

NATURE NOTES AND QUERIES.

By **DONALD MACDONALD.**

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Argus, 17 March 1911

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5.1 The Setting

The genesis of the Murray-Darling Basin dates back to a time when the continent was a part of the southern super-continent known as Gondwana. At the end of the Cretaceous era, some sixty five million years ago, Australia remained attached to Antarctica. The convection forces within the Earth's mantle that drive plate tectonics, had already initiated the break-up of Gondwana with the departure of India, Africa and finally South America. Eventually a rift valley formed between Australia and Antarctica some 40 million years ago, leading to the separation of the two continents. The process produced a warping of the Australian Plate raising its eastern flank, while its centre and southern edge subsided, generating the primordial Murray-Darling Basin (Veevers, 1984). Australia drifted northwards and, during its journey, rises and falls in sea level driven by changes in climate as well as further movements of the continental crust resulted in shallow seas periodically invading and retreating from the basin. The most extensive period of inundation commenced thirty two million years ago, when the Murravian Gulf extended inland as far as present day Balranald. This epoch of inundation lasted for about the next twenty million years (Brown & Radke, 1989).

Westerly flowing rivers steadily eroded the eastern mountain chains, depositing their sediments to a depth of four hundred metres in the central depression. The deposits left by the periodic inundations of the Murray-Darling Basin and the rivers contain fossils revealing the inhabitants of these ancient waters including plants, crustaceans, fish and even whales. In 1940 fossils of a fish, which present day anglers would recognise as a 'cod', were discovered at Bugaldie near Coonabarabran (Hills, 1946). More recently, similar fossils have been discovered near Cooma (Taylor *et al.*, 1980). Dating techniques suggest that the fossils may have formed between seven and twenty six million years ago, with the possibility that they may be substantially older (Rowland, 2005). It is clear that cod-like fish species have been present in the Murray-Darling Basin for many millions of years. As the sea retreated, the receding waters carved a channel into present day South Australia. About 3.2 million years ago uplifting near Swan Reach effectively dammed the drainage creating a giant freshwater body known as Lake Bungunnia which extended upstream to about the present site of Robinvale. As the continent dried the giant lake receded and became increasingly saline, the Murray finally breaking through the barrier about seven hundred thousand years ago, adopting more or less its present course (Steavenson & Brown, 1989).

Comparatively late in its history, humans became inhabitants of the Murray-Darling Basin. It is uncertain as to how many times the ancestors of the first Australians made the passage across the waters of the Torres Strait, or exactly when this took place. In 1969 the oldest evidence of human occupation in the basin in the form of human remains was discovered near Lake Mungo in western New South Wales. Subsequent discoveries suggest a human presence at least 32 000 years ago, possibly much longer. Along with the bones of humans, the sands of Mungo have revealed middens containing the skeletal remains of fish which clearly formed an important component of the diet of the people, who must have viewed the bountiful waters of the ancient Lake Mungo as a bonanza. Over the millennia the aboriginal nations of the Murray-Darling Basin developed a profound knowledge of its idiosyncratic rivers and their piscine inhabitants, learnt through the hardships endured by El-Nino generated boom/bust cycles superimposed on long term climate fluctuations. Unfortunately they left no written record of that experience, but their understanding could have provided us all with a much greater insight to the rivers as they once were. With the destruction of their society and disintegration of their culture by Europeans that knowledge has been largely lost save for the written accounts by the early colonials and the traditional stories that have survived. The crossing of the Great Dividing Range by Blaxland, Wentworth and Lawson in 1813 provided the first opportunity for Europeans to encounter the fish of the Murray-Darling Basin. Those first tentative steps into the basin by Europeans signalled not only the beginning of a cataclysm for the aboriginal nations of the Murray-Darling but of its entire ecology.

5.2 Discovery

The first European account describing the existence of fish ultimately to be known as 'cod' comes from the journal of George Evans who was sent on a journey of exploration to the interior by Governor Lachlan Macquarie. Departing from Emu Plains in November 1813, Evans crossed the Great Dividing Range, and on the 30th of November encountered the upper reaches of a stream at the Evans Crown Reserve near Tarana. On that date he recorded in his journal 'leading into a fine valley at the end I met a large Riverlett arising from the Southern Hills. We shot ducks and caught several trout weighing at least 5 or 6 pounds each' (Mackaness, 1965). His party followed the river downstream, and there are many references to the fish in his journal, in particular describing their astonishing abundance. This ultimately prompted Evans to name the waterway the Fish River. Soon after Evans' return, William Cox was charged by Governor Macquarie with the task of the construction of a road over the Blue Mountains to the region. On November 23 an advance party led by a J. Tye travelled to the Fish River to identify suitable crossing points. Cox recorded their return in his journal on November 27:

At 5 p.m. J. Tye and his party returned from the Fish River. They brought some fish with them, which proved to be rock cod, weighing about 5 lb. each. / During their stay they caught 10 fish, and state that had the water not run so strong they would have caught as many as they pleased (Mackaness, 1965).

Cox's journal makes a number of subsequent references to further fish being caught. It contains the first written use of the word 'cod' for the large fish of the western rivers, without any explanation for its origin.

Lachlan Macquarie, in company with Evans and the Surveyor General, John Oxley, in May 1815, travelled to the colonial outpost established at the junction of the Fish and Cambell Rivers. Macquarie surveyed a site for a town on the banks of the Macquarie River, just downstream from the junction, naming it Bathurst on May 7th. What is generally believed to have been Macquarie's account of the journey (Mackaness, 1965) was more likely penned by Allan Cunningham, an identical account being credited to him (Cunningham, 1816). The account elaborated, provides an explanation for the use of the word 'cod' for the fish of the Bathurst region:

All around Bathurst abounds in a variety of game; and the two principal rivers contain a great quantity of fish, but all of one denomination, resembling the perch in appearance, and of a delicate and fine flavour, not unlike that of a rock cod. This fish grows to a large size, and is very voracious. Several of them were caught during the Governor's stay at Bathurst, and at the halting-place on the Fish River. One of those caught weighed 17 lb.; and the people stationed at Bathurst stated they had caught some weighing 25 lb. (Cunningham, 1816).

The initial descriptions of the fish as 'rock cod' was almost certainly in reference to the saltwater rock cod, *Epinephelus daemeli*, frequently captured from the waters of Port Jackson and esteemed as a table fish by the colonists. This origin for the word cod was clearly iterated in a latter account: 'The Lachlan, Macquarie, and other rivers in the interior abound with fish of a large size and fine flavour: they have not, I believe, been properly described as yet, but resemble the rock cod and mullet of the sea coast' (Atkinson, 1826).

The first naturalists to visit the upper Macquarie were French. In 1822 the *Coquille* under the command of Captain Louis Duperrey, set sail from Toulon studying Natural History throughout the southern hemisphere. Key members of the crew held the responsibility of documenting and collecting specimens from the various disciplines of natural history which they were assigned. The surgeon Prosper Garnot, and his assistant Rene Lesson, were allocated the responsibility for zoology, with Garnot electing to study mammals and birds. The *Coquille* arrived in Port Jackson on the 17th of January 1824, and the crew called upon the new Governor of the colony of New South Wales, Sir Thomas Brisbane. Brisbane authorized and provided support for the French

to carry out an expedition to the upper Macquarie led by Garnot and Lesson. A high priority was to acquire specimens and knowledge of the platypus referred to by the French as 'paradoxes'. Garnot and Lesson stayed at Bathurst on the 4th and 5th of February, in the care of their host Mr. Morisses who commanded the garrison stationed there. Upon the return of the *Coquille* to France in March 1825, Lesson lodged with the Museum National D'Histoire Naturelle in Paris the fish and other specimens collected during the Bathurst expedition. He published a detailed account of the natural history encountered during his journey over the Blue Mountains (Lesson, 1825), which was later roughly translated into English and popularised in the *Edinburgh New Philosophical Journal* (Lesson, 1828). Lesson reported the existence of two species of fish he collected from the Macquarie River, describing his encounter with the fish in the following modern translation:

The Macquarie River, not very wide or deep, has banks covered with European plants. One finds there Potamogeton, aquatic Ranunculus, Lythrum salicaria, Samolus valerandi, Polygonum avicularis – or a closely-related species, etc. I found there fish that form two new genera – the first species, named *Gryptes Brisbanii*, of the family of Percoides, and the second species called *Macquaria Australasiae* (1). They attain a large size, and their flesh is held in high regard. The *Gryptes* is often three feet long, and nearly sixty pounds in weight. (1) By Messrs Cuvier and Valenciennes, Catalogue of the collections that we have brought back to the Museum. - I have proposed the name *Gryptes Brisbanii* for the first in honour of the Governor of South Wales, who received us enthusiastically (Lesson, 1828).

The 1828 English translation for the footnote stated: So named by MM. Cuvier and Valenciennes Collections which we brought to the Museum of *Gryptes Brisbanii* for the first, in honour of the Governor of New South Wales, who received us with the greatest kindness (Lesson, 1828). One specimen of Lesson's *Gryptes* and another of *Macquaria* were ultimately deposited and catalogued at the Museum National D'Histoire Naturelle. Lesson apparently named the second species *Macquaria Australasia*, referring to its source the Macquarie River, and its southern location. For *Gryptes Brisbanii* it is clear that the fish honours Sir Thomas Brisbane as Lesson stated, but the origin of the term *Gryptes* is not apparent.

Johann Kuefer, later known as Barron Georges Cuvier, was, in the early decades of the nineteenth century, one of the world's leading taxonomists. His work with fish commenced in 1801 and was later supported by his student Achille Valenciennes. Together, between 1828 and 1848, they produced *Histoire naturelle des poissons* naming and describing over 5000 species of fish, completed by Valenciennes after Cuvier's death in 1832. From Lesson's account, it is implied that Cuvier and Valenciennes supported the names for the two species of fish collected at Bathurst, and it is likely that they had a hand in creating them. In 1802 politician and naturalist Bernard de Lacépède published his work *Histoire naturelle des poissons* in which he provided a description, and illustration, of a fish from the Carolinas in the United States which he named *Labrus salmoides*, now known as *Micropterus salmoides*, the American largemouth bass. Subsequently in 1829 Cuvier provided his own name and description for the same fish, erecting the genus *Grystes*, the term 'gryste' meaning to growl or grunt, a characteristic of largemouth bass apparently incorrectly attributed to it (Gallaher, 1937). What followed was a description of the cod specimen from Bathurst presented in this modern translation (Cuvier, 1829):

The Growler of River Macquarie (*Grystes Macquariensis*, nob.)

The most essential characteristics of the growler of America were also found in a fish of the Macquarie River in New Holland, which in its shape, however, resembles more the common perch. Mainly by the height of the nape of the neck, from where its profile goes down obliquely. Its muzzle is also more elongated than the growler's, and it is rather its upper jaw that exceeds the other. Its scales, especially those of the back, are smaller than the growler's, and its spinal and anal fins are much more compared to all the other fish of this family. The thorny part of the dorsal is separated from the soft part by marked a fairly noticeable notch. The

cheek is a bit 'inflated'. There are no teeth neither in the under-orbital nor in the preoperculum, which does not have even a distinct edge. The osseous cover, operculum, has only a small pointed spine. The first pivot of the dorsal is very small; the others very strong. The soft part is higher, shorter and rounded. The caudal one is square, and has its corners rounded.

B. 7; D. 11/14; A. 3/12; C. 17; P. 19; V. 1/5

The colour of this fish (in the alcohol) appears a purplish grey, paler below, sown with cloudy blackish spots, poor and irregular. The edge of the soft part of the dorsal and the anal, and the two edges of the caudal close to its corners, are white. Our individual is ten inches long. The liver of this grystes is large, located transversely under the œsophagus, and it forms only one triangular lobe, of which the sharpest corner is prolonged in the left of the abdomen. The œsophagus is broad and short; the stomach narrow, elongated, a little curved and rounded at the back. Its walls are very thick, and their internal surface is furrowed by large irregular wrinkles. The rising branch that leads to the pylorus is large, because the thickness of its walls; but its channel is narrow. The pylorus is provided with 3 very short cœca, one on the left and two on the right. The intestine is of medium length; it goes down a little further than the stomach, where it bends and returns up to the ascending branch of the stomach; it makes a second turn there, and it goes to the anus. With each fold the diameter of the intestine decreases, and its walls are thicker. This greater thickness also exists for the duodenum; but its diameter is large. The spleen is oval, elongated and located on the duodenum. The flotation bladder is very large, simple, and oval, with silvery walls, much thicker in the posterior part. The kidneys meet in a large single lobe, near the anus, and they empty the urine into the bladder, which has very thick walls, where they form a kind of rather broad cone, which goes up between the seminal glands. The stomach was empty (Cuvier, 1829).

Noted illustrator Felix Guérin-Méneville provided a colour lithograph of the specimen of *Grystes macquariensis* in the *Iconographie du Règne Animal de Cuvier*, a supporting work published as a series between 1829 and 1838, and eventually as a complete work (Guérin-Méneville, 1829, 1838).

The following year Lesson published his description for the fish he collected from the Macquarie. Lesson provided a location for the capture of the type specimen (Macquarie River opposite Bathurst) and also described the size of fish encountered as follows in this translation:

101 Growler De Brisbane. *Grystes Brisbanei*, Less.

LESS., Ann. sc. nat. ; (November 1825).

Grystes Macquariensis, Cuv., Poiss. (fish), vol. III, p. 58 (1829), and

Guérin, l c., pl. V, f. 2.

B. 7; p. 19; d. 11/14: cat. 1/5; a. 1/12; c. 17

The grystes, whose generic name translated into French by Mr Cuvier as growler (*grogneur*) is used in the state of New York to designate the labre salmoïde Lacépède, are fish of the family percoïdes, not having any canines, but many velvet teeth, and the preoperculum without any serration on its edge. Only two species of them are known, one in the United States, and the other in New Holland. The latter we discovered in the Macquarie river, opposite Bathurst, on the painful trip that we made beyond the Blue Mountains. It is commonly 10 inches long, although we saw individuals of them more than two feet long, and there are individuals weighing up to sixty pounds, according to the statement of Mr Morisses, governor of the military post. The specific name of Brisbane will commemorate a governor of the southern English colony, a member of the Institute of France, who singularly supported us in our research of natural history, and to whom we are indebted for having been able to undertake various excursions in the interior districts of the county of Cumberland. This growler is lengthened, compressed on the sides, thinned towards the tail, with a sloping faceline, and with a snout consequently rather acute, and rather thin compared to the high nape of the neck. The lower jaw is thin,

overhung by the upper jaw. Its eye is large, rounded. The operculum, which ends in an acute point, and the preoperculum, are covered with tiny and very tight scales. The scales on the body are also small, regular, and a little rough. The dorsal spines are straight, thick, the first being shortest, and overflow the membrane. The latter is lowered and indented at the point where it receives the first articulated radius of the soft dorsal, which is higher than the spiny one, with a round edge. The pectoral one is oval. The catopes have their anterior spines less long than the braided radii. The three spines dorsal are short and equal; the fin with radii is short, a little angular. The caudal one is indented little or almost rectilinear. This fish is of a uniform purplish-grey colour all over. Spots, round or oval, russet-red, cover the back, the sides and the jowls. The pectoral ones are fair. The edges of the soft dorsal and the anal fin are white. The colonists of Bathurst esteem this fish, which they call in English "freshwater perch" (Lesson, 1830).

