The Dragon Fish

Edited by John Dawes, Lim Lian Chuan and Leslie Cheong

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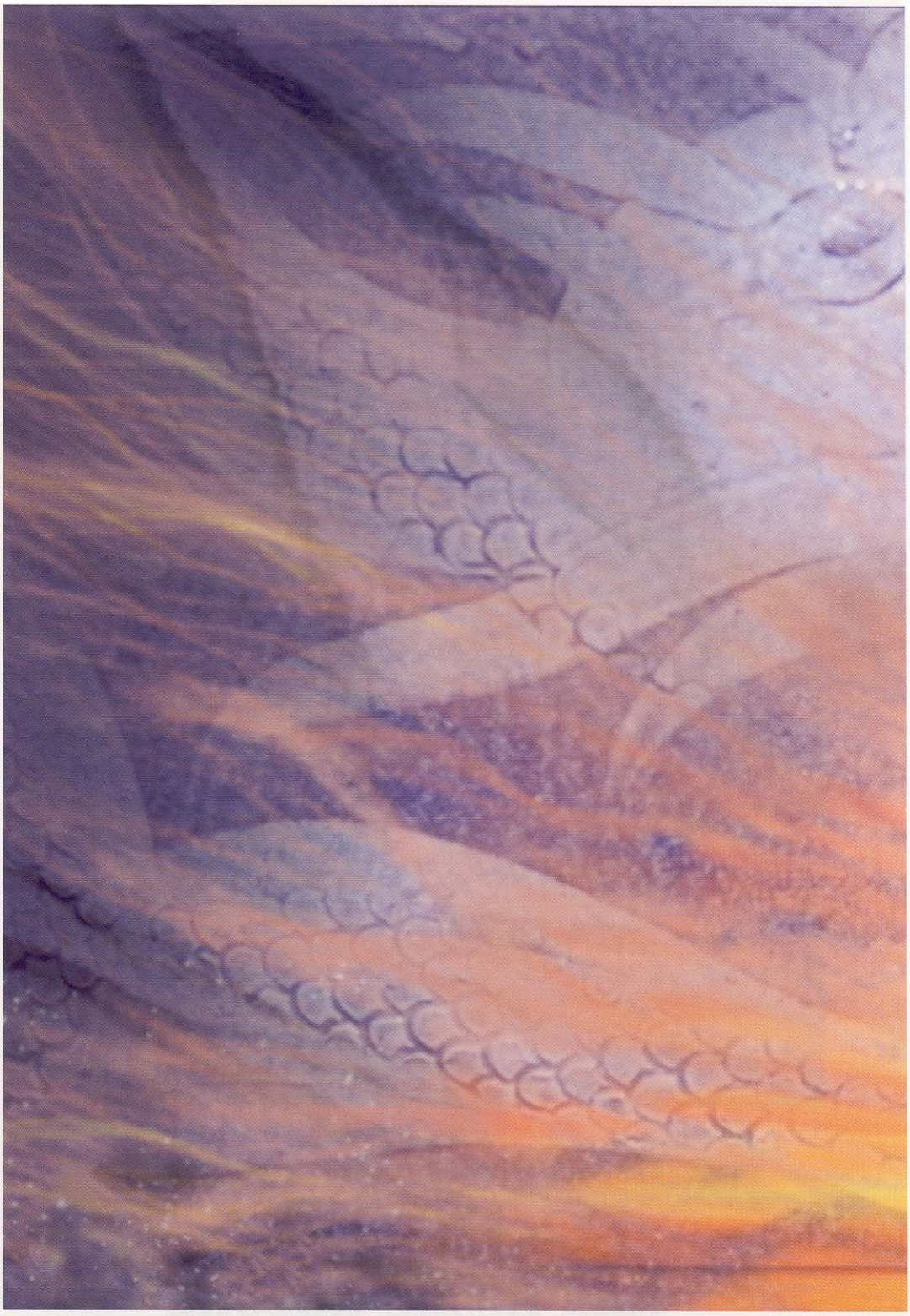

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Contributors

Together with his wife, Vivian, **John Dawes** runs a consultancy business, which covers everything from advising on the feasibility of developing hot springs into a fish breeding unit to collaborating on a joint Arabic/English book on the fishes of the Arabian Seas, as well as producing videos for companies and government departments and contributing monthly columns and features for trade, consumer and scientific journals. They have been consultants to Aquarama, the international aquatic industry show held in Singapore since 1987. They also run the Ornamental Fish International Secretariat, a worldwide aquatic industry organisation with members in 39 countries.

Lim Lian Chuan is currently Head of the Ornamental Fish Section in the Primary Production Department, Singapore, and is a keen aquaculturist with over 25 years' experience. He is a BSc with first-class honours in Zoology. He specialises in fish breeding and water quality management. His current research interests are the application of modern larviculture technology to ornamental fish production, hybridization of Dragon Fish, guppy sex reversal and breeding of new fish species. He is a regular contributor to scientific journals and at conferences, and has some 50 papers on oceanography and aquaculture to his credit.

Leslie John Cheong is the Head of the Technology Development and Services Branch of the Agrotechnology Division, Primary Production Department. He has been with the Department for more than 25 years having, in the past, been mainly involved in the development of the aquaculture industry in Singapore.

Kan Tien Siong has been keeping Dragon Fish as pets since the early 1980s, and turned it into a business when he set up Panda Aquatic Centre Ptd Ltd for Dragon Fish farming in the Lim Chu Kang Agrotechnology Park, Singapore, in 1996. He bred the Red and Gold Dragon successfully in 1992. Mr Kan has immense knowledge and long years of practical experience in keeping and breeding Dragon Fish. He is well known within the Singapore Dragon Fish community as an authority on keeping and selecting good-quality Dragon Fish.

Ho Kiat Huat is a pioneer in Dragon Fish breeding in Singapore and Malaysia. He started breeding Dragon Fish in his ornamental fish farm in the 1970s and succeeded in breeding Red and Gold Dragons as early as 1985. In 1992, he joined with the Singapore Primary Production Department to document the production of second filial generation Dragon Fish. The project led to his successful registration with CITES in August 1994, making his farm the first in the world approved for the production and sale of all the three common varieties of Dragon Fish. At present, Mr Ho keeps more than 4000 Dragon Fish brooders in his seven hectare farm, the Rainbow Aquarium Pte Ltd, in the Sungei Tengah Agrotechnology Park, Singapore.

Chapter 1: Legendary beginnings

John Dawes

Suddenly, its powerhouse of a body tenses. It flexes itself into a shallow 'S' and, with a lightning-fast flick of its large, paddle-like tail, it launches itself into the air. Two seconds later, it returns with an almighty splash, having plucked an unsuspecting cricket from an overhanging branch more than a metre above the water surface.

This 'lethal weapon' of a mouth can, in total contrast, and with amazing tenderness, act as the gentlest and safest of nurseries for up to 90 or so babies. Over a period lasting as long as two months, this perfectly-honed predator can go without food, dedicating its every second towards the protection and survival of its young.

This is no ordinary fish. This is the legendary Dragon Fish.

In the forests of central Sumatra, a legend is told of a Fishing Eagle that swooped down from the sky into the foaming waters of a stream and mated with a large fish. All folklore is based, however tenuously, on fact and, in this case, what may have happened is that a Fishing Eagle was seen to swoop down on an intended victim (a Dragon Fish). As it struck, a great deal of splashing and flapping was generated as the eagle tried repeatedly to sink its talons into the 'armour-plating' of the fish. Then, having failed in its attempts to capture the fish, the eagle flew away empty-handed (or empty-taloned), leaving the Dragon Fish behind. The human bystander saw the commotion and that the Dragon Fish survived, and translated this into a mating story. Later, when young Dragon Fish were seen attached to large, bird-like yolks, the story seemed to have been proved.

Gold Dragon Fish.

Whether or not one believes in legends is immaterial; the inescapable fact is that the Dragon Fish is a very special fish indeed. One could even call it bewitching – in the nicest sense of the word.

For a start, there are few fish that can look a human straight in the eye quite like a Dragon Fish. Move close to the front of an aquarium housing a large Dragon Fish, and the chances are that it will respond by gracefully

Close-up of the head of a Dragon Fish. Note the large, deep eyes.

doing likewise, so that the only thing separating fish and human is the aquarium glass itself. Next, move slowly down the length of the tank, and the Dragon Fish will follow, its large, deep eyes fixed on yours in a most unfishlike manner.

Little wonder, then, that over the years so many people have fallen under the magical spell of these imperious, magnificent, mysterious dragons.

Searching for Origins

Although various names are used in connection with this species, by far the most evocative and intriguing, and one which has undoubted mythical undertones, is Dragon Fish.

Tracing the actual origins of the name is not an easy task, but a brief look at the dragons of Chinese legend may offer us some clues, even if they do not, and perhaps cannot, provide the complete answer.

Dragons, whether benevolent or malevolent, have been with us for several thousand years. All the world's great cultures have their complement of such legendary, magical creatures, some breathing fire and wreaking havoc and destruction at every opportunity, others having more benign dispositions. Yet others oscillate between the two states, depending on their mood, or as a consequence of the actions or beliefs of humans.

Stylised representation of a dragon.

Chinese dragons made their first appearance in about 2000 BC and are generally of the benevolent kind, rarely coming into conflict with heroes, as they do in other cultures, or gods. Indeed, any conflict that did occur usually was accidental rather than planned.

The earliest Chinese dragons had an elongated body, no wings and clawed feet, and looked something like a hybrid between a snake and a crocodile. The Dragon Fish does not have clawed feet, but it does have an elongated body which it moves as gracefully and sinuously as some serpents, and it does have an enormous mouth (as do crocodiles).

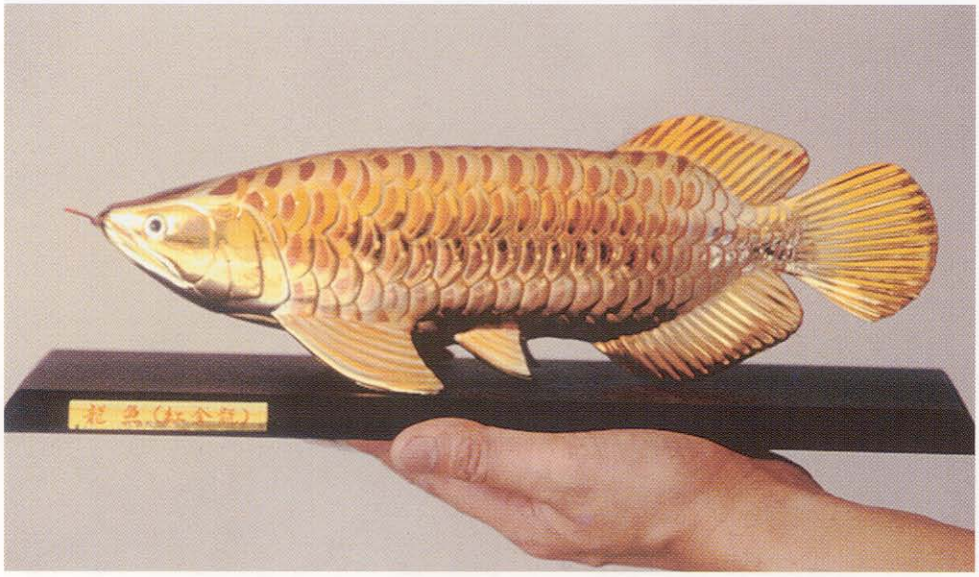
In addition, the bodies of many dragons are covered in large scales, just as the Dragon Fish is. Then there are the very large eyes and, very importantly, the two long 'tendrils' that emerge from the area

The dragon motif is still popular.

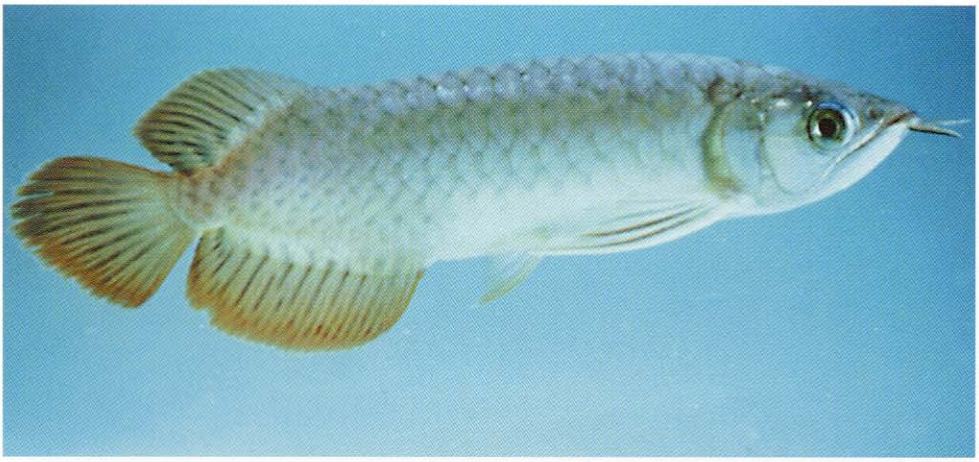
The Dragon Fish has many features similar to the Dragon: elongated body covered with large scale, very large eyes and two long 'tendrils' (barbels).

between the nostrils and the eyes in dragons which may have their counterparts in the two chin barbels possessed by the Dragon Fish.

There are also numerous links between dragons and water. The Long Wang, or Dragon Kings, for example, were patron divinities of rivers, lakes and seas, and lived in underwater palaces. However, the connection between dragons and Dragon Fish may have more to do with the origins of some of the former, rather than where they lived, and the qualities they could bestow on humans and their lives.



The Dragon Fish is even used as an ornament.



A young Red Dragon.

In Chinese lore, we are told that some dragons were created through the transformation of other creatures, including fish, while others hatched from eggs. In contrast, the fish/dragon or animal/dragon association could also go the other way, with dragons able to disguise themselves as fish, snakes, rats, cats, dogs, cows and even humans. However, dragons disguised as fish could be detected easily because they emitted a five-coloured light, or spoke with a human voice while they were being cooked!

Gold Dragon Fish swimming together in the pond.

Dragons could be white, green, blue, black, red or gold, each type arising from 1000-year-old gold of the appropriate colour, with golden dragons deemed superior to all the others. Today, Red Dragon Fish are generally considered to be 'superior' but Golden Dragon Fish are still very valuable. We also have Green and so-called White and Black Dragon Fish from certain areas of Indonesia but, alas, no Blue Dragon Fish – at least, not that we know of.

A Red Dragon Fish, probably the most superior of the colours.

Knowing your dragons was crucial in ancient China, because a long and propitious life might well depend on this knowledge. In a similar vein, Ch'i-lin, an ancient, noble dragon, represented peace, prosperity and good fortune. These desirable qualities are also attributed today to the owning of a Dragon Fish so here we have yet another link with the past and, perhaps, further clues as to the origins of the name.

The connections are many and varied, but none give us a definitive answer as to how or when the name arose. Perhaps this is how it should be. A little mystery, mystique and uncertainty seem a perfectly appropriate combination of qualities with which to endow the exceptional fish that we have come to know and love as Lóng Yú, the Dragon Fish.

Chapter 2: Dragon Fish and their Nearest Relatives

John Dawes

A Golden Dragon Fish.

With the possible exception of Goldfish and Koi few, if any, fish are steeped in legend to the extent that the Dragon Fish is. However, once we go beyond these mythical stories and qualities, we find that Dragons are straightforward, though nonetheless impressive, biological entities, with their own circle of relatives with which they share a number of important characteristics.

In addition to sharing a number of skull and other skeletal features, Dragon Fish and their wider assortment of relations are distinguished from most other so-called Bony Fishes in that, unusually, their intestine (lower gut) passes to the left of the oesophagus (gullet) and stomach on its way down the body. The Cyprinidae, which include Goldfish and Koi, also possess this 'left-handed' characteristic, but their combination of skull and other features is quite different and separates them very firmly from the order to which the Dragon Fish belongs, the Osteoglossiformes.

Within the Osteoglossiformes, the Dragon Fish and its now considerably tighter unit of closer relatives possess a number of jaw, swim bladder, pelvic fin and lateral line features that place them within the suborder Osteoglossoidei, such as having six pelvic fin rays and 21–55 lateral line scales.

Taking matters a stage further, some members of this suborder have the characteristic 'bony' (toothed) tongue that distinguishes them as

members of the family Osteoglossidae. By this stage, we are now down to just seven or eight different fish, having started off with approximately 217. Two or three of these, the Pirarucu or Arapaima *(Arapaima gigas), Heterotis niloticus and Clupisudis* (considered by some authors to be a synonym of *Heterotis*, hence the doubt about the numbers), have no mandibular (lower jaw) barbels and are therefore grouped within the subfamily Heterotidinae. The remaining five all have distinct barbels on the mandible and constitute the subfamily Osteoglossinae.

Members of this subfamily are divided into two genera (singular: genus) *Osteoglossum* and *Scleropages*. There are two species of *Osteoglossum: O. bicirrhosum,* referred to as the Silver Arowana/Arowana/Aruana/Arowhana, and the Black Arowana, *O. ferreirai*. *Scleropages* contains the three remaining members of the family: *S. jardinii,* variously referred to as the Jardini, Gulf Saratoga or Northern Spotted Barramundi, *S. leichardti*, the Saratoga or Spotted Barramundi, and the Dragon Fish itself, *S. formosus*.

Telling *Osteoglossum* from *Scleropages* is very easy, even for the budding aquarist. In *Osteoglossum*, the dorsal (back) and anal (belly) fins are very broad-based. The dorsal, for example, contains anything from 42 to 57 fin rays. In *Scleropages*, on the other hand, there are only around 20 dorsal fin rays. In addition, the caudal (tail) fin in *Osteoglossum* is quite small, whereas in *Scleropages* it is broad and powerful.

Dragon Fish displaying the barbels which places it in the subfamily Osteoglossinae.

Scleropages formosus (Dragon Fish) swimming in a pond.

Arowana, Dragon Fish, Saratoga or Barramundi?

The term 'Arowana' has always been used when referring to the two South American species in the subfamily, the Silver and Black Arowanas (*Osteoglossum bicirrhosum* and *O. ferreirai,* respectively). It has also been (and still is) used often when referring to *Scleropages formosus,* the Dragon Fish, under the name Asian Arowana.

No doubt, the fact that both Dragon Fish and Arowanas have elongated bodies clothed in large, robust scales, possess barbels and cavernous mouths, and exhibit similar behaviour traits, such as mouthbrooding and jumping out of the water to catch their prey, has contributed to this name sharing. Interestingly, however, the two predominantly Australian species (one is also found in Papua New Guinea and Irian Jaya) are hardly ever referred to as Arowanas. Instead they are known as Saratogas or Barramundis, the latter name also being used in at least one book, *Dr Axelrod's Atlas of Freshwater Tropical Fishes, 8th edition* (TFH 1995), when referring to *Scleropages formosus*. The name Barramundi is also used for the Australian Giant Perch *(Lates calcarifer)*, a member of the Snook family (Centropomidae).

The story doesn't end there. The Dragon Fish, as well as being known as the Asian Arowana, has a battery of other common English-language names: Red Arowana, Green Arowana, Golden Arowana, Orange Arowana, Silver Arowana (each of these being used when applied to a specific colour variety, although Green and Silver are often interchanged), Asian Bonytongue, Malayan Bonytongue and even Emperor Fish.

More locally, *Scleropages formosus* is known as either Cherek Kelesa or Ikan Arowana in Malaysia, and Lóng Yú (Dragon Fish) in Chinese-speaking countries. In Spanish, it is referred to as Pez Lenguihueso Malayo; in French, it is the Scleropage d'Asie; in German, it is known as Malaüscher Knochenzungler and in Italian as Scleropage Asiatico.

As can be seen from the above, a considerable degree of confusion can arise through the use of common names. It is for this reason that the scientific community often frowns upon the use of such names, preferring instead to stick to scientific nomenclature, under whose strict rules only one valid name exists for a species at any one time. This does not eliminate all problems, especially when names are being reviewed, but it does make identification of what fish is actually being referred to considerably less ambiguous. Having said this, the Gulf Saratoga appears as both *Scleropages jardinii* and *S. jardini* in aquatic literature!

