, and exchanges of fish would only be allowed between SPF-classified establishments.
- Fish free of coded pathogenic organisms (CPF), for which examination would be for diseases appearing in a list drawn up by an international agreement. For Southeast Asian countries, such a list has yet to be drafted. Water supply would have to be pretreated. CPF-classified farms could receive SPF or CPF fish but could not dispatch fish to SPF farms.
- Fish free of specified diseases (SDF). Diseases that are readily controlled by therapy could occur. Certification for freedom from certain diseases would be issued but would guarantee against only the diseases listed in the document. Such a farm could receive fish from SPF or CPF farms, as well as enterprises of similar sanitary level.
- Uncontrolled fish for which no examination has been conducted for the presence of diseases or pathogens. Fish exchange would be only with farms of similar category, although inputs could be received from any other fish farms.

This sanitary classification of fish farms provides a basis for permits for fish import, export, exchange, or restocking, as it would minimize gross contamination. Strict vigilance by fishery authorities, however, would have to be observed, with regular checks on fish-health status.

Ultimately, quarantine requirements can only be enforced through legislation. Existing laws, particularly on aspects of live-fish traffic, would have to be revised to stipulate that certain fish species be prohibited entry except in limited quantities for research and experimental purposes; live fish be imported only through one main port of entry; all persons intending to import live fish first file an application with the Director of Fisheries; the permittee notify the Director of Fisheries or an authorized representative when fish arrive at the port of entry so that they can be inspected; imports of fish from foreign countries be accompanied by a certificate of health issued by the proper government authority of the country of origin stating that the fish are free from infectious fish diseases; fish found to be free from infectious fish diseases be certified by a fish-quarantine officer and, only then, allowed to enter the country, diseased fish being returned to the country of origin or destroyed.

The penalty for not conforming to regulations should be a fine not exceeding P5000 (US$ 1 = P9) or imprisonment from 6 months to 4 years or both a fine and imprisonment at the discretion of the Director of Fisheries.

DISCUSSION

The list of infections found among Philippine fishes indicates the potential hazards posed by fish pathogens to the aquaculture industry. Because of the scanty information available, one cannot accurately assess the occurrences and distribution of the pathogens; in addition, the reliability of the diagnoses may sometimes be in question. The principal diseases include bacterial infections from *Vibrio* sp., *Pseudomonas* sp., *Flexibacter* sp., and *Aeromonas* sp.; fungal infections caused by *Lagenidium* spp.; and parasitic infections from isopods and *Lernaea* sp. However, other diseases should not be underestimated; with the increasing fish exchanges among fish farmers, rapid dissemination of pathogens can occur among unexposed, susceptible stocks. The problem is compounded when new pathogens are introduced into the country with live imported fish. Since 1976, no fewer than 75 permits have been granted for imports of various fish species for breeding and experimental purposes. A practical quarantine procedure, therefore, must be incorporated into existing fishery regulations. An international quarantine plan must, likewise, be formulated and coordinated among countries.

REFERENCES

Baticados, M.C.L. 1980. Histopathology of microspo-

ridiosis of white prawn, *Penaeus merguiensis* de Man, 1888. Diliman, Philippines, University of the Philippines. 78 p. (master's thesis).

Baticados, M.C.L., Lio-Po, G.D., Lavilla, C.R., and Gacutan, R.Q. 1977. Isolation and culture in artificial media from *Penaeus monodon* larvae. Quarterly Research Report, SEAFDEC Aquaculture Department, 1, 9–10.

Bauer, A.W., Kirby, W.M.M., Sherris, J.C., and Turck, M. 1966. Antibiotic susceptibility testing by a standardized single disk method. American Journal of Clinical Pathology, 45, 493–496.

BFAR (Bureau of Fisheries and Aquatic Resources). 1980. Fisheries statistics of the Philippines. Quezon City, Philippines, BFAR, 29. 315 p.

Bian, B.Z., Hatai, K., Lio-Po, G.D., and Egusa, S. 1979. Studies on the fungal diseases in crustaceans. 1: *Lagenidium scylla* sp. nov. isolated from cultivated ova and larvae of the mangrove crab (*Scylla serrata*). Transactions of the Mycological Society of Japan, 20, 115–124.

Canlas, J.R. 1978. Notes on the import and export of live fish in the Philippines with reference to diseases and parasites. Paper prepared for the workshop on Diseases of Fish Cultured for Food in Southeast Asia, Cisarua, Bogor, Indonesia, 28 November–1 December. 5 p.

Dejarme, H.E., Dominisac, J.B., and Dejarme, S.M. 1982. Notes on spawner collection methods and larval rearing of giant prawn (*Macrobrachium rosenbergii* de Man) at MSU-IFRD Station, Naawan, Misamis Oriental, Philippines. In New, M.B., ed., The Development in Aquaculture and Fisheries Sciences, Giant Prawn Farming, 10, Bangkok, 72–84.

Duncan, B.L. 1973. *Cichlidogyrus sclerosus* Paperna and Thurston from cultured *Tilapia mossambica*, Kalikasan. Philippine Journal of Biology, 2, 154–158.

Duremdez, R.C. 1982. Identification and characterization of the physiological properties of *Pseudomonas* sp. isolated from cultured *Sarotherodon niloticus* fry. Iloilo, Philippines, University of the Philippines. 98 p. (master's thesis).

Gacutan, R., Llobrera, A., Gutierrez, P., and Lio-Po, G. 1977. Suctorean parasite of *Penaeus monodon* larvae. In Lewis, D.H., and Leong, J.K., compilers, Second Biennial Crustacean Health Workshop, Galveston, Texas. Austin, Texas, USA, University of Texas, 231–244.

Gacutan, R.Q., Trillo-Llobrera, A., and Banno-Santiago, C. 1976. Microorganisms associated with *Penaeus monodon* postlarvae and mysis in hatchery tanks. Paper prepared for the fifth annual meeting of the Philippine Society for Microbiology, Quezon City, Philippines, 22–23 April.

Ghittino, P., and de Kinkelin, P. 1975. Proposed control measures for the principal contagious diseases of fish. Bulletin of the Office of International Epizootics, 83, 689–715.

Guerrero, L.A., and Monje, P.M. 1980. Common ectoparasites of *Tilapia* spp. at the FAC. Muñoz, Philippines, Central Luzon State University, Freshwater Aquarium Centre, FAC-CLSU Technical Report 18, 15–18.

Hara, S. 1977. Culture of catfish *Clarias macrocephalus* Gunther. Japan Overseas Cooperation Volunteers Philippines, Philippines Report. 33 p.

Hatai, K., Bian, B.Z., Baticados, M.C.L., and Egusa, S. 1980. Studies on the fungal diseases in crustaceans. 2: *Haliphthoros philippinensis* sp. nov. isolated from cultivated larvae of the jumbo tiger prawn (*Penaeus monodon*). Transactions of the Mycological Society of Japan, 21, 47–55.

IFP (Inland Fisheries Project, Philippines). 1973. Parasites. IFP Technical Report, 4, 31–34.

1973–74. Diseases of bangus. IFP Technical Report, 3, 38–40.

1975. Parasites and diseases of freshwater fishes: common carp fingerlings. IFP Technical Report, 6, 62–67.

1976. Disease and disease prevention in cultured fish. Quezon City, Philippines, BFAR. 5 p.

Laviña, E.M. 1978. Study on certain aspects of the biology and control of *Caligus* sp., an ectoparasite of the adult milkfish *Chanos chanos* (Forskal). Fisheries Research Journal of the Philippines, 3, 11–24.

Lio-Po, G.D., Baticados, M.C.L., Lavilla, C.R., and Sanvictores, M.E.G. in press. In-vitro effects of fungicides on the fungus *Haliphthoros philippinensis*. Journal of Fish Diseases (in press).

Lio-Po, G.D., Sanvictores, M.E.G., Baticados, M.C.L., and Lavilla, C.R. 1982. In-vitro effect of fungicides on hyphal growth and sporogenesis of *Lagenidium* sp. isolated from *Penaeus monodon* larvae and *Scylla serrata* eggs. Journal of Fish Diseases, 5, 97–112.

Palisoc, F.P. 1982. Observations on certain aspects of the *Epipenaeon ingens* Nobili (Isopoda: Bopyridae) in *Penaeus semi-sulcatus* de Haan from the Navotas Fishery Port, Navotas, Metro Manila, Philippines. Diliman, Philippines, University of the Philippines. 80 p. (master's thesis).

Ronquillo, I.A., and Caces-Borja, P. 1960. Notes on the infestation of *Chanos chanos* by a parasitic isopod. Philippine Journal of Fisheries, 8, 113–117.

SEAFDEC (Southeast Asian Fisheries Development Center). 1977. Aquaculture Department annual report. Tigbauan, Iloilo, Philippines, SEAFDEC. 40 p.

1978. Aquaculture Department annual report. Tigbauan, Iloilo, Philippines, SEAFDEC. 37 p.

1980. Aquaculture Department annual report. Tigbauan, Iloilo, Philippines, SEAFDEC. 52 p.

Velasquez, C.C. 1975a. Digenetic trematodes of Philippine fishes. Diliman, Philippines, University of the Philippines (published for the National Research Council of the Philippines). 140 p.

1975b. Status and needs of studies on fish parasites and diseases in the Philippines. Paper prepared for the Philippine Council for Agriculture and Resources Research (PCARR) first fisheries research congress in Legaspi City, 7–10 March. 16 p.

1979. Parasites and diseases of *Chanos chanos*

Forskal in the Philippines. Technology consultation on available aquaculture technology in the Philippines. In SEAFDEC/PCARR (Philippine Council for Agriculture and Resources Research), Proceedings, February 8–11. Tigbauan, Iloilo, SEAFDEC, 65–67.

1980. Cammallanidae (Nematoda) from Philippine fishes. Fisheries Research Journal of the Philippines, 5, 53–62.

Vicente, H.J., and Valdez, F.M. 1979. Preliminary observations on *Epistylis* sp. infestation in food organisms and shrimp hatchery tanks. Davao City, Philippines, Mindanao State University, Institute of Fisheries Research and Development, MSU/IFRD Technical Report, 1, 82–86.

Vicente, H.J., Valdez, F.M., Dejarme, S.M., and Apongan, A.B. 1979. Notes on the occurrence of undesirable organisms in MSU-IFRD prawn (*P. indicus* Milne Edwards and *P. monodon* Fabricius) hatchery tanks. Davao City, Philippines, Mindanao State University, Institute of Fisheries Research and Development, MSU/IFRD Technical Report, 1, 87–100.

