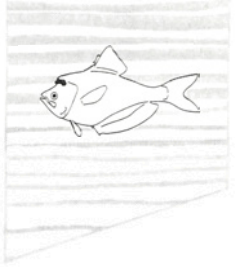

Freshwater Fishes

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INTRODUCTION

Australian freshwater fishes are not as conspicuous as some other groups of native vertebrates; in addition, local fishes are poorly known. The enormous rise in general awareness of native fauna combined with stocking and increasing aquaculture — in open ponds, farm dams and aquarium complexes — has resulted in a situation where there is a clear need for an accessible group of people able to give professional advice on husbandry and diseases.

Although fishes do not form a significant part of normal veterinary practice at present, logically it is veterinarians who are the most accessible professionals and who will increasingly be consulted; however, to date, veterinary science courses have not contained anything more than a token lecture on fishes.

In view of this lack of background knowledge, the objectives of this chapter are broad. They are: to illustrate the diversity of size and form in the Australian freshwater fish fauna; to give size, range and sexual maturity information on more common angling species used in stocking and aquaculture; to discuss general features of physiological tolerances, diet and reproduction; to provide general comments on handling and the use of anaesthetics; and to introduce the concept of water quality in relation to common disease problems.

DIVERSITY

This unique fauna comprises approximately 200 species, a low number in comparison with other regions; for example, African freshwaters contain 1900 species and the Mekong