In order to avoid confusing matters even further with regard to common names, and in an attempt to bring a little more uniformity to the current somewhat *ad hoc* state of affairs, we would suggest the following arrangement:

Scleropages jardinii.

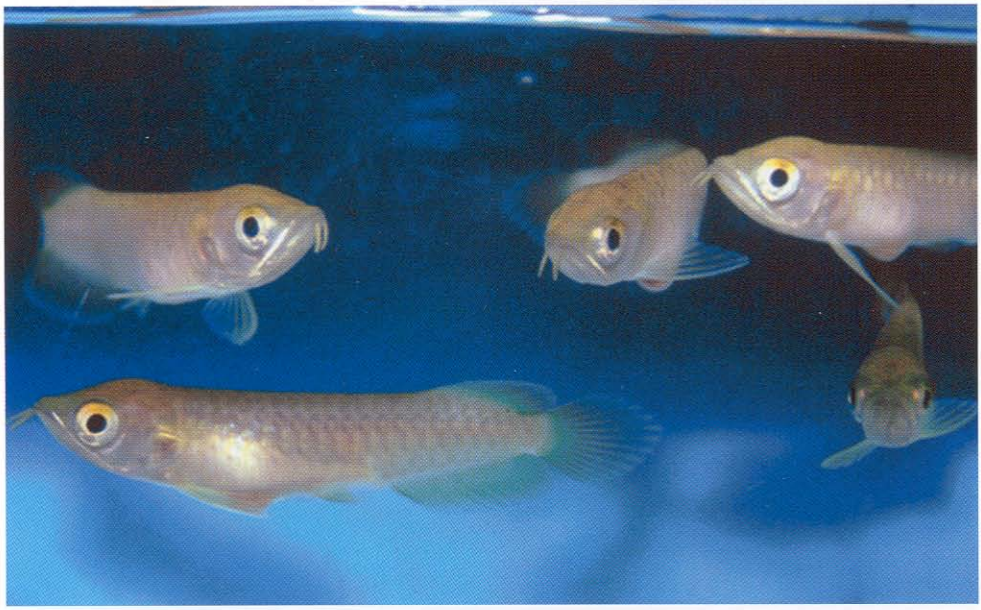
Scientific Name	Common English Name
Osteoglossum bicirrhosum	Silver Arowana
Osteoglossum ferreirai	Black Arowana
Scleropages formosus	Dragon Fish
Scleropages jardinii	Gulf Saratoga
Scleropages leichardti	Spotted Saratoga

Within this overall framework, as the Dragon Fish is found in a number of colour forms, we suggest that these varieties be identified by the main colours as follows: Green Dragon Fish, Golden Dragon Fish and Red Dragon Fish, with any other descriptive terms being added as necessary as in, for example, the Sumatran Red Dragon Fish.

Drifting in Time

Before proceeding to a discussion of the individual species, it is worth taking a brief look at a possible explanation for their present-day fragmented geographical distribution.

There can be no doubt that the two *Osteoglossum* species, both of which occur in South America, are more closely related to each other than they are to the three *Scleropages*. Equally, the two predominantly Australian Saratoga species are more similar to each other than they are to the Dragon Fish, whose natural distribution is limited strictly to south-east Asia. Taking this observation one step up through the classification hierarchy, all five species are more closely related to each other than they are to other Bonytongues such as the South American *Arapaima* and the African *Heterotis*.



Scleropages formosus fry – their descendents may have become separated during the Continental Drift Process.

Dragon Fish, which naturally occur in South East Asia, pictured in a typical Singaporean home.

Yet, for all their similarities, the various subgroups or individual species are physically separated from each other by hundreds or thousands of kilometres. At first sight, this may seem a somewhat puzzling situation. After all, how can a South American fish like the Silver Arowana be so similar to an Australian Saratoga whose native home is over half a world away? The most likely answer is that they shared a common ancestor at some stage in the distant past. But, if this were so, how is the distance factor accounted for? By definition, offspring from a common ancestor would be born at least in the same region, but not in separate continents. It is this, of course, that provides the vital clue.

The argument goes something along the following lines. If all the descendants from a postulated common ancestor were once found within a single landmass and then this landmass began to split up and drift apart, each subgroup could subsequently evolve in total isolation from all the others, eventually giving rise to a range of genera and species.

Countless links of this type exist between currently isolated species of plants and animals the world over and such examples have long been accepted as evidence of the existence of a single ancient 'super continent' named Pangaea. It is believed that Pangaea split up and that its fragments began drifting apart somewhere around the Upper Carboniferous Epoch of the Carboniferous Period, some 270 million years ago. This process, called Continental Drift, is still in progress today.

Viewed in this way, the current distribution of the Bonytongues begins to make a little more sense. It is not difficult to see how, as the various

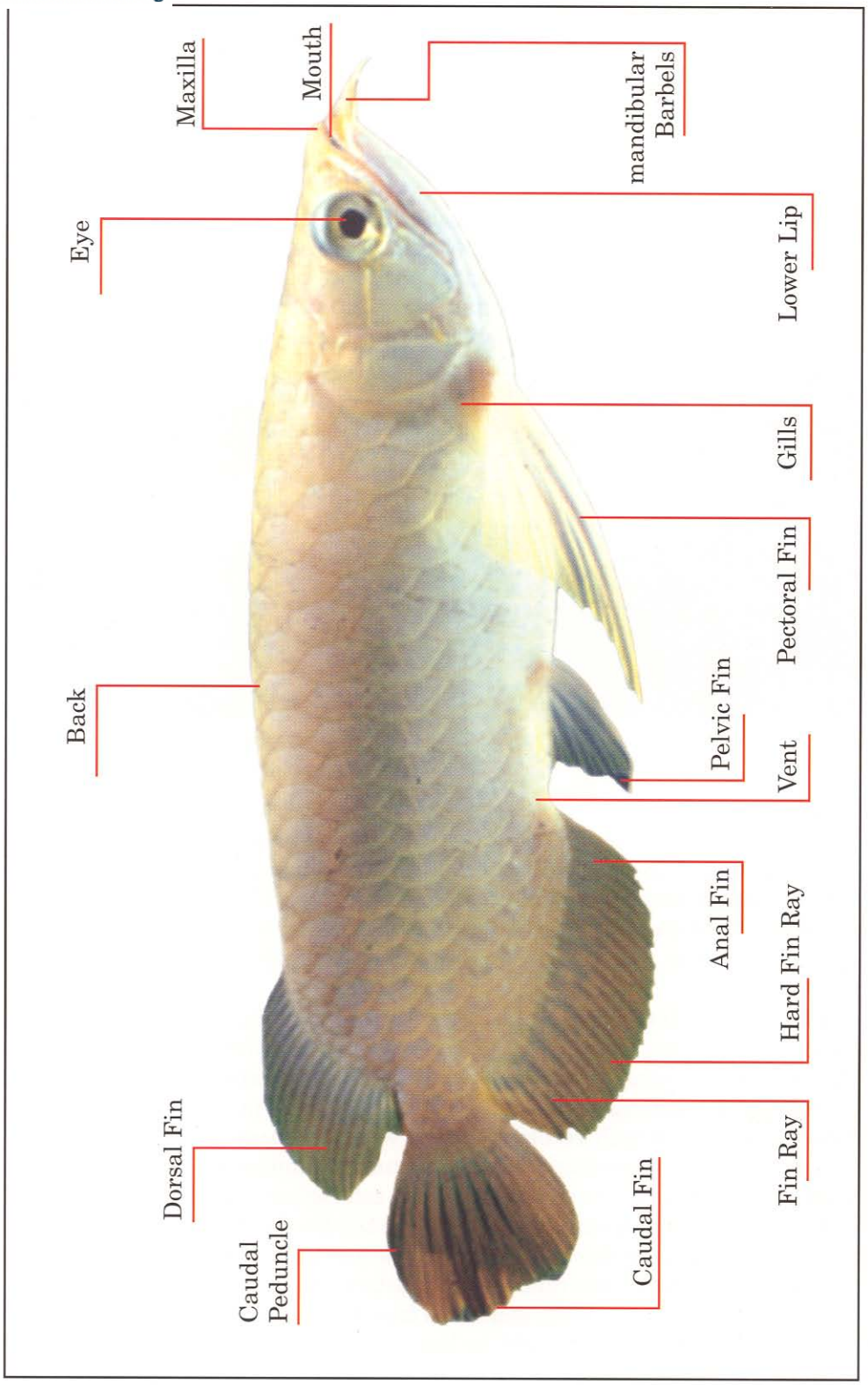
A mature Red Dragon.

landmasses began to drift apart, populations of ancient Bonytongues and their descendants became isolated from each other and were thus unable to interbreed. Add to this other important factors such as differing environmental and habitat conditions, chance mutations and all those other myriad influential elements that together constitute natural selection, and changes become inevitable, with some types becoming extinct and others evolving into new forms.

Eventually, two main types of ancestral 'Arowanas' appear to have evolved from their assumed common ancestor. One type evolved with broad-based dorsal and anal fins and a relatively small caudal fin *(Osteoglossum)*, while the other evolved into a form possessing narrower-based dorsal and anal fins, but a more powerful and larger tail *(Scleropages)*.

Having got this far, further changes of a more minor nature could have resulted relatively easily in the evolution of the two South American *Osteoglossum* species from their common ancestor and (probably) two *Scleropages* species, one of these subsequently evolving into the different natural colour forms of Dragon Fish of south-east Asia, and the other into the two predominantly Australian Saratogas.

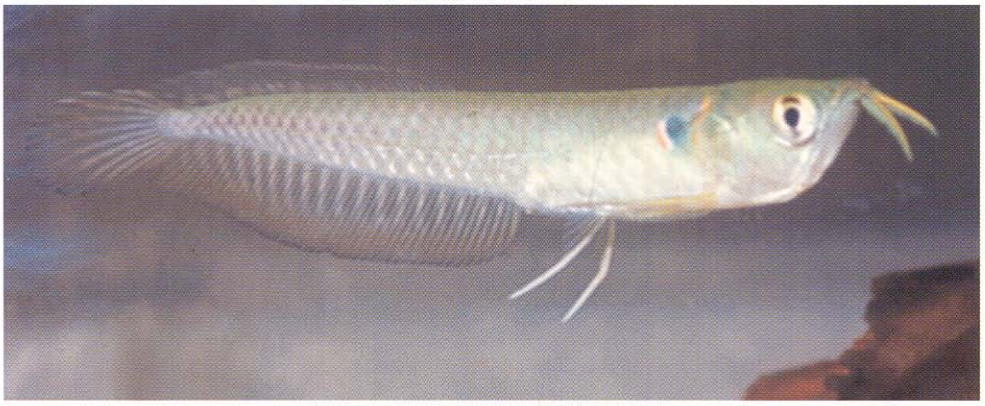
Although we do not possess unequivocal fossil evidence that the above was indeed the case, such a sequence of events would help to explain the distribution pattern that exists today for the Dragon Fish and its four most closely-related species.



Chapter 3: Species Profiles

John Dawes

In order to understand and appreciate a particular species in any real depth, it is essential to know something about its closest relatives. Thus, similarities and differences can be put into perspective and a deeper insight gained into the unique qualities of the species concerned. It is with this in mind that the following species profiles have been compiled.



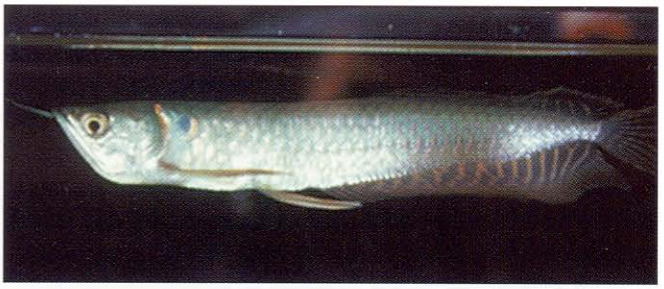
Arowana. Photograph by Dr Karl Knaack.

Silver Arowana

Scientific Name *Osteoglossum bicirrhosum*, Vandelli
Synonyms *Ischnosoma bicirrhosum, Osteoglossum vandelli*
Distribution Amazon drainage, western Orinoco, Guyana
Habitat Preferences Flooded forest and lakes; often found in shallow water near the shore, where they make relatively easy targets for fishermen.
Preferred Water Conditions Slightly or moderately acid, soft water maintained at between 24–30°C (75–86°F). While deviations from these chemical conditions can be tolerated in aquaria, any changes must be gradual and ammonia and nitrite levels must be kept at a minimum.
Size Maximum length recorded in the wild is 100cm (39in), but the vast majority of both wild-caught and aquarium specimens are usually smaller.
Diet In the wild, Michael Goulding and colleagues (1980) carried out gut content analyses of specimens collected in the Rio Machado which revealed a wide range of prey items. The highest percentage (over 40%) consisted of insects and spiders, but remains of crustaceans, molluscs, fish (just over 10%), snakes and even birds were also found. Some plant material was also recorded, but this was thought to have been incidental and to have been ingested accidentally along with animal prey. An earlier author (Lowe-

McConnell, 1964) also reported bat remains.

In aquaria, this species will accept insects and other substantial live and frozen foods, as well as meat-based home-prepared formulae such as boiled fish paste and fish chunks. Pellets may also be taken. Young specimens must not be fed until they absorb their yolk sacs.



A rare shot of a wild Silver Arowana (*O. bicirrhosum*) rising to the surface.

Breeding The sexes are very similar to each other, with the female being somewhat deeper-bodied than the male. Like all its relatives, *O. bicirrhosum* is a mouthbrooder. In the wild, spawning occurs at the onset of the annual rains (around December and January in the Rio Machado). Goulding (1980) recorded 210 ova in a ripe female. Fertilised eggs and developing embryos are incubated orally by males for 40–60 days. When the fry are released, they can measure up to 10cm (4in) in length.

The beginning of the rainy season varies throughout the natural range of the species but is invariably during the autumn and winter months, so wild-caught young Silver Arowanas generally become available during this time, many still carrying substantial yolk sacs. Provided these young fish are acclimatised properly and handled carefully, they settle down well and grow very quickly. A size of 30cm (12in) can be attained in as little as six months on a diet of meat-based live and frozen foods.

There are few accounts of successful aquarium spawnings, but commercial breeding of this species is becoming established in some countries. The result of these ventures is that the Silver Arowana is now available throughout most of the year.

Additional Details The Silver Arowana is considered an important food fish in the Amazon where it is often hunted with harpoons or bows and arrows at night. The species' natural inclination to swim in shallow water near to the shore makes it an easy target, with large specimens being caught in as little as 30cm (12in) or less of water. Despite the ease with which they can be hunted, wild stocks of the Silver Arowana are not under threat, since the species is both abundant and widely distributed in Amazonian waters.

Just as the Dragon Fish has a special place in Far East folklore, so does the Silver Arowana among the Amazonian river people. It is, for instance, one of the few fish that women who have recently given birth are allowed to eat during their recovery period.

Like the Dragon Fish, the Silver Arowana is an excellent jumper, often attacking flying or terrestrial prey perched on branches above the water surface. This acrobatic ability has earned it the name of 'water monkey' (macaco d'agua) in parts of the Brazilian Amazon.

Young Black Arowana.

Black Arowana

Scientific Name *Osteoglossum ferreirai*, Kanazawa
Synonyms None
Distribution Rio Negro
Habitat Preferences As for *O. bicirrhosum*
Preferred Water Conditions Similar to those preferred by *O. bicirrhosum*. However, because of the acidic conditions which exist in the Rio Negro, this aspect of the water chemistry may be somewhat more important for the long-term well-being of *O. ferreirai*.
Size Sizes above 60cm (24in) have been recorded in wild-caught specimens.
Diet Gut content analyses of wild-caught specimens carried out by Goulding *et al* (1988) show a similar range of food items to those consumed by *O. bicirrhosum*.
Breeding As *O. bicirrhosum*. Young Black Arowanas are particularly attractive, having a predominantly black body with a contrasting creamy yellow stripe that runs from the snout through

Black Arowana harpooned for food.

the top edge of the eye and along the top of the body, ending at the tip of the caudal (tail) fin. There is also a pronounced vertical creamy yellow band just behind the head.

Additional Information The Black Arowana, while being overall very similar to its Silver relative, is somewhat slimmer in appearance owing to its higher number of lateral line scales, dorsal and anal fin rays and vertebrae.

Gulf Saratoga *(Scleropages jardinii)*.

Gulf Saratoga

Scientific Name *Scleropages jardinii*, (Saville-Kent)

Synonyms *Scleropages jardini*

Distribution Northern Australia from the Jardine River to the Adelaide River, and central/southern drainage systems of Papua New Guinea and Irian Jaya.

Habitat Preferences According to Merrick and Schmida (1984), this species is found in a wide range of habitats, including faster-flowing stretches in the upper reaches of water courses and still waters (billabongs), exhibiting a preference for clear water conditions. According to Allen (1989), the Gulf Saratoga prefers still waters and slow-moving stretches.

Although it can swim at all levels, the Gulf Saratoga is more commonly found in the middle and upper zones of the water column, often being spotted near the surface or close to the shoreline and among submerged vegetation.

Preferred Water Conditions A wide range of temperatures is reported to be tolerated, with 18–33°C (c. 64–91°F) for general maintenance. Spawning is said to occur in the early summer season when temperatures rise above 23°C (c. 73°F).

Size Merrick and Schmida (1984) report a record size of 90cm (35.4in) and a weight of 17.2kg (37.9lb). Most specimens are, however, considerably smaller, between 50–60cm (c. 20–24in) in length. Allen (1989) reports that *S. jardinii* may attain 27kg (59.5lb) in weight. Fully mature males may be a little longer than mature females.

Diet In the wild, fish, crustacea, insects and other vertebrates and invertebrates form part of the natural diet. In aquaria, this species can be weaned on to fresh and frozen meat-based foods.

Young Gulf Saratogas are said to begin feeding at a length of 2–3cm (0.8–1.2in) even before the yolk sac is fully absorbed.

Breeding Telling the sexes apart is impossible during the developmental stages. Even in fully mature specimens, sexual dimorphism is not externally apparent, although certified males of around five years of age have been shown to attain a slightly greater length than females (see **Size** above).

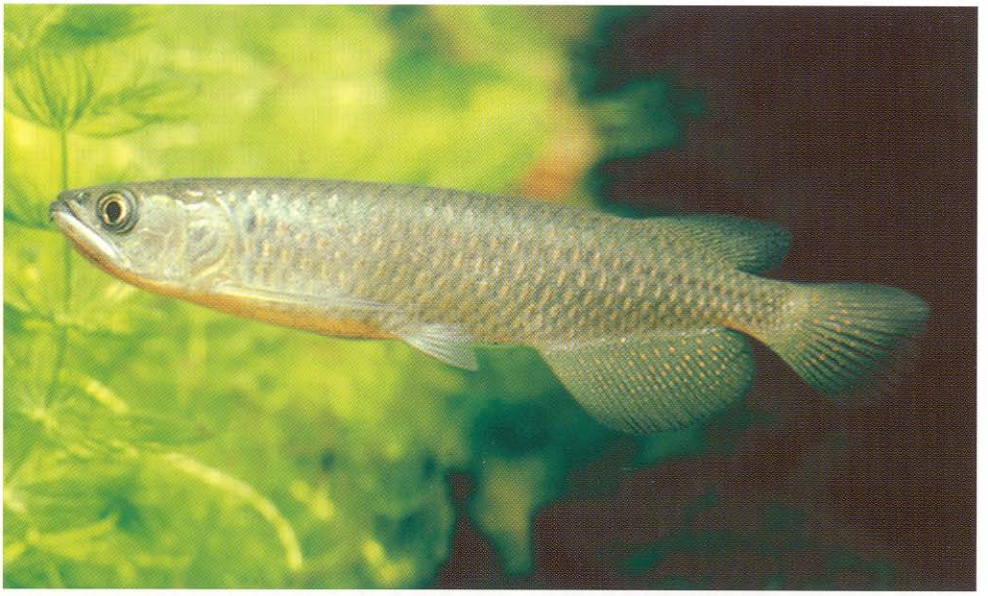
Like the other members of the subfamily, *S. jardinii* is a mouthbrooder. However, Allen reports the mouthbrooding parent to be the female. In the *Osteoglossum* species and the Dragon Fish, *S. formosus*, it is the male that undertakes this role.