APPENDIX 1: FORM USED BY SEAFDEC TO REQUEST LABORATORY EXAMINATION

PATHOLOGY PROJECT, AQUACULTURE DEPARTMENT, SOUTHEAST ASIAN FISHERIES DEVELOPMENT CENTER, Tigbauan, Iloilo, Philippines

REQUEST FOR MICROBIAL DIAGNOSIS

Date _____ Case Code No. _____

Time sampled _____ Water type _____

Specimen collection site _____

Species _____ Age/stage _____ Sample size _____

Specific signs observed _____

_____

_____

Initial date symptoms were detected _____

Population data and environment for 5 days preceding sampling

	DAY					
Parameter	5	4	3	2	1	0
Temperature						
Salinity						
Oxygen						
pH						
Nitrite						
Ammonia						
Turbidity						
Water exchange						
Stock size						
% affected						

Distribution of disease in the aquaculture system _____

_____

Condition of rearing water

Microfiltered ( ) Screen filtered ( ) Not filtered ( )

Sand filtered ( ) UV treated ( )

Experimental treatments _____

Feed composition/feeding rate _____

Any indications of poor water quality _____

Other fish in system _____

Recent introduction into the system _____

Origin and date of introduction _____

Recent changes in management _____

Time between first appearance of disease and death (days) _____

Implemented treatment, if any _____

_____

Other relevant information _____

_____

Submitted by _____ Received by _____

Study title and code _____

Project leader _____ Project leader _____

Address if non-AQD _____

_____

_____

APPENDIX 2: FORM USED BY SEAFDEC TO RECORD RESULTS OF LABORATORY EXAMINATION

LABORATORY RECORD CASE CODE NO_____

Pathology Project, Aquaculture Department, Southeast Asian Fisheries Development Centre, Tigbauan, Iloilo, Philippines

Date Examined_____ Date of Report_____

Source_____

Specimen_____ Stage/age_____

Size_____ Weight_____ Number_____

Transported: Live_____ Frozen_____ Preserved_____ Dead_____

Clinical history_____

_____

Tentative diagnosis_____

Laboratory findings_____

Microbiological_____

Parasitological_____

Histological_____

Pathogenicity_____

Comments_____

_____

Potential treatment_____

Report received by Examined by_____

_____ Noted by_____

Project leader

SINGAPORE

LESLIE CHEONG, RENÉE CHOU, RAGBHIR SINGH, AND CHAO TIEN MEE[1]

Live fish are imported into Singapore for transshipment as well as for farming: the majority of freshwater foodfish fingerlings and aquarium fish are meant for transshipment, whereas most of the marine foodfish fingerlings are for farming operations in Singapore. Imports of the latter have more than quadrupled (91 767 in 1981 and 493 011 up to October 1982) since the Marine Fish Farming Scheme was implemented in March 1981, with grouper (*Epinephelus tauvina*) and sea bass (*Lates calcarifer*) constituting the bulk of the imports.

At present, imported fish are not subjected to quarantine. The importer has to declare the types and numbers of fish imported (Inward Declaration Form) and obtain endorsement from the Primary Production Department (PPD) on the form before the fish can be released by Customs. Fish that are exported are declared in an Outward Declaration Form. Samples of the consignment are sent to PPD for visual inspection and certification. Exporters must comply with PPD stipulations for their packing premises, which are checked periodically by PPD officers. For example, floors must be durable and water resistant, with a slope for drainage; the drains must be adequate to effect quick and thorough clearing of standing water and, if connected directly to a sewer, must be equipped with deep-seal traps. The water supply for fish packing must be potable, and all equipment kept clean and in good repair. Other stipulations cover packing materials, working space, disposal of refuse and dead fish, as well as toilet and first-aid facilities for the workers.

To date, there has been no serious epizootic on fish farms in Singapore, but some form of quarantine is needed and is envisaged in the near future. The focus will be on marine foodfish fingerlings, which are directly stocked (40/m^2) in floating net cages in the sea. Any disease outbreak at such densities would be costly.

PPD has initiated studies on quarantine procedures for marine foodfish fingerlings, and the establishment of a quarantine centre to facilitate and coordinate operations is being considered. As Singapore is a compact island state with good road connections to the farming areas located along the northern part of the island, i.e., east and west Johore Straits, a central quarantine centre located near the airport at Changi Fisheries Complex would be most suitable. Disease cases are handled by the department and recorded (Appendix 1).

FISH DISEASES

Healthy, farmed fishes (groupers and sea bass) are checked regularly for parasites and bacteria. Encysted parasites, namely protozoans, trematodes, and nematodes, are occasionally found in the gills, liver, kidney, spleen, and heart. Pathogenic bacteria found in these organs are mainly *Vibrio* sp., *V. parahaemolyticus, V. alginolyticus, Aeromonas hydrophila, Edwardsiella tarda,* and *Yersinia enterolitica.*

The most widespread fish kill encountered to date was associated with swollen swim bladder in farmed groupers in September–October 1982. Fish, mainly adults (total length > 20 cm), at both east and west Johore Straits, were affected. The fish floated upside down, and the bloated part of the abdomen, which was exposed, usually became reddish and inflamed by bacterial infection. The fish kill was not total in the farms — a maximum 5–10 fish dying daily (0.5–1%) per farm — and was mainly restricted to groupers, although during the peak of the outbreak, some yellowfin jacks (*Caranx ignobilis*) and golden snapper (*Lutjanus johnii*) were also affected. Postmortem examination revealed that the pos-

[1]All the authors can be contacted through the Primary Production Department, 300 Nicoll Drive, Changi Point, Singapore.

terior bladder was stretched thin and was greatly distended because of excessive gaseous secretions. The anterior wall was more vascularized than normal, and nematode cysts as well as encysted protozoans were found in the bladder wall. Pathogenic bacteria were not detected in the bladder, but *V. parahaemolyticus* and *V. alginolyticus* were found in the spleen of affected fish. Depending on the degree of swelling, the fish recovered when treated in baths of potassium permanganate ($KMnO_4$) or Dimetron sodium® (Table 1) or when held in a tank with a throughflow of sand-filtered seawater sterilized by ultraviolet rays. However, the large (4–6-kg body weight) and more seriously affected fish were difficult to save. Nitrofurazone baths proved effective in treating inflammations on the fish body. The cause of the excessive gaseous secretions is not known and its restriction to groupers is noteworthy (the experience at PPD, unlike that in Malaysia, indicated that puncturing the swim bladder was not an effective treatment and, in fact, increased damage in many cases).

Other fish kills have been limited to a particular net or nets within a farm and have included cases of lymphocystis and anemic condition in sea bass, as well as exophthalmus and body and tail lesions (vibriosis) in groupers. These cases usually involved young imported fish. The success of the treatments (Table 1) depended on the condition of the fish at the time of treatment.

Diseased-fish specimens are inspected (Appendix 2), killed (cut behind the head so that the spinal cord is severed), and then prepared for microbiological examinations. The steps include:

- Swabbing the abdomen with 95% ethyl alcohol and then cutting open the ventral aspect with a sterilized scalpel (dipped in alcohol and held over a flame);
- Holding the heart with sterilized forceps while cutting the tip with sterilized scissors and dipping it on agar (TSA: a "nonselective" bacterial medium) (TCBS: selective medium for *Vibrio*);
- Following the same procedure for the liver;
- Removing the spleen whole, swabbing the tip and touching it onto agar plates; and
- Sterilizing the surface of the kidney with the flat of a flamed scalpel, slitting it, and looping the contents onto an agar plate.

These four organs are sampled for bacteria. For histopathological examinations, the heart, liver, spleen, kidney, gills, and one eye are routinely removed and fixed in buffered formalin; the swim bladder, muscle, fins, and brain are also removed and examined if the disease signs warrant.

The organs are streaked onto Trypticase soy agar (prepared with seawater) and onto selective media for *Vibrio* sp. (thiosulfate, citrate, bile salt medium, TCBS), and *Aeromonas* sp. (Rimmler-

Table 1. Summary of cases of fish disease treated by the Primary Production Department.

Case	Chemical/drug	Dose	Bath duration	Results
Trematodes (*Diplectanum* sp.) in gills of grouper and sea bass adults	Formalin	100–300 ppm	0.5 h/day, 3 days	Effective in farm conditions
Ciliates in gills of sea bass fry (2.5–3 cm)	Formalin	150 ppm	0.5 h	Ineffective: 100% mortality (fish too young to survive formalin treatment), ciliates protected in mucous envelope
Lymphocystis in sea bass fry (3–4 cm)	$KMnO_4$; nitrofurazone (Monafuran®)	2 ppm; 24 ppm	1 h/day; continuous except during $KMnO_4$ bath, 4 days	Ineffective: 100% mortality caused by disease
Swim-bladder swelling in grouper adults ($\geq$ 20 cm) (cause unknown; anterior portion of bladder particularly vascularized)	$KMnO_4$; nitrofurazone	2 ppm; 24 ppm	1 h/day; continuous except during $KMnO_4$ bath, 4 days	Partially effective: 60% recovery

continued

Table I concluded

Case	Chemical/drug	Dose	Bath duration	Results
Swim-bladder swelling in grouper adults (≥ 20 cm) (cause unknown; anterior portion of bladder particularly vascularized)	Sodium 4-methoxy-6-sulfanilamido pyrimidine monohydrate (Daimetron sodium®)	100 ppm	Continuous, 4 days	Effective: 100% recovery
Vibriosis (lesions, rot, ulcers with bacterial infection) in grouper fry and adults, and sea bass, usually found in stressed fish; lesions caused mainly by *V. parahaemolyticus* in grouper; *V. parahaemolyticus* and *V. alginolyticus* in sea bass	Nitrofurazone	24 ppm	Continuous, 4 days or until first signs of recovery	Partially effective, depends on condition of fish at treatment
Vibriosis (lesions, rot, ulcers with bacterial infection) in grouper fry and adults, and sea bass, usually found in stressed fish; lesions caused mainly by *V. parahaemolyticus* in grouper; *V. parahaemolyticus* and *V. alginolyticus* in sea bass	Nifupirinol with malachite green (Furanace-P®)	20 ppm	Continuous until recovery	Partially effective, depends on condition of fish at treatment
Vibriosis (lesions, rot, ulcers with bacterial infection) in grouper fry and adults, and sea bass, usually found in stressed fish; lesions caused mainly by *V. parahaemolyticus* in grouper; *V. parahaemolyticus* and *V. alginolyticus* in sea bass	Chlortetracycline	20 ppm	Continuous, 4 days or until recovery	Partially effective, depends on condition of fish at treatment
Vibriosis with gill parasites	Chlortetracycline; formalin	20 ppm; 150 ppm (range 100–300 ppm depending on fish condition)	Continuous; 0.5 h/day, 4 days	Partially effective, depends on condition of fish at treatment; because of tendency for fish to relapse when formalin treatment is withdrawn, formalin treatment should be repeated at 3-day intervals (once a week for closed systems of water circulation) after apparent recovery of fish
Vibriosis with gill parasites	Formalin; nitrofurazone	300 ppm; 24 ppm	0.5 h/day; 1 h/day, 3 days	Effective in farm conditions

Shotts agar). The plates are then incubated at room temperature for 24 h.

On the selective TCBS medium, two commonly encountered bacterial species are *V. parahaemolyticus* and *V. alginolyticus*. *Vibrio parahaemolyticus* colonies are green on TCBS, as the species ferments sugars other than sucrose, whereas the colonies of *V. alginolyticus*, which ferments sucrose, are yellow.

On Rimmler-Shotts agar, the four characteristic types of colonies are: yellow, yellow with black centres, greenish yellow to green, and green with

black centres. The yellow colonies, i.e., maltose fermenting on Rimmler-Shotts agar, are probably *Aeromonas* sp. *Citrobacter* sp. are also yellow but can be differentiated from *Aeromonas* by the oxidase test, *Citrobacter* being negative and *Aeromonas* being positive.

Next, biochemical tests are done, and the results recorded (Appendix 2).

For drug-sensitivity tests on *Vibrio* sp., single colonies from pure cultures of *Vibrio* sp. are inoculated into brain–heart infusion broth and incubated 8 h at optimum temperature; a sterile swab is immersed into the broth and the inoculum plated onto Trypticase soy agar (TSA with seawater); sterile papers containing the drugs are then placed on the plates and incubated at optimum temperature for 24 h, after which the diameter of inhibition is measured. The discs are obtained from commercial sources (oxytetracycline and nitrofurazone from Oxoid; Flumequine from May and Baker, and the rest from Baltimore Biological Laboratories).

