

PNG/85/001  
Field Document Number 12/b  
March, 1990



PAPUA NEW GUINEA

Sepik River Fish Stock Enhancement Project  
PNG/85/001

Phase one final report and recommendations

PART 2 - Fish species suitable for stocking  
and stocking strategies

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Rome, 1990

This report was prepared during the course of the project identified on the title page. The conclusions and recommendations given in the report are those considered appropriate at the time of its preparation. They may be modified in the light of further knowledge gained at subsequent stages of the project.

The designations employed and the presentation of the material in this document do not imply the expression of any opinion whatsoever on the part of the United Nations or the Food and Agriculture Organisation of the United Nations concerning the legal or constitutional status or any country, territory or sea, or concerning the delimitation of frontiers.

## SUMMARY

(1) This report details some species of fish considered appropriate for stocking the Sepik/Ramu Rivers.

(2) Fishes thought suitable for introduction have been divided into three categories: Category A (species whose introduction is recommended); Category B (species that are thought to be of particular interest which are presently being evaluated in detail); and, Category C (interesting species with longer-term potential). Only category A species are presently recommended. All other species under consideration are to be evaluated further by the project before it is prepared to recommend their introduction. Brief details of some of the category B and C species are given in order to illustrate the various options being evaluated.

(3) At present only three species are recommended (category A). These are the introduction of Tilapia rendalli and the transfer (within PNG) of Osphronemus gouramy and Trichogaster pectoralis. Each of these species has been subject to an in-depth evaluation of their potential effects and the justification for their introduction in-line with procedures adopted under the code of practice adhered to by the project.

(4) Proposals and justifications for each of the three recommended species were reviewed by the independent project Advisory Group. The consensus of opinion of the Advisory Group was generally supportive of all three recommendations.

(5) One Advisory Group member (out of seven) mentioned certain criticisms of the proposed introduction of T. rendalli which are included for PNG to consider further. A number of Advisory Group members remarked that the introduction of O. gouramy was perhaps less justifiable on the grounds of its possible low impact upon fisheries in the region.

(6) All three recommended species are considered approved for introduction through necessary procedures under the code of practice. However, PNG should consider whether to proceed with these introductions based upon comments received from the Advisory Group and further deliberation upon these by the project.

(7) Full details of all three present recommendations are included in the text, together with copies of all responses and comments received from the Advisory Group.

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## 1. INTRODUCTION

This report presents conclusions and recommendations arising from phase one of the Sepik River Fish Stock Enhancement Project. This report is divided into three sections:

- Part 1 - Recommendations relating to stocking and options to stocking
- Part 2 - Species suitable for stocking and stocking strategies (this document)
- Part 3 - Annex. Containing copies of all supplementary information and reports

Part 1 of this report discussed the question of whether or not PNG should embark on a stocking programme in phase two of the project. Subject to PNG approval of this option, in consideration of opinions expressed by the project Advisory Group (see Part 1), this report details those species of fish which are considered to be appropriate for introduction and how they should be introduced if accepted by PNG.

Throughout the consideration of fish introductions the project has been guided by adherence to a code of practice regarding fish species transfers. The current code adopted is outlined by Turner (1988) and this process was explained in more detail in Part 1 of this report.

One recommendation arising from Part 1 of this report was that PNG initiate a stocking programme whilst continuing to follow the code. As such, recommendations provided in the present report should be viewed by PNG in the light of opinions expressed by the Advisory Group which are included as an annex to this document.

## 2. BACKGROUND INFORMATION

In the interests of brevity, much of the recommendations and suggestions made here assume familiarity with the supporting information as supplied in Part 3 of this report. In particular, knowledge of the following supporting documents is essential in appraising the recommendations made here:

- (1) Coates (1989a) - reviewed the present distribution and ecology of fishes inhabiting Sepik/Ramu floodplains and identified those trophic niches and habitat types considered to be presently vacant or under-utilised.

(2) Van Zwieten (1989a, 1989b, 1989c, 1989d) - described studies on the fish fauna presently inhabiting Sepik/Ramu tributary streams and identified the types of trophic niches considered to be vacant or under-utilised at various altitudes and those considered to be most appropriate for stocking.

(3) Coates and Mys (1989) - detailed the present population distributions of people living within the Sepik/Ramu catchments and identified those areas where stocking is required in terms of the needs of the people. That report also lists vegetation types occurring.

(4) Coates (1989b), Dudgeon (1989a, 1989b) and Coates et al. (1989) provide additional data on Sepik/Ramu freshwater environments.

Other supporting information is referred to as necessary.

### 3. PROCEDURE

Only a brief outline of the reasoning for considering or recommending certain species is presented in the body of this report. Where species are actually recommended for introduction a full evaluation of the recommendation is provided for each in the annex of this report. Such recommendations should be viewed in the light of comments arising from the Advisory Group. Official comments from the Advisory Group are not required until a species reaches "recommended" status; although the group actively corresponds with the Chief Technical Adviser during this process.

The selection of species suitable for stocking has been a lengthy process. There might be approximately 20,000 species of freshwater fish that one could think of introducing. This list has obviously been reduced to a manageable number. Where possible, species have been restricted to those:

- (a) with well-known habits,
- (b) in regular use either for stocking or aquaculture,
- (c) that are relatively easily obtainable,
- (d) that are somewhat easier to quarantine, handle and stock.

There are, however, a number of species under consideration that may not fit the above attributes ideally. These are presently included here as being under consideration but as yet these are not "recommended".

The project was initially designed as, in simple terms, - phase one (evaluate fish introductions), to - phase two (introduce fish). It has, however, become more logical to begin stocking in phase two with a few appropriate species whilst continuing to appraise other species for possible introduction at a later stage. Two reasons account for this:

(1) after the considerable amount of effort undertaken in research during phase one of the project (and by other people before that) it was considered inappropriate to then, perhaps, negate that work by recommending species too hastily. This particularly applies to lower order (tributary) rivers and streams where most background information was not formulated until very recently. It was considered particularly important that the project Advisory Group have more time to consider such areas based on information only recently provided to them; and

(2) the facilities and staff available for stocking fish in PNG are obviously limited. In view of this, it made sense to select a moderate number of the more easily handled species and, whilst these were being dealt with, to evaluate other species further and plan their introduction as "recommended" species at a later date. The project considers it highly advantageous that as much time as possible is spent evaluating species before they are recommended, provided that this does not infringe greatly upon development and PNG's intended stocking programme.

The recommendations arising here are considered sensitive to the above factors and a rational way of proceeding with stocking.

In order to clarify present considerations, species of fish being investigated for their potential for stocking have been divided into three categories:

Category A - species considered appropriate for stocking immediately at the start of phase two of the project. These are in effect those species presently "recommended" and on which the Advisory Group have been asked to provide their official opinions.

Category B - species considered highly appropriate for introduction but which the project considers should be subject to further evaluation and investigation. These are

species which are sometimes less well-known, not in common use for stocking or aquaculture, or with which there may be difficulties with quarantine which need to be solved before they can be recommended. Certain of these are very close to "recommended" (Category A) status and could be fairly rapidly evaluated and stocked (if approved) as necessary.

Category C - species with interesting potential which are presently undergoing further evaluation.

Only category A species need to be appraised here, since these are the ones actually recommended for stocking. However, brief details of species presently in categories B and C are included here in order to illustrate the options presently being considered. Category A species are subject to a full description and evaluation in the annex of this report. Such more detailed appraisals will be undertaken for each of the other species moved into category A status.

Fish species suitable for stocking depend somewhat on PNG's objectives and priorities in terms of stocking. The following list is flexible and can be modified according to PNG's requirements, provided Category A species are evaluated as recommended under the code.

#### 4. SPECIES OF FISH CONSIDERED APPROPRIATE FOR STOCKING

##### 4. 1 Floodplain regions

Part 1 of this report detailed certain problems concerning stocking Sepik/Ramu floodplains. Stocking floodplains might be considered to be aimed at the development of a more commercially orientated fishery based on improved fish stocks. There are, however, socio-economic limitations. Part 1 of this report should be consulted for further details but the conclusions reached were that a compromise be taken in terms of stocking proceeding slowly. Part 1 of this report also recommended that PNG advise the project on its aspirations in terms of the long-term development of the Sepik/Ramu floodplain fishery. The following list of species is presented on the assumption that PNG agrees with the sentiments expressed in Part 1 of this report and is satisfied with the comments arising from the Advisory Group in these respects.

Coates (1989a) has listed the feeding resources and habitats considered to be vacant or under-utilised in Sepik/Ramu floodplain regions. The following species are considered appropriate for stocking:



(1) Tilapia rendalli CATEGORY A (full evaluation undertaken in the annex to this report)

Redding (1989) has undertaken a review of the present Sepik/Ramu tilapia fishery which is based upon the introduced tilapia - the "Mosambique mouthbrooder", Oreochromis mossambicus. This species is highly productive in the Sepik/Ramu floodplains, by Sepik/Ramu standards, and highly esteemed by local people. The present tilapia, however, feeds extensively on algae and detritus, "mud" etc. The introduction of other species of tilapias feeding on different food sources is, therefore, logical. There is a considerable problem, however, of possible interbreeding between the present tilapia and any other species of Oreochromis introduced, with unknown consequences. However, fish of the genus Tilapia are not expected to interbreed with O. mossambicus. Tilapia rendalli is selected because of its appropriate size and the fact that it feeds extensively on plant material including aquatic macrophytes and emergent vegetation. This food resource is considered to be under-utilised in Sepik/Ramu floodplain regions.

Tilapia rendalli also has the considerable advantage that it is easy to obtain, quarantine, breed and stock.

Further evaluation of this species is undertaken in the annex to this report.

(2) Giant gouramy (Osphronemus gouramy) CATEGORY A (a full evaluation undertaken in the annex to this report)

The giant gouramy feeds extensively on vegetation and fruits. This species is also capable of breathing air and is intended to utilise vegetable resources available primarily in Sepik/Ramu backwaters that may suffer oxygen depletion. No present Sepik/Ramu species are tolerant of oxygen deficient waters. The giant gouramy also builds nest from "bubbles" it produces at the surface and its breeding habits are considerably different to those of all of the existing species.

The giant gouramy also has the considerable advantage that it occurs in PNG already and can be found in water bodies in the vicinity of at least Port Moresby and Lae. Hopefully, stocks can be obtained from these sources. It is widely used in aquaculture.

(3) Snakeskin gouramy, Trichogaster pectoralis CATEGORY A (full evaluation in annex to this report)

As per the giant gouramy (above) this species will tolerate deoxygenated waters and is a surface nest building species. The snakeskin gouramy, however, primarily feeds on epiphytic algae (etc.) and zooplankton. It is also widely used in aquaculture.

The species has been introduced into PNG before and populations are reported from Central and Gulf Provinces of PNG; although project staff have never seen such since they do not sample there. In theory, stocks can be obtained from within PNG.

(4) Nematalosa sp CATEGORY B

Nematalosa sp occurs in rivers in southern PNG and northern Australia (where it is referred to as the "bony bream"). Nematalosa sp accounts for a high proportion of fish catches from the Fly River (Hortle 1986) and feeds on a variety of invertebrate fauna and larger forms of detritus. It is considered to be mainly a river and lake dweller and does not inhabit floodplains as such but is considered appropriate for rivers and lakes in floodplain regions. The fish might also be expected to ascend tributary rivers to a limited altitude thus increasing fish stocks in such regions. The fish has a high fat content and may, therefore, be appropriate for improving dietary fat amongst the Sepik/Ramu people (further details in part one of this report). In Australia, a certain degree of expertise exists in handling and stocking this fish; it is stocked into reservoirs where it is used as a forage fish for predators. The fish was previously bred and stocked from Walkamin Research Station, Department of Primary Industry, Queensland.

In view of this being one of the few species within the Australasian region thought suitable for stocking the Sepik/Ramu, its further consideration is given a high priority. The project is presently in the final stages of evaluating this fish and seeking comments from the Advisory Group regarding its suitability. The project considers that it may be appropriate to approach the Department of Primary Industry in Queensland to ascertain their views on the possibility of transferring this fish from Australia to PNG which would be much easier than obtaining stocks from within PNG.

(5) Anabas testudineus CATEGORY B

The "climbing perch" (A. testudineus) is considered primarily insectivorous although possibly having supplementary predatory habits. Being an anabantid, like the

gouramies, it is expected to be able to tolerate deoxygenated waters in floodplain regions. The species is particularly interesting because it has already inadvertently appeared in rivers in southern PNG. It is believed to have entered PNG from Iran Jaya where it was introduced from Java in which region it is native and cultured. It is possible that the species may enter the Sepik/Ramu system inadvertently anyway; not that this factor alone justifies its purposeful introduction. This species has the considerable advantage that it would be possible to investigate populations in PNG's southern rivers and evaluate its feeding behaviour and ecology under New Guinea conditions before possible introduction into the Sepik/Ramu. In view of this, the project is attempting to stimulate research on this species in southern PNG.

(6) Puntius gonionotus (CATEGORY B) is an important fish in certain rivers in Asia, such as the Chao Phraya in Thailand. It feeds on submerged higher plants, inundated land plants, fruits and seeds. It spawns in the middle of channels and does not seem preoccupied as to where the fertilised benthic eggs lodge. Its adhesive eggs stick to submerged live or dead plants, sand or gravel. It spawns at the start of the rainy season, when rivers are in flood. Parent fish are at least one year old and 250 mm long. Under aquaculture conditions, six to ten fish are needed to obtain a good seed production. Eggs will hatch two to three days after fertilisation. This species might be suitable for introduction into floodplain areas in order to utilise vegetable food resources in river channels. It has established breeding populations in a river in Fiji.

(7) Prochilodus sp CATEGORY B

Prochilodus spp are fine detritus feeders found in rivers in South America. They account for up to 60% of fish catches from river channels in some regions. Further details were provided by Coates (1989a). Detritus is considered to be the major under-exploited resource presently available within the Sepik/Ramu and it is considered a high priority to determine which species would be appropriate to fill this gap. Prochilodus spp might be expected to live predominantly in river channels. The two present detritivores, common carp, Cyprinus carpio, and tilapia, O. mossambicus, both predominantly utilise floodplains. In addition, Prochilodus spp can undertake migrations, in large schools, from floodplain regions into tributary rivers at higher elevations. As such, the species may be extremely useful in increasing fish supply to such regions via the movement of, self-propelled, protein sources produced at lower altitudes to regions where there may be a greater shortage of fish.

The fish grows rapidly, is highly productive and has good eating qualities. Several factors delay the project from placing this fish as category A:

(i) there is presently discussion concerning which species is appropriate. There are a number of species throughout S. America. In addition, it is known that different stocks of the same species have different habits - particularly concerning their migrations within river systems;

(ii) the species is not used extensively in aquaculture and there is limited experience with stocking it. However, interest in these fields is increasing and research is presently underway in a number of countries; and,

(iii) the species may present difficulties with quarantine since it is likely that the importation of eggs and rearing broodstock under quarantine conditions in PNG would be very difficult to undertake.

A number of people within FAO, on the Advisory Group and elsewhere are familiar with and appreciate the advantages of this fish. It is considered a high priority to investigate the possibilities of this species further. The project will undertake this during the course of phase two of the project.

#### (8) Other species CATEGORY C

Coates (1989a) noted the need to consider species of fish adapted to eating allochthonous material, particularly fruits, seeds and leaves, entering higher-order rivers from forests. In this respect other species of Puntius, Asian carps, and the Amazonian Colossoma (Peiractus) spp are under consideration. The latter are particularly interesting, being important food fishes in the Amazon and feeding almost exclusively on fruits, berries, seeds and nuts falling into the water from floodplain forest. The particular advantage of this group is that they are highly specialised and occupy a feeding niche totally vacant amongst the existing Sepik/Ramu fish fauna. Unfortunately, Colossoma spp may be difficult to transport and introduce although aquaculture using these species is now in an experimental stage. Species of Labeo from Asia and Africa are also interesting as they offer opportunity to exploit riverine detritus resources and may be alternatives to Prochilodus should the latter prove too difficult to transfer.

#### 4. 2 Non-floodplain regions

Details of existing fish stocks and fisheries in lower-order tributary rivers and streams in non-floodplain regions have only recently become available. However, a considerable body of information is now available enabling the project to evaluate species with potential for stocking such regions. Before species are recommended for introduction it is considered appropriate that the Advisory Group be given further time to deliberate on the information provided to them. In addition, it is recommended that the project make further comparisons between Sepik/Ramu non-floodplain environments and similar environments elsewhere, especially in Asia, and the species of fish they contain that are of use for fisheries. Such a process is not anticipated to cause overt delays in fish stocking in phase two since the Category A species (mentioned above) would occupy project and the Department of Fisheries and Marine Resources staff adequately during the early stages of phase two of the project. It is considered necessary, however, to have a list of at least three or four Category A species for such regions by about mid-1990.

Non-floodplain habitats are divided into two categories here; mid-altitude regions (middle order rhithronic rivers) and highlands regions. All of these regions present particular problems in terms of stocking as it may be difficult for fish to move from one area to another since they may not be able to tolerate conditions in lower reaches; through which they must pass in order to colonise adjacent areas. Solutions to this include multiple stockings over a wide area and providing fingerlings from hatchery facilities that can be collected by, or delivered to, institutions and groups throughout the catchment. For example, good use of the Department of Agriculture and Livestock, Church and School facilities might be made.