There are no reports of successful aquarium breeding attempts. Legget and Merrick (1987) recommend the use of earthen (mud) ponds for this purpose. Water conditions should be a temperature of around 23°C (c. 73°F), pH between 6.5 and 8.0 and total hardness between 0–100 ppm (mg/1).

In the wild, spawning occurs just before or during the early stages of the rainy season (November or December), which is early summer in the southern hemisphere.

The females, like their counterparts in the other members of the subfamily, possess a single ovary. Numbers of eggs range from around 60–95 according to Merrick and Schmida, and 30–130 according to Allen. These figures are higher than the average range for the Dragon Fish, but lower than those recorded for the Silver Arowana. At 10–11mm (c. 0.4in) the eggs are large and rich in yolk, a vital ingredient for the developing embryos.

Hatching takes 1–2 weeks, but the newly-hatched fry are incubated orally for a further 4–5 weeks, during which time the yolk sac is gradually absorbed. Feeding, however, begins before total absorption has been completed. On a good, meat-based diet, juveniles can attain a standard length (SL), measured from the snout to the base of the tail, of around 10cm (4in) in as little as three months.



Spotted Saratoga (*Scleropages leichardti*).

Additional Information Like its closest relative, the Spotted Saratoga *(S. leichardti),* the Gulf Saratoga is deemed a good sport fish by anglers in its native Australia owing to its excellent fighting qualities. It is also said to make very tasty eating.

Some adult specimens kept in large aquaria have been observed gulping air at the surface and releasing bubbles shortly afterwards. Since the water was of good quality and well aerated, it is believed this behaviour indicates the possession of an auxiliary breathing organ or mechanism, probably the swim bladder as in other Bonytongues.

Spotted Saratoga

Scientific Name *Scleropages leichardti,* Günther 1864
Synonyms None
Distribution The Spotted Saratoga has a much more restricted distribution than the Gulf Saratoga, being found naturally only in the Fitzroy River system of central-eastern Queensland. Stocks have been transferred from here to south-eastern Queensland, including the Mary River system. Allen (1989) reports that Günther's published Burdekin River location for this species is incorrect.
Habitat Preferences Although its distribution is patchy, *S. leichardti* is more commonly encountered in turbid water in the upper reaches of streams and rivers, and is not usually found near estuaries. During the daylight hours of the warmer months of the year, Spotted Saratogas tend to swim just under the surface and close to vegetation, migrating to deeper water once surface temperatures rise above approximately 30°C (86°F).

Preferred Water Conditions Still or slow-moving water maintained between 15–30°C (59–86°F) is recommended, although the full temperature range tolerated by the species is 7–40°C (c. 45–104°F). See also **Breeding** below.

Size Sizes up to 90cm (35.4in) and weights of 4kg (8.8lb) are reported, but lengths of 50–60cm (c. 20–24in) are more common. As the lighter weight indicates, when compared to a similarly-sized *S. jardinii, S. leichardti* is, overall, a slightly slimmer fish. Allen quotes the greatest body depth as being 23–25% of the Standard Length for *S. leichardti* and 25–28% for *S. jardinii*.

Diet Insects, both aquatic and terrestrial, account for the largest percentage of the natural diet of adults, but aquatic vertebrates such as fish and frogs are also taken. Saratogas will jump out of the water in their attempts to catch flying insects. In captivity, a meat-based diet, including fish chunks, prawns and even mice, has proved acceptable, but this species is generally regarded as a fussy feeder.

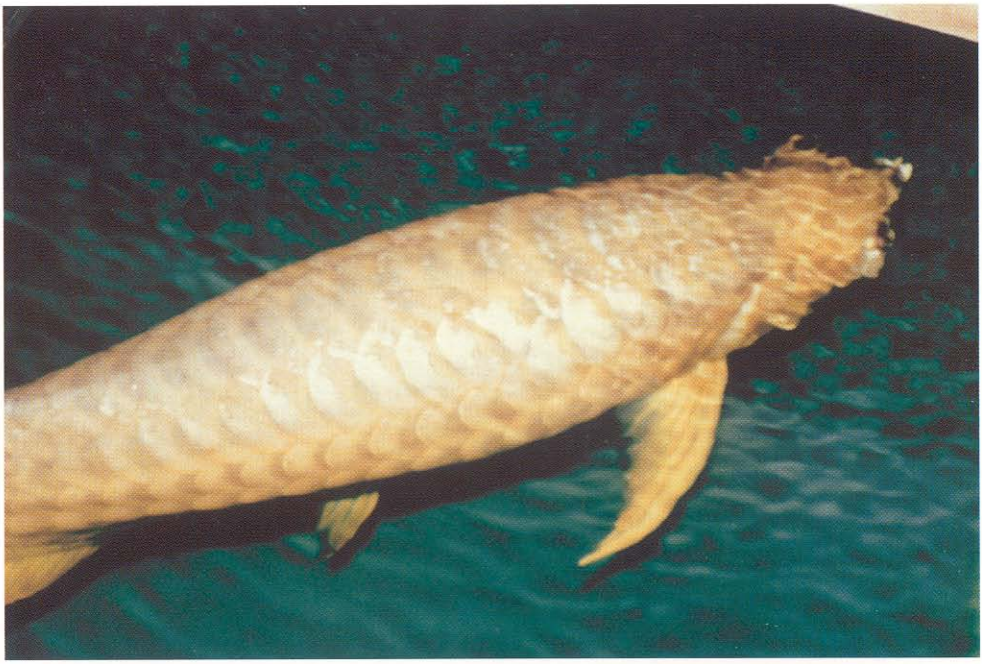
Breeding Sexing is as difficult in this species as in *S. jardinii*. Courtship begins around September/October, and spawning is said to occur during the spring when temperatures are between 20–23°C (68–73°F). Actual spawning takes place near the surface at night and away from the shore. The 50 or so large eggs, measuring around 10mm (0.4in) are incubated orally by the female (Leggett and Merrick). Hatching occurs between 1–2 weeks following fertilisation, with the total incubation period lasting 5–6 weeks. A size of 10cm (4in) can be attained by juveniles in about three months on a good diet.

No reports of successful aquarium spawnings are available, but Leggett and Merrick recommend the following environmental parameters for earthen pond spawning attempts: temperature at 20–23°C (68–73°F); pH between 7 and 9; total hardness 5–150 ppm (mg/l).

Additional Information In addition to being somewhat slimmer (see above), the Spotted Saratoga *(S. leichardti)* can be distinguished from the Gulf Saratoga *(S. jardinii)* in having fewer dorsal fin rays (15–19 instead of 20–24) and anal fin rays (25–27 instead of 28–32). It also has a proportionately smaller head, accounting for 21–26% of the Standard Length, rather than 28–31%. The angle of the mouth is also somewhat shallower; about 24–25° in relation to the body's horizontal axis, rather than 41–45°. One of the most easily-distinguishable characteristics, though, is that in mature *S. leichardti*, the forehead profile leading on to the back of the fish is almost straight, while in *S. jardinii*, it is distinctly convex. This refers to mature specimens in normal swimming positions and not, as in photographs of some preserved/anaesthetised specimens, laid out on their sides.

In *S. leichardti* the belly region is white, while in *S. jardinii*, it is bronze in colour. There are also one or two orange or red spots per scale in *S. leichardti* and three to four orange or red ones on the scales of *S. jardinii*, giving these a crescent-like pattern.

Merrick and Schmida (1983 a, b) report that occasionally 'rich red



Dorsal view of Gold Dragon Fish.

individuals' of *S. leichardti* 'are recorded'. Interestingly, red specimens of the Dragon Fish *(S. formosus)* are also found in the wild.

Dragon Fish

Scientific Name *Scleropages formosus,* (Müller and Schlegel)
Synonyms None
Distribution Natural wild populations are known to exist in Cambodia, Lao PDR, Peninsular Malaysia, the Philippines, Vietnam and Indonesia (Kalimantan and Sumatra). The best wild red specimens are found in West Kalimantan. There is some doubt regarding the existence of wild populations in Myanmar (formerly Burma) and the species may now be extinct in Thailand. Populations are also known from various locations in Singapore, most or all arising from releases, including that of surplus captive-bred specimens from an official Government breeding programme carried out during the early 1980s.
Habitat Preferences Still or slow-flowing waters which are often turbid or weedy. The Dragon Fish is said not to occur either in mountainous regions or lowlands in nature. This species shows a distinct preference for the upper layers of the water column, particularly at night and during courtship.
Preferred Water Conditions Although generally found in turbid waters in the wild – a condition faithfully reproduced in the earthen ponds in which this species is bred in captivity – Dragon Fish appear to do equally well in clear, good-quality water in large aquaria. For fuller details, see the section on Aquarium Care by Kan Tien Siong (page 54).

Broad-bodied specimen.

Size Up to around 90cm (35.4in) has been reported, but usually the fish is smaller. In the Primary Production Department (Singapore) collection, the maximum length attained by an individual specimen was 70.5cm (27.8in); its weight was 4.2kg (9.3lb). Some of the specimens in this collection are more than 12 years old.

Diet In the wild, the Dragon Fish will eat a wide range of invertebrate and vertebrate foods, largely from the surface and the upper layers of the water column. Like its relatives, though, it will also jump out of the water to grab flying prey or small animals resting on branches and other perches above the water.

In captivity, a wide range of meat-based diets is accepted, as described by Kan Tien Siong (page 55).

Breeding Lim *et al* (1996) report that Dragon Fish become mature during the third to fourth years of their lives and usually begin to spawn from the fourth year. At this time, they measure between 45–60cm (18–24in). Dragon Fish spawn almost throughout the year, with peak spawning occurring between July and December.

The sexes are indistinguishable prior to maturity, and are only identified with considerable difficulty (and experience) even after maturity is reached. Males may be slightly slimmer than females and the skin of their chin area may show signs that they possess a distendable buccal cavity in which to incubate the eggs. Males may also possess bigger mouths.

Actual spawning is preceded by a protracted period of courtship and pair bonding which takes place over a period of two to three months. Most courtship sequences are observed at night when the fish tend to swim closest to the water surface. They do, however, also occur during the day, both in open water and close to the shore. Side-by-side body

quivering/flexing and prolonged nose-to-tail circling are common features of these bouts of courtship behaviour, during which the courting pair will vigorously chase away intruders.

Female Dragon Fish possess a single ovary which, when ripe, contains around 20–30 large ova approximately 1.9cm (0.75in) in diameter, according to Scott and Fuller (1976). However, later studies, plus personal observation, have shown that fecundity can be considerably higher. In August 1988, for example, a brood of fry harvested from the mouth of a Green Dragon male (mistakenly identified as a female) numbered no fewer than 93 individuals (Dawes, 1989), but this is exceptional. Lim *et al* report that, more commonly, the brood size ranges between 4 to 62 for Red Dragons, with an average number of 34.9 based on 102 broods.

A handful of larval fish, freshly collected from a brooding male.

Red x Golden Dragon F_1 hybrid.

The male incubates the yolk-rich eggs and, subsequently, the larvae in his mouth for approximately 5–6 weeks, during which period a very pronounced chin pouch is detectable. The male appears not to feed during incubation and is generally more placid than at other times.

The large yolk sacs take several weeks to be fully absorbed, by which time the fry have attained a Total Length (TL) from tip of snout to tip of tail of around 9cm (3.5in). Teo (1993) reports that it takes almost two months for larvae measuring 2.6cm (c. 1in) TL and possessing a yolk sac of 1.6cm (0.63in) diameter to attain a length of 9cm (c. 3.5in). However, feeding does commence before the yolk sac has been fully absorbed.

Growth of juveniles is uneven and, owing to the aggressive nature of the species, physical injury or even cannibalism can occur unless preventive measures are undertaken, such as isolating individual specimens.

Despite this inherent threat to health, Teo reports that the survival rate of fry during their first six months is as high as 83%. At six months, a length of 26.8cm (10.6in) and a weight of 162.8g (5.7oz) will have been reached in pond-raised fish (see below for comparison with aquarium-raised specimens).

Breeding Dragon Fish in aquaria was first achieved in 1972 by Hiroshi Azuma in Japan. However, it took a further 30 or so spawnings over a

Dragon Fish in shallow water.

period of 17 years to achieve success in a male retaining eggs until they hatched. The successful event occurred after a spawning between a 9-year-old male and a 7-year-old female, the pair's pre-spawning courtship activities lasting 2–3 months.

When the fish eventually spawned, they did so near the bottom of a bare-based aquarium. The eggs were released in clusters, fertilised by the male and scooped up by him into his mouth. For a period of 22 days,until the female was removed, the pair swam together all the time.

Hatching is assumed to have occurred 12 days after spawning as evidenced by the discovery of an 'empty eggshell' (membrane) on the bottom of the aquarium. The fry were retained in the male's mouth for a further 37 days, at which point they were allowed out for short periods. It took another 12 days before they 'finally swam free of their father for extended periods'. During this incubation/protection phase, the male exhibited dark oval mandibular patches, one on each side of his lower jaw. These were referred to by Azuma as 'brooding marks' and their purpose may have been to act as orientation marks for the fry to re-enter their father's mouth after their external forays, as happens in mouthbrooding cichlids.

Although by this time the yolk sacs were small, it took five further days before the fry began to accept livefood (bloodworms). Even at this young

Red Dragon spawners being released into a pond.

age, the fry were aggressive towards each other and therefore had to be separated in small individual aquaria. Sizes of around 7.5cm (3in) were attained within 60 days of spawning, around 14.2cm (5.6in) at 120 days, 18.3cm (7.2in) at 180 days, and a maximum of some 22.9cm (9in) at 210 days. No indication is provided as to whether these figures refer to Standard Length or Total Length.

A comprehensive report of his whole 20-year project is provided by Hiroshi Azuma in the January 1992 issue of the American hobby magazine *Tropical Fish Hobbyist*. This fascinating article should be regarded as essential reading by anyone attempting to breed Dragon Fish in aquaria.

Caution must, however, be exercised in extrapolating directly from this, albeit extremely valuable, aquarium-based account to conditions and behaviour in the wild or in earthen ponds. In the aquaria used by Azuma, for example, there was no gravel on the bottom. Therefore, even if the pair were genetically disposed towards producing a spawning depression, they would have been unable to do so. Further, while the female was observed to swim close to the male for several weeks after spawning, brooding males are often seen swimming on their own in earthen ponds.

Clearly, much more needs to be learned and discovered about the courtship and breeding of the Dragon Fish but, thanks to methodical observers and expert practitioners such as Hiroshi Azuma, valuable headway is being made all the time.

Additional Information *Scleropages formosus* occurs naturally in three main colour forms. In Malaysia, most specimens are either Green or Golden Dragon Fish, while in Indonesia most are Gold or Red (Teo, 1993). There is also considerable variation within each colour variety. The Sumatran Red Dragons, for example carry a distinct, dark (almost black) broad band down the top of the back. White Dragons are reported by Luxmore (1990) from southern Sumatra and 'green, white and black' varieties from the coastal districts of Indonesia.

Releasing a Red Dragon male back into the pond after harvesting of fry.

At least one breeder in Singapore (Lee Ah See) has cross-bred Golden and Red Dragons. The resultant fish are, in my opinion, not as attractive as the pure varieties.

Occasionally, albino specimens have been recorded. One such individual was featured by W J Tavip (1995) in an article in *Tropical Fish Hobbyist* (see Bibliography).

On 1 July 1975, fears surrounding the state of *Scleropages formosus* in the wild led to its being listed in CITES Appendix I (see Chapter 4 CITES and the Dragon Fish).

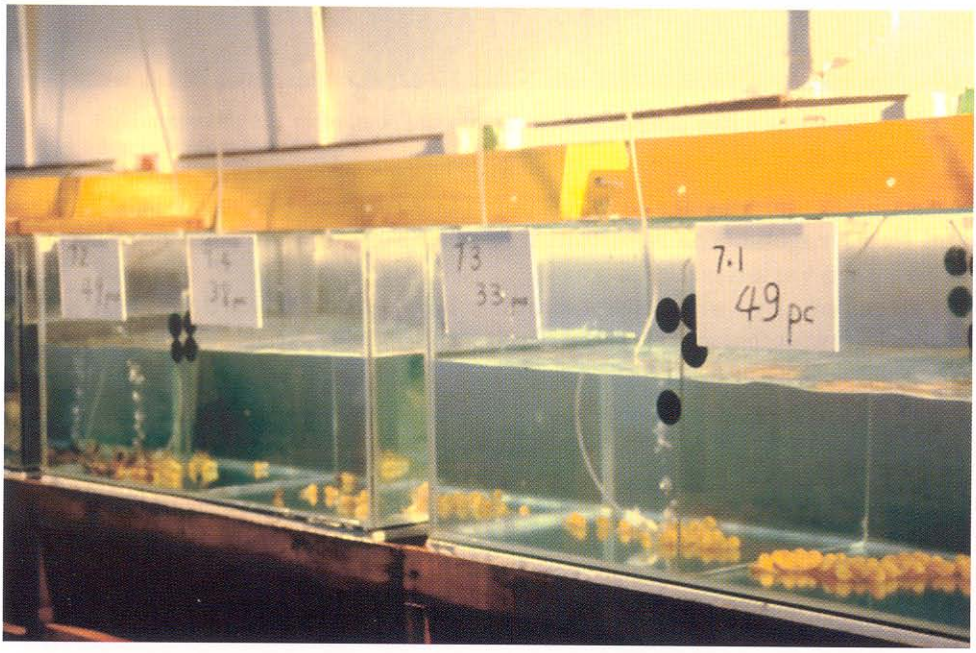
Chapter 4: CITES and the Dragon Fish

John Dawes

Whenever there is a genuine reason for concern regarding the continued survival of a species of plant or animal in the wild, it makes sense to take steps to protect it. In many instances, the geographical range of a species or subspecies can be so restricted, the numbers of adult reproducing specimens so low, and the generation times so long (as with the various subspecies of Galapagos Giant Tortoises) that only drastic measures and an energetic conservation programme can offer any degree of security.

Clearly, in such cases – and even where the species in question is known to be threatened but is not on the brink of extinction – trade must be carefully controlled and monitored or, if necessary, banned. Where doubt exists, or where there is insufficient information available on the actual status of wild populations, precautionary steps are usually taken with regard to trade. These precautionary measures can range from restrictions to total bans.

Several fish fall within one or other of these categories. The world-famous living fossil, the Coelacanth *(Latimeria chalumnae)*, for example, is considered to be most highly endangered. So, interestingly, is the Dragon Fish. Both are therefore afforded the highest degree of protection by being listed in CITES Appendix I.



Larval fish being raised in well-aerated aquarium tanks.

CITES is an acronym for the Convention on International Trade in Endangered Species of Wild Fauna and Flora. Rather than an actual organisation or official body, CITES is an agreement between countries, called signatories (around 130 at the present time), the aim of which is to regulate, not ban, international trade in wildlife and wildlife products. Therefore, for example, not only are the threatened species of marine turtles listed as a result of criteria defined by the Convention, but so are products derived from them, such as tortoise-shell ornaments and accessories.

The idea of the Convention originally arose out of a series of meetings held during the 1960s and early 1970s between representatives from countries who were concerned about threats to wild stocks arising from international trade in specimens and their products. These meetings culminated in a gathering in February 1973 at which 81 countries finally launched the agreement and thus set up the Convention with an effective official starting date of 1 July 1975.

CITES operates mainly through three Appendices, each reflecting a different level of perceived threat and defining specific controls with regard to trade.

Appendix I

This is the highest risk category and, consequently, the one with the strictest level of control with regard to trade. Animals and plants to which Appendix I applies *'...are endangered species and commercial import, export and sale is normally prohibited...'*.