QUARANTINE

At present, trial quarantine studies are being conducted with marine foodfish fingerlings, like groupers and sea bass. Imported fish are held overnight (500 fingerlings, 7.5–10.0 cm total length or 5-kg biomass/m^3 seawater, in a flow-through system), and records (Appendix 3) are being kept.

The fingerlings are put into a $KMnO_4$ bath (1–2 ppm) for 0.5 h, followed by a bath of nitrofurazone at 15 ppm for 4–5 h before flowthrough is started. A formalin bath at 100–200 ppm for 0.5 h may also be given. All water used is sand-filtered, UV-treated, and strongly aerated at all times when fish are stocked. During overnight holding, dead fish are to be removed, with one or two workers being needed at night to maintain the system. An officer oversees the stocking of fish, mixing of the chemicals or drugs, and release of the fish. Examination of some of the fingerlings after treatment shows that potassium permanganate and formalin, at the dosage tested, are suitable for removal of external parasites; use of nitrofurazone would be for treatment of lesions resulting from rough handling.

Marine aquarium fishes for transshipment are bathed in Furanace-P® (nifupirinol and malachite green) at 13 ppm for 0.5 h. Sick fish, usually clown fish, are placed in copper-sulfate baths of 0.5 ppm. All fish are held in tanks, supplied with good filtered seawater, for 3 days before re-export. Mortality during this holding period ranges from 10% to 40%, depending on the initial condition of the fish.

For export, fish (with the exception of sabellid worms) are packed individually in small plastic bags (0.05 mm thick), irrespective of size. No antibiotics or drugs are used. Seawater used for packing is filtered and ascertained as free from nitrites. Oxygen is usually 1.5–3.5 times the volume of packing water for marine fish for a journey of up to 12 h; for invertebrates, it is twice the volume of the water. Styrifoam cartons (2 cm thick) hold the inflated bags.

As all fish importers are licenced by PPD, quarantine control could be enforced reasonably easily if made mandatory. The Inward Declaration Form could be stamped when the importer complied with the requirements.

APPENDIX 1: FORM USED BY PPD FOR DATA COLLECTION AT FISH FARM

FISH EXAMINATION REPORT
Aquaculture Unit, Changi Fisheries Complex
FORM A (to be completed at site)

Date of report_____ Ref. no. FD/A_____

FARM PARTICULARS

Name of owner_____ Farm no._____ Farm location_____

Fish affected	Total stocked (no./net)	No. dead to date (no./net)	No. of cages affected	Period stocked (days/months)	Country of origin	Initial condition[a]
( ) grouper ( ) siakap ( ) golden snapper ( ) red snapper ( ) others (specify)						
Net fouling ( ) normal ( ) heavy			Net shape ( ) normal ( ) swept to one side			
Last net change ( ) 1 week ago ( ) 2 weeks ago ( ) 1 month ago ( ) other (specify)						

a = Good, normal, poor.

DESCRIPTION OF PROBLEM

Date problem first noticed_____	No. dying/day grouper_____
Are there any sick/diseased fish in surrounding area? ( ) Yes ( ) No	siakap_____
Has a similar problem arisen before? ( ) Yes ( ) No If yes, when was last occurrence? ( ) 2 weeks ago ( ) 1 month ago ( ) 1 month	Golden snapper_____ Red snapper_____ Other (specify)_____
Has farmer attempted to treat fish? ( ) Yes ( ) No If yes, specify treatment: Drug/chemical, dosage, method (bath/injection)	When is problem more serious? ( ) low tide ( ) high tide ( ) day ( ) night

FISH BEHAVIOUR

Feeding ( ) normal ( ) decreased ( ) refused to feed date:
Swimming: ( ) school normal ( ) school inactive ( ) school dispersed ( ) swimming singly ( ) vertically ( ) dizzily ( ) erratically ( ) circling ( ) lying on side ( ) jumping ( ) rubbing body
Change in body coloration ( ) Yes ( ) No If yes: ( ) pale to dark ( ) dark to pale

TYPE OF FOOD

Food used in affected cage(s): ( ) trash fish ( ) shellfish ( ) entrails ( ) others (specify)		
Is food used in unaffected cages similar? ( ) Yes ( ) No If no, elaborate:		
Amount fed/day to affected cage: kg/kati		
Treatment of food prior to feeding		
Frozen	Fresh	Artificial
thawing by:	kept for ____ days	Manufacturer:
( ) running water	Condition:	
( ) soaking	( ) good	Storage:
( ) natural means	( ) normal	( ) room temperature
	( ) poor (smelly)	( ) freezer
Change of food during culture ( ) Yes ( ) No If yes, state reason and type of food changed to:		

WATER QUALITY/CONDITION

Time(s) of observation sampling: Heights and time of tides:						
Weather conditions:( ) bright ( ) dull ( ) drizzling ( ) stormy ( ) windy						
Colour of water: ( ) normal ( ) turbid ( ) coloured (specify)						
Analysis: No. samples collected: Ref. no. samples:						
Sample no./depth	date	pH	NH_3-N	NO_2-N	NO_3-N	Bacteriology (MPN; pathogens)

PROVISIONAL RECOMMENDATIONS

Comments:				
Treatment:				
drug/chemical	dosage	period (h/day)	method	follow-up
Other recommendations:				

Name and signature of reporting officer

_____ _____

Date: _____

APPENDIX 2: FORMS USED BY PPD FOR LABORATORY REPORTS ON DISEASED FISH

FISH EXAMINATION REPORT
Aquaculture Unit; Changi Fisheries Complex

FORM B
(Postmortem and special examinations)

Ref.no. FD/B _____
Date of report _____ Ref.no. FD/A _____

RECORD OF FISH EXAMINED

No.	Length (cm)	Weight (g)	Degree of infection/description of condition	Remarks
1				
2				
3				
4				
5				
6				

Provisional diagnosis from postmortem examination (see attached, pages 3-4)

_____

_____

_____

MICROBIOLOGICAL EXAMINATION (fish must be freshly killed)

Species _____ (use separate forms for each species)

No.	Method of sampling (pulverization/loop)	Areas sampled	Bacteria isolated	Bacteria sensitivity	Identification	Code no.
1						
2						
3						
4						
5						
6						

[a] Attach sensitivity test sheet.

Drug(s)/chemical(s) recommended as treatment:_____
_____ dose:_____ length of treatment:_____ h for _____ days

Stock cultures taken (state code):_____

Microbiological examination report:_____
_____

Causative bacteria:_____

HISTOLOGICAL EXAMINATION (fish must be freshly killed)

Species:_____ (use separate forms for each species)

Organs fixed			
( ) skin	( ) muscle	( ) liver	( ) gall bladder
( ) kidney	( ) stomach	( ) spleen	( ) pyloric caeca
( ) heart	( ) liver	( ) eyes	( ) intestine (upper/mid/lower)
( ) gills	( ) muscle	( ) pylorus	( ) CNS (indicate portion
Others (specify):			

Sent to CVC/overseas (specify institution)/processed at AQU

Histological examination report (attach all other reports):_____
_____
_____
_____
_____

Final diagnosis:
_____
_____
_____

Name and signature of reporting officer

_____ _____

Date:_____

POSTMORTEM EXAMINATION: EXTERNAL (to be done on freshly killed fish)

Parasites:	nil	no. on gill/body/fin:		position:	identification:		recommended treatment:	
Shape of body	normal	( ) bulging abdomen	( ) scale loss	( ) scales raised	( ) skeleton deformed	( ) jaw crooked	( ) damaged body	( ) uneven body surface
Skin	normal	( ) colour change ( ) eroded	( ) dropping off ( ) spotted	( ) abnormally slimy ( ) reddish	( ) abrasions ( ) purplish	( ) lesions ( ) bleeding	( ) ulcers ( ) bored into (specify locations)	( ) exposed muscles
Fins	normal	( ) eroded ( ) beady lumps	( ) bleeding at base ( ) abnormally soft	( ) reddish base	( ) reddish (overall)	( ) damaged	( ) rotted	( ) fin loss
Operculum	normal	( ) deformed (congenital)	( ) missing (congenital)	( ) missing (damaged)	( ) swollen	( ) bleeding (inside/ outside)	( ) ulcers	( ) ulcers
Gills	normal	( ) dark red	( ) yellow red	( ) light red	( ) purplish	( ) abnormally slimy	( ) damaged	( ) missing
Eyes specify (left/right)	normal	( ) damaged ( ) "cataract"	( ) missing	( ) bulging	( ) bleeding	( ) cloudy or opaque		
Nostrils	normal	( ) damaged	( ) reddish	( ) bleeding	( ) ulcers	( ) bone exposed	( ) slimy	( ) open or closed
Mouth/lips	normal	( ) bleeding	( ) ulcers	( ) lacerated	( ) others (specify)			
Anus	normal	( ) expanded	( ) reddish	( ) bleeding	( ) fibrous	( ) colour	( ) others (specify)	
Others (specify)								

POSTMORTEM EXAMINATION: INTERNAL (to be done on freshly killed fish)

Heart								
Gall bladder	normal	( ) deep green	( ) green	( ) purple	( ) light yellow	( ) colourless	( ) exudation of bile	( ) hardened
Liver	normal	( ) hard ( ) damaged	( ) soft	( ) lumpy	( ) spotted	( ) bleeding	( ) uneven colour	( ) pale
Stomach	normal	contents ( ) feed ( ) slime ( ) empty	( ) elastic ( ) transparent	( ) hardened	( ) bleeding	( ) congested	( ) ulcers	
Pylorus	normal	( ) reddish	( ) bleeding	( ) others (specify)				
Intestine	normal	( ) reddish	contents ( ) dig. food ( ) undig. food ( ) empty	( ) bleeding	( ) transparent	( ) elastic	( ) hardened	
Spleen	normal	( ) coloured (state)	( ) fatty	( ) shriveled	( ) liquid	( ) bleeding	( ) lumpy	
Kidneys	normal	( ) reddish	( ) bleeding	( ) liquid	( ) fatty	( ) swollen	( ) lumpy	( ) hard ( ) soft ( ) normal
Air bladder	normal	( ) capillary dilated	( ) bleeding	( ) knotted lumpy				
Mesenteric fat	normal	( ) coloured (specify)	( ) degree +/++/+++	( ) soft	( ) hard			
Abdominal cavity wall	normal	( ) accumulation of water	( ) coloured	( ) reddish	( ) bleeding	( ) ulcers		

REQUEST FOR VETERINARY EXAMINATION

*(Delete where necessary)

This form must be completed in duplicate and forwarded to the Veterinary Laboratory, 40 Kampong Java Road, Singapore 9. On completion of the examination a copy with the laboratory report incorporated below will be returned to the Centre requesting the examination.

Vet centre	Name of owner	Ref. no
Species/specimen	Breed	Sex *Alive/dead
Age No. at risk	No. sick	Vaccination
Management		
Feeding		
Clinical signs		
Case history		
Treatment by farmer	Treatment by veterinarian	
Provisional diagnosis and remarks		

Date _____ Signature of centre/private veterinarian _____

FOR VETERINARY LABORATORY USE ONLY
Report:

Date _____ Laboratory Veterinarian _____

FOR VETERINARY LABORATORY USE ONLY

O.i/c_____ Ref:_____

Condition: Alive/dead:

P.M.E.