##### 4. 2. 1 Middle order rhithronic rivers (altitudes from about 300 to about 1000 m)

Stocking such regions, technically, presents PNG with less of a problem than in highlands regions. There is, in theory, a greater choice of species for such areas. Water temperatures are within the approximate range 19 to 24 °C and, consequently, existing facilities at the disposal of the Department of Fisheries and Marine Resources, and those established for stocking Category A species for floodplain regions might be utilised for a number of species.

Coates and Mys (1989) note that this region is particularly sparsely populated by people, especially from

500 to 1000 m. There are, however, still in the region of 150,000 people living there. Habitats are almost entirely rhithronic rivers bordered extensively by well developed forest. Fish distributions in such regions and the ecology of the species occurring have been reported by Van Zwieten (1989a, 1989b, 1989c, 1989d). Conclusions reached are that stocking such regions should concentrate on species with well-defined and specialised habits, particularly species feeding on:

(a) auwfuchs, including algae, on the surface of rocks etc., especially in wider rivers with un-shaded sections;

(b) detritus feeders destined for quiet pools where detritus accumulates, or species feeding on organic sediments amongst rocks and pebbles in areas of greater water flow; and

(c) especially species feeding on allochthonous inputs of fruits, seeds, berries, nuts and leaves (etc.) raining onto the waters from the extensive forest cover.

A range of Asiatic carps, for example, Puntius gonionotus, Acrossocheilus sp., Leptobarbus sp, Tor sp and Labeo sp seem appropriate for further consideration. Puntius gonionotus (Category B) is particularly interesting in view of it being widely used in aquaculture. This species has been brought to PNG before for use in experimental ponds at Aiyura but was not distributed to natural waters (for unknown reasons) or did not survive at that time.

Misgurnus anguillicaudatus is also a possibility for further consideration. This species has formed wild populations in Australian rivers via escaping from aquaria or ornamental fish ponds. Further investigations are underway but it appears that the species is capable of inhabiting streams in Victoria and the Australian Capital Territory (around Canberra) and can, therefore, tolerate reasonably low temperatures. It is not known to have any detrimental environmental effects in that region.

#### 4. 2. 2 Highlands regions (above about 1000 m)

This region will present the project with the greatest difficulties in terms of stocking. It is, however, the most important region for stocking in terms of subsistence protein supply. 397,968 people inhabit the Sepik/Ramu catchment above 1000 m elevation (Coates and Mys 1989). Stocks of native fish species in these regions are presently negligible (Van Zwieten 1989a). The major areas for potential stocking are medium to small rhithronic rivers to higher altitude streams, all with good water quality. Waters

are generally clear, well oxygenated (Coates *et al.* 1989), with copious sources of potential invertebrate food sources for fishes (Dudgeon 1989a, 1989b). Water temperatures range from about 20°C down to less than 10°C. However, few people live above 2500 m elevation where temperatures lower than about 12 to 14 °C occur. About 50% of the potential habitats for fishes, in regions where people live, are rivers flowing through forest and the remainder are rivers flowing through open grasslands. Major food sources for introduced fishes would, therefore, be:

(a) invertebrates, especially aquatic insects in all water bodies. Note, however, that most species of fish presently living at lower altitudes feed almost exclusively on this food source. Care must be taken if insectivorous fish introduced at higher altitudes were to descend into lower reaches because their effects on existing fish stocks below about 1000 m would then need to be considered;

(b) algal grazers feeding on algae (etc.) covering substrates in un-shaded grassland rivers;

(c) species feeding between rocks and on benthic food sources other than invertebrates; and

(d) species feeding on allochthonous materials entering rivers from forested areas.

A considerable problem in determining species suitable for such regions has been the general lack of knowledge on stocking fish, other than trout, in coldwaters in the tropics. Two species are presently under detailed consideration:

(1) Rainbowtrout, Salmo gairdneri CATEGORY B

Rainbowtrout are already part of stocking practice in PNG and established stocks of this species are known to already occur in several highlands regions within the Sepik/Ramu catchment. Coates (1989c) has reviewed the current situation. Trout stocking in PNG has apparently had minimal impact on fish production and trout have not proliferated in the highlands. This may be due, in part, to PNG utilising trout that are regarded as cold-water stocks. It may be possible to considerably improve upon the benefits of trout stocking in PNG by obtaining stocks from a different source that are adapted to warmer waters. This also has the advantage of promoting stocks at lower altitudes in highlands regions where a considerably larger number of people occur. It is highly likely that previous trout

introductions may have produced fish populations at altitudes where no people occur within the Sepik/Ramu.

Trout have the considerable advantage of being particularly easy to obtain and stock. This is, presumably, why they are part of existing fish stocking practice in PNG. Trout are, however, one of the few species of fish with proven detrimental environmental effects. They are known to have displaced a number of native species in other regions and are predatory in nature. Within the Sepik/Ramu this factor is considered less relevant because negligible stocks of fish occur in regions where trout would be expected to establish. However, it is a major concern of the project that to increase trout stocking in the Sepik/Ramu, by for example selecting a more appropriate strain, may jeopardise further fish stocking options for this region. It is for this reason that trout are presently placed in Category B awaiting further deliberation on this matter.

(2) Snowtrout, Schizothorax sp CATEGORY B

Snowtrout are cyprinids (carps) occurring in mountainous regions of Asia; particularly the Himalayas. They live in regions of the Himalayas remarkably similar to PNG highlands (Coates, personal observation). Snowtrout have several potential advantages over salmonids, i.e. "conventional trout", in particular:

(i) they have sub-terminal mouths and feed extensively on plant material, especially algae grazed from rocks and boulders;

(ii) they are not predatory;

(iii) their temperature tolerance is much broader than that of salmonid trout and they can occur in fast flowing rivers with water temperatures as high as at least 24.0 °C but also lower than 11.0 °C (= 2500 m and above). In effect, they are much more suitable for the water temperature ranges available in Sepik/Ramu catchments than are salmonid trout. This factor means that they would possibly disperse more widely than salmonids, making stocking easier, and be available to a much larger percentage of the highlands population.

Salmonid trout are, however, known to displace snowtrout in areas where the former have been stocked. For this reason a full evaluation of the usefulness of salmonid trout must consider the possible impacts on snowtrout utilisation, as mentioned above.



The project has established a considerable database on snowtrout. At present, snowtrout are considered to be much more appropriate for PNG conditions than salmonids. The following problems, however, are presently being investigated:

- (a) there are a large number of species and considerable differences exist between these in terms of their altitudinal preferences and breeding requirements;
- (b) snowtrout are not well studied, by comparison to trout, in terms of hatchery and breeding techniques required to stock these fish under PNG conditions, although expertise with these fish is available in other countries; and
- (c) quarantine considerations relating to snowtrout are yet to be determined.

In view of the importance placed by the project on stocking highlands regions of the Sepik/Ramu it is considered a priority to obtain an attractive alternative to salmonids for stocking, in particular snowtrout. It is hoped that the project will be able to finalise its searches by early 1990 and present a concise recommendation in this respect.

#### (3) Other species CATEGORY C

A number of other interesting alternatives exist which are presently being investigated. Certain minor carps such as Labeo dero, Crossocheilus sp and Garra sp offer possibilities. The "mahseers" from the Himalayan region are particularly attractive, for example, Acrossocheilus hexagonolepis and Tor sp., although certain of the Tor sp might be discounted because of a tendency towards predation.

#### 5. STOCKING STRATEGIES

Stocking strategies and facilities required during phase two of the project depend very much on the species selected. Where possible, species with characteristics of ease of handling and low costs of introduction have been selected. For the three species presently recommended for introduction adequate facilities exist already within PNG which can be modified and upgraded utilising existing project funds. Several of the Category B species under consideration could also probably be stocked in this fashion, at least for floodplain and mid-altitude regions. Details of how this is proposed to be undertaken will be provided in a separate report.

However, there is a need for PNG to consider its present capabilities of fish stocking in coldwater regions in the highlands. A number of trout farms presently exist within PNG that could be utilised for fish breeding and rearing for stocking alternative species to trout. Unfortunately, none of these are within the Sepik/Ramu catchment and non are suitable as quarantine stations. Recommendations and costings for stocking highlands regions will also be provided in a separate report.

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## ANNEX ONE

CATEGORY A SPECIES RECOMMENDED FOR  
INTRODUCTION AS OF MARCH, 1990

(Note: as outlined above, this list will be extended during the course of phase two of the project).

In order to quantify responses of Advisory Group members they were given a list of possible answers to various questions relating to each species recommended for introduction. Copies of these "opinionaires" are attached together with responses from group members. In addition, group members were asked to provide any additional comments they wished relating to the matters under consideration. Copies of these are appended to this report.

As far as possible, the project has followed recommended procedures under the code of practice (Turner 1988) in compiling these opinionaires. It was found, however, that several questions recommended in opinionaires (Turner 1988) were inappropriate in this instance, for example "is the organism safe from over exploitation in its native range". Should the attached opinionaires not cover topics adequately, the advisory group members have the option of raising additional points as comments appended to their responses.

All three of the presently listed recommendations are species destined for Sepik/Ramu floodplain regions. Only one, Tilapia rendalli, is in fact a new introduction to PNG. The other two, Osphronemus gouramy and Trichogaster pectoralis, already occur in PNG and the project recommends their transfer within PNG to the Sepik/Ramu. Despite this fact, the project advises it would be appropriate to consider these latter two recommendations in the same way as if they were new introductions.

The following recommendations are made on the assumption that PNG agrees with the factors outlined in part one of this report in relation to the rationale for stocking Sepik/Ramu floodplains:

## RECOMMENDATION NUMBER ONE

THE INTRODUCTION OF TILAPIA RENDALLI INTO SEPIK/RAMU  
FLOODPLAIN REGIONS.1. Data sources

The following is a brief summary of detailed information provided primarily in Coates (1989a), Redding (1989) and ancillary information provided in Part III of this report. Familiarity with this information is assumed in the following presentation.

2. Justification

To increase fish stocks in Sepik/Ramu floodplain regions in order to alleviate fish protein supply problems and improve stocks upon which longer-term commercial fisheries can develop as explained further by Coates (1989a) and in Part 1 of the present report.

3. Intended habitat/resource utilisation

As a macrophyte feeder for oxygenated waters in Sepik/Ramu floodplain regions, including lakes, backwaters and swamps. Further details are provided in Coates (1989a) and Redding (1989).

4. Anticipated range of establishment

Primarily floodplain regions to an altitude of about 100 m. There is a possibility the species may extend its range into lower sections of tributary rivers at the edge of the floodplain belt. This is unlikely since aquatic macrophytes are limited in such regions. The existing tilapia, Oreochromis mossambicus, enters such regions but is stunted there. T. rendalli is not expected to enter salt- or brackish-waters.

5. Anticipated interactions with existing fish stocks

## 5. 1 Native species: - minimal.

There are no macrophyte feeding fishes within the river system, or elsewhere in Papua New Guinea. T. rendalli is a nest builder in floodplain regions of rivers and shallow sections of lakes. Amongst the native fishes only the plotosid catfishes, Tandanus spp, construct nests in this fashion. T. novaeguinae is the only plotosid occurring in floodplain regions but its nesting sites are unknown. This species does not contribute significantly to the present

fishery in floodplain regions. T. novaeguinae also occurs in tributary rivers in non-floodplain regions which are considered to be its main habitat. All the other Sepik/Ramu plotosids are lower order river/stream dwellers at much higher altitudes.

Note, however, comments in section 10 on the possible consequential effects of overt macrophyte destruction by T. rendalli.

5. 2 Common carp, Cyprinus carpio: - minimal

5. 3 tilapia, Oreochromis mossambicus: - as discussed by Redding (1989)

T. rendalli is not expected to compete for food with O. mossambicus. There may, however, be competition for nesting areas as discussed further by Redding (1989) who also evaluates the possible consequences of this.

#### 6. Numbers of people potentially benefiting from its introduction

Approximately 155,976 people at altitudes below 100 m in the Sepik/Ramu catchment might have direct access to stocks of this fish (Coates and Mys 1989). Were the fish to be exploited commercially then a greater number of people within PNG in general might benefit. T. rendalli is also suitable for utilisation in the existing Sepik salted-tilapia fishery.

#### 7. Sources of stock

Through the Institute of Aquaculture, Stirling University, Scotland. This institution maintains "genetically pure" strains of this species or might be able to obtain suitable stocks for the project through their existing contacts. This source is recommended first because the Institute is also well equipped to undertake pre-shipment disease checks. Note: it is particularly important that the genetic content of tilapias brought to PNG be known in view of possible interbreeding with O. mossambicus. Such is unlikely with Tilapia rendalli but as an additional safeguard it is recommended that the genetic make-up of imported stocks, whilst under quarantine conditions, be confirmed before introduction into the wild.

#### 8. Quarantine procedure

Full quarantine procedures as recommended under the code of practice and as detailed by Turner (1988). Stocks obtained

from Stirling would be expected to be relatively "disease free" anyway. Nevertheless, full quarantine measures are still thought appropriate. In short:

- import eggs which are tested for diseases before shipment and subject to appropriate pre-shipment quarantine/disease control methods;
- rear broodstock and test for diseases under quarantine conditions (i.e. enclosed systems with no water escape and/or disinfection of waste waters etc.);
- introduce the F1 generation subject to satisfactory test results.

[NOTE FOR ADVISORY GROUP: the project intends to contract the services of fish disease specialists regarding quarantine procedures and money is allocated in the budget for this purpose. Quarantine controls in PNG are governed by the Department of Agriculture and Livestock, not the project or Dept. of Fisheries. The above, however, is how the project will advise quarantine authorities. No doubt project staff will undertake the quarantine activities but other departments will supervise this. Pathology labs. exist in PNG and other lab. work required can be sub-contracted to Australia or elsewhere. Due to these factors the project is unable at this stage to be entirely specific regarding quarantine and will be guided by other experts. For present purposes you should base your deliberations on the assumption that the minimum controls will be as recommended by Turner 1988. Any major deviations from this will necessitate us contacting the Advisory Group again for a second evaluation.]

9. Special note to the Advisory Group on T. rendalli versus T. zillii

Redding (1989) has suggested that T. zillii is an alternative to T. rendalli for introduction into the Sepik/Ramu for reasons as stated in her report. It is not feasible to suggest both be introduced and select either according to your comments. It has to be one species, or the other, or neither. To solve this problem you are asked questions relating to T. zillii in the attached questionnaire. Should a consensus prefer T. zillii then we will proceed with that species. In such a case T. zillii would be substituted for T. rendalli in this recommendation. All other factors in the recommendation would remain unchanged.

The following is provided for your information: the project does not consider that the relative size of the two species is an issue at present. T. zillii, although the much smaller of the two species, is adequately large to be



exploited by people living in the Sepik/Ramu for both consumption directly and/or for sale. Note is also made that preferences for either species generally refer to aquaculture situations and such considerations are not directly relevant to the Sepik/Ramu introduction. However, were T. rendalli to be considered a better aquaculture species (which is not the present purpose of its introduction) then it would, all other things being equal, be preferred; the reason being because it would cater for any desire PNG may have at a later stage to import T. rendalli for aquaculture purposes. It is for this reason that T. rendalli is recommended and your opinions on T. zillii as an alternative are requested and not vice versa.

This is a complicated question. Should group members feel unable to comment on the relative virtues of either species that option of response is listed. In the event of a limited response from group members making our evaluations in this respect difficult, the project will seek the advice of other experts in this specific field before proceeding.

#### 10. Special note to Advisory Group members on the introduction of T. rendalli

Redding (1989) has pointed to some potential dangers with the introduction of T. rendalli into the Sepik/Ramu. These are based on uncertainties regarding its effects on aquatic vegetation. Aquatic vegetation is not consumed by any other species of fish in the river. However, aquatic plants, particularly submerged stems of emergent macrophytes, are used extensively as a source of epiphytic algae and "auwfuchs" by O. mossambicus. Such effects are of less concern to the project since if there were drastic effects on O. mossambicus food resources then, presumably, there would need to be a considerable supplementary fishable stock of T. rendalli to compensate for this. O. mossambicus is itself an exotic species and effects on that species are only relevant when considering total fish resources resulting from introductions.

However, what is a more important question is the effect of T. rendalli on aquatic vegetation and consequential effects on aquatic plant invertebrate faunas and native species. The extent of utilisation of aquatic plants by certain native species for purposes other than food is unknown. The following information is provided to assist your deliberations further:

(a) few native species occupy floodplains. Only Glossolepis multisquamatus, Ophieleotris aporos and Oxyeleotris heterodon utilise floodplains and may be heavily dependent

upon them. G. multisquamatus is abundant on floodplains but prefers areas in marginal regions with turbid waters and is not utilised significantly in the fishery (it is too small). Both Ox. heterodon and Op. aporos occupy shallow floodplain primarily in areas of dense emergent vegetation cover. Op. aporos feeds extensively on invertebrates from amongst aquatic vegetation. Ox. heterodon feeds almost entirely on Op. aporos. Both of these gudgeons are presently important to the fishery. Both species also occur in areas where T. rendalli is not expected to establish significant populations, e.g. flooded forest. It is unlikely that T. rendalli would eradicate any of these species from floodplain regions but the possibility of a reduction in their populations in some regions cannot be excluded;

(b) all other native species living in floodplain regions of the Sepik/Ramu predominantly occupy main river channels which are turbid and devoid of aquatic vegetation; a number of these may utilise marginal floodplain and lakes but these are not considered to be their major habitats. Amongst these, only the ariid catfishes and Megalops cyprinoides are important to the fishery and these do not utilise aquatic vegetation for reproductive purposes; the ariids are mouthbrooders, M. cyprinoides spawns in the sea.

