To reference this article:

Browne RK. 2003. Pipefish, Museums, Marine Naturalists and Fish Conservation. Seadragon Foundation Articles. www.seadragonfoundation.org/articles/Browne_1.pdf

This article was the seed for the “Inshore Fish Group”, now a working group in Seadragon Foundation Inc.

Museums, Marine Naturalists and Fish Conservation

Dr Robert Browne

Robert lived in South Australia for forty years before beginning a career in science. Robert is devoted to the conservation of the Seadragons and other inshore fish and their habitats across Southern Australasia. Robert has a wide interest in conservation biology from reproductive physiology and gene banking of threatened species to broad scale fauna assessments and ecological studies.

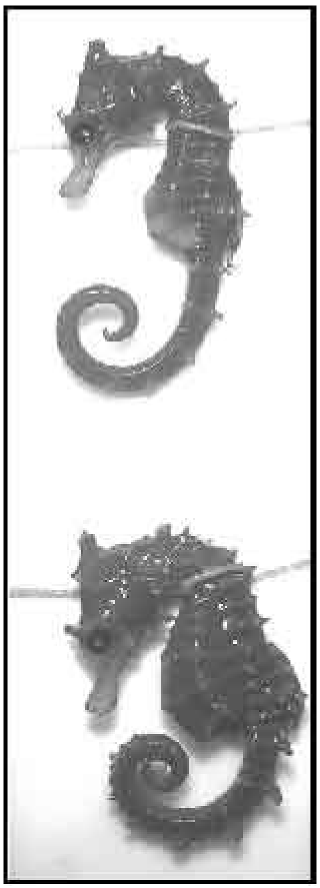
One of those idyllic days of the autumn of 2003, still, warm and clear, I was on the rocks south of Hallett Cove looking at rock pool fish. My friend Peter Cullen who was snorkeling over the seagrass beds beached himself and held up a hand net.

Peter showed me a tiny green fish about 2.5 cm long. What do you think it is? As this fish was not listed in our fish books, into the South Australian Museum it went. Two days later we were told it was a grass clingfish, a new record for the State. The finding a novel species so close to Adelaide and so close inshore begged the question, "How many other inshore marine fish species were unrecorded?".

Although much of my childhood during the 60s was spent exploring the coast south of Brighton, my main interaction with fish mainly consisted of harvesting them with rod or spear. However, I was also a naturalist and attempted to identify, and find out the natural history of, the various fish I encountered. Due to a strong history of natural sciences in South Australia up to the 1980s, the State was endowed with the most comprehensive guides to marine fish in Australia. The accuracy of these guides was confirmed by beautifully preserved museum specimens (Figure1), the legacy of pioneering marine naturalists who named most fish species mentioned in this essay.

However, even with the available literature, the identification of marine fish, except for large common species, was a difficult and frustrating experience. Many just did not match. The long hours attempting the identification of a novel fish usually ended with "Well it could be that one but then again!" My growing amateur interest and desire to contribute to the knowledge and conservation of South Australian fish was severely curtailed.

In 1923 Mr. Edgar R. Waite published a catalogue of the fishes of South Australia. "There is a lack of inexpensive but accurate books dealing with the plants and animals of South Australia, the absence of such has been a real handicap to young Australia, and so to the progress of Australian science." He considered the catalogue accurate, "As far as the more familiar fishes are concerned, it may be accepted as reliable, for the gaps in our knowledge relate mainly to small, rare and obscure forms." He used as an example the seahorses and pipefish (Family: Syngnathids) "At least six were found to be incorrectly determined, and the examination of the single group revealed one new genus and five new species." Waite's catalogue listed ten pipefish. We now consider that there are at least thirty-four Syngnathids in South Australia and there are probably many more.



These Short-snouted Seahorses Hippocampus brevis *were collected by Sir Joseph Verco in 1920. Sir Joseph Verco personally financed many marine expeditions and greatly contributed to the knowledge of marine biodiversity in South Australia.*

The Syngnathids of southern Australia are important from a global perspective. Of approximately 210 species in 52 genera worldwide listed in Dawson 1985, almost half in 38 genera exist in Australia. Of these 38 genera, 37% are regarded as endemic, with 25% of the world's species considered endemic to Australia.