Skin:	Mouth:	Eyes:	Ears:
Rectum:	Genitals:	Feet:	Navel:

Stomach
Crop:
Gizz:

Intestine:

Kidneys:

Bladder:

Genitals:

Spleen:

Liver:

Heart:

Lung:

Trachea:

CNS:

Tentative diagnosis:

Special examinations:

Final diagnosis and remarks:

Initials:_____ Date:_____

ROUTINE TEST FOR THE IDENTIFICATION OF BACTERIA

Vet.centre: _____ Name of owner: _____

Ref.no.: _____ Age of animal: _____

Date: _____

Stock no.: Incubation Aerobic/Anaerobic/CO_2

Organism isolated from: $22^oC/37^oC$

GROWTH ON SOLID AGAR

Sheep blood agar
Nutrient agar
Chocolate agar
MacConkey agar
DCA/SS/BG agar
EMB agar/XLD

GROWTH ON SOLID AGAR

TCBS agar
TSA agar
TSA agar + 3% NaCl
Swarming surface growth on 1.5% agar
Rimler Shotts (RS) agar
Pseudosel agar

GROWTH IN LIQUID MEDIUM

Nutrient broth (+ serum)
Brain--heart infusion broth

STAINING CELL MORPHOLOGY

Gram stain
MZN stain
ZN stain
Giemsa stain
Others
Vegetative cells:
- size
- shape
- ends
- arrangement
- spores
- pigment

First stage	Results
Shape	
Acid fast	
Spores	
Motility ($22^oC/37^oC$)	
Growth in air	
Growth anaerobically (H_2/CO_2)	
Catalase	
Oxidase	
Glucose (acid)	
OF (glucose)	

Table 1. For Enterobacteriaceae only		
	Acid	
Dextrose	Gas	
Lysine decarboxylase		
Ornithine decarboxylase		
H_2S	TSI agar	
	K iron agar	
	SIM agar	
Indol	SIM agar	
	Peptone water	
Lactose		
Dulcitol		
Phenylalanine deaminase		
Urease		
Citrates	S	
	K	

Pathogenicity test

Animal numbers — Dose: — Date: — Culture:

Days postincubation

1	2	3	4	5	6	7	8	9	10

Serological test

Table 2. Enterobacteriaceae only[a]		
Indol	Peptone water SIM agar	
Methyl red		
Voges-Proskauer		
Citrates	S K	
H_2S	K iron agar SIM agar TSI agar	
Urease		
Motility (22°C/37°C)		
Gelatin (22°C)		
Lysine decarboxylase		
Arginine dihydrolase		
Ornithine decarboxylase		
PPA		
Malonate		
Glucose	Acid Gas	
Lactose		
Sucrose		
Mannitol		
Dulcitol		
Salicin		
Adonitol		
Inositol		
Sorbitol		
Arabinose		
Raffinose		
Rhamnose		
Maltose		
Nitrate		
ONPG		
Trehalose		
Xylose		
Glycerol		
Aesculin		
Gluconate		
Arginine hydrolysis		
Growth at 37°C		
Growth at 22°C		
Growth at °C		
Growth at °C/min		
Growth at °C/min		
Growth at pH 9		
CO_2 requirement		

Table 3. Other bacteria[b]				
SUGARS	24 h	48 h	1 2 week	Other tests
Lactose				Indol (PW)
Glucose				MR
Mannitol				VP
Sucrose				C citrate
Dulcitol				K citrate
Maltose				S citrate
Arabinose				TSI KIA
Dextrin				Butt
Galactose				Slope
Inositol				H_2S
Rhamnose				SIM H_2S
Raffinose				Agar indol
Sorbitol				Malonate
Salicin				Urease
Trehalose				Nitrate
Xylose				Nitrite
Glycerol				MB
Adonitol				LM
Fructose				KCN
Sorbose				Aesculin
Melexitose				Gluconate
Cellobiose				Tartrate
Mannose				ONPG
Melibiose				PPA
Amygdalin				Arginine
Erythritol				Lysine
Inulin				Ornithine
				LV(lecithinase)
				Optochin
Glucose (seal)				Bile solubility
Maltose (seal)				Starch hydrolase
				Gelatin hydrolase
				Arginine hydrolase
				Coagulase
				10% bile
				40% bile
				1/4000 tellurite Agar
Growth in 0% NaCl				
Growth in 3% NaCl				
Growth in 7% NaCl				
Growth in 10% NaCl				
Sensitivity to 0/129				
Sensitivity to novobiocin				

Organism identified as:

[a]Refer to Manual of Identification of Medical Bacteria by S.T. Cowan and K.J. Steel (1974).
[b]Nomenclature and data according to W.H. Ewing's Differentiation of Enterobacteriaceae by Biochemical Reactions, Centre for Disease Control, Atlanta, 1968 (Revised and amended 1970).

APPENDIX 3: FORM USED BY PPD TO RECORD IMPORTS OF FISH RECEIVED AND HANDLED BY THE AQUACULTURE UNIT

FLIGHT PARTICULARS

Flight no.:_____ Time of arrival:_____ Airway bill no.:_____

FISH PARTICULARS

Grouper:_____ Sea bass:_____ Other (specify):_____

Origin:_____ Country:_____ Town/city:_____

Numbers stated in invoice:_____ No. of cartons received_____

Carton number	Actual count			Volume of water	Analysis of water	
	Total fish	Dead	Alive		NO_2-N	NH_3-N
1						
2						
3						
4						
Mean/total						

Dead fish (if none dead, measure and weigh sample of 20)

Date	Number	Length	Bulk weight
Mean/total			Weight/fish:

Date transferred to farmer:_____ Nos. transferred live:_____

Fish condition:_____ injured/lesions/ulcers/fin rot/abrasions/deformed/flashing/ parasites/lips/head/flanks/fins/abdomen

Description:

Size difference: ( ) significant (>50% exceeding 2 cm in each carton)
( ) not significant (>50% NOT exceeding 2 cm in each carton)

WATER CONDITION AND PACKING

Salinity of water:_____ppt

Clarity: ( ) turbid ( ) coloured ( ) clear ( ) other (specify)

Acclimation (increase by 5 ppt/day)

Date	Salinity (ppt)
Arrival	

Packing: Bags deflated_____ %___(approx)
Bags leaking_____ %___

TREATMENT

Drug/chemical	Date	Period (h)	Dosage
$KMnO_4$			
Formalin			
Antibiotic (specify)			
Other			

FISH COLLECTION

Farmer's name_____

Fish taken on (date)_____ Total fish taken _____

Mode of transportation: boat/lorry

Mode of packing: plastic bags (____ fish/bag) tanks (size of tank)_____
(number)_____ (fish/tank)_____

Trips made:_____

COST

Freight charges S$_____
Cost of fish S$_____ (S$_____/fish)
Total cost S$_____ (S$_____/fish)
Sold @ $_____/fish

THAILAND[1]

SUPRANEE CHINABUT[2] AND YAOWANIT DANAYADOL[3]

Thailand is one of the major fish-producing countries of the region, with high levels of exports. In 1981, fishery-products exports were valued at 5.3 billion baht (US$ 1 = 22.9 baht). Of this total, live fish accounted for 30 million baht; ornamental fish constituted about 14.9 million baht. To maintain its markets abroad and protect its local industry, Thailand needs to adopt measures that ensure standards of quality for both the aquarium-fish exports (Appendix) and the consumable fish. For these reasons, concerted efforts are now under way in the area of fish-disease studies, which are carried out in the National Inland Fisheries Institute (NIFI) and the National Institute of Coastal Aquaculture (NICA). The range of fish species produced for sale in Thailand is great, as is the volume exported. The fry for such fish production are obtained in a variety of ways ranging from natural production to sophisticated breeding techniques involving hypophysation and, in the case of crustaceans, eyestalk ablation. Stocking is often very dense, and the fry, especially, suffer heavy mortalities.

The diseases that have been diagnosed by Thai research workers cover a wide spectrum, including infestations with metazoan and protozoan parasites, bacterial infections, mycotic infections, neoplasias, and nutritional abnormalities. For example, in one species of freshwater fish (*Kryptopterus apogon*) collected from Ubolratana Reservoir between October 1979 and September 1980, 11 species of parasites were found, representing monogenetic and digenetic trematodes, ciliate protozoans, acanthocephalans, copepods, nematodes, and Glochidia. Virus diseases are suspected in catfish culture and possibly in other systems, but definitive studies have not yet been carried out. The major farmed fishes are the catfishes, tilapias, sand goby, and carp, as well as crustaceans such as *Macrobrachium* sp. and *Penaeus monodon*.

Almost 40 disease agents have been found in Thailand, and some success has been experienced with the treatments used (Table 1). Most of the disease outbreaks occurring in the country are associated with the high stocking densities or with other environmental factors such as poor water quality, transportation, or handling. For instance, great losses were experienced from poor environmental conditions in 1981–82 in Songkhla Lake where brackish-water fish culture (primarily *Lates calcarifer* and *Epinephelus tauvina*) began only 3 years ago. Poor maintenance of the culture system was deemed to be the major cause of the four diseases observed in the fish. Recently, studies have also emphasized the important range of toxicological problems associated with pesticides and herbicides. Unreliable or improperly compounded feeds are also responsible for losses in intensive culture of both marine and freshwater fish.

Quarantine facilities are not currently available, but, as Thailand is a major exporter rather than an importer, the emphasis is placed on certification of live fish for export. Exporters provide samples of fish for visual inspection and diagnosis, after which a certificate of health is provided where necessary. Efforts are still being made to improve on this system and to develop quarantine services; a start has been made in the provision of lists of diseases occurring, provision of diagnostic services (for example, NICA has seven laboratories, although only two have relatively complete facilities), and training of extension workers.

The fish-diseases studies currently being sponsored by NIFI for freshwater fish and NICA for

[1]This paper is an edited version of two papers; the cooperation of the authors in agreeing to a single country report is acknowledged.

[2]National Inland Fisheries Institute, Bangken, Bangkok 9, Thailand.

[3]National Institute of Coastal Aquaculture, c/o Department of Fisheries, Ministry of Agriculture and Cooperatives, Kaoseng, Songkhla Province, Thailand.

Table 1. Disease agents reported in Thailand and their treatment.[a]

Agent	Recommended bath treatment
Trichodina sp.	Formalin, 25–75 ppm, prolonged
Epistylis sp.	Formalin, 25–75 ppm, prolonged
Oodinium sp.	Formalin, 25–75 ppm, prolonged
Ichthyophthirius sp.	Formalin, 25–75 ppm, prolonged
Cryptocaryon sp.	Formalin, 25–75 ppm, prolonged
Scyphidia sp.	Formalin, 25–75 ppm, prolonged
Glossatella sp.	Formalin, 25–75 ppm, prolonged
Zoothamnium sp.	Formalin, 25–75 ppm, prolonged
Dactylogyrus sp.	Formalin, 25–100 ppm, 24 h
Gyrodactylus sp.	Formalin, 25–100 ppm, 24 h
Ancylodescoides sp.	Formalin, 25–100 ppm, 24 h
Argulus sp.	Dipterex, 0.25–0.5 ppm, 24 h
Ergasilus sp.	Dipterex, 0.25–0.5 ppm, 24 h
Lamproglena sp.	Dipterex, 0.25–0.5 ppm, 24 h
Lernaea sp.	Dipterex, 0.25–0.5 ppm, 24 h repeated four times at 7-day intervals
Rocinella sp.	Dipterex, 0.25–0.5 ppm, 24 h
Piscicola sp.	Formalin, 50–100 ppm, 24 h
Glochidia	Formalin, 50–100 ppm, 24 h
Saprolegnia sp.	Malachite green, 0.1 ppm, with formalin, 25–50 ppm, 24 h
Aeromonas hydrophila	Antibiotic
Flexibacter columnaris	Antibiotic
Vibrio sp.	Antibiotic

[a]Other agents reported in Thailand for which no treatment is currently recommended include species of digenetic trematodes (*Pleurogenoides* sp., *Carassostrema* sp., *Allocreadium* sp., *Helostomatis* sp., *Macrotrema* sp.); of acanthocephalans (*Pallisentis* sp., *Acanthosentis* sp., *Fillicollis* sp.); of sporozoans (*Myxidium* sp., *Myxobolus* sp., *Henneguya* sp., *Myxosoma* sp.); of nematodes (*Camallanus* sp., *Cucculanus* sp., *Spinnitectus* sp., *Proleptus anabantis*); and a cestode (*Senga* sp.).

brackish-water fish are exemplified by work on *K. apogon* at Ubolratana Reservoir and on *L. calcarifer* and *E. tauvina* at Songkhla Lake.