(c) in view of the extent of Sepik/Ramu floodplains, their diversity and the abundance of aquatic macrophytes, the project considers it highly unlikely that T. rendalli, or any species, will destruct vegetation to such an extent as to cause a major ecological imbalance. The project cannot, however, guarantee that shifts in ecological conditions will not occur in some areas.

In view of these factors you are provided with the option of suggesting that an alternative species of macrophyte feeder be considered for Sepik/Ramu floodplains. This option is in addition to the T. zillii option already listed. This option is provided in order to assist group members to be positive about the introduction of a macrophyte feeder, but negative regarding T. rendalli, if they so wish. In this respect, however, please note the following:

The project anticipates that, irrespective of decisions regarding the introduction of T. rendalli into the Sepik River, various bodies within PNG will probably have a desire to introduce a macrophyte feeder, especially T. rendalli, for aquaculture purposes in the future. It could be assumed that, if this occurred, the species would eventually enter rivers. In fact, various bodies have already indicated their interest in this species and the Department of Fisheries and Marine Resources have only been able to satisfy their

enquiries by mentioning that this project is actively investigating the possibilities. This fact in itself does not justify the recommendation by this project that T. rendalli be introduced into the Sepik/Ramu. In short, if we are unhappy with it we should exclude it for our own purposes. The point is, however, that if a macrophyte feeder is desirable for the Sepik/Ramu then the project should give attention to a species also having favourable aquaculture potential; this reduces any need for PNG to have to import other species in the future for this purpose.

The project notes that the cases of previously reported environmental damage caused by T. rendalli or T. zillii, in terms of destruction of vegetation, may or may not be relevant to the Sepik situation. In view of the anticipated variations in ecological factors affecting T. rendalli stocks within the Sepik/Ramu it is unlikely that serious consequences, overall, will arise. We cannot, however, guarantee this. The project also notes that it is possible that such previous phenomena are only known because of the large amount of experience with these species. We note that the suggestion of an alternative macrophyte feeder, to a tilapia, based on the argument of no or less known environmental damage, does not necessarily solve this problem. It may be simply that alternative species have been less well studied in these respects. A major reason for selecting a tilapia for recommendation is the wide experience available with these fish.

Appropriate options in the opinionaire are available to cover most possible responses. Should Advisory Group members prefer the project either not introduce a macrophyte feeder, or introduce an alternative species to a tilapia then it would be appreciated if they could amplify upon this response with additional comments.

#### RECOMMENDATION NUMBER TWO

##### THE TRANSFER OF OSPHRONEMUS GOURAMY INTO SEPIK/RAMU FLOODPLAIN REGIONS

###### 1. Data sources

Coates (1989a) outlined the food resources and habitats in floodplain regions of the Sepik/Ramu Rivers considered to be presently under-utilised and appropriate for fish introductions. Familiarity with that report is assumed in the following presentation.

## 2. Justification

To increase fish stocks in Sepik/Ramu floodplain regions in order to alleviate fish protein supply problems and improve stocks upon which the fishery is based as explained further by Coates (1989a) and in Part 1 of the present report. O. gouramy is already established in PNG.

## 3. Intended habitat/food resource utilisation

As a feeder on vegetable matter including submerged higher plants, filamentous algae, inundated land plants, fruits and seeds primarily in deoxygenated backswamps of the river systems.

## 4. Anticipated range of establishment

The species may establish in oxygenated areas also but the purpose of its introduction is to colonise deoxygenated waters that other macrophyte feeding species suggested for introduction would not be expected to utilise. The species is not expected to establish in tributary rivers. Welcomme (1988) suggests that it may be tolerant of brackish-water but it is not expected to establish in brackish-water or enter marine habitats. There is no evidence that this species has spread in PNG via movement through brackish-water or the sea.

## 5. Numbers of people potentially benefiting from its introduction

About 155,976 people live in Sepik/Ramu floodplain regions (Coates and Mys 1989). The number of people living near deoxygenated backswamps is unknown. This fish, however, is intended to utilise habitats that few species of fish presently enter.

## 6. Sources of stock

This fish is already established in PNG. West and Glucksman (1976) state that O. gouramy was first imported into PNG in 1957 from Malaya and was released into a small pond at Bomana Gaol (Port Moresby) where they subsequently bred. They are reported to still occur at Bomana and individuals up to 400 mm are occasionally caught and eaten or sold. In 1962, O. gouramy were obtained from Dutch officials in Hollandia (now Jayapura - Irian Jaya) and placed in Ponds at Amanab and Wewak. There followed some distributions to natural waters in the Sepik and Madang areas. Sepik introductions obviously did not survive as the species is not recorded there. There is no information on where or how

it was introduced and it is not possible to determine if this was a significant attempt to establish it in the Sepik. Populations are also known to occur near Lae but it is not clear whether these originated from Bomana or Wewak. Preferred sources of this fish would be Lae or Madang (if they can be found). This would negate the need to transfer the fish from southern to northern PNG; these two areas are ecologically separated by the highlands range and this approach would minimise the potential for disease transfer across this natural barrier (see also disease controls listed later).

#### 7. Anticipated impact in terms of fish production

Throughout its known range within PNG O. gouramy is not reported as producing significant fishable resources but this fish is caught and utilised where it occurs. It is not anticipated that the fish would produce large populations in Sepik/Ramu floodplain areas. Its actual impact in terms of increasing fish stocks may or may not be significant. It is, however, anticipated that it may significantly increase fish stocks in de-oxygenated regions. Neither can it be predicted that the species will establish in the Sepik/Ramu. It has been introduced into a number of PNG habitats without establishing. However, it is possible that in some areas appropriate stocking strategies were not undertaken.

Whilst the above might suggest that this species may not be ideal, in terms of fish production, it should be remembered that the fish already occurs in PNG. It is for this reason, together with having suitable ecological habits, that it is recommended for transfer into the Sepik/Ramu. Trials using this species are thought preferable to recommending an alternative species at this stage. Such an approach will not increase PNG's total exotic species count. The impact of O. gouramy in the Sepik/Ramu can be evaluated at a later stage and, if found to be disappointing, a re-evaluation of species suitable for its intended niche and habitats can be made.

#### 8. Previous experiences in transferring this species

Welcomme (1988) lists this species as being transferred to ten countries in Africa, Asia and Oceania. No negative impacts of its introduction have been reported. O. gouramy is also known to have been introduced into Irian Jaya where it is established (Note to Advisory Group: Dr. Hardjamulia will presumably advise if there are any known detrimental effects of its introduction there; as far as the project is aware it has not caused any problems there). It has also been introduced into PNG (previous comments refer).

#### 9. Quarantine procedure

The project advises PNG that despite this species already occurring within the country its transfer to the Sepik/Ramu should be considered as an inter-basin transfer for quarantine purposes. It is recommended that the species be given similar quarantine considerations as a new introduction. Quarantine procedures as outlined in Turner (1988) are recommended to be followed.

#### 10. The biology/ecology of *O. gouramy*

Osphronemus gouramy (Lacepede) (Osphronemidae) is native to the Greater Sunda Islands (Indonesia). The fish, however, has been quite widely used in aquaculture throughout its native range and introduced into several other countries for that purpose. It is an anabantid (Anabantoidei) and, as such, it has supra-brachial respiratory organs allowing the fish to breath air. It is, therefore, able to tolerate low dissolved oxygen concentrations or even zero oxygen availability in water. Vaas (1953) lists the diet of *O. gouramy* in the lake district of the Kapuas River (Borneo) as vegetable, especially submerged higher plants, inundated plants, fruits and seeds but also filamentous algae and benthic algae. Further detailed studies on its feeding habits in natural waters are limited. However, being widely distributed and used in aquaculture, there are no reports of any deviations from its primarily vegetarian habit.

All anabantids have well documented breeding habits. They build nests at the surface amongst vegetation.

Data on temperature tolerance of the species are not available at present. However, the species is not known to occupy habitats other than low-altitude swamps and lakes, including within PNG.

Since the species already occurs within PNG it might be possible to investigate its habits under PNG conditions, before it is transferred to the Sepik/Ramu, if the project is able to locate a reasonably large population. If this is feasible, it will be undertaken.

#### 11. Anticipated interactions with existing fish stocks

These are expected to be minimal. *O. gouramy* is intended to occupy anoxic backwaters that no existing species are adapted to inhabit. Even if *O. gouramy* inhabits a broader habitat range its feeding habits to not overlap at all with

any of the existing species. Its breeding habits are totally different from any existing species within the Sepik/Ramu.

### RECOMMENDATION NUMBER THREE

#### THE TRANSFER OF TRICHOGASTER PECTORALIS INTO SEPIK/RAMU FLOODPLAIN REGIONS

##### 1. Data sources

Coates (1989a) outlined the niches and habitats in floodplain regions of the Sepik/Ramu Rivers considered to be presently under-utilised and appropriate for fish introductions. Familiarity with that report is assumed in the following presentation.

##### 2. Justification

To increase fish stocks in Sepik/Ramu floodplain regions in order to alleviate fish protein supply problems and improve stocks upon which the fishery is based as explained further by Coates (1989a) and in Part 1 of the present report. T. pectoralis is already established in PNG.

##### 3. Intended habitat/niche

As a feeder on detritus and algae, secondarily on zooplankton, primarily in deoxygenated backswamps of the river systems.

##### 4. Anticipated range of establishment

The species may establish in oxygenated areas also but the purpose of its introduction is to colonise deoxygenated waters that other species suggested for introduction would not be expected to utilise. The species is not expected to establish in tributary rivers. There have been many previous introductions into highlands regions of PNG and none have established (West and Glucksman 1976).

##### 5. Numbers of people potentially benefiting from its introduction

About 155,976 people live in Sepik/Ramu floodplain regions (Coates and Mys 1989). The number of people living near deoxygenated backswamps is unknown. This fish, however, is intended to utilise habitats that few species of fish presently enter.

## 6. Sources of stock

This fish is already established in PNG. West and Glucksman (1976) state that T. pectoralis was brought to PNG in 1957 but the source of the original stock is not certain but possibly Malaya or Singapore. Breeding stocks were established at Bomana Gaol (Port Moresby) and fish distributed to a number of regions. It appears, however, that most introductions were to the highlands where, not surprisingly, it did not survive. It is reported to have been introduced into Waigani Swamp on the outskirts of Port Moresby but it is not known if it still occurs there. Established populations of T. pectoralis are reported in areas of Gulf Province in eastern inland coastal regions, as far west as Movaivi. There are no reports of it being introduced into lowland areas of the Sepik/Ramu previously.

## 7. Anticipated impact in terms of fish production

Utilisation of T. pectoralis for food is reported in Gulf Province, the only region where established stocks are reported to occur. In aquaculture situations, the fish is much more productive than O. gouramy. Boonsom (1984) reports productions of 2,000 kg per hectare per year using this fish in ponds in Thailand, by fermenting aquatic weeds, spreading chicken manure and T. pectoralis feeding on the resultant zooplankton. Although a small species, growing to perhaps 250 mm, it is fast growing and hardy (Welcomme 1988). The fish is adequately large to be utilised in both the Sepik/Ramu subsistence and commercial fisheries. Potential improvements in fish abundances due to the transfer of this species are difficult to estimate. It is, however, considered to be suitably productive in appropriate environments. The project considers its transfer to Sepik/Ramu areas justifiable on the grounds that its habits are acceptable, it already occurs in PNG and knowledge suggests that the species may be potentially productive and beneficial.

## 8. Previous experiences in transferring this species

Welcomme (1988) lists this species as being transferred to ten countries in Asia, Oceania and South and Central America. No adverse effects of its introduction are reported. Welcomme (1988) notes that with the PNG introduction it is reported as being "of no value at present although the species has potential in sewage ponds". This was based on West and Glucksman (1976) who reported that



the fish was too small to be of use in aquaculture in PNG. This was at a time when aquaculture development was promoted along western-country lines. T. pectoralis is, in fact, larger than most species of fish presently contributing to the diet of people within inland areas of PNG.

#### 9. Quarantine procedure

The project advises PNG that despite this species already occurring within the country its transfer to the Sepik/Ramu should be considered as an inter-basin transfer for quarantine purposes. It is recommended that the species be given similar quarantine considerations as a new introduction. Quarantine procedures as outlined in Turner (1988) are recommended to be followed.

#### 10. The biology/ecology of T. pectoralis

The native range of T. pectoralis (Regan) (Osphronemidae) is South Vietnam, Thailand and the Malay Peninsula (Welcomme 1988). Being an anabantid (Anabantoidei) it has accessory respiratory organs enabling air-breathing during conditions of low oxygen availability in water.

All anabantids have well documented breeding habits. They build nests at the surface amongst vegetation.

Data on temperature tolerance of the species are not available at present. However, the species is not known to occupy habitats other than low-altitude swamps and lakes, including within PNG.

Boonsom (1986) reports the largest size of this species as about 240 mm, 200 g. Breeding size, in ponds, is generally between 160 and 210 mm, 95 to 120 g, at about 6 to 8 months of age. In ponds in Thailand it breeds all year round. Fecundity is about 13,000 to 68,000 eggs per year. Nests, however, seldom yield more than 4,000 larvae (Hora and Pillay 1962).

Fry feed on zooplankton and secondarily on protozoans (Boonsom 1986). At about 15 mm in length fish begin feeding on detritus and algae (Boonsom 1983). Most reports on feeding by adults list the species as an epiphytic algal browser (Hora and Pillay 1962, Hickling 1961); although in ponds it will feed exclusively on zooplankton. There are no reports of the species having deviated significantly from these habits anywhere.

Since the species already occurs within PNG it might be possible to investigate its habits under PNG conditions,

before it is transferred to the Sepik/Ramu, if the project is able to locate a reasonably large population. If this is feasible, it will be undertaken.

11. Anticipated interactions with existing fish stocks

These are expected to be minimal. T. pectoralis is intended to occupy anoxic backwaters that no existing Sepik/Ramu species are adapted to inhabit. Even if T. pectoralis inhabits a broader habitat range its feeding habits do not overlap significantly with any of the existing species except possibly O. mossambicus, which also feeds on epiphytic algae. It is highly unlikely that T. pectoralis would compete significantly with O. mossambicus in the latter's major habitats. The breeding habits of T. pectoralis are totally different from any existing species within the Sepik/Ramu.

## ANNEX TWO

## RESPONSES FROM THE ADVISORY GROUP ON THE THREE SPECIES RECOMMENDED TO BE TRANSFERRED/INTRODUCED

Advisory group members were requested to give their opinions on the each recommendation. They were sent opinionaires on each species and requested to provide whatever additional comments they wished. Copies of all these opinionaires and comments are appended to this document.

At the time of writing responses from Mr. Pholprasith were not received (possibly due to postal delays). Dr. Payne also had not replied in writing but the project CTA discussed his views in person by telephone. Six replies were, therefore, received and the following summary includes these six replies and the CTA's perception of Dr. Payne's views where appropriate.

A number of questions were presented for each recommendation (see appendix) and responses are, therefore, difficult to quantify. According to the code of practice, each question is recommended to be "scored" and an average score taken. The project has, however, decided to treat each response on its own merits and highlight both positive and negative responses accordingly. Scoring of the responses is helpful in cases of controversy amongst the group. Only an overview of general responses is provided here. Copies of all responses are attached for further deliberation by PNG in more detail if required. (Responses from Advisory Group members show that certain questions were ambiguous and these are left out of this general analysis).

(1) TILAPIA RENDALLI

Is there a need to stock Sepik/Ramu floodplains with a macrophyte feeding fish?

Responses:	Yes	- 3
	Probably	- 3 (includes Payne verbal)
	Possibly	- 1
	Other responses	- 0

Is T. rendalli an appropriate species ?

Responses:

Probably	- 5	(includes Payne verbal)
Possibly	- 1	
Unlikely	- 1	
Other responses	- 0	

Is T. zillii more appropriate ?

Responses:

Unlikely	- 4
No	- 1
Don't know	- 1
Other responses	- 0

Is the supportive information provided on Sepik/Ramu fish stocks and associated factors adequate to draw the conclusions presented?

Responses:

Yes	- 3	
Probably	- 4	(includes Payne verbal)
Other responses	- 0	

Is the supportive information provided on T. rendalli adequate for purposes of this evaluation ?

Responses	Yes	- 3
	Probably	- 2
	Unlikely	- 1
	Other responses	- 0

Would the most consequences of the introduction of T. rendalli be beneficial to humans ?

Responses:

Yes	- 1
Probably	- 3
Possibly	- 1
Don't know	- 1
Other responses	- 0

Are the safeguards against the importation of diseases and parasites adequate ?

Responses:

Yes	- 2
Probably	- 3
Don't know	- 1
Other responses	- 0

Has the project adequately evaluated all possible factors relating to this proposed introduction in view of the constraints that exist ?

Responses:

Yes	- 3
Probably	- 2
Possibly	- 1
Other responses	- 0

Based on all the available information do the benefits of this exotic fish introduction outweigh the risks ?

Responses:

Probably	- 4
Possibly	- 1
Unlikely	- 0

Additional comments received:

Copies of all original correspondence relating to this introduction are appended. A summary of additional comments received, in addition to supportive remarks, is:

(1) Pullin has suggested that the project should look at obtaining stocks of T. rendalli from additional sources to The University of Stirling. This is in order to improve upon the genetic base of the introduced stock. This the project will consider undertaking should the introduction proceed.