In his description Lesson used the generic name *Grystes* instead of *Gryptes* used in his 1825 account of their capture. The absence of the term *Gryptes* in his reference to this account implies that it was his intention to name the fish *Grystes*. Clearly in 1825 someone intended that the term *Grystes* be used both for the American large mouth bass and the fish from Bathurst, most likely Cuvier who was the recognized authority in fish taxonomy. Lesson's use of *Gryptes* may have either been a typological error by the printer from a written draft, or a misunderstanding on his part of the term created by Cuvier. They clearly disagreed on the proposed species name for the fish. Years later Valenciennes apparently claimed authorship for naming the two species of *Grystes* (Valenciennes, 1847). What is clear is that the principals involved in naming the cod captured at Bathurst agreed that the overhanging upper jaw was an obvious external distinguishing feature, separating it from the American large mouth bass.

Once passage over the Blue Mountains had been accomplished, colonial exploration and settlement expanded, and more accounts were written of the Murray-Darling fish. Various authors employed the names 'rock cod', 'cod fish', 'river cod', 'cod perch', 'Macquarie cod', 'Lachlan cod' and ultimately 'Murray cod'. George Bennett in his account of the fish of the Yass and Murrumbidgee Rivers, discussed the "river cod": 'They are named by the colonists "river cod," and by the aborigines "Mewuruk"'. In the Tumut country, varieties of the "river cod" are called by the natives Bewuck, Mungee, &c' (Bennett, 1834). This strongly implies that the indigenous peoples of the region believed in the existence of more than one type of cod. Bennett's writings included a footnote: 'This fish is of the family of perches, and probably the same as described by the French naturalists, as a new genus, under the name *Gryptes Brisbanei*' (Bennett, 1834). This demonstrates that contemporary Australian naturalists were familiar with Lesson's initial naming of *Gryptes brisbanii* in 1825 and probably its subsequent descriptions. The claim of multiple cod species was repeated by Bennett many years later adding that the two were varieties or species of the 'river cod': 'In the Tumut country, there are supposed to be varieties or other species of the River Cod, named by the blacks of that district, 'Berwuck' and 'Mungee'' (Bennett, 1864). On first reading it is tempting to accept Bennett's aboriginal names as specifically attributed to two types of cod. Other authors have identified the term 'mungee' as meaning fish in general rather than a specific type of fish (e.g. Robinson, 1845; Clarke, 1860; Clark, 2000) and this is supported by the fact that the word was used by aboriginal groups outside the Murray-Darling Basin. It is plausible that the terms 'Mewuruk' and 'Bewuck' may have been used for two types of cod which from Bennett's physical description the former is likely to apply to the Murray cod, but this is only a possibility.

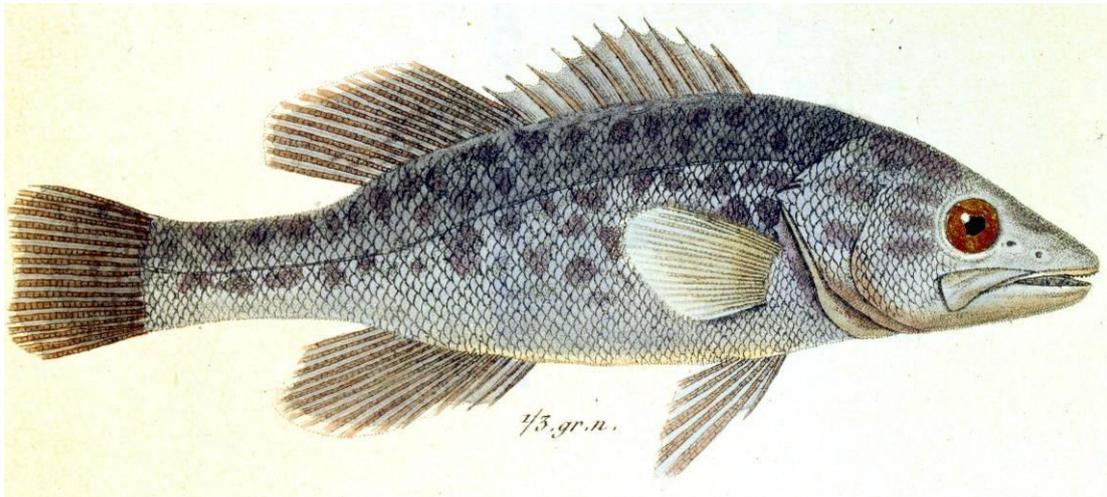
Major Thomas Mitchell provided numerous accounts of the fish encountered during his four expeditions into the Murray-Darling Basin. Prior to embarking on his first expedition, he recorded in his journal on December 12, 1831, eating cod at Bathurst and so was familiar with what was known then as the Bathurst cod fish. Then on January 24, 1832, in a footnote in his journal, Mitchell provided a brief description of a type of cod captured from the Peel River along with an excellent illustration. He named the species *Acerina Gristes Peelii mihi* and the following description are recognised by modern taxonomists as applying to the Murray cod:

Family, Percidae; Genus, Acerina; subgenus, Gristes, Cuv. or Growler; Species, Gristes Peelii mihi, or Cod-Perch. Colour, light yellow, covered with small irregular dusky spots, which get more confluent towards the back. Throat pinkish, and belly silvery white. Scales small, and concealed in a thick epidermis. Fins obscure. The dorsals confluent. The first dorsal has 11 spines, and the caudal fin is convex (Mitchell, 1838).

Mitchell was well read and aware of the differences between the fish he encountered in the western rivers, and the description provided by Cuvier and Valenciennes. He clearly stated so in his footnotes:

Observation: This fish may be identical with the fish described by MM. Cuvier and Valenciennes Volume 3 page 45 under the name of Gristes macquariensis: but it differs from their description in not having the edge of the second dorsal and anal white; and besides is in many respects very different from the figure given by M. Guerin of the Gristes macquariensis in the Iconographie du Regne Animal (Mitchell, 1838).

Photograph 5.1 The First Trout Cod



Above: Lithograph of *Gristes macquariensis* created by Felix Guérin-Méneville of the holotype for Trout cod published in *Iconographie de regne animal de G. Cuvier, Vol 1*, in 1836. The illustration depicts the specimen collected by Rene Lesson from the Macquarie River at Bathurst in February 1824 and named by him *Grystes brisbanii*. Reprinted with permission from the Rare Books Collection, *State Library of Victoria*.

Below: Photograph of the same specimen which survives to this day. The image has been reversed to match the illustration. Richardson cast aspersions on the ability of the French to create accurate illustrations of their specimens. An objective opinion would be that Guérin-Méneville created a reasonably faithful representation of the specimen. Photograph by Claude Ferraro, copyright of the *Museum National D'Histoire Naturelle, Paris*.

5.3 Genesis of an Argument

In October 1839 the ships *Erebus* and *Terror*, under the command of Captain James Ross, set sail from England on a journey to locate the south magnetic pole and chart the Antarctic continent, the latter which had eluded Captain James Cook. Australian zoological specimens were collected, the expedition subsequently returning to England in 1842 (Ross, 1847). The experienced ichthyologist Englishman John Richardson received the specimens after the return of the expedition. He subsequently prepared *Ichthyology of the voyage of H. M. S. Erebus and Terror, under the command of Captain Sir James Ross* which included many descriptions and illustrations of the fish encountered on the expedition. Included was one for the Australian 'cod perch':

Grystes macquariensis. In Mitchell's Expeditions in Australia, Pl. 6, f. 1 represents a fish locally named 'cod perch,' and to which the author has given the specific name of *Grystes peelii*, because it varies in some respects from the description of *G. macquariensis* in the *Histoire de Poissons*, and does not correspond with Guerin's figure in *Iconographie de Regne Animal*. Our specimens have the pale margins to the dorsal and anal, which exists in *macquariensis*, but which *peelii* is said to want. Their form, however, is that of Mitchell's fish, and as they agree sufficiently with the detailed description in the *Histoire des Poissons*, the probability seems to be *macquariensis* and *peelii* are but one species, and that Guerin's figure, as in many other instances, has been carelessly drawn (Richardson, 1845).

Richardson concluded that there was only one species of cod, focusing on Mitchell's observation of his example of *peelii* lacking obvious white margins on the fins, ignoring a key characteristic of *macquariensis* being the overhanging upper jaw identified by the French. Richardson had obtained a number of cod specimens between 6 and 18 in. long, including an example of Mitchell's *peelii* as demonstrated by his illustration. If Richardson had seen a specimen of the French *macquariensis* he might have formed a different opinion.

In 1859 Albert Gunther, of the British Museum, determined that the American and Australian species of *Grystes* represented separate genera based on a number of characters notably that the American species had many pyloric caecae (gut pouches) and that from Australia few. He erected the genus *Oligorus* for the Australian fish the term implying 'few openings', referring to the few gut pouches (Gunther, 1859). Gunther too missed the significance assigned by the French to the overhanging upper jaw or, having separated the Australian cod from the largemouth bass into a new genus, considered it now irrelevant. Gunther followed Richardson's lead in recognising only one species of cod, *Oligorus macquariensis*, though his description of 'Brownish grey, with irregular dark spots' suggests that he may have possessed a specimen resembling the French fish. This is confirmed by the drawing he subsequently published in 1880 which is clearly a Trout cod, possessing an overhanging upper jaw and spotting (Gunther, 1880). In a later work, a contemporary from the British Museum, Albert Boulenger, recorded the coloration of the species as being 'Greyish or olive, spotted or dotted' (Boulenger, 1895). It appears that Richardson's cod specimen was lost, and may have denied Gunther the opportunity of examining both species. In fairness to both Richardson and Gunther, they worked during an era when there was no clear cut definition of what constituted a 'species'. Carolus Linnaeus, the father of modern taxonomy in the 18th century, based his notion of a species on the existence of readily identifiable 'ideal forms' with clear cut differences from other 'ideal forms'. The Linnaean species concept accepted that variations did occur from these forms, but considered that they should be ignored. These ideas may have influenced people like John Richardson and Albert Gunther in reaching their decisions on the two types of cod. It was all very vague, subjective and open to individual interpretation. Taxonomists themselves became classified as 'splitters', those with a tendency to highlight differences between organisms, and 'lumpers', those who highlighted the similarities and who acted accordingly when deciding the taxonomic status of organisms.

Polish born emigrant Wilhelm Blandowski arrived in Australia in 1849, and derived a living from a number of vocations. From an early date, however, he engaged in the recording and study of natural history. In June 1854 he was appointed government zoologist for the Victorian Museum of Natural History, and was subsequently a founding member of the Philosophical Society of Victoria. Blandowski undertook an expedition to the Murray River between the Gunbower area and the Murray-Darling Junction region, with an extended stay at Chaffee's Landing during 1857 collecting over 17 000 specimens (Kean, 2005). He later published an account of the nineteen types of fish he encountered during the expedition, where he used the names *Gristes Macquariensis* and *Gristes Peeli*, indicating that he was familiar with the original descriptions for the two cod species (Blandowski, 1858). His report published illustrations of the two types of cod, and he preserved specimens of both *peeli* and *macquariensis*, without providing provenances, which survive in the collection of *Museum Victoria*. Blandowski provided aboriginal names for the two cod species indicating that both were familiar to the indigenous people, the Yarree Yarree (Jari Jari), of the lower Murray in Victoria:

Gristes Macquariensis (S) "Yaturr", of the Yarree Yarree. Is of a dirty green colour and has less spots, than *Gristes Peeli*. In both the scales are small and covered by an epidermis. Both are characteristic forms of the Murray River and its tributaries, and the principle fishes on which the natives subsist during the greater part of the year. They grow from 36 to 40 inches in length. 'Gristes Peeli (J) "Barnta", of the Yarree Yarree. This fish, as well as the preceding, No. 13, have both been already observed in America (Blandowski, 1858).

There is some doubt as to whether the collection of the cod specimens, and the creation of the drawings by Blandowski, actually took place during the 1857 expedition. The original drawing of *Gristes peeli*, which survives in the Historische Arbeitsstelle Museum fur Naturkunde in Berlin, contains the inscription 'am Murray den 27. Januar 1850 Blandowski' indicating that the drawing was created well before the expedition to the Darling junction (Hannelore Landsberg, pers. comm.). A similar background can be inferred for the drawing of *Gristes macquariensis*, the original of which has not been located. Blandowski is also likely to have deposited specimens at the National Museum of Victoria from 1854 onwards, when he was appointed government zoologist.

It can be reasonably concluded that Blandowski's report in 1858 represented his collective experience gathered from all his sojourns into northern Victoria rather than just that obtained from the Darling junction region. Altogether Blandowski's work was of great value, not only recording natural history, but details of aboriginal life and culture at an early date. Upon his return from the expedition, Blandowski presented his findings to the Philosophical Institute and initiated a furor, creating provocative descriptions and names for some specimens. His reputation in tatters he fled Australia with much of his original work and returned to Europe where he died in relative obscurity (Humphries, 2003; Kean, 2005). His contemporaries failed to recognise the value of his work and his account of the two types of cod was ignored.

The *Deniliquin Pastoral Times* of March 11 1865 contained a brief news item reporting on recent angler success in the Edward River: 'Piscatoria. The disciples of old Isaac must at present be possessed of much patience to meet a reward. The river is too low for anything but small fish to be caught, still there have been some very nice perch and trout taken through the week'. The reference to the 'trout' indicates that the fishermen of the district by that time had assigned that name to a local variety of fish sharing some characteristics with the Brown trout of the mother country. In fact the use of the term 'trout' or 'Murray trout' by the fishermen of the region can be traced back to at least 1859, when a newspaper advertisement promoted that the Stead brothers of Sandhurst (Bendigo) 'had a regular supply of that delicious fish Murray cod, Golden Carp, Blackfish and Trout' (*Argus*, 13 August 1859). There is evidence that over the next fifty years the name continued in use by fisherman, before serious enquiries were made as to the identity of the 'trout' which ultimately was identified as being applied to a type of cod.

In 1855 Joseph Rice established the Moira Lake Fishing Company, later the Murray River Fishing Company, and while there is ample evidence that commercial fishermen had operated in the Murray-Darling Basin prior to this time, the company appears to have been one of the first to act on a large scale and develop distant markets. Their base was located on an island in Moira Lake near Barmah and, utilizing the knowledge and skills of the local indigenous Yorta Yorta people, the business grew into an industry initially supplying Bendigo and later other centres such as Ballarat and Melbourne. In 1861 the Acclimatisation Society of Victoria was formed out its predecessor the Zoological Society, its foundation being stimulated by a movement originating in Europe to distribute animals and plants considered of value around the world. The acclimatization movement not only introduced many exotic plants and animals to Australia but translocated indigenous flora and fauna perceived to be of value. At that time the first tentative steps were being taken in acclimatizing fish and the earliest efforts were with native fish (Wilson, 1857). Rice sought to expand his business by providing live fish to acclimatisation societies in Victoria as well as supplying native fish fingerlings to interests in Tasmania and England (*Riverine Herald*, 17 February 1864, 23 March 1864).

In March 1870 a newspaper report discussed the progress made in acclimatisation activities in Victoria. Reference was made to the successful introduction of the hare, the usefulness of sparrows and the survival of the first trout introduced to the state. It also reported that live fish had been supplied to the Avoca Acclimatisation Society, this information sourced from an article published in the local newspaper for the Echuca region, the *Riverine Herald*, on the 9th of March:

Live fish from the Murray are being transported from that river to the waters of the Avoca. On Monday, as we learn from the Riverine Herald, 500 Murray cod and trout were forwarded to the Avoca Acclimatisation Society by Mr. Pascoe. / The fish were supplied by the Murray Fishing Company (*Australasian*, 12 March 1870).