Of the currently recognized 330 species, about 36% occur in Australian waters. Of these, many exist in monotypic genera and are of particular significance in respect to ecology, biogeography and phylogeny, thus their conservation is particularly important.

Of the pipefish, ten of the world's 14 genera are endemic to Australia; from Bermagui, NSW, there are 23 species, of which 25% are Australian endemics and 17% regional endemics; and from Shark Bay, WA, to Robe, SA, there are 38 species, of which 41% are Australian endemics and 29% regional endemics. Similar endemicity also applies to many other southern Australian inshore demersal (bottom dwelling) fish.

This endemicity occurs because Australia was long isolated from other continents and the coast of southern Australia is the longest east-west temperate coastline in the world, and therefore a unique marine biogeographical region. Further, South Australia's coastlines unique northward curve in the Great Australian Bight supplemented by the Leeuwin Current from Western Australia, and the northern end aspect of Spencer Gulf and, to a lesser extent, St Vincent Gulf, have provided warm isolated habitats enabling the evolution and survival of relict sub-tropical species. South Australia also has a wide variety of marine habitats for fish, including many enclosed bays separated by deeper, high energy coastlines, and within these bays are micro-habitats, provided by the greatest variety of macro-algae in the world.

Male Leafy seadragon Phycodurus eques *with eggs. Image by Brian Scupham courtesy of Seadragon Foundation Inc..*

For instance, Dr Barry Hutchins from the Western Australian Museum says, in respect to clingfish, "W*e have been actively surveying reef and sea grass fauna. Countless new species have been discovered. Only two species of clingfish were known from seagrass habitat*. *We now have over 20 species*. *It is not known how many species are shared with South Australia, but I would suspect that the number would be considerable"*. The gobies, weedfish, and snake-blennies are other inshore fish where many new species can be expected. Novel inshore fish species are being frequently discovered using hand nets, or lines with small hooks, even at places near Adelaide, like West Lakes and the Port River.

A comprehensive knowledge of inshore fish is particularly important for their conservation because a large number of fish species are concentrated within the first five metres of depth in bays and estuaries. These rich inshore areas are subject to increasing recreational use and development. The obvious lack of information on inshore demersal fish limits their conservation and consequently the conservation of global marine life.

It is now quite clear that the conservation of broad habitat types, even though essential to the conservation of many species, offers little protection to some. Therefore a sound knowledge of the diversity and distribution of individual species is essential to their conservation. The demise of many mammals in uncleared forest and brushland was due to exotic predators, competitors or diseases.

Further, all frog species that have reached extinction in Australia appear to have have done so as a result of introduced disease, not of broad habitat change.

In fact many of these extinct frogs inhabited regions of pristine rainforest in national parks. It is relevant that the extinction of many of these species was not recorded until many years after their demise, and only after overseas extinctions were recorded, because there was no systematic monitoring of frog populations. In respect to the monitoring of populations, the situation with inshore demersal fish today is similar and probably worse than that which occurred with the extinct frogs.

Introductions of disease, exotic predators and competitors are occurring at an accelerating rate in the marine environment. Hopefully, quarantine will slow the introduction rate of these pests. Nevertheless, many of these pests are increasing their range. In the Derwent estuary, Tasmania, the Spotted Handfish, *Brachionichthys hirsutus,* has been endangered by the introduction of the Northern Pacific seastar, *Asterias amurensis*. Similarly, the European fan worm (sabellid) which has occupied large areas of Port Phillip Bay in Victoria, and which is now found in South Australia, may endanger inshore demersal fish.

As the European fan worm feeds on zooplankton and replaces shelter, its effect on plankton feeders such as pipefish may be particularly detrimental. There have also been records of exotic crabs including established populations of the European Shore Crab - crabs are a major predator of pipefish- in South Australian waters. Invasive *Caulerpa taxifolia* also poses a clear threat to other marine species. Mass die-offs of the Common seadragon, *Phyllopteryx taeniolatus,* were noted by Dragon Search and these corresponded to novel viral epidemics in pilchards. Such events could lead to population loss in other Syngnathids such as pipefish.

This suggests that in the future many marine species will decline or reach extinction in the wild. The pressures on the marine environment are unrelenting. For example, worldwide 90% of large predators have been removed by fishing, thus producing imbalance in the food chain, and the oceans continue to be polluted, by both chemical agents and by the physical agent of greenhouse warming. In the shallow northern end of Spencer Gulf the effects of climate change are exacerbated by warming from power stations. This area holds many unique species of marine life and is poorly known and monitored.