The studies at Ubolratana were undertaken to support development efforts in techniques for culture of *K. apogon*, which is regarded in Thailand as one of the most delicious freshwater fish and is becoming increasingly scarce. From October 1979 to September 1980, 215 fish were collected by dip nets and by set pole-and-line and seine methods. They were taken to the laboratory alive, measured, separated by sex, killed, and examined post mortem within 24 h of capture. Each fish was examined for external parasites, after which fins were removed and mucous smears made for microscopic examination. Gills were removed from the left side of the fish, and, after examination under a microscope, were placed in formalin solution (0.25 ppt) for 45–60 minutes so that the monogenetic trematodes could be removed. The eyes, brain, alimentary system, heart, liver, spleen, kidney, swim bladder, urinary bladder, and gall bladder were removed, put in saline solution (0.85%), and examined microscopically. All parasites were fixed and stained by standard techniques. The resulting data were subjected to analysis of variance, correlation Chi-square analysis, and the Student's t-test.

Eleven species of parasites were found, including *Ancylodiscoides* sp. (97% prevalence); *Pleurogenoides* sp.; *Trichodina* sp.; *Pallisentis ophicephali; Fillicollis* sp.; and *Ergasilus* spp. There were significant ($P < 0.05$) differences in seasonal intensities, with maximum mean intensities (parasites/host) of monogenetic trematodes and *Ergasilus* sp. being in the rainy season and acanthocephalans in the summer. The host size did not appear to have any effect on intensity, but sex seemed to be related to intensity with *Ergasilus* sp., the males being more heavily infested than females.

At Songkhla Lake, culture of *E. tauvina* and *L. calcarifer* has been under way for 3 years in net cages. Four diseases caused serious losses in 1981–82: gill fluke disease, white spot disease, trichodiniasis, and vibriosis. Both gill fluke disease and trichodiniasis were associated with a decrease in salinity, whereas white spot disease occurred when the water temperature dropped from 28°C to 26°C. These findings clearly show the importance of maintaining water quality.

APPENDIX: SPECIES OF AQUARIUM FISH EXPORTED FROM THAILAND

Scientific names	Popular names	Scientific names	Popular names
Acanthophthalmus kuhli	Coolie loach	*Hyporhamphus unifasciatus*	—
A. myersi	Coolie loach	*Irvineia voltae*	—
A. semicinctus	Coolie loach	*Kryptopterus bicirrhus*	Glass sheet fish
Acanthopsis choirorhynchus	Longnose loach	*K. cryptopterus*	—
Aplocheilus panchax	Blue panchax	*Labeo bicolor*	Redtail black shark
A. siamensis	Killifishes	*L. chrysophekadion*	Black shark
Astronotus ocellatus	Oscar	*L. erythura*	Rainbow shark
Balantiocheilus melanopterus	Tricolour shark	*L. frenatus*	Rainbow shark
Betta splendens	Showey fighter	*Lates calcarifer*	Cock-up
Botia beauforti	Tiger botia	*Leiocassis siamensis*	Siamese rock catfish
B. horae	Skunk botia		
B. hymenophysa	Tiger loach	*Leonensis bamber*	Lion fish
B. macracantha	Clown loach	*Leptobarbus hoeveni*	—
B. modesta	Yellowtail botia	*Lobistes reticulatus*	—
B. pulchripimis	Yellowtail botia	*Macrognthus aculeatus*	Peacock eel
B. sidthimunki	Dwarf siambotia	*Mastacembelus erythrotaenia*	Fire spiny eel
Brachydanio rerio	Zebra fish	*M. maculatus*	Spiny eel
Brachygobius xanthozona	Bumblebee fish	*M. pancalus*	Spiny eel
Bunocephalus coracoideus	Stone fish	*Microphis boaja*	Common freshwater pipe fish
Carinotetraodon somphongsi	—		
Chalceus macrolepdoteus	—	*Monodactylus argenteus*	Monos
Chanda ranga	Glass fish	*Mystus* spp.	—
C. wolffi	Glass fish	*Notopterus afer*	Knife fish
C. asiatica	Glass fish	*N. chitala*	Spotted featherback
C. lala	Glass fish	*N. mikereedi*	Clown knife fish
Cichlasoma negrofasciatum	Jack Dempsey	*N. notopterus*	Gray featherback
C. biocellatum	Jack Dempsey	*Ophicephalus micropeltes*	Snake head
C. salvini	Jack Dempsey	*Oryzias javanicus*	—
Cirrhina mrigala	Black carp	*Osphronemus gouramy*	Giant gouramy
Clarias batrachus	Walking catfish	*Oxyeleotris marmoratus*	Marbled sleepy goby
C. macrocephalus	Walking catfish	*Pangasius micronema*	—
Colisa lilia	Dwarf gouramy	*P. pangasius*	—
C. chuna	Honey gouramy	*P. sutchi*	Striped catfish
Datnioides quadrifasciatus	Fourbar tiger	*Pelmatochromis arnolde*	—
D. microlepsis	Siamese tiger	*Periophthalmus* sp.	Mud skipper
Dermogenys pusillus	Halfbeak	*Poecilia latipinna*	—
Epalzeorhynchus kallopteurs	Flying fox	*P. sphenops*	—
E. siamensis	—	*Potamorraphis groctos*	—
Esomus danrica	Flying barb	*P. guianensis*	Asian gar-needle fish
E. malayensis	—	*Pterophyllus scalare*	—
Garra taeniata	Mountain stream algae eater	*Puntius altus*	Redtail barb
		P. hexasona	Tiger barb
Gyrinocheilus aymonieri	Algae eater	*P. orphoides*	Tiger barb
Halophryne trispinosus	Toad fish	*P. schwanenfeldi*	Tiger foil barb
Haplochromis callipterus	—	*P. sumatranus*	Tiger barb
Helostoma rudolfi	Green kissing gouramy	*P. tetrazona*	Tiger barb
		Rasbora argyrotaenia	Silver rasbora
H. temmincki	Pink kissing gouramy		
Hemichromis bimaculatus	—		

Appendix continued

Scientific names	Popular names	Scientific names	Popular names
R. borapetensis	—	*T. palembangensis*	Puffer eight
R. dusonensis	Yellowtail rasbora	*T. somphongsi*	Green puffer
R. hengili	—	*Therapon jarbua*	Target fish
R. heteromorpha	Harlequin fish	*Toxotes jaculator*	Archer fish
R. meinkeni	Redtail rasbora	*Trichogaster microlepis*	Moonlight gouramy
R. trilineata	Scissors-tail rasbora	*Trichopsis pumilis*	Croaking gouramy
Scatophagus argus	Green scat	*T. vittatus*	Croaking gouramy
Stigmatogobius sadanundio	—	*Xenentodon canella*	Fresh-water gar fish
Symphysodon discus	Regular discus	*Xiphophorus helleri*	Swordtail
Tetraodon fluviatilis	Spotted puffer	*X. maculatus*	Moonfish

APPENDICES

1. BIBLIOGRAPHY[1]

Australia, Department of Health. 1982. New quarantine system for live fish. Canberra, Australia, Department of Health, Animal Quarantine Section. 9 p. *Document outlines the conditions that individuals wishing to import live fish will likely have to comply with in Australia; the conditions were being considered for implementation in 1982.*

Bell, G.R., and Margolis, L. 1972. Considerations and recommendations for the control of fish diseases in Canada. Ottawa, Canada, Fisheries Research Board of Canada, Miscellaneous Special Publication 16. 52 p. *This study led to Canada's present fish-health protection regulations.*

Bohl, M. 1980. Import of exotic fishes and its consequences. Tierarztliche Praxis, 8, 115–120 (in German).

Boustead, N. 1978. Virus and disease control. Catch '78, 5, 23–24. *New Zealand's policy of prohibiting the import of certain fish and fish products is aimed at preventing the introduction of diseases (several of which are mentioned in the article).*

Brown, J.J. 1975. Fish imports and the problems of control. In Fisheries Research Division, Fish Disease Seminar 1974. Wellington, New Zealand, Fisheries Research Division, Occasional Publication 7.

Canada, Fisheries and Environment. 1977. Fish health protection regulations. Manual of compliance. Ottawa, Canada, Fisheries and Environment Canada, Fisheries and Marine Service, Miscellaneous Special Publication 31. 32 p. *The document contains the regulations and disease-detection method intended to prevent the spread of salmonid diseases into and within Canada.*

Canlas, J.R. 1978. Notes on the import and export of live fish in the Philippines with reference to diseases and parasites. Paper prepared for a workshop on Diseases of Fish Cultured for Food in Southeast Asia, Cisarua, Bogor, Indonesia, 28 November–1 December. 5 p.

Conroy, D.A. 1975. Evaluation of the present state of world trade in ornamental fish. Rome, Italy, FAO, Fisheries Technical Paper 146. 128 p. *The paper contains a section advocating health certification in ornamental fish trade and provides examples of health certificates.*

1981. Importance of fish disease in relation to the development of salmonid culture in South America. Rivista Italiana di Piscicoltura e Ittiopatologia, 16, 57–64. *The paper includes a discussion on the need for legislation to prevent the import into, and spread within, South America of the principal infectious diseases of salmonids.*

Conroy, D.A., Morales, J., Perdomo, C., Ruiz, R.A., and Santacana, J.A. 1981. Preliminary observations on the ornamental fish diseases in northern South America. Rivista Italiana di Piscicoltura e Ittiopatologia, 16, 86–100. *Paper catalogues infections occurring in ornamental fish from northern South America — infections that may kill the fish or be transported with the fish.*

Davy, B., and Graham, M., ed. 1979. Diseases of fish cultured for food in Southeast Asia: report of a workshop held in Cisarua, Bogor, Indonesia, 28 November–1 December 1978. Ottawa, Canada, IDRC (International Development Research Centre), IDRC-139e. 32 p.

