

INTRODUCTION AND DISTRIBUTION OF EXOTIC FISH IN PAPUA NEW GUINEA

G. J. West and J. Glucksman*

ABSTRACT

Twenty species of exotic freshwater fish are known to have been introduced to Papua New Guinea. These introductions have been made for various reasons: for mosquito control, to establish sport fisheries, to improve the protein-deficient diet of inland people, to supply forage for introduced predatory fish, and for aquaculture. Nine of these species, including two that presumably escaped from ornamental aquaria, are now established in natural waters. *Salmo gairdneri* is, to date, the only species showing potential for intensive aquaculture, while two species originally intended for aquaculture, *Tilapia mossambica* and *Cyprinus carpio*, support fisheries in natural waters. The Department of Primary Industry has severely restricted the importation and distribution of most exotic fish, and the severity of the restrictions will probably increase.

INTRODUCTION

THE first exotic fish to be introduced to Papua New Guinea was the mosquito fish *Gambusia affinis*† (Baird and Girard), brought in by Public Health authorities in 1930 as part of their malaria control programme.

Further interest in fish introductions was not evident until after the Second World War. A nutrition survey conducted in 1947 indicated that the diet of inland people was deficient in animal protein and it was recommended that supplies of fish be developed to the maximum possible extent (Anon. 1947).

In 1950, at the request of the Department of External Territories, W. H. Schuster, a fisheries specialist from Indonesia visited Papua New Guinea to advise on methods for increasing the fish harvest. His first recommendation was simply to intensify the coastal and brackish water fisheries. He realized, however, that problems in handling and transporting fresh fish would prevent this increased production from being distributed inland, where protein deficiency was most marked. For inland areas the aquaculture of *Cyprinus carpio* Linnaeus and *Tilapia mossambica* (Peters) was recommended, though Schuster noted that the people lacked any tradition of aquaculture (Schuster 1951).

Schuster also pointed out that the yield in many natural bodies of water would probably be below the potential indicated by primary production, because of a paucity of native plankton-eating species. He noted such a situation in the lower Sepik River, and suggested that if it became necessary to increase production, herbivores and omnivores such as *Trichogaster pectoralis* (Regan), *Helostoma temminckii* Cuvier and Valenciennes, and *Puntius gonionotus* (Bleeker) could be introduced. He emphasized that this should be done only after exhaustive ecological investigation.

Concerning the introduction of *Cyprinus carpio* and *Tilapia mossambica* to the highlands, Schuster considered that there could be no objections, as in this area there were no fish known to be of economic importance.

Whitley (1951), however, opposed the introduction of exotic fish and suggested that methods of preservation and distribution be improved so that existing fish populations could be more fully exploited, thus avoiding the almost inevitable ecological disruptions which follow introduction of exotic species.

In 1956, H. Van Pel, an inland fisheries specialist with the South Pacific Commission, visited Papua New Guinea and his report encouraged the introduction of exotic fish to natural waters (Van Pel 1956).

*Kanudi Fisheries Research Station, DPI, Konedobu.

†Common names are those in current use in Papua New Guinea.

The early attempts to develop freshwater fisheries followed the direction suggested by Schuster and Van Pel, although the recommendations of the former concerning methods of minimizing the possibility of ecological disruption were generally ignored.

The Department of Primary Industries has been responsible for the majority of the introductions, most of which were intended to increase the yield of inland fisheries. A brief summary of the first introductions of each species, with comments on their distribution and relative success, is given in Table 1, and a detailed history of the introduction of each of the twenty species is given to the following section.

HISTORY OF INTRODUCTIONS

Gambusia affinis (Baird and Girard)
MOSQUITO FISH

The mosquito fish was introduced to Rabaul in March 1930 when Public Health authorities obtained stocks of these fish from Sydney and placed them in a pond at the Rabaul Botanic Gardens (Table 2). When they began reproducing, stocks were transferred to numerous outstations (Anon. 1931). They were thought to have considerably reduced the mosquito population of the Lakunai Swamp, near Rabaul (Anon. 1932). Breeding continued in Rabaul and the fish were supplied free on request to all parts of the Trust Territory of New Guinea (Anon. 1936).

