

## Ichthyology at the Australian Museum: Collections, Databases and the Web

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**Abstract** The Australian Museum was established in 1827. Since 1864 there has been an almost unbroken sequence of ten fish Curators/Researchers. Today the Fish Section is staffed by one full-time Ichthyologist, two retired Research Fellows, a Collection Manager and several technical staff. The Australian Museum Fish Collection (AMS) is part of a larger national collection made up of seven major collections and several smaller collections. Statistics are presented that compare the major collections. In December 2004 the AMS collection contained over 1.6 million specimens (168,800 lots) comprising 635,000 adult fishes (136,000 lots) and approximately 1,000,000 larvae (32,800 lots). The type collection contained 2,271 type species (11,302 specimens in 4,726 lots). In the mid 1970s digitisation of collection data began. In 1998 a Compaq Proliant server was purchased to store the databases and to serve data to the Web. Data have remained on this server until the present time, but will shortly be moved to a SUN server. The Australian Museum used KE Titan database software from 1987 until 1995 when data were moved to KE Texpress. The fish databases are currently in the process of being upgraded to KE EMu software. The Australian Museum Fish Website first went online in 1995 and now contains approximately 3000 pages (8000 files). It gives users access to over 850 species fact sheets primarily on Australian fishes and other content areas including online access to fish collection data and maps. In the twelve months between November 2004 and October 2005, the site received nearly 7 million page views (2.5 million visits). The benefits and drawbacks of developing and maintaining a website are briefly discussed. Three recent projects that have involved the AMS Fish Section are discussed, along with the future plans for collection development, databases and the website.

**Key words:** Australian Museum, fish collection, databases, Web, website.

### Staff

The Australian Museum was established in 1827. Since 1860 when Gerard Krefft was appointed as Sub-Curator (Director in 1864), there have been ten fish Curators/Researchers. The first two Curators, Krefft and Edward Ramsay were employed as Directors of the Australian Museum, and both worked on other animal groups in addition to fishes. Despite his interest in reptiles, mammals and fossils, Krefft cemented his reputation as an ichthyologist with the description in 1870 of the Queensland Lungfish, *Neoceratodus forsteri*. Ramsay's primary area of research was ornithology although he co-authored fish papers with James Ogilby. His major contribution to Australian ichthyology was negotiating the purchase of a portion of Military Surgeon Francis Day's important fish collection from southern Asia, and thereby significantly increased the AMS type specimen holdings. Dates of tenure for the ten fish Curators/Researchers are

Table 1. Australian Museum ichthyologists and years of tenure at the Australian Museum.

| Staff member                            | Years of tenure at AM |
|---|-----------------------|
| Johann Ludwig Gerard Krefft (1830–1881) | 1860–1879             |
| Edward Pierson Ramsay (1842–1916)       | 1874–1894             |
| James Douglas Ogilby (1853–1925)        | 1884–1890             |
| Edgar Ravenswood Waite (1866–1928)      | 1892–1906             |
| Allan Riverstone McCulloch (1885–1925)  | 1898–1925             |
| Gilbert Percy Whitley (1903–1975)       | 1922–1964             |
| Dr Frank Hamilton Talbot (1930–)        | 1965–1975             |
| Dr John Richard Paxton (1938–)          | 1968–1998             |
| Dr Douglass Fielding Hoese (1942–)      | 1971–2004             |
| Dr Jeffrey Martin Leis (1949–)          | 1979–                 |

Table 2. Current staff of the Australian Museum Fish Section.

| Position name  | Permanent employee | Name                 |
|--|--------------------|----------------------|
| Research Scientist (1)                               | Yes                | Dr Jeffrey Leis      |
| Collection Manager (1)                               | Yes                | Mr Mark McGrouther   |
| Technical Officers (2)                               | Yes (full time)    | Dr Thomas Trnski     |
|  | Yes (half time)    | Ms Sally Reader      |
| Research Fellows (2)                                 | No (retired 2004)  | Dr Douglass Hoese    |
|  | No (retired 1998)  | Dr John Paxton       |
| Visiting researcher (1)                              | No (2 years at AM) | Dr Hiroyuki Motomura |
| Technical Officer on grant funds awarded to Leis (1) | No                 | Ms Amanda Hay        |
| Volunteers (4)                                       | No                 | Ms Lawrie Davis      |
|  |                    | Ms Barbara Harvey    |
|  |                    | Mr Rowan Kleindeinst |
|  |                    | Mr Peter Swieca      |

shown in Table 1.

Today the Fish Section includes four permanent staff (one of whom is employed half time), one person on grant funds awarded to Leis, two retired Research Fellows, one long-term visiting researcher, and four volunteers. Sadly, the number of staff in the Section has decreased over the last decade with the retirement of two Research Scientists and the loss of two non-permanent Technical Officer positions in 2004 (Kerryn Parkinson and John Pogonoski). A listing of current staff is shown in Table 2. More detailed information on Australian Museum Fish Section staff is available at <http://www.amonline.net.au/fishes/about/research/staff.htm>.