(2) Mackinnon has raised some criticisms of this introduction based upon the potential effects of T. rendalli on vegetation and associated possible reductions in some of the native Sepik/Ramu fishes, especially Op. aporós and Ox. heterodon. These points were mentioned in the text of this document and by Redding (1989). Mackinnon has wished to highlight these, and related, points and bring these to the

attention of PNG and the project. Mackinnon's written comments should be referred to for further information.

### Summary and conclusions

The general consensus amongst the Advisory Group is that the introduction of T. rendalli into the Sepik/Ramu River is appropriate. Were the opinionaires on this matter to be "scored", as suggested under the code of practice, the overall result would be clearly supportive of this introduction. Simply scoring the responses in this fashion would, however, diminish the potential importance any adverse comments received. The project considers it appropriate to mention to PNG any such adverse criticism, even if in the minority. In this respect, five of the six written replies received did not unduly criticise this proposal and were supportive (six out of seven, if Payne's general verbal comments are included). Only Mackinnon has criticised this introduction and his comments are appended to this report in their original form.

### (2) OSPHRONEMUS GOURAMY

Is there a need to stock Sepik/Ramu floodplain regions with a vegetable feeding fish adapted to inhabit anoxic backwaters ?

Responses:

Yes	- 1
Probably	- 3
Possibly	- 2
Other responses	- 0

Is O. gouramy suitable for this purpose in view of the species already occurring in PNG ?

Responses:

Yes	- 2
Probably	- 3
Possibly	- 1
Other responses	- 0

Would another species besides O. gouramy be more appropriate in view of O. gouramy already occurring in PNG and stocking this niche could be reconsidered in the light of future experiences with O. gouramy ?

Responses:

No	- 1
Unlikely	- 1
Possibly	- 2
Probably	- 1
Don't know	- 1
Other responses	- 1

Is the supportive information provided on Sepik/Ramu fish stocks and associated factors adequate to draw the conclusions presented ?

Responses:

Yes	- 4
Probably	- 2
Other responses	- 0

Is the supportive information provided on O. gouramy adequate for purposes of this evaluation in view of it already being established in PNG and its wide use in other countries ?

Responses:

Yes	- 4
Probably	- 2
Other responses	- 0

Would most consequences of O. gouramy be beneficial to humans ?

Yes	- 1
Probably	- 3
Possibly	- 2
Other responses	- 0

Are the safeguards against transfer of disease and parasites adequate ?

Responses:

Yes	- 2
Probably	- 3
Don't know	- 1
Other responses	- 0

Has the project adequately evaluated all possible factors relating to this proposed introduction in view of the constraints that exist ?

Responses:

Yes	- 4
Probably	- 2
Other responses	- 0

Based on all of the available information, do the benefits of this exotic fish introduction outweigh the risks ?

Yes	- 1
Probably	- 4
Unlikely	- 1
Other responses	- 0

#### Summary of responses and additional comments received

The general consensus is one of approval of this species, and no serious objections against its transfer were put forward. (In addition to the six responses listed above, Payne was not against this transfer).

However, some Advisory Group members mentioned that they were not enthusiastic about its transfer on the grounds of perceived benefits to the fishery. Osphronemus gouramy is not highly productive in natural waters anywhere that it occurs (including PNG). Mackinnon notes that this species, being an anabantid and producing "bubble nests" may not succeed well in heavy rainfall areas (rain destroys the nests). This is a valid point and may explain why in PNG the species is restricted to areas of lower rainfall that experience more of a "dry" season. Despite the fact that this species is officially "approved" for transfer to the Sepik/Ramu the project would like to consider further whether its transfer is justifiable in terms of anticipated benefits and in view of staff and time limitations.



(3) TRICHOGASTER PECTORALIS

Is there a need to stock Sepik/Ramu floodplain regions with a detritus/algae feeding fish adapted to inhabit anoxic backwaters and swamps ?

Responses:

Yes	- 1
Probably	- 4
Possibly	- 1
Other responses	- 0

Is T. pectoralis suitable for this purposes in view of the species already occurring in PNG ?

Responses:

Yes	- 2
Probably	- 4
Other responses	- 0

Would another species besides T. pectoralis be more appropriate in view of T. pectoralis already occurring in PNG and stocking this niche could be reconsidered in the light of future experiences with T. pectoralis ?

Responses:

Unlikely	- 4
Probably	- 1
Don't know	- 1
Other responses	- 0

Is the supportive information provided on Sepik/Ramu fish stocks and associated factors adequate to draw the conclusions presented ?

Responses:

Yes	- 3
Probably	- 3
Other responses	- 0

Is the supportive information provided on T. pectoralis adequate for purposes of this evaluation in view of the species already being established in PNG and its wide use in other countries ?

Responses:

Yes	- 3
Probably	- 3
Other responses	- 0

Would most consequences of the introduction of T. pectoralis be beneficial to humans ?

Responses:

Yes	- 1
Probably	- 4
Possibly	- 1
Other responses	- 0

Are the safeguards against the transfer of diseases and parasites adequate ?

Yes	- 2
Probably	- 2
Don't know	- 2
Other responses	- 0

Has the project adequately evaluated all possible factors relating to this proposed introduction in view of the constraints that exist ?

Responses:

Yes	- 4
Probably	- 2
Other responses	- 0

Based on all of the information, do the benefits of this exotic fish introduction outweigh the risks ?

Responses:

Yes	- 1
Probably	- 2
Possibly	- 3
Other responses	- 0

### Summary and additional comments received

The general consensus is one of support for the transfer of this species and no serious adverse comments were received (including Payne in addition to the six listed above).

Mackinnon has noted that T. pectoralis could also be vulnerable to heavy prolonged rainfall (as per O. gouramy) and remarks that this may be one reason why in Thailand it is naturally restricted to northern areas of the country with a drier climate. This may also explain its present distribution in PNG. It is doubtful if such prolonged dry periods exist anywhere in the Sepik/Ramu, although some areas do experience reduced rainfall at certain times. The species is, however, much more productive than O. gouramy under suitable conditions. In view of the general support for this species, its established record and the potential for reasonable production the project feels this species is a suitable candidate for transfer to the Sepik/Ramu. It should be noted, however, that its introduction may not be successful.

APPENDIX

COPIES OF ORIGINAL RESPONSES RECEIVED FROM THE ADVISORY  
GROUP (ATTACHED)



COLLEGE OF AGRICULTURAL AND  
ENVIRONMENTAL SCIENCES  
AGRICULTURAL EXPERIMENT STATION  
COOPERATIVE EXTENSION

DEPARTMENT OF WILDLIFE AND FISHERIES BIOLOGY  
UNIVERSITY OF CALIFORNIA  
DAVIS, CALIFORNIA 95616-5270

January 3, 1990

Dr. David Coates  
c/o "Westlin"  
Rockcliffe via Daleattie  
Kirkcudbrightshire  
Scotland, U.K.

Dear David:

This has been a very interesting experience reviewing the materials you sent. I wish we had the chance to really sit down and discuss them!

I was really impressed with the amount and quality of information you and your colleagues provided, as well as your thoughtful analyses of it. This project must be one of the most extensively studied introduction efforts ever made. It also has made a major contribution to understanding the biota of New Guinea streams, which will certainly be a lasting contribution. I hope you will find the time to edit and combine this material into a book that would be readily available in major libraries as well as to continue to publish separate papers.

As my opinionaires indicate, I agree that some introductions are necessary, especially Tilapia rendalli. I must admit I am not wildly enthusiastic about them as I think alterations and perhaps extinctions of native biota are an inevitable consequence. However, planned introductions, with international blessings, are at least likely to be fewer and less harmful than the unplanned ones that have been perpetrated on so many aquatic systems. I just hope that the government of PNG will limit itself to your recommendations and that follow-up studies will be conducted. Here are some of my other thoughts on the project:

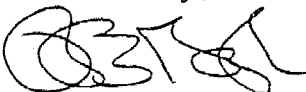
1. I worry that efforts like this will not really do any good in the long run. In a protein-short region, an influx of new, high quality food may stimulate a population increase, with the final result being that there are simply more people who are short of protein and more degraded environment. I realize that this concern is beyond the scope of your project and beyond the planning capabilities of most governments. Perhaps the introduction will help to buy time for PNG to make its entry into the modern world less stressful.
2. I would like to see future efforts focus on considerations of introducing fishes from the Fly River or other streams of New Guinea. I realize that this presents enormous political and logistical

difficulties, not to mention the need to conduct studies on the fishes themselves. However, the results might be worth the effort for the following reasons:

- a. My experience is that introduction of species from nearby drainages in North America are less likely to cause extinction of native species than is introduction of exotic species. Shifts in the community (niche compression) occurs but the resulting community is more likely to have long-term stability. Presumably this is because the introduced species is more adapted to local environmental conditions, including the local biota.
  - b. Introductions of disease are less likely because of previous connections between the waters by way of birds (as intermediate hosts of parasites etc.) and headwater captures.
  - c. Aesthetically, one could argue that such introductions are an acceleration of natural events, rather than being a radical departure from them as when exotic species are brought in.
  - d. The studies of potential introductions would contribute to our understanding of the other systems, increasing the probability that they could be managed better as well.
3. I worry about the possibility of endemic invertebrates being eliminated by the introductions. David Dudgeon's studies are certainly a good start towards understanding the invertebrate fauna, but most identifications are not to the species level. Making the initial introductions herbivores and detritivores also reduces the possibility of invertebrate extinctions. I guess this really just points out the need for more taxonomic studies of the invertebrates (the fishes too!). This, of course, mirrors a worldwide problem: there are few people interested in such studies and few funds to do them in any case.
4. Please avoid using the term "vacant niche." By definition, a niche is a characteristic of an organism, not its environment. When the term "vacant niche" is used you are really referring to resources, such as zooplankton, that are not being used in ways that we fully understand or that benefit humans directly. The term "vacant niche" also implies that introductions can be successfully made that will have no effect on the established biotic communities, something that is highly improbable.

Anyway, I congratulate you and your colleagues on a job well done. You have done more than I would have thought possible under the circumstances.

Sincerely,



Peter B. Moyle

PBM:sc

OPINIONAIRE FOR THE SEPIK RIVER FISH STOCK ENHANCEMENT  
ADVISORY GROUP

Recommendation 1

- the introduction of T. rendalli into the Sepik/Ramu Rivers

NAME Moyte SIGNATURE  DATE 4/5/90

Dear Advisory Group Member,

Based on the information provided to you could you please provide your opinions on the following questions by circling only one of the alternative responses for each question.

You may provide whatever additional comments you wish as an attachment. Please direct such to the project Chief Technical Adviser. These will be taken into account by the project and passed on to PNG authorities in their original form.

RESPONSE

	NO	UNLIKELY	POSSIBLY	PROBABLY	YES	DON'T KNOW
(1) Is there a need to stock Sepik/Ramu floodplains with a macrophyte feeding fish ?					<input checked="" type="radio"/>	
(2) Is <u>Tilapia rendalli</u> an appropriate species for this purpose ?				<input checked="" type="radio"/>		
(3) Do you consider that <u>Tilapia zillii</u> is more appropriate ?	<input checked="" type="radio"/>					
(4) Would another species besides a tilapia be more appropriate ?					<input checked="" type="radio"/>	<input checked="" type="radio"/>
(5) Is the supportive information provided on Sepik/Ramu fish stocks and associated factors adequate to draw the conclusions presented ?				<input checked="" type="radio"/>		

(6) Is the supportive information provided on Tilapia rendalli adequate for purposes of this evaluation ?

NO UNLIKELY POSSIBLY PROBABLY YES DON'T KNOW

(7) Would T. rendalli have mostly positive ecological impacts ?

NO UNLIKELY POSSIBLY PROBABLY YES DON'T KNOW

*Poor question. It will have an impact - positive or negative depends on point of view. Many/most effects will not be known until after introduction is established*

(8) Would most consequences of the introduction of T. rendalli be beneficial to humans ?

NO UNLIKELY POSSIBLY PROBABLY YES DON'T KNOW

(9) Are the safeguards against importation of diseases and parasites adequate ?

NO UNLIKELY POSSIBLY PROBABLY YES DON'T KNOW

*as good as they get but...*

(10) Has the project adequately evaluated all possible factors relating to this proposed introduction in view of constraints that exist ?

NO UNLIKELY POSSIBLY PROBABLY YES DON'T KNOW

(11) Based on all of the available information, do the benefits of this exotic fish introduction outweigh the risks ?

NO UNLIKELY POSSIBLY PROBABLY YES DON'T KNOW

*I see it as inevitable - better under controlled circumstances*

\* if your response is "no" to this question please disregard all other questions and append your reasons even if only in brief.



OPINIONAIRE FOR THE SEPIK RIVER FISH STOCK ENHANCEMENT  
ADVISORY GROUP

Recommendation 2

- the transfer of O. gouramy into the Sepik/Ramu Rivers

NAME Moyle SIGNATURE  DATE 4 Jan 90

Dear Advisory Group Member,

Based on the information provided to you could you please provide your opinions on the following questions by circling only one of the alternative responses for each question.

You may provide whatever additional comments you wish as an attachment. Please direct such to the project Chief Technical Adviser. These will be taken into account by the project and passed on to PNG authorities in their original form.

RESPONSE

	NO	UNLIKELY	POSSIBLY	PROBABLY	YES	DON'T KNOW
(1) Is there a need to stock Sepik/Ramu floodplain regions with a vegetable feeding fish adapted to inhabit anoxic backwaters and swamps ?			<input checked="" type="radio"/>			
(2) Is <u>Osphronemus gouramy</u> suitable for this purpose in view of the species already occurring in PNG ?			<input checked="" type="radio"/>			
(3) Would another species besides <u>O. gouramy</u> be more appropriate in view of <u>O. gouramy</u> already occurring in PNG and stocking this niche could be reconsidered in the light of future experiences with <u>O. gouramy</u> ?	<input checked="" type="radio"/>					
(4) Is the supportive information provided on Sepik/Ramu fish stocks and associated factors adequate to draw the conclusions presented ?					<input checked="" type="radio"/>	

(5) Is the supportive information provided on O. gouramy adequate for purposes of this evaluation in view of it already being established in PNG and its wide use in other countries ?

NO	UNLIKELY	POSSIBLY	PROBABLY	<u>YES</u>	DON'T KNOW
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*Yes*

(6) Would O. gouramy have mostly positive ecological impacts ? *poor question (see T. Rendell)*

NO	UNLIKELY	POSSIBLY	PROBABLY	YES	DON'T KNOW
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(7) Would most consequences of the introduction of O. gouramy be beneficial to humans ?

NO	UNLIKELY	<u>POSSIBLY</u>	PROBABLY	YES	DON'T KNOW
----	----------	-----------------	----------	-----	------------

(8) Are the safeguards against transfer of diseases and parasites adequate ?

NO	UNLIKELY	POSSIBLY	<u>PROBABLY</u>	YES	DON'T KNOW
----	----------	----------	-----------------	-----	------------

(9) Has the project adequately evaluated all possible factors relating to this proposed introduction in view of constraints that exist ?

NO	UNLIKELY	POSSIBLY	<u>PROBABLY</u>	YES	DON'T KNOW
----	----------	----------	-----------------	-----	------------

(10) Based on all of the available information, do the benefits of this exotic fish introduction outweigh the risks

NO	<u>UNLIKELY</u>	POSSIBLY	PROBABLY	YES	DON'T KNOW
----	-----------------	----------	----------	-----	------------

*I am not enthusiastic about this introduction, as its probable benefits are small - unlikely to contribute much to fishery.*

\* if your response is "no" to this question please disregard all other questions and append your reasons even if only in brief.

OPINIONAIRE FOR THE SEPIK RIVER FISH STOCK ENHANCEMENT  
ADVISORY GROUP

Recommendation 4

- the transfer of Trichogaster pectoralis into the Sepik/Ramu Rivers

NAME Moyle SIGNATURE  DATE 9 Jan 90

Dear Advisory Group Member,

Based on the information provided to you could you please provide your opinions on the following questions by circling only one of the alternative responses for each question.

You may provide whatever additional comments you wish as an attachment. Please direct such to the project Chief Technical Adviser. These will be taken into account by the project and passed on to PNG authorities in their original form.