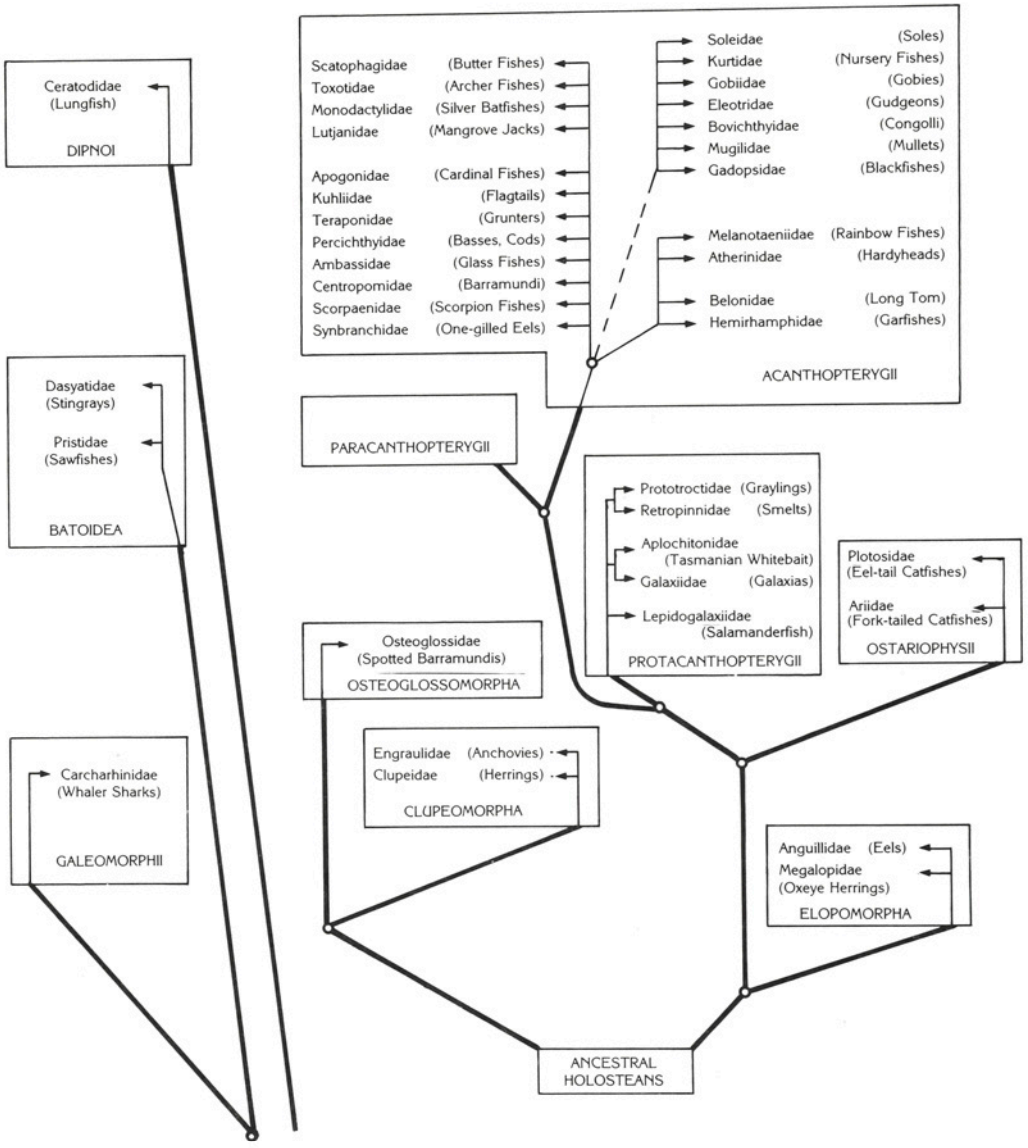

Fig. 1. This diagram summarizes the diversity and suggested evolutionary relationships of Australian freshwater fishes — adapted from Merrick and Schmida (1984). Uncertain relationships are indicated by a dotted line.

River system in South-East Asia supports about 500 species. The Australian fauna is comprised of representatives of 39 families (shown in Fig. 1), including sharks like the River Whaler *(Carcharhinus leucas)*, rays, and sawfishes.

These first three groups are all cartilaginous fishes but the bony fishes are also very diverse in form. The oldest bony resident is the Queensland Lungfish *(Neoceratodus forsteri)*; this species can grow to almost two metres in length. Another older group includes the small galaxias or native minnows; the Mountain Galaxias *(Galaxias olidus)* is one of the more

abundant and widespread species. Other colourful small species include the rainbow fishes; the example shown is *Melanotaenia splendida australis.* Rainbow fishes are very popular with aquarists.

Among the more familiar forms is the Barramundi *(Lates calcarifer)*, the species so prized by anglers, gourmets and restauranteurs. There are also less abundant and unusual forms such as the soles, of which there are several small species, and the Nursery Fish *(Kurtus gulliveri)*, which demonstrates unusual reproductive behaviour — the male carries the eggs around, like bunches of grapes, attached to a hook on his forehead (Fig. 2).

COMMERCIAL SPECIES

Including the two large freshwater eels *(Anguilla australis, A. reinhardti)* and the Barramundi, there are only about a dozen native Australian freshwater species which are harvested or cultured regularly.

The Barramundi moves downstream to estuarine or onshore areas to spawn, but of the species which complete their life cycles in freshwaters perhaps the best known is the Murray Cod *(Maccullochella peeli).* This cod (family Percichthyidae) is the largest of our freshwater species, growing to 1.8 m and 113.5 kg. It is widespread in the Murray-Darling drainage division (Fig. 3). It is territorial and can only be stocked in small numbers. Both sexes mature at about 550 mm when 4 or 5 years of age.

The Yellowbelly or Golden Perch *(Macquaria ambigua)* and Macquarie Perch *(M. australasica)* are in the same family as the Murray Cod. The Golden Perch has a wide natural range in the Murray-Darling, Lake Eyre, Bulloo-Bancannia and North-east Coast divisions (Fig. 3). It has also been introduced to other areas, this species having been cultured and stocked more extensively than any other. Females mature at about 400 mm and 4 years of age; males may breed earlier at a smaller size (200 mm at 2-3 years old).