There is no reason to assume that many of the current generation will not continue to recklessly and ignorantly destroy the ocean’s ecology. However, there is also no reason to assume that many future generations will not prefer the sustainable use of natural resources. Imagine if 40 years ago society had said "Why conserve whales, the are almost extinct, what’s the point?", or had said "Why bother setting up national parks?". Thus, although we accept a marine conservation crisis, we also realize that many species can be saved in the wild, and others can be preserved for reintroduction in the future.

Fortunately, for species which will become extinct in the wild, programs are being developed for their preservation. Some of these programs are incidental, such as the aquaculture of seahorses, and encourage economic development. Other programs for the conservation of non-commercial endangered species consist of population enhancement through captive breeding, with genetic diversity maintained through genetic resource banks, offering the best cost to benefit solutions.

Captive breeding is currently being used for the preservation of the Tasmanian Spotted handfish. Stocks, and genetic diversity, of many commercial and non-commercial fish throughout the world are already maintained by these methods. For fish and amphibians (frogs) technologies to enable the indefinite preservation of endangered species through cryopreservation are being developed.

As other technologies develop, the introduction of genes conferring immunity to exotic diseases will enable the re-establishment of populations lost through this cause. Similarly the future eradication of marine pests or genetic technologies may allow the reintroduction of endangered marine species conserved through captive breeding and genetic resource banks. However, no conservation program can be successful without an adequate inventory of species and knowledge of their range, distribution, habitat and biology.

To assess the ability of populations to survive habitat change, biological factors such as size distribution, reproductive age and rate, habitat specificity and dispersal ability are also important. The species most vulnerable to population decline through broad habitat change are those with a limited range and distribution consisting of localized inshore populations with a low reproductive potential. In respect to exotic diseases, it is often very difficult to identify those species most at risk.

The conservation significance of fish species, or definitions of fish biodiversity and marine bioregions, cannot be accomplished without knowing species diversity and distribution. For example, a recent publication by the Natural Heritage Trust, "Conservation overview and action plan for Australian threatened and potentially threatened marine and estuarine fishes" (Pogonoski et al 2002), was clearly compromised by the lack of information on fish diversity and distribution.

Further, advanced methods used to establish marine bioregions are currently based on statistical analysis of species assemblages including those of fish. Considering the resources put into these reports, and their use to direct resources in conservation programs, the lack of funding for an accurate assessment of fish diversity and distribution is remarkable. Many ecologists working on biodiversity programs are producing inaccurate reports based on models using unsubstantial data. Resources would be better spent through the collection of substantial data from the field.

The approach I made to elucidate the conservation knowledge of inshore demersal fish was to study, in detail, one fish group. This study included the group’s range and distribution, habitat and biology. The range of a species is a bio-geographical concept; for instance "the Deep-bodied pipefish is found from Port Phillip Bay, Victoria to Davenport Creek, South Australia". The distribution of a species is the patchiness, and nature of the patchiness, within its range "is restricted to the shallow low energy parts of bays or estuaries at Pelican Lagoon, Port Phillip Bay, St Vincent Gulf, etc.". or "generally distributed throughout its range". The habitat of species includes the geological, vegetation, faunal, and other components within its range.

These may range from essential, to preferred or incidental. For a pipefish an essential component could be *Zostera* seagrass, a preferred certain depth where populations thrive and an incidental bryozoan which always grows on the seagrass, or mud or sand substrate.
Of the inshore groups to choose from, the larger reef fish are being systematically studied by divers in the program “Reefwatch”. Many large reef fish also have long life spans which can

result in "living dead" populations where large old individuals are present but there is inadequate recruitment to maintain the population.

Pelagic (migratory mid-water fish) are monitored by the department of Primary Industry and Resources (PIRSA) to determine the impact of commercial and recreational fishing. These species also generally produce many thousands of highly planktonic larvae which limits measuring the effect of local populations to recruitment. Often they spawn over a limited season which can result in population fluctuations due to poor conditions at the time. Their abundance, particularly at a local scale through migration or schooling behavior can be extreme, further limiting their value as small scale environmental indicators.