The 'normally prohibited' clause allows for some flexibility, so that limited trade can be permitted if, for example, the specimens concerned:

- are bred in captivity or (in plants) are artificially propagated;
- are required for research purposes;
- will be used for non-commercial purposes;
- date from before the Convention came into force.

At the moment, the Dragon Fish, the Coelacanth and six other species of fish are listed under Appendix I.

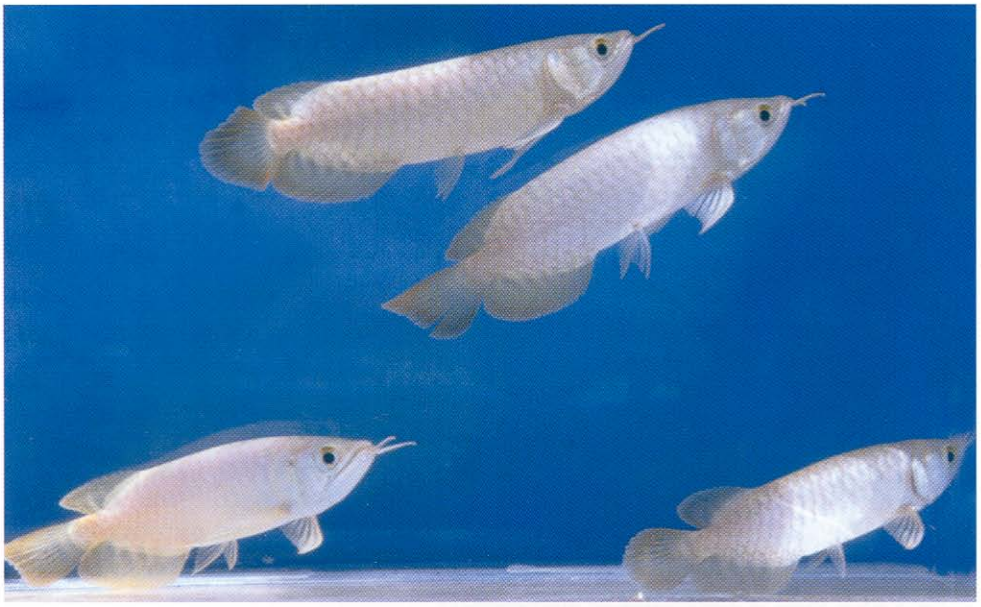
Appendix II

Under the less strict Appendix II controls are listed animals and plants which *'...are vulnerable species but (which) may be traded commercially provided that import or export permits have been obtained...'*.

This level of control is designed to ensure that populations of such species do not decline to such an extent that they become threatened with extinction. In other words, these measures aim to prevent an Appendix II species from having to be transferred to Appendix I.

Also included in Appendix II are any species which closely resemble

other species listed under Appendix I. No fish currently fall within this group of lookalikes, but five species qualify for listing under Appendix II. These include the Australian Lungfish *(Neoceratodus forsteri)*, the Arapaima or Pirarucu *(Arapaima gigas)* – a close relative of the Dragon Fish – and the American Paddlefish *(Polyodon spathula)*. For a while the Indonesian populations of the Dragon Fish were listed under Appendix II, but these have now been transferred back to Appendix I.



Shoal of juveniles about 12cm (c. 5in) total length.

Appendix III

Species listed under Appendix III are deemed not to be under major threat, and regulations controlling their trade are domestically devised and administered, although individual countries can call on international co-operation if they feel that this is required. Generally speaking, though, controls are, quite rightly, more relaxed for Appendix III species than for those listed under Appendices I and II.

Need for Evaluation

For a species to qualify for listing under Appendix I, it needs to meet certain criteria. For example, the wild population must be small and either:

- be in decline in terms of numbers or habitat; or
- consist of small sub-populations; or
- contain a concentration of individuals in one population; or
- exhibit large short-term fluctuations in numbers; or
- be prone to high vulnerability due to biology or behaviour.

Alternatively, large populations can qualify for listing if they satisfy certain criteria with regard either to having a restricted natural distribution, or to exhibiting a distinct decline in total numbers, due to a range of factors which can include deterioration of habitat and a decrease in reproductive potential.

In addition to having to meet one or other of the main criteria outlined above, there are also certain trade factors that have to be met before listing can proceed. Clearly, therefore, listing is a matter that calls for a great deal of data and careful consideration and is not something that is ever taken lightly.

In the case of the Dragon Fish, growing concern for its continued survival in the wild led to its listing under Appendix I on 1 July 1975, with exports from Indonesia becoming illegal in 1978 when the country acceded to CITES, and those from Singapore in 1980. Singapore itself joined CITES on 30 November 1986. On 18 January 1990, the Indonesian population of Dragon Fish was downlisted to Appendix II, with all other populations remaining on Appendix I, but on 16 February 1995 it was returned once more to Appendix I. Therefore, all populations of Dragon Fish are currently listed under Appendix I.

International Union for Conservation of Nature and Natural Resources (IUCN)

Interestingly, if we look at how another major conservation-based (but not trade-related) organisation rates the status of *Scleropages formosus* in the wild, we get a slightly different picture. In its 1994 list of threatened animal species, the IUCN (International Union for Conservation of Nature and Natural Resources) considered the status of Dragon Fish as 'Insufficiently Known'.

According to the official definition of this category, listed species are *'suspected but not definitely known to belong to any of the above categories, because of lack of information'*. The 'above categories' include Extinct, Endangered, Vulnerable, Rare and Indeterminate.

This classification probably represents a more accurate picture with regard to our current state of knowledge regarding wild population levels of the Dragon Fish and the firm 'Endangered' label imposed upon it by being listed in CITES Appendix I. However, since in cases of uncertainty, one must always err on the side of caution, it would not help matters if an argument were to be advanced to downlist the Dragon Fish to Appendices II or III without detailed and unequivocal evidence derived from first-hand studies carried out in the wild. The fact is that we lack reliable data based on population studies carried out throughout the species' natural range. Indeed, much of the evidence we do have is anecdotal or secondhand or, as the following example from Vierke (1992) shows, intriguing. It would therefore not be sensible or helpful to base major decisions on such shaky foundations.

Sub-adult *O. bicirrhosum*.

In an interesting article written for *Tropical Fish Hobbyist*, Vierke reports on a visit to Malaysia. He tells of a large 'nature park', Taman Negara, in some of whose waters Dragon Fish are known to occur. Visitors to the park are urged to 'Take Nothing but Pictures', a commendable sentiment which is perfectly in tune with everyone's concept of conservation, particularly within the confines of an area dedicated to the welfare of wildlife.

However, reportedly, Vierke came across a 'prospectus', written in German but published by the Malaysian Ministry of Commerce and Industry, providing information on angling within the national park. This prospectus contains a section on where Dragon Fish may be found in the park's waters saying that, for example, they prefer small coves along the river bank. It also includes advice on what types of hook are best for catching Dragon Fish, provides a fishing map and even describes the sort of fight this fish puts up when hooked.

It is always easy to jump to conclusions, especially when one is dealing with such an emotive issue as the Dragon Fish. Such a tendency should, however, be resisted since it often leads to misleading, inaccurate and potentially damaging statements that may not take into account specific, and probably unique, local factors which may have a direct bearing on the situation. Neither should one allow personal feelings regarding the actual activity of sport angling *per se* to cloud the issue.

The crucial thing here is what this sort of publication tells us about the Dragon Fish population in the park. It would seem unlikely, irrespective of whether or not the area concerned is part of a national park, that such a guide would be made available if the numbers of Dragon Fish were down, or close, to endangered levels. Indeed, the very existence of published advice on how to angle for Dragon Fish may indicate quite the opposite; that the population is sufficiently large and widespread to make angling feasible. If this were to be the case, and if it were an accurate reflection of population levels elsewhere in the species' range, then the Dragon Fish may be more secure in the wild than we fear.

In reality, of course, this prospectus does not provide proof of abundance or of scarcity, and therefore could not be used to advance any argument regarding the official categorisation of the Dragon Fish.

Disappointingly, there is no indication at present that any census studies are being contemplated. The unfortunate consequence of such a lack of research is that, until and unless we know for certain how the Dragon Fish is faring in its native waters, not only might we be classifying it incorrectly but, more worryingly, the species could conceivably (though this is perhaps unlikely) be undergoing a dangerous natural decline without this even being detected.

So far, an earthen pond has proved the best habitat for captive breeding of Dragon Fish.

Two other relatives of the Dragon Fish also appear in the 1994 IUCN list. The Spotted Saratoga *(Scleropages leichardti)* is classified as Rare, which identifies it as being 'at risk' of becoming either Vulnerable or Endangered, while the Pirarucu *(Arapaima gigas)* is rated, like the Dragon Fish, as Insufficiently Known.

Stocking larvae in aquarium tanks in hatchery.

In late 1994, the IUCN revised its categories, resulting in the following classifications listed in order of threat: Extinct, Extinct in the Wild, Critically Endangered, Endangered, Vulnerable, Lower Risk (subdivided into: Conservation Dependent, Near Threatened and Least Concern), Data Deficient and Not Evaluated.

At the present time, the extensive existing species list has not been reallocated with respect to the new categories, so no definite statement can be made with regard either to the Dragon Fish, the Spotted Saratoga or the Pirarucu. It is unlikely, however, that on current levels of knowledge, any of the three will undergo a dramatic change in status, perhaps ultimately ending up either under one of the Lower Risk subcategories or under the Data Deficient category.

Packing of fry.

Conclusion

Whatever the outcome, it seems improbable, unless there is an unforeseen development of some kind, that sufficiently startling new evidence will come to light in the short term regarding wild populations to warrant downlisting the Dragon Fish from CITES Appendix I to Appendix II.

Therefore, for the foreseeable future, the Dragon Fish will continue to be regarded as Endangered according to the CITES criteria and remain subjected to all the trade restrictions implied by being listed in Appendix I. This does not, however, mean that no international trade is allowed but rather, as mentioned earlier, that this trade needs to be closely regulated and that permission will only be granted if CITES' strict criteria can be met.

Among these criteria, as has already been outlined, there is one that can result in permission to trade in listed species if the specimens in question have been bred in captivity. Clearly, of course, it is not sufficient merely to claim that this has been achieved. Convincing evidence must be provided, and this is easier said than done, but it is not impossible. Chapter 8 describes how one enterprising Singaporean Dragon Fish breeder joined forces with the government's Primary Production Department in a sophisticated captive breeding project designed to provide the CITES authorities with precisely this kind of evidence.

Chapter 5: Selecting Dragon Fish

Kan Tien Siong

Criteria for Selection

All Dragon Fish are beautiful creatures and have outstanding qualities. Yet some are more beautiful than others. So how does one go about selecting a good specimen? What is it that separates a top-quality fish from the rest? What should we be looking for when trying to come to such an important decision?

Basically, there are eleven factors that should be considered: colour, body shape, scales, mandibular barbels (whiskers), fins, eyes, mouth, teeth, gill covers, vent and swimming style. No single fish can score perfect marks in all these categories, of course, but the higher the notional score in each section, the better the overall quality of the specimen in question. The following has been prepared with this in mind and, at the very least, should help you to obtain a Dragon Fish that is healthy and pleasing to the eye. At the end of this section, you will find a summary table for easy reference. The chapter concludes with a brief discussion on the specific qualities to look out for in certain commercial varieties of Dragon Fish.

Colour

The most important criterion is the colour of the fish, because often it is the colour that first attracts the hobbyist. If the body shape is correct but not the colour, then the fish cannot be considered perfect. Naturally, the colour differs according to the variety of Dragon Fish (see Dragon Fish Varieties, pages 50-53).

Golden Dragon.

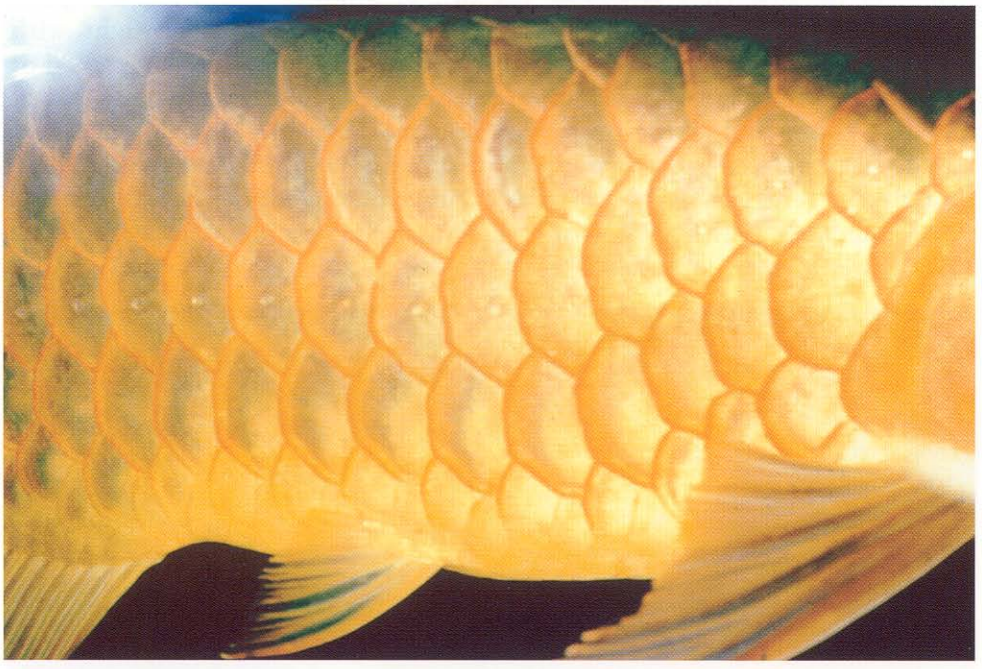
Body Shape

A stunted specimen.

The ideal shape is one that is in proportion and symmetrical. The body should be neither too fat nor too thin. It should have a firm appearance, without bulges or depressions. Body shape can be affected by the environment the fish is kept in and the type of food it receives.

The size of the tank has a direct effect on the growth and development of the body. A fish grown in a small tank will be stunted and the body rounded and hunched. Dragon Fish should preferably be kept in a tank which is three times the body length.

The diet should be nutritious and consists of food which enhances the body colour. Live fish and shrimps represent good food for the Dragon Fish, but do not allow the fish to have a preference for one type of food, or overeat.

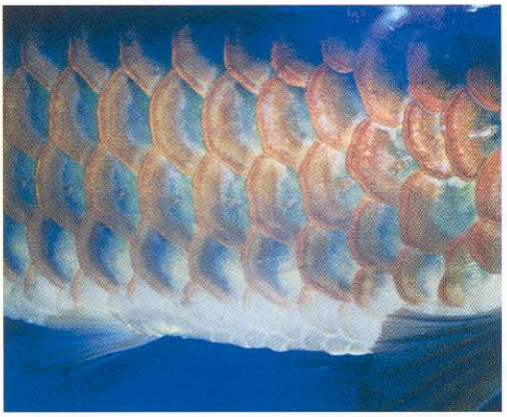


Scale pattern on a Golden Dragon Fish.

Scales

The scales of a Dragon Fish are most distinctive. They should be neatly layered, slippery, even in size and radiant. There should not be any dark spots, although red spots are welcome as these are considered auspicious (but see 'Red Spot' Disease, chapter 6, page 61).

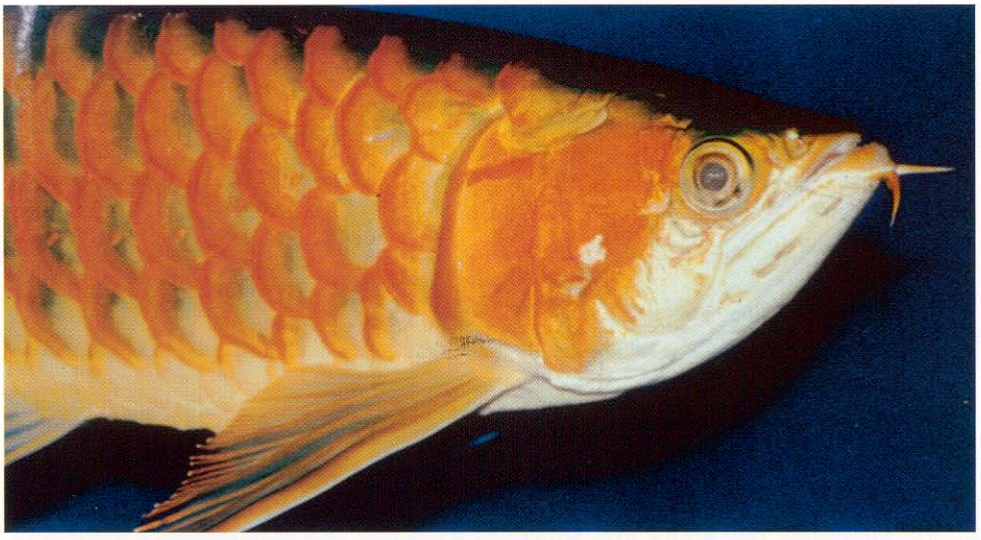
Many people have a misconception that scales which drop off are not replaced. Dropped-off scales will be replaced with new ones. However, during the replacement process, the fish tends to rub its body against the sides of the tank because it feels itchy, and this may result in body damage. To prevent this, remove all objects in the tank that can damage the fish during this time. It takes about three to five weeks for the fish to regain its lost scales. Water condition should be monitored and quality maintained to prevent bacterial growth. If any scale is mis-shapen, it can be removed surgically and a new scale will eventually grow in its place.



Close-up of scales.

Mandibular Barbels (Whiskers)

Many fish lovers have high regard for the Dragon Fish's barbels or whiskers because they resemble the dragon's horns which are a sign of blessing. Mandibular barbels must be of equal length and be straight, with the colour similar to the body colour of the fish. Any broken, shortened or bent barbels may mean a reduction to the fish's majestic appearance, but how can these barbels be preserved and maintained? Most importantly, make sure there is ample space for the fish to swim freely in the tank, thereby preventing the barbels from being damaged. Without sufficient space, the barbels cannot grow properly and the tips may rub against the sides of the aquarium and become damaged.



Specimen with good eyes and undamaged barbels.

To avoid damage to the barbels:

1. Do not decorate the aquarium with furnishings such as rocks.
2. Do not drop food in a corner; put it in the centre of the aquarium.
3. Do not knock against the aquarium and frighten the Dragon Fish.
4. Cover the aquarium with thick glass with smooth, rounded edges for safety.

The above four points can help to minimise damage to the Dragon Fish's barbels, especially when the fish is excited or frightened.

Should the barbels be broken or damaged, the recovery period varies according to the age of the fish. Normally, a young fish recovers faster than an older one. Barbels may be damaged in two ways:

- At the root: when this occurs, recovery may be difficult even for a young Dragon Fish.
- Away from the root: it is necessary to decide whether to leave the barbel to grow back naturally, or to use a needle to help speed the growth. Even if the barbel is bent but not broken, it is best to cut it off so that it will not be out of shape when it re-grows.

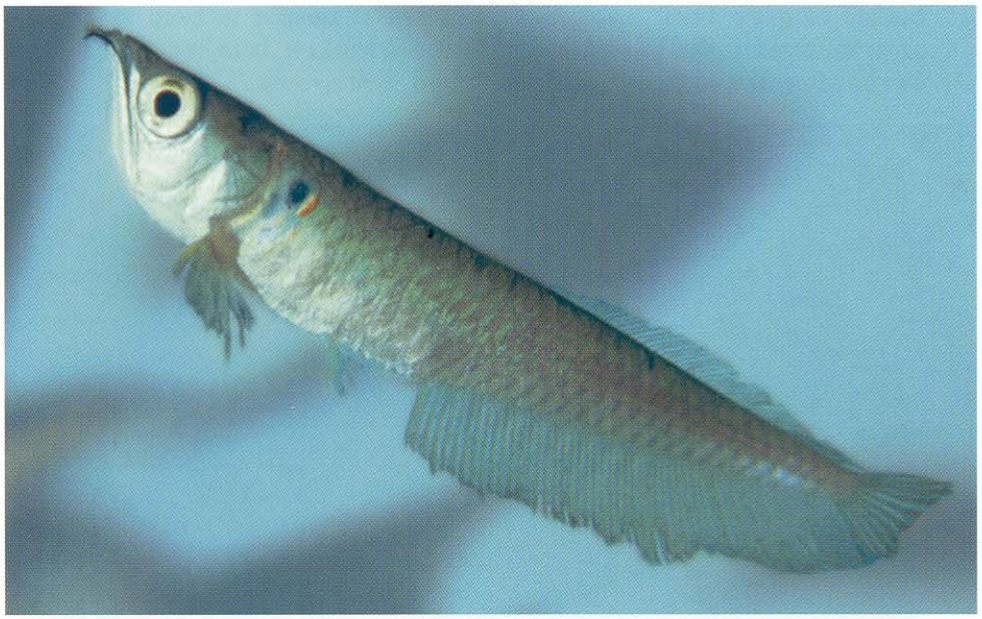
Anaethetised Dragon Fish.