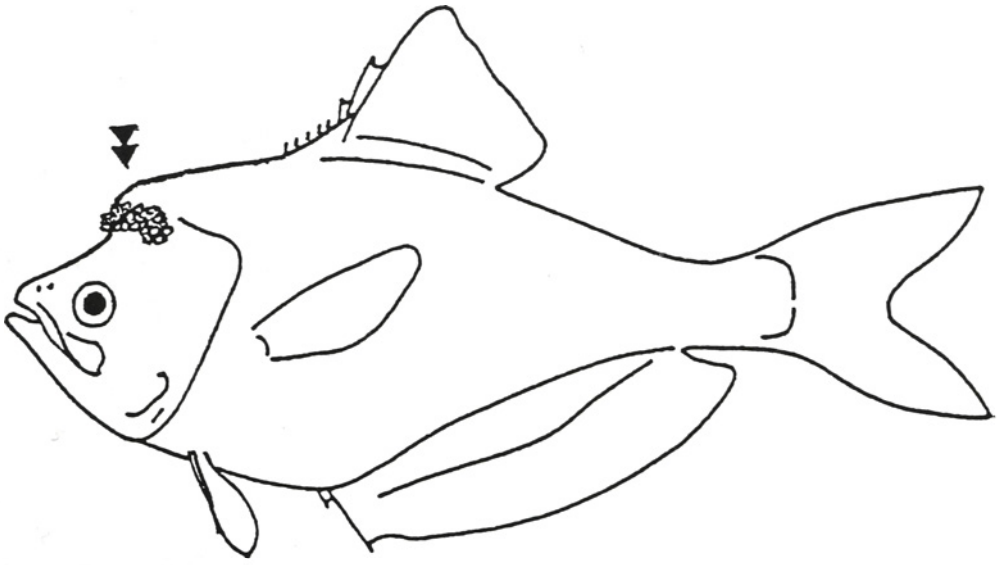

Fig. 2. The Nursery Fish *(Kurtus gulliveri)* with eggs on either side of head (adapted from Merrick and Schmida 1984).

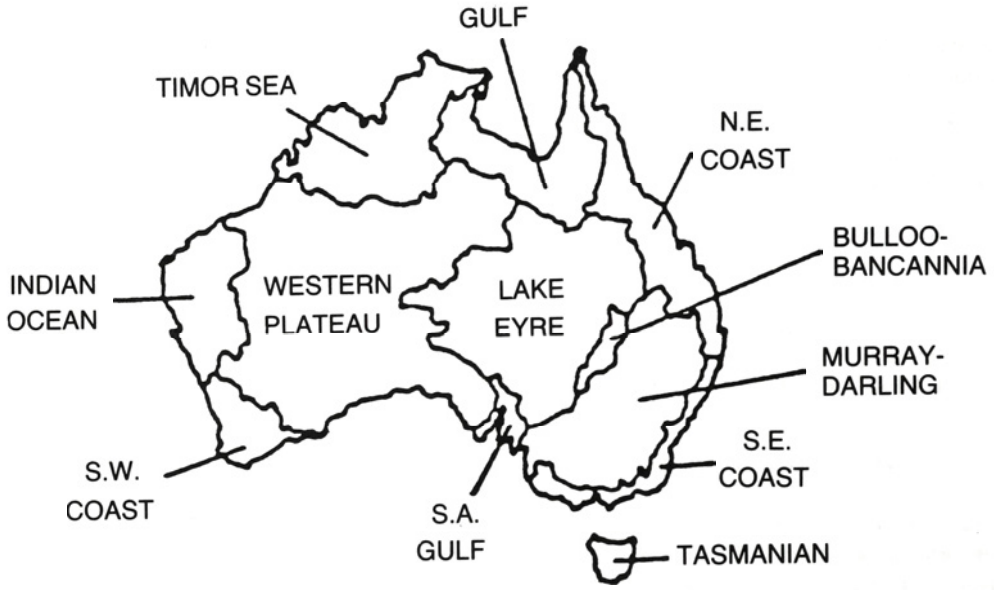

Fig. 3. Drainage divisions (from Merrick and Schmida 1984).

The Macquarie Perch has been the focus of considerable attention in recent years as its range and abundance in the Murray-Darling division have been greatly reduced. Among factors contributing to this decline are stream modifications and introductions. For example, it has been suggested that increased silting destroys spawning sites; and the Macquarie Perch does not appear to be able to compete very well with introduced trouts. Females mature at about 300 mm and 3 years of age; males appear to mature when younger (2 years) and smaller (200 mm).

There are two important grunters (members of the family Teraponidae); these are the Silver Perch *(Bidyanus bidyanus)* and the Sooty Grunter *(Hephaestus fuliginosus)*.