Dill, W.A., ed. 1972. Report of a symposium on the major communicable fish diseases in Europe and their control, organized by FAO/EIFAC with the support of OIE, Amsterdam, 20–22 April 1972. Rome, Italy, EIFAC (European Inland Fisheries Advisory Commission), Technical Paper 17. 43 p. *The document summarizes the symposium's findings on six salmonid and two cyprinid diseases with respect to occurrence, etiology diagnosis, transmission, prophylaxis, and treatment; inspection at source and fish-farm certification were deemed to be the most practical and effective measures to adopt to prevent the spread of certain important fish diseases.*

1973. Symposium on the major communicable fish diseases in Europe and their control. Panel reviews and relevant papers. Rome, Italy, EIFAC (European Inland Fisheries Advisory Commission), Technical Paper 17, Supplement 2. 255 p. *The technical reports on the major communicable fish diseases contained in this document led to a call for studies to investigate*

[1]This partially annotated bibliography on fish quarantine and certification was compiled by T.P.T. Evelyn, Department of Fisheries and Oceans, Pacific Biological Station, Nanaimo, Canada. Dr. Evelyn expresses his thanks to R.J. Roberts, Institute of Aquaculture, University of Stirling, Scotland, and G.L. Hoffman, U.S. Fish and Wildlife Service, Fish Farming Experimental Station, Stuttgart, Arkansas, USA, for providing several references that might otherwise have been overlooked; L. Ashburner and N. Boustead, fish-health researchers in Australia and New Zealand, respectively, for their kindly providing information on the regulations in their countries pertaining to live-fish imports; and Z. Szpakowska, IDRC project officer, Fisheries Information, Vancouver, Canada, for her expert assistance in compiling many of the references, particularly those originating in Southeast Asia.

the feasibility of fish inspection at source and certification of source as a means of controlling the spread of fish diseases.

Elliott, D. 1978. Fish disease inspection and certification. Marine Fisheries Review, 40, 69–71. *The author outlines problems encountered in carrying out health inspections with salmonids and the changes in the inspection procedures made to facilitate the inspections.*

FAO (Food and Agriculture Organization of the United Nations). 1974. Government consultation on an international convention for the control of the spread of major communicable fish diseases, Aviemore, Scotland, 30 April–1 May 1974. Rome, Italy, FAO, Fisheries Reports 149. 17 p. *The document contains the draft convention and inspection and certification procedures that interested countries were asked to consider adopting in an effort to prevent the spread of important diseases of salmonids and cyprinids.*

FAO/OIE. 1977. Government consultation on the international convention for the control of the spread of major communicable fish diseases, Paris, France, OIE, 25–28 January. Rome, Italy, FAO, Fisheries Reports 192. 44 p. *This document outlines efforts, subsequent to the Aviemore government consultations, to arrive at fish inspection and certification procedures that would be widely acceptable internationally.*

Ghittino, P. 1964. Standardization and harmonization of regulations or criteria regarding the import and export of fish and other fishery products. Paper prepared for the FAO/OIE/WHO (World Health Organization) meeting on Basic Principles for the Control of International Traffic in Animals and Animal Products, Berne, Switzerland. 7 p.

1966. Suggestions pour l'établissement d'une liste internationale des maladies contagieuses des poissons. Bulletin de l'Office international des épizooties, 65, 1165–1172.

1968. Les maladies contagieuses des poissons incluses dans le Code zoosanitaire international de l'OIE. Paris, France, OIE. 72 p.

1974a. Il controllo internazionale dei pesci. Die internationale Fischueberwachung. Rivista Italiana di Piscicoltura e Ittiopatologia, 9, 113–117 (in German).

1974b. Some remarks on the health regulations for aquarium fishes. Rivista Italiana di Piscicoltura e Ittiopatologia, 9, 19–21.

1979. International aspects of disease control in aquaculture. In Pillay, T.V.R., and Dill, W.A., ed., Advances in Aquaculture. Papers Presented at the FAO Technical Conference on Aquaculture, Kyoto, Japan, 26 May–2 June 1976. Farnum, Surrey, England, Fishing News (Books) Ltd. *This article contains a comprehensive account of the efforts being made by various governments and international organizations to regulate traffic in fish, especially live fish, so as to prevent the spread of fish diseases with fish shipments.*

Ghittino, P., and de Kinkelin, P. 1975. Proposed control measures for the principal contagious diseases of fish. Bulletin de l'Office international des épizooties, 83, 689–715.

Ghittino, P., de Kinkelin, P., and Fijan, N. 1979. International zoo-sanitary code and fish diseases. General session of the committee of the OIE, Paris, France, 21–26 May 1979. Rivista Italiana di Piscicoltura e Ittiopatologia, 15, 20–23. *This article summarizes what the international zoosanitary code is and how it is intended to function to prevent the spread of certain salmonid and cyprinid diseases.*

Gratzek, J.B., Shotts, E.B., and Blue, J.L. 1978. Ornamental fish: diseases and problems. Marine Fisheries Review, 40, 58–60. *Bacteria, viruses, and parasites found in shipments of ornamental fish from Southeast Asia to the United States are reported.*

Indonesia, Directorate General of Fisheries (Direktorat Jenderal Kehutanan). 1980a. Coordination of the implementation of animal, fish, plant quarantine and control of fauna and flora traffic from the natural conservation point of view. In Directorate General of Fisheries, Report of the Technical Meeting on Agricultural Quarantine, Semarang, Indonesia. Jakarta, Indonesia, Direktorat Jenderal Kehutanan. 25 p. (in Indonesian). *This document is available in the Bogor library.*

1980b. Coordination of the implementation of animal, fish, plant quarantine and control of fauna and flora traffic from the fish-quarantine point of view. In Directorate General of Fisheries, Report of the Technical Meeting on Agricultural Quarantine, Semarang, Indonesia. Jakarta, Indonesia, Direktorat Jenderal Kehutanan, part 4. 7 p. (in Indonesian). *This document is available in the Bogor library.*

Indonesia, Ministry of Agriculture (Departemen Pertanian). 1979. Fish quarantine and other regulations in the traffic of live fish. In Ministry of Agriculture, Collection of Papers on the Program for the Establishment and Co-ordination of Agricultural Quarantine. Jakarta, Indonesia, Departemen Pertanian, 1, part 5, 1–6. *The document is available in the Bogor library.*

McDaniel, D.W., ed. 1979. Fish health blue book. Procedures for the detection and identification of certain fish pathogens. Bethesda, Maryland, USA, American Fisheries Society, Fish Health Section. 118 p. *This book outlines methods for detecting various fish infections of concern to fish culturists in North America; in the United States, it is the closest publication in the fish-health field to a manual of standard diagnostic methods; it, therefore, plays an important role in fish-health inspection and certification in the USA.*

McKay, R.J. 1977. Australian aquarium fish industry and the possibility of the introduction of exotic fish species and diseases. Canberra, Australia, Fisheries Division, Fisheries Paper 25. 36 p.

New Zealand, Ministry of Agriculture and Fisheries. 1982. Manual of instructions of the Agricultural Quarantine Service. Part F: fish. Wellington, New Zealand, Ministry of Agriculture and Fisheries. *The manual deals with the types of fish and fish products that can be imported into New Zealand and outlines*

the conditions with which potential fish importers or dealers must comply; portions of the manual are confidential because they contain commercial information.

OIE (Office international des épizooties). 1975. O.I.E. meeting of experts for the study of criteria that may be followed in establishing SPF (specific pathogen free) and MD (minimum disease) fish farms, Paris, 3–5 December 1974. Bulletin de l'Office international des épizooties, 83, 743–754. *This document outlines the considerations that went into deciding on the nature of the health certificates issued to fish farms: the certificates should reflect the recent disease history of the farm as well as the disease-free quality of the farm's water supply.*

Oka, I.N. 1978. Fish quarantine service in Indonesia. Paper prepared for a workshop on Diseases of Fish Cultured for Food in Southeast Asia, Cisarua, Bogor, Indonesia, 28 November–1 December. 9 p.

Oslon, R.E. 1979. Review of North American fish disease control regulations. In Oregon State University, Proceedings from a Conference on Disease Inspection and Certification of Fish and Fish Eggs. Corvallis, Oregon, USA, Oregon State University, Sea Grant College Program, Publication ORESU-W-79-001, 10–18. *This article outlines the fish-disease control regulations in effect in Canada and the United States; it also describes how they are applied and who applies them.*

Rabanal, H.R. 1978. International traffic of live fish and fish eggs and control of the spread of fish diseases. Paper prepared for a workshop on Diseases of Fish Cultured for Food in Southeast Asia, Cisarua, Bogor, Indonesia, 28 November–1 December. 4p.

Roberts, R.J. 1981. Development of a fish quarantine system for Indonesia. Report on visit to Indonesia on behalf of FAO, Rome, 22.10.81–9.11.81. Rome, Italy, FAO. 64 p. *Specific recommendations are made with respect to the implementation of a fish-quarantine system for Indonesia and for the setting up and staffing of diagnostic and research laboratories in support of the system.*

Rohovec, J. 1979. Review of international regulations concerning fish health. In Oregon State University, Proceedings from a Conference on Disease Inspection and Certification of Fish and Fish Eggs. Corvallis, Oregon, USA, Oregon State University, Sea Grant College Program, Publication ORESU-W-79-001, 7–9. *This paper briefly reviews international fish-health regulations governing the traffic in fish and fish products.*

Rosenthal, H. 1978. Bibliography on transplantation of aquatic organisms and its consequence on aquaculture and ecosystems. Bredene, Belgium, European Mariculture Society, Special Publication 3. 146 p. *This volume includes a wealth of background material on transfers of aquatic organisms. Some 1515 references are cited.*

Shotts, E.B., Jr, Kleckner, A.L., Gratzek, J.B., and Blue, J.L. 1976. Bacterial flora of aquarium fishes and their shipping waters imported from Southeast Asia. Journal of the Fisheries Research Board of Canada, 33, 732–735.

Thompson, P.E., Dill, W.A., and Moore, G. 1973. Major communicable fish diseases of Europe and North America. A review of national and international measures for their control. Rome, Italy, EIFAC (European Inland Fisheries Advisory Commission), Technical Paper 17, Supplement 1. 48 p. *This article reviews national and international fish-disease control measures up to 1972 and examines ways of improving their effectiveness.*

Zenny, F.B. 1969. Comparative study of laws and regulations governing the international traffic in live fish and fish eggs. Rome, Italy, EIFAC (European Inland Fisheries Advisory Commission), Technical Paper 10. 52 p. *This study showed very clearly the need for establishing a uniform system of fish-health regulations for governing international traffic in live fish and fish eggs.*

2. PARTICIPANTS AND OBSERVERS

Sri Lestari Angka, Bogor Agricultural University, Faculty of Fisheries, Bogor, Indonesia

M. Nasyiruddin Arsyad, Fisheries Extension Officer, South Sumatra Province, Jalan Kapten A. Rivai 669/11, Palembang, Indonesia

Tom Bergin, Senior Veterinary Officer, Australian Quarantine Service, Department of Health, P.O. Box 100, Woden, Act 2606, Australia

Leslie John Cheong, Head, Aquaculture Unit, Primary Production Department, 300 Nicoll Drive, Changi Point, Singapore 1749

Supranee Chinabut, Senior Fisheries Biologist, National Inland Fisheries Institute, Bangken, Bangkok 9, Thailand

John Copland, Director, National Fish Health Reference Laboratory, P.O. Box 388, Benalla, Victoria 3672, Australia

Darnas Dana, Bogor Agricultural University, Faculty of Fisheries, Bogor, Indonesia

Yaowanit Danayadol, Fisheries Biologist, National Institute of Coastal Aquaculture, c/o Department of Fisheries, Ministry of Agriculture and Cooperatives, Kaoseng, Songkhla Province, Thailand

Thaib Dano, Centre for Agriculture Quarantine, Ministry of Agriculture, Jalan Salemba Raya 16, Jakarta, Indonesia

F. Brian Davy, Acting Associate Director (Fisheries), Agriculture, Food and Nutrition Sciences Division, International Development Research Centre, Asia Regional Office, Tanglin P.O. Box 101, Singapore 9124

Rustami Djajadiredja, Senior Scientist, Research Institute for Inland Fisheries, 1 Jalan Sempur, Bogor, Indonesia