### The Australian Museum Fish Collection

In December 2004 the Australian Museum Fish Collection contained 635,000 adult specimens (136,000 lots) and approximately 1,000,000 larval specimens (32,800 lots). The type collection contains 2,271 type species (11,302 specimens in 4,726 lots). Most specimens are preserved in 70% ethyl alcohol. The majority of 'adult' specimens are stored in glass screw top jars, although there are specimens stored in over 650 drums and 58 tanks. Larval specimens are stored in screw cap vials in large jars filled with 70% ethyl alcohol.

Supplementary collections include 1282 lots of otoliths, 1241 cleared & stained lots, 630 lots

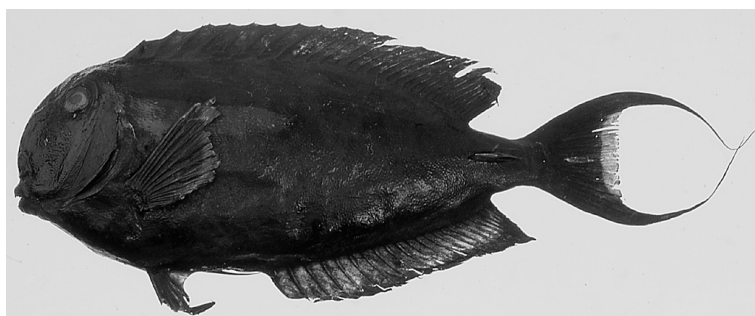


Fig. 1. The oldest specimen in the Australian Museum fish collection, an orangeband surgeonfish, *Acanthurus olivaceus* (AMS IB.6315), collected in 1858.

Table 3. Summary of outgoing specimen transactions 1995–2004. Recent loan figures contain transactions that include no specimens. These ‘loans’ usually document the allocation of new AMS registration numbers supplied to researchers who wish to assign them to manuscript type specimens.

|      | Outgoing loans | Outgoing exchanges and gifts | Outgoing transfers | Outgoing specimen returns | Total outgoing transactions |
|------|----------------|------------------------------|--------------------|---------------------------|-----------------------------|
| 2004 | 60             | 22                           | 1                  | 19                        | 102                         |
| 2003 | 74             | 22                           | 5                  | 16                        | 117                         |
| 2002 | 62             | 28                           | 7                  | 2                         | 99                          |
| 2001 | 69             | 30                           | 2                  | 11                        | 112                         |
| 2000 | 75             | 11                           | 3                  | 7                         | 96                          |
| 1999 | 103            | 20                           | 2                  | 5                         | 130                         |
| 1998 | 71             | 5                            | 6                  | 9                         | 91                          |
| 1997 | 98             | 12                           | 8                  | 20                        | 138                         |
| 1996 | 101            | 17                           | 8                  | 12                        | 138                         |
| 1995 | 67             | 10                           | 9                  | 22                        | 108                         |

of skeletal material, 499 skins and stuffed specimens. Over 1035 specimen lots have been x-rayed on 811 x-ray plates.

The oldest fish in the collection (IB. 6315) is a dry orangeband surgeonfish, *Acanthurus olivaceus*, which was collected in 1858 by J. MacGillivray in Aneityum, Vanuatu (Fig. 1).

Strengths of the collection include fishes from New South Wales and the Great Barrier Reef, Queensland. The collection also has strong representation of fishes from temperate rocky reefs, mesopelagic waters and from the upper slope waters down to 1000 m depth. Additional collection strengths reflect the research interests of Paxton (Myctophidae and other deepsea taxa), Hoese (gobiids), Leis (larvae) and visiting Collection Fellow, Motomura (Scorpaenidae).

Other collection highlights include three specimens of Goblin shark, *Mitsukurina owstoni*, from Australia; four Stout infantfish, *Schindleria brevipinguis*, the ‘media-hungry’ smallest fish in the world (<http://www.amonline.net.au/fishes/fishfacts/fish/sbrevip.htm>); thirty Queensland Lungfish, *Neoceratodus forsteri*; and one Coelacanth, *Latimeria chalumnae*.

There has been a strong loan program for many years. Recently it has become increasingly difficult to maintain the high number of loans due to reduced staffing resources. A summary of specimen transactions for the last ten years is shown in Table 3.

### Australian Fish Collections

The Australian Museum Fish Collection (AMS) is part of a larger national collection made up of seven major collections and several smaller collections in other cities around the country. The major collections house nearly 3 million specimens. Table 4 shows summary statistics of the collection holdings for the major Australian fish collections in 1992/3 (from Paxton & McGrouther, 1997) and 2004. Summary statistics for the type specimen holdings of AMS and other major Australian fish collections are shown in Table 5.