The needle treatment

1. Sterilise a fine needle.
2. Administer anaesthesia to the Dragon Fish so that it is unconscious during the operation. MS222 is a clean and effective anaesthetic. Use 50 ppm (parts per million or mg/l) by mixing 2g of the chemical, which comes in powder form, with a small quantity of water, then stir this into an aquarium tank containing 40 litres of water. Next, carefully transfer the

fish from its aquarium using double-layer plastic bags (see Fish Transfer page 56) into the tank containing the water with anaesthetic. Watch the fish until it shows signs of flipping over onto its belly, indicating that it is unconscious.

3. Place the unconscious fish on a rubber or plastic sheet.
4. With the sterilised needle, quickly but carefully prick the root region until it is swollen and bleeding. Apply antiseptic cream to the wound.
5. Place the fish back into the aquarium. The fish, being unconscious, will be belly-up. Increase the aeration and place the air stone near to the operculum (gill cover) of the fish to help its recovery. Place Acriflavine in the water (suggested concentration of 2 ppm) with 0.3–0.5% salt to safeguard against infection of the wound. Change 30% of the water daily for the next 3–5 days.



Juvenile Arowana with fins damaged by its tankmates.

Fins

The fins of the fish are like its limbs. This is no different for the Dragon Fish. Any damaged fin can affect the graceful movement and, ultimately, the beauty of the whole fish. A beautiful fin should be one which is complete, smooth and outstretched, with all its hard rays straight and smooth. There should be no tear in the fin.

Care of the fins should begin when the fish is young. At this stage, the fish should not be given too much space in which to swim about as it would feel insecure in a spacious environment and tend to be easily frightened. When frightened, a young Dragon Fish dashes about at the slightest disturbance, thereby injuring itself. A smaller space to give the fish a feeling of security also enables it to be more active, thereby strengthening the fins at the same time.

To avoid damage to the fins:

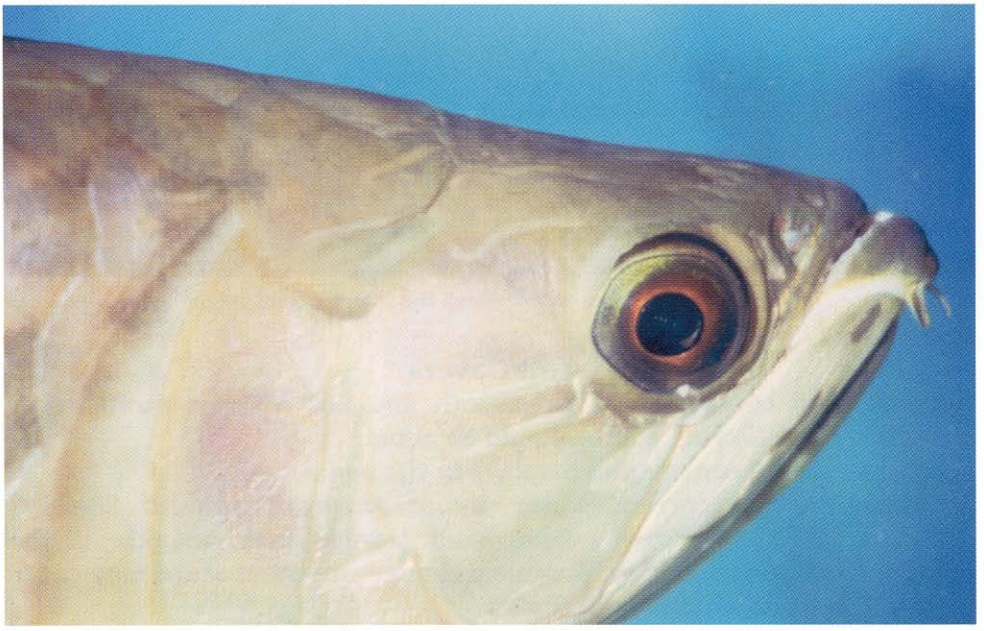
- Do not install ornamental displays such as rocks.
- Do not rear other fish in the same tank.
- Use a fine-mesh net when scooping out the young fish. When the fish reaches 15cm (6in) in length, do not use a net but a double-layer plastic bag to remove it from the tank.

If a portion of the hard ray of the fin is injured, that is, broken or bent, gently remove the ray at its base with a pair of scissors and a new ray will grow in its place. In the case of more rays being damaged, place the fish under anaesthesia and remove the broken rays. Any case of broken rays should be attended to immediately, especially if the tail rays are involved, as the Dragon Fish depends largely on its tail fin to move about.

Eyes

In its natural environment, the eyes of a Dragon Fish are focused on the surface of the water to search for live food. However, when a fish is reared in an aquarium which is transparent all round, the eyes tend to look downwards due to the surrounding distractions and because food is readily available in the water, usually at the bottom of the tank. Sometimes, due to lack of exercise, the fish develops fat around the eyes and this may cause them to bulge in their sockets, thereby giving rise to protruding or droopy eyes.

The aquarist need not be unduly worried about a fish's downward-looking eyes, as this phenomenon is only the fish's natural adaptation to its environment. However, the value of the fish is adversely affected by this abnormality.



Close-up of eye (Green Dragon).

A good-quality fish must have eyes which are centrally focused. The eyes must not be droopy or protruding. They must be evenly shaped, clear and move naturally, and have a bright sparkle.

Mouth

When the mouth is closed, the upper and lower lips must not protrude and the lower jaw should not hang loose. In the aquarium, fish often rub against the glass wall of the tank, resulting in the loosening of the jaw muscles. To avoid this, increase the volume of the aquarium; you could install a water jet to increase the flow of water into the tank.

Teeth

Generally, fish hobbyists do not pay much attention to the teeth of their fish. However, if the teeth are not healthy-looking, the fish's health will be affected and this, in turn, will affect the fish's outward appearance.

Fish with gill-cover deformity at the intermediate stage.

Gill Covers

Normally, gill covers should be smooth and flat with no scratches or wrinkles. The following points should be noted:

- Do not install ornamental displays in the aquarium.
- Maintain the correct water temperature at around 26–28°C (c.79–82°F). Gill covers and head tissues may wrinkle if the temperature is too high. A drastic change in temperature may cause the fish to suffer tilted gill covers.

- Change water regularly and maintain a clean tank, keeping water at optimum quality condition. Water should be clear, not murky, and there should not be a layer of bubbles on the surface. The latter condition indicates a high organic load which should be avoided.
- Raise aeration to increase dissolved oxygen concentration in the water.
- Practise prophylactic preventive treatment should you see any injuries on the gill covers. Place 2 ppm of Acriflavine in the water once every two weeks, as this minimises infection by fungi and external parasites.

Vent

The vent of a healthy fish is located horizontally to the pelvic region and should not be easily visible. If the vent protrudes, it means that the fish has a stomach problem, an indication that it is not healthy. Exceptions are when the fish is due to spawn or after spawning.

Swimming Style

The manner in which a fish swims is important, as graceful movement enhances its aesthetic value. Correct posture is when the fish swims horizontally in the water, with its dorsal body profile parallel to the water surface and its fins spread out. The mandibular barbels must be pointing outwards and be straight. Seen from the top of the tank the fish must also have a proportionate, torpedo-shaped body. The fish must be able to turn around the tank swiftly. A fish which moves up and down or diagonally is not ideal.

A graceful swimming style.

Summary of General Selection Criteria

1 Colour: according to the variety, the body colour should be bright and lustrous.
2. Body shape: sufficiently broad, long and symmetrical.
3. Scales: neatly arranged, shiny, evenly shaped and large.
4. Mandibular barbels: long and straight, equal in length and matching the body colour of the fish.
5. Fins: big, widespread and complete.
6. Eyes: even in shape and size, not droopy or protruding, lustrous and not misty.
7. Mouth: tightly closed, and jaws not protruding.
8. Teeth: neatly arranged and in line with jaw.
9. Gill covers: compact and close to the head and body; shiny and not scarred.
10. Vent: not protruding, flat on pelvic region.

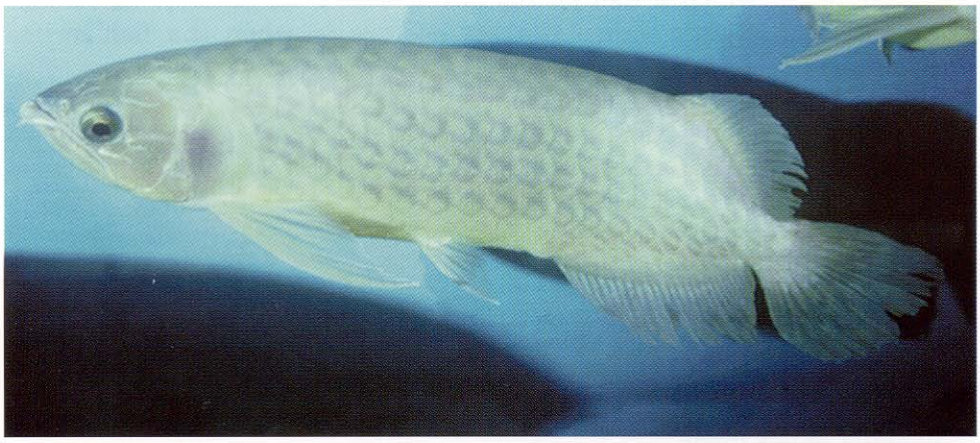
11. Swimming style: graceful and often swimming in the upper levels of the water in the aquarium.

Specific Selection Criteria

The specific selection criteria for four commercial varieties of Dragon Fish, namely, Green Dragon, Indonesian Red-Tail Gold Dragon, Malaysian Gold Dragon and Indonesian Red Dragon are described below.

Green Dragon Fish

Green Dragon Fish are native to Thailand, Malaysia, Vietnam and Myanmar. These fish have green scales and a prominent lateral line. The more expensive varieties have scales which are purplish-spotted; fish without the purple spots are more common and, therefore, cheaper. Generally, the Green variety is the least expensive of the four varieties described.



Green Dragon Fish.

Scales: At 10cm (4in) length, the fish is silver in colour, having shades of grey and green. The colour is dull, mostly greyish.

Fins: Young fish have yellow fins, similar to the Gold Dragon Fish described below. However, when they become adult, the colour becomes bluish-green with grey overtones.

Head Region: This variety has a smaller head region than the other varieties, with dull greyish lips.

Body Shape: The fish has a relatively shorter and smaller body than the other three varieties.

Indonesian Red-Tail Gold Dragon Fish

In this variety, the dorsal portion of the fish is dark green, including the dorsal fin and upper half of its tail fin. The rest of the body scales are gold.

A good fish should have half of its scales glittering. Its gill cover does not have any red colour, but assumes a glittering gold. This attractive variety is found in Kalimantan and Sumatra, Indonesia.

Indonesian Red-Tail Gold Dragon.

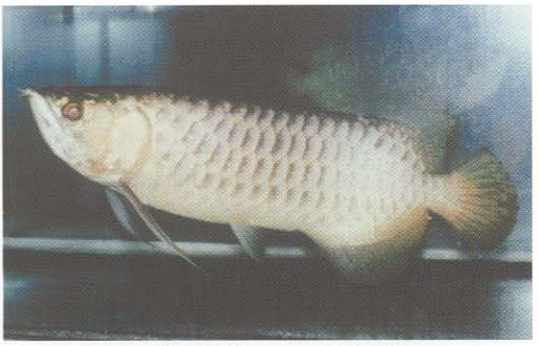
Scales: When the fish is only 10cm (4in) in length, it has golden scales tinged with pink. The edge of each scale is green, similar to the Malaysian Gold Dragon. At this young stage, it is difficult to distinguish between the two varieties, although the Malaysian variety is the more brightly coloured of the two. When the fish reaches 20cm (8in) and over, the lustre of the scales of the Malaysian variety extends to the fifth row, but not in the Indonesian variety.

Fins: At 10cm (4in) length, the fish has fins that are comparable to the Malaysian variety. The Indonesian variety has 9–11 spiny rays (hard fin rays) on its pelvic fin. These spines are black and close together. The caudal fin has six spiny rays. When the fish reaches about 15cm (6in) or over, the black colour of the rays gradually disappears.

Head Region: Lower gill covers are radiant, and the mouth is not as pointed as that of the Malaysian variety. In addition, adult fish do not assume as lustrous an appearance as their Malaysian counterparts.

Malaysian Gold Dragon Fish

This variety shares some characteristics of the Indonesian Red-Tail Gold, except that the former has golden scales overlapping the dark green back scales, causing the whole body to shine. This fish is in great demand because of limited supplies. Therefore it is more expensive than the Indonesian variety. Sometimes, the Malaysian Gold can be even more expensive than the Red Dragon.



Young adult Malaysian Gold Dragon.

Scales: When the fish is about 10cm (4in) long, the scales turn yellow, with a tinge of olive green. The glow extends to the fourth row of scales (from the stomach region). The edge of each scale is pinkish, with some golden

yellow colour. When the fish is fully grown, the pink colour of the scales disappears, and the whole fish turns golden yellow. This glowing colour extends to the fifth row of scales and over the back of the fish. Note that, depending on the environment in which the fish is raised, the colour may differ. When there is insufficient light, the colour of the scales is darker than when the light is adequate.

Fins: At 10cm (4in), the fish has pinkish pectoral and pelvic fins and a red tail (caudal) fin. The pectoral fins are more arched and pointed at the tip. There are 7–9 black fin rays on the anal fin and five black rays on the tail fin. When the fish is fully grown, the black colour on the fins disappears and they turn reddish. The pectoral and pelvic fins turn golden. The anterior portion of the dorsal fin still retains a tinge of black. When the tail fin is broad and big, it indicates that the fish is in good health and condition.

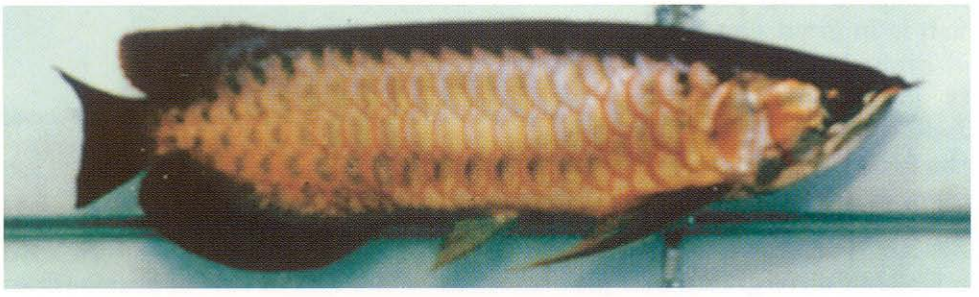
Body Shape: At 20cm (8in) length, the fish's body is broad and elongated. Body colour is also brighter than in smaller specimens.

Head Region: The lower lips of the fish are silvery and bright, and taper towards the mouth.

Indonesian Red Dragon

In Hong Kong, this variety is also known as the 'Red Pearl-spitting Dragon Fish'. In Malaysia and Singapore, Chinese businessmen call it the 'Prosperous Fish'. The Red Dragon is native only to Kalimantan and Sumatra, Indonesia. However, in the mid-eighties, this variety was bred in captivity by fish breeders and hobbyists in Singapore. It is the most sought-after variety of the Dragon Fish as its red colour is associated, especially by the Chinese and Japanese, with wealth and prosperity. A good-quality fish has a 'chilli' or blood-red body colour, and the edges of the scales are radiant. The gill covers have a unique red colouring, and all the fins and the edges of the scales may be apricot, pink, deep red, blood red, or even brown or liver-coloured.

Scales: At 10cm (4in) length, the fish has scales which are orange-yellow with a bit of light green; the edges of the scales are pink and radiant. When

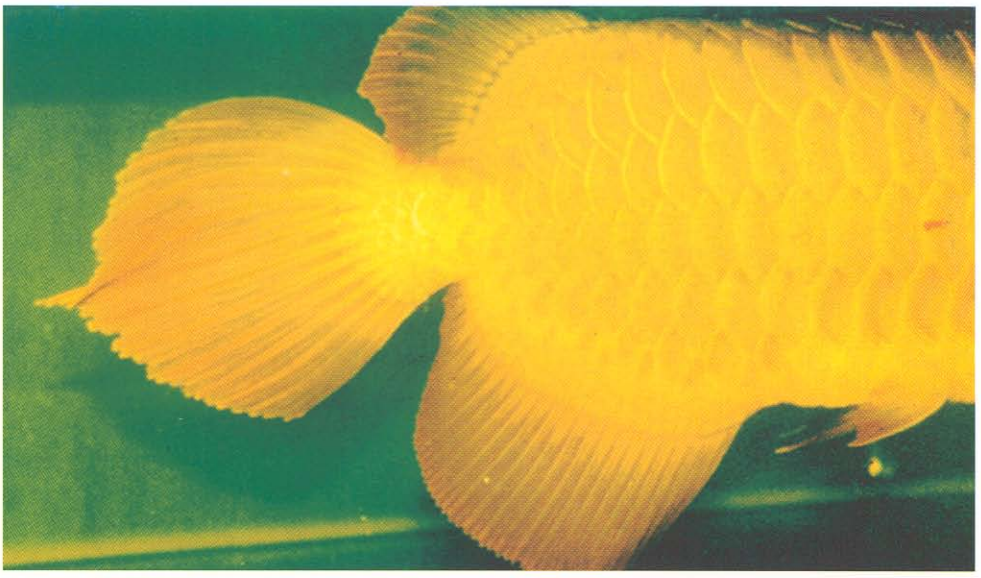


Young adult Red Dragon of exceptional quality.

the fish is fully grown, the scales bear prominent red trimmings. The larger the fish, the redder these trimmings become. The scales take on a shade of purplish blue when the fish becomes fully grown.

Fins: The dorsal, tail and anal fins are bright red, whereas the pectoral and pelvic fins are bright orange, with a particular lustre. The tail fin is shaped either like a pear or a fan.

Red Dragon Fish (Chilli Red).



The pear-shaped tail.

It has 9–12 hard spiny rays, which are darker in colour and close together, just like the Indonesian Red-Tail Gold variety, but these rays will later turn dark red when the fish is fully grown.

Body Shape: Red Dragon adults usually have longer bodies than specimens of the other three varieties.