T.P.T. Evelyn, Research Scientist, Fish Health and Parasitology Section, Department of Fisheries and Oceans, Pacific Biological Station, Nanaimo, Canada V9R 5K6

Fauzi, Fisheries Service of Riau Province, Jalan Pattimura 6, Pekanbaru, Riau, Indonesia

Mars R. Gintings, Agency for Agricultural Education, Training and Extension, Department of Agriculture, Jakarta, Indonesia

A.A. Harmony, Chief of Fishery Service of Bali, Jalan Pattimura 77, Denpesor, Bali

Wardana Ismail, Research Institute for Marine Fisheries, Mariculture Division, Jalan Kerapin 12, Jakarta, Indonesia

Gilda Lio-Po, Research Associate, Pathology Project, Aquaculture Department, Southeast Asian Fisheries Development Center, 6th Floor, Triumph Building, 1610 Quezon Avenue, Quezon City 3008, Philippines

T.H. Panjaitan, Chief, Subdivision of Environment Management, Directorate General of Fisheries, Jalan Salemba Raya 16, Jakarta, Indonesia

Julita Pascual, Supervising Fishery Technologist, Department of Natural Resources, Bureau of Fisheries and Aquatic Resources, 860 Quezon Avenue, Quezon City, Metro Manila, Philippines

H.R. Rabanal, Consultant (Aquaculture), FAO/UNDP South China Sea Fisheries Development and Coordinating Program, P.O. Box 1184 MCC, Makati, Metro Manila, Philippines

Ronald J. Roberts, Consultant, FAO/UNDP South China Sea Fisheries Development and Coordinating Program, c/o Institute of Aquaculture, University of Stirling, Stirling FK9 4LA, Scotland, UK

Akhmad Rukyani, Chief, Research Institute for Inland Fisheries, 1 Jalan Sempur, Bogor, Indonesia

Bambang Basuki Salamoen, Chief, Jakarta City Fish Quarantine, Halim PK Airport, Room 155, Jakarta, Indonesia

Josefina Santos, Supervising Fishery Technologist, Department of Natural Resources, Bureau of Fisheries and Aquatic Resources, 860 Quezon Avenue, Quezon City, Metro Manila, Philippines

Adi Sarono, Chief, Section of Diseases and Germs, Directorate General of Fisheries, Jalan Salemba Raya 16, Jakarta, Indonesia

Darti Satyani, Inland Fisheries Research Institute, 1 Jalan Sempur, P.O. Box 30, Bogor, Indonesia

Mohd. Shariff bin Mohd. Din, Lecturer, Faculty of Fisheries and Marine Science, Universiti Pertanian Malaysia, Serdang, Selangor, Malaysia

V. Soesanto, Senior Training/Extension Officer, FAO/UNDP South China Sea Fisheries Development and Coordinating Program, P.O. Box 1184 MCC, Makati, Metro Manila, Philippines

Soewito, Director of Resources Management, Directo-

rate General of Fisheries, Jalan Salemba Raya 16, Jakarta, Indonesia

B. Suboko, Chief of Regional Provincial Fisheries Services of North Sumatra, Medan, Indonesia

Suhairi bin Alimon, Fisheries Officer, Fisheries Research Institute, Glugor, Penang, Malaysia

Hambali Supriyadi, Parasitologist, Research Institute for Inland Fisheries, 1 Jalan Sempur, P.O. Box 51, Bogor, Indonesia

Enang Harris Surawidjaja, FAO/UNDP Project of Extension Services Support to Small Scale Fisheries, Semarang, Indonesia

Mohd. Tarmizi bin Mior Yahya, Assistant Biologist, Projek Penetasan, Majuikan, Fisheries Development Authority, Tanjong Dawar, Kedah, Malaysia

Pipik Taufik, Bacteriologist, Research Institute for Inland Fisheries, 1 Jalan Sempur, P.O. Box 30, Bogor, Indonesia

Jeremy Ting Thian Ming, Fisheries Officer, Department of Fisheries, Mail Bag 107, Kota Kinabalu, Sabah, Malaysia

M. Unar, Director, Central Research Institute for Fisheries, Agency for Agricultural Research and Development, P.O. Box 30, Palmerah, Jakarta, Indonesia

Adrian F. Vijiarungam, Fisheries Officer, Fisheries Division, Ministry of Agriculture, Swettenham Road, Kuala Lumpur, Malaysia

Ibnuhajar Zain, Chief, Fisheries Service, South Sumatra, Jalan Kapten A. Rivai 669/11, Palembang, Indonesia

Technical editor

Amy Chouinard, Communications Division, International Development Research Centre, P.O.Box 8500, Ottawa, Canada K1G 3H9

3. PAPERS SUBMITTED[1]

Chinabut, Supranee, Study of Parasitic Fauna and Their Seasonal Abundance on *Kryptopterus apogon* (Bleeker) from Ubolratana Reservoir

Copland, J., and Bergin, T., Fish Diseases and Quarantine in Australia

Yaowanit Danayadol, Some Diseases of Brackish-Water Fishes from Songkhla Province

Djajadiredja, Rustami, Satyani, Darti, and Supriyadi, Hambali, Notes on Fish Post-Entry Quarantine Service

Djajadiredja, Rustami, Panjaitan, T.H., Rukyani, Akhmad, and Sarono, Adi, Present Status of Fish Quarantine in Indonesia

Lio-Po, Gilda, Pascual, J.P., and Santos, J.G., Fish Diseases and Quarantine in the Philippines

Primary Production Department, Status of Fish Quarantine in Singapore

Suhairi bin Alimon, and Vijiarungam, Adrian Francis, Fish Diseases in Malaysia (A Review)

Ting Thian Ming, Status of Fish Diseases and Fish Quarantine in Sabah

[1]Copies available from authors.

4. AUSTRALIA

J. COPLAND AND T. BERGIN, NATIONAL FISH HEALTH REFERENCE LABORATORY, BENALLA; AND AUSTRALIAN QUARANTINE SERVICE, WODEN, AUSTRALIA

Finfish culture began in Australia in 1864 and centred largely on freshwater culture of the Salmonidae, principally trout, *Salmo gairdneri* and *S. trutta*. Although cultured fish form a very small percentage of the total fish consumption today, the increasing costs of capture fishing and the availability of modern culture techniques have increased interest in fish culture. Cage culture of salmonids has commenced, as has the culture of eels (*Anguilla* spp.), Murray cod (*Maccrillochella peeli*), golden perch (*Macquaria ambigua*), and chinook salmon (*Oncorhynchus tshawytscha*). Attention is now focused on the culture of warm-water fish, and there are plans to import the Nile perch (*Lates niloticus*) and to produce or import fingerlings of the sea bass or barramundi (*L. calcarifer*). Shellfish culture began about 20 years earlier than finfish culture, with the Sydney rock oyster (*Crassostrea commercialis*). Later, pearl oyster (*Pinctada* spp.) and mussels (*Mytilus* spp.) were farmed.

In recent years, the Pacific oyster (*C. gigas*) has been introduced for farming in the south, and now both species of *Crassostrea* are being laboratory raised. Experiments on the culture of various scallops and abalone (*Haliotis* spp.) are also under way.

Crustacean culture is a relatively recent development, but the freshwater yabbie (*Cherax destructor*) and the west Australian freshwater crayfish or marron (*C. tenuicollis*) are being farmed commercially. The experimental culture of various species of *Penaeus* has been successful and is now being tried on a commercial scale, and culture of *Macrobrachium rosenbergii* has commenced.

Experience in intensive culture has shown how vulnerable these industries are to the introduction of disease agents. The importation of live molluscs and crustaceans has long been prohibited except for scientific purposes, and, in 1977, imports of live salmonids and uncooked salmonid meat were also prohibited.

Australia is very dependent economically on its exports of animal and plant materials, which it has protected from imported diseases since early 1800 with a quarantine system. In 1979, a Senate Select Committee reviewed this quarantine system and recommended the early introduction of a system of quarantine for live fish. The recommendation was based on extensive evidence from Australia and overseas that not all aquarium fish remain in aquaria. Some exotic fish have escaped or were released and have become established in local rivers, replacing native species and posing a risk of disease introduction. The two most serious releases were the European carp (*Cyprinus carpio*) in cold waters and *Oreochronius mossambicus* in the tropics.

Now, only 505 freshwater aquarium species and marine fish can be imported under customs regulations. Food fish require a special permit.

Concern has been expressed about water in which fish are imported as a possible medium for the introduction of plant pests (e.g., *Salvinia* sp.) or snails that carry cercaria of human or animal flukes. Water can carry some serious human pathogens, notably *Vibrio cholerae* and *Salmonella typhi*, and these two organisms, which are not pathogenic for fish, can survive for up to 14 days in the guts of fish.

The overriding concern, however, has been the fear of introducing serious fish-disease agents such as the viruses causing infectious pancreatic necrosis and infectious hematopoietic necrosis or *Myxosoma cerebralis*. A survey of diseases already present in Australia (Table 1) indicated that protection against these agents was essential.

A total halt to all movements of fish, fish products, and water would be the only means of completely removing the risks of introducing these disease agents, but this step was not recommended by the Senate Select Committee. In fact, this type of approach is not practical except in emergencies. As long as there is a demand for fish, people will find a way to procure them. A ban would lead to large-scale smuggling without regard to the disease history of the fish or to the quality of water in which they are shipped. Furthermore, there is evidence that some people had planned to put exotic species into ponds or streams to farm and sell if a total import ban had been introduced. Finally, the entire fish industry relies on movement — movement of fingerlings from hatcheries to grow-out waters and of fish from catching areas to markets. The only realistic option was to establish a fish quarantine system that would minimize the risks of disease spread.

Not all diseases are regarded as equal for quarantine purposes. It is not particularly useful to quarantine for a disease that is widespread in both importing and exporting countries, although it may cause serious mor-

Table 1. Disease agents detected in Australia.[a]

Bacteria	**Fungi**
Mycobacterium sp.	*Ichthyophonus hoferi*
Vibrio anguillarum	*Saprolegnia* sp.
Aeromonas hydrophila	**Platyhelminths**
A. salmonicida (atypical)	*Gyrodactylus* sp.
Myxobacteria	*Dactylogyrus* sp.
Corynebacterium sp.	*Ligula* sp.
Protozoa	**Nematodes**
Trichodina sp.	*Eustrongyloides* sp.
Ichthyoboda necatrix	*Acanthocephala* sp.
Chilodonella sp.	**Arthropoda**
Eimeria sp.	*Argulus* sp.
Myxobolus sp.	*Lernaea* sp.
Myxidium sp.	**Mollusca**
Thelohanellus sp.	Glochidia
Ichthyophthirius multifillis	
Oodinium sp.	

[a]Disease surveillance of imported ornamental fish includes virological, bacteriological, and mycological examination of the liver, kidney, and spleen of 60 fish samples from each consignment; parasitological examination of 60 fish; histopathological examination of all organs of 30 fish as well as chemical analysis and visual inspection of the water.

tality at times. On the other hand, a disease absent in the importing country and widespread in the exporting country would be well worthwhile quarantining, although it may cause only low mortality or morbidity. Fish producers often operate on narrow profit margins, and a relatively small decrease in production can make the industry uneconomic. Some diseases are particularly important economically because their introduction can close markets for Australian fish in other countries.

In response to the committee's recommendations, the Australian government formulated a strict fish-quarantine system, which is expected to be implemented in 1983. The system includes several measures to ensure that the imports are approved species; that they are healthy; and that they are packed in clean water from a known source.