Eight full-time taxonomists work at these institutions. This figure has dropped from ten in

Table 4. Summary of Australian collection sizes in 1992/3 (from Paxton & McGrouther, 1997) and 2004.

| Collection    | Adult specimens (1992/3) | Adult specimens (2004) | % increase | Larval specimens (1992/3) | Larval specimens (2004) | % increase | Total specimens 2004 |
|---------------|--------------------------|------------------------|------------|---------------------------|-------------------------|------------|----------------------|
| AMS Sydney    | 457,000                  | 635,000                | 40%        | 500,000                   | 1,000,000               | 50%        | 1,635,000            |
| NMV Melbourne | 67,000                   | 320,000                | 378%       | 0                         | 38,000                  | —          | 358,000              |
| QM Brisbane   | #140,000                 | #250,000               | 79%        | 0                         | 0                       | —          | #250,000             |
| NTM Darwin    | 89,000                   | 175,357                | 97%        | 0                         | 41(lots)<br>(lots)      | —          | 175,398              |
| WAM Perth     | 120,000                  | 168,000                | 40%        | 0                         | 0                       | —          | 168,000              |
| CSIRO Hobart  | 72,000                   | 83,201                 | 16%        | 100,000                   | *50,645                 | -49%       | 133,846              |
| SAMA Adelaide | 62,000                   | ?                      | ?          | 0                         | 1500                    | —          | 63,500               |
| TOTALS        | 1,007,000                | 1,631,558              | 62%        | 600,000                   | 1,090,186               | 81%        | 2,783,744            |

AMS=Australian Museum, CSIRO=ISR Munro Fish Collection, NMV=Museum Victoria, NTM=Northern Territory Museum, QM=Queensland Museum, SAMA=South Australian Museum, WAM=Western Australian Museum.

# Number of specimens not recorded in database. Figure shown is an estimate based on number of lots x 7 specimens per lot.

\* This reduced figure reflects a more accurate calculation of the number of larvae than was available in 1992/3.

? Figures not available due to lack of staffing in the Fish Section.

Table 5. Summary of fish type specimens in Australian collections in 1992/3 (from Paxton & McGrouther, 1997) and 2004.

| Collection | Type specimens/lots (1992/3) | Type specimens/lots (2004) | % increase | Type species: (1992/3) | Type species: (2004) | % increase |
|------------|------------------------------|----------------------------|------------|------------------------|----------------------|------------|
| AMS        | 8,633/3,711                  | 11,302/4,726               | 30%/27%    | ~1500                  | 2271                 | 51%        |
| WAM        | 6,559/1,545                  | 7,420/1,845                | 13%/19%    | 432                    | 632                  | 46%        |
| NTM        | 1,093/188                    | 2055/395                   | 88%/110%   | 69                     | ~400                 | 580%       |
| NMV        | 392/174                      | 837/471                    | 114%/171%  | 69                     | 202                  | 193%       |
| CSIRO      | @/230                        | 621/463                    | -/101%     | 123                    | 136                  | 11%        |
| QM         | #/476                        | #/644                      | -/35%      | 365                    | 307                  | '-15%'     |
| SAMA       | 249/?                        | ?/175                      | —          | 125                    | —                    | —          |
| TOTALS     | 16,926/2,613                 | 4,447/8719                 | 49%/77%    | 2683                   | 3948                 | 144%       |

AMS=Australian Museum, CSIRO=ISR Munro Fish Collection, NMV=Museum Victoria, NTM=Northern Territory Museum, QM=Queensland Museum, SAMA=South Australian Museum, WAM=Western Australian Museum.

@ Figures not available in 1992/3.

? Figures not available due to lack of staffing in the Fish Section.

# Number of specimens not recorded in database.

1992. There are very few young Australian fish taxonomists, and there is no tertiary course in systematic ichthyology available in Australia.

### **Databasing at the Australian Museum**

The earliest Australian Museum register (the Palmer register) was begun in 1877. Traditional registers were used by the Fish Section for about 100 years. By 1969, eight different registration number prefixes had been used for fish specimens—A, B, E, S, I1, I2, IA and IB. These were followed by the I3 and I4 registers. In 1979 the entry of data into traditional registers was discontinued and data were hand written on data sheets. This practice continued until the mid 1990s, when the electronic printing of data sheets was begun.

Three series of 3"×5" card files are stored in the Fish Section. The first series of 18 drawers was maintained by Ogilby (tenure: 1884–1890). The second set of 36 drawers was kept by Whitley (tenure: 1922–1964). The third set of 54 drawers was begun around 1900 and contained a card for each lot in the collection until 1988. All three sets of card files provide an historical record that is still referred to, albeit infrequently. Sometimes they prove immensely valuable. Recently over 100 of Whitley's cards containing many unpublished records of Oarfish beach strandings were copied and sent to Dr Tyson Roberts to assist in his research. The importance of these card files has declined with the entry of data into computer databases.