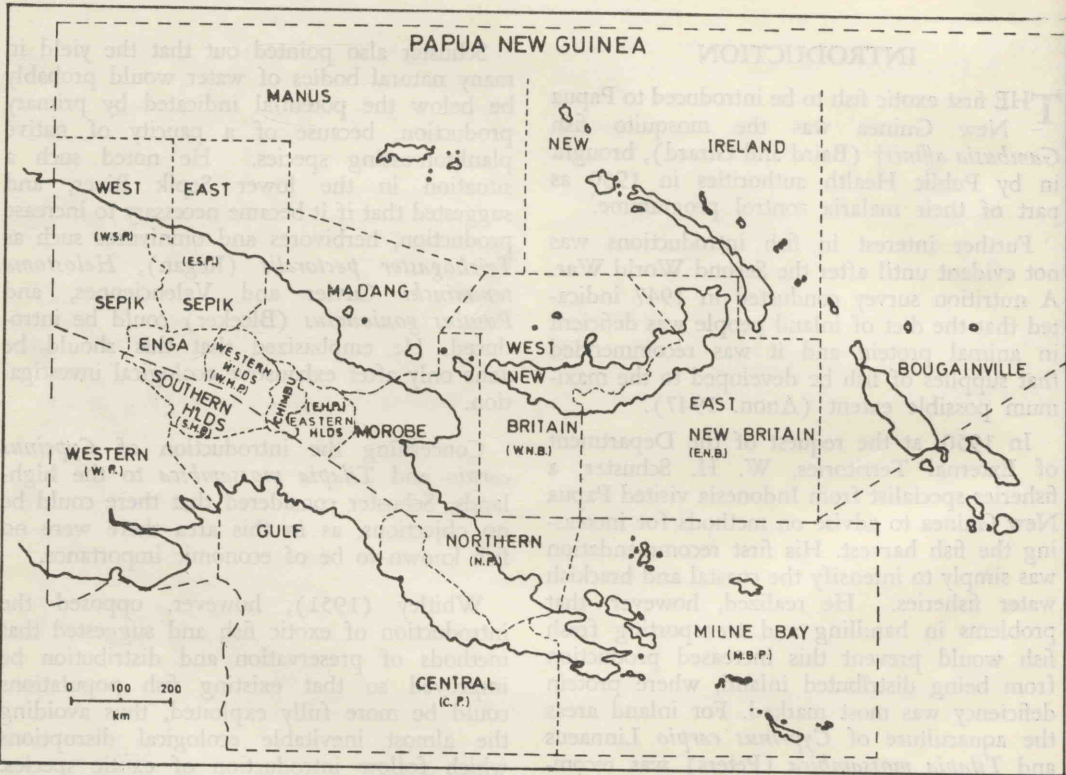


Figure 1.—Provinces of Papua New Guinea

Table 1.—Fish introductions in Papua New Guinea

Species	Date of first introduction	Present distribution	Comments
<i>Gambusia affinis</i>	1930	Very widespread	Of little value in malaria control, and possibly harmful to native fish.
<i>Salmo trutta</i>	1949	S.H.P. Chimbu, E.H.P.	Moderate potential for localized food source, aquaculture, and tourist incentive.
<i>Salmo gairdneri</i>	1952	E.H.P., S.H.P., W.H.P., Enga, Chimbu, W.S.P.	Similar, but better potential than <i>S. trutta</i> .
<i>Tilapia mossambica</i>	1954	Very widespread	Important as food, especially in Sepik and Central Provinces. Considerable potential.
<i>Trichogaster pectoralis</i>	1957	Very limited distribution; Central & Gulf Provinces	Of no value at present; possible potential in sewerage ponds and manure-methane digester systems.
<i>Osphronemus goramy</i>	1957	Small, widely scattered populations	Of little value, and low potential.
<i>Cyprinus carpio</i>	1959	In most suitable highland streams and lakes; isolated populations in lowlands	Of moderate value, potential probably realized.
<i>Hypophthalmichthys molitrix</i>	1961	Nil	Unsuccessful in pond culture trials.
<i>Bidyanus bidyanus</i>	1962	Nil	Intended for stocking in natural waters, but did not survive.
<i>Tandanus tandanus</i>	1963	Nil	Pond culture trials discontinued and stocks destroyed.
<i>Carassiops klunzingeri</i>	1963	Nil	Intended as forage fish, but did not survive.
<i>Retropinna semoni</i>	1963	Nil	Intended as forage fish for trout, but did not survive.
<i>Ctenopharyngodon dellus</i>	1964	Nil	Unsuccessful in pond culture trials. Stocks destroyed.
<i>Plectroplites ambiguus</i>	1966	Nil	Released in natural waters but did not survive.
<i>Trachystoma petardi</i>	1966	Nil	No information available.
<i>Puntius gonionotus</i>	1970	Experimental ponds. Aiyura, E. H. P.	Not to be distributed.
<i>Poecilia reticulata</i>	1967?	Port Moresby area	Escaped aquarium fish, possibly harmful.
<i>Trichogaster trichopterus</i>	1970?	Port Moresby area	Escaped aquarium fish, possibly harmful.
<i>Salvelinus fontinalis</i>	1974	Some fry released in streams in S.H.P.	Considerable mortality of ova during hatching.

Mosquito fish were first introduced to the Territory of Papua in 1933, when Public Health authorities in Port Moresby received a shipment from Rabaul. They were placed in rainwater storage tanks and a billabong near the Laloki River, 20 km from Port Moresby. Subsequent floods gave the fish access to the Laloki River and adjacent swamps. Studies at the time indicated that the fish showed promise for the control of mosquito larvae (Giblin 1936). Distribution continued well into the Second World War, when demand declined with the advent of DDT (Anon. 1950).

Whitley (1951) considered that the mosquito fish might be no more effective in controlling mosquito larvae than many native freshwater fish, and that its introduction might offer the

native species serious competition.

The Department of Health no longer considers larvivorous fish to be effective in malaria control and the distribution of any fish for this purpose is now discouraged (Venters 1973, unpublished report).

Salmo trutta Linnaeus BROWN TROUT

Salmo gardneri Richardson RAINBOW TROUT

Salvelinus fontinalis (Mitchill) BROOK TROUT

Trout were first introduced in 1949, when Sir Edward Hallstorm imported 20 000 brown trout fingerlings from Oberon, N.S.W., and released them in streams in the Nondugl area and in a pond at the Hallstrom Fauna Trust

Table 2.—Introduction of *Gambusia affinis*

Year	Date	Source	Place of introduction	Place of Discovery	Comments
1930	March	Sydney	Rabaul		Successfully bred in pond in Botanic Gardens. Distributed to outstations.
1930-31		Rabaul Botanic Gardens	Lakunai Swamp, Rabaul		
1933	July	Rabaul	Port Moresby ponds near Laloki River, S.D.A. Mission Mirigeda		Spread into Laloki River system.
1934-37		Rabaul	New Guinea, Samarai, Solomon Is., Gilbert & Ellice Is.		Widespread introductions.
1942-44		Port Moresby	Sogeri, Lakekamu, Lae, Milne Bay		
1944-45		Port Moresby	Wewak, Madang		
1950 (?)			Manus I.		Introduced by DASF
1954				Nondugl	In ponds at Hallstrom Fauna Trust.
1955	20 August			Laloki R. swamps	Abundant.
1956	24 August			Lae Botanic Gardens	Moderate population reported.
1958			Irian Jaya		sent by DASF
1961	July			Minj area	Found in many ponds.
1962		Aua I.	Uvulu I.		Have since become abundant.
1972	October			Chambri Lake	Moderate population reported.
1972	December			Mendi area	Found in streams.

(Rapson, unpublished) (Table 3). The area was inspected in 1950, but there was no evidence of their survival, due probably to the turbid conditions during violent floods in the wet season (Schuster 1951).

The next introduction involved eyed eggs, which were much cheaper to transport by air than fingerlings. Bulolo Gold Dredging Ltd successfully hatched 10 000 rainbow trout ova in a raceway in the Upper Buane Creek, a tributary of the Bulolo River, in 1952. The company continued hatching eggs and distributing fry in the Bulolo River and its tributaries for several years, and the fish apparently survived until about 1964.

Private introductions continued until 1959, but as with the earlier releases, the streams to which they were introduced apparently were not suitable for long term survival or reproduction. The reasons for the introductions do not appear in the records, but it was the opinion of one visiting fisheries consultant that "From the point of view of local food resources, trout is not very important and its interest lies more in providing sports fishing for the European population" (Van Pel 1956).

The Division of Fisheries first became involved in importing trout in 1964, when 2 000 rainbow trout fry were released in the Baiyer and Gumanch Rivers near Mount Hagen. The release sites were evidently more suitable than those of earlier private introductions, for the fish survived and reproduced. Further introductions of small numbers of fingerlings were made in 1968 and 1970. In 1971 a small hatchery was established at Mendi, and by the end of the 1973 hatching season approximately 180 000 rainbow trout had been distributed throughout the highlands (Table 4). The growth rates exhibited by these trout have been very encouraging and they are heavily fished by the highlands people. Now that it has become economically feasible to periodically stock waters unsuitable for natural reproduction, it is felt that trout will not only make a contribution to the diet of the people, but that they will have some value in encouraging tourism. During the severe famine in 1972, caused by drought and frost, considerable quantities of trout were caught in some of the worst affected areas and served as a very welcome addition to the people's diet (Blichfeldt 1974, unpublished report).

There has been little objection to trout introductions because the native fish fauna in the highlands is sparse and trout are a far more attractive food item. In addition, because trout can survive only in cold highland streams, they offer no threat to the valuable lowland native fish fauna.

Commercial trout farming was first begun in 1973 by two private individuals, David Hunter and Ian Holder, who organized the Kotuni Trout Farm in conjunction with the landowners along Kotuni Creek. To date 250 000 eggs have been hatched and the resulting trout are being reared for market.

In August 1974 the Mendi Local Government Hatchery received a trial shipment of 50 000 eyed ova of the brook trout, *Salvelinus fontinalis* (Mitchill) from New South Wales State Fisheries. Hatching was not successful, and only 4 000 fry were released in the Margarima River.

Tilapia mossambica (Peters) TILAPIA or MAKAU

In December 1954, 250 tilapia fry from Malaya arrived in Port Moresby. Most of them were forwarded to Goroka, from where further distributions were made.

Experiments with tilapia, as well as other species under consideration for highlands pond culture, were carried out by the Division of Fisheries at the Dobel experimental ponds, Mount Hagen, where tilapia were first introduced in October 1955. Tilapia proved disappointing in pond culture trials in the highlands. The fish bred rapidly, ponds quickly became overcrowded, and the maximum size attained fell to about 15 cm.

In the lowlands, the first record of tilapia occurring in natural waters was in 1956, when tilapia were noticed in a stream near Port Moresby (Van Pel 1956). Van Pel encouraged the introduction of new species into natural waters, and it was only shortly after that that extensive distributions of tilapia commenced (Table 5). Claims were made at the time that tilapia were effective in controlling mosquito larvae, and since they grow to what was considered a more desirable size for human consumption, they were distributed in preference to *Gambusia affinis*.