The company also supplied native fish to Saville Kent in his efforts to acclimatise Murray River fish species in Western Australia. The shipments included Murray cod, Murray perch, Macquarie perch, Murray trout and other species (*Hobart Mercury*, 30 November 1911).

Francois Laporte, better known as Francois or Comte de Castelnau, was a French diplomat, naturalist and a council member of the Zoological and Acclimatisation Society of Victoria. Castelnau held a lifelong passion for the study of fish, and the reports of the 'trout' from the Murray being available for sale may have been the impetus to acquire some samples. Stating that the specimens had come from the Murray River, possibly acquired through the Melbourne Fish Market, he went on to provide a name and description of the fish (Castelnau, 1873). Surprisingly Castelnau, who studied under Cuvier in France, was either unaware or ignored the details of his mentor's description of *Grystes macquariensis*. He provided a detailed physical description of the second cod species based on two specimens, one large (30 inch) and one juvenile. Castelnau named the species *Oligorus mitchelli* and his description is almost identical to that used by biologists today for the fish now known as *Maccullochella macquariensis*:

The genus *Oligorus* is thus restricted to the Murray Cod, but I believe that two distinct species are confounded under this name. The head much broader; the eye considerably larger, being contained only six times in the total length of the head and twice in the length of the snout to the anterior edge of the eye. The upper profile is more convex than in the usual sort. The upper jaw is longer than the lower jaw... The caudal is rather longer and more rounded. The colour is a livid grey, covered entirely with small round obscure spots. The fishmongers consider this fish as distinct, and give it the name Murray Perch (not the Golden Perch, which is a Dules) (Castelnau, 1873).

Of interest is the reported use, in the late nineteenth century, of 'Murray perch' for this type of cod instead of the *Macquaria ambigua*. This latter was reported to be marketed at the time by commercial fishermen as 'golden perch'. Morris (1898), in his dictionary of Australian words, assigns the term 'Murray-Perch' to *Oligorus mitchelli* and cites Garnet Walch's (1880) use of the term. Walch describes the fish as a 'less bulky, equally flavourless congener' of the Murray cod. It is unclear whether these latter authors were simply repeating Castelnau's usage or learnt of the term independently. It is possible, with the decline in catches of the second cod species in many areas in the first half of the twentieth century, that the names were transposed thus resulting in contemporary use of the name 'Murray perch' for *M. ambigua*. Castelnau's description of the second type of cod precipitated an ongoing debate about the existence of two forms or species of cod in the Murray-Darling Basin with evidence of growing confusion.

Between 1878 and 1890 Frederick McCoy, the director of the Museum of Victoria, published his *Prodromous of the Natural History of Victoria*. Research for the project commenced in 1858 and the successive volumes contained many notes, descriptions and colour lithographs of the Victorian fauna. In the *Prodromous* McCoy discussed the two forms of cod:

There is a very common opinion among the fish dealers and other observers that there are two distinct species confounded under the name of Murray Cod, the one with a narrow snout, and the other with a broadly-rounded blunt one, and it is easy to sort the two forms when a heap of fish is sorted. I am convinced, however, that the difference is sexual / (McCoy, 1884).

McCoy apparently reached the latter conclusion based on the examination of five fish for which he provided a table of comparative measurements, including two large adults being male and female. In addition to the discussion and data provided, McCoy included two colour lithographs of examples of cod. After his appointment as director of the museum he engaged a number of artists to record the appearance of the flora and fauna. Plate 86 in the *Prodromous* was an illustration of a small Murray cod (1 foot 7½ inches) drawn by artist Andrew Bartholomew in May 1882. Bartholomew had a long association with McCoy, preparing drawings and lithographs for nearly forty years. Plate 85 was drawn in 1858 by the talented Ludwig Becker, who perished shortly after on the ill-fated Burke and Wills expedition. This illustration was stated by McCoy to be of a male cod three feet four and a half inches in length and reported to have contained twenty full grown Murray crayfish. The direct reference to the fish being male implies that the fish was of the narrow snout form and Berra and Weatherly (1972) suggested that the illustration may have been of a Trout cod.

John Kean of *Museum Victoria* has undertaken considerable research into the artists and illustrations of the *Prodromous*, the Museum's website now providing a wealth of background information and unpublished illustrations. The provenance of the fish depicted in plate 85 remains unknown. Given the anatomical detail recorded by McCoy, and the observation of the crayfish in its stomach, it is likely that the specimen was sourced from the Melbourne fish market and the illustration drawn in the laboratory. While the fish is distorted, possibly by its neck being broken, the head does show a resemblance to a Trout cod. Its form suggests that if the mouth were closed the upper jaw may overhang the lower. Some of Becker's original sketches show the eyes placed on the side of the head, which is more typical for a Trout cod than the Murray cod. Becker recorded in his own hand that the snout of the fish was 'blueish black'. If the specimen was a Trout cod then this may be the first reference to what would become a widely recognised feature of the species leading to the colloquial name 'bluenose'. Amongst the surviving material for the *Prodromous* are background notes and measurements of the cod examined, including comparisons between a twenty two inch specimen of the narrow snout form and a similar sized specimen of that with the broad snout. Arthur Bartholomew in May 1891 prepared a watercolour drawing for an unfinished lithograph of a cod which clearly records the body markings of a Trout cod. Whether the Becker illustration is of a Trout cod is still in question but there is little

doubt that McCoy did handle the two types of cod and the weight of evidence suggests that he did examine one three feet four and a half inches in length. McCoy's conclusion as to the differences between the two types of cod being sexual was, from his records, probably the product of the limited number of specimens examined. Had he encountered specimens of both sexes for the two forms he may have reached a different conclusion.

Tenison-Woods (1882) described both species of cod, repeating Castelnau's description for *mitchelli*, adding a few personal observations and suggesting that rivers north of Sydney held that species. Subsequent government publications similarly ascribed *O. macquariensis* to the western rivers, and *O. mitchelli* to the northern coastal rivers of N.S.W. Ramsay (1883) stated: 'Two species of Murray cod are recognised by naturalists, the *Oligorus macquariensis*, Cuv. et Val., and *Oligorus mitchelli* Castelnau'. All these authors from Castelnau to McCoy had obviously not consulted the original description of *macquariensis* by Cuvier, relying on those provided by Richardson and Gunther. Adding to the growing confusion was Sir William Macleay's description of another species of cod, based on a single juvenile fish collected from the Murrumbidgee River near Yass by local surveyor Charles Jenkins. The specimen clearly had a serious head deformity and was described many years later by Gilbert Whitley of the Australian Museum as 'teratological or pug-headed' (Whitley, 1937). Macleay assigned it to species status with the name *Oligorus gibbiceps*, literally meaning 'hump headed' (Macleay, 1885).

Douglas Ogilby commenced work with the *Australian Museum* in 1885 and in 1893 he published *Edible Fishes of New South Wales* where he discussed at length the issue of the two species of cod. Unlike some of his predecessors he recognized the significance of the overhanging upper jaw in the descriptions of both Cuvier and Castelnau. Ogilby cited Gunther as indicating that the lower jaw was longer (though no mention was made by Gunther of this characteristic in his original description; he described the mouth simply as 'large, protractile') and stated that in five specimens of cod which he personally examined and based his description on that the jaws were equal. Ogilby postulated that environmental conditions could affect other anatomical features of cod and ultimately concluded 'These four characters may, therefore, be at once be set aside as valueless' and went on to criticize Castelnau for 'the ingenuity with which the most important characters are entirely omitted, and trivial or secondary characters brought forward into prominence' (Ogilby, 1893). Close examination of his writing suggests that he based his conclusion on five specimens of Murray cod, and the only specimen of the other type he examined was Macleay's deformed *O. gibbiceps* which he described 'as merely a stunted Alpine form of *O. Macquariensis*' (Ogilby, 1893).

The excesses of both professional and amateur fishermen ultimately led to some regulation of the fishery, with the appointment of officers, or 'inspectors' as they came to be known, to ensure compliance with legal practice. One of the earliest was Assistant Inspector Osbourne Wilshire, based at Deniliquin, who had the unenviable job of policing much of the Murray River fishery centred on the Barmah Lakes. In his report on the Inland Fisheries for 1887, Wilshire wrote: 'The principal species of fish in these waters are Murray cod, trout, gold and silver perch, silver and black bream' (NSW Fisheries Report, 1888). During his time as inspector Wilshire collected numerous fish specimens, forwarding them to Sydney. Museum records suggest that some of these may have been 'trout' but there generally appears to have been very little interest. In May 1892 *The Adelaide Register* published a lengthy news story on the fish of the Murray River written by an un-named 'correspondent' from Blanchetown, believed to be W. J. (William) Nott. The author was clearly a highly experienced commercial fisherman who provided detailed observations on fish, crustaceans, turtles and birds. His first-hand experience dated back to before the great flood of 1870. The article provided a wealth of detail on the types of fish captured near Blanchetown and briefly discussed a fish called the 'rock cod':

The rock cod are very rarely caught about here. The largest I have caught would be about 8 lb. and the smallest about 1 lb. Although they resemble a cod in many ways, the formation of their body is different. They also have a much larger eye than the cod, thus indicating that it is night when they obtain their food (*Adelaide Register*, 20 May 1892).

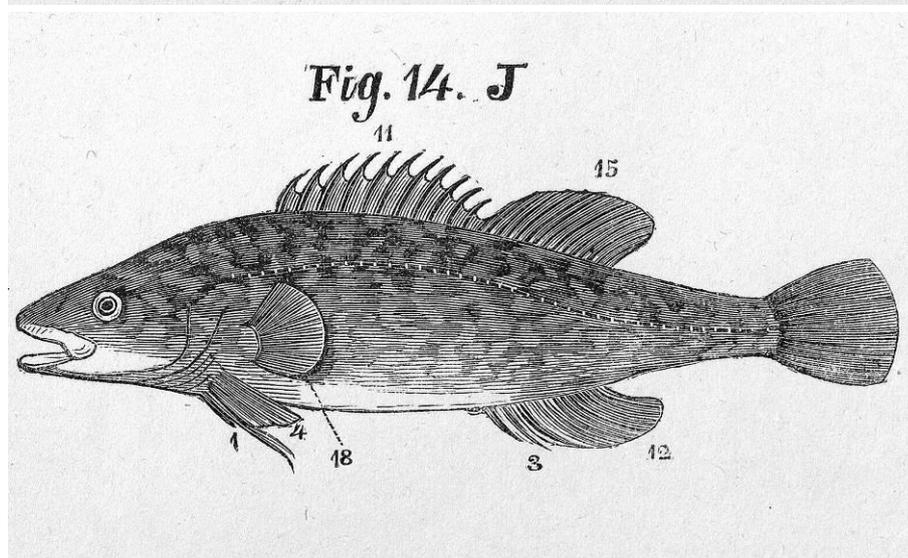
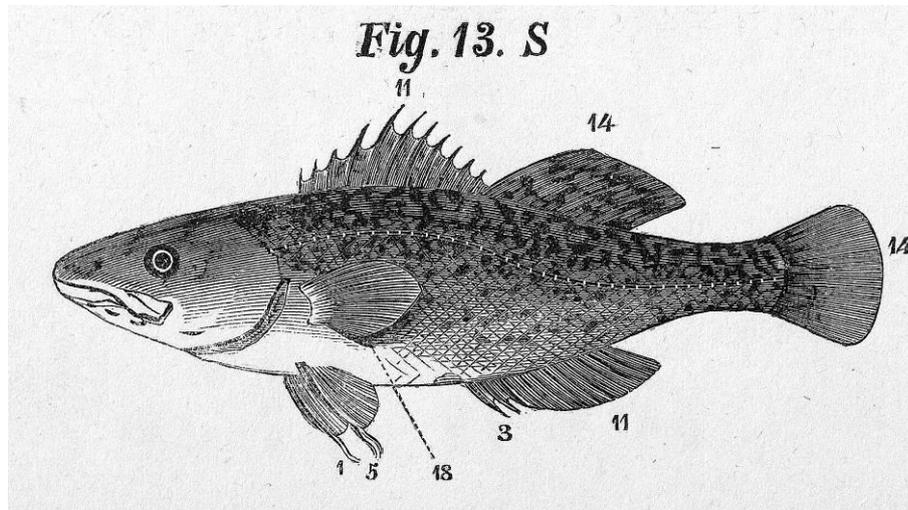
Irrespective of what the men of science thought, many fisherman in the late nineteenth century believed there were two species of cod in the Murray-Darling Basin. It is apparent that the term 'rock cod' was applied to distinguish a second form from the usual Murray cod, by fishermen like Nott (Stead, 1929b). Another name utilised was 'bluenose' describing the coloration of the snout in some specimens (Rhodes, 1999) along with the term 'trout' or 'Murray trout' employed by Deniliquin and Barmah fishermen (Stead, 1929b).

The reported capture of a fish from the Yarra River in the *Argus* newspaper in 1898 elicited an interesting response from a reader. The issue of September 8, 1898, described the existence in the Yarra of a second cod species:

Murray Trout in the Yarra. Sir, - the fish referred to in your par. of yesterday as having been caught at Dight's Falls is what is known on the Murray as a Murray trout. It is closely allied to the Murray cod, but does not grow so large, and its habits are different. The cod is a sluggish fish, feeding on the bottom of rivers, while the "trout" frequents the most rapid portions of the stream, and feeds near the surface. I have frequently observed them rising at flies and other insects in a manner similar to the English trout - hence the name it has acquired. The particular fish under notice is the largest I have seen caught on a rod, and its weight is probably due to the fish being full of spawn. These fish were introduced to the Yarra about 10 years ago, and many of them have been caught at all points between Melbourne and Healesville. I myself caught one of the same species about five years ago near Heidelberg, weighing 3½ lb. The markings of the cod are stripes on a greenish ground, while the trout is speckled on a blackish ground; besides this, the formation of the jaws of the two fish are distinctly different (*Argus*, 8 September 1898).

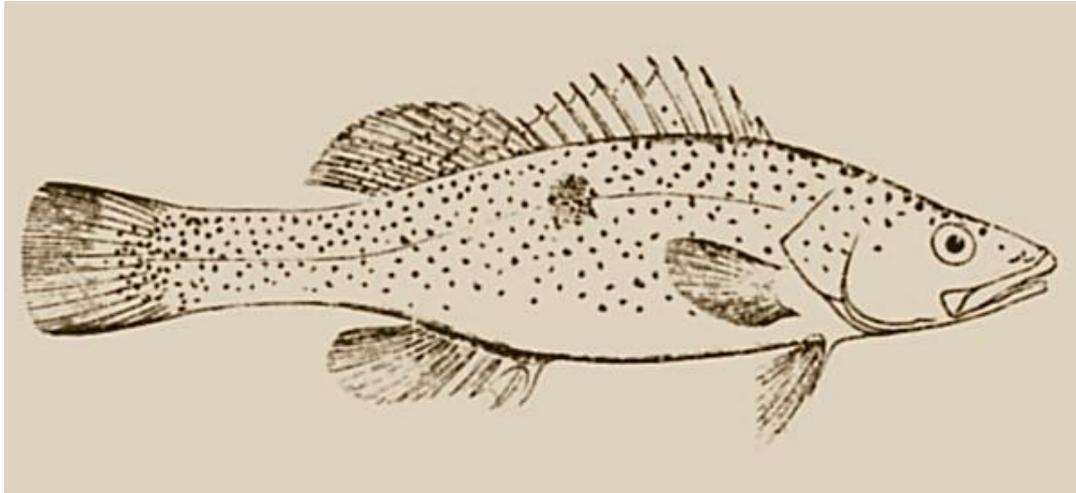
For many years scientists and anglers have wondered whether both species of cod had been introduced to the Yarra River and this news item provides the answer. Initial translocations of cod into the Yarra catchment had occurred from the King Parrot Creek in 1857 and the Murray River near Barmah in 1864. Major fish kills occurred in the Yarra during the early 1870s, decimating the cod population, and further translocations from the Murray River and Goulburn River near Seymour were undertaken to top up the population (Trueman, 2007). Any, and probably all, of these shipments of cod could have contained Trout cod and been responsible for their introduction.