Digitisation of collection data began in the mid 1970s, when data were loaded onto a CSIRO CYBER 76 computer. From 1987 until 1998 three computers were used to store the fish database — a Unison D21, followed by two 386 processor computers. In 1998 a Compaq Proliant 1600 server was purchased to store the databases and to serve data to the Web. Data have remained on this server until the present time, but during late 2005 or early 2006, will be moved to a SUN SunFire 280R server. This computer is linked to a 1.4TB SAN and a tape backup robot.

In 1986, data were loaded into Titan databases. Titan database software was first released by Melbourne based company, Knowledge Engineering in 1984. Titan databases were used until 1995 when data were moved to KE Texpress (<http://www.kesoftware.com/texpress/index.html>) databases. Texpress was also developed and released by Knowledge Engineering (now trading under the name KE Software).

There are currently 18 databases in use by the Fish Section, with the main specimen database containing approximately 170,000 records. These databases are currently in the process of being upgraded to the latest KE Software product, KE EMu (see future plans, Digital Records).

The entire registered collection is databased. There is a relatively small but increasing backlog of unregistered fishes that have accumulated over the last few years. This reflects the decrease in human resources available to the Fish Section.

### **The Data**

From the first fish registered in 1858, until 1969, a standard three part registration number was used. Registration numbers comprised the institution code (AMS) followed by an alpha prefix and a numerical string separated by a full stop, e.g. AMS IA.345.

One year after the arrival of John Paxton in 1968, a four part registration number format was adopted, e.g. AMS I.22822-009. This registration number format reflects a station-lot registration system. The first three parts comprise the institution prefix (AMS), the Fish Collection prefix 'I' (for Ichthyology) and a 5 digit numeric string (e.g. 22822). Together, the prefix and the numeric

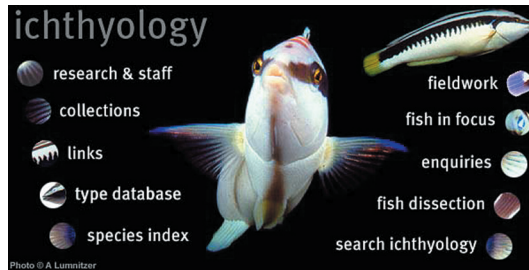


Fig. 2. The October 1997 version of the Australian Museum fish site home page (captured in March 1998).

string comprise the station number. The fourth part of the registration number is a three digit suffix which is preceded by a dash (e.g. -009). In this case, the station number 'I.22822' refers to a trawl station made off north-western Australia in April 1982. The suffix '009' refers to the ninth lot of fishes registered in station 'I.22822' (which currently contains 25 lots).

This station-lot registration system has real advantages. A quick glance at registration numbers I.22822-003 and I.22822-025, reveals that they share the same station number (I.22822) and thus come from the same collecting event. It also reveals that there must be at least 25 lots of fishes collected from the station. Another advantage of a station-lot registration system arises if a lot of fishes e.g. -025 is re-examined after registration and more than one species is identified from the lot. In this case it is a simple matter to add a new lot number for the additional species record. For the example above, the new lot would be -026.

### The Australian Museum Fish Website

The Australian Museum Website went online in 1995. In October 1997 the fish site became a recognisable section within the main site after a significant upgrade and the addition of a new frontpage (Fig. 2).

In February 1998 online access to the fish type database was added to the site. An enquiries section called 'Something Fishy' also came online in 1998, but was subsequently abandoned during the next upgrade and all relevant pages were included in other areas of the site. In November 1999 a specimen mapping facility was added.

In May 2000 a major upgrade of the site (Fig. 3) was made to cope with the increasing content and complexity of the site. It included a new link to fish movies and a 'What's new?' column that presented the latest pages to users. The new site also involved a change of site layout and navigation.

The most recent upgrade went online in November 2004 (Fig. 4). This upgrade involved a change in site layout, navigation and the use of style sheets throughout. Considerable work went into the navigation design. A 'card sort' procedure was used to organise the site into logical units (Robertson, 2001).

All site upgrades were made by the Australian Museum webteam in consultation with the author. The composition of the webteam is shown in Table 6.

The site currently contains approximately 3000 pages (8000 files). Most of the content has been written by the author, with some input from other members of the Fish Section. The site is divided into ten major navigation areas. These are shown in Table 7.

The majority of the site content is located in the 'Find a Fish' section, which contains over



Fig. 3. The May 2000 version of Australian Museum fish site home page (captured in September 2004).



Fig. 4. The November 2004 version of the Australian Museum fish site home page (captured in November 2005).