Table 3.—Introduction of trout

Year	Province	Species	Date	Source		Number and life stage	Place of introduction	Comments
				External	Internal			
1949	W.H.P.	Brown	30 Nov.	Oberon, N.S.W.		20 000 fingerlings	Arl River, near Nondugl; pond at Nondugl.	Imported by Hallstrom Fauna Trust. Did not survive.
1952	Morobe	Rainbow	1 Oct.	New Zealand		10 000 ova	Bulolo River and tributaries, Wau area.	Imported by Bulolo Gold Dredging Ltd. Hatching successful.
1954	Morobe	Rainbow	6 Oct.			20 000 ova	Bulolo River and tributaries, Wau area.	Imported by Bulolo Gold Dredging Ltd. Hatching successful.
1955	Morobe	Rainbow				20 000 ova	Bulolo River and tributaries, Wau area.	Bulolo Gold Dredging Ltd. No trout sighted since 1964.
	Morobe	Brown	30 June			20 000 ova	Bulolo River and tributaries, Wau area.	Bulolo Gold Dredging Ltd. High mortality before release.
1956	E.H.P.	Rainbow			Bulolo Gold Dredging Ltd.	fry	Streams around Goroka.	Organized by Farmers and Settlers Association. Established and reproducing in Kotuni Creek.
	E.H.P.					50 000 ova		Imported by Farmers and Settlers Association. Total mortality during hatching.
	W.H.P.		Mar. ?				Minj River at Minj, Mumbul River at Banz, Kayne River at Kudjip, Aviam River at Aviam, Limil River at Kinjip.	Stocked by Banz Farmers and Settlers Association. Apparently not successful, possibly due to wet season floods, from November to March, at the time the fish were released.
1959	Morobe	Rainbow		Ballarat, Victoria*		500 fry	Komo and Ove Rivers, Kokoda	Organized by Kienzle Bros. Did not survive. Rivers subject to torrential flooding.
1964	W.H.P.	Rainbow		Jindabyne, N.S.W.†		2 000 fry	Baiyer and Gumanch Rivers, near Mt Hagen	Introduced by DASf. Subsequent natural reproduction.

Table 3.—continued

Year	Province	Species	Date	Source		Number and life stage	Place of introduction	Comments
				External	Internal			
1968	W.H.P.	Rainbow			Gumants River	Fingerlings	Nebilyer River, near Mt Hagen	Transplanted by private individuals T. Kinkuy and P. Lovell.
	Chimbu	Brown	13 Dec.	Ballarat, Victoria		Approx. 200 fry	Aunde Lake, Mt Wilhelm	Good growth, some mortality of large fish. Subsequent natural reproduction.
	E.H.P.	Brown	13 Dec.	Ballarat, Victoria		Approx. 1 000 fry	Streams around Goroka	Introduced by DASF. Apparently unsuccessful.
	S.H.P.	Brown	13 Dec.	Ballarat, Victoria		Approx. 300 fry each	Mangani River, Mendi and Iaro River, Ialibu	Introduced by DASF. Good growth, subsequent natural reproduction.
	W.H.P.	Brown	13 Dec.	Ballarat, Victoria		Approx. 400 fry	Nebilyer River, Mt Hagen	Introduced by DASF. Apparently unsuccessful.
1970	W.H.P.	Brown Rainbow	27 Oct.	Hume Weir Trout Farm Albury		70 yearlings and 500 fry		Introduced by DASF. Intended for Kaugel River, Tambul, but all died in transit.
	S.H.P.	Rainbow	24 Nov.	Hume Weir Trout Farm		400 fry	Iaro River at Kagua	Introduced by DASF. Subsequent natural reproduction.
			8 Dec.	Hume Weir Trout Farm		400 fry	Piwa River at Tari	Introduced by DASF.
1971-74	See Table 4 for hatching and release details of Rainbow Trout from Mendi Local Government Hatchery.							
1973	E.H.P.	Rainbow	Aug.	Hume Weir Trout Farm		50 000 ova	Kotuni Trout Farm	Hatched and reared for market.
	E.H.P.	Rainbow	Sept.	Silver Stream Trout Farm, Buxton, Vic.		200 000 ova	Kotuni Trout Farm	Hatched and reared for market.
1974	E.H.P.	Rainbow	Sept.				Kotuni Trout Farm	

*Ballarat Fish Acclimatisation Society.

†New South Wales State Fisheries.

Table 4.—Introduction of rainbow trout hatched at Mendi, 1971-1974

Date	Place of introduction	Province	Number	Origin of ova	Comments
4.8.71	Andel River	S.H.P.	1 700	Hume Weir Trout Farm, Albury	Original shipment of 2 000 eggs arrived on 22-7-71.
30.8.71	Upper Mangani River	"	1 500	" " " " "	25 000 ova arrived 5-8-71; 16 500 fry released.
1.9.71	Upper Tongo River, Komia	"	5 000	" " " " "	Subsequent reproduction.
2.9.71	Lake Egari	"	200	" " " " "	
2.9.71	Lake Pipak	"	200	" " " " "	
6.9.71	Upper Kaugel River	"	5 000	" " " " "	Subsequent reproduction.
6.9.71	Hydro-dam, Mendi	"	100	" " " " "	
21.9.71	Aip River	"	500	" " " " "	
22.9.71	Upper Margarima	"	3 750	" " " " "	Unconfirmed reports of reproduction.
30.9.71	Tributary of Upper Mangani River	"	400	" " " " "	
6.12.71	Tongo River, Komiakul	"	800	Gaden Hatchery, Jindabyne, N.S.W. State Fisheries	50 000 ova arrived 2-11-71; 10 500 fry released.
7.12.71	Tongo River, Komia	"	2 400	" " " " "	Subsequent reproduction.
7.12.71	Tongo River, Egari	"	3 300	" " " " "	
9.12.71	Kompian via Wabag	W.H.P.	4 000	" " " " "	
18.8.72	Upper Andabare	"	3 000	Hume Weir Trout Farm, Albury	
18.8.72	Waga River, Kandep-Laiagam	"	3 000	" " " " "	
19.8.72	Tinj River, Kandep-Laiagam	"	2 000	" " " " "	
19.8.72	Marient River, Kandep-Laiagam	"	2 000	" " " " "	
24.8.72	Poru River, Pangia	S.H.P.	1 000	" " " " "	
24.8.72	Nama River	"	1 000	" " " " "	

Table 4.—continued

Date	Place of introduction	Province	Number	Origin of ova	Comments
24.8.72	Luma River	S.H.P.	1 000	Hume Weir Trout Farm, Albury	
24.8.72	Ibei River	"	1 000	" " " " "	
31.8.72	Lake Egari, Mendi	"	2 000	" " " " "	
4.9.72	Aweta River, Kapiago	"	1 000	" " " " "	Have appeared in Lake Kapiago.
4.9.72	Paga River	"	1 000	" " " " "	
5.9.72	Iaro River	"	4 000	" " " " "	Brown trout previously established.
5.9.72	Konju River	"	1 000	" " " " "	
6.9.72	Sau River	"	2 000	" " " " "	
6.9.72	Kai River	"	2 000	" " " " "	
7.9.72	Wagaba River, Komo	"	1 000	" " " " "	
7.9.72	Tamaria River	"	1 000	" " " " "	
9.9.72	Aiyena River, Tari	"	3 000	" " " " "	
9.9.72	Aura	"	3 000	" " " " "	
9.9.72	Wambip Creek	"	2 000	" " " " "	
9.9.72	Wapu Creek	"	2 000	" " " " "	
10.9.72	Arkim River, Mendi	"	1 000	" " " " "	
10.9.72	Anga River	"	3 000	" " " " "	
12.9.72	Andabare River	W.H.P.	3 000	" " " " "	
12.9.72	Lai River	"	1 500	" " " " "	
12.9.72	Yangi River	"	3 000	" " " " "	
12.9.72	Kera River	"	1 500	" " " " "	
13.9.72	Ambum River (Wabag-Kampian)	"	2 000	" " " " "	
13.9.72	Leima River	"	2 000	" " " " "	