RESPONSE

	NO	UNLIKELY	POSSIBLY	PROBABLY	YES	DON'T KNOW
(1) Is there a need to stock Sepik/Ramu floodplain regions with a detritus/algae feeding fish adapted to inhabit anoxic backwaters and swamps ?			<input checked="" type="radio"/>			
(2) Is <u>T. pectoralis</u> suitable for this purpose in view of the species already occurring in PNG ?				<input checked="" type="radio"/>		
(3) Would another species besides <u>T. pectoralis</u> be more appropriate in view of <u>T. pectoralis</u> already occurring in PNG and stocking this niche could be reconsidered in the light of future experiences with <u>T. pectoralis</u> ?		<input checked="" type="radio"/>				
(4) Is the supportive information provided on Sepik/Ramu fish stocks and associated factors adequate to draw the conclusions presented ?				<input checked="" type="radio"/>		

(5) Is the supportive information provided on <u>T. pectoralis</u> adequate for purposes of this evaluation in view of the species already being established in PNG and its wide use in other countries?	NO	UNLIKELY	POSSIBLY	<u>PROBABLY</u>	YES	DON'T KNOW
(6) Would <u>T. pectoralis</u> have mostly positive ecological impacts ? <i>Don't know</i>	NO	UNLIKELY	POSSIBLY	PROBABLY	YES	DON'T KNOW
(7) Would most consequences of the introduction of <u>T. pectoralis</u> be beneficial to humans ? <i>Don't know</i>	NO	UNLIKELY	POSSIBLY	<u>PROBABLY</u>	YES	DON'T KNOW
(8) Are the safeguards against transfer of diseases and parasites adequate ?	NO	UNLIKELY	POSSIBLY	<u>PROBABLY</u>	YES	DON'T KNOW
(9) Has the project adequately evaluated all possible factors relating to this proposed introduction in view of constraints that exist ?	NO	UNLIKELY	POSSIBLY	<u>PROBABLY</u>	YES	DON'T KNOW
(10) Based on all of the available information, do the benefits of this exotic fish introduction outweigh the risks	NO	UNLIKELY	<u>POSSIBLY</u>	PROBABLY	YES	DON'T KNOW

*Benefits likely to be small.*

\* if your response is "no" to this question please disregard all other questions and append your reasons even if only in brief.



18 January 1990

Dr. David Coates  
Chief Technical Adviser  
United Nations Development Program  
Office of the Resident Representative  
in Papua New Guinea  
P.O. Box 1041  
Port Moresby

Dear David,

Many congratulations on the excellent Phase One final report and recommendations. The thoroughness of your distribution of documents is exemplary. I liked the Dudgeon report very much. I enclose my completed 'opinionaires'.

In addition, I have the following comments:

1. Why not get a good common carp population genetics group to look at specimens from the PNG stock and describe them thoroughly. The group that I recommend for this is Stefano Cataudella, Donatella Crossetti and Luciana Sola at the University of Rome. You could then decide whether an additional importation of new common carp genetic material would be useful and, if so, and from where it should come. I think also that another introduction of *O. mossambicus* from near its southern limits (most cold-tolerant) could also be useful. You can write to:

Dr. Stefano Cataudella  
Prof. of Fisheries and Aquaculture  
Department of Biology  
University of Rome  
Tor Vergata  
Via O. Raimundo  
00100 Rome - Italy

Please say that it was my suggestion if you go ahead.

2. Much as I admire Stirling University's activities in maintaining pure stocks of tilapias, I would recommend some importations from Africa, if possible. We can possibly help with contacts. I think you would get a broader genetic base from direct transfers from the

wild. This was the view we took for our 'gene' hunting. However, your logistic arrangements have to be good for this and your quarantine arrangements excellent. We ship tilapias from Africa to Asia using the University of Hamburg as a 'staging post'. Perhaps the answer is to do both i.e. collect in Africa, ship to Stirling for initial quarantine, recovery etc. (this would give them new/extra material as well) and then ship to PNG both old and new stocks. You could write to Ron Roberts to explore this. His address is:

Prof. R.J. Roberts  
Director of Institute  
Institute of Aquaculture  
University of Stirling  
Stirling FK9 4LA  
Scotland, U.K.

We will help all we can with arrangements in Africa if you decide to pursue this, but the funds will have to come from somewhere.

That's all for now. Good luck with all your endeavors.  
Best regards.

Yours sincerely,



DR. ROGER S.V. PULLIN  
Director  
Aquaculture Program

Enclosure - 'opinionaires'

RSVP/emr\*

OPINIONAIRE FOR THE SEPIK RIVER FISH STOCK ENHANCEMENT  
ADVISORY GROUP

Recommendation 1

- the introduction of T. rendalli into the Sepik/Ramu Rivers

NAME R.S.V. Puccin SIGNATURE RSV. RM. DATE 17/1/90

Dear Advisory Group Member,

Based on the information provided to you could you please provide your opinions on the following questions by circling only one of the alternative responses for each question.

You may provide whatever additional comments you wish as an attachment. Please direct such to the project Chief Technical Adviser. These will be taken into account by the project and passed on to PNG authorities in their original form.

RESPONSE

	NO	UNLIKELY	POSSIBLY	PROBABLY	YES	DON'T KNOW
(1) Is there a need to stock Sepik/Ramu floodplains with a macrophyte feeding fish ?				<input checked="" type="radio"/>		
(2) Is <u>Tilapia rendalli</u> an appropriate species for this purpose ?				<input checked="" type="radio"/>		
(3) Do you consider that <u>Tilapia zillii</u> is more appropriate ?		<input checked="" type="radio"/>				
(4) Would another species besides a tilapia be more appropriate ?			<input checked="" type="radio"/>			
(5) Is the supportive information provided on Sepik/Ramu fish stocks and associated factors adequate to draw the conclusions presented ?				<input checked="" type="radio"/>		

(6) Is the supportive information provided on <u>Tilapia rendalli</u> adequate for purposes of this evaluation ?	NO	UNLIKELY	POSSIBLY	PROBABLY	YES	DON'T KNOW
(7) Would <u>T. rendalli</u> have mostly positive ecological impacts ?	NO	UNLIKELY	POSSIBLY	PROBABLY	YES	DON'T KNOW
(8) Would most consequences of the introduction of <u>T. rendalli</u> be beneficial to humans ?	NO	UNLIKELY	POSSIBLY	PROBABLY	YES	DON'T KNOW
(9) Are the safeguards against importation of diseases and parasites adequate ?	NO	UNLIKELY	POSSIBLY	PROBABLY	YES	DON'T KNOW
(10) Has the project adequately evaluated all possible factors relating to this proposed introduction in view of constraints that exist ?	NO	UNLIKELY	POSSIBLY	PROBABLY	YES	DON'T KNOW
(11) Based on all of the available information, do the benefits of this exotic fish introduction outweigh the risks ?	NO	UNLIKELY	POSSIBLY	PROBABLY	YES	DON'T KNOW

\* if your response is "no" to this question please disregard all other questions and append your reasons even if only in brief.



OPINIONAIRE FOR THE SEPIK RIVER FISH STOCK ENHANCEMENT  
ADVISORY GROUP

Recommendation 2

- the transfer of O. gouramy into the Sepik/Ramu Rivers

NAME RSV. Purnin SIGNATURE RSV. Purnin DATE 17/11/90

Dear Advisory Group Member,

Based on the information provided to you could you please provide your opinions on the following questions by circling only one of the alternative responses for each question.

You may provide whatever additional comments you wish as an attachment. Please direct such to the project Chief Technical Adviser. These will be taken into account by the project and passed on to PNG authorities in their original form.

RESPONSE

	NO	UNLIKELY	POSSIBLY	PROBABLY	YES	DON'T KNOW
(1) Is there a need to stock Sepik/Ramu floodplain regions with a vegetable feeding fish adapted to inhabit anoxic backwaters and swamps ?				<input checked="" type="radio"/>		
(2) Is <u>Osphronemus gouramy</u> suitable for this purpose in view of the species already occurring in PNG ?				<input checked="" type="radio"/>		
(3) Would another species besides <u>O. gouramy</u> be more appropriate in view of <u>O. gouramy</u> already occurring in PNG and stocking this niche could be reconsidered in the light of future experiences with <u>O. gouramy</u> ?			<input checked="" type="radio"/>			
(4) Is the supportive information provided on Sepik/Ramu fish stocks and associated factors adequate to draw the conclusions presented ?				<input checked="" type="radio"/>		

(5) Is the supportive information provided on <u>O. gouramy</u> adequate for purposes of this evaluation in view of it already being established in PNG and its wide use in other countries ?	NO	UNLIKELY	POSSIBLY	PROBABLY	YES	DON'T KNOW
(6) Would <u>O. gouramy</u> have mostly positive ecological impacts ?	NO	UNLIKELY	POSSIBLY	PROBABLY	YES	DON'T KNOW
(7) Would most consequences of the introduction of <u>O. gouramy</u> be beneficial to humans ?	NO	UNLIKELY	POSSIBLY	PROBABLY	YES	DON'T KNOW
(8) Are the safeguards against transfer of diseases and parasites adequate ?	NO	UNLIKELY	POSSIBLY	PROBABLY	YES	DON'T KNOW
(9) Has the project adequately evaluated all possible factors relating to this proposed introduction in view of constraints that exist ?	NO	UNLIKELY	POSSIBLY	PROBABLY	YES	DON'T KNOW
(10) Based on all of the available information, do the benefits of this exotic fish introduction outweigh the risks	NO	UNLIKELY	POSSIBLY	PROBABLY	YES	DON'T KNOW

\* if your response is "no" to this question please disregard all other questions and append your reasons even if only in brief.

OPINIONAIRE FOR THE SEPIK RIVER FISH STOCK ENHANCEMENT  
ADVISORY GROUP

Recommendation 2

- the transfer of Trichogaster pectoralis into the Sepik/Ramu Rivers

NAME R.S.V. Rullu SIGNATURE R.S.V. Rullu DATE 17/1/90

Dear Advisory Group Member,

Based on the information provided to you could you please provide your opinions on the following questions by circling only one of the alternative responses for each question.

You may provide whatever additional comments you wish as an attachment. Please direct such to the project Chief Technical Adviser. These will be taken into account by the project and passed on to PNG authorities in their original form.

RESPONSE

	NO	UNLIKELY	POSSIBLY	PROBABLY	YES	DON'T KNOW
(1) Is there a need to stock Sepik/Ramu floodplain regions with a detritus/algae feeding fish adapted to inhabit anoxic backwaters and swamps ?				<input checked="" type="radio"/>		
(2) Is <u>T. pectoralis</u> suitable for this purpose in view of the species already occurring in PNG ?				<input checked="" type="radio"/>		
(3) Would another species besides <u>T. pectoralis</u> be more appropriate in view of <u>T. pectoralis</u> already occurring in PNG and stocking this niche could be reconsidered in the light of future experiences with <u>T. pectoralis</u> ?		<input checked="" type="radio"/>	<input checked="" type="radio"/>			
(4) Is the supportive information provided on Sepik/Ramu fish stocks and associated factors adequate to draw the conclusions presented ?				<input checked="" type="radio"/>		

*disregard*  
*R.S.V. Rullu*

(5) Is the supportive information provided on <u>T. pectoralis</u> adequate for purposes of this evaluation in view of the species already being established in PNG and its wide use in other countries?	NO	UNLIKELY	POSSIBLY	PROBABLY	YES	DON'T KNOW
(6) Would <u>T. pectoralis</u> have mostly positive ecological impacts ?	NO	UNLIKELY	POSSIBLY	PROBABLY	YES	DON'T KNOW
(7) Would most consequences of the introduction of <u>T. pectoralis</u> be beneficial to humans ?	NO	UNLIKELY	POSSIBLY	PROBABLY	YES	DON'T KNOW
(8) Are the safeguards against transfer of diseases and parasites adequate ?	NO	UNLIKELY	POSSIBLY	PROBABLY	YES	DON'T KNOW
(9) Has the project adequately evaluated all possible factors relating to this proposed introduction in view of constraints that exist ?	NO	UNLIKELY	POSSIBLY	PROBABLY	YES	DON'T KNOW
(10) Based on all of the available information, do the benefits of this exotic fish introduction outweigh the risks	NO	UNLIKELY	POSSIBLY	PROBABLY	YES	DON'T KNOW

\* if your response is "no" to this question please disregard all other questions and append your reasons even if only in brief.

**RESEARCH INSTITUTE FOR FRESHWATER FISHERIES  
AGENCY FOR AGRICULTURAL RESEARCH AND DEVELOPMENT**

Our Ref : *KS.1.10.29.1.90*  
Your Ref :  
Bogor, 8 January 1990

1, Jalan Sempur  
P.O. Box - 51  
Bogor - Indonesia  
Phone : (0251) 22200  
Cable : Balitkanwar

Dr. David Coates  
Chief Technical Adviser  
Sepik River Fish Stock  
Enhancement Project  
FAO Fisheries Development  
R O M E

Dear Dr. Coates,

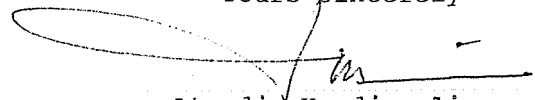
I am pleased to send you my response on opinionaire for the Sepik River Fish Stock Enhancement. I regret to inform you that I have no experience at all with both Tilapia rendalli and T. zillii, so my response of the species is not satisfactory.

I hope my opinion on the recommendation for the introduction of T. rendalli and the transfer of Trichogaster pectoralis and Osphronemus gouramy will be contributing for the decission making.

In this occassion I wish you all the best for a prosperous new year, 1990.

My best regards

Yours sincerely



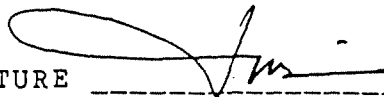
Atmadja Hardjamulia  
Director

CC :

OPINIONAIRE FOR THE SEPIK RIVER FISH STOCK ENHANCEMENT  
ADVISORY GROUP

Recommendation 1

- the introduction of T. rendalli into the Sepik/Ramu Rivers

NAME A. HARDJAMULIA SIGNATURE  DATE 28 DECEMBER, 1989

Dear Advisory Group Member,

Based on the information provided to you could you please provide your opinions on the following questions by circling only one of the alternative responses for each question.

You may provide whatever additional comments you wish as an attachment. Please direct such to the project Chief Technical Adviser. These will be taken into account by the project and passed on to PNG authorities in their original form.

RESPONSE

	NO	UNLIKELY	POSSIBLY	PROBABLY	YES	DON'T KNOW
1) Is there a need to stock Sepik/Ramu floodplains with a macrophyte feeding fish ?					<input checked="" type="radio"/>	
2) Is <u>Tilapia rendalli</u> an appropriate species for this purpose ?				<input checked="" type="radio"/>		
3) Do you consider that <u>Tilapia zillii</u> is more appropriate ?						<input checked="" type="radio"/>
4) Would another species besides a tilapia be more appropriate ?				<input checked="" type="radio"/>		
5) Is the supportive information provided on Sepik/Ramu fish stocks and associated factors adequate to draw the conclusions presented ?					<input checked="" type="radio"/>	

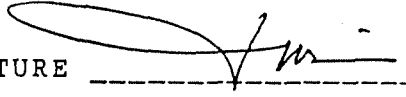
(6) Is the supportive information provided on <u>Tilapia rendalli</u> adequate for purposes of this evaluation ?	NO	UNLIKELY	POSSIBLY	PROBABLY	YES	DON'T KNOW
(7) Would <u>T. rendalli</u> have mostly positive ecological impacts ?	NO	UNLIKELY	POSSIBLY	PROBABLY	YES	DON'T KNOW
(8) Would most consequences of the introduction of <u>T. rendalli</u> be beneficial to humans ?	NO	UNLIKELY	POSSIBLY	PROBABLY	YES	DON'T KNOW
(9) Are the safeguards against importation of diseases and parasites adequate ?	NO	UNLIKELY	POSSIBLY	PROBABLY	YES	DON'T KNOW
(10) Has the project adequately evaluated all possible factors relating to this proposed introduction in view of constraints that exist ?	NO	UNLIKELY	POSSIBLY	PROBABLY	YES	DON'T KNOW
(11) Based on all of the available information, do the benefits of this exotic fish introduction outweigh the risks ?	NO	UNLIKELY	POSSIBLY	PROBABLY	YES	DON'T KNOW

\* if your response is "no" to this question please disregard all other questions and append your reasons even if only in brief.

OPINIONAIRE FOR THE SEPIK RIVER FISH STOCK ENHANCEMENT  
ADVISORY GROUP

Recommendation 2

- the transfer of O. gouramy into the Sepik/Ramu Rivers

NAME A. H. ARDJANULIA SIGNATURE  DATE 28 DECEMBER 1989

Dear Advisory Group Member,

Based on the information provided to you could you please provide your opinions on the following questions by circling only one of the alternative responses for each question.

You may provide whatever additional comments you wish as an attachment. Please direct such to the project Chief Technical Adviser. These will be taken into account by the project and passed on to PNG authorities in their original form.

RESPONSE

	NO	UNLIKELY	POSSIBLY	PROBABLY	YES	DON'T KNOW
1. Is there a need to stock Sepik/Ramu floodplain regions with a vegetable feeding fish adapted to inhabit anoxic backwaters and swamps?					<input checked="" type="radio"/>	
2. Is <u>Osphronemus gouramy</u> suitable for this purpose in view of the species already occurring in PNG?					<input checked="" type="radio"/>	
(3) Would another species besides <u>O. gouramy</u> be more appropriate in view of <u>O. gouramy</u> already occurring in PNG and stocking this niche could be reconsidered in the light of future experiences with <u>O. gouramy</u> ?				<input checked="" type="radio"/>		
(4) Is the supportive information provided on Sepik/Ramu fish stocks and associated factors adequate to draw the conclusions presented?					<input checked="" type="radio"/>	



(5) Is the supportive information provided on <u>O. gouramy</u> adequate for purposes of this evaluation in view of it already being established in PNG and its wide use in other countries ?	NO	UNLIKELY	POSSIBLY	PROBABLY	<input checked="" type="radio"/> YES	DON'T KNOW
(6) Would <u>O. gouramy</u> have mostly positive ecological impacts ?	NO	UNLIKELY	POSSIBLY	PROBABLY	<input checked="" type="radio"/> YES	DON'T KNOW
(7) Would most consequences of the introduction of <u>O. gouramy</u> be beneficial to humans ?	NO	UNLIKELY	POSSIBLY	PROBABLY	<input checked="" type="radio"/> YES	DON'T KNOW
(8) Are the safeguards against transfer of diseases and parasites adequate ?	NO	UNLIKELY	POSSIBLY	PROBABLY	YES	<input checked="" type="radio"/> DON'T KNOW
(9) Has the project adequately evaluated all possible factors relating to this proposed introduction in view of constraints that exist ?	NO	UNLIKELY	POSSIBLY	PROBABLY	<input checked="" type="radio"/> YES	DON'T KNOW
(10) Based on all of the available information, do the benefits of this exotic fish introduction outweigh the risks	NO	UNLIKELY	POSSIBLY	PROBABLY	<input checked="" type="radio"/> YES	DON'T KNOW

\* if your response is "no" to this question please disregard all other questions and append your reasons even if only in brief.