The Silver Perch or Bidyan is an active schooling species with an extensive range in the Murray-Darling division. Females will breed at 350 mm when three years old; males mature from 250 mm in length.

The Sooty Grunter is abundant in the coastal drainages of northern Australia. After the Barramundi, the Sooty Grunter is the most popular fish in northern recreational fisheries. Females mature at about 275 mm, males when about 200 mm long.

Another important species in south-eastern Australia is the Freshwater Catfish or Dewfish *(Tandanus tandanus)*. The natural range of the Catfish includes the Murray-Darling and South-east Coast divisions (Fig. 3). This species will breed regularly in farm dams and although less popular than the Murray Cod, Yellowbelly or Bidyan, it has considerable potential for aqua-culture. The Catfish matures at 400-500 mm when five years old; it is the only nest-builder in the fauna.

One gudgeon is utilized in northern fisheries; this is the Sleepy Cod *(Oxyeleotris lineolatus)*. The Sleepy Cod is legendary for its lack of fighting abilities, but it is easy to catch and is excellent for eating. Both sexes mature at about 250 mm in length.

PLATE I

1A (above) — The River or Freshwater Whaler *(Carcharhinus leucas)* is one of nearly 200 native Australian freshwater fish. *Photo: J. Merrick.*

1B (left) — Leichhardt's Sawfish *(Pristis microdon)* from a northern Queensland stream. Note the saw with rows of teeth, after which the group is named. *Photo: J. Merrick.*

1C (below) — A mountain galaxias *(Galaxias olidus)* from the Sydney area is one of the most abundant and widespread of small galaxias or native minnows, a very old Australian group of freshwater fishes. *Photo: J. Merrick.*

1D (below) — Other colourful, small native freshwater fishes include the rainbow fishes such as *Melanotaenia splendida australis. Photo: J. Merrick.*

1E (above) — Some of the less abundant and unusual freshwater fish, Saltpan Soles *(Brachirus salinarum),* from northern Queensland. *Photo: J. Merrick.*

1F (above) — The Nursery Fish *(Kurtus gulliveri)* displays very unusual reproductive behaviour: the male carries the eggs around, like a bunch of grapes, attached to a hook on his forehead. *Photo: J. Merrick.*

1G (below) — The Murray Cod *(Maccullochella peeli),* widespread in the Murray-Darling River system, is the largest of Australia's freshwater species, growing to 1.8 m and 113.5 kg. *Photo: J. Merrick.*

1H (below) — The Yellowbelly or Golden Perch *(Macquaria ambigua),* of the same family as the Murray Cod, has been cultured and stocked more extensively than any other native freshwater species. *Photo: J. Merrick.*

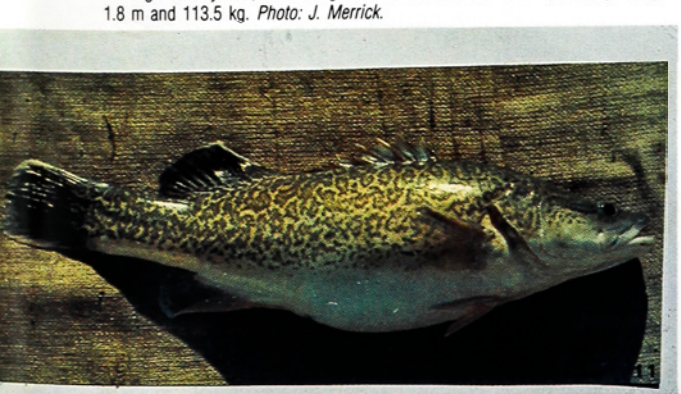

PLATE II

2A (above) — The range and abundance of the Macquarie or Mountain Perch *(Macquaria australasica)* has greatly declined in recent years; factors contributing to this include stream modifications and introduced trouts. *Photo: J. Merrick.*

2C (below) — The Freshwater Catfish or Dewfish *(Tandanus tandanus)* will breed regularly in farm dams and has considerable potential for aquaculture. *Photo: J. Merrick.*

2B (above) — The Bidyan or Silver Perch *(Bidyanus bidyanus)* is an active schooling grunter with an extensive range in the Murray-Darling division. *Photo: J. Merrick.*