Photograph 5.2 Blandowski's Trout Cod



Above and Centre: Illustrations of *Gristes Macquariensis* (Fig.13. S) and *Gristes Peeli* (Fig. 14 J) published by Wilhelm Blandowski as part of Plate 133 in his work *Discoveries in Natural History on the Lower Murray*, 1858. Below: Photograph of the preserved skin of a Trout cod collected by Blandowski demonstrating that he was familiar with the species. All images reproduced with the permission of *Museum Victoria*.

Photograph 5.3 Gunther's Drawing of a Trout Cod



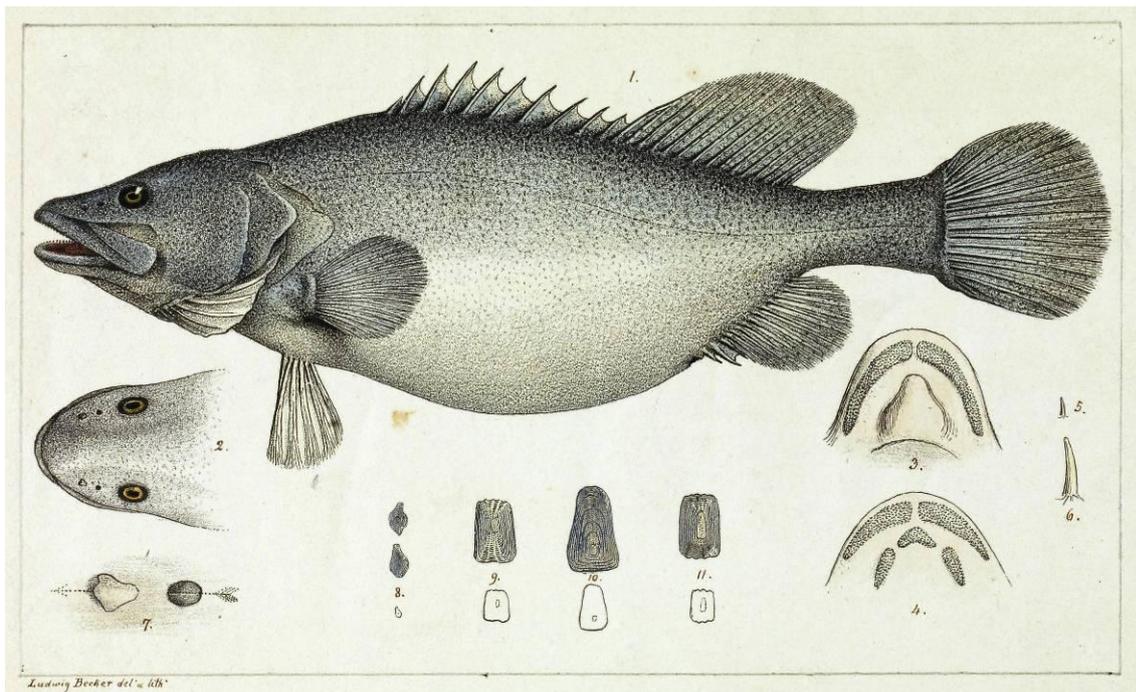
In 1880 Albert Gunther of the British Museum published *An Introduction to the Study of Fishes* which contained this illustration of the species *Oligorus macquariensis* the drawing of which, from the overhanging upper jaw, is clearly of a Trout cod (Gunther, 1880). It is apparent that many of the early specimens of cod forwarded to Europe were Trout cod and as a consequence this may in part have been responsible for the old world naturalists concluding that there was only one species. Image reproduced from the collection of the *National Library of Australia*.

Photograph 5.4 Castelnau's Trout Cod



In 1873 Francois de Castelnau published his description for a new species of cod which he named *Oligorus mitchelli*. The description was based on two specimens whose fate is unknown. Castelnau lodged this specimen of a Trout cod under the name *Oligorus mitchelli* with the *Museum National D'Histoire Naturelle* in Paris in 1877. Photograph by Claude Ferrara, copyright of the *Museum National D'Histoire Naturelle*, Paris.

Photograph 5.5 Trout Cod or Murray Cod?



Original lithograph of a male cod, possibly a Trout cod, prepared by artist Ludwig Becker in 1858 who perished shortly afterwards on the Bourke and Wills expedition. The fish was reported to have been three feet four and a half inches in length. This illustration was subsequently used in the preparation of Plate 85 in Frederick McCoy's *Prodromus of the Natural History of Victoria*, 1884. Certain identification of the fish as a Trout cod is not possible with the mouth open though McCoy recorded that it was of the form of cod with a narrow pointed snout.

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Photograph 5.6 An Artist's Work



Left: Handwritten annotations on artist Ludwig Becker's sketch of the head of a cod dated July 26, 1858 read 'Snout, blueish black, without scales'. The figure was ultimately used to prepare Plate 85 of Frederick McCoy's *Prodromus of the Natural History of Victoria*, published posthumously in 1884. This may be the earliest reference to what was to become a feature used by some anglers to distinguish a fish known as a 'bluenose' from the usual Murray cod.

Right: Part of a drawing dated May 16 1891 prepared by Arthur Bartholomew of features of a cod. Such drawings were undertaken to record detail necessary to illustrate a whole fish. The markings are clearly those of a Trout cod demonstrating beyond doubt that specimens of the species were handled by McCoy and his artists. The final illustration of the whole fish was never completed. Both illustrations reproduced with the permission of *Museum Victoria*.

Photograph 5.7 *Oligorus gibbiceps*



This deformed specimen of a Trout cod was captured from the Murrumbidgee River near Yass by Charles Jenkins in 1885. Sir William Macleay described it as a new species naming it *Oligorus gibbiceps*. Photograph copyright of the *Australian Museum*.

5.4 Renaissance Under Stead

David Stead was an Australian born scientist, passionate about the environment, who made major contributions to the study of natural history and its popularisation with the layperson. He was also a leading light in the genesis of the Australian conservation movement. As a member of the Linnaean Society of NSW, Stead acted as the consulting naturalist in a South Australian enquiry into the status of the Murray River fishery in 1900. He relied heavily on information provided by Samuel McIntosh, the Chief Inspector of Fisheries in South Australia, who interviewed many fishermen in order to collect evidence for the inquiry. In his report on the types of fish present in the Murray River he discussed the reported existence of a second type of cod:

Throughout the evidence reference has here and there been made to “two kinds of cod.” In most cases this has reference to those Murray cod living in the still waters of lakes and lagoons – particularly Lake Victoria in New South Wales and Lake Bonney, South Australia – as compared with those living in the rivers. / Now and again also a “rock cod” is mentioned. “it is not so numerous as the Murray cod and not so large (from 6 to 10 lb.)”. Apparently, in appearance it is half-way between the Murray perch and the Murray cod, as some of those that have observed it fancied that it was “a cross between” those two species. It appears to be the name given to one of the varieties of Murray cod stated by Mr. M’Intosh to be *Oligorus mitchelli* (Stead, 1903).

It is apparent that Stead did not personally examine a ‘rock cod’ during his visit to South Australia in 1900. In his book *Edible Fishes of New South Wales* he made no mention of it (Stead, 1908). Confirmation of the identity of the fish as *Oligorus mitchelli* appears to have come from the honorary Director of the South Australian Museum Amandus Zeitz, acknowledged in a footnote to the text: ‘It must be stated that the information supplied by Mr. M’Intosh was obtained from Mr. A. Zeitz F.L.S. to whom we are directly indebted’ (Stead, 1903). It would appear that Zeitz had either seen examples of ‘rock cod’ or had been provided with a good account of what one looked like. Being familiar with Castlenau’s 1873 description of *Oligorus mitchelli* it is clear that Zeitz had provided the identification for the ‘rock cod’.

In 1902 the NSW Department of Fisheries hired Norwegian Harald Dannevig, a leading authority on marine fisheries and hatcheries, as Superintendent of Fisheries Investigations. David Stead, who joined the Department the previous year, acted as scientific assistant under Dannevig, though in many departmental publications he was referred to as ‘the Naturalist’. Dannevig left the Fisheries Department in 1908 and Stead assumed much of his responsibilities in the research area, particularly with the inland fishery. Under Stead’s stewardship research on many aspects of the biology of native fish commenced, including their migratory habitats and reproduction. This represented the birth of genuine scientific study of them. Experiments in the artificial propagation of native fish, initiated by Dannevig in 1905, were undertaken at Prospect Ponds near Sydney, and on the Murrumbidgee River, by Inland Fisheries Officer H. K. Anderson, assisted by professional fisherman W. J. Hill and physician Dr. H. O. Lethbridge, both of Narrandera. In addition extensive translocation of native fish and crustaceans was carried out. In early 1909 Henry Dawson, the Representative of Inland Fisheries travelled to Deniliquin to meet with local residents who had petitioned the government to end professional net fishing in the region. During his visit Dawson interviewed residents and fisherman, and generally investigated the state of the fishery. He subsequently submitted a report on his findings to the Chairman of the Fisheries Board. In his report Dawson described the purported existence by local fishermen of a type of fish unknown to him simply called ‘trout’: ‘A fish called by the local anglers “Trout” is fairly plentiful. I have my doubts as to the identity of the latter, and have been promised that the fish shall be forwarded for identification’ (NSW Fisheries Report, 1910). From his account it is obvious that Dawson during his visit never personally examined a ‘trout’.

The following month Dawson travelled to Deniliquin to secure a specimen of the 'trout' and one of 17½ inches in length was obtained and forwarded to Stead. In 1929 Stead recounted how he suspected that a second, smaller species of cod existed based on specimens he received from anglers at Narrandera and Wagga, around 1905 (Stead, 1929b). Stead displayed the specimen at a meeting of the Fisheries Board. At that meeting Stead suggested naming it a 'trout cod' though the chairman indicated a better name could be found, with Dawson stating that an indigenous name would be better (*Sydney Morning Herald*, 23 November 1909).

Newspaper accounts of the time indicate that Stead's discovery generated considerable public interest, but also some controversy. At a meeting of the NSW Amateur Fishermen's Association the second cod species was discussed and clearly some members were already familiar with it: 'A good deal of angling interest is being shown in the capture of a new variety of Murray cod. Mr. R. Eastway informed the members of the Amateur Fishermen's Association on Thursday evening that Mr. John Gale, of Queanbeyan, had caught these fish many years ago in the Queanbeyan River' (*Sydney Morning Herald*, 27 November 1909). It was also reported that Stead considered naming the fish *Oligorus truttaceus* but the editor cautioned him as his opinion on the existence of the species differed from that of Ogilby, Gunther and others (*Sydney Morning Herald*, 9 December 1909; Stead, 1929b).

Stead recounted his discovery of Trout cod in the Annual Report for NSW Fisheries:

The fish taken at Deniliquin in August, 1909, locally called "trout," which were similar to specimens already received from Narrandera and Wagga Wagga, as "Murray cod" has been found to be distinct from either of the species mentioned, and has been designated "trout cod." The Naturalist is of the opinion that in the trout cod has been discovered the long-lost "*Oligorus mitchelli*" of Castelnau, the very existence of which has been generally doubted (NSW Fisheries Report, 1914).

In October 1909 Stead and Dawson travelled to Deniliquin to oversee tagging experiments with native fish in the Edward River. No Trout cod were reported captured (NSW Fisheries Report, 1910). However, they subsequently toured the Murrumbidgee district as part of a delegation representing the Fisheries Board, collecting information on native fish and acquiring specimens. A footnote attached to a photograph of a Trout cod lodged in the NSW DPI Library at Cronulla records: 'It inhabits the Murrumbidgee River (and probably other western streams) and frequents running water'. During his sojourn on the Murrumbidgee a great deal of information was collected on Trout cod:

In regard to size, the Naturalist inclines to the belief that the average female Murray cod becomes sexually mature and bears ripe eggs at a length of from 18 to 19 inches, and of a weight of a little over 2 lb., and that the average length of trout cod at maturity is 10 inches, with a weight of about 6 oz.; / Dixon's dam was visited by the Naturalist, the late Chairman of the Fisheries Board, and the Inland Commissioner, and it was found that it was heavily stocked with Murray cod and other native fishes, and that trout cod is as abundant in the Murrumbidgee as is the Murray cod (NSW Fisheries Report, 1910).

One location which Stead visited was Narrandera and in correspondence with the Narrandera Anglers Club, published in the local newspaper, he demonstrated his enthusiasm for the fish:

Mr. Stead writes that the trout-cod, now prevalent in the Murrumbidgee, is a species absolutely distinct from the Murray cod; nor is it, as its name would seem to imply, a cross between the trout and cod, for it has absolutely nothing in common with the trout of the genus *Salmo*. The trout-cod is really a species of perch, and Mr. Stead is enthusiastic as to its value, both as a table fish and affording good angling (*Narrandera Argus*, 11 January 1910).

The 'discovery' of 'trout cod' heralded the arrival of a golden era of work on the species. The period from WW1 until well into the depression years, in hindsight, can be viewed as the only period during which extensive investigation into the biology of Trout cod occurred, while it remained abundant in some of its former habitat, albeit often as an adjunct to research on Murray cod. Most of the surviving museum specimens of Trout cod were collected by Stead and his associates during this period. Live Trout cod were collected and held at the government trout hatchery at Prospect Ponds for quite a number of years but failed to reproduce. A scheme termed 'utilization of nature's waste' was employed whereby fish, including Trout cod, were captured from drying-up waterholes adjacent to the Murrumbidgee River and conveyed to permanent waters. Translocations from the Murrumbidgee itself to other waterways also took place. Target waters for these translocation activities included Cataract Reservoir and the Nepean River near Sydney, and the newly constructed Burrinjuck Dam on the Murrumbidgee River (NSW Fisheries Reports, 1914).

Around the time that Stead made his 'discovery', a correspondent to the *Argus* newspaper of April 5, 1910, identified as "M.St.B." of Foster, posed the question of two types of cod to distinguished journalist Donald Macdonald. He wrote:

Can you tell me if the name Murray cod includes all cod found in our freshwaters, because the blacks insisted upon two different kinds, name Parnthall and Gnomell, and would name a fish, one or the other, at a glance. As a boy I always recognised them as different fish, and still pick them out in fish-shop windows? (*Argus*, 5 April, 1910).