Table 4.—continued

Date	Place of introduction	Province	Number	Origin of ova	Comments
15.9.72	Andawe River, Ialibu	S.H.P.	2 000	Hume Weir Trout Farm, Albury	Original shipment of 2 000 eggs arrived on 22.7.71.
15.9.72	Iaro River	"	1 000	"	25 000 ova arrived 3.4.71; 14 000 fry released
15.9.72	Linengi River	"	1 000	"	Subsequent reproduction.
15.9.72	Lake Iwiva (Ipea)	W.H.P.	2 000	"	
15.9.72	Ailee River	"	2 000	"	
16.9.72	Korman River, Mt Hagen	"	2 000	"	Subsequent reproduction.
16.9.72	Tuman River, Angalimp	"	2 000	"	
17.9.72	Upper Mendi River	S.H.P.	6 000	"	
18.9.72	Mambo River Kagua	"	3 000	"	Unconfirmed report of reproduction.
18.9.72	Sugu River, Kagua	"	2 000	"	
20.11.72	Kiburu River (Longo)	"	2 000	Gaden Hatchery, Jindabyne, N.S.W. State Fisheries	20 000 ova arrived 1.11.71; 10 000 fry released.
4.12.72	Sol River, Telefomin	W.S.P.	1 000	"	
9.12.72	Catholic Mission Dam, Pangia	S.H.P.	100	"	Trout from bushwater, camped.
12.12.72	Ankura River	"	5 000	"	
13.12.72	Pino River	"	2 000	"	These stocked in Lake Korohe
13.12.72	Anga River	"	2 000	"	
13.12.72	Biano River	"	1 000	"	
16.12.72	Nebilyer River, Mt Hagen	W.H.P.	1 000	"	
20.12.72	Kolba Creek, Lai Valley	S.H.P.	1 500	"	
9.1.73	Aip River	"	1 500	"	
9.1.73	Enep Creek, Upper Mangani	"	2 250	"	

Table 4.—continued

Date	Place of introduction	Province	Number	Origin of ova	Comments
10.1.73	Lower Mangani	S.H.P.	3 400	Gaden Hatchery, Jindabyne, N.S.W. State Fisheries	
30.8.73	Kum River, Mt Hagen	W.H.P.	1 000	Hume Weir Trout Farm, Albury	50 000 ova arrived 29-7-73; 20 400 fry distributed.
30.8.73	Kuna River	"	5 000	" " " " "	
31.8.73	Kagua River, Kagua	S.H.P.	1 000	" " " " "	
4.9.73	Minj River, Minj	W.H.P.	3 000	" " " " "	
4.9.73	Arl River, Nondugl	"	3 000	" " " " "	First stocked in 1949 with brown trout.
7.9.73	Piwa River, Tari	S.H.P.	2 000	" " " " "	
7.9.73	Huria River, Tari	"	4 000	" " " " "	
1.10.73	Korn River, Mendi	"	1 400	" " " " "	
3.10.73	Rivers near Kompiam	Enga	5 000	" " " " "	65 000 ova arrived 28-8-73; 37 000 fry distributed.
3.10.73	Noka River, Wapenamanda	"	2 000	" " " " "	
4.10.73	Arou River, Kopiago	S.H.P.	1 000	" " " " "	
10.10.73	Minamp River, Wapenamanda	Enga	3 000	" " " " "	
10.10.73	Tobak River, Wapenamanda	"	2 000	" " " " "	
10.10.73	Tale River, Wapenamanda	"	3 000	" " " " "	
11.10.73	Megabo River, Henganofi	E.H.P.	2 000	" " " " "	
11.10.73	Dunatina River, Henganofi	"	3 000	" " " " "	
11.10.73	Akuitana River, Kainantu	"	3 000	" " " " "	
11.10.73	Ibauta River, Kainantu	"	2 000	" " " " "	
15.10.73	Nali River, Pangia	S.H.P.	2 000	" " " " "	
16.10.73	Tekin River, Telefomin	W.H.P.	2 000	" " " " "	
16.10.73	Lutap-Feramin Rivers	"	2 000	" " " " "	
16.10.73	Iram River, Tifalmin	W.S.P.	2 000	" " " " "	
17.10.73	Bernaria River, Tari	S.H.P.	1 000	" " " " "	
17.10.73	Tebi River	"	1 000	" " " " "	
19.10.73	Nembi River, Nipa	"	3 000	" " " " "	
24.10.73	Rivers near Ialibu	"	4 000	Gaden Hatchery, Jindabyne, N.S.W. State Fisheries	50 000 ova arrived 4-10-73; 33 600 fry distributed.
25.10.73	Kolba River, Mendi	"	2 000	" " " " "	
7.11.73	Rivers near Ialibu	"	4 000	" " " " "	
8.11.73	Nijo River, Laiagam	Enga	2 000	" " " " "	

Table 4.—continued

Date	Place of introduction	Province	Number	Origin of ova	Comments
8.11.73	Lake Iviva	Enga	1 000	Gaden Hatchery, Jindabyne, N.S.W. State Fisheries	Previous stocking of 2 000 failed to reproduce.
8.11.73	Lagaip River	"	5 000	" " " " "	
8.11.73	Kinduli River, Kandep	"	1 000	" " " " "	
8.11.73	Yenat River	"	1 000	" " " " "	
8.11.73	Sais River	"	1 000	" " " " "	
8.11.73	Yakwat River	"	1 000	" " " " "	50 000 ova arrived 24-10-73; 34 400 fry distributed.
8.11.73	Kuliak River	"	1 000	" " " " "	
13.11.73	Poru River, Pangia	S.H.P.	1 000	" " " " "	
13.11.73	Ioropini River, Pangia	"	1 000	" " " " "	
13.11.73	Ombrey River, Pangia	"	3 000	" " " " "	
14.11.73	Ingish River, Mendi	"	1 000	" " " " "	
15.11.73	Wiwi River, Pangia	"	2 000	" " " " "	
15.11.73	Lua River, Pangia	"	1 000	" " " " "	
15.11.73	Nali River, Pangia	"	1 000	" " " " "	
19.11.73	Nomandi River, Kerowagi	Chimbu	2 000	" " " " "	Brown trout previously established.
21.11.73	Nipa River, Mendi	S.H.P.	2 000	" " " " "	
27.11.73	Tilipa River, Mendi	"	1 000	" " " " "	
29.11.73	Kegan River, Kandep	Enga	1 000	" " " " "	
29.11.73	Labai River, Kandep	"	2 000	" " " " "	
29.11.73	Ko River, Kandep	"	1 000	" " " " "	
29.11.73	Moi River, Kandep	"	2 000	" " " " "	
5.12.73	Mubi River, Kutubu	S.H.P.	2 000	" " " " "	
11.12.73	Enep River, Mendi	"	1 000	" " " " "	
11.12.73	Mangani River, Mendi	"	2 000	" " " " "	
12.12.73	Lake Kapiago, Koroba	W.H.P.	1 000	" " " " "	
12.12.73	Paga River, Kapiago	"	500	" " " " "	
12.12.73	Hembe River, Kapiago	"	500	" " " " "	
17.12.73	Tongo River, Mendi	S.H.P.	2 000	" " " " "	

Table 5.—Introduction of *Tilapia mossambica*

Year	Province	Date	Source		Place of introduction	Place of discovery	Comments
			External	Internal			
1954	Central	10 Dec.	Malaya		Bomana ponds		50 sent to Bomana.
	E.H.P.	"	Malaya		Goroka ponds		200 sent to Goroka.
1955	"	6 June		Goroka	Goroka area		
	W.H.P.	20 July		Goroka	Korn Farm, Mt Hagen		
	"	17 Aug.		Goroka	Nondugl, Minj		
	Chimbu	29 Aug.		Goroka	Chimbu Catholic Mission		
	Central	31 Aug.		Goroka	Port Moresby		
	"	1 Sept.		Goroka	Sogeri		
	W.H.P.	20 Sept. Oct.		Goroka	Baiyer River Dobel Fish Ponds		Reproducing readily (1960). Largest fish 0.2 kg (July 1961).
	Central	15 Jan. Feb.		Bomana	Port Moresby	Port Moresby	To ponds behind Jackson's airstrip. Observed in a stream near Port Moresby, (Van Pel 1956).
1956	W.N.P.	2 May		Bomana	Kandrian		
	Morobe	4 May		Bomana	Bulolo		To Bulolo Gold Dredging Ltd.
	Central	7 June		Bomana	Waigani Swamp		Established in Waigani Swamp and Laloki River by 1959.
	E.H.P.	8 July		Bomana	Aiyura		To ponds at H.A.E.S. Aiyura.
	Central	12 Sept.		Bomana	Laloki R. Agric. Station		
	Morobe	12 Sept.		Bomana	Wau		To Mr A. L. Hurrell and Mr Dix.