2D (below) — The Spotted Barramundi *(Scleropages leichhardti)* is a saratoga, restricted to central and south-eastern Queensland and highly prized by anglers. *Photo: J. Merrick.*

2E (above) — The Gulf Saratoga or Northern Spotted Barramundi *(Scleropages jardini)*, also favoured by anglers, is more widespread in the Gulf of Carpentaria and Timor Sea divisions. Both saratogas are mouth brooders. *Photo: J. Merrick.*

2G (below) — The Bully or Sea Mullet *(Mulgil cephalus)* is one of Australia's 10 herbivorous freshwater fish. Another 20 species are omnivores. *Photo: J. Merrick.*

2F (above) — The Banded or Black-striped Grunter *(Amniataba percoides)* will tolerate rapid changes in salinity without stress. *Photo: J. Merrick.*

2H (below) — The Small-mouthed Salmon Catfish *(Cinetodus froggatti)* of northern Australia is a carnivore that feeds only on small molluscs such as muscles. *Photo: J. Merrick.*

Last but not least come the two saratogas — both also confusingly called Spotted Barramundi although they are not related to *Lates calcarifer* mentioned above. The Spotted Barramundi *(Scleropages leichhardti)* is restricted to central and southeastern Queensland. The Gulf Saratoga or Northern Spotted Barramundi *(Scleropages jardini)* is more widespread in the Gulf of Carpentaria and Timor Sea drainage divisions. These two species (family Osteoglossidae) are present naturally in small numbers and have significance not only because they are highly prized by anglers, but also because they are mouth brooders or oral incubators. The female incubates up to 50 eggs in her mouth and shows extended parental care for larvae until they are six weeks old and about 40 mm long. Aquarists also value these spectacular fishes, but their size and antisocial temperaments pose certain problems in small community tanks. Adults of both species mature at about 400 mm when five years old.

General comments on aspects of biology, handling procedures, anaesthetics and disease treatment follow. These points are relevant not only for the commercial species discussed above but also apply to many other species.

PHYSIOLOGICAL TOLERANCES

Although not rigorously tested in many native species, tolerances to water conditions are known to be wide. Take the four major parameters of temperature, oxygen, salinity and pH as examples. Most species will withstand temperatures from 10° to 30°C; some, such as the Silver Perch *(B. bidyanus)* will take temperatures as low as 2°C — others, like the Dalhousie Catfish (*Neosilurus* sp.) from central Australia, as high as 44°C. Nearly all species do well at 20°-25°C, which can be considered a general optimal range. The recommended minimum for oxygen concentrations is 5 p.p.m., although some species (such as the Freshwater Catfish *T. tandanus*) can cope with much lower levels for a period of hours without any apparent distress. Concentrations of dissolved oxygen vary considerably with temperature but levels of 5-8 p.p.m. or higher are recommended.

Most species will withstand salinities of up to half seawater (approx. 18 000 p.p.m.) with no ill-effects. Species such as the Desert Goby *(Chlamydogobius eremius)* can withstand a sudden transfer from soft freshwater to seawater without stress; fishes with this ability to tolerate wide ranges of salinity rapidly are described as euryhaline. Other species known to have this ability include the Banded Grunter *(Amniataba percoides)*. The saratogas are probably more sensitive to salt than most — a closely related Asian species stops feeding at 8 000-9 000 p.p.m. The general tolerance to salt should be remembered and used to advantage when treating for the common diseases.

In general, species withstand a pH range of 5.0-9.0, but levels close to 7.0 are recommended; 6.5-8.0 is the optimal range for many species.

FEEDING AND DIET

There are only 10 herbivorous species known in the fauna; examples of herbivores are the Snub-nosed Garfish *(Arrhamphus sclerolepis)*, and the three mullet species. Over 20 species are known to be omnivorous; however, of the important angling species discussed above only two, the Bidyan and Sooty Grunter are omnivores — all other species are carnivores. It should be noted that omnivores still need substantial variety in their diets. For example, in pond culture situations where substantial supplementary feeding may be necessary, pelleted components should be held at low levels, as part of a mixture including frozen, fresh and live foods. At present, details of nutritional requirements of Australian fishes are unknown.