Macdonald was a keen naturalist and angler who regularly corresponded with readers in columns of the *Argus* entitled *Nature Notes and Queries* and *Notes for Boys*. In 1887 he had published *Gum Boughs and Wattle Blooms*, a book recording stories of life in the bush including a whole chapter devoted to the pleasures of fishing for Blackfish. M.St.B.'s recollections of indigenous names for two species of cod corresponds with those recorded by Luise Hercus as used in the Wemba Wemba language of the Swan Hill region being *Pandyil* for the Murray cod and *Ngumel* for the 'Murray trout', ie., Trout cod (Hercus, 1992). Macdonald, referring to Frederick McCoy's work, advised that there was only one species, with the two forms representing sexual differences. M.St.B.'s letter was to initiate ongoing correspondance with readers on the Trout cod which continued until Macdonald's death in 1932. Today these articles provide valuable records on the past distribution and habits of Trout cod.

Mr. R. W. Harvie of Kerang enquired of Macdonald about a fish occasionally caught in that area and Mildura called a Murray trout which had different markings to the Murray cod (*Argus*, March 3, 1911). Two weeks later the chief inspector of fisheries for Victoria, Major Semmens, provided a detailed response:

the fish described by Mr. Harvie is identical with what D. H. Stead calls a 'trout cod'. The fish has been brought under Mr. Stead's notice in recent years, but has been known to many northern Victorian anglers as a Murray trout for a great number of years. It is a much smaller fish than the Murray cod, and, instead of being mottled like the latter, is spotted, though many of the spots are confluent. I have been looking out for a specimen for some time to get it scientifically examined as to whether it really is a distinct species from the Murray cod (*Argus*, 17 March 1911).

In the same column Mr. W. Wilson of Castlemaine reported catching dozens of Murray trout in the Coliban River.

Over the ensuing years a number of correspondents wrote of the Murray trout, but the most notable was fisherman J. H. Jarman of Narrandera who had worked closely with Stead. Responding in 1917 to a published letter on a small cod species in the Violet Town area, Jarman detailed contemporary tagging work on Trout cod, and provided additional information on Trout cod and other native fish at intervals up to Macdonald's passing.

Jarman outlined his knowledge of Trout cod:

The cod alluded to, if they are cod, is what D. G. Stead has named trout cod, an entirely distinct species, and much smaller than the Murray cod. They mature and will spawn as small as 4oz., though they may then be three years old, and a fish of 8lb. or 10lb. is a giant, the female always the largest. To the casual observer they are much like the Murray cod, but are readily distinguished by an expert. They have a dark mark along the cheek through the eye. The jaw is undershot, the spots are dark and irregular in shape, and the back is dark in colour, while the Murray cod is brown on the back, with shiny bronze mottles (not spots) on the sides, these merging into each other. In the Murray cod the jaw is not undershot. The trout cod is never found out of a running stream, and is voracious and snappy after bait, while the Murray cod, either in lagoons or elsewhere, takes the bait more deliberately. He grows much faster, and does not spawn at less than 1½lb. weight or more. The experience on the Murrumbidgee is that cod spawn from July to December, seldom later. In fact they are spawning now. The closed season fixed by Stead is October and November. Some five years ago Mr. Stead and myself and others caught and released a number of both kinds of cod after they had been tagged with silver numbers and a register kept. One fish of 7¼lb. was caught 10 weeks later in the same locality, and was then 8½lb. Other tagged fish were caught later, but their weights and measurements were unfortunately not recorded. The fish mentioned by 'M.C.G.' of Violet Town are assuredly not less than 18 months or two years old (*Argus*, 20 July 1917).

Jarman forwarded a specimen of a Trout cod to Macdonald who wrote in the *Argus* on March 8 1918 that 'I can speak without any doubt as to its table qualities'. In 1920 he received more information from Jarman on Trout cod:

Some interesting points in connection with the habits of Murray fishes were mentioned by Mr. J. H. Jarman of Narrandera, in recent conversation. While the trout cod, recognised in his locality as a distinct variety of subspecies of the Murray cod, and always commanding high prices from those who know its merit as a table fish are fairly common in the Murrumbidgee, he cannot find that it exists in the western rivers such as the Lachlan and the Darling (*Argus*, 1 October 1920).

Macdonald's final correspondence on Trout cod appeared in 1932 and was received from retired commercial fisherman R. J. Larsen:

Murray trout and cod. In spite of scientific opinion Mr. R. J. Larsen of Elsternwick is not prepared to accept that Murray cod and trout are the one species with only sexual differences, though he has, he says, not the biological training that would justify a positive statement. He has, however, caught and cleaned tons of Murray cod, and could discern differences in shape and colour markings that were due to sex. The markings differ in localities, and the condition is largely dependent upon the cleanness of the water. The trout markings are, however, constant wherever the fish is taken. The cod, as we know, runs to great weights, but the largest Murray trout Mr. Larsen got was only 10lb., the largest he ever heard of 13lb. and it is not unusual for anglers or fisherman to underestimate the weight of their fish. Other Indicators. In cleaning such quantities of Murray cod for market Mr. Larsen is familiar with their internal appearance at different periods of the year. Cod of both sexes show rolls of fat, which gradually disappear as spawning time approaches: the trout has no sign of this fat

at any time. In cod the eggs are small at maturity about the size of a grain of sago – while trout ovaries are more rounded, of bigger shape and the eggs much larger. The head of the trout is, he says, more pyramidal in outline, the underfins larger, and the body more evenly tapered to the tail than with cod, while there is a distinct difference in the flavour of the two fish when caught from the same waters. Use of the Tether. Mr Larsen mentions another peculiar difference between Murray cod and trout which recalls the old time ways of Murray fishermen or “Murray whalers” in tethering their spare cod in the bank to keep them alive until they are needed. If cod and trout of the same size are tethered and a big wandering cod comes along he will invariably tackle the trout first. Mr. Larsen has put it to the test by tethering alternately two or three trout with the same number of cod and often found all the trout had been attacked, but not one cod (*Argus*, 12 February 1932).

Photograph 5.8 The First Photograph



David Stead included this photograph of a Trout cod in a feature news article in the *Sydney Mail* in 1929, in the *Australian Geographer* in 1932 and the following year in his book *Giants and Pygmies of the Deep*. It was the first photograph of the species ever published. The original survives in the NSW DPI Library at Cronulla. A caption attached to the photo states: ‘TROUT COD (*Oligorus mitchelli*) Grows to a weight of about 14 lbs and is equal to the Murray cod in the excellence of its flesh. It inhabits the Murrumbidgee River (and possibly other western streams) and frequents running water’. Photo reproduced with the permission of the *NSW Department of Primary Industries*.

Photograph 5.9 Whitley's Trout cod



Gilbert Whitley in his 1937 paper noted that in one specimen of a Trout cod he examined at the Australian Museum the jaws were equal in length. This specimen, which survives in the museum's collection, is likely to be the one referred to by Whitley. When the mouth is closed the jaws close almost perfectly though the lack of an overhanging upper jaw may have been the product of shrinkage during preservation. Photo copyright of the *Australian Museum*.

Murray Cod and Trout Cod

By David G. Stead

For many years there have been the most lively discussions among anglers and residents of our western rivers system concerning the identity of the various fishes of their waters. But none has attracted such attention as the Murray Cod and its close cousin the Trout Cod. In the following notes Mr. Stead describes and illustrates the two species, and gives some valuable information concerning each of these fine food-fishes.

IN the year 1902 I began a series of official investigations into the distribution and spawning habits of our edible fishes. Apart from its general utility and interest in the prosecution of fisheries work, it had an immediate application in the making of fisheries regulations—especially relating to lawful sizes, close seasons, and so on. Immediate attention was bestowed, naturally, upon our marine fishes, partly because these were of paramount importance and because there were greater facilities for the capture and study of coastal collections. In the process of elucidating spawning times, rate of growth, occurrence of young fry, nature of eggs and productivity, food and feeding habits, etc., many thousands of commercial fishes (and others) were

"trout cod," as I named it at the time, did actually become sexually mature at about half a pound weight (or even a little under), while the Murray Cod did not spawn below a weight of about two and a half pounds.

It is worthy of mention that the information obtained during these investigations formed the basis for all subsequent regulations by the Fisheries Department relating to close seasons and lawful size of capture.

Trout Cod and Murray Cod Compared

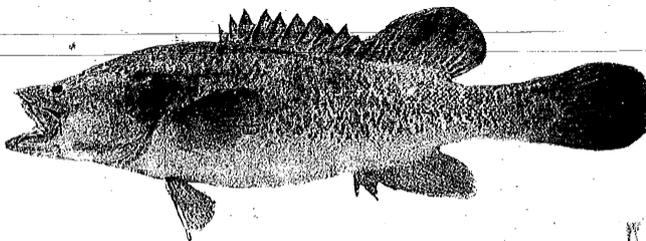
THERE are certain well-defined characters which render the two species quite easy of determination even by the lay. One prominent feature of the Trout Cod is the bold snout, not so excavate or shovel-nosed

as in the Murray Cod, and which, in the former, overhangs or protrudes beyond the lower jaw, while in the Murray Cod the reverse is found—the lower jaw protruding beyond the upper, and this, coupled with the excavate snout, giving to the larger fish that familiar flattened shovel-nosed head. In the field the two kinds are very distinct, and the wonder is to me that anglers did not themselves point out the differences long before. To many of the professional fishermen the Trout Cod had been known for many years, and distinguished as "trout" or (on the lower Murray) as "rock cod." The

Trout Cod a Long-Last Fish

AFTER having definitely determined that the Trout Cod was a distinct species I came to the conclusion that it was quite new to science. Its nearest relative, the Murray Cod, is known as *Oligorus macquariensis*. I intended, on account of the spotted skin and more elegant form, to call the Trout Cod *Oligorus frutaceus* (trout-like). But on looking through Australian ichthyological literature I found a description—a very imperfect one—of a fish discovered about 38 years before by Count Castelnau (then in Melbourne) among a consignment of fresh fish from the Murray River, and which he had named *Oligorus mitchell*. This seemed to be my new fish. I then found that there was a fish under this name in the old collection at the Macleay Museum at Sydney University. Upon examining it, sure enough it was my fish. Mr. George Masters, the veteran naturalist, who was then in charge, and who had been very closely connected with Sir William Macleay—whom I may call the father of Australian ichthyology, as he was the father of general science in so many ways—told me that he had no doubt that the label had been put on the fish after consultation between Sir William and Count Castelnau. In the same collection I found a specimen of the same fish with a divergent snout, which Sir William had erroneously thought to be a distinct species and had named it *Oligorus gibbiceps*. Apparently he did not know that we get these pug-faced specimens in many kinds of fish. I have had them frequently, especially among young fish—trout, whiting, mullet, etc. In these cases the snout drops almost sheer away from the front of the eyes.

Thus a long-lost fish came to light again, and with the facts at my disposal, *Oligorus mitchell*, the Trout Cod, was not only reinstated, so to speak, but a mystery (and a source of great confusion in fisheries administration) was elucidated. Regulations are now made independently for each species—the Trout Cod and the Murray Cod—and one important cause of dissatisfaction and agitation among Riverina anglers has been removed.



THE MURRAY COD — THE KING OF AUSTRALIA'S FRESHWATER FISHES
Attains a weight of 100lb. Found in all western rivers, lagoons, and billabongs of South Queensland, New South Wales, and Victoria, and in the upper waters of Clarence River.

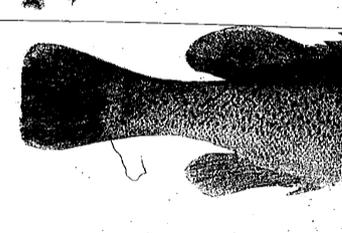
handed, measured, weighed, and examined. While this was going on there was quite a considerable agitation in our freshwater fisheries as to the lawful sizes of the principal fishes, suggesting prohibition of certain forms of fishing gear, closed areas, and close seasons. Naturally, this agitation centred chiefly round the king of Australia's freshwater fishes—the Murray Cod, which may be justly claimed to be one of the best of the world's food fishes.

Discovery of Trout Cod

PRELIMINARY investigations which had been made into the Murray Cod indicated that it attained a fairly large size before spawning; so the lawful size at which it might be captured was fixed accordingly. The public is wont to fix its own sizes, however, and these are based upon one consideration only—is it of a size worthy of individual cookery? This is a far more important factor than might be imagined, and in some sea species must be taken into account. Added to the clamour at the time were the voices of those who asserted that the Murray Cod spawned at as low a weight as half a pound! No notice of this was taken at the time, as one was quite used to the wildest assertions of those who created "fish stories" for their own benefit; but when some worthy anglers in 1905 made the statement that at Narrandera, on the Murrumbidgee River, they had often seen Murray Cod of this small size—"full-roed," I sent away to them at once and invited them to prove their assertion by sending in some examples. In due course two fishes arrived, weighing, respectively eight and nine ounces, which both contained roe in a well-advanced state of development. An examination of the fishes showed that if they were to be classed as ordinary Murray Cod they averaged a good deal from the ordinary types as known from many parts of the western river system. Further, the eggs (nearly ripe) were decidedly smaller than those of the Murray Cod that I had examined, and which ran into many thousands. I then put them aside as probably belonging to a distinct species of fish not hitherto recorded. Later on further examples of the same form were obtained from Wagga (sent in as Murray Cod, of course)—but though I saw that they were identical with the Narrandera specimens, I was loath to go so far as to say that they represented a new species, without first seeing the fish and its mode of occurrence in the natural state.

During August of 1909 my late friend Henry Davson (of the old Monaro family) paid a visit to Deniliquin, and while there heard the fishermen frequently refer to a fish that they called "trout." Doubting the existence of any true trout there, he arranged for a specimen of about 17½ inches in length to be sent to me, when it proved to be of the same kind as the Narrandera and Wagga Wagga specimens. The Board of Fisheries then instructed me to investigate the matter. This I did very closely during 1909 and 1910 in many parts of the western river system, from the Barwon to the Murray and the lower Darling. One result of these intensive investigations was that it was established beyond a doubt that there was an entirely distinct species of fish, of a much smaller size than the Murray Cod, and possessed of quite distinctive physical features, colour, and habits. It was ascertained further that this

name trout was applied to this fish, no doubt, on account of the spotted sides and more elegant appearance. In the Murray Cod the sides are always more or less marbled rather than spotted, whereas in the Trout Cod the sides are always quite distinctly spotted. The spots may be round (and either fairly widely separated or close together) or else they may be oval, oblong-oval, or confluent. When the fish is lying in the water alive a dark stripe on each side, running from the point of the snout to the eye and continued across the gill-cover, is very prominent. In addition to the differences of snout and jaw, the eyes of the Trout Cod are larger than those of the Murray Cod, and the sides of the head are more flattened. The former fish is also much higher in the body and more perch-like than the latter. In the spawning period it is at once noted by the angler that whereas the young Cod, say, under a pound weight, show no development of the roes whatever, the young Trout Cod from half a pound upwards have the eggs and the milk (soft roe) fully developed.



THE TROUT COD OF THE WESTERN RIVERS OF N.S.W.
This fish grows to about 15lb or 20lb in weight.

Another important difference noted by me in these two species is as regards their mode of occurrence in the rivers and billabongs. One seldom encounters the Trout Cod in the latter, although the Murray Cod are almost at their best in such still waters. The Trout Cod loves moving waters, and is most commonly found in the vicinity of river bends or "larrooles." Here, against a fairly deep bank, is the best spot to try for the Trout Cod if fishing with hook and line. When hooked the fish puts up quite a fair fight, altogether different from the comparative sluggishness of the Murray Cod, so well known to river anglers.