Table 6. Composition of the Australian Museum Webteam.

| Position            | Full or part time | Number | AM Staff | Contractor |
|---------------------|-------------------|--------|----------|------------|
| Web Manager         | Full-time         | 1      | Y        |            |
| Designer            | Full-time         | 1      | Y        |            |
| Researchers/Editors | Part-time         | 2      | Y        |            |
| Web Production      | Full-time         | 1      |          | Y          |
| Web Production      | Part-time         | 1      |          | Y          |

Table 7. Major content areas of the Australian Museum Fish Website.

| Navigation Area | Content  |
|-----------------|--|
| About Fishes    | What is a fish?, fish versus fishes, fish scales, bones, parts of a fish                       |
| Fish Department | Staff, research, fieldwork, Research Associates, students, volunteers, photographers, visitors |
| Collections     | Data, maps, types, collection tour, papers citing AMS specimens                                |
| Larval fishes   | AMS larval fish site, database, descriptions, gallery, links                                   |
| Fish Links      | Relevant external links  |
| Find a fish     | Over 850 fish fact sheets, glossary  |
| Identify a fish | Link to the Australian Museums Online (AMOL) fish key  |
| Student stuff   | Fish dissections, 'fish in focus', fish key, fish memory game                                  |
| FAQs            | Frequently asked questions about fishes and the collection                                     |
| Fish Movies     | Short fish movies in Windows Media and Quicktime formats                                       |

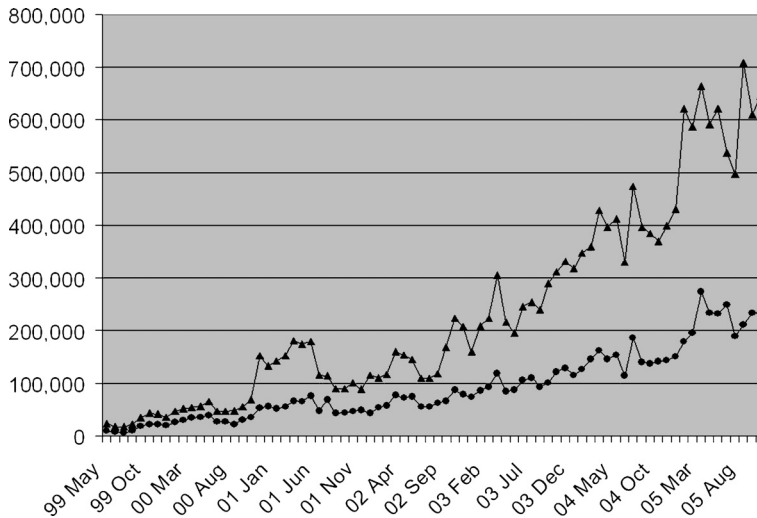


Fig. 5. Australian Museum Fish Website statistics from May 1999 to October 2005. ▲=page views ●=visitor sessions.

850 species fact sheets primarily on Australian fishes. This is the fastest growing part of the site.

Early site visitation statistics were not kept for the fish site, but rather for the entire Australian Museum website. Separate statistics for the fish site became available in 1988. In April 1988 there were approximately 3700 page views each month. By August 2000 statistics were encouraging with monthly page views increasing to 48,394 (22,356 user sessions). Over the next four years the number of page views and visitor sessions grew markedly. In the twelve months between November 2004 and October 2005, the site received nearly 7 million page views (2.5 million visits). At the time of submitting this paper (November 2005), the site had begun to receive over 600,000 page views per month, with the highest figure (708,036) in August 2005. Figure 5 shows the growth in page views and visitor sessions against time.

Developing and maintaining the fish website have had both benefits and drawbacks. It is now much easier to answer many enquiries, because the enquirer can be directed to the relevant page on the site. This is becoming increasingly easy as more content is put online. The site also provides a first point of access to collection data. The online data facility is used extensively by



scientists who wish to assess the specimen holdings of particular taxa.

On the down side, the more people who visit the site and thus the more people who become aware of the site, the more enquiries the Fish Section receives. The other drawback is the cost in terms of money and time. Hosting a large website on a fast, reliable computer system costs money as does employing staff to maintain and develop the site.

Developing content for the site takes time. The author spends at least one hour most working days adding content to the site and significantly more time at home in the evenings developing content.

### Other Projects

During recent years, the Fish Section has been involved in a number of external projects. These include the OZCAM website, the GBIF primary types photography project and the Oz-FishNet project.

### OZCAM Website

The OZCAM (Online Zoological Collections of Australian Museums) website is an initiative of the Council of Heads of Australian Faunal Collections (CHAFC). OZCAM (<http://www.ozcam.gov.au/index.php>) is a distributed online query network that allows the querying of a range of different faunal groups from ten Australian institutions (<http://www.ozcam.gov.au/participants.php>).