Table 5—continued

Year	Province	Date	Source		Place of introduction	Place of discovery	Comments
			External	Internal			
1956	Morobe	Sept.		Goroka	Bulolo		Sent by Highlands Farmers and Settlers Association to Bulolo Gold Dredging Ltd. By 1961 tilapia had become established in Bulolo River. Considered by local people as inferior to catfish as food.
		3 Oct.	Singapore				No data on place of introduction.
	Morobe	23 Oct.			Lae		To ornamental ponds, Lae Botanical Gardens.
	S.H.P.	?			L. Kutubu		Date uncertain. Apparently did not survive.
1957	Madang	27 May				Madang	Caught in DASF station dam.
		10 June		Bomana	Maprik		Natural pond stock.
	E.H.P.	27 Nov.		Kainantu	Aiyura		To ponds at H. A. E. S. Aiyura.
1958	W.N.B.	27 May		Bomana	Talasea		To Mr Searle. No further information.
	Central	July		Bomana	Bisianumu		To Agriculture Station pond.
	"	19 Sept.		Bomana	Koitaki		To Mr Sefton, Sogeri area.
	Northern	30 Sept.		Bomana	Kokoda		To Mr Kienzle at Yodda.
	"	10 Oct.		Bomana	Kokoda		To Mamba Plantation.
	Central					Bolegila River, Rigo	Tilapia reported.
1959	Northern	Jan.		Lae	Awala Plantation		Later released in Sohu River from where they moved into the Kumusi River. Plentiful by 1963.
	Central	24 July				Waigani Swamp	Tilapia caught with 3¼ inch gill net averaged 0.4 kg. First noticed for sale at Koki Market on 28 June, 1961.
	"	Aug.			Kemp Welch River		Numerous by 1962.
	Bougainville	20 Aug.			Tauu (Mortlock) I.		No further information.
	"				Arawa Plantation		Spread to Jaba-Panguna system.

Table 5—continued

Year	Province	Date	Source		Place of introduction	Place of discovery	Comments
			External	Internal			
1959	Morobe				Mumeng		Escaped from dams into natural waters.
	"				Bulolo		To ponds of Golden Pines Sawmilling Co. Ltd. Had stunted by 1961.
	E.S.P.				Screw River		Subsequently moved into Sepik River where they were plentiful by 1966.
1960	Bougainville	25 Feb.		Bomana	Sohano		Released in airport bomb craters.
	E.N.B.	16 Mar.		Bomana	Warangoi		To Mr Morris. Tilapia reported to be plentiful in Warangoi River, 12 Oct., 1971.
	New Ireland	16 Mar.			Kavieng		No further information.
	Western	2 May		Bomana	Balimo		Intended for mosquito control.
	"	12 Oct.			Balimo, Lake Murray		Apparently did not survive.
	Gulf				Kerema		In pond near district office; reported still present.
1961	Western	2 June		Bomana	Balimo		To Awaba Mission.
	Central	2 June			Bereina		About 200 sent for planting in backwaters.
	"	10 July				Inauaia (Bereina District)	
	Northern	10 July				Popondetta	
	W.S.P.	10 July				Lumi	Tilapia reproducing in ponds in Somoro area.
	W.H.P.	10 July				Kerowagi, Henganofi, Banz, Bena Bena, Wahgi River near Minj	Tilapia known to be present.
		12 Aug.			Natural waters near Mt Hagen		Tendimbuga and Ambra areas.
1963	Northern						Tilapia being introduced to slow-moving streams in the province.
1964	Morobe	1 May			Miliom, Wigotei, Rautei, Eretei	Kabwum	Tilapia breeding well.
	W.S.P.	July			Amanab		Ponds stocked with tilapia.
		Nov.		Wewak			200 fish introduced.

Table 5—continued

Year	Province	Date	Source		Place of introduction	Place of discovery	Comments
			External	Internal			
1965	Central	1 June			Bereina		
1966	Gulf	30 Nov.			Terapo		
1967	"	1 Feb.			Kukipi		
1968	Central	15 Mar.			Cape Rodney		
	Madang				Tung		Bogia area. Introduced by F. Beale.
	"				Ramu River backwaters		Introduced by J. McKinnon.
1969	"	27 Mar.			Ramu River at Aiome		By DASF. Apparently unsuccessful.
	"				Ramu River backwaters near Annaberg		By Catholic Mission, Annaberg.
1970	"	15 Dec.			Ramu River backwaters near Annaberg		By DASF. Tilapia caught in same area in April 1972.
1971	Morobe	7 Sept.				Boana area	Approximately 200 ponds previously stocked.
	Gulf					Tauri River backwaters	Originally transplanted from pond at Kerema.
1972	W.H.P.	18 May				Baiyer River	
	E.H.P.	29 Aug.				Ramu River backwaters, Arona	
1972	Bougainville	Oct.		Arawa Plantation	Tributary of Jaba River, B.C.L. Jaba pump station		Washed out of ponds at headwaters of Jaba River. These are descendants of Arawa stock, transported by ex-labourers.
1974	E.H.P.	May			Pond at Okapa		Poisoned to begin culture of carp.
	Bougainville	May			Billabong at Pagana River		Probably intentionally introduced by local inhabitants, from Jaba stocks.

Table 6.—Introduction of *Trichogaster pectoralis*

Year	Province	Date	Source		Place of introduction	Place of discovery	Comments
			External	Internal			
1957	Central	2 Oct.	Malaya		Bomana		300 imported.
1959	W.H.P.	24 July		Bomana	Dobel Ponds		5 fish transferred. Did not breed at Dobel.
1960	Central	June	Malaya		Waigani Swamp		20 fish survived out of shipment of 300.
	Central	21 Dec.	Singapore		Waigani Swamp		150 fish released.
1962		Nov.	Malaya				1 000 fish sent, but only 500 survived.
1963	Central	13 Jan.	Malaya		Bomana		120 fish released.
	"	21 May		Bomana	Sirinumu Dam		700 fish released. Very rare by 1969.
1972	Gulf					Gulf Province	Snake-skinned goramy reported in eastern coastal areas, as far west as Moviavi.

Table 7.—Introduction of *Osphronemus goramy*

Year	Province	Date	Source		Place of introduction	Place of discovery	Comments
			External	Internal			
1957	Central	2 Oct.	Malaya		Bomana		30 fish arrived.
1959	W.H.P.	3 July		Bomana	Dobel ponds		2 fish transferred.
1960	Central	16 June	Sydney		Bomana		96 fish.
1960	"	5 July	Sydney		Bomana		140 fish.
1960	Western	25 July		Bomana	Balimo		
1960	W.H.P.	20 July		Bomana	Dobel Ponds		A further 10 fish introduced.
1960	E.N.B.	July		Bomana	Rabaul		25 fish sent to G. Morris, Warangoi. Growth excellent.
1961	W.H.P.	20 Oct.		Dobel	Golf course pond, Mt Hagen		All fish transferred. Survival improbable.
1960		July	Malaya				400 fish.
1962	E.S.P.	Nov.	Jayapura		Wewak		1 000 fish.
1962	Madang		Irian Jaya	Wewak	Dumpu, Bogia		Released in lake near Dumpu, and at Bogia. No information on survival.
1963	W.S.P.	Aug.		Kreer ponds, Wewak	Amanab		20 fish transferred, reproducing (1972).
1971	E.S.P.	Mar.			Lake Imbia near Maprik		85 fish introduced—still present at Jan. 1973.
	Morobe	14 Sept.				Lae	Present at Botanical Gardens and Animal Industry Section.
1966	Central	2 Nov.		Wewak	Sirinumu impoundment		28 fingerlings introduced; no evidence of survival.
	Morobe				Lake Wanum		Some doubt about species—possibly <i>Trichogastre pectoralis</i> . No goramy caught in survey of 1975.
1970	Central	6 May		Bomana	Iarowari High School		30 fish placed in a pond with access to Laloki River. Pond subsequently destroyed.