Most of the carnivores are opportunistic, eating whatever comes along, but some show clear dietary seasonality. For example, the Yellowbelly eats mostly crustaceans and insects in the warmer months, but in winter, in some areas, it feeds almost exclusively on small Bony Bream *(Nematolosa erebi)* and eel-tail catfishes (*Neosilurus* spp.). Dietary specialization in carnivores is rare, but one exception is the Small-mouthed Salmon Catfish *(Cinetodus froggatti)*; this species only eats small molluscs (e.g., mussels). It occurs in a few northern rivers and is a representative of the fork-tailed catfish family Ariidae.

REPRODUCTION

The nest-building Catfish, Nursery Fish and mouth-brooding barramundis have been discussed; oral incubation also occurs in the fork-tailed catfishes (family Ariidae) and the cardinal fishes (family Apogonidae). but in these groups the male incubates. Most species do not exhibit reproductive specialization; they follow a standard pattern.

Most species do not show marked differences between the sexes; males may mature at a smaller size and sexing is often only possible immediately before the spawning season. Generally, breeding occurs once annually, although the season may be prolonged, extending from early spring to late summer or early autumn.

Most species undertake at least limited movements to spawning sites. Approximately 90 species are known to be potadromous (i.e., moving entirely within freshwaters); a few such as the Yellowbelly and Bidyan make long and well-defined migrations. Some 18 species are catadromous (i.e., move downstream to estuarine or marine areas to spawn) and only three are known to be anadromous; members of this last group normally live in estuarine or marine environments and move upstream to freshwaters to spawn.

Most species breed in small groups or pair directly and deposit demersal eggs. These demersal (sinking) eggs may be adhesive (sticking to plants, logs or rocks) or non-adhesive (settling into crevices in gravel). A few species such as the Yellowbelly and Bidyan, have pelagic eggs which remain in suspension in flood flows.

Most species show little or no parental care. With the notable exceptions of saratogas and fork-tailed catfishes, where parental care is demonstrated it is of short duration: usually a few days, perhaps up to a week until the eggs hatch. Development is usually rapid and individuals become independent as very small larvae.

HANDLING

With most other vertebrate groups –– aside from the physiological stress of capture — handling the animals when necessary is not a problem; however, with fishes the general rule is to handle them as little as possible. This is because of the high risk of accidentally removing some scales or protective slime, leading to subsequent infection.

When handling and treatment are required, there are a number of measures that can be taken to minimize risk. Firstly, some times of year are better than others; don't handle in winter or mid-summer. Spring or early summer months, prior to spawning, are best; individuals are then in peak condition to cope with shock and to recover from minor injury. Very late summer or early autumn is the alternative; individuals have usually had some time to recover from spawning and temperatures are moderate.

Ensure that nets are of a soft material, such as nylon or cotton mesh, and that hands are wet. A number of anaesthetics are available to calm and sedate the animals (see below); salt in low concentrations (up to 5000 p.p.m.) can be used to guard against infection.

It should be emphasized that regardless of the care and precautions taken, some species will always be delicate and difficult to handle. For example, the Snub-nosed Garfish and Bony Bream invariably react badly to capture shock, are easily damaged and high mortalities following handling are normal; juveniles (up to 100 mm in length) are frequently more hardy than adults.

ANAESTHETICS

A number of substances including carbon dioxide and tobacco juice have been used to narcotize fishes, but most known anaesthetics have limitations or problems. Criteria by which a particular chemical is assessed as a desirable fish anaesthetic include expense, dosage, water solubility, sedation times, recovery times and the retention of residues in the body. In Australia, the two main compounds currently in use are MS-222 (tricaine methanesulphonate) and quinaldine. Benzocaine and chlorobutanol are also used infrequently, usually in experimental work rather than in routine fish culture.

Unfortunately MS-222 is very expensive and when used in moderate concentrations (up to 300 p.p.m. recommended) can substantially alter the pH of water in the narcotization container. Quinaldine is less expensive but it has other disadvantages. Used at recommended levels (10 p.p.m.) quinaldine sedates slowly and has a very strong persistent odour which irritates the fish as it is being narcotized. Anaesthesia is deep and recovery times slow; quinaldine is also not very soluble and so vigorous mixing and agitation is necessary to disperse droplets.