The OZCAM concept was first raised at an Australian Biological Resources Study (ABRS) meeting in the early 1970s. The Australian Museum has been involved in the project since CHAFC started discussing the idea during the early 1990s. In 1996 a Committee was set up to look at the feasibility of OZCAM, and in October 1997 CHAFC decided to make OZCAM a reality.

The OZCAM site allows public and club level access (for contributing members). Records retrieved can be viewed as columnar data or maps. If maps are viewed through the public access level, the latitude and longitude values are ‘fuzzied’, resulting in less precise plotting of dots on maps. Figure 6 shows an example of a distribution map generated by the OZCAM website using public level access.

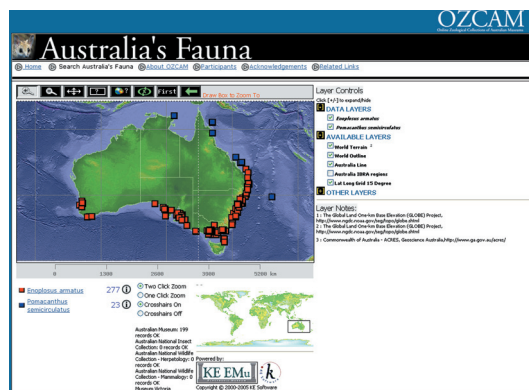


Fig. 6. A sample OZCAM map showing 328 records of old wife, *Enoplosus armatus*, and 52 records of blue angelfish, *Pomacanthus semicirculatus*, retrieved from ten fish collections.

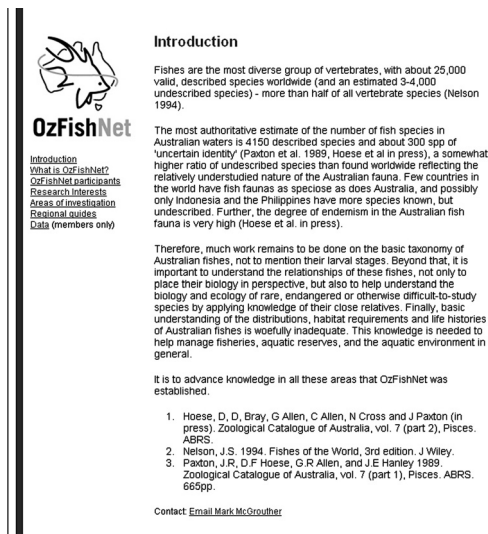
The Australian Museum currently serves over 300,000 specimen records through the OZCAM portal. Faunal groups covered are fishes, insects, reptiles and amphibians, mammals, birds, spiders, shells, cephalopods and several other groups of marine invertebrates. The Australian Museum also serves specially recorded port survey data on barnacles that assist in tracking introduced species. The museum plans to expand the number of records available to OZCAM in the near future.

### GBIF Type Photography Project

In late 2003 a consortium of Museums from around Australia was awarded funding from the Global Biodiversity Information Facility (GBIF) to photograph Australian primary type specimens of fishes, mammals, reptiles, birds and molluscs. A total of 6024 Australian Museum type specimens were photographed, including 1551 fishes. These images were digitally captured over a period of one year using three cameras, a Nikon D100, a Nikon Coolpix 990 (hooked to a television screen) and a Nikon D70 with bellows attachment. The animals photographed ranged in size from only a few millimeters in length to well over one meter. Some very small fishes were photographed down a binocular microscope. Small fishes were photographed on a copy stand. Larger fishes were photographed on a specially constructed glass photographic table. The images were edited to a standard format using Photoshop, and then loaded onto the OZCAM website in December 2005. They can now available for public access. Examples can be viewed at [http://www.faunanet.gov.au/webservices/images\\_fish/abudefduf\\_flavipinnis\\_1.jpg](http://www.faunanet.gov.au/webservices/images_fish/abudefduf_flavipinnis_1.jpg) (*Abudefduf flavipinnis*) and [http://www.faunanet.gov.au/webservices/images\\_fish/hoplichthys\\_haswelli\\_1.jpg](http://www.faunanet.gov.au/webservices/images_fish/hoplichthys_haswelli_1.jpg) (*Hoplichthys haswelli*).

### OzFishNet

Staff of the major Australian fish collections have joined together to work on selected projects under the name OzFishNet (Fig. 7) (<http://www.amonline.net.au/fishes/ozfishnet/index.htm>). This collaboration has resulted in the completion of a number of projects that would not have been possible if individual institutions worked in isolation. Recent projects include: 1) Descrip-



**Introduction**

Fishes are the most diverse group of vertebrates, with about 25,000 valid, described species worldwide (and an estimated 3-4,000 undescribed species) - more than half of all vertebrate species (Nelson 1994).