Table 7—continued

Year	Province	Date	Source		Place of introduction	Place of discovery	Comments
			External	Internal			
1971	Manus	12 Jan.		Bomana	Lake Puwan, Tong I.		62 fish introduced.
	E.N.B.	Aug.			Vudal Agricultural College		
1972	"					Kerevat River	Report of giant goramy in Kerevat River.
1973	E.S.P.	8 Jan.				Lake Imbia	A 4 kg fish caught by handline.

Table 8.—Introduction of *Cyprinus carpio*

Year	Province	Date	Variety	Source		Place of introduction	Place of discovery	Comments
				External	Internal			
1959	Central	Aug.	Golden	Taronga Park, Sydney		Bomana ponds		26 fish
	"	Aug.	"	Taronga Park, Sydney		Dobel ponds		10 fish
1960	E.H.P.	Dec.	"		Dobel	Goroka		6 fish to I. Downs
	W.H.P.	Dec.	"			Mt Hagen		6 fish to G. Broomhead
1961	E.H.P.	Jan.	"		Dobel	Aiyura H.A.E.S.		6 fish
	"	Jan.	"		"	Goroka		6 fish to I. Downs
	W.H.P.	Jan.	"		"	Banz		6 fish
	Madang	Jan.	"		"	Madang		6 fish to Agriculture Office
	Morobe	Jan.	"		"	Lae		6 fish to 3-mile Agriculture station
	S.H.P.	Mar.	"			Mendi		12 fish to District Commissioner
	W.H.P.	Mar.	"		Dobel	Wapenamanda		6 fish
	"	Mar.	"		"	Catholic Mission, Mt Hagen		6 fish
	Morobe	Mar.	"			Wau		6 fish to H. Fleck
	E.H.P.	21 April	"			Aiyura		12 fish to W. Larner
	"	21 April	"			Aiyura H.A.E.S.		23 fish
	W.H.P.	6 May	"			Mt Hagen		17 fish to golf course pond; subsequently reproduced
	S.H.P.	17 June	"			Kandep		12 fish for release in Kandep lakes; now very common
	W.H.P.	20 June	"			Mt Hagen		6 fish
	"	4 July	"	Lake Sentani, Irian Jaya		Dobel ponds, Mt Hagen		6 fish brought by A. Tubb
	"	8 July	Mirror	Singapore		Dobel ponds		325 fish

Table 8—continued

Year	Province	Date	Variety	Source		Place of introduction	Place of discovery	Comments
				External	Internal			
1961	Central	8 July	Mirror	Singapore		Bomana ponds		25 fish.
	E.N.B.	8 July	"	"		Warangoi		25 fish to G. Morris.
	E.H.P.	8 July	"	"		Arau Plantation Aiyura		25 fish to W. Larner. Dam burst in 1966; carp established in Wanton and O'awa Rivers.
	W.H.P.	17 July	Golden			Korgua	Lae Botanical Gardens	6 fish to D. Leahy.
	Morobe	7 Aug.						Carp present.
	W.H.P.	25 Aug.	Mirror			Wabag		15 fish to station pond.
	"	24 Sept.	Golden			Golf course pond, Mt Hagen		6 fish.
	"	18 Oct.	Mirror			Minj		To Swiss Mission and private individuals.
	"	18 Oct.	"			Nondugl		To Hallstrom Trust.
	"	20 Oct.	Cantonese			Mt Hagen		20 fish to golf course pond.
	E.H.P.	25 Oct.	"			Goroka		17 fish to DASF piggery pond.
	W.H.P.	26 Oct.	Golden			Dobel ponds		200 fish.
	Morobe	26 Oct.	"			Lae Botanical Gardens		6 fish.
	S.H.P.	1 Nov.	Mirror			Mendi		20 fish to station pond.
	Central	17 Nov.				Tapini		On 5th May 1962 dam burst and carp escaped.
	W.H.P.	27 Nov.	Cantonese			Minj		45 fish to Swiss Mission and private individuals.
	"	27 Nov.	"			Nondugl		25 fish to Hallstrom Trust.
	"	1 Dec.	"			Wapenamanda		15 fish to Lutheran Mission.
	E.H.P.	6 Dec.	"			Aiyura		100 fish to H.A.E.S.
	"	6 Dec.	"			Goroka		60 fish to 4 plantations.

Table 8—continued

Year	Province	Date	Variety	Source		Place of introduction	Place of discovery	Comments
				External	Internal			
1961	W.H.P.	22 Dec.	Golden			Nondugl		20 fish to Hallstrom Trust.
1962	S.H.P.	Jan.	Golden, Cantonese, Mirror				Mendi	Golden, cantonese and mirror carp held in DASF ponds.
	Central	7 June			Dobel	Tapini and Kosipi Swamps		50 fish, 40 for release in swamps.
	Northern	13 June	"		Dobel	Kokoda		To Mamba Plantation.
	Chimbu	29 Sept.			Dobel	Kerowagi		5 carp sent.
	E.S.P.	Oct.			Mt Hagen	Wewak		120 fish to Boram Corrective Institute.
1963	W.H.P.	20 Feb.	Golden and Cantonese		Dobel	Lake Kapiago		9 Golden, 24 Cantonese carp introduced. Have since become abundant.
	E.S.P.	June	Golden		Mt Hagen	Wewak		25 fish to Kreeer Ponds.
	W.H.P.	Aug.				Western Highlands		200 carp distributed.
	E.S.P.	Aug.	Golden		Goroka	Wewak		10 fish to Kreeer Ponds.
	W.S.P.	Dec.	"			Ponds in Somoro area		Fish grew well.
1964	E.N.B.	7 May	Cantonese		Aiyura, H.A.E.S.	Rabaul		20 fish.
	Bougainville	7 May	"		Aiyura, H.A.E.S.	Buin		30 fish.
	Morobe	May	"		Aiyura, H.A.E.S.	Lae		100 fish.
	Central	May	Golden			Bomana pond		17 fish stocked.
	S.H.P.	May				Tari and Pangia		Released in natural waters.
	E.H.P.	July	Golden			Bena Bena, Hengano		Ponds stocked with small number of fish.
	Morobe	July	"			Lake near Boana		Lake thought to have no native fish; no outlet.
	S.H.P.	Nov.	"			Egari area		Fish ponds stocked.
	"	Dec.	Cantonese			Kagua		15 fish for pond project.

Table 8—continued

Year	Province	Date	Variety	Source		Place of introduction	Place of discovery	Comments
				External	Internal			
1965	S.H.P.	Feb.	Golden			Lake Kutubu		Subsequent unconfirmed sightings.
	W.H.P.					Lake Iviva (Ipea)		50 fish stocked. Present in 1970 survey.
1966	E.H.P.					Henganofi		Carp escaped from burst pond into Kamanotina and Kafetina Rivers.
1967	W.H.P.	Jan.			Dobel		Wahgi River	Fish escaped into Wahgi River.
	Morobe	Oct.				Lake Trist		Have since become abundant.
	Madang					Ponds at Simbai		Approx. 80 ponds had previously been stocked.
1970	W.H.P.	13 May				Lake Iviva (Ipea)		68 carp introduced.
		May					Lake Birip	Established.
	Central	July					Laloki River, Port Moresby	Established.
	W.H.P.	Oct.	Cantonese				Lagaip River, Laigam	Carp abundant in backwaters.
	S.H.P.	Oct.					Haliabadia Creek, Komo.	Carp escaped from burst dam into tributary of Waguba River.
	Madang	21 Nov.	Golden				Simbai	Ponds flooded during heavy rain and carp lost.
1971	S.H.P.	Feb.					Lakes Egari, Pipiak and Walolo	Established.
	W.S.P.	Feb.					Vanimo Vocational School	Established.
	W.H.P.	20 Aug.					Wahgi River near Mt Hagen, and Lai River near Wabag.	Established.
	"	5 Nov.			Banz			500 fish to Lutheran Agricultural Training School.