Both benzocaine and chlorobutanol are best dissolved in a small amount (50 ml) of ethanol; chlorobutanol has been more frequently used on estuarine or marine fishes. Benzocaine is becoming more popular with fish researchers because it is competitively priced and has several advantages over MS-222 and quinaldine. At recommended dosages (approximately 100 p.p.m.) complete sedation takes 3-5 minutes without any of the irritation caused by quinaldine. Benzocaine is just as effective (complete sedation for 10 minutes) as other anaesthetics but recovery times are much shorter.

Several general points should be made about the use of anaesthetics. Firstly, only use minimum recommended concentrations; high mortalities can result from fishes not coming out of the anaesthetic. It is also very time-consuming attempting to resuscitate heavily sedated specimens. Secondly, different species show widely varying tolerances to the same anaesthetic. Thirdly, individuals of the same species will show varying tolerances to an anaesthetic with different seasons. Fourthly, where two or more sedations are necessary in a limited period, allow at least 24 hours (preferably a few days or a week) recovery time between treatments.

Other factors such as temperature can also influence reactions to anaesthetics, but for general use benzocaine is recommended; by slightly varying dosages, satisfactory anaesthesia (rapid, complete sedation in 3-5 minutes and rapid recovery in 3-5 minutes) can be consistently achieved.

DISEASES

The knowledge of fish diseases in Australia is still very limited and detailed consideration of treatments for even the most common ones is beyond the scope of this paper; however, a number of general points are relevant.

The common pathogens can be broadly divided into five groups. These are fungi, bacteria, parasitic protozoans, parasitic worms and parasitic crustaceans; the first and last two groups are most frequently observed in the wild. It is emphasized that diseases are often

related to poor water quality. Many problems can be alleviated or prevented by such measures as: aeration; partial water changes; filtration; and the addition of small amounts of salt. Low dosages of chemicals such as methylene blue, malachite green and formalin are frequently used for the treatment of fungal and protozoan infections. Ashburner (1976) and Beumer *et al.* (1982) are recommended for summaries on fish diseases and parasites in Australia.

For supplies of the dyes, fixatives and anaesthetics mentioned contact Ajax Chemicals, Sydney or Selby Anax Pty Ltd, Sydney.

Agricultural, domestic and industrial effluents contain many substances which will adversely affect water quality in freshwater habitats. Some of these pollutants will induce disease symptoms and contribute to fish kills; detailed information on this aspect of management is provided by Hart (1986).

A short list of the most recent and comprehensive references on various aspects of native fishes is included below, but several additional points might be helpful. Firstly, although the book by Hoffman and Meyer (1974) is based on North American experience and species, it is useful because recommended treatments for a wide variety of fish diseases are clearly tabulated. Secondly, there is no general Australian aquaculture manual currently available although large conferences on local aquacultural practice and disease problems have been held since 1983, and the proceedings have been published (Reynolds 1986; Humphrey and Langdon 1986). For the most up-to-date summaries on aspects of native fish culture the only works available are those of Owen and Bowden (1986) and Leggett and Merrick (1987). Thirdly, new developments in Australian aquaculture and research are usually featured in the monthly magazine *Australian Fisheries;* overseas developments are comprehensively documented in American Fisheries Society journals.

CONCLUSIONS AND RECOMMENDATIONS

In summary, Australia has a diverse freshwater fish fauna comprising less than 200 species. Of the dozen species regularly harvested or cultured, most are carnivores; sexual dimorphism is absent or very limited and maturity is attained at lengths exceeding 200 mm and at ages of 2-5 years. The fauna is generalized. Most species have: wide tolerances to temperature, salinity and pH; varied diets; and standard reproductive strategies.

The minimum amount of handling possible should be completed in warmer months when temperatures are at 20-25°C, oxygen levels are 7-9 p.p.m. and pH 6.5-8.0; benzocaine is recommended as the safest anaesthetic. In the treatment of disease, water quality is of paramount importance. The addition of salt or dyes such as methylene blue is often effective against common problems, but the use of drugs should only be considered as a last resort for valuable stock.

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