Under the name of Rock Cod the Trout Cod is very well known, and is quite abundant, on the lower Murray from Wentworth well down into South Australia. Some fishermen think it is a cross between the Murray Cod and the yellow-belly, or golden perch; but there is not the slightest foundation for such an idea. Anyway, all over the world this is quite a pet idea among many fishermen to imagine that nearly allied kinds of fish are hybrids. The fish is more often seen in the Melbourne market than in Sydney.

My illustrations give a very good idea of the different appearance of two specimens—one of the Trout Cod and the other of the ordinary Murray Cod—of about the one size. But the first-mentioned was a mature fish that had spawned, probably two or three years in succession, while the second was an immature Cod, whereas the Murray Cod may reach one hundred pounds in weight (or even more), a Trout Cod of fifteen to twenty pounds is quite a large one, and five pounds would be nearer to the normal size of large specimens.

Spawning of Murray Cod

ONE of the most frequently asked questions relates to the spawning of the Murray Cod. The principal spawning time is during October and November, but at any time during the warmer months, if a long-continued rise in the river takes place, a certain amount of spawning occurs. The eggs are deposited primarily in backwaters and billabongs. Under normal conditions of temperature the eggs, which are attached to submerged objects, hatch out in about seven or eight days. The young Cod immediately seek over or under friendly sticks or sunken leaves.

In the 27 November 1929 edition of the Sydney Mail David Stead published this lengthy feature article on the discovery and biology of Trout cod. Despite citing key differences between the two cod species including their reproduction his claim of two cod species was ignored by many of his peers.

5.5 Return to Obscurity

While some of Stead's contemporaries accepted his view on the Trout cod, others questioned his recognition of the species or were at least uncertain. Howard Joseland (1921) in his angling guide makes passing reference to Stead and Trout cod: 'The Trout Cod Mr. Stead places as a species distinct from the Murray cod. It is a handsome fish resembling a well-grown Leven trout in colour, but heavier in build'. That there was ongoing debate on the existence of two cod species was revealed by Waite (1923) who posed the question 'What, for example, is the status of the "trout cod"?' Allan McCulloch began his association with the Australian Museum in a voluntary capacity as a 13 year old in 1898 and by 1906 was in charge of the vertebrate collection at the museum. In 1922 he published his *Australian Zoological Handbook No 1* and in the section describing the Murray cod he discussed Trout cod: 'It varies considerably in form and colour-marking, and one variety with trout-like markings and an overhanging upper jaw has been regarded as a distinct species under the name of Trout Cod, *Oligorus mitchelli* Castelnau' (McCulloch, 1922). It appears that McCulloch was uncertain as to the status of Trout cod.

After leaving NSW State Fisheries Stead apparently sensed that some of his peers did not accept the existence of Trout cod as a separate species. He continued to promote Trout cod, and in 1929 wrote a very large feature article in the *Sydney Mail*. He provided much background on the discovery of Trout cod, the common names used for it by fishermen, described in detail the physical differences between the two cod species, its habitat preferences and behaviour, and differences in the reproductive biology of Trout cod compared to Murray cod and included photographs of both species (Stead, 1929b). In 1932 he published another shorter article on Trout cod in the *Australian Geographer* (Stead, 1932) and the following year in his book *Giants and Pygmies of the Deep* further discussed the species (Stead, 1933).

Gilbert Whitley joined the Australian Museum in 1922 and succeeded McCulloch after his death in 1925 as ichthyologist. In 1929 he identified the fact that the genus *Oligorus* given to the Murray cod by Gunther in 1859 had in fact previously been allocated to a North American beetle and was therefore preoccupied. As a consequence he erected the genus *Maccullochella* for the Murray cod to honour his mentor and late friend Allan MacCulloch (Whitley, 1929). Whitley turned his attention to the existence of Trout cod. It is not known what stimulated his interest, most probably a request from the NSW Chief Secretary's Department to create a bibliography for the Murray cod. In his review of the literature he quoted observations made by Stead and H. K. Anderson regarding aspects of the reproductive biology of the Trout cod citing manuscripts he possessed. In the text Whitley stated:

I am unable to recognize more than one species of Murray Cod / I have examined all the Murray Cod in the Australian Museum from Benalla, Victoria; Mary R., Queensland; Richmond River, Wellington, Murrumbidgee and many other New South Wales localities, also the Murray River, and cannot find valid criteria for specific separation. / The snout overhangs the lower jaw in most specimens but in one the jaws are equal, and, as the fish grows, the lower jaw projects more and more. The spotted sides of the Trout Cod do not differ from those of a large Murray Cod and it is evident that the latter is merely the adult form of the young or Trout Cod stage; it is remarkable that we have no young Murray Cod without the trout cod characteristics (Whitley, 1937).

Whitley, like Ogilby, correctly identified that the Bathurst holotype had the characteristics of a Trout cod. He concluded:

If it be later found necessary to distinguish the two nominal forms, the custom of some Palaearctic ichthyologists might be followed and the Trout Cod known as *Maccullochella macquariensis* forma

macquariensis and the Murray Cod as *Maccullochella macquariensis forma peeli*, this name having been given to a specimen with marbled coloration and a projecting lower jaw by Major Mitchell in 1839 (Whitley, 1937).

In a footnote in his bibliography to the reference for Castelnau he added 'The Murray Cod has been described several times as a "new" species but modern authorities do not consider that there is more than one, somewhat variable species' (Whitley, 1937). Whitley faced a number of problems that may have led him to his decision. He clearly was influenced by the large number of small Trout cod held in the museum collection, many of which had been collected by David Stead and his associates. By Whitley's time some of the Museum's collection had been exchanged with other institutions, was in poor condition or had been destroyed. At least one Trout cod specimen did have jaws of nearly equal length though probably produced as a distortion through preservation (Author's pers. obs.) and in larger specimens of Murray cod the markings tend to be spotted.

By Whitley's time, the species concept had evolved from that understood by nineteenth century taxonomists. Subsequent to the publication of Charles Darwin's *Origin of Species* in 1859, which highlighted the importance of variation and the relatedness of organisms, there was much debate about the definition of species. This ultimately led to the creation of the biological species concept, invoking reproductive isolation, formalised by Ernst Mayer (Mayer, 1942), though even today in the vast majority of cases, species are separated on the basis of physical or DNA differences rather than a consideration of their reproductive biology. Although the biological species concept had not yet been formalised, the biologists of Whitley's time did have an understanding that reproductive differences were important in discriminating between similar species, according to the concepts of natural selection elucidated by Darwin. Although aware of, and quoting, the reproductive differences between the two types of cod reported by Stead and Anderson, Whitley drew his conclusion on the basis of museum specimens, ignoring advice from those that worked with the living animal like Anderson. His suggestion that the possibility of further evidence could change his view on the existence of two types of cod could have been obtained through an attempt at the collection of juveniles of the Murray cod form. The action of his paper, combined with the disappearance of Trout cod from much of its former range at that time, can be identified as a major source of the confusion as to the existence and status of the fish that persisted for the following three decades.

Whitley's influence on contemporary biologists was considerable. The following year William Dakin and Geoffrey Kesteven, in their report on the artificial propagation of the Murray cod at Bringagee on the Murrumbidgee River, cited Whitley and concluded that Trout cod were a migrating variant of the Murray cod. Their view may have been coloured by their stated opinion that Stead had impeded the development of hatchery techniques for native fish with his translocation activities. With respect to Trout cod Dakin and Kesteven made the following observations:

Certainly colour variations are present – possibly due to habits associated with the breeding season. Thus two distinct colour varieties were brought before our notice in the course of the work to be described – they were spoken of as local and traveling fish, the former had apparently "normal" characteristic marking on a greenish background, whilst the latter were grey and the markings much less distinct (Dakin & Kesteven, 1938).

Others were clearly less certain about Whitley's conclusion. Ian Munro in his *Handbook of Australian Fishes* accurately described Trout cod as 'A bluish or white colour variety with spotted sides and a dark stripe along the head, and a projecting upper jaw is sometimes recognized as a distinct species known as the Trout Cod, *M. mitchelli* (Castelnau 1873)' (Munro, 1938). John Tubb from 1936 to 1938 was Fisheries Adviser to the Victorian Fresh Water Research Committee and during this period investigated the Barmah Lakes fishery. During his field

study Tubb recorded differences in the spawning season of the two types of cod, attempted the artificial propagation of Trout cod, and clearly recognised them to be different from Murray cod (Cadwallader, 1977).

5.6 Resolution

With a significant decline in the inland commercial fishery apparent by the end of the Second World War, the then Victorian Fisheries and Game Department, with the support of the NSW Fisheries Department, initiated a survey to report on its status. From 1949 to 1952 John Langtry collected data on the distribution, abundance and biology of the major fish species, including Trout cod. Not only did he undertake netting surveys at intervals along the Murray River, Langtry interviewed professional and amateur fishermen recording their observations and thoughts. Significantly he interviewed William Hill and Dr. H. O. Lethbridge, both in their twilight years and pioneers in the artificial propagation of native fish, recording their recollections, and utilized the work of his predecessor John Tubb. From all these information sources and from his own personal observations, Langtry listed in detail the key physical and reproductive differences between Murray cod and Trout cod, as well as providing descriptive and numerical data on the distribution and abundance of both species. Langtry ultimately concluded 'It is considered that Murray cod and trout cod are different: if not as distinct species then certainly as races of the same species' (Langtry, 1960). Limited copies of Langtry's report were not circulated until 1960 and it was not freely available until 1977 (Cadwallader, 1977). The delay in preparation of the report and the failure to disseminate this information at the time was an opportunity lost, not only to clarify the taxonomic status of Trout cod, but to take affirmative action to conserve the species while some significant populations were still extant. Dr. Philip Cadwallader who edited Langtry's manuscript in 1977 reflected on the opportunity that had been missed: 'It is a sad reflection on freshwater fisheries research in Australia during the last 25 years that much of the research suggested by Langtry has not yet been conducted. His suggestions for preventing the decline of native fish stocks have largely gone unheeded' (Cadwallader, 1977).

During the 1950s other authors suggested that there were two distinct species of cod. Theodore Roughley, Superintendent of NSW State Fisheries, pointed out that fishermen and taxonomists held opposing views on the existence of Trout cod as a separate cod species and cited evidence of blood serum tests conducted in the United States suggesting that there were two species. He discussed a number of aspects of the biology of Trout cod and suggested that it was probably a distinct species (Roughley, 1955). In 1959 John Lake, the Inland Fisheries Biologist for the NSW State Fisheries Department, prepared a document summarizing what was considered reliable information on the biology of all the freshwater fish species found in NSW as a prelude to an extensive research program (Lake, 1959). He had previously conducted research on the trout fishery and, coincidentally, was related to the first European to encounter a cod, George Evans. In this work he speculated on the existence of two types of cod:

It varies considerably in form and colour pattern and it is possible that two species exist. One colour variety has an overhanging upper jaw and most pyloric caecae are much smaller and sometimes fewer in number. It has been regarded by some people as a distinct species under the name of trout cod. It is reputed to spawn mainly in September, spawn at a smaller size, and has larger and brighter coloured eggs. Colour variations are not very significant since they occur in most species and vary according to habitat, age, and habits such as those associated with the breeding season. It will be considered here as one species. Further work may, in the future, prove otherwise (Lake, 1959).

Lake did not specify where he had sourced the observations discussed, though the reproductive details suggest it may have been the manuscript prepared by H. K. Anderson cited by Whitley.

In 1962 NSW State Fisheries opened the Inland Fisheries Research Station on the banks of the Murrumbidgee River near Narrandera, with the purpose of researching the biology of native fish and developing techniques for their artificial propagation. A previous attempt at establishing a native fish hatchery at Burrinjuck Dam in the late 1920s had been abandoned after damage by floods, an inability to procure mature broodstock and the onset of the Great Depression. Lake was appointed biologist in charge commencing research activities during the construction phase in 1960. In his endeavours he relied heavily on the pioneering work of Hill, Lethbridge, Anderson, Tubb and Langtry and forged a close alliance with professional fisherman William Davies of Swan Hill whose practical insight into the fish proved invaluable. Davies assisted in the collection of broodstock and their maintenance in ponds as well as supplying family photographs subsequently used in publications by the department and its staff. Research into the basic biology of all of the larger native fish species of the basin was carried out, with attempts at stimulating spawning in ponds of the Murray cod, Golden perch, Silver perch and Catfish were ultimately successful. In April 1962 a large Trout cod was captured from the Murray River in the Yarrowonga region a photograph of which was used in a number of publications (Lake, 1967; 1971). It is clear that by 1967 Lake had handled live Trout cod and by this time had developed a firm position on their status: 'There is not sufficient evidence to definitely separate this fish, as a distinct species from the Murray cod. From the evidence seen by this Author it is strongly suspected that two species do exist. Further work is required however' (Lake, 1967). Lake went on to list the many physical differences he observed between the two species of cod as well as observations on their handling characteristics gleaned at the Narrandera facility. In a footnote to an addendum Lake made his thoughts on the status of Trout cod quite clear: 'The trout cod is almost certainly a distinct species' (Lake, 1967).

Langtry's manuscript, along with Lake's recommendation for further work, did initiate some action on the case of Trout cod. The head of the Victorian Fisheries and Game Department, Alfred Dunbavin Butcher, in 1959-60 organized the collection of specimens of cod from Lake Sambell, near Beechworth and the Seven Creeks, near Euroa, both locations being cited by Langtry, which were subsequently lodged in museum collections. In particular, local newspaper accounts from the mid 1960s indicate that the Department showed considerable interest in the management of the Lake Sambell cod fishery. Butcher himself published a paper making reference to Trout cod, including observations sourced, it is believed, of specimens obtained from the Seven Creeks (Butcher, 1967; Barney Kipping, pers. comm.). Ultimately he provided the impetus for the resolution of the existence of the two species of cod. Correspondence between Professor Allan Weatherly of the Australian National University and Dr. Tim Berra of Ohio State University in 1967 ultimately led to an investigation into the existence of two cod species being carried out during 1969 and 1970. They located and reviewed the early writings of the naturalists and examined museum and living specimens of cod sourced from a wide range of locations. From their reading of the literature, penned by previous workers going back well over a century, they knew what they were looking for. It was no coincidence that these two researchers concentrated their efforts on Lake Sambell and Seven Creeks as Langtry had provided these locations with pinpoint accuracy as the key to answering their questions. Using physical characteristics of living and museum specimens, combined with electrophoretic data, the two species of cod were separated as the Murray cod utilizing Mitchell's *peeli*, and Trout cod utilizing Cuvier's *macquariensis*. Their description for Trout cod was strikingly similar to those of Cuvier in 1829 and Castelnau in 1873 (Berra & Weatherly, 1972; Berra, 1974). It was only with the publication of their work that there was general acceptance within the scientific community of the existence of two species of cod in the Murray-Darling Basin.

Since 1972 additional studies of Trout cod, including detailed electrophoretic and genetic analysis, as well as knowledge gained about the reproductive biology from hatchery production, have supported its status as a species distinct to Murray cod (MacDonald, 1978; Jerry *et al.*, 2001; Bearlin & Tikel, 2003). Ironically most of the distinguishing characteristics between the two species, save for those uncovered by the modern

development of electrophoresis and DNA characterisation, was certainly known by the third decade of the twentieth century and much of it in the late nineteenth century. David Stead's detailed account published in 1929 outlining key physical and reproductive differences between the two types of cod (Stead, 1929b) should have been accepted at that time as indicating that two species existed.