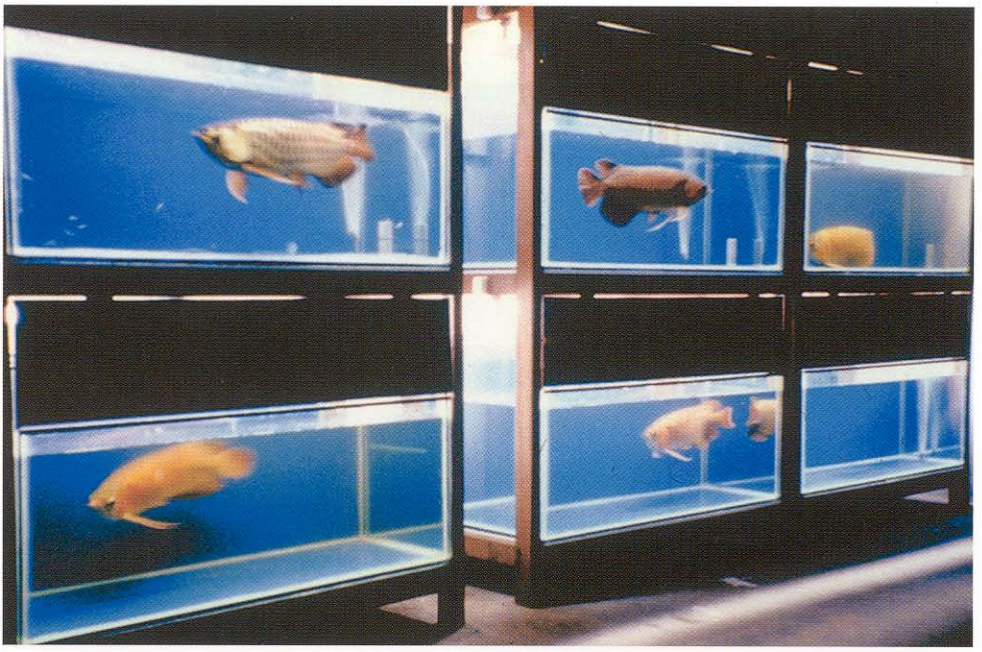
Head Region: The lips are pink or a golden colour.

The fan-shaped tail.

Chapter 6: Caring for the Dragon

Kan Tien Song

This chapter is about the care that should be exercised when rearing Dragon Fish in aquariums and the treatment for some of the common diseases to which the fish is prone.



Examples of aquariums showing how the Dragon Fish should be kept in open, uncluttered tanks with very basic filtering and aeration systems.

Fish Care and the Aquarium

The Dragon Fish is a large fish that swims about actively in the water. Therefore, the basic rule to follow when rearing it in an aquarium is to provide it with ample space in which to swim to prevent its growth being stunted.

Tank Size

Although easily domesticated, the Dragon Fish's aggressive nature means that it is best raised individually in a tank. For a fish not exceeding 40cm (16in) Total Length (TL), use a tank measuring 90 x 45cm (36 x 18in). For larger fish, a tank measuring 120–150 x 75cm (48–60 x 30in) should be used. Maintaining water in the tank at a depth of about 60cm (24in) would be adequate in either case.

Tank Location

Cover the tank and place it in a quiet area of the house, away from direct sunlight and constant human activity. Aeration and filtration are essential, but avoid tank furnishings which may damage the fish if it swims against them accidentally while trying to catch its food or when it is excited.

Water Quality

As in all good fish practice, water should be maintained at a high level of quality, namely, with dissolved oxygen levels exceeding 5 ppm (mg/l) and a level of free ammonia not exceeding 0.1 ppm (mg/l). However, in your attempts to maintain good water quality, do not subject the fish to sudden changes of water as they need time to adapt to their new environment and would be stressed and fall sick easily if not allowed to acclimatise. The Dragon Fish is extremely sensitive to chlorinated water so, if you use tap (potable) water, age the water for at least a day before use. Change the water every week, but only partially (not more than a third) to avoid upsetting the fish with the new water. Never alter the water pH or hardness suddenly because this can prove fatal to the fish. If any changes are to be made to pH and hardness, you should do these gradually to allow the fish to adapt to the changes. This also applies to any changes in water temperature.

Feeding Red Dragon Fish with shrimp in a home aquarium.

Feeding

Favourite foods of Dragon Fish are live insects (e.g. crickets and grasshoppers), small frogs and fishes such as Guppies and Mollies. To give the fish that rich body colour, feed it with live shrimps. For convenience, the fish can be fed chopped fish meat. They will also take cockroaches and

centipedes, but this is to be avoided as such creatures may be contaminated by insecticides. Young Dragon fish can be fed 2–3 times daily, while adults can be fed once daily, or even on alternate days.

1. Live food should constitute 75% of the feed given to Dragon Fish.
2. Keep all live food in separate tanks until you need to use it. Rinse small fish and shrimps to cleanse them of dirt before feeding to the Dragon Fish.
3. When feeding shrimps to Dragon Fish, it is best to remove the sharp shells to prevent the Dragon Fish from injuring its gut and stomach when ingesting. Avoid feeding whole shrimp to the fish, especially to young specimens.

Fish Transfer

The following equipment should be prepared when transferring a Dragon Fish to a new aquarium.

- Styrofoam box with lid in which to place the bagged fish.
- Plastic bags for bagging the fish.
- Oxygen cylinder or battery-operated aerators (air pumps).
- Newspaper, rubber-bands, adhesive tape, medication and scoop nets.

Prior to transfer

- Starve the fish for two days before the transfer.
- Check to see that the plastic bags are not leaking.
- Clean and fill the new aquarium, ensuring that aged water is used and that the water pH and hardness are adjusted as closely as possible to what the fish is currently held in.

Procedure for transfer

1. Use a hand scoop net to net fish which are below 15cm (6in) TL, but use plastic bags to transfer fish exceeding 15cm. Use two bags together, with one bag placed inside the other.
2. In the water, face the mouth of the bag towards the fish's head, and gently nudge the fish into the bag.
3. Once the fish is in the bag, adjust the water level in the bag to a depth that is about 1.5 times the depth of the fish and twist the mouth of the bag.
4. If the fish can be transferred within 10–20 minutes into a new aquarium, there is no need to inject oxygen into the bag. For longer periods, it is necessary to inject the bag with oxygen and tie it securely. In this case, insert a piece of newspaper as a lining between the two plastic bags, (a) to make the fish less excitable, as the paper keeps the inside bag dark and (b) to minimise water leakage if the inner bag is punctured.
5. At the new aquarium, float the entire bag (fish and all) in the water for 5–10 minutes to equalise the temperature of the bag water with that of the tank water.

6. Open the mouth of the bag and gently allow the fish to swim out. Observe the fish in its new environment for 30 minutes.
7. Leave the fish alone in the aquarium for a whole day. Do not switch on the lights during the day so that the fish is kept in the dark. However, in the evening it is best to leave on a dim light to minimise the risk of the fish leaping out of its new environment.
8. It is not necessary to feed the fish until it is relatively more stable and acclimatised.

Diseases and their Treatment

Generally, the Dragon Fish is a very hardy animal, having good resistance against most diseases as long as it is well maintained, given wholesome food, kept in water which is well aerated and clean, and not subjected to stress due to mismanagement arising from human negligence and ignorance of handling procedures.

The causes and symptoms of some of the more common diseases which may afflict the Dragon Fish are described below, together with their suggested treatment. Any treatments should be carried out either by a veterinary surgeon or someone with a great deal of experience with fish.

Tilted (Overturned) Gill Covers

Causes

1. Fouled water: this could develop as a result of rotting food particles and accumulated wastes in the aquarium. The strong presence of organic matter in the water can reduce the level of dissolved oxygen (0_2) in the water, while free ammonia (NH_3) and nitrite (NO_2) can be toxic to the fish.
2. Space constraint: the Dragon Fish needs sufficient space to swim around and, if this is lacking, can develop overturned gill covers.
3. Water temperature change: as the gills of the fish are sensitive to sudden water temperature change, any such sudden change, either becoming too hot or too cold, would cause the gill covers to become overturned.

Symptoms

At the onset of the disease, the fish shows irregular movement of the gill covers, and also breathes faster than normal. Later, the gill covers become concave, and the edges may curl outwards, causing the gills behind to be exposed.

As the disease becomes more serious and towards the final stage, the fish pushes its head constantly to the surface for air, and at the same time loses its appetite. By then, the gills within have become infected by bacteria, impairing breathing and leading to eventual death.

Treatment

As soon as you notice that a Dragon Fish is not breathing properly, change the aquarium water immediately. Then every 2–3 days thereafter, change 20% of the water. Provide more aeration by installing another aerator and

Fish with gill-cover deformity at an advanced stage.

put in more air stones to increase the level of dissolved oxygen in the water. Also, the filter medium or media should be replaced with coral sand.

When the gill cover is slightly curled but not yet hardened, besides taking the above-mentioned measures, you should create a strong current in the water. This measure gives the fish a 50% chance of recovering without the need to subject it to an operation.

However, when the gill cover is tilted and hardened, and gills are already exposed, the fish needs to have the hardened tissues of the tilted region trimmed off. For this, you need to have a pair of scissors, surgical spirit, gloves, plastic bag, rubber sheet and a sheet of waterproof fine sandpaper. The scissors must be sterilised by flaming the cutting tips over the spirit, while the other items must be new.

The gill cover deformity has been trimmed with surgical scissors.

Operation procedure

1. Transfer the Dragon Fish to a smaller tank that has been filled with water to a level about twice the depth of the fish.
2. Replace the water in the original tank and make sure it is filtered and well aerated.

3. Administer anaesthesia into the small tank (see page 45).
4. Once the fish has lost consciousness, promptly place it on a rubber sheet laid on a table.
5. Using the sterilised scissors, carefully trim the curled edges of the gill cover. It may be necessary to use fine sandpaper to scrape off any jagged edges.
6. After the operation, apply antiseptic lotion/cream to the trimmed edges.
7. The fish should be returned to the original tank to regain consciousness. Instead of letting the fish float in its unconscious state, hold it upright and direct an air stream from the aeration tube towards its gills to facilitate its recovery.
8. When it regains consciousness, switch off all the lights so that it can recuperate under dim conditions. There is no need to feed if the fish shows no interest in food.
9. Add 4 ppm (mg/l) of Acriflavine and 0.5% coarse salt to the water to minimise the risks of bacterial infection. Change 30% water daily for 3–5 days.

The trimmed portion of the gill cover must grow again fully before the operation can be considered successful.

Cloudy Eyes

Causes

- Eye injury as a result of poor handling.
- Contaminated water.

Specimen with drooping eyes and sunken cheeks.

Symptoms

Initially, one eye may appear cloudy, then become mouldy, as though a membrane is hanging over it. Eventually, both eyes may swell and become covered with a bluish foreign matter. If not treated at this stage, the fish may become blind or even die.

Treatment

At the initial stage, change one-third of the aquarium water and add 0.5% coarse salt to the tank. Increase the water temperature to 30°C (86°F) or up to 33°C (91.4°F).

Observe for two days. If the fish's condition improves, change one-quarter of the water every third day and add more salt to maintain 0.5% salt content in the water until the fish has recovered completely. At the intermediate stage, use medication such as Acriflavine as a bath treatment to minimise bacterial infection and help recovery. Follow the instructions given for such medication. Acriflavine can be used at 4 ppm (mg/l).

Specimen with pop-eye ailment - accumulation of fatty tissues behind the eye that cause the eye to pop-out.

At the stage where the eyes appear mouldy, the fish will take about 2–3 months to recover if treated. If swelling subsides, medication can be reduced or even terminated. After recovery, the eyes may appear smaller, but that situation is normal.

Protruding Scales Disease

This often affects young Dragon Fish. Adult fish seldom develop this problem.

Causes

- Extreme temperature changes within the aquarium.
- Contaminated water due to poor water management.

Symptoms

At the initial stage, the scales tilt at every 5th to 8th scale. Blood traces may be seen at the root of the scales. If not arrested at this stage, the scales will gradually tilt, redness may appear, and the scales will not be able to protect the body against infection. At a later stage, the scales may all drop off, causing the body to decay and the fish to die.

Treatment

Add 0.5% coarse salt to the water. Also increase the water temperature to

around 30–34°C (86–93°F). Increase aeration to increase dissolved oxygen level in the water and change water by one-quarter every 3–4 days. Copper sulphate could also be added at 1–1.5 ppm (mg/l) to the water as a bath.

Rotting Gills Disease

This disease is highly contagious to other fish and you should take precautions by thoroughly cleaning all the utensils after use.

Causes

The primary agent is a protozoan parasite which is not visible to the naked eye. It hides in the gills and derives its food by drawing on the blood of the host. The parasite multiplies speedily in temperatures of around 25°C (77°F). Polluted water, especially that which has not been changed for some time, carries such parasites.

Young adult with a damaged swim bladder.

Symptoms

The breathing rhythm of the fish is quickened, and it acquires a dull body colour.

Treatment

Similar to that of 'White Spot' Disease (see page 63).

Stomach Ailments

These occur when the fish is very young.

Causes

- Mainly due to the fish consuming stale food.
- Inflammation of the stomach due to injuries inflicted by the sharp pincers or shells of shrimp eaten by the fish.

Symptoms

At the initial stage, the fish displays a swollen stomach and a swollen anal region. At the advanced stage, an affected fish may lose its balance, swimming with its head dipped downwards.

Treatment

At the moment, there are only limited means of treating this affliction. You could try raising the water temperature by 2–3°C.

'Red Spot' Disease

This is often regarded as a terminal disease, and mostly affects young fish.

Causes

Due to bacterial infection as a result of poor tank management, such as an accumulation of uneaten food or fish faeces in the tank leading to poor water quality.

Symptoms

Red spots appear on the lower back portion of the body. At the initial stage, patches of red spots appear and the body gradually swells, with scales becoming upturned. At the final stage, the fish may rot to death.

Treatment

Bathe the fish in an antibiotic bath, such as oxy-tetracycline at 2 ppm (mg/l), for four hours.

Red Dragon Fish (Brownish-Red).

Parasites

Live food for Dragon Fish often acts as the carrier for parasites.

Causes

The most common parasites of Dragon Fish are Fish Lice and Anchor Worm.

Fish Lice *(Argulus):* The parasite is approximately 3–5mm long (0.1–0.2in) and can be seen with the naked eye on the surface of the fish's body. It has a flattened body shell, with a needle-like structure at the mouth to suck the body fluid of its host.

Anchor Worm *(Lernaea):* This parasite is found mainly around the fins or within the body of the fish, commonly in the gut. The whole parasite can be as long as 1cm (just under 0.4in).

Symptoms
Besides finding the parasites on the fish body or within, you may notice that the afflicted fish are irritable, scraping and rubbing themselves against the aquarium sides, and losing their appetite for food.

Treatment
The most effective treatment to eradicate Anchor Worm and Fish Lice is to dip the fish in Dipterex* at **not more than 0.5 ppm (mg/l)** for a day. However, this should be done with extreme care, as an over-dose could kill the fish instantly. There should be strong aeration in the tank used for treatment. The original aquarium should be sterilised and thoroughly washed to rid it of the parasites.

Please note: In some countries Dipterex is either banned or restricted. Please check with your local authority.

'White Spot' Disease (Ich)

This disease is very common among fish and is highly contagious, hence the need to exercise caution and use individual utensils for each tank.

Causes
The parasite is the protozoan *Ichthyophthirius multifiliis* that only attacks fish which are low in resistance.

Symptoms
At the initial stage, the disease mainly affects the fins. The afflicted fish tends to rub itself against the aquarium sides and bottom to try to get rid of the itch. The affected region looks as though it is covered with white powder. The fish loses its appetite and the affected fin starts to rot. At the final stage, the parasite may attack the gills, with possibly fatal consequences to the fish.

Treatment
- 1% salt
- Commercial medication for Ich.

Increase the water temperature in the aquarium by 2–3°C. Add either of the above to a bath. Place the fish in the bath for two hours. Meanwhile, clean the original aquarium thoroughly and disinfect it before refilling it with new, clean water. Increase aeration in the original aquarium. During treatment, the fish should be given nutritious food to allow it to build up its resistance.

Chapter 7: Breeding the Dragon

Lim Lian Chuan

Introduction

In the 1970s and 1980s, the dream of many fish farmers and hobbyists was to breed Dragon Fish successfully. Due to the high price of the fish (a Red Dragon about 30cm (12in) long fetches at least £1500 or approximately US$2500 in the open market), many farmers attempted to breed the fish in captivity but with little success. However, the dream became a reality in 1981 when the then Freshwater Fisheries Laboratory (now known as Ornamental Fish Section) of the Primary Production Department (PPD) of the Ministry of National Development, Singapore, succeeded for the very first time in breeding the Green Dragon variety in captivity.

Since then, Dragon Fish of the three varieties (Red, Gold and Green) have been bred in captivity on several farms in Singapore, Malaysia and Indonesia. However, the farmers were not allowed to sell their Dragon Fish as the species is placed under Appendix I of the endangered list of species by the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) (see page 35). Any trade in the fish was restricted to captive-bred second filial generation (F_2) specimens derived from farms which had demonstrated capability in breeding the species to at least the F_2 generation and obtained approval from CITES.

This situation changed in 1994, when a commercial farm in Singapore, with the assistance of the PPD, successfully documented the production of F_2 progeny of the Dragon Fish and subsequently registered with, and obtained approval from, CITES to trade in the fish. This farm became the first in the world allowed to trade in all the three varieties of Dragon Fish. To date, a total of 11 farms in Singapore, Malaysia and Indonesia have obtained approval from CITES to trade in the Dragon Fish.

This chapter describes the technology practised by PPD and the commercial farm in breeding the Dragon Fish.

Pairing the fish

To breed Dragon Fish, it is important to understand their spawning behaviour.

Dragon Fish spawn in pairs. In their natural habitat, it is relatively easy for the fish to select their partners and form pairs. In the captive environment, however, it is critical to provide the necessary conditions for the fish so that pairing can take place easily. Keeping several fish in a large pond provides just such an opportunity for the fish to select their

Courting Red Dragons.

partners more readily. One should also choose fish that are compatible, both in size and age. The difference in age (and, hence, the size) should not be greater than three years. A sex ratio of one male to one female should be kept in the pond to enhance the chances of pairing.

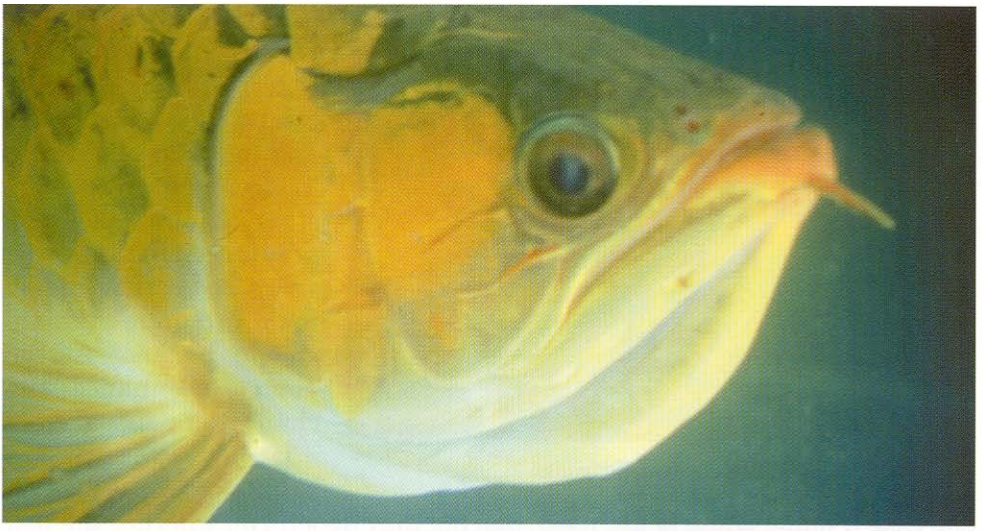
If only two fish are held together, as is often the case if home aquaria are used, pairing may depend on whether the fish have been correctly sexed (sometimes it turns out that both are of the same sex) and, if correctly sexed, on whether the individuals are sufficiently compatible with each other to pair up. It is, therefore, not uncommon to find eggs in an aquarium, but these will be unfertilised because the female has not been mated. To match a pair of Dragon Fish successfully in an aquarium is like winning a lottery! This explains why, while there have been many records of successful breeding in large ponds, there is only one published record of successful breeding in an aquarium in Japan in 1989 (see page 30 and Bibliography).

Female Malaysian Gold Dragon Fish.

Sex Differentiation

It is not easy to differentiate the sexes in Dragon Fish as they all look more or less the same externally, there being no morphological differences between the males and females. It takes a very experienced farmer to sex the fish and, even then, he may not be accurate all the time.