Because of the volume (10–12 million live fish annually) and the nature of trade (thousands of small consignments), it would be administratively impossible for the exporting authority in each country to sample and supervise the packing of each consignment. Further, many disease agents in fish do not express themselves before the stress of transport; consequently, they would not be apparent on visual inspection of consignments.

It was felt that the best guide to the health status of a consignment of fish is the health history of the farm of origin. The person in the best position to assess the health of fish is the farmer and exporter who examine the fish during packing and supervise the changes of water. Although this person would be tempted to view all of his or her products as fit for sale, a false assessment could mean the loss of customers and even livelihood. For this reason, the Australian system relies, in the first instance, on assessment and certification by the owner or exporter.

However, not all exporters have the facilities to ensure safe shipments, and, thus, the Australian system restricts imports to those from premises that have been inspected and recommended by an appropriate authority in the exporting country. In addition, the exporter must have each consignment statement examined and countersigned by the authority. In this way, it is hoped that opportunists and fringe operators can be discouraged and gradually eliminated from the fish-export business.

The proposed system also details requirements for packing and for the coding of fish to enable more rapid and thorough inspection at the airport of entry and to ensure that unsatisfactory shipments can be quickly traced to the source. On arrival in Australia, the fish bags will be examined by quarantine officers, many of whom have already been trained in fish quarantine. It will be the officers' duty to check the documents and examine the bags for:

- Prohibited fish species;
- Sick, dead, or overcrowded fish;
- Incorrect coding;
- Incorrect packaging;
- Dirty water; and
- Inclusions such as snails, plants, shrimp, etc.

After airport clearance, marine fish can be sold immediately, but freshwater fish must undergo a minimum of 14 days in quarantine. This period was stipulated because:

- *V. cholerae* and *S. typhi,* two important human pathogens, can survive in tropical fish for up to 14 days;
- Signs of disease agents that are tolerated by fish under normal conditions but that cause disease during the stress of transport can generally be seen within a week;
- Results from laboratory analysis of samples taken from fish consignments can usually be reported within 14 days; and
- There are no known tropical-fish diseases of sig-

nificance that require more than 14 days to become apparent.

A great deal of thought was given to the type of facility most appropriate for fish quarantine. At one stage, a single government-run facility was suggested, but this was opposed on the grounds of initial cost to the taxpayer as well as high running costs.

The Senate Select Committee recommended that importers be required, as a prerequisite for licencing, to provide quarantine facilities that comply with minimum standards and can be supervised by quarantine officers. Removing fish from the premises during quarantine or any other failure to comply with requirements could result in the deregistration of the premises and of the import licence.

Water is to be disposed of into the sewage system after pasteurization at 65°C for 30 min. This treatment was recommended because the temperature is lethal to most fish viruses, bacteria, and fungi as well as to plant spores, snails, human bacteria, metacercaria of flukes, and larvae of other parasites. Also, pasteurization has proved more effective than chemical or ultraviolet methods of sterilization.

The proposed system relies very much on the establishment of a close working relationship with authorities in exporting countries. The full details of any diseases or prohibited materials detected in fish or in the transport containers on arrival or during the course of laboratory surveys would be given to the exporting authority so that measures could be taken to rectify the problem and protect their export markets. We believe that, over the years, this system of information exchange between countries will become the key to fish quarantine.

5. OPENING ADDRESSES

ABDU RACHMAN, DIRECTOR GENERAL OF FISHERIES, JAKARTA, INDONESIA

It is indeed an honour for me to have this special opportunity to deliver a keynote address at the opening ceremony of this fish-quarantine workshop, in Jakarta, the capital city of Indonesia.

I am particularly pleased to say that this workshop is not the first activity in which IDRC and the Government of Indonesia have cooperated. I recall that, in 1976, a research project on the fish parasite *Lernaea* was conducted in Java and Sumatra, and IDRC extended technical assistance to the government through the Directorate General of Fisheries. This activity was followed by a workshop on fish diseases, held in 1978, in Bogor, also supported by IDRC.

Unlike plant and animal quarantine, fish quarantine is quite new in the lexicon of Indonesian fisheries. Some people regard it as inappropriate; they reason that fish quarantine could be covered by the long-existing plant- or animal-quarantine services.

I do not intend to argue with this opinion, but, by presenting you the outlook of Indonesian fisheries and several aspects of its development, I believe it is clear that ignoring the presence and the importance of fish quarantine could lead to an undesirable outcome.

As an archipelagic state, 70% of the Indonesian territory is covered by water masses, both marine and fresh water. On the inland water side, there are nearly 1.4×10^6 ha of open waters (natural lakes, rivers, reservoirs, etc.). Aside from this, there are about 5.0×10^4 ha of freshwater aquaculture ponds and 1.9×10^5 ha brackish-water ponds. Open waters have a potential production of 6.9×10^5 t/year, whereas freshwater aquaculture and brackish-water ponds respectively produced 2.2×10^5 t and 1.03×10^5 t in 1981. Total fish production in 1981 was 1.869×10^6 t, and, of this, 4.8×10^5 t came from inland fisheries, or 25.7% of the whole production. These figures show that the role played by inland fisheries in Indonesia is outstanding.

With a population of 150 million, the yearly per-person consumption of fish (12.4 kg) is far below the projected target (22.5 kg). Thus, Indonesia is working to increase fish production as well as consumption as one of the main objectives in the first to the current (third) 5-year development plan.

All reasonable efforts will be exerted to achieve a higher fish production, both intensive and extensive, in both marine and inland-water fisheries. Particularly in aquaculture, considerable efforts are under way to improve cultivation and breeding procedures and to introduce new techniques and methods.

A rapid development in aquaculture could be achieved if one could guarantee that the fish were free of disease and other harmful organisms. In Indonesia, there have been numerous cases, in which imported living organisms have inflicted or have been suspected of causing serious harm to freshwater and cultured fish; for example,

- *Lernaea* parasites caused tremendous losses in cultured fish; in 1970, in Java alone, 30% of fry production of common and Java carp died. Similar losses also occurred in north Sumatra in 1971;
- In late 1980, an unprecedented outbreak of bacterial disease occurred in west Java, causing the deaths of 125 t of common carp, and infection in nearly 500 t. Later, a thorough examination indicated that this disease was caused by *Aeromonas* sp. and *Pseudomonas* sp.
- More recently, piranha and electric eel were discovered in aquaria and are believed to have been brought from abroad by someone who did not know the danger involved if the fish were released into open waters.

These cases show that, in the past, Indonesia has lacked controls on internal and international transportation of live fish. It is well accepted that the most effective means of controlling the spread of fish diseases is quarantine. Given the potential of the country's inland fisheries, which must be protected, and the ever-present threat from fish parasites and diseases (caused mainly by the increasing traffic of live fish), Indonesia's establishment of a fish-quarantine setup was not only inevitable but also long overdue.

At present, fish quarantine in Indonesia is at a preliminary stage. An agricultural quarantine law, which covers plants, animals, and fish, has been proposed by the government to be endorsed by Parliament. This law is a prerequisite for proper quarantine measures, although fish quarantine has been performed in six major ports of entry since 1975, executed by provincial fisheries services and supervised by the Directorate General of Fisheries.

Concomitant with the proposed agricultural quarantine law, the Directorate General of Fisheries took several steps, all intended to improve quarantine measures, i.e.:

- Proposing a fish-quarantine organization, which, unlike the present scheme, would be a single national body responsible for fish quarantine;
- Completing a fish-quarantine manual, to be used by quarantine personnel in their routines;
- Providing fish-quarantine stations with laboratory equipment and other facilities; and
- Providing fish-quarantine training to personnel.

It seems to me that an ideal quarantine system requires many things, and establishing the ideal would be time-consuming.

It is of great interest to me that this workshop, attended by representatives of neighbouring countries, could produce results to be used not only by Indonesia but also by other participating countries, and I do hope that, through this workshop, all the countries can cooperate more closely, especially with regard to fish quarantine.

Again, at this special occasion, it is my pleasure to wish all of you successful discussions, and I hope that you will enjoy your short stay in metropolitan Jakarta. Herewith, I officially declare the workshop open.

M. UNAR, AGENCY FOR AGRICULTURAL RESEARCH AND DEVELOPMENT (AARD), JAKARTA, INDONESIA

On behalf of the Director General of AARD, first of all I would like to express my warmest welcome and deepest appreciation, particularly, to my colleagues from the Asean member countries, the UK, Australia, and international agencies for their participation in this fish-quarantine workshop.

Indonesia is very happy to have you here, though only for a very short period, to discuss problems related to fish quarantine — a subject of worldwide importance because of the accelerated international traffic of imports and exports of live animals.

As fish has long been a cheap animal protein for food for Indonesia's people, development of aquaculture has been given high priority. Aside from the existing 1.8×10^5 ha of tambaks, 4.0×10^4 ha of freshwater ponds, 8.0×10^4 ha of fish culture in paddy fields, and about 11 ha of cage culture, Indonesia has about 3.6×10^6 ha of mangrove swamps, 4.5×10^6 ha of irrigated paddy fields, 13.7×10^6 ha of open waters, and 6.1×10^4 km of coastline that can be used for the industry.

Despite this great area with potential for development of the industry, aquaculture production has remained low. Although some intensive culture systems have high production potentials, these are exceptions. Several constraints that might be responsible for the low production include seed-supply shortages, environmental stress, disease agents, etc.

During the last few years, fish businesses, especially in ornamental fish and in fish seed, in Indonesia have increased markedly. Consequently, the traffic of live fish both intra- and internationally has grown, with concomitant risks of disease introduction and spread.

In 1970, an epizootic of *Lernaea cyprinacea*, which was accidentally introduced into Indonesia from Japan, caused heavy losses in the production of freshwater fish fry of common carp, java puntius, giant gouramy, etc. A total loss of 1.48 billion fry, valued at 7.4 billion rupiahs occurred during the epizootic. This was only one incident that prompted the development of control measures under the fish-parasites research project supported by IDRC. During the project, a number of new myxosporidian parasites, which caused serious fish kills of common carp seed, were detected.

Again in 1980, a disease outbreak occurred in west Java, which killed 125 t of fish, including 30% of the existing brood stock of common carp. An estimated total loss of 30 billion rupiahs occurred in 2.3 months. Although fish mortalities caused by the disease have decreased, the disease is now established in the country and, since 1981, has also been responsible for mortalities among catfish. Great efforts were made to suppress the disease outbreak through a national program in which AARD was made responsible for the study of the mode and behaviour of the disease, aspects of diagnosis, therapy, etc. As a result, a number of techniques of control were encouraged, for which only 25 million rupiahs were spent.

There are many dangerous fish-disease agents that have not been found in Indonesia and that are serious threats to the fishery resources, especially as the quantity and the frequency of imports of several species are increasing considerably.

Therefore, positive steps to prevent the introduction of such disease agents have been taken with the establishment of a fish-quarantine service in the main ports of entry. In 1980, AARD implemented the Post-of-Entry Quarantine Service in Jakarta to pioneer and support the quarantine service, which is under the Directorate General of Fisheries.

From this meeting, the Indonesian government is expecting in-depth discussions and exchange of ideas and experiences to provide important input to the implementation of a sound and good fish-quarantine system. May this seminar produce positive and applicable suggestions and recommendations. To the International Development Research Centre and the FAO/UNDP South China Sea Fisheries Coordinating Program, I wish to express my appreciation and gratitude for sponsorship of this meeting. I am confident that the result will benefit aquaculture development in this region, especially in Indonesia. I would like also to express my gratitude to the local organizing committee for the efforts made to make this seminar successful.