Table 8—continued

Year	Province	Date	Variety	Source		Place of introduction	Place of discovery	Comments
				External	Internal			
1971	S.H.P.	10 Nov.			Dobel	Tomba		80 fish.
	W.H.P.	19 Nov.			Dobel	Minj		450 fish to D.A.S.E.
1972	Western	13 Jan.	Golden				Aramia River, Balimo area	Established.
	E.H.P.	Aug.					Ramu River, Kainantu	Established.
1973	Distribution of fish from Dobel and Aiyura restricted to approved aquaculture projects in highlands.							

Although tilapia were first introduced to the highlands, it is only in lowland waters with their warmer temperatures and more abundant food supply that tilapia have become of economic importance.

In Port Moresby, tilapia caught in Waigani Swamp were first noticed for sale at Koki Market in June 1961. During the season of the south-easterly trade winds they are one of the most common species at the market, and by 1969 the annual sale there was estimated at 70 tonnes, worth approximately K60 000.

It is in the Sepik River system that the impact of tilapia (called "makau" in this area) has been greatest. It was noted by Schuster as an area where the fish production could be greatly increased by the introduction of suitable species. Tilapia were introduced first to a natural pond at Maprik in June 1957, from where, apparently as a result of a flood in 1959, they entered the Screw River, a tributary of the Sepik. By 1966 they were abundant in the Sepik River system, and the stock is considered sufficiently large that, if it could be suitably processed locally, it might largely displace imported low-priced canned fish.

Tilapia introduction and natural dispersal have been extensive. There is insufficient information to assess their effect on the native fish fauna, but subjective observations suggest that, to date, there have been no ill effects.

Trichogaster pectoralis (Regan) SNAKE-SKINNED GORAMY

The introduction of this fish to waters containing no species capable of directly exploiting primary production was suggested by Schuster (1951). Limited trials at Dobel Ponds indicated that, as expected, the fish were unsuitable for the highlands, and all subsequent releases were in lowland natural waters or ponds (Table 6). There is no record of how this fish became established in the Gulf Province, the only area where its utilization for food is reported. Except in sewerage ponds and manure-methane digester systems, there is little interest in the pond culture of this relatively small fish.

Osphronemus goramy Lacepède GIANT GORAMY

Van Pel (1956) suggested this species for lowland pond culture, an activity previously given low priority by Schuster (1951). The fish first arrived from Malaya in 1957 and were released in a billabong at Bomana Gaol, where they subsequently bred. They are still present at Bomana, and some individuals as large as 40 cm are occasionally caught. These fish have been the source of various introductions throughout Papua New Guinea (Table 7). A small number were sent to Dobel for trials in pond culture, but the growth rate was poor, and they failed to reproduce.

In 1962 *Osphronemus goramy* were obtained from Dutch officials in Hollandia (now Jayapura) and placed in ponds at Amanab and Wewak. There followed some distributions to natural waters in the Sepik and Madang areas, but little is known of the success of these introductions.

Cyprinus carpio Linnaeus COMMON CARP

Although the introduction of carp had been recommended in 1951 by Schuster and again in 1956 by Van Pel, the Division of Fisheries was somewhat reluctant to introduce this fish, which was already considered a noxious species in several countries. However, when tilapia proved unsuccessful in highland pond culture the introduction of carp was deemed necessary, and the first stocks were secured in 1959 (Table 8).

Of the three varieties introduced, Golden, Cantonese and Mirror, only the Cantonese and Golden survived past 1969. They proved amenable to highland conditions, breeding readily in ponds at Dobel, and later at the Highlands Agricultural Experimental Station at Aiyura. The first stocks of fingerlings for distribution were ready at Dobel in 1961 and Aiyura in 1963. From then on extensive stocking of artificial ponds (most of which were improperly constructed), rivers and lakes took place, and now nearly every body of water in the highlands even marginally suitable for carp has been stocked. The wisdom of some of these stockings has subsequently been questioned, particularly that of Lake Kutubu in

1965, which had a unique and plentiful fish and invertebrate fauna (Rapson 1967).

Under proper management, the yield from the pond culture of carp can be very considerable. For example, experiments with supplemental feeding of local pig rations consisting of 10 per cent fishmeal and 90 per cent cooked sweet potato (*Ipomoea batatas*), resulted in production equivalent to 1 600 kg/ha/annum. Another experiment with a specially formulated pellet feed produced 3 000 kg/ha/annum (Glucksman 1973, unpublished report). However, even from the inception of the carp distribution programme, doubts were expressed about the economic viability of carp culture, based mainly on the high cost of fish food (Van der Meulen 1962). In addition, problems of capital, labour, expertise, preservation and transport prevented the indigenous small-holder from achieving yields even approaching this magnitude, or marketing the bulk of lesser harvests.

In a Department of Agriculture, Stock and Fisheries survey in October 1973 it was found that fish constituted a negligible portion of the animal protein marketed in the highland centres of Mendi, Mount Hagen, Kundiawa and Goroka, and that what fish were marketed were almost invariably taken from wild populations (Glucksman 1974, unpublished report).

In the lowlands, carp are economically important only in Port Moresby. Individual carp, taken from surrounding swamps, first appeared in Koki Market in 1971. Since then their numbers have increased steadily and in 1974 they amounted to between 5 and 10 per cent of the tilapia catch.

Hypophthalmichthys molitrix (Cuvier & Valenciennes) SILVER CARP

Ctenopharyngodon idellus (Cuvier & Valenciennes) GRASS CARP

Puntius gonionotus (Bleeker) JAVANESE CARP

These fish were introduced at various times for highland pond culture because they were thought to be superior to common carp in that they required less supplemental feeding,

particularly of protein, and were amenable to multi-species culture in chemically fertilized ponds.

The early introductions of silver and grass carp did little to establish their usefulness in pond culture, due mainly to difficulties in obtaining seed stock, and a lack of research facilities. There were some introductions to natural waters, both deliberate and accidental, but it appears that there has been no survival (Table 9).

After 1970, when the contribution of highlands aquaculture began to be questioned, carp other than *Cyprinus carpio* were restricted to experimental ponds. There has been little success in the culture of these species except for *Puntius gonionotus*. Individuals reared in a pond fertilized at the rate of 360 kg/ha/annum of calcium triple superphosphate have reproduced.

Australian Freshwater Fish Introductions

Seven species of Australian freshwater fish have been introduced to Papua New Guinea (Table 10). *Bidyanus bidyanus* (Mitchell), the silver perch, and *Carrassiops klunzingeri* Ogilby, the western carp-gudgeon were released together in Sirinumu Dam near Port Moresby, the carp-gudgeon being intended as a forage species. However, the number of fish involved was small, and the introduction was unsuccessful.

The freshwater catfish *Tandanus tandanus* (Mitchell), was introduced to test its suitability for highland pond culture, but all the fish were destroyed when it was decided to discontinue the experiment.

The Australian smelt *Retropinna semoni* (Weber), was released in streams which had previously been stocked with trout. It was intended as a forage species but it apparently did not survive.

There is little information available about the introduction of *Percalates colonorum* (Gunther), the estuary perch, and *Trachystoma petardi* (Castlenau), the freshwater mullet, to a pond at Mageri Agricultural Station, Sogeri, but apparently neither species survived.

The last introduction was that of the golden perch, *Plectroplites ambiguus* (Richardson).