OPINIONAIRE FOR THE SEPIK RIVER FISH STOCK ENHANCEMENT  
ADVISORY GROUP

Recommendation 1

- the introduction of T. rendalli into the Sepik/Ramu Rivers

NAME A. HARDJANULIA SIGNATURE  DATE 28 DECEMBER, 1989

Dear Advisory Group Member,

Based on the information provided to you could you please provide your opinions on the following questions by circling only one of the alternative responses for each question.

You may provide whatever additional comments you wish as an attachment. Please direct such to the project Chief Technical Adviser. These will be taken into account by the project and passed on to PNG authorities in their original form.

RESPONSE

	NO	UNLIKELY	POSSIBLY	PROBABLY	YES	DON'T KNOW
(1) Is there a need to stock Sepik/Ramu floodplains with a macrophyte feeding fish ?					<input checked="" type="radio"/>	
(2) Is <u>Tilapia rendalli</u> an appropriate species for this purpose ?				<input checked="" type="radio"/>		
(3) Do you consider that <u>Tilapia zillii</u> is more appropriate ?						<input checked="" type="radio"/>
(4) Would another species besides a tilapia be more appropriate ?				<input checked="" type="radio"/>		
(5) Is the supportive information provided on Sepik/Ramu fish stocks and associated factors adequate to draw the conclusions presented ?					<input checked="" type="radio"/>	

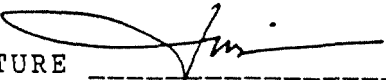
(6) Is the supportive information provided on <u>Tilapia rendalli</u> adequate for purposes of this evaluation ?	NO	UNLIKELY	POSSIBLY	PROBABLY	YES	DON'T KNOW
(7) Would <u>T. rendalli</u> have mostly positive ecological impacts ?	NO	UNLIKELY	POSSIBLY	PROBABLY	YES	DON'T KNOW
(8) Would most consequences of the introduction of <u>T. rendalli</u> be beneficial to humans ?	NO	UNLIKELY	POSSIBLY	PROBABLY	YES	DON'T KNOW
(9) Are the safeguards against importation of diseases and parasites adequate ?	NO	UNLIKELY	POSSIBLY	PROBABLY	YES	DON'T KNOW
(10) Has the project adequately evaluated all possible factors relating to this proposed introduction in view of constraints that exist ?	NO	UNLIKELY	POSSIBLY	PROBABLY	YES	DON'T KNOW
(11) Based on all of the available information, do the benefits of this exotic fish introduction outweigh the risks ?	NO	UNLIKELY	POSSIBLY	PROBABLY	YES	DON'T KNOW

\* if your response is "no" to this question please disregard all other questions and append your reasons even if only in brief.

OPINIONAIRE FOR THE SEPIK RIVER FISH STOCK ENHANCEMENT  
ADVISORY GROUP

Recommendation 2

- the transfer of Trichogaster pectoralis into the Sepik/Ramu Rivers

NAME A. HARDJAMULIA SIGNATURE  DATE DECEMBER, 28, 1989

Dear Advisory Group Member,

Based on the information provided to you could you please provide your opinions on the following questions by circling only one of the alternative responses for each question.

You may provide whatever additional comments you wish as an attachment. Please direct such to the project Chief Technical Adviser. These will be taken into account by the project and passed on to PNG authorities in their original form.

RESPONSE

	NO	UNLIKELY	POSSIBLY	PROBABLY	YES	DON'T KNOW
(1) Is there a need to stock Sepik/Ramu floodplain regions with a detritus/algae feeding fish adapted to inhabit anoxic backwaters and swamps?					<input checked="" type="radio"/>	
(2) Is <u>T. pectoralis</u> suitable for this purpose in view of the species already occurring in PNG?					<input checked="" type="radio"/>	
(3) Would another species besides <u>T. pectoralis</u> be more appropriate in view of <u>T. pectoralis</u> already occurring in PNG and stocking this niche could be reconsidered in the light of future experiences with <u>T. pectoralis</u> ?				<input checked="" type="radio"/>		
(4) Is the supportive information provided on Sepik/Ramu fish stocks and associated factors adequate to draw the conclusions presented?					<input checked="" type="radio"/>	

(5) Is the supportive information provided on <u>T. pectoralis</u> adequate for purposes of this evaluation in view of the species already being established in PNG and its wide use in other countries?	NO	UNLIKELY	POSSIBLY	PROBABLY	<input checked="" type="radio"/> YES	<input type="radio"/> DON'T KNOW
(6) Would <u>T. pectoralis</u> have mostly positive ecological impacts ?	NO	UNLIKELY	POSSIBLY	PROBABLY	<input checked="" type="radio"/> YES	<input type="radio"/> DON'T KNOW
(7) Would most consequences of the introduction of <u>T. pectoralis</u> be beneficial to humans ?	NO	UNLIKELY	POSSIBLY	PROBABLY	<input checked="" type="radio"/> YES	<input type="radio"/> DON'T KNOW
(8) Are the safeguards against transfer of diseases and parasites adequate ?	NO	UNLIKELY	POSSIBLY	PROBABLY	<input type="radio"/> YES	<input checked="" type="radio"/> DON'T KNOW
(9) Has the project adequately evaluated all possible factors relating to this proposed introduction in view of constraints that exist ?	NO	UNLIKELY	POSSIBLY	PROBABLY	<input checked="" type="radio"/> YES	<input type="radio"/> DON'T KNOW
(10) Based on all of the available information, do the benefits of this exotic fish introduction outweigh the risks	NO	UNLIKELY	POSSIBLY	PROBABLY	<input checked="" type="radio"/> YES	<input type="radio"/> DON'T KNOW

\* if your response is "no" to this question please disregard all other questions and append your reasons even if only in brief.

डा० कृष्ण लाल सहगल  
परियोजना निर्देशक  
DR. K. L. SEHGAL  
Project Director



तार : माहसीर  
Grams : MAHSEER  
टेलीफोन कार्या. : 445  
Office : 445  
निवास : 330  
Resi. : 330

राष्ट्रीय ठंडापानी मत्स्यकी अनुसंधान केन्द्र (भा० कृ० अनु० १०)  
शिल्वा हिल्स नर्सरी, रूपनगर, पोस्ट बाक्स नं० २८,  
हल्दवानी-२६३ १३६ जि० नैनीताल (उ०प्र०)  
National Research Centre on Coldwater Fisheries (I. C. A. R.)  
Shilwa Hills, Nursery, Roopnagar, Post Box No. 28,  
Haldwani-263 139 Distt. Nainital (U. P.)

BY AIR MAIL

No.F. 4-4(19)/89/DC/2413

December 18, 1989.

Dear Dr. Coates,

I write to refer to your letter of 30th October, 1989 alongwith the enclosures. The receipt of the letter has already been acknowledged through a telex message. As desired therein, I am sending separately four opinionaires duly filled in. I am enclosing one copy of the opinionaires for your necessary action. The second copy is being posted to Dr. T. Petr, FAO Fisheries Department, FAO, Rome through FAC Representative in India by diplomatic pouch. I am also enclosing a brief note on my views regarding introduction of T. rendalli. In case you feel useful the information may be incorporated.

Regarding Part.II/Phase.I of Final Report, I am preparing a detailed note on my views pertaining to non-flood plain regions of the Sepik and the proposed introduction of various categories of coldwater fish species. This note will provide additional information on different aspects of researches carried out in India on Schizothoracids, mahseers (Tor spp.), trouts and Crossocheilus, etc.

With regards and Happy Christmas and New Year.

Yours sincerely,

(K.L.SEHGAL)

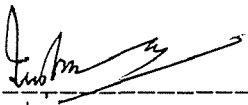
Encl: As above.

Dr. David Coates,  
C/o Westlin,  
Rockliffe, via Dalbeattie,  
Kirkcudbrightshire, Scotland, U.K.

OPINIONAIRE FOR THE SEPIK RIVER FISH STOCK ENHANCEMENT  
ADVISORY GROUP

Recommendation 1

- the introduction of T. rendalli into the Sepik/Ramu Rivers

NAME DR. K.L. SEHGAL SIGNATURE  DATE 18 December 1989

Dear Advisory Group Member,

Based on the information provided to you could you please provide your opinions on the following questions by circling only one of the alternative responses for each question.

You may provide whatever additional comments you wish as an attachment. Please direct such to the project Chief Technical Adviser. These will be taken into account by the project and passed on to PNG authorities in their original form.

RESPONSE

	NO	UNLIKELY	POSSIBLY	PROBABLY	YES	DON'T KNOW
(1) Is there a need to stock Sepik/Ramu floodplains with a macrophyte feeding fish ?					<input checked="" type="radio"/>	
(2) Is <u>Tilapia rendalli</u> an appropriate species for this purpose ?			<input checked="" type="radio"/>			
(3) Do you consider that <u>Tilapia zillii</u> is more appropriate ?		<input checked="" type="radio"/>				
(4) Would another species besides a tilapia be more appropriate ?				<input checked="" type="radio"/>		
(5) Is the supportive information provided on Sepik/Ramu fish stocks and associated factors adequate to draw the conclusions presented ?					<input checked="" type="radio"/>	

(6) Is the supportive information provided on Tilapia rendalli adequate for purposes of this evaluation ?

NO	UNLIKELY	POSSIBLY	PROBABLY	<b>YES</b>	DON'T KNOW
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(7) Would T. rendalli have mostly positive ecological impacts ?

NO	UNLIKELY	<b>POSSIBLY</b>	PROBABLY	YES	DON'T KNOW
----	----------	-----------------	----------	-----	------------

(8) Would most consequences of the introduction of T. rendalli be beneficial to humans ?

NO	UNLIKELY	POSSIBLY	<b>PROBABLY</b>	YES	DON'T KNOW
----	----------	----------	-----------------	-----	------------

(9) Are the safeguards against importation of diseases and parasites adequate ?

NO	UNLIKELY	POSSIBLY	PROBABLY	<b>YES</b>	DON'T KNOW
----	----------	----------	----------	------------	------------

(10) Has the project adequately evaluated all possible factors relating to this proposed introduction in view of constraints that exist ?

NO	UNLIKELY	<b>POSSIBLY</b>	PROBABLY	YES	DON'T KNOW
----	----------	-----------------	----------	-----	------------

(11) Based on all of the available information, do the benefits of this exotic fish introduction outweigh the risks ?

NO	UNLIKELY	POSSIBLY	<b>PROBABLY</b>	YES	DON'T KNOW
----	----------	----------	-----------------	-----	------------

\* if your response is "no" to this question please disregard all other questions and append your reasons even if only in brief.



### Recommendation 1

The two exotic species, (viz., common carp and T. mossambica (= Oreochromis mossambicus) are found to control to a degree the aquatic vegetation on account of their feeding habits. The addition of T. rendalli (T. malanoplura) into the Sepik system will enable to convert high density mass of macrophytes into fish flesh. The principle on which macro-phytophagous species to be considered for a candidature is that it should consume variety of weeds as its food, hardy and easy to handle, does not interfere with other fishes, economical to maintain and adds to the fish yield. T. rendalli meets all these requirements. Due to absence of mouth incubation in this species possibility of high production potential exists. The natural food of T. rendalli includes filamentous algae, semi-submerged or floating vegetation. The species is an established biological tool to control Chara, Najas and other submerged soft vegetation (Avault et al., 1968, Lungen 1968, Blackburn 1968; and Lawrence 1968) which are available in the flood plain region of the Sepik. The effectiveness of T. zilli to control macrophytes is not well-established when compared to T. rendalli.

The alternative species to control macrophytes is the tawes of Indonesia (Puntius javanicus). This species feeds on selected plants belonging to the families of Characeae, Polygonaceae, Najadaceae, Graminae, etc. This fish is reported to be effective in controlling submerged weeds and filamentous algae in large water bodies of Indonesia (Ling, 1967).

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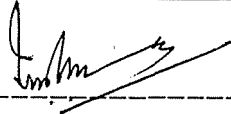
QUESTIONNAIRE FOR THE SEPIK RIVER FISH STOCK ENHANCEMENT  
ADVISORY GROUP

Recommendation 2

- the transfer of O. gouramy into the Sepik/Ramu Rivers

NAME DR. K.L. SEHGAL

SIGNATURE



DATE

18 December 1989

Dear Advisory Group Member,

Based on the information provided to you could you please provide your opinions on the following questions by circling only one of the alternative responses for each question.

You may provide whatever additional comments you wish as an attachment. Please direct such to the project Chief Technical Adviser. These will be taken into account by the project and passed on to PNG authorities in their original form.

RESPONSE

	NO	UNLIKELY	POSSIBLY	PROBABLY	YES	DON'T KNOW
(1) Is there a need to stock Sepik/Ramu floodplain regions with a vegetable feeding fish adapted to inhabit anoxic backwaters and swamps ?			POSSIBLY			
(2) Is <u>Osphronemus gouramy</u> suitable for this purpose in view of the species already occurring in PNG ?				PROBABLY		
(3) Would another species besides <u>O. gouramy</u> be more appropriate in view of <u>O. gouramy</u> already occurring in PNG and stocking this niche could be reconsidered in the light of future experiences with <u>O. gouramy</u> ?						DON'T KNOW
(4) Is the supportive information provided on Sepik/Ramu fish stocks and associated factors adequate to draw the conclusions presented ?					YES	

(5) Is the supportive information provided on <u>O. gouramy</u> adequate for purposes of this evaluation in view of it already being established in PNG and its wide use in other countries ?	NO	UNLIKELY	POSSIBLY	PROBABLY	YES	DON'T KNOW
(6) Would <u>O. gouramy</u> have mostly positive ecological impacts ?	NO	UNLIKELY	POSSIBLY	PROBABLY	YES	DON'T KNOW
(7) Would most consequences of the introduction of <u>O. gouramy</u> be beneficial to humans ?	NO	UNLIKELY	POSSIBLY	PROBABLY	YES	DON'T KNOW
(8) Are the safeguards against transfer of diseases and parasites adequate ?	NO	UNLIKELY	POSSIBLY	PROBABLY	YES	DON'T KNOW
(9) Has the project adequately evaluated all possible factors relating to this proposed introduction in view of constraints that exist ?	NO	UNLIKELY	POSSIBLY	PROBABLY	YES	DON'T KNOW
(10) Based on all of the available information, do the benefits of this exotic fish introduction outweigh the risks	NO	UNLIKELY	POSSIBLY	PROBABLY	YES	DON'T KNOW

\* if your response is "no" to this question please disregard all other questions and append your reasons even if only in brief.

## Recommendation 2

The additional information on O. gouramy based on its transplanting in India is that the species is slow growing (Sukumaran 1969) under tropical conditions. The lower limit on the thermal scale for O. gouramy to grow and reproduce is about 15°C. The fish established itself in India at an elevation of 720 m above msl (Bhimachar et al. 1944).

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OPINIONAIRE FOR THE SEPIK RIVER FISH STOCK ENHANCEMENT  
ADVISORY GROUP

Recommendation 2

- the transfer of Trichogaster pectoralis into the Sepik/Ramu Rivers

NAME DR. K.L. SEHGAL

SIGNATURE



DATE 18 December 1989

Dear Advisory Group Member,

Based on the information provided to you could you please provide your opinions on the following questions by circling only one of the alternative responses for each question.

You may provide whatever additional comments you wish as an attachment. Please direct such to the project Chief Technical Adviser. These will be taken into account by the project and passed on to PNG authorities in their original form.

RESPONSE

	NO	UNLIKELY	POSSIBLY	PROBABLY	YES	DON'T KNOW
(1) Is there a need to stock Sepik/Ramu floodplain regions with a detritus algae feeding fish adapted to inhabit anoxic backwaters and swamps ?				<input checked="" type="radio"/>		
(2) Is <u>T. pectoralis</u> suitable for this purpose in view of the species already occurring in PNG ?				<input checked="" type="radio"/>		
(3) Would another species besides <u>T. pectoralis</u> be more appropriate in view of <u>T. pectoralis</u> already occurring in PNG and stocking this niche could be reconsidered in the light of future experiences with <u>T. pectoralis</u> ?						<input checked="" type="radio"/>
(4) Is the supportive information provided on Sepik/Ramu fish stocks and associated factors adequate to draw the conclusions presented ?					<input checked="" type="radio"/>	

(5) Is the supportive information provided on <u>T. pectoralis</u> adequate for purposes of this evaluation in view of the species already being established in PNG and its wide use in other countries?	NO	UNLIKELY	POSSIBLY	PROBABLY	YES	DON'T KNOW
(6) Would <u>T. pectoralis</u> have mostly positive ecological impacts ?	NO	UNLIKELY	POSSIBLY	PROBABLY	YES	DON'T KNOW
(7) Would most consequences of the introduction of <u>T. pectoralis</u> be beneficial to humans ?	NO	UNLIKELY	POSSIBLY	PROBABLY	YES	DON'T KNOW
(8) Are the safeguards against transfer of diseases and parasites adequate ?	NO	UNLIKELY	POSSIBLY	PROBABLY	YES	DON'T KNOW
Has the project adequately evaluated all possible factors relating to this proposed introduction in view of constraints that exist ?	NO	UNLIKELY	POSSIBLY	PROBABLY	YES	DON'T KNOW
(10) Based on all of the available information, do the benefits of this exotic fish introduction outweigh the risks	NO	UNLIKELY	POSSIBLY	PROBABLY	YES	DON'T KNOW

\* if your response is "no" to this question please disregard all other questions and append your reasons even if only in brief.