Generally, sex differentiation of Dragon Fish is based mainly on the body shape and the mouth (buccal cavity) size of the fish. A male fish usually has a more spindle-shaped and slimmer body, and shallower body depth than the female fish, while its mouth is deeper and wider than that of the female. A brooding male can be recognised easily by its conspicuous brood pouch, which is used for holding its eggs and, later, the writhing young.



A brooding male with a conspicuous buccal cavity.

Water Quality Management

Optimal water quality conditions should be provided for the breeding population, and good water management is a key element in any successful breeding programme. But what are the optimal conditions and what constitutes good water management?

pH An important condition is that the pH of the water is maintained within the range of 6.0 to 7.5. This corresponds to the pH of the water in the Dragon Fish's natural habitat.

Oxygen Another important condition is that dissolved oxygen is maintained at more than 5 parts per million (ppm or mg/l) at all times. Oxygen availability should not be a problem in an aquarium if proper aeration is provided and the tank is cleaned and water changed regularly.

However, in open ponds the level of dissolved oxygen in the water may fluctuate widely due to the effects of phytoplankton. If the phytoplankton blooms, as happens when there is a sudden increase in nutrients or change in temperature in the water (such as after rain on a hot day), then very high dissolved oxygen results during the day due to the production of oxygen during photosynthesis. Conversely, extremely low oxygen results just before daybreak when the oxygen required for respiration by the phytoplankton and other organisms in the water exceeds the amount of oxygen produced by photosynthesis during the day. Low dissolved oxygen in the water causes stress and affects the spawning performance of the fish.

Ammonia The ammonia content of the water is another important factor that needs special attention. There are two forms of ammonia in water:

ionised ammonia and free ammonia. Only free ammonia is toxic to fish, and levels of this compound should be kept within the tolerable level for the particular species which, in the case of spawning Dragon Fish, is 0.01 ppm (mg/l).

There are many water test kits available from aquarium and pet shops to check ammonia in water. However, these kits measure only total ammonia and not the free ammonia. To ascertain the latter, you can convert the total ammonia readings to free ammonia values if you also measure the water temperature and pH. The percentage of free ammonia within total ammonia increases with increase in water temperature and pH.

In the case of Dragon Fish that you want to breed, where water pH is maintained below 7 and ambient water temperature is below 30°C (86°F), free ammonia constitutes only 1% or less of the total ammonia and, under such conditions, free ammonia should be within tolerable levels of 0.01 ppm (mg/l) if the total ammonia reading is below 1 ppm (mg/l) (that is, 1% of 1 ppm = 0.01 ppm (mg/l)). On the other hand, when the pH in pond water is increased to 8.5 or more, which is quite common during a phytoplankton bloom, the percentage of free ammonia increases to about 20%. At the same total ammonia of 1 ppm, the free ammonia content becomes 20 times the critical level of 0.01 ppm (mg/l) (that is, 20% of 1 ppm (mg/l) = 0.20 ppm (mg/l)). Hence, it is critical to prevent the occurrence of phytoplankton blooms in the spawning ponds, otherwise the high pH may cause ammonia toxicity and, subsequently, affect the spawning performance of the fish.

Water change In the event of any of the above parameters not being met, it is always advisable to change the culture water and replace it with new clean water. However, it is not necessarily true that large water replacement is better for the fish, as a water change is, in itself, a form of stress. This is because the environment is altered with a change of water, and the fish has to adapt to this sudden change in its surroundings. This is especially true when there is a temperature difference between the new water and culture water. To minimise the stress suffered by the fish, check water temperatures before effecting the change to ensure minimal or no difference in both waters at the time of adding the new water. Another way of achieving this is to change the water gradually to allow the fish time to adapt. The frequency of water change could also be reduced and be dictated by the quality of the culture water.

While water which turns turbid is a good indication that it is time for a change, this, alas, could be too late, as stress to the fish may have set in by that time, affecting spawning performance. A more reliable way is to check the various water quality parameters described, that is, pH, dissolved oxygen and ammonia. Water should be changed partially when the pH falls below 6.0 or rises to about 8.0, or when total ammonia exceeds 1 ppm (mg/l). As a general guideline, it is best to change water once every one or two weeks and change about 30–40% of the total water volume on each occasion.

Feeding

Feeding plays an important role in helping fish to spawn. Dragon Fish are hardy, and healthy adults should survive well even if they are not fed for up to six months or more. However, this would have an adverse impact on their spawning capability.

Fish used for spawning should be well fed at all times, in terms of both the quality and quantity. It is best to feed the spawners a variety rather than a single type of food. This ensures that nutritional deficiency is avoided. In general, trashfish and shrimp are considered suitable food for the spawners. You should

Monitoring water conditions in the breeding pond.

Group of Red Dragons.

avoid feeding the spawners with insects such as cockroaches and crickets and reptiles such as house lizards, as these may be contaminated with pesticides.

It is wrong to assume that the more food given to the fish, the better this is for them. The amount of food eaten by Dragon Fish affects not only their growth, but also their gonadal development, that is, development of the testes and ovaries. Dragon Fish which are overfed develop more mesenteric fat around the gonads, and this adversely affects gonadal development, especially so in the case of testicular development in male fish. In general, the feeding rate should be maintained at less than 2% of the fish body weight per day.

Stocking Dragon Fish spawners in earthen ponds.

Checking the buccal cavity for larval fish.

Spawning

Male Dragon Fish mature earlier than females. Most male fish mature at 3–4 years and female fish at 4–5 years. Our experience in spawning the fish in earthen ponds shows that spawning in the population takes place throughout the year. About two to three months before spawning, the fish select their partners and form pairs, whereupon the pair starts to display the unique courtship behaviour of Dragon Fish. Initially, the couple swim in circles, with the male trailing the female. This behaviour is easily visible in ponds at night with the assistance of a strong spotlight. About one or two weeks before spawning, the two fish swim side by side, and there is a lot of body contact between the pair. Feeding drops drastically towards the time of spawning.

Immediately after spawning, the male picks up the fertilised eggs in his mouth and broods them until the eggs hatch and the larvae develop into free-swimming fry. In farming practice, the larvae, still with their yolk sacs, are removed from the father's mouth approximately two weeks after

spawning. Removal of the eggs is carried out during a physical check for brooding males.

To release the eggs or larvae, the mouth of the brooding male is gently prised open. An average of 30–35 larvae can be found in a single brood, with the maximum recorded for Red Dragons being 62 and for Gold and Green Dragons 93 each. Research by the PPD with a commercial farm showed that about 5–17% of the male spawners in a pond can be found brooding at a single checking operation, the average brooding rate being 12.4%.

By implanting an electronic microtag into selected males (see page 75), PPD researchers could follow the spawning performance of individual

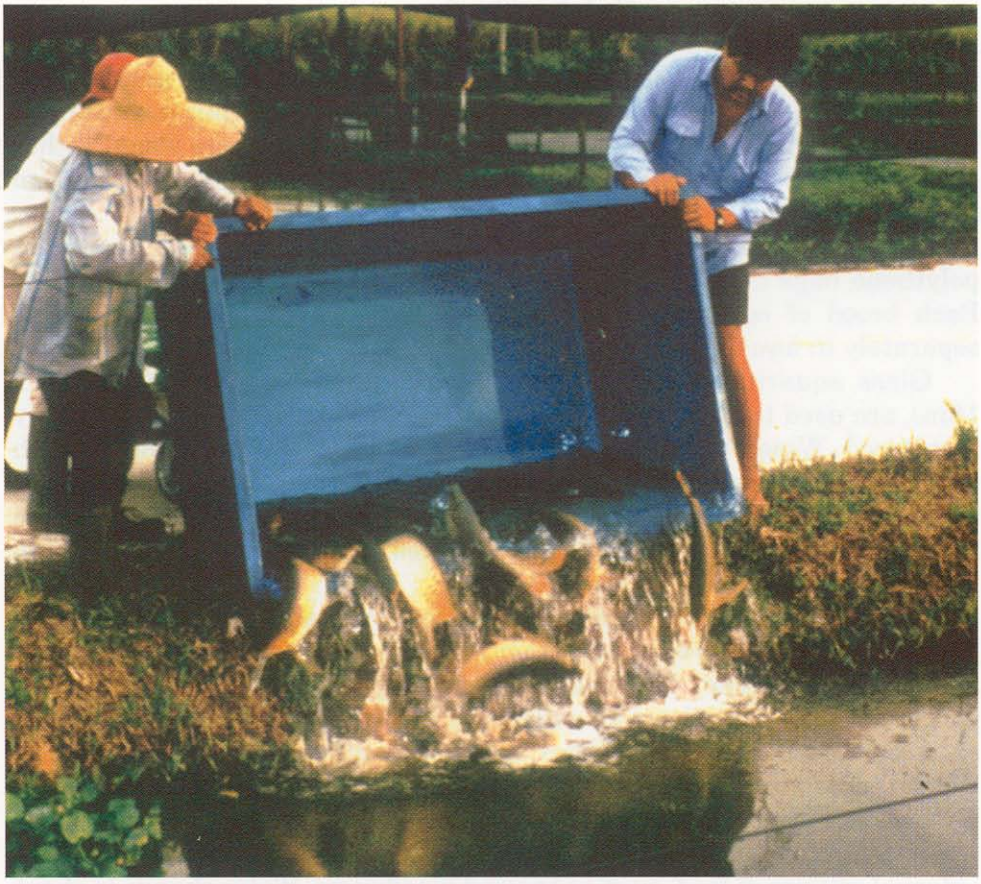
Brooding male with buccal cavity filled with larval fish.

Release of larval fish from a brooding male.

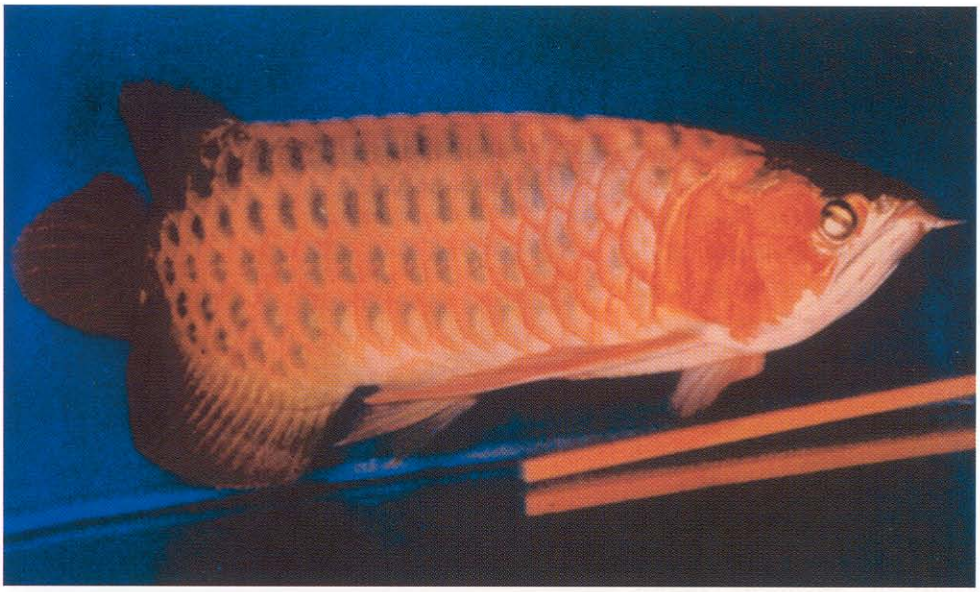
The very first batch of larval fish collected from a male spawner under the joint project.

fish. In a two-year period, it was found that about 30% of the male spawners incubated eggs or larvae in their mouth at least once, with the maximum being five times. The male fish which brooded five times produced a total of 188 larvae in that period. This is also the same fish found incubating 62 larvae in a single brood! The average interval between consecutive broods ranges from four to eight months, with the shortest interval being only 80 days.

Freshly-harvested Red Dragon larvae.



A tank of Red Dragon spawners being released into the pond.



One of the new colour varieties: Red Dragon Fish (Blue-based Blood Red).

Raising the Larvae

Dragon Fish eggs are orange-red, non-adhesive and denser than water, that is, they sink. They are relatively large, with diameters ranging from 16–18mm (0.6–0.7in). The eggs can be incubated in well (but not strongly) aerated aquarium tanks. However, more commonly, farmers would rather allow a male parent to incubate its own eggs, and collect the larvae from its mouth later.

Once removed from the parent, the eggs or larvae are packed in polythene bags in water and rushed to the hatchery for further rearing. Each brood of eggs or larvae from one male parent should be raised separately in aquarium tanks.

Glass aquarium tanks, each measuring 90 x 45 x 45cm (36 x 18 x 18in), are used to rear the larvae so that their development can be easily monitored. Water temperature is kept around 28–30°C (82–86°F) with the use of heater-thermostats, while dissolved oxygen is maintained at about 5 ppm (mg/l) through continuous aeration of the water. Acriflavine is added to the water to heal any injuries the fish may suffer during handling.

During the first few weeks, when the larvae are still carrying large yolk sacs, they tend to crowd together at the tank bottom and remain there most of the time. They only start swimming upward periodically when the yolk sac becomes smaller, with swimming becoming more active as the yolk sac gets absorbed. Water changes are kept to the minimum at this stage. When the larvae reach a size of 7cm (c. 3in) TL, the yolk sac is significantly reduced and they can swim quite freely, remaining in the upper part of the water column most of the time. At this stage, the larvae start feeding on external sources of food, such as thawed bloodworm. Water change is about 10% every two to three days.

At 8–9cm (c. 3.5 in) TL, the larvae have fully absorbed their yolk sac and changed into fry. At this time they are more active during feeding and, in addition to bloodworm, also feed on small live shrimp or fish that are added into the tank. About 20% of the tank water can be changed once every two or three days during this stage. Two weeks later, the fish can be weaned over to fish or shrimp meat.

Packing F_2 Dragon Fish for export.

When the fry reach 15cm (6in) TL, which is the market size, they are more hardy and can be transferred to outdoor tanks or ponds for raising to adults, or packed for airfreighting overseas. If held in ponds, about 20–30% of the water should be changed every day.

Chapter 8: PPD/Rainbow Joint Project

The Road to International Trading of Dragon Fish

Leslie Cheong, Lim Lian Chuan and Ho Kian Huat

Encouraged by the first spawning success of a Green Dragon Fish by the then Freshwater Fisheries Laboratory (now known as Ornamental Fish Section) of the Primary Production Department (PPD) in Singapore as early as 1981, several ornamental fish farms in Singapore, Malaysia and Indonesia attempted to spawn the species using a similar technique in the years that followed. They stocked the brooders in earthen ponds and allowed them to spawn naturally. By the mid-1980s, a number of breeders had succeeded in breeding the three varieties of Dragon Fish, the Red, Gold and Green, in captivity.

Despite this success in the early years, none of these breeders were able to sell their fish in the open market because, since 1980, the Dragon Fish has been classified by CITES as one of the most highly endangered species (see page 35) and listed under CITES Appendix I. Such animals are considered threatened with extinction and are, or may be, affected by trade. Their commercial import, export and sale are normally prohibited in all member countries (about 130, known as signatories of the CITES agreement) unless the specimens concerned are bred in captivity or can be artificially propagated, or used for non-commercial purposes such as research, teaching, breeding or propagation.

The basis for CITES to consider lifting the ban on the trading of Dragon Fish appears to be whether the fish has been bred in captivity or, more precisely according to the CITES regulations, whether it has been bred through the second generation. The issue, however, is not as simple as whether the Dragon Fish has actually been bred repeatedly in captivity, as this has already been witnessed and confirmed many times over the last ten years or more, and there is no doubt about the ability of some breeders to achieve this. It is more of a problem for the breeders to be able to verify their claims of captive breeding success for two consecutive generations. This means that the breeders have to produce verifiable and certifiable evidence to convince CITES that their fish have been bred through to the second generation.

This is not an easy task, considering the complicated nature of the work involved. First, the breeders are required to have the proper documentation of the breeding cycle of the fish. Secondly, they must have a reliable and appropriate tagging system for individual identification of the fish brooders of different generations and to differentiate captive-bred fish from wild ones at the point of sale. Furthermore, although there was a small number of breeders who had bred the fish through the second

generation, it was hard for them to meet the CITES requirements as they had not been keeping accurate spawning records. The situation was even worse for those who mixed fish of different generations in the same ponds. Hence, unless a systematic study was implemented to improve this situation, the pioneer breeders of Dragon Fish, despite their early headstart, were nowhere nearer to being able to register with CITES for trading their fish.

The PPD/Rainbow Aquarium Connection

In recognising the need to solve the problem of documenting the breeding process commercially, PPD decided that it was best to work with a commercial Dragon Fish breeder who had sufficient numbers of brooders and who was prepared to place a substantial number of the fish in the Department's ponds and have them tagged to allow for proper monitoring and documentation.

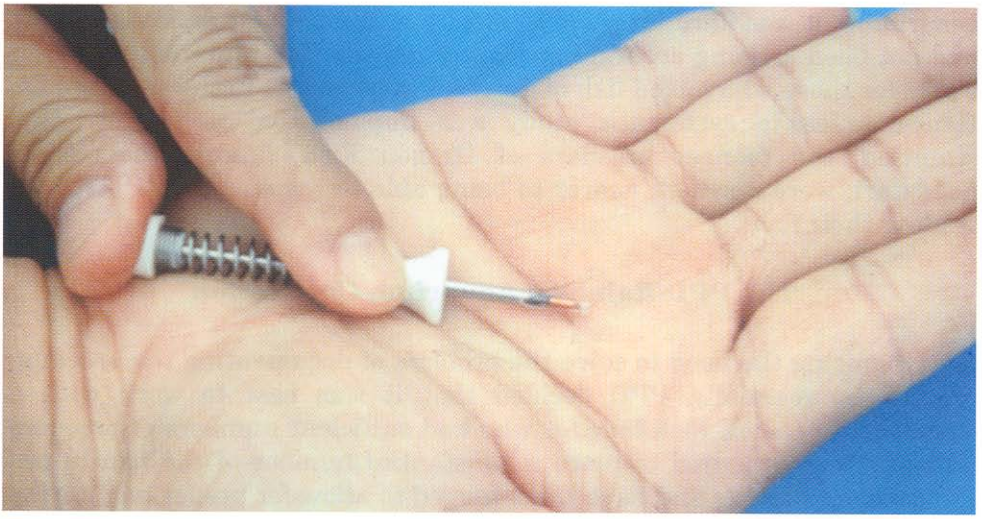
In early 1992, PPD found such a company, Rainbow Aquarium. This company, which started breeding Dragon Fish in the early 1980s, had succeeded in breeding all three varieties and had a substantial number of brooders: more than 1000 of all three varieties. Most importantly, the company had been keeping the brooders of the different varieties and parent and F_1 cohorts in separate ponds. It was therefore possible to start the project using known F_1 stocks.

A three-year project was drawn up with the objective of documenting the production of F_2 progeny from the F_1 stocks using the Red variety, which is the most expensive, as the test fish. The project was carried out at the PPD's Sembawang Field Experimental Station, and some 400 parent fish and F_1 brooder stocks were used in the study.

Tagging the Dragon Fish

To find a suitable tagging system for the fish was the first and most important challenge for the Project Team. In order to trace the parentage of offspring and monitor the spawning performance of the brooders, it was critical to be able to identify each brooder and every offspring. However, the tags available at the time were all external tags and using these would deface the Dragon Fish and lower their ornamental value. Internal tags would be more suitable in this case.