Table 9.—Introduction of *Hypophthalmichthys molitrix*, *Ctenopharyngodon idellus* and *Puntius gonionotus*

Year	Date	Source	Place of introduction	Comments
		External	Internal	
<i>Hypophthalmichthys molitrix</i> —Silver carp				
1961	8 July	Singapore	Bomana Dobel Aiyura	25 fish. 190 fish. Sent to W. Larner. Washed into Wanton and O'awa Rivers in 1966. Check in 1970 revealed no survivors.
	25 Oct.		Dobel ?	10 fish to golf course pond.
	1 Nov.		Mt Hagen Mendi	20 fish to station pond. Survived until about 1964.
	9 Nov.		Dobel ? Minj	20 fish to P. Maxtone-Graham. No further record.
1963	June		Mt Hagen	21 fish, no further record.
1965	22 Oct.	Hongkong	Kreer ponds, Wewak Bomana, Dobel, Goroka	Unsuccessful.
1972	21 Feb.	Japan	Dobel	15 fish, subsequently destroyed by vandals in 1973.
<i>Ctenopharyngodon idellus</i> —Grass carp				
1964	Dec.	Hongkong	Bomana Dobel Goroka	No records. 1 surviving at present. No records.
1965	22 Oct.	Hongkong	Waigani	Apparently unsuccessful.
1972	21 Feb.	Japan	Dobel	12 fish, destroyed by vandals 1973.
<i>Puntius gonionotus</i> —Javanese carp				
1970	15 Dec.	Kuala Lumpur	Aiyura H.A.E.S.	200 fish, surviving and reproducing.

Table 10.—Introduction of native Australian freshwater fish

Species	Date	Province	Place of introduction	Comments
<i>Bidyanus bidyanus</i>	1963 May	Central	Sirinumu impoundment	No evidence of survival.
<i>Carassiops klunzingeri</i>	1963 May	"	" "	"
<i>Tandanus tandanus</i>	1963 May	W.H.P.	Dobel Ponds	Stocks subsequently destroyed.
<i>Retropinna semoni</i>	1963 May			Died in transit.
	1968 Mar.	S.H.P.	Mangani River	Approx. 300 fish introduced. Apparently unsuccessful.
		W.H.P.	Nebilyer River	Approx. 400 fish introduced. Apparently unsuccessful.
<i>Plectroplites ambiguus</i>	1966	Central	Pond at Mageri Agricultural Station	No evidence of survival.
<i>Percalates colonorum</i>	1966	Central	" " " " "	" " " " "
<i>Trachystoma petardi</i>	1966 8 July	"	Pond near Waigani Swamp	12 fish. No evidence of survival.
	1968 27 June	"	Pond at Bisianumu Agricultural Station	Apparently unsuccessful, checked 1969.
		W.H.P.	Dobel Ponds	4 remaining 1972, probably all dead by 1974
		Madang	Usino	30 fish released in natural waters—no further reports.
			Aiome	40 fish released in natural waters—no further reports.
		Morobe	Wau	20 fish to ponds of H. McKenzie and O. Kadletz. No further reports.
		S.H.P.	Mendi	No further record.

Many of the 500 fish introduced in 1968 died because of transport and handling difficulties, but a small number were released in ponds and natural waters. Several of the release sites have not been investigated since, but it appears unlikely that these fish have become established.

Freshwater Aquarium Fish

The guppy, *Poecilia reticulata* Peters, and the three-spot goramy, *Trichogaster trichopterus* (Pallas), are both established in natural waters around Port Moresby (West 1973). The guppy is present in drains and streams leading into Waigani Swamp, and the three-spot goramy is commonly found in backwaters of the Laloki River. At times guppies are so numerous in drains in the suburb of Boroko that they are collected for food. A single specimen of another aquarium fish, *Puntius semifasciolatus* (Günther) was reported from Waigani Swamp in January 1966 (Filewood, pers. comm.).

To reduce the risk of further species becoming established in natural waters the Department of Agriculture, Stock and Fisheries banned the importation of aquarium fish in 1975.

DISCUSSION

Nine of the twenty species of fish introduced to Papua New Guinea have established naturally reproducing populations. Two of them, tilapia and carp, have not become the basis of an aquaculture industry as originally intended, but are components of large inland commercial or subsistence fisheries. At present, rainbow trout is the only species showing potential for successful intensive aquaculture. The brown trout, snake-skinned and giant goramys are of value in extremely localized areas, and may prove to be so in others, while the mosquito fish, guppy and three-spot goramy are essentially valueless.

Because of the uncontrolled and inevitable movement of fish by private individuals, or natural dispersal, the distributions are probably greater than reported in this paper, and at any rate may be considered to be expanding.

The importation by individuals of exotic fish other than trout, and the transplanting of existing introduced fish, except for trout, to areas where they are not presently established, was

prohibited in 1975. The authors are in wholehearted agreement with this policy. The Department of Primary Industry may import freshwater fish for research purposes, but has not done so since 1972, and in keeping with the world-wide reaction against the introduction of exotic fish, probably will not in the future.

ACKNOWLEDGMENTS

Much of the information contained in this paper was obtained from Government records throughout Papua New Guinea and, therefore, we are indebted to many Government Officers, particularly those of the Department of Primary Industry. Many private individuals, especially those who were involved in fish introductions, have also volunteered information. The assistance given by co-workers L. F. Reynolds, N. Blichfeldt, L. W. Filewood, Ishmael Pai'ia and C. R. McIntosh is gratefully acknowledged. We are especially grateful to D. E. Shaw and D. A. Pollard for their very helpful criticism of the manuscript.

REFERENCES

- ANON. (1931). *Report to the Council of the League of Nations on the Administration of the Territory of New Guinea from 1st July, 1929 to the 30th June, 1930*. Government Printer, Canberra. 146 pp.
- (1932). *Report to the Council of the League of Nations on the Administration of the Territory of New Guinea from 1st July, 1930 to the 30th June, 1931*. Government Printer, Canberra. 130 pp.
- (1936). *Report to the Council of the League of Nations on the Administration of the Territory of New Guinea from 1st July, 1934 to the 30th June, 1935*. Government Printer, Canberra. 126 pp.
- (1947). *Report of the New Guinea Nutrition Survey Expedition*. Government Printer, Canberra. 308 pp.
- (1950). *Report to the General Assembly of the United Nations on the Administration of the Territory of New Guinea from 1st July, 1948 to the 30th June, 1949*. Government Printer, Canberra. 171 pp.
- GIBLIN, W. E. (1936). *Gambusia affinis* as a factor in mosquito elimination in Papua. Annexure A, in the *Territory of Papua Annual Report 1934-1935*. Government Printer, Canberra. 67 pp.
- RAPSON, A. M. (1967). A brief history of fisheries of Papua and New Guinea. *Papua New Guin. Sci. Soc. Ann. Rept. Proc.*, 1967.

- (unpublished). Trout and Trout Culture. DASF Circular No. 41, 1970. Trout series 5/7, Mimeograph. 4 pp.
- SCHUSTER, W. H. (1951). A survey of the inland fisheries of the Territory of New Guinea and Papua. *Aust. J. mar. freshw. Res.*, 2 (2):226-236.
- VAN DER MEULEN, J. (1962). *Fish Marketing in Papua New Guinea*. University of New England, Faculty of Agricultural Economics, Armidale, N.S.W. 83 pp.
- VAN PEL, H. (1956). *Notes and Suggestions on the Development of Fisheries in the Territory of Papua New Guinea*. S.P.C., Noumea. 18 pp.
- WEST, G. J. (1973). The establishment of exotic aquarium fish in Papua New Guinea. *Papua New Guin. agric. J.*, 24 (1):30-32.
- WHITLEY, G. P. (1951). Introduced fishes II. *Aust. Mus. Mag. X* (7):234-238.

(Accepted for publication December, 1975)

Printed and Published by E. C. Awo—Papua New Guinea Government Printer,
Port Moresby.—7920/1,500.—7.76.