The most authoritative estimate of the number of fish species in Australian waters is 4150 described species and about 300 spp of 'uncertain identity' (Paxton et al. 1989, Hoese et al. in press), a somewhat higher ratio of undescribed species than found worldwide reflecting the relatively understudied nature of the Australian fauna. Few countries in the world have fish faunas as speciose as does Australia, and possibly only Indonesia and the Philippines have more species known, but undescribed. Further, the degree of endemism in the Australian fish fauna is very high (Hoese et al. in press).

Therefore, much work remains to be done on the basic taxonomy of Australian fishes, not to mention their larval stages. Beyond that, it is important to understand the relationships of these fishes, not only to place their biology in perspective, but also to help understand the biology and ecology of rare, endangered or otherwise difficult-to-study species by applying knowledge of their close relatives. Finally, basic understanding of the distributions, habitat requirements and life histories of Australian fishes is woefully inadequate. This knowledge is needed to help manage fisheries, aquatic reserves, and the aquatic environment in general.

It is to advance knowledge in all these areas that OzFishNet was established.

1. Hoese, D. D, Bray, C, Allen, C, Allen, N, Cross and J Paxton (in press). Zoological Catalogue of Australia, vol. 7 (part 2), Pisces. ABRIS.
2. Nelson, J.S. 1994. Fishes of the World, 3rd edition. J Wiley.
3. Paxton, J.R., D.F. Hoese, G.R. Allen, and J.E. Hanley. 1989. Zoological Catalogue of Australia, vol. 7 (part 1), Pisces. ABRIS. 665pp.

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Fig. 7. A The OzFishNet website homepage (captured in June 2005).

tions of 33 new fish species (17 papers) in a special volume of the Records of the Australian Museum (volume 56, number 2) in July 2004; 2) Two projects investigating the bioregionalisation of coastal Australia; 3) An international collaborative biodiversity survey of deepwater areas in the Tasman Sea (NORFANZ) was carried out in May-June 2003.

A long term goal of OzFishNet is to produce a guide to the estimated 4226 species of fishes occurring in Australian waters.

### **Future Plans**

For many years the Australian Museum Fish Section has been known for its strong collection and active research program. The Section fared very well against the 'Necessary Attributes of a Modern Museum' as stated by Ng (2000). Over the last decade however, the number of research and technical staff in the Section has declined. This has resulted in a reduction in many aspects of collection maintenance and development along with research potential. Future plans for the collection, digital records and website are discussed below.

### **Collection**

Inadequate storage facilities, in terms of quantity and quality, present an ongoing problem for many museums. Currently the fish collection storage areas at the Australian Museum are filled to capacity. As the collection continues to grow it is becoming increasingly difficult to adequately maintain it within the current collection space.

By September 2008 a new building will have been constructed at the Australian Museum. The building is currently being described as 'the new science building'. It will house most of the scientific sections within the museum that for many years have been scattered in various localities at the College Street site and beyond. The new building will also contain new collection space that will alleviate some current storage problems and theoretically provide expansion space for the next twenty years. Importantly, the building will be constructed adjacent to the existing collection area. This will result in considerably improved access between staff offices and the collection, thereby facilitating significant operational improvements.

The Fish Section will attempt to fill gaps in the knowledge of the fish fauna of New South Wales, Australia and beyond by the use of targeted collecting trips.\* Plotting of collection station data into ArcView GIS software has helped us to identify many collecting gaps in New South Wales and beyond. Simply plotting the locations of all collection stations gives a misleading picture of the comprehensiveness of collection coverage. Many stations contain a single lot, often a donation from the public, and thus do not represent a true collection station. Plotting the location of collection stations that contain twenty or more lots provides a much more useful picture of the extent of intensive collecting for the region. This is clearly shown in Fig. 8, which shows all bottom trawls around Australia (Fig. 8a) and those that contain twenty or more lots (Fig. 8b).

### **Digital Records**

As the number of specimens increases, so too will the number of database records. We aim to enter these new data into the database, but also to enhance existing database records by the inclu-

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\* Conducting large scale collecting trips, and more importantly processing the resulting specimens, is becoming increasingly difficult in times of decreasing numbers of support staff and increased regulations governing where and how fishes can be collected.

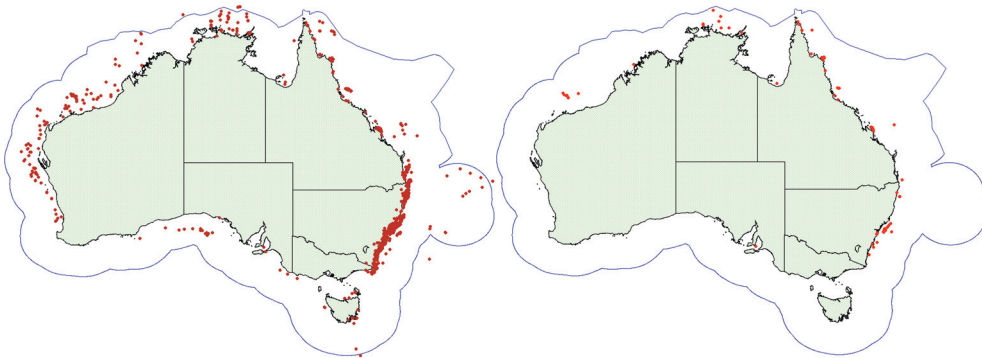


Fig. 8. Bottom trawl collection stations in Australian waters that contain one or more lots (a) and twenty or more lots (b).