Additional species of *Maccullochella* have also been identified in some coastal streams outside of the Murray-Darling Basin. These include the Eastern Freshwater Cod (*Maccullochella ikei*) of the Clarence River system, the Mary River cod in southern Queensland (*Maccullochella mariensis*) and at least three of unknown status which have become extinct since European settlement in the Richmond, Logan and Brisbane River systems (Rowland, 1993; Nock *et al.*, 2010). A detailed account written by angler D. Donovan suggests cod were also present in the tributaries of the Burnett River system (*Brisbane Courier*, 17 September 1879). This is supported by a latter news account reporting the capture of two specimens in the Degilbo Creek near Biggenden and their abundance in the 'southern watershed' of the catchment (*Brisbane Courier*, 7 October 1902). Recent mitochondrial RNA analysis has indicated that the coastal species of cod were created by passage of fish over the Great Dividing Range about one million years ago. The eastern taxa of *Maccullochella* are closely allied to Murray cod but divergence between Trout cod and Murray cod is much greater than that between the latter and the coastal forms, suggesting that the separation of these two species was a much more ancient event occurring around seven million years ago (Jerry *et al.*, 2001; Nock *et al.*, 2010). The mechanism driving the divergence of the two cod species in the Murray-Darling Basin can only be speculated. The fossil evidence is so sparse as to provide no indication of where and when the separation took place. All that can be concluded is that two species evolved and were present when Europeans arrived in the basin.

Berra and Weatherly, despite the assistance of the fisheries authorities of two states, professional and amateur fisherman, could only reliably collect living specimens of Trout cod from the Seven Creeks and Lake Sambell. Ironically the species was not native to either location, but had been translocated to those waters by anglers in previous years (Cadwallader & Gooley, 1984). Only one living specimen was collected from the rest of the Murray-Darling Basin by angler Anthony Bell from the Murrumbidgee River near Angle Crossing in the ACT. Further fish were taken by a number of local anglers including Gordon Winter and Keith Shields from the same area in subsequent years. Writing on their findings Berra and Weatherly concluded: 'Trout cod in our opinion represent a rare and endangered species. Their extremely restricted present distribution makes them especially vulnerable. If some calamity were to befall Seven Creeks or Lake Sambell trout cod would probably become extinct' (Berra & Weatherly, 1972). The issue as to the existence and status of Trout cod had been resolved. Their warning was a call to arms to scientists and managers to act to bring the fish back from the brink of extinction and restore former populations. The debate on the existence of this enigmatic fish was brought to a conclusion, but was replaced by a new debate as to where it was originally found and what type of habitat was suited to it, questions fundamental to ensuring its recovery.

Photograph 5.11 Lake Sambell Trout Cod



Top: Lake Sambell, Beechworth, January 2006. Trout cod were introduced to the lake after its construction in 1928 and established a self-supporting population. In July 1970 it was one of only two waters in the Murray Darling Basin in which Tim Berra and Allan Weatherly could reliably capture specimens as part of their study to demonstrate the existence of two cod species. The population was decimated by a massive fish kill in September 1970 and until recently extinct in the water. In 2010 DPI Victoria commenced stocking the lake with hatchery produced Trout cod to create a recreational fishery. Photo courtesy of Paul Bannister.

Bottom: This image of an 11 kg Trout cod, captured from Lake Sambell in July 1970, presents the markings and features from a dorsal perspective on what would be considered to be a reasonably large specimen. The fish is heavily speckled with highlighting around the markings and the conical head and pointed snout are evident. The grey/blue coloration present on the head is quite distinctive and gave rise to the popular colloquial Victorian name 'bluenose'. Photo courtesy of Professor Tim M. Berra, Ohio State University.

Photograph 5.12 Large Trout Cod from Lake Sambell



These large (>10 kg) Trout cod were captured by Tim Berra and Allan Weatherly from Lake Sambell in July 1970. Fish from that source as well as the Seven Creeks were utilized to ultimately confirm the animal as a distinct species to Murray cod. This photograph is probably the best ever taken of large Trout cod and clearly depicts the markings and coloration of large examples of the species. Photo courtesy of Professor Tim M. Berra, Ohio State University.

6 The Key External Differences between Murray Cod & Trout Cod

Berra and Weatherly (1972) listed the key external distinctive features of Trout cod as being an overhanging upper jaw, straight head slope, longer snout, a prominent dark stripe through the eyes and grey colour with a speckled pattern. In contrast Murray cod possesses jaws of equal length or the lower jaw protrudes, a concave head slope, a shorter snout, a faint or absent eye stripe, and green colouration with a mottled pattern. These distinctions were identified by the comparison of living and preserved specimens of both types of cod. A total of 120 live Murray cod, collected from the Darling, Lachlan, Murrumbidgee and Murray Rivers and 29 live Trout cod, collected from Lake Sambell, Seven Creeks and the upper Murrumbidgee River, were examined, as well as 36 museum specimens of Murray cod and 25 museum specimens of Trout cod originating from across the Murray-Darling Basin. The Murray cod specimens ranged in length from 30.70 mm up to 1235.00 mm and the Trout cod ranged from 64.00 mm up to 685.00 mm in total length (Berra & Weatherly, 1972). A number of other features such as a generally longer caudal peduncle, larger eyes and broader white margin on the tail were identified as features typical, but not distinctive, of Trout cod, as the range of these features overlap considerably between the two cod species. The single reliable apomorphic physical difference between Trout cod and Murray cod is that in the former when the jaws are closed the upper jaw overhangs the lower jaw.

The author, between the late 1960s and early 1990s, examined in excess of a hundred Trout cod captured by angling from the Murray, Buffalo, King and Mitta Mitta Rivers and the Seven Creeks. This sample greatly exceeds the 29 live specimens examined by Berra and Weatherly and was sourced from four additional waters containing wild populations of Trout cod at that time. None approached the size of the largest fish they examined, at around 11 kg, though a number of fish from the Murray River exceeded 5 kg and one from the Seven Creeks was estimated to be over 6 kg in weight. The author has also examined all the museum specimens of Trout cod held by the *Australian museum* and a number at other locations. It is from the observations of these fish, as well as observations of stocked specimens in the Ovens, Goulburn and Murrumbidgee Rivers in recent years, those reported by Berra and Weatherly in 1972 and observations sourced from anglers familiar with the two cod species that the following discussion on the external differences between the two types of cod has been prepared.

The coloration and markings of the two types of cod are the source of much confusion amongst anglers and in some publications. Berra and Weatherly's statement of Trout cod being 'livid' grey (a dull grey-green) and the Murray cod green is a generalization of the specimens they saw (Berra & Weatherly, 1972). The colour of both types of cod is highly variable and dependent upon the clarity of the water and the size of the fish. Trout cod from turbid water can possess a general golden/tan coloration while small Murray cod under the same conditions are often white or pale yellow with dull grey or green blotches (Author's obs. of Trout cod and Murray cod from the Murrumbidgee River near Narrandera). As Murray cod grow larger (>10 kg) in turbid water, they often take on a light grey-blue colour background colour (Author's obs. of Murray cod from the Murray River near Echuca and the Murrumbidgee River near Darlington Point).

Trout cod taken under moderately clear conditions from the Murray River near Cobram were grey and often distinctly blue on the dorsal surface (Author's obs.). Some Trout cod captured from the Murray River when the water was very clear exhibited the 'livid grey' (green-grey) colour reported by Berra and Weatherly (1972) and were never the bright green colour of Murray cod that could be taken from that water under similar conditions (Author's obs.). No Trout cod taken from the Seven Creeks by the author have ever exhibited the distinctly blue colour of some Murray River fish with most being livid grey when taken from clear water and light grey under turbid conditions. Similarly specimens from the King River lacked any bluish coloration although those from the Buffalo River were sometimes quite dark blue (Author's obs.). Large (>4 kg) specimens of Trout cod from the Murray River have exhibited a dark blue or black coloration on the head (Author's obs.) which has

been reported by a number of senior anglers this feature giving rise to the colloquial name 'bluenose'. When specimens of the two cod species from the same water at the same time are compared the coloration is usually different but given the variability in colour under different conditions in general coloration, while useful, is not a diagnostic feature.

The markings of the two types of cod are generally very distinctive in fish below about 5 kg in weight (Author's obs.). Trout cod are usually prominently marked with a pattern of dark grey or black spots and dashes, with brighter highlighting around them. Rarely, modern anglers have reported the markings on Trout cod to be a russet or orange colour and this was observed in the Bathurst holotype (Lesson, 1930) though this may have been an artefact of its preservation. Smaller Murray cod are usually covered from head to tail with grey or green blotches creating a generally mottled appearance which may be overlain with some darker spotting (Author's obs.). The distinctions in the markings of the two cod species become somewhat ambiguous as the fish grow larger. In some larger (>10 kg) Murray cod the pattern may break up into numerous lines and spots or general spotting all over the body and can be covered in numerous Trout cod-like dashes (Author's obs.). Some elderly anglers familiar with larger Trout cod in the past have stated that some specimens they caught were heavily spotted (Laddie Clifford, Bert McKenzie, pers. com.) and this is visible in the few photographs of larger Trout cod exceeding 10 kg that have been published (Lake 1967 b & 1971, Berra & Weatherly 1972, Berra 1974, Berra 1975). In some of these images the fish is peppered with fine spots with the dashed markings diminished in number thus resembling the markings present on some Murray cod over about 10 kg in weight. As Trout cod get larger, the dashed markings may extend in numbers over the head, this characteristic being quite apparent in some of the old preserved specimens and the head of a large specimen from the Goulburn River (Berra, 1974). Larger specimens of Trout cod from the Seven Creeks are usually very heavily spotted including the head (Author's obs.).

Many anglers believe that the presence of a head stripe through the eye is also diagnostic of Trout cod but it is not a distinguishing feature. Certainly in most small Trout cod it is obvious in life, though may fade rapidly after death. It may also be present in small Murray cod but tends to be comprised of a series of fine lines rather than a broad mark and is usually not present in fish over five kg (Author's obs.). In Trout cod the eye stripe can vary from a sharply defined fine line to a vague broad marking and in larger fish the eye stripe can be less distinctive (Author's obs.). Anglers have reported that it may sometimes be absent in large specimens (Laddie Clifford, Henry Davies, pers. Com.). Both types of cod can develop dark patches or mottling over their body after death while some Trout cod may become entirely black, while at the same time the spots and dashes diminish in prominence. This is demonstrated clearly in a comparatively recent colour photograph of a Trout cod taken by Rod Harrison from the Murray River at Brigenbrong in 1972 (refer to the section on the Upper Murray River). Where fish have been in contact with the ground or other surfaces the skin can become bleached white.

6.1 Key External Features of Murray cod & Trout cod

(Based on Berra & Weatherly, 1972. Text in italics is based on the Author's observations of living specimens of both species from the Seven Creeks and Murray, Buffalo, King and Mitta Mitta Rivers)

Table 6.1 Key External Features of Murray cod & Trout cod

Feature	Murray cod	Trout cod
Jaws	Jaws equal or lower jaw protruding. <i>When the mouth is closed the jaws are equal in length or the bottom jaw is longer.</i>	Upper jaw overhangs lower jaw. <i>When the mouth is closed the top jaw is longer and overhangs the lower jaw.</i>
Head	Head concave between the eyes, snout short. <i>Head usually flattened with a concave profile, eyes usually placed towards the top, may be strongly depressed between the eyes, snout usually blunt and short. In larger fish the head may be more conical.</i>	Head slope straight, snout long. <i>Head conical with a straight profile, may be slightly depressed between the eyes, eyes placed towards the side, snout long and pointed.</i>
Background Colour	Yellowish green with dark markings. <i>Background colour varies from white to yellow to bright green in smaller fish, though some larger fish may have a steel grey colour.</i>	Livid grey. <i>Varies from a light tan colour, to steel grey, to dull blue, to 'livid grey' (A dull grey-green colour).</i>
Body Markings	Grey to black mottling becoming reticulated in very large specimens. <i>Small to moderate fish covered in blotches or mottling, grey to dark green in colour. In larger fish (>10 kg) the mottling may break up into general grey or black spotting.</i>	Small black spots some of which are elongated into dashes. <i>Smaller fish marked with dark grey to black spots and dashes. Larger fish (> 5 kg) may be heavily marked with numerous fine spots and prominent dashes.</i>
Head Markings	<i>Patches or mottling which may break up into heavy spotting in large fish. Markings may include fine lines through the eyes in small fish (<5 kg).</i>	Dark stripes on the head extending through the eyes. Very few spots on head in most specimens. <i>In smaller fish there are usually few spots on the head, but larger fish can have many spots (refer to photographs). A dark stripe, which may be broad or fine, is present through the eyes though may fade after death or during stress. Larger fish (>5 kg) may have a very dark snout and a black or blue patch on top of the head between the eyes.</i>
Eye Size	Smaller than Trout cod of a similar size, but not a reliable feature.	Large than Murray cod of a similar size, but not a reliable feature.
Caudal Peduncle	Generally a shorter caudal peduncle than Trout cod, but not a reliable feature.	Generally a long caudal peduncle than Murray cod, but not a reliable feature.
Fin Markings	Commonly have narrow white or <i>pink</i> margins, <i>often absent in large fish.</i>	Have broad white fin margins.

Photograph 6.1 Murray Cod and Trout Cod Compared



Top: Photograph of a Trout cod weighing about one kg captured from the Murray River near Barmah in 2006. The fish displays the typical appearance of fish in the Murray River population with the distinctly grey coloration, is lightly marked with dark spots and dashes, possesses a dark stripe along the head passing through the eye and has a very straight head slope. The overhanging upper jaw is quite apparent.

Bottom: Photograph of a similar sized Murray cod captured from the Murray River in the same area as the photo above. The fish displays the typical yellow/green colouration and mottled pattern present in smaller animals. The more concave slope of the head is evident but the protruding lower jaw is obscured by the fishing equipment. A faint, obscure line is just visible passing through the eye. It is more apparent in very small Murray cod and is never present in fish much bigger than the one in this image. Both photos courtesy of Ramon Clifford.

Photograph 6.2 Trout Cod Variations



Variations in the distribution and intensity of the body markings of Trout cod.

Top left: A stocked Trout cod captured from the Ovens River. Note that the individual markings are very fine, that few are present in the anterior half of the animal and almost none on the head. The dorsal colour is generally grey with a distinctive purple/blue colour on the snout and head. Photo courtesy of Adam Bosley.

Top Right: Another stocked Trout cod captured from the Ovens River near Peechelba. The fish is much darker and is also much more heavily marked. Individual markings are much broader and the background colour is slightly mottled highlighting the markings. Photo courtesy of Adam Bosley.

Bottom left: This large (≈ 6 kg) trout cod was angled in July 1983 from the Seven Creeks at the base of the Gooram Falls. Trout cod from the Seven Creeks are often heavily speckled, including the head, and the markings are sometimes quite broad. In this individual the markings were reasonably dense and completely covered the head. Photo courtesy of Collin Luker.