Therefore, candidate groups for this study were non-migratory demersal (bottom dwelling) fish, with small numbers of eggs, whose larvae had limited dispersal, and which had a high percentage of species living inshore in bays and estuaries. Previous studies suggested that the Syngnathids (seahorses, seadragons, pipehorses and pipefish) with possibly 50 species, most weedfish (30 species); and many gobies (40 species), snake-blennies and shore eels (20 species), and clingfish (20 species) could be suitable. I chose, of the Syngnathids, pipefish and pipehorses because of their popularity, a reasonable number of species and museum records, and the availability of literature.

The accuracy of taxonomics (the identification of and evolutionary relationships between species), and sampling type and effort, could bias an accurate conservation assessment of a species. Examples of sampling type are equipment used and the time of sampling; time of day, tides, seasons. Sampling effort includes the number of locations, the time spent sampling, and the amount and type of information recorded. Consequently, the pipefish were categorized by sampling types; inshore seagrass/rubble (0-2m; handnets or beach seines), shallow seagrass (2-20m; beam trawls), reef (1-20m; diving), and deepwater species (20-100m; commercial trawls).

Before the study could begin, an accurate key for pipefish identification that was easy to use was needed. Available keys were difficult to use so I produced an easy to use and accurate flow diagram-based key which reduced the number of pages for pipefish from 30 in the standard identification book to 10. I then checked whether the new key system worked with another group. Similarly the pages for weedfish (*Heteroclinus*) were reduced from 22 to 5. This type of key was based on three concepts and it could also easily have species removed to enable simplified regional keys to be made.

To familiarize myself with the species of pipefish and their confirmed distribution I consulted texts and ran through the collection at the South Australian Museum. To gain some practical field experience I handnetted a few locations to see how easy pipefish were sampled. I also established contacts with experts in fish from Victoria and Western Australia, and enquired if there were any studies or specimens of pipefish not included in current books or the museum records.

To my surprise, in the literature there were few records of the size of maturity, fecundity (reproductive rate), or seasonality of reproduction in pipefish. In respect to conservation, these variables can tell you much about the reproductive potential of populations. The habitats in which reproducing and juvenile or sub-adults are found can also tell you the importance of different habitats to life stages. Because of the frequent questions I get asked about the reproduction of pipefish and the paucity of reports in the popular literature, I have included a short review of the current literature.

In many museums unless dedicated studies have been undertaken, studies of non-commercial marine fish species generally have to rely on a poor database. However, this is not the case for all groups and species. The ability of community organizations to contribute is shown by Native Fish Australia SA in their recent studies of the freshwater fish of South Australia. They have recently surveyed the South-east, Kangaroo Island and, to some extent, the River Murray and northern areas. A search of museum and other records were also made. Through this considerable effort, our knowledge of the diversity and distribution of South Australian fish has been greatly increased. Many species new to the state, or to regions, have been identified, and new species recognized. This has shown that conservation measures were inadequate for many species.

Molecular biology programs enable the clear separation of species and of sub-populations. This knowledge combined with information about the range of species enables sound conservation practice. The molecular biology program also needs specimens of marine fish from throughout South Australia, from each species populations to distinguish phylogeny, species, sibling species (newly evolving species), unique populations and other information critical to conservation.

Molecular studies with frogs in eastern Australia showed that what had appeared as one species was, in fact, several, enabling improved conservation management. These studies also infer that many species of previously unidentified frog species are already extinct. This is why the molecular analysis of South Australian fish is essential to their conservation.

On the shelves in the museum were several hundred bottles of pipefish. Many of these bottles contained one or two pipefish, but some contained more. The specimens were from a scattering of locations across South Australia. However, some collectors had left a legacy of locations where systematic collecting over time of a range of species had occurred. From each sample in the museum I recorded the location and date, checked the species, measured the size and sexual maturity and, if brooding, the number of eggs on males.

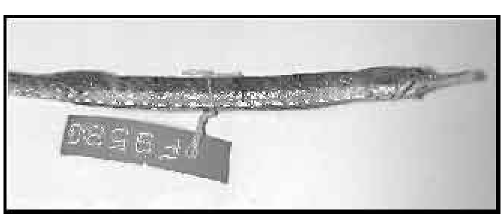
The collection of pipefish in the South Australian Museum. The collection includes samples of many other inshore demersal fish, many of which are unidentified, misidentified, or uncatalogued.