Table 8. Codes to indicate the accuracy of specimen identification. These codes are used in most Australian Fish collection databases.

| Code | Description  |
|------|--|
| 1    | Highly reliable (identified by taxon specialist)         |
| 2    | High degree of confidence (identified by trained person) |
| 3    | Identification probably correct                          |
| 4    | Identification made with limited confidence              |
| 5    | Identification superficial only                          |
| N    | Not rated (used initially for all database records)      |

Table 9. Codes to indicate how latitude and longitude values were obtained.

| Code | Data original or subsequently derived | Method by which data obtained  |
|------|---------------------------------------|--------------------------------|
| GPS  | Original                              | Electronic positioning eg. GPS |
| OCM  | Original                              | Chart, map etc                 |
| OES  | Original                              | Estimation or approximation    |
| CMG  | Subsequent                            | Chart, map or gazetteer        |
| EST  | Subsequent                            | Estimation/approximation       |
| UNK  | Unknown                               | —                              |

sion of additional accuracy codes, citation information and other data that are currently missing. Most of the major fish collection databases in Australia use a six level specimen identification accuracy code as shown in Table 8. Two locality codes are also used. Codes that indicate the method by which latitude and longitude values were obtained are shown in Table 9. Accuracy codes for latitude and longitude values are shown in Table 10.

By late 2005 or early 2006 the fish databases will have been transferred from KE Texpress to KE EMu (Electronic Museum) database software. EMu (<http://www.kesoftware.com/emu/>) is an integrated collection management system that will bring a number of significant advantages to the Australian Museum. As well as the standard documentation of specimens, EMu contains modules for many of the operational procedures of museums such as specimen loans, movements, conservation, valuations, insurance, bibliography etc. It also has a parties module that records information about people and their institutions, as well as an impressive multimedia

Table 10. Codes to indicate the accuracy of the latitude and longitude values.

| Code value | Accurate between: | Remarks   |
|------------|-------------------|---|
| 0          | 0 m–1 m           | Not used at this time.  |
| 1          | >1 m–10 m         | Usually not used.   |
| 2          | >10 m–100 m       | Used for positional information obtained by GPS (excluding trawls).   |
| 3          | >100 m–1 km       | Used for original data obtained from a chart or map (must have seconds).  |
| 4          | >1 km–10 km       | Used for coordinates subsequently derived from a gazetteer or atlas. Also includes coordinates obtained by GPS on short trawls. |
| 5          | >10 km–100 km     | Used for imprecise place names and longer trawls.   |
| 6          | >100 km           | Used for very poor data such as 'coast of NSW'.   |

repository into which can be loaded many different types of files such as images, movies, sound files, pdfs, Word and Excel spreadsheets. These all become part of the queryable record.

### Website

Museums can relatively easily tap into wider audiences by utilising the World Wide Web. By using the Web, museums can make a huge contribution to increasing public knowledge and disseminating information about their collection holdings to scientists. To make quality information available however, there needs to be a commitment to this goal by senior museum managers. In short, this requires the allocation of appropriate support and resources. In 2004 a Web Content Committee was established at the Australian Museum to provide a rational evaluation of Web content proposed by staff. This was an important step towards changing the institutional culture.

The Australian Museum Fish Section will continue to improve its website. Currently collection data are only retrievable by genus, species and subspecies. After data are moved across to KE EMu, the query facility will be expanded, which will allow users to interrogate the database by additional fields.

Currently over 850 species fact sheets are available on the website. Australia's ichthyofauna contains at least 4226 species. There is still a huge amount of work required before the site contains a fact sheet on all the commonly encountered species.

There are currently many Web-based opportunities. In May 2005 a species list of the 571 fishes known from Port Jackson (Sydney Harbour) was added to the site (<http://www.amonline.net.au/fishes/fishfacts/sydney.htm>) and in September 2005 'Scorpionfishes of Australia' was added (<http://www.amonline.net.au/fishes/fishfacts/scorpionfishes.htm>). Other possibilities for future Web projects include a fish forum, a geographical/regional search facility and possibly a more advanced fish identification facility.

Natural history museums are in the unique position of having extensive collections, staff with biological knowledge and staff with the technical skills to deliver informative and reliable websites. More work is required before museum websites are firmly entrenched in the minds of both the public and scientists as stable sites that contain informative and reliable information.

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