Bottom right: Some anglers are reporting the capture of 'hybrid' Murray cod/trout cod such as the fish depicted in this image taken from the Murrumbidgee River in 2006. While hybrids have been produced artificially under hatchery conditions they are rare in the wild. The markings on this specimen appear intermediate between those of a Murray cod and a typical Trout cod and the head stripe resembles that seen in juvenile examples of the former. However, the shape of the snout and overhanging upper jaw are diagnostic of a Trout cod. Certain identification as a hybrid is only possible through laboratory testing. Photo courtesy of Nigel Paton.

Photograph 6.3 Trout Cod Heads



Top Left: Head of a Trout cod from the King River showing the conical snout, straight head slope and few markings on the head. Photo author.

Top Right: Photo of the preserved head of a Trout cod weighing about 12 kg taken from the Goulburn River near Thornton c1960. A slight depression between the eyes is visible and the head is covered with spots and dashes. The tip of the snout clearly overhangs the bottom jaw. Photo courtesy of Professor Tim M. Berra.

Bottom: Photo of the head of a Murray cod from the Murray River. In large Murray cod the mottled markings may be replaced by heavy spotting similar to that of Trout cod. This is apparent in this image though the animal is readily identified as a Murray cod by the long lower jaw. A number of historical sources such as Whitley (1937) suggested that the two cod species become more similar with size though the head and jaws of Trout cod are always distinctive. Photo courtesy of Ramon Clifford.

7 Methodology: Reconstructing the Past

7.1 Describing Fish Abundance

Progress towards achieving the goals of the *Native Fish Strategy* is monitored by the *Sustainable Rivers Audit* first published in 2008 (Davies *et al.*, 2008). The assessment of native fish stocks in waterways is undertaken by comparing contemporary data on fish populations collected by surveys with a set of reference conditions indicating the original abundance of fish species at the time of European settlement. The reference conditions are developed by an 'expert panel', a group of scientists familiar with a catchment or region, who use a range of evidence to describe the original expected abundance of fish species. The evidence considered includes museum records, old government data, historical accounts and personal judgement of the suitability of habitat for individual species based on contemporary evidence of habitat association.

Fish abundance can be described in a variety of numerical ways such as density or catch effort. However, data of this nature has only been collected in recent decades and does not exist for native fish populations at the time of European settlement. The *Sustainable Rivers Audit* reference conditions employ 'rarity scores', numerical indicators of fish abundance. The scores are not precisely defined, but are general descriptors of the former abundance of individual species in the main channel of larger waterways in specific catchments. A rarity score of '0' signifies the total absence of a species, a '1' that they were rare, a '3' that they were common and a '5' that they were abundant. Where a species was restricted to a section of stream due to a barrier, it was scored on its abundance in the area where it was present. In some cases the terms 'upper' and 'lower' may be assigned to rarity scores providing a finer grained description of abundance (Frederick Bouckaert, MDBA, pers. com.).

The process of developing reference conditions and assigning rarity scores is dynamic, with regular reviews of the evidence and subsequent amendment if new information becomes available. The system does, however, have the potential to introduce bias. For example assigning scores based on the abundance in the main river channel could produce an underestimate of the former presence of species whose habitat preference is the floodplain or billabongs. Making judgements based on current habitat associations of individual species may also introduce bias, given the fact that virtually all environments in the basin have been modified and that native fish populations are greatly reduced.

In this project native fish abundance has been described so as to be comparable with the rarity scores employed in the reference conditions, but more precisely defined. As most of the information collected on historic native fish abundance referred to fish taken by angling, abundance is described in terms of the frequency of capture and the numbers taken by this means. This too can introduce bias as it may overestimate the abundance of species highly susceptible to angling or specifically targeted by this means. In the upper Murrumbidgee River anglers have reported Trout cod to be preferentially caught to Murray cod (Lintermans *et al.*, 1988) so angler accounts may tend to inflate their relative abundance. Similarly it may underestimate the abundance of those less susceptible to angling or less sought after by anglers.

The rarity scores in this project have been defined on what was typically reported from the oldest available accounts for the main channel of major streams in each habitat zone of a catchment. Fish captures can vary seasonally and between years and no attempt was made to average scores over the course of a full year. The scores were based on the most frequently reported numbers of fish taken during the locally recognised season and ignored times of the year such as winter when generally fewer fish were taken.

The scores are defined as follows:

0 = Absent: no credible account reporting the species former presence;

1 = Rare: a few individual fish could be expected to be taken by a resident angler each year;

3 = Common: regularly taken by a resident angler in small numbers; a typical expected catch would be less than 5 fish per day. The species may have been patchily distributed preferring specific reaches or habitats;

5 = Abundant: frequently taken by a resident angler in good numbers; a typical catch would exceed 5 fish per day. Generally found along the length of the main channel though may have exhibited some local variations in abundance.

In addition the symbols 'U' and 'L' have in some instances been used representing abundance at the upper end of a score and that at the lower end respectively. These have been employed where there is some uncertainty between two potential scores or where abundance varied significantly along a section of stream.

7.2 The Habitats

The *Sustainable Rivers Audit* defined habitats within river catchments as a series of zones. The definition of these zones was developed by the former MDBC based on the Murrumbidgee River where distinctive environments were associated with altitude. They are defined as a lowland zone (< 200 m ASL), a slopes zone (200 – 400 m ASL), an uplands zone (400 – 700 m ASL) and a montane zone (>700 m ASL) (Lintermans, 2007). Using the Murrumbidgee River as a model, the lowland zone has a low gradient and wide, extensive floodplains, the slopes zone is confined by hills or mountains with a much narrower floodplain and the upland zone has a steeper gradient with a relatively narrow river valley. There is also a distinctive difference in the substrates in these three types of habitat from silt, sand and clay in the lowland zone, to sand, coarse gravel and some rock in the slopes zone, to extensive exposure of bedrock in the upland zone. The montane zone is less well defined but implies areas where regular snowfalls occur. Montane streams can have a similar form to those of the upland zone or may flow through alpine or sub-alpine plains with adjacent swamps.

The Murray-Darling Basin is tilted upwards in a north east direction so that the changes in river morphology occur at progressively higher elevations northwards. In Victoria these changes occur rapidly as a result of the steeper gradients and at generally lower altitudes than those defined for the Murrumbidgee River. Similarly in northern NSW the changes in river morphology occur at higher altitudes. For simplicity the same types of habitat zones as those in the *Sustainable Rivers Audit* have been used and the altitudinal definitions largely retained but in a small number of cases the boundaries have been modified to reflect the actual physical form of the waterways. In the descriptions for each river catchment these zones have been geographically identified to provide clarity. While the rarity scores are defined in terms of fish abundance in the main river channels, the discussion for each river catchment highlights variations in fish distribution and abundance in a range of habitats other than main river channels such as the smaller streams, billabongs and lakes.

7.3 Evidence Collected

In this project three types of historical evidence were mainly collected on the past distribution and abundance of Trout cod and other large native fishes of the basin, these being photographs, written accounts and oral history. For Trout cod, records held in museum databases were also located and used. As many museum specimens predate the final description of the species in 1972 it was essential that museum records were confirmed as being of Trout cod. In the case of the *Australian Museum* most surviving specimens were examined by the author to confirm their identity. Where specimens were held in overseas collections, curators

either arranged for a taxonomist to confirm their identity, or photographs of the specimens were supplied. For the other, larger, native fish species, museum records were not sourced as they, along with more recent collections, have been mapped (Lintermans, 2007). However, a number of old published accounts describe the details of their collection, sometimes with indications of their abundance, and these have been used.

Nearly 400 photographs of catches of cod and other native fish were located and examined, most of which predate 1950 and the oldest dating from 1862. Photographs were sourced from anglers, angling clubs, individuals, historical societies, books and newspapers. Most were in the possession of local families passed down over the generations. Photographs were scanned at a resolution of 800 dpi, but some of high quality were scanned at 1200 dpi, and saved as jpg's. Private photographs were given an identity describing the catchment and number (eg. OR12 = Ovens River # 12) and electronic copies lodged with the MDBA. Photographs sourced from institutions or publications are identified by the source and either title or catalogue number. Where necessary images were enlarged or enhanced to facilitate the identification of fish.

An extensive search of old written accounts of captures of native fish was undertaken. This included the writings of early settlers, naturalists and anglers. A large number of hand-written manuscripts held in the collections of the *National Library of Australia* and the *State Library of Victoria* were searched for accounts of fish. The reports and appendices published by the Legislative Assembly of NSW on the activities of the NSW State Fisheries Department were thoroughly examined. Electronic versions of a number of newspapers held in the *National Library of Australia*, including the *Melbourne Argus* and the *Sydney Morning Herald*, were searched for stories on native fish up to the 1940s. Key words likely to reveal articles such as 'fishing' or 'fish' combined with the names of individual waterways or fish species were used. The search was fairly comprehensive though many articles have probably been missed due to poor letter recognition in old text by the search engine. In some cases regional historical societies have developed records or databases on news items and these were perused for possible stories on fish. Some regional newspapers stored on microfilm by the *State Library of Victoria* were searched around the times that fish translocation activities took place, or when exotic fish were introduced, as it was suspected that they may discuss the status of local native fish populations at the time. While many useful stories were located, a vast number in regional newspapers must remain unidentified.

Local historical societies and angling clubs were contacted to help identify senior residents that may possess knowledge of fish. Initial interviews in most cases were conducted by phone often followed up by second conducted in person by the author. In some instances only a few comments were provided, but some interviews lasted over an hour. The general ethical guidelines outlined by the *Oral History Association of Australia* for interview (www.ohaansw.org.au/page/guidelines_to_ethical_practice.html) were followed, with the interviewees being informed of the purpose of the project, how their interview was to be published and that information they considered confidential was not included. Typical questions included asking the person to describe their personal history, what fish they caught including when and where, and the changes they observed over the years. They were asked to describe the fish so as to confirm the identity of the species being discussed. For interviews conducted in person the angler was shown a random selection of contemporary photographs of native fish and asked to name them. This often provided a definitive identification of the species discussed in the interview. Emphasis was placed on providing a timeframe for observations or key events either by the individual providing dates or descriptions of phases in their lives. Interviews were recorded by hand, word processed and provided to the individual for correction and confirmation. Brief comments or additional information provided after interviews have been recorded as comments or 'personal communications'. Over 140 people were contacted with the two oldest being 95 years of age whose memories reached back into the 1920s.

7.4 Assessing the Information

Given the similarity of the two cod species, the scientific uncertainty as to the existence of Trout cod up to 1972, and the confusion over the correct scientific names for Murray cod and Trout cod, care has to be exercised in confirming the identity of cod in historical accounts. Douglas *et al.*, (1994) suggested that some angler reports of Trout cod in north east Victoria were the result of misidentification and there is evidence that post World War Two the term 'Trout cod' was applied by some anglers to any cod with a thin build (Trueman, 2007). Apart from 'Trout cod' other terms used by anglers for this species and in some written accounts are 'Murray trout', 'bluenose' and 'Rock cod'. The problem of reliable identification also exists for other fish species. Some distinctive names used are 'yellowbelly' and 'callop' for Golden perch, 'grunter' for Silver perch and 'jewfish' or 'eel-fish' for Catfish, and are good indicators of the identity of the species. Two species of Blackfish have only recently been recognised (Sanger, 1984) and it is impossible to separate them in historical accounts, often referred to as 'greasies', 'slipperies' or 'slimies' which are distinctive, and identify them as Blackfish, but not which species. Throughout this document the term Blackfish is used as applying to either or both species. Other terms such as 'bream' or 'Murray perch' are less specific and have been applied by anglers to a range of species. Identification is not certain even when fairly specific common names are used. For example some anglers refer to dark coloured Silver perch as 'Macquarie perch' and similar species may be confused by less experienced anglers.

Validation of historical accounts, and in particular oral history, can employ 'triangulation' approaches involving cross-checking of information with external empirical sources such as photographs, government records and newspaper stories as well as corroborating information from multiple observers (Robertson *et al.*, 2000). Multiple historical accounts of the same observation from independent observers increase the reliability of the observation suggesting that it may be accurate. Certain individuals, because of their background, such as some prominent early naturalists, scientists and enforcement officers, are 'expert witnesses' and their observations are likely to be reliable. Museum specimens and unambiguous photographs provide indisputable physical proof of a species former presence in a water, provided there is good confirmation of their origin.

During this project individual pieces of historical evidence for the presence of native fish in specific waters was identified and its reliability assessed and rated as high, moderate or low. The source localities of the reported captures were recorded with grid references using 'ACME Mapper' and in the case of many oral accounts with high accuracy in the presence of the individual interviewed. An estimate was made at that time of the accuracy of the source location.

A species was determined to be present in a water if it satisfied one of the following criteria:

- (a) A museum specimen exists supported by documentation of its origin;
- (b) A photograph exists clearly showing key features permitting accurate identification. In the case of Trout cod images considered to be conclusive were examined by a number of scientists for confirmation;
- (c) A written account by an expert witness exists who has demonstrated familiarity with the species concerned;
- (d) A written or newspaper account describes the presence of the species in the water using a scientific name or an unambiguous common name and is supported by a good description or other evidence;
- (e) A first hand account by an angler reports the species presence with a detailed physical description including key discriminating features and the angler has the ability to accurately identify it in photographs and/or continues to capture the species at present. Other independent evidence supports the species presence in the water;

- (f) Multiple second hand accounts 'triangulated' by other evidence including photographs of modest quality and the species confirmed presence nearby.

From the information collected, maps were created recording the locations of historical accounts for each species considered to be of high quality in each river catchment. For many old accounts it is certain that cod were taken but it is impossible to reliably identify the species of cod due to insufficient information. As many of these records are of significance they have been recorded on the maps as 'cod'. Once a species was confirmed as being present in a water, its rarity rating was determined based on the collective descriptions of its abundance.

The historical material has been collated and summarised for each catchment. Each chapter commences with early European accounts of the fishery, followed by a review of the evidence used to confirm the presence of species and assign rarity scores, an overview of the changes to native fish populations that have transpired, and a summary of significant environmental changes and events that may have contributed to the decline of native fish populations. It concludes with the assessment of current native fish populations in the catchment provided by the *Sustainable Rivers Audit*.

Photograph 7.1 Habitat Types of the Murray Darling Basin



These images depict the typical features of rivers in the four habitat zones used in the *Sustainable Rivers Audit*.

Top Left. The Goulburn River upstream of Mitchellstown is lowland habitat and flows through a wide flood plain with a low gradient over a substrate of clay and mud.

Top Right: The Goulburn River near Kerrisdale represents slopes habitat with increased gradient, a narrow flood plain confined by low ranges and flowing over extensive gravel substrates.

Bottom Left: The Goulburn River upstream of Jamieson is an example of upland habitat and has a steep gradient with no flood plain and flows over gravel and rock substrates.

Bottom Right: The Goulburn River upstream of Woods Point is in the Montane Zone. Some montane rivers, like the Goulburn, have steep gradients and flow over bedrock while others rise on alpine tablelands, have relatively low gradients and exist as chains of ponds.

Photograph 7.2 Variations in Photo Quality



These images depict the degree of uncertainty that can exist in identifying Trout cod in photographs. The top image was considered to be a certain record by all who viewed it. For the second image initial opinion was divided between it being a probable or certain record. When enlarged and viewed in high resolution most people considered it to be a confirmed record. Opinion on the third image also ranged from probable to certain but with clear evidence of the upper jaw being longer it has been concluded to be a confirmed record. The bottom image is certainly of a cod and some features suggest that it could be a Trout cod but the quality prevents identification.