# King's College London

UNIVERSITY OF LONDON

DIVISION OF BIOSPHERE SCIENCES

HEAD OF DIVISION: PROFESSOR P.J.PETERSON  
DEPUTY HEAD: DR.C.F.THURSTON

Campden Hill Road  
LONDON W8 7AH  
Telephone: 01 937 5411  
Fax: 01 937 7783

Dr D.Coates  
C/O 'Westlin'  
Rockcliffe via Dalbeattie  
Kirkcudbrightshire  
Scotland

22 December 1989

Dear David,

Sepik River Fish Stock Enhancement Project

I have to confess to being a bit overwhelmed by all of the reports and data analysis that this project has generated. I've tried to digest those items relevant to the present proposals and retain the remainder for consideration when further recommendations come up. I would congratulate you on your hard work in generating much of this information and upon organising the material to best effect.

Well, I have now exercised my judgement and I will be interested to learn in due course what the overall consensus of advice has been. Do you expect to stay with the project if / when stocking gets underway ?

Meanwhile I trust that you are enjoying a good break from it all in Scotland.

I expect to back in College from about 3 January but should you wish to contact me at home please do not hesitate. My telephone number is 028 14 3361 (that is Farnham Common 3361).

Season's Greetings and all the best for 1990

Yours sincerely,

*Roland.*

Roland Bailey



OPINIONAIRE FOR THE SEPIK RIVER FISH STOCK ENHANCEMENT  
ADVISORY GROUP

Recommendation 1

- the introduction of T. rendalli into the Sepik/Ramu Rivers

NAME ROZANNA BAILEY SIGNATURE RO Bailey DATE 22-12-89

Dear Advisory Group Member,

Based on the information provided to you could you please provide your opinions on the following questions by circling only one of the alternative responses for each question.

You may provide whatever additional comments you wish as an attachment. Please direct such to the project Chief Technical Adviser. These will be taken into account by the project and passed on to PNG authorities in their original form.

RESPONSE

	NO	UNLIKELY	POSSIBLY	PROBABLY	YES	DON'T KNOW	
(1) Is there a need to stock Sepik/Ramu floodplains with a macrophyte feeding fish ?				<u>PROBABLY</u>			Macrophytes are present Eaten by wide variety of spp. already but presume incidental part of diet
(2) Is <u>Tilapia rendalli</u> an appropriate species for this purpose ?				<u>PROBABLY</u>			No specialist plant eaten in river - altho' propose Gowamy intro. is also plant eaten
(3) Do you consider that <u>Tilapia zillii</u> is more appropriate ?		<u>UNLIKELY</u>					long track record of intro.
(4) Would another species besides a tilapia be more appropriate ?							* meaning "instead of NO * meaning "as well as PROBABLY - I support intro of Gowamy.
(5) Is the supportive information provided on Sepik/Ramu fish stocks and associated factors adequate to draw the conclusions presented ?					<u>YES</u>		OK.

(6) Is the supportive information provided on Tilapia rendalli adequate for purposes of this evaluation ?

NO UNLIKELY POSSIBLY PROBABLY YES DON'T KNOW

(7) Would T. rendalli have mostly positive ecological impacts ?

NO UNLIKELY POSSIBLY PROBABLY YES DON'T KNOW

*Don't understand Q*

(8) Would most consequences of the introduction of T. rendalli be beneficial to humans ?

NO UNLIKELY POSSIBLY PROBABLY YES DON'T KNOW

*In African captive fishes I know it has never formed a major part of the tilapia catch.*

(9) Are the safeguards against importation of diseases and parasites adequate ?

NO UNLIKELY POSSIBLY PROBABLY YES DON'T KNOW

(10) Has the project adequately evaluated all possible factors relating to this proposed introduction in view of constraints that exist ?

NO UNLIKELY POSSIBLY PROBABLY YES DON'T KNOW

(11) Based on all of the available information, do the benefits of this exotic fish introduction outweigh the risks ?

NO UNLIKELY POSSIBLY PROBABLY YES DON'T KNOW

*I would not object to its introduction (the precedent of other foreign intros has been set) but I doubt whether it will become important ecologically or economically.*

\* if your response is "no" to this question please disregard all other questions and append your reasons even if only in brief.

OPINIONAIRE FOR THE SEPIK RIVER FISH STOCK ENHANCEMENT  
ADVISORY GROUP

Recommendation 2

- the transfer of O. gouramy into the Sepik/Ramu Rivers

NAME ROZAND BAILEY SIGNATURE R Bailey DATE 22/12/89

Dear Advisory Group Member,

Based on the information provided to you could you please provide your opinions on the following questions by circling only one of the alternative responses for each question.

You may provide whatever additional comments you wish as an attachment. Please direct such to the project Chief Technical Adviser. These will be taken into account by the project and passed on to PNG authorities in their original form.

	RESPONSE						
	NO	UNLIKELY	POSSIBLY	PROBABLY	YES	DON'T KNOW	
(1) Is there a need to stock Sepik/Ramu floodplain regions with a vegetable feeding fish adapted to inhabit anoxic backwaters and swamps ?				<input checked="" type="radio"/>			Seasonal desoxygen. water demonstrated. No specialists to occupy & consume veg. at present. Will show similar nich for <u>T. rendalli</u> if latter introduced outside anoxic waters
(2) Is <u>Osphronemus gouramy</u> suitable for this purpose in view of the species already occurring in PNG ?					<input checked="" type="radio"/>		
(3) Would another species besides <u>O. gouramy</u> be more appropriate in view of <u>O. gouramy</u> already occurring in PNG and stocking this niche could be reconsidered in the light of future experiences with <u>O. gouramy</u> ?		<input checked="" type="radio"/>					
(4) Is the supportive information provided on Sepik/Ramu fish stocks and associated factors adequate to draw the conclusions presented ?					<input checked="" type="radio"/>		

5) Is the supportive information provided on <u>O. gouramy</u> adequate for purposes of this evaluation in view of it already being established in PNG and its wide use in other countries ?	NO	UNLIKELY	POSSIBLY	PROBABLY	<u>YES</u>	DON'T KNOW
6) Would <u>O. gouramy</u> have mostly positive ecological impacts ?	NO	UNLIKELY	POSSIBLY	PROBABLY	YES	<u>DON'T KNOW</u> - Don't understand Q.
7) Would most consequences of the introduction of <u>O. gouramy</u> be beneficial to humans ?	NO	UNLIKELY	<u>POSSIBLY</u>	PROBABLY	YES	DON'T KNOW - present data suggests limited yields in other capture fisheries.
8) Are the safeguards against transfer of diseases and parasites adequate ?	NO	UNLIKELY	POSSIBLY	PROBABLY	<u>YES</u>	DON'T KNOW
9) Has the project adequately evaluated all possible factors relating to this proposed introduction in view of constraints that exist ?	NO	UNLIKELY	POSSIBLY	PROBABLY	<u>YES</u>	DON'T KNOW
10) Based on all of the available information, do the benefits of this exotic fish introduction outweigh the risks	NO	UNLIKELY	POSSIBLY	<u>PROBABLY</u>	YES	DON'T KNOW

\* if your response is "no" to this question please disregard all other questions and append your reasons even if only in brief.

OPINIONAIRE FOR THE SEPIK RIVER FISH STOCK ENHANCEMENT  
ADVISORY GROUP

Recommendation 2

- the transfer of Trichogaster pectoralis into the Sepik/Ramu Rivers

NAME ROLAND BAILEY SIGNATURE R.R. Bailey DATE 22/12/89

Dear Advisory Group Member,

Based on the information provided to you could you please provide your opinions on the following questions by circling only one of the alternative responses for each question.

You may provide whatever additional comments you wish as an attachment. Please direct such to the project Chief Technical Adviser. These will be taken into account by the project and passed on to PNG authorities in their original form.

	RESPONSE					
	NO	UNLIKELY	POSSIBLY	PROBABLY	YES	DON'T KNOW
(1) Is there a need to stock Sepik/Ramu floodplain regions with a detritus/algae feeding fish adapted to inhabit anoxic backwaters and swamps?	NO	UNLIKELY	POSSIBLY	PROBABLY	YES	DON'T KNOW
(2) Is <u>T. pectoralis</u> suitable for this purpose in view of the species already occurring in PNG?	NO	UNLIKELY	POSSIBLY	PROBABLY	YES	DON'T KNOW
(3) Would another species besides <u>T. pectoralis</u> be more appropriate in view of <u>T. pectoralis</u> already occurring in PNG and stocking this niche could be reconsidered in the light of future experiences with <u>T. pectoralis</u> ?	NO	UNLIKELY	POSSIBLY	PROBABLY	YES	DON'T KNOW
(4) Is the supportive information provided on Sepik/Ramu fish stocks and associated factors adequate to draw the conclusions presented?	NO	UNLIKELY	POSSIBLY	PROBABLY	YES	DON'T KNOW

Altho' found in many spp. considered incidental. ∴ as abundant potential fish food worth an introduction

(5) Is the supportive information provided on <u>T. pectoralis</u> adequate for purposes of this evaluation in view of the species already being established in PNG and its wide use in other countries?	NO	UNLIKELY	POSSIBLY	PROBABLY	<input checked="" type="radio"/> YES	DON'T KNOW	
(6) Would <u>T. pectoralis</u> have mostly positive ecological impacts ?	NO	UNLIKELY	POSSIBLY	PROBABLY	YES	<input checked="" type="radio"/> DON'T KNOW	<i>Q. nuclear bomb</i>
(7) Would most consequences of the introduction of <u>T. pectoralis</u> be beneficial to humans ?	NO	UNLIKELY	<input checked="" type="radio"/> POSSIBLY	PROBABLY	YES	DON'T KNOW	<i>Diversifies potential catch: acceptable food fish.</i>
(8) Are the safeguards against transfer of diseases and parasites adequate ?	NO	UNLIKELY	POSSIBLY	PROBABLY	<input checked="" type="radio"/> YES	DON'T KNOW	
(9) Has the project adequately evaluated all possible factors relating to this proposed introduction in view of constraints that exist ?	NO	UNLIKELY	POSSIBLY	PROBABLY	<input checked="" type="radio"/> YES	DON'T KNOW	
(10) Based on all of the available information, do the benefits of this exotic fish introduction outweigh the risks	NO	UNLIKELY	<input checked="" type="radio"/> POSSIBLY	PROBABLY	YES	DON'T KNOW	

\* if your response is "no" to this question please disregard all other questions and append your reasons even if only in brief.



Dear David,

Some fairly disorganized thoughts on stocking of your category A species. Sorry they are late. Comments on *T.rendalli* in most cases refer equally to *T. zillii*.

The implication that sheer size and diversity of the Sepik floodplain macrophyte beds makes them safe from significant modification is questionable. An r-adapted species such as *T.rendalli* which, in the Sepik, would mature at 7 months old and spawn at short intervals year round is obviously capable of great increases in biomass during the course of a single wet season. There is the potential for very high population densities when all these fish retreat to permanent floodplain habitat during the dry season. The thought of high densities of *T.rendalli* in dry season refuge habitats combined with their prodigious feeding rate at high temperatures is worrying. From information supplied it seems most roundwaters are deep and steep sided and that the area of submerged/emergent macrophyte beds in them is limited. I suspect that macrophyte cover in permanent floodplain habitats could be reduced by *T.rendalli*, and this would probably have marked effects on several species including the electroide important to the existing fishery.

Recruitment of existing species (both native and introduced) onto the floodplain proper during the wet season comes from roundwaters rather than the river channel and most species in the roundwaters depend to some extent on macrophytes. A significant reduction in macrophyte beds in the permanent habitats will probably result in reduced recruitment onto the floodplain during the flood season.

As it is the temporary floodplain habitats which are most obviously underutilized it would be unfortunate to limit their use by the few species that do already use them.

Dudgeon says in shallow water regions of floodplain sites there was an almost complete absence of benthic invertebrates. Also very few in floating macrophytes. This implies that rooted macrophyte sites must be of prime importance as feeding sites to native species which eat aquatic invertebrates.

Despite the abundance and diversity of aquatic vegetation in the Sepik the only rooted species inhabiting deep water (>1- 1.5m) which are mentioned either by Dudgeon or in your limnological report are *Ceratophyllum* and water lilies. *T.rendalli* appears to have been very effective at destroying these "deeper water" macrophytes in Madagascar and Redding mentions that *Ceratophyllum* is consumed in preference to other plants. How important are these deeper water species as dry season shelter/feeding/breeding areas for existing species particularly in the "one in ten" dry year? Selective removal of soft-leaved, shallow-rooted species of macrophytes by tilapia might be exacerbated by the effects of carp which is still a very new addition to the Sepik fauna and has not yet achieved equilibrium. Australian studies suggest that carp has reduced such species of macrophytes.

Any reduction in macrophyte cover might affect reproduction of species attaching eggs to vegetation especially those breeding mainly in the dry season. Where do the Sepik eleotrids lay their suspended, adhesive eggs? Do they use macrophytes (perhaps the underside of lily pads) to attach them or do they use submerged timber?

From a brief look at what little literature I've got here the only fish species I could find which attaches eggs to macrophytes within the natural distribution of *T.rendalli* is Johnston's topminnow (*Aplocheilichthys johnstoni*) which may attach eggs to (floating?) vegetation. This fish occurs in both the Zambesi and the Zaire systems. I know very little of African fishes and you will probably be able to reassure me that plenty of vegetation spawners are found along with *T.rendalli/zilli* - do you know of any?

Moreau (1986) says of Madagascar "the decrease in aquatic weeds following the introduction of tilapias has resulted in fewer available breeding areas for endemic species". I suspect that *Paretroplus pecti* which you state was nearly wiped out following the introduction of *T.rendalli* to Madagascar may well attach its eggs to macrophytes? Is this so? All I've been able to find out is that it breeds "more like Asian than African cichlids."

In addition to the references you give to document the effects of *T.rendalli* in Madagascar, Moreau (1986) suggests that introduction of this "very prolific and aggressive species" is a major reason for the disappearance of *Ptychochromis betsileanus* from Lake Itasy, a small shallow lake surrounded by swamps, i.e. morphologically similar to a Sepik roundwater. *P.betsileanus* feeds on larval insects, vegetation, small fishes and prawns i.e. similar to a typical unspecialised Sepik fish diet.

*Oxyeleotris heterodon* is probably very similar to *O. lineolatus* in its habits. Peak spawning activity in the dry season which you noted in *O.heterodon* agrees with observations on closely related species. In Lake Tinaroo *O.lineolatus* does not breed in the early part of the dry season when temperatures drop below 24°C but when temperatures rise again in September/October breeding starts and most spawning activity is completed during the early summer while water levels are still falling. From January/February when the water level starts to rise the number of spawnings is greatly reduced although some egg patches are found throughout the rainy season until the temperature falls to about 25°C around April. In Thailand peak spawning activity of *O. marmorata* is similar, peaking in May-June just before the rains.

Male *O.lineolatus* are territorial at least during the breeding season as are most of the eleotrids which have been studied. Tag recaptures from artificial spawning substrate traps in Lake Tinaroo (where annual drawdown varies between 2.5 and 8 metres) show that males return to the same dry season territories from year to year.

The species is cannibalistic, at least during early juvenile stages. Like many other lurking predators *O.lineolatus* associates closely with structure such as submerged timber and macrophyte beds at least during daylight. Juveniles < 75mm are particularly

closely associated with macrophyte beds in Lake Tinaroo. The close association with floating or submerged vegetation has been noted for other large electroid species in other parts of the world (refs available). Would a reduction of the physical structure (weedbeds) in Sepik roundwaters reduce available breeding/feeding territories for the adult Sepik electroids (particularly *O.heterodon*) and/or lower survival of juveniles through increased cannibalism/predation?

What about possible aggression from tilapia species competing for their preferred nesting/nursery sites in the shallow water areas adjacent to weedbeds which are also the habitat of the electroids. *T.rendalli* is reported as being "aggressive" by Coche (1979) whereas he considers *S.mossambicus* as only "somewhat aggressive". Redding mentions the possibility of competition between these two species for nesting sites and there are precedents where *T.rendalli* has largely displaced *O.mossambicus*. The presence of two tilapia species competing with the electroids for overlapping breeding territories might further impact on the electroids.