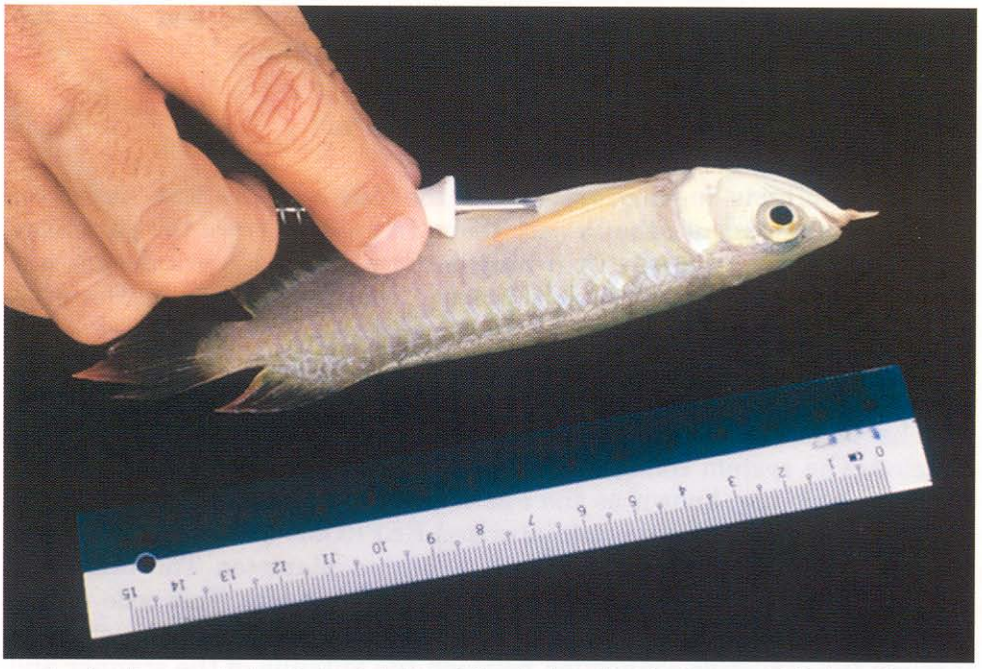
The electronic tagging system used for pet animals was therefore selected. The system consists of electronic tags, implanters and scanner. The electronic tag, known as the Passive Implantable Transponder (PIT) tag, has a coded microchip (miniaturised EEPROM) embedded in a glass casing, which measures 10mm long x 2.1mm diameter. The microchip carries a unique 12-digit, alpha-numeric code of 54 bits. This code is pre-programmed and cannot be deleted or tampered with. The tag is activated through the inductive connection between the antenna of the scanner and



Electronic tag in a tag implanter.

the coil integrated in the tag. The frequency is 125 KHz and the tag code can only be read by using a tag scanner of the same frequency. The implanter is a disposable short plastic plunger with a 12-gauge needle.

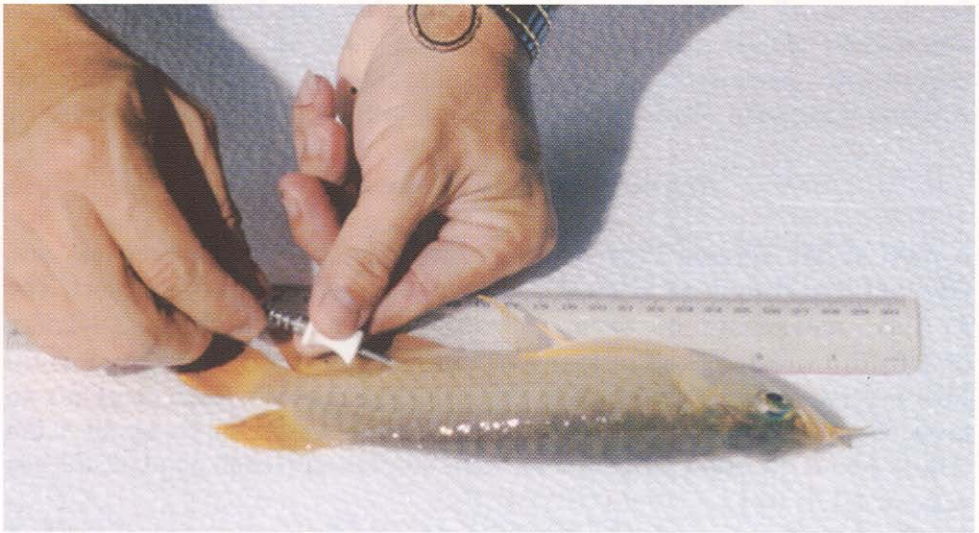
All the brooders used and the offspring produced by the project were tagged with a PIT tag. Tagging of the brooders was carried out just before the fish were stocked into the spawning ponds, while the offspring were tagged when each fish reached a length of 15cm (6in), usually 2–3 months after the young fish is taken from its parent. In both cases, the fish were first anaesthetised with 0.01% quinaldine sulphate. Then they had a tag



Implanting an electronic tag into the abdominal cavity of a Dragon Fish fingerling.

Note the scar on the dorsal muscle near the tail fin on the newly tagged fish.

implanted into their left dorsal muscle. After tagging, the tag number of the individual fish was read with a scanner to ensure that the implanted tag was functioning properly and that the tag number corresponded with that given on the tag label. Once the fish recovered from the anaesthesia, they were returned to the spawning pond or nursery tank respectively. The insertion mark disappeared after 2–3 weeks and the fish appeared without blemish externally and were none the worse from the tagging process in terms of beauty and behaviour, or breeding and brooding capability.



Implanting an electronic tag into the dorsal muscle is more effective than into the abdominal cavity for the Dragon fish.

Scanning a newly-tagged juvenile.

A one-year monitoring of 89 fish, body weights 0.02kg–2.90kg (0.04–6.4lb) and TL 15–60cm (6–24in) showed that 100% of tags were retained when tagged in the dorsal muscle, whereas only 60% retention was encountered in another group of fish for tags implanted in the abdominal cavity. Implantation in the dorsal muscle is therefore recommended. The PIT tag is ideal for tagging the Dragon Fish or, for that matter, any fish of high commercial value.

Electronic tagging has now become a standard requirement by CITES for tagging all captive-bred Dragon Fish that are traded. In order to distinguish traded Singapore-bred Dragon Fish, all the F_2 stocks are tagged with specially-manufactured tags each with a unique code number starting with 8888. World-wide, the code allocated to Singapore is 888.

Implementation of the Project

A total of 382 Dragon Fish brooders, including 102 parent brooders and 280 matured first generation (F_1) brooders, were used in the project. The F_1 fish, measuring 58–62cm (23–25in) TL and weighing 2.4–2.9kg (5.3–6.4lb), were stocked in four earthen ponds at the PPD's Ornamental Fish Section at Sembawang Field Experimental Station. Each pond has an area of 500–600m^2 (c. 5380–6460 sq ft), with water depth about 0.9m (36in). About 60–80 F_1 Dragon Fish were stocked into each pond, at the sex ratio of 1:1.

The brooders were fed on trashfish at a feeding rate 1–2% of the fish body weight a day. Live ornamental fish such as Mollies were occasionally

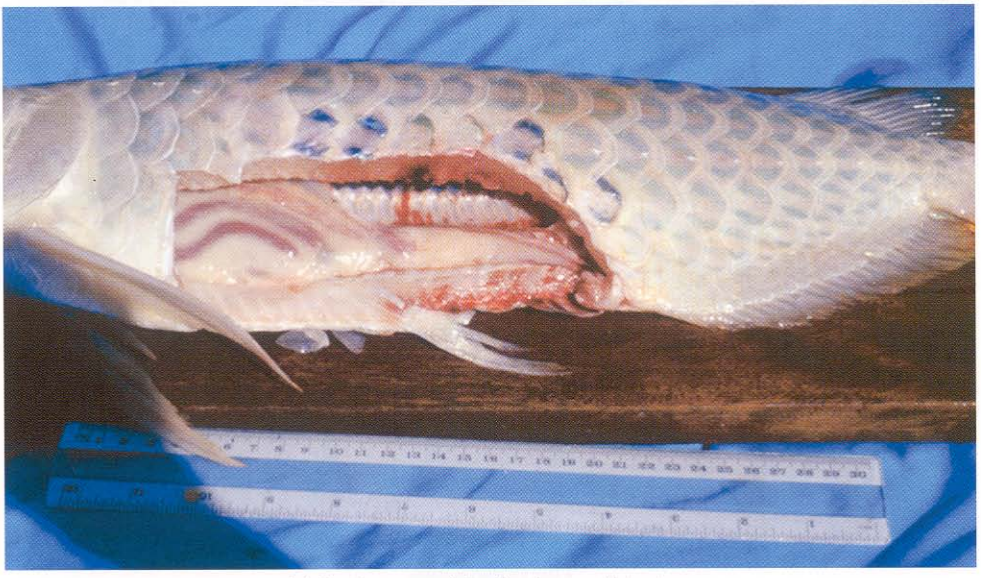
Transferring Dragon Fish spawners to the project site.

given to the fish. It is critical to control the amount of food given to Dragon Fish, as over-feeding not only pollutes the pond water, but also causes mesenteric fat to grow around the gonads of the breeders, especially the males, which inhibits the development of the ovary or testes, thereby affecting the reproductive performance of the fish.

The project site.

Feeding Dragon Fish spawners.

A water quality monitoring programme was implemented to ensure that conditions in the spawning ponds were at optimal levels at all times. For example, the pH was maintained at 6.0–7.5, dissolved oxygen above 5 ppm (mg/l) and free ammonia below 0.01 ppm (mg/l). Special attention was paid to the occurrence of phytoplankton blooms in the pond water, as blooms raise the pH and therefore the ammonia toxicity during the day while causing oxygen depletion at night. To maintain the water quality at optimal levels and to prevent the occurrence of phytoplankton bloom, water in the ponds was changed once every two weeks at about 30% of the total volume on each occasion.



Male Dragon with single small testes.

Red Dragon male with brood pouch.

Dragon Fish are mouthbrooders. They spawn naturally in the ponds and, after spawning, the male fish broods the fertilised eggs in its buccal cavity until the eggs develop into free-swimming fry. However, in order to prevent the fry from being eaten by other brooders in the pond, harvesting of the fish is performed well before the fry stage is reached, that is when the hatchlings are still at the larval stage. A male fish that is incubating the young can be distinguished from other non-brooding males by a conspicuous brood pouch that protrudes from the operculum. It takes a keen eye, and certainly one with lots of experience, to spot these males from a distance as they swim occasionally to the surface of the water. Once such males are spotted, the time to harvest the fry from them is at hand.

The male broods the fertilised eggs in its buccal cavity until the eggs develop into fry.

Green Dragon male showing brood pouch.

Once the male fish are netted out, they are checked for larvae. For each checking operation carried out during the project, about 5–17% of the male brooders were found brooding. Such brooding males have to be handled with great care. The mouth of the brooding male needs to be gently prised open to release the larvae. An average of 30–35 larvae can be obtained from each brooding male although, in one instance, as many as 90 larvae were obtained.

Harvesting larvae from a Red Dragon male.

With the tagging in place, it is possible to trace the spawning performance of individual male brooders. The particulars of the tagged fish, such as its tag number, length, weight, variety, origin, generation status and the number of larvae obtained from each brood, were recorded and keyed into a database. In this way, the growth and breeding performance of each fish could be followed and analysed while, at the same time, the production of the F_2 progeny was documented.

At the time when a spawning check is carried out most of the larvae are still carrying a large yolk sac, which serves as the major nutrient source for the next 2–4 weeks. The larvae are scooped out by hand with great care to avoid injury, and transferred to the hatchery where they are raised in aquarium tanks. During the first few weeks when the larvae are yolk-laden, no feeding is required. The first feeding consists of bloodworm. By then, the yolk sac for each larva is greatly reduced and the larva is capable of swimming quite freely. By the time the yolk sac is fully absorbed, the hatchling is about 8–9cm (3.2–3.5in) TL and can be said to have attained the fry stage. Fry are then fed on live shrimp or fish for about two weeks before they are completely weaned over to fish or shrimp meat. They are ready for sale when they attain 15cm (6in). This is also the stage when they are implanted with the PIT tag.

Success in CITES Registration

Seining pond to harvest spawners for spawning check.

By the end of the project in July 1995, some 3500 F_2 progeny had been raised. The first batch of F_2 was produced in January 1993 and, by April 1994, a total of 1200 F_2 offspring were obtained. Rainbow Aquarium applied for CITES registration in April 1994 and, for the application, the company also produced a video tape recording of the work done under the project, especially dealing with the technology used in the breeding of the Dragon Fish and the tagging system employed.

Approval by CITES for the company to trade in captive-bred Dragon Fish was given on 17 July 1994, three months after the submission of the application. The farm became the first Dragon Fish farm in the world to be allowed to produce and export all three varieties of Dragon Fish without restriction. The project was a complete success, having achieved its

Entering details into the project database.

objective of documenting the production of F_2 Dragon Fish and getting CITES approval a year ahead of its schedule.

Membership Scheme of Tagging and Certification

Following the successful registration of Rainbow Aquarium with CITES for the captive breeding of Dragon Fish, PPD, the Singapore CITES authority, was entrusted with the responsibility to ensure that all the Dragon Fish exported from Singapore were farm-bred fish. To ensure good management of Dragon Fish stocks for sustained production and to regulate recruitment of new stock, in August 1994 the Department implemented a scheme, known as *Membership Scheme on the Tagging and Certification of Identity of F_2 and Beyond Dragon Fish Produced by Farms in Singapore Through Captive Breeding.* Under the scheme, all farms that wish to be considered for Dragon Fish breeding and subsequent trading must register with the Department as a Dragon Fish farm and have its Dragon Fish stocks, both parents and progeny, electronically tagged by PPD officers. For export purposes, these farms must have CITES approval, and the F_2 progeny produced will be tagged and each issued with a Certificate of Identify by PPD to authenticate that they are captive-bred in Singapore.

In addition, the registered farms are required to submit a breeding programme and declare to PPD all the breeding specimens, including the

offspring obtained and those retained for development into brooders. Through the tagging system, PPD is able to trace the breeding stock, as well as those that are traded. At the end of each year, the farms have to submit an annual report to PPD, stating the balance of the fish stock in the farm, and this report, in turn, is sent to CITES.

A Certificate of Identity issued by the PPD.

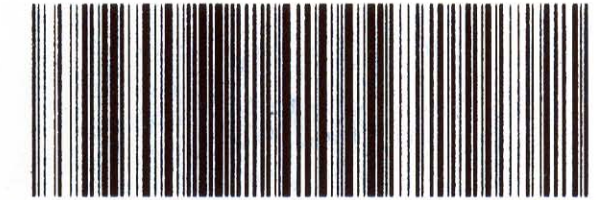
Market-size Dragon Fish juvenile about 15cm (6in) total length.

The registered farms are allowed to sell or export only F_2 Dragon Fish. PPD officers carry out regular inspections of the registered farms to confirm the identify of brooders and offspring. The farms are also required to report and register with PPD whenever they produce a new brood of fry from their captive breeding operation. The procedures include the following:

1. Before each spawning check operation, the owner has to submit an application to PPD to request an on-site inspection of the harvest of Dragon Fish.
2. During the spawning check operation, the farmers are required to record the number of larvae obtained from each brood and the tag number of the male parent from which the fry are obtained.
3. Within one week of the harvest, farmers are required to submit a return declaring the number of Dragon Fish larvae harvested.
4. When the offspring reach the size of 12–15cm (4.7–6in) TL, and before they are sold, the fish have to be tagged with PIT tags by PPD officers.

The Certificates of Identity are specially designed with each bearing a unique barcode. To confirm the authenticity of the Certificate, a barcode scanner can be used to read the 27-digit barcode at the bottom of the left-hand corner of the Certificate. This barcode is the sole reference for the particular fish described on the Certificate of Identity. The structure of barcode is shown in Fig 8.1. The barcode is in the format of a supplementary EAN-128 barcode. By scanning this barcode, the figure '010' (position #1–3) always precedes the EAN-13-digit code. The standard 13-digit code has the prefix number 888 exclusive to Singapore (position #4–6), followed by a 4-digit company code (#7–10), a 5-digit product code (#11–15) and a check digit (#16). The last 12 digits are the code of the tag

Explanation of Structure of 30-Digit Bar-Code on Certificate of Identity for Dragon Fish



Structure of Bar-code

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
0	1	0	8	8	8	8	8	9	9	0	0	0	0	1	9	2	1	8	8	8	8	3	D	E	2	4	3	D	E

(1) – (3) "010" to indicate bar-code is a sup-plementary EAN-128

(4) – (6) "888" prefix exclusive to Singapore

(7) – (10) Code for Company

(11) – (15) Code for Product (00001 : red 00002 : gold 00003 : green)

(16) Check Digit

(17) – (18) Application Identifier

(19) – (30) Serial number unique for each fish, begins with prefix "8888" exclusive to PPD

Figure 8.1: The structure of the barcode on the Certificate of Authenticity.

Red Dragon.

(#19–30). Between the 13-digit code and the 12-digit code there is the Application Identifier '21' (#17-18) to denote that the 12-digit code is the serial number for the fish in question. Hence the barcode provides the following important information to the buyer of a fish.

1. Country of production: for fish produced from Singapore, this is represented by the 3-digit '888' at position #4–6.
2. Farm from which the fish was produced: denoted by the four digits at #7-10.
3. Variety of the fish: represented by the 5-digit product code at #11-15, with 00001 for Red Dragon, 00002 for Gold Dragon and 00003 for Green Dragon.

Red Dragon.

With the electronic tagging system, it is possible for PPD to ensure that all the Dragon Fish produced in Singapore farms are obtained from captive breeding. With the Certificate of Identity, buyers of Singapore Dragon Fish are assured of the country of origin and the fish's variety. They may also trace the farm from which the fish came, in case there is any problem with the fish. If, by any chance, the tag is lost from the fish, that fish can be re-tagged by PPD and the tag code could be written on to the Certificate to allow the owner to maintain the trace-back system.

A young adult F_2 Dragon.

The First Export of Singapore Dragon Fish

The date of 4 December 1994 marked a milestone in the development of Singapore's ornamental fish industry. On this day, the first batch of Dragon Fish obtained from the Dragon Fish Project was exported to Japan, just four months after Rainbow Aquarium obtained approval from CITES for sale and export of the fish. The consignment consisted of 300 pieces of Red Dragon, each measuring around 15cm (6in) TL. With a retail value of about US$1 million, this represented a new sector within the ornamental fish industry. Even overseas retailers were happy with the security provided by the dual tagging and certificate system.

The Dragon Fish has once been threatened with extinction through human over-exploitation. Commercial breeding should ensure that wild stocks will thrive again and that we can continue to enjoy the beauty of this magnificant fish through proper management of captive breeding stocks.

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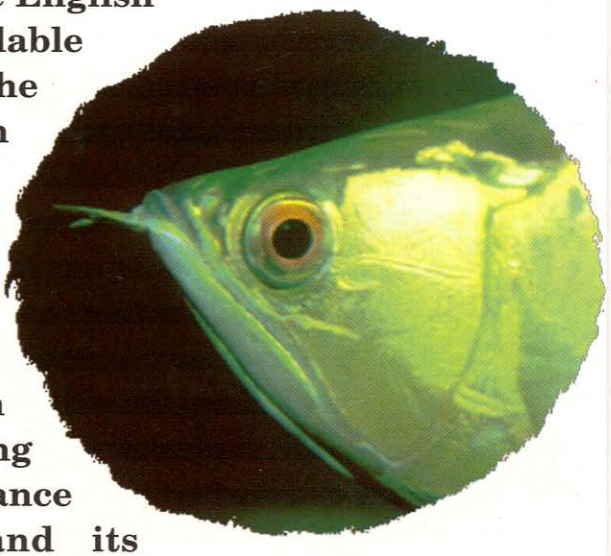
The Dragon Fish

The Dragon Fish is an animal steeped in mystery and legend. A symbol of good luck and health for a thousand years and still a symbol of wealth and prosperity, it is now on the endangered species list and may be under the threat of extinction in the wild.



For the first time in the English language, a book is available that gives the history of the Dragon Fish, putting it in its place in the fish hierarchy and comparing it with its closest relations. An important section explains the CITES agreement which protects the world's living heritage, and its significance to the Dragon Fish and its commercial worth. The book also gives the story behind the successful commercial breeding of the Dragon Fish, carried out under the guardianship of the Primary Production Department of the Ministry of National Development in Singapore and with the expert aid of a reputable breeder.

The editors of this remarkable book have provided the aquaculture world with an important addition to what is already known about an amazing and elusive fish. The book will be welcomed by everyone with an interest in aquaculture, both commercial and as a hobby.

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