For details of systematics, Dawson 1984 was consulted. Museum database records the date, locality and species and sometimes notes on habitat. Many discoveries were made during the examination of the museum specimens. Some were mislabeled, some included more than one species and some were not included in the catalogue. Currently many databases from museums and other institutions are being incorporated into a national database. This database will be a powerful tool and will be accessible through the web showing a map of the recorded locations of any species and the specific museum record of any sample to be accessed.

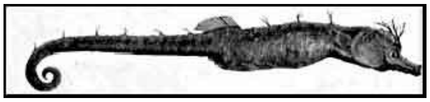
Robert observes pipefish under the microscope. Because of their small size microscope work is needed for some pipefish taxonomy. However, once species are confirmed simple keys can be used for their identification.

However, the efforts with beam trawls by Ward (1980) in the incidental collecting pipefish, a study of the effect of pollution on the benthic invertebrates at Port Pirie, and McDonald (2002) in a study of the fish of seagrass beds of Spencer Gulf had greatly increased the knowledge of shallow seagrass species and communities. Larger deepwater pipefish were regularly caught in trawls but smaller species may not have been detected. One interesting species sampled by trawling is the Tiger pipefish, *Filicampus tigris*. Three records of this species were taken in Spencer Gulf in the vicinity of Port Pirie and Whyalla. No specimens were known in museum databases until recently, in spite of some resurveying.

In fact, the Tiger pipefish was listed as extinct in South Australia by Kuiter (2000), supposedly due to the effects of pollution on a small population. However, recently trawled specimens show the species is still found. Another interesting type is Gales pipefish, *Campithys galei*, from WA, and Tryons pipefish, *Campichthys tryoni*. These are small species (7 cm) with only one supposed specimen of each found in South Australia. As Tryons pipefish has only been recorded from mid-north Queensland, whether the South Australian species is true remains uncertain. Species in this group have recently been sampled and further study may reveal the true status of this group.



A Tiger pipefish Filicampus tigris *recently lodged at the Museum showed this species is not extinct in South Australia as previously suggested.*



The Pygmy Pipehorse Idiotropiscis australe *and many other cryptic reef dwelling species are best discovered by divers. New species have recently been found even in suburban Sydney Harbour, NSW. By observing these species, which are usually localized, divers have made substantial contributions to our knowledge of their behavior and reproduction.*

The ability of marine naturalists to contribute to conservation was shown with reef and inshore/rubble species. Reef species which represent about 30% of potential species were hardly represented in collections and should be readily sampled by recreational divers. Even at the busy Clovelly Beach in Sydney's eastern suburbs, the well-known underwater photographer Akos Lumnitzer found a new species of pygmy pipe-horse in 2003.

However, only one of the reef species, the Southern Pygmy pipehorse, *Idiotropiscis australe,* is recorded in South Australia from Cape Jervis and St Vincent Gulf. Pygmy pipehorses are small (20-50mm long) and they camouflage themselves by growing appendages exactly matching the filamentous algae on reefs where they live. Pygmy pipehorses are distinguished from the protected seahorses and seadragons by their heads being in line with their bodies. Pygmy pipehorses are best observed at night and collected by divers sweeping a fine hand net through such habitat. Habitat preference suggests that many of the other reef pipefish found in Victoria and Western Australia could be found in South Australia.

The Spotted pipefish, *Stigmatopora argus* is found from NSW to Western Australia. Specimens of the Spotted pipefish vary considerably across this range. Consequently, new species could be identified within this complex. Systematic collecting from across southern Australia and the use of molecular analysis are needed to determine the taxonomic status of this group.

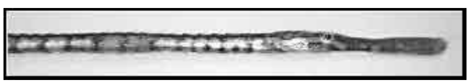
The Southern Gulf pipefish Stigmatopora narinosa *(Browne and Smith, 2007; Museum Victoria, in press). This is the first new species discovered by members of the Inshore Fish Group of the Seadragon Foundation Inc. Image courtesy of Graham Short.*

Interestingly, one of the *Stigmatopora* complex, the Southern Gulf pipefish *Stigmatopora narinosa*, was in 2003 not officially recognized. However, as it was clearly identified from underwater photographs by diving marine naturalist Rudie Kuiter, a specific search was made for it in the museum. I found eleven unrecorded specimens and, if its authenticity is confirmed, the Gulf pipefish