Although one can argue that any reduction in catch of the electroid species would be compensated for by new catches of *T.rendalli* you have stressed the importance of trying to avoid effects on native species especially those which are already important in the fishery. While the problems of the Sepik are very much in the "now" and the "real" maintaining the electroid catch could be more commercially valuable in the long term than reducing it in order to increase catches of tilapia. If a well organised commercial fishery in the future could overcome constraints to export then *O.heterodon* could well be a high value product on southeast Asian markets as an alternative to *O.marmorata*. Demand for *O.marmorata* in southeast Asia and Hong Kong is greater than current aquaculture production and capture fisheries are small. Low survival and slow growth of the species will probably continue to limit aquaculture production (references available) and there is little chance that wild fish catch will increase. PNG and Irian Jaya are possibly the only places where substantial wild stocks of large *Oxyeleotris* exist to supply the potential market. On the other hand there would be little chance of exporting any tilapia.

Salinity tolerance of *T.rendalli* appears to be at least 19 ppt and I do not understand why you would expect it not to enter brackish water. I presume that the Sepik pipefish only inhabits weedbeds in the lower portion of the river and that an appreciable reduction of macrophyte beds along the river banks would affect this species. *T.zilli* can survive full sea water and would probably spread rapidly to all catchments in New Guinea.

-Possible reduction in abundance of *Glossolepis multisquamatus* which attaches eggs to plants and is "usually found where there is an abundance of aquatic plants in moderately turbid water".

*Arius nox* is mainly confined to the permanent floodplain waters and apparently gets its food from amongst aquatic vegetation.

*Eleotris aquadulcis*. Mainly found in oxbow lakes. Food suggests close association with vegetation, probably also dependent on

vegetation for shelter/breeding.

*Glossogobius koragensis* is mainly found in roundwaters where it apparently breeds. Diet info suggests close association with vegetation and it almost certainly has suspended adhesive eggs which may be attached to vegetation.

I note that Matthes (1977) says that *T.z/////* is destructive to rice crops by nibbling through the stalks. From what I have read about *T.rendall* it would probably do the same and seems to be somewhat wasteful in the way it feeds on grasses, just cutting the stalks and leaving the tops floating. Given that introduction to the Sepik should be regarded as a likely introduction to any other PNG drainage in the long run, has this any implications for existing or future rice production

The anticipated range of establishment of *T.rendall* in the Sepik is also questionable. In Madagascar the species inhabits waters up to 1700m altitude and is present in running waters (Moreau, 1986).

The Mantasoa reservoir where the species is apparently abundant has a temperature range of 15 to 25°C. It appears that the minimum temperature tolerated is below 13°C and in the Sepik this would allow survival to at least 2 500 m. In Mauritius *T.rendall* has invaded "all fresh water bodies" apparently with little human assistance apart from the initial introduction. While preferred weedbed/swamp habitats may be relatively few and far between outside the floodplain there seems little doubt that *T.rendall* will reach habitats such as, for example, Yamkil Swamp at elevation 470 m. (Station 24, Allen and Coates, in press). Obviously we should look not only at possible effects on floodplain species but also at fish from higher altitudes. *T.z/////* which can survive at 8°C could go even higher. Although reproduction and growth would be slower at high altitudes Balarin (1979) refers to yields of 2t/Ha of *T.rendall* at above 1500m.

It would be naive to think that introduction of *T.rendall* would not result in the spread of the species to most freshwaters in PNG (and probably Irian Jaya as well). Given the record of the species in other countries where it has been introduced it would be equally naive to think that extinctions of native species would not occur.

One group at high risk would be melanotaenid species with extremely restricted distributions, particularly those found in close association with aquatic vegetation. Some PNG species which might be most at risk include: - *Melanotaenia herbertaxelrodi*,

*M.lacustris*, *M.parkinsoni*, *M.pilmanala*, *Orilallia* *axelrodi*, *Glossolepis wanamensis*, *G.maculosus*. The list of Irian Jaya rainbowfishes which are equally vulnerable would be longer. While most of these species exist as captive populations (genetically pristine?) in private aquarium collections the possibility of their extinction in the wild is undesirable.

Apart from those species at risk of extinction, abundance of all rainbowfishes could be reduced as all attach their eggs to aquatic vegetation. Could this have an effect on mosquito populations?

Other environmental effects which could result from the presence of *T.rendalli* are a change in the balance of primary production through cropping of the macrophytes and remobilization of their nutrient content leading to increased phytoplankton production and a resultant increase in turbidity, which could further limit the deeper water macrophyte species. I note also that breeding rate of tilapia is related to light penetration. Could this assist in the replacement of *T.mossambicus* by *T.rendalli*.

Increased phytoplankton production would probably also result in increased "leakage" of nutrients to the sea, particularly during the wet season, and increased flow of nutrients from surface waters of the floodplain roundwaters to be locked up in deeper bottom sediments (see Welcomme, River Fisheries, p78). This reduction in available nutrients would seem to act against the chances of maximising the fisheries yield.

Welcomme (1984, in Courtenay and Stauffer) lists *T.rendalli* as being widely classified as a pest where it has been introduced. He also subscribes to the general principle that diversity equates with stability and that adverse effects of introductions are most likely where recipient communities are depauperate in species (as is the Sepik).

Given your stated intent to "...supplement existing stocks with minimal predicted effects on existing species" and your belief that "irrespective of increases in yield, existing stocks should, ideally, be maintained" I think that *T.rendalli/zillii* is a very risky introduction, which could have a big impact on a number of native species as well as on existing stocks of *O. mossambicus*. I feel that ultimate maximisation of fish production from the Sepik could be adversely affected by the introduction. On the other hand I don't doubt that the species would be well received by the locals and agree that increase of fisheries production from the present situation would probably result.

One final (possibly irrelevant) comment- Kenmuir's "Fishes of Kariba" says *T. rendalli* are caught by community effort, "beating" the fish from grassy areas into gill nets and that it is not readily caught by conventional gill netting because of its' diurnal habits.

#### Thoughts on *Osphronemus goramy*

Its record in both PNG and in Madagascar suggest there is probably little to fear from an introduction to the Sepik. In Mauritius since 1951 it has been widely distributed.

Madagascar (and that all successful introductions in PNG have been at low altitudes?) suggests that this species might indeed be restricted to floodplain altitudes. What little information I can find about reproduction in the species suggests that that female fish under Sepik conditions would probably produce 5 000 - 10 000 eggs per year at bimonthly intervals and fish would probably mature at 2 years old. While this might make establishment in the Sepik more difficult than it would be with tilapias it also suggests this species would be a safer macrophyte feeder to introduce given the importance of macrophytes to so many of the native species. The species is also a highly valued food fish everywhere it occurs.

#### Thoughts on *Trichogaster pectoralis*

The record of this species shows little cause for concern, although there is some dietary overlap with other native and exotic species inhabiting the Sepik floodplain. One thing which might limit its usefulness is the year round frequency of rainfall with no marked dry season. Huet (Textbook of Fish Culture) indicates that rain can destroy the bubble nest and while Boonsom (1986) indicates the species can spawn virtually year round it is interesting to note that she indicates that the original distribution of the fish only covers the drier parts of Thailand (rainfall < 1500mm) where there is a distinct dry season. The coastal area of Perak where Boonsom says the species became well established after introduction is one of the lowest rainfall areas of peninsular Malaysia.

A general comment on your statement that *O.gouramy* and *T.pectoralis* are intended to occupy deoxygenated waters that "other species suggested for introduction would not be expected to utilise" or that "no existing species are adapted to inhabit". I think it is a feature of many representatives of genera in northern Australia and PNG that they can withstand very low dissolved oxygen levels even though they may not be so quite so well adapted as the above two species. Many eleotrids have this characteristic and so do some of the aridiids, saratoga, (and archer fish I suspect). That brings me to another question - what happened to archer fish (*T. chatareus*) as a potential introduction candidate? - I seem to remember it being mentioned early on in the piece but lately there has been no mention. With its diet being largely terrestrial insects which it actively imports from outside the aquatic habitat, its excellent edible quality, its habitat preferences, its fecundity and ability to reproduce in freshwater ponds I would have thought it could have been a great candidate for the floodplain.

On to bony bream - I suspect that some people who suggest that it may not be a good species for the fishery might be thinking in European terms. Keith Bishop tells me bony bream is very popular with Northern Territory aborigines despite the fact they have access to a similar but somewhat greater range of species to those available in the Sepik floodplain. Are they used by villagers in the Fly? They do have a lot of fine bones - on the other hand it appears to have a very high oil content. *Dorosoma petenense* has an oil content of 12%. Dead fish certainly go off quickly in nets (probably because of the oil content) but in my

experience it doesn't die any more quickly in the nets than other fish. If we're talking about a system where the subsistence fishery is as important as the commercial fishery then storage may not be much of an issue. As far as large catches of bonies "filling up" nets - yee it can (occasionally) happen if you are using 3" or 3½" nets - I've never had it happen in 4" mesh. I suspect the reaction of a Sepik villager to a net full of bony bream could be more positive than the reaction of most Australians. If there is any problem getting rid of a net full of bonies they'd probably make admirable pig food.

I think Keith Bishop might provide useful info on movements on and off the floodplain. My impression is that a large percentage of young fish would travel upstream off the floodplain at the end of the flood - large numbers of young fish head up into the river from Tinaroo at the end of each summer. This appears to be similar to the migrations you mention in *Prochilodus*.

If bony bream is really not utilisable and is likely to be a real nuisance to fishing activities then it probably should not be stocked as I wouldn't be surprised if it ended up being the highest yielding species in the river. I think there is a vague chance that sheer numbers could cause habitat changes which might affect other fish but I think experiences with dorosomids in general and the nature of the likely candidate species for the Sepik in particular, should be investigated further and the boney breams should definitely not be discarded at this stage.

I must fax this to you tonight so I'm sorry it hasn't been better organised. Cheers to both you and Tomi.

Mal.





OPINIONAIRE FOR THE SEPIK RIVER FISH STOCK ENHANCEMENT  
ADVISORY GROUP

Recommendation 1

- the introduction of T. rendalli into the Sepik/Ramu Rivers

NAME M. Mackinnon SIGNATURE [Signature] DATE 3/1/90

Dear Advisory Group Member,

Based on the information provided to you could you please provide your opinions on the following questions by circling only one of the alternative responses for each question.

You may provide whatever additional comments you wish as an attachment. Please direct such to the project Chief Technical Adviser. These will be taken into account by the project and passed on to PNG authorities in their original form.

RESPONSE

	NO	UNLIKELY	POSSIBLY	PROBABLY	YES	DON'T KNOW
1) Is there a need to stock Sepik/Ramu floodplains with macrophyte feeding fish ?			<input checked="" type="radio"/>			
2) Is <u>Tilapia rendalli</u> an appropriate species for this purpose ?		<input checked="" type="radio"/>				
3) Do you consider that <u>tilapia zillii</u> is more appropriate ?	<input checked="" type="radio"/>					
4) Would another species besides a tilapia be more appropriate ?			<input checked="" type="radio"/>			
5) Is the supportive information provided on Sepik/Ramu fish stocks and associated factors adequate to draw the conclusions presented ?				<input checked="" type="radio"/>		

1) Is the supportive information provided on <u>Alapia rendalli</u> adequate for purposes of this evaluation ?	NO	UNLIKELY	POSSIBLY	PROBABLY	YES	DON'T KNOW
2) Would <u>T. rendalli</u> have mostly positive ecological impacts ?	NO	UNLIKELY	POSSIBLY	PROBABLY	YES	DON'T KNOW
3) Would most consequences of the introduction of <u>rendalli</u> be beneficial to humans ?	NO	UNLIKELY	POSSIBLY	PROBABLY	YES	DON'T KNOW
4) Are the safeguards against importation of diseases and parasites adequate ?	NO	UNLIKELY	POSSIBLY	PROBABLY	YES	DON'T KNOW
5) Has the project adequately evaluated all possible factors relating to this proposed introduction in view of constraints that exist ?	NO	UNLIKELY	POSSIBLY	PROBABLY	YES	DON'T KNOW
6) Based on all of the available information, do the benefits of this exotic fish production outweigh the risks ?	NO	UNLIKELY	POSSIBLY	PROBABLY	YES	DON'T KNOW

If your response is "no" to this question please disregard all other questions and append your reasons even only in brief.

OPINIONAIRE FOR THE IK RIVER FISH STOCK ENHANCEMENT  
ADVISORY GROUP

Recommendation 2

- the transfer of O. ramy into the Sepik/Ramu Rivers

NAME M. MACKINNON SIGNATURE *M. Mackinnon* DATE 3/1/90

Dear Advisory Group Member,

Based on the information provided to you could you please provide your opinions on the following questions by circling only one of the alternative responses for each question.

You may provide whatever additional comments you wish as an attachment. Please direct such to the project Chief Technical Adviser. These will be taken into account by the project and passed on to PNG authorities in their original form.

RESPONSE

QUESTION	NO	UNLIKELY	POSSIBLY	PROBABLY	YES	DON'T KNOW
1) Is there a need to stock Sepik/Ramu floodplain regions with a vegetable feeding fish adapted to inhabit anoxic backwaters and swamps ?				<input checked="" type="radio"/>		
2) Is <u>Osphronemus gouramy</u> suitable for this purpose in view of the species already occurring in PNG ?				<input checked="" type="radio"/>		
3) Would another species besides <u>O. gouramy</u> be more appropriate in view of <u>O. gouramy</u> already occurring in PNG and stocking this niche could be reconsidered in the light of future experiences with <u>O. gouramy</u> ?			<input checked="" type="radio"/>			
4) Is the supportive information provided on Sepik/Ramu fish stocks and associated factors adequate to draw the conclusions presented ?				<input checked="" type="radio"/>		

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JAN 05 '90  
D.F.I. MALKMIN 070

<p>(5) Is the supportive information provided on <u>O. gouramy</u> adequate for purposes of this evaluation in view of it already being established in PNG and its wide use in other countries ?</p>	NO	UNLIKELY	POSSIBLY	PROBABLY	YES	DON'T KNOW
<p>(6) Would <u>O. gouramy</u> have mostly positive ecological impacts ?</p>	NO	UNLIKELY	POSSIBLY	PROBABLY	YES	DON'T KNOW
<p>(7) Would most consequences of the introduction of <u>O. gouramy</u> be beneficial to humans ?</p>	NO	UNLIKELY	POSSIBLY	PROBABLY	YES	DON'T KNOW
<p>(8) Are the safeguards against transfer of diseases and parasites adequate ?</p>	NO	UNLIKELY	POSSIBLY	PROBABLY	YES	DON'T KNOW
<p>(9) Has the project adequately evaluated all possible factors relating to this proposed introduction in view of constraints that exist ?</p>	NO	UNLIKELY	POSSIBLY	PROBABLY	YES	DON'T KNOW
<p>(10) Based on all of the available information, do the benefits of this exotic fish introduction outweigh the risks</p>	NO	UNLIKELY	POSSIBLY	PROBABLY	YES	DON'T KNOW

141 05 '90 00:00 D.P.I. MALDEN I.D. 070 3330E

if your response is "no" to this question please disregard all other questions and append your reasons even if only in brief.

OPINIONAIRE FOR THE SEPIK RIVER FISH STOCK ENHANCEMENT  
ADVISORY GROUP

Recommendation 2

- the transfer of Trichogaster pectoralis into the Sepik/Ramu Rivers

NAME M. MACKINNON SIGNATURE *M. Mackinnon* DATE 3/1/90

Dear Advisory Group Member,

Based on the information provided to you could you please provide your opinions on the following questions by circling only one of the alternative responses for each question.

You may provide whatever additional comments you wish as an attachment. Please direct such to the project Chief Technical Adviser. These will be taken into account by the project and passed on to PNG authorities in their original form.

RESPONSE

	NO	UNLIKELY	POSSIBLY	PROBABLY	YES	DON'T KNOW
(1) Is there a need to stock Sepik/Ramu floodplain regions with a detritus/algae feeding fish adapted to inhabit anoxic backwaters and swamps				<input checked="" type="radio"/>		
(2) Is <u>T. pectoralis</u> suitable for this purpose in view of the species already occurring in PNG ?				<input checked="" type="radio"/>		
(3) Would another species besides <u>T. pectoralis</u> be more appropriate in view of <u>T. pectoralis</u> already occurring in PNG and stocking this niche could be reconsidered in the light of future experiences with <u>T. pectoralis</u> ?		<input checked="" type="radio"/>				
(4) Is the supportive information provided on Sepik/Ramu fish stocks and associated factors adequate to draw the conclusions presented?				<input checked="" type="radio"/>		

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(5) Is the supportive information provided on <u>T. pectoralis</u> adequate for purposes of this evaluation in view of the species already being established in PNG and its wide use in other countries?	NO	UNLIKELY	POSSIBLY	PROBABLY	YES	DON'T KNOW
(6) Would <u>T. pectoralis</u> have mostly positive ecological impacts ?	NO	UNLIKELY	POSSIBLY	PROBABLY	YES	DON'T KNOW
(7) Would most consequences of the introduction of <u>T. pectoralis</u> be beneficial to humans ?	NO	UNLIKELY	POSSIBLY	PROBABLY	YES	DON'T KNOW
(8) Are the safeguards against transfer of diseases and parasites adequate ?	NO	UNLIKELY	POSSIBLY	PROBABLY	YES	DON'T KNOW
(9) Has the project adequately evaluated all possible factors relating to this proposed introduction in view of constraints that exist ?	NO	UNLIKELY	POSSIBLY	PROBABLY	YES	DON'T KNOW
(10) Based on all of the available information, do the benefits of this exotic fish introduction outweigh the risks	NO	UNLIKELY	POSSIBLY	PROBABLY	YES	DON'T KNOW

if your response is "no" to this question please disregard all other questions and append your reasons even if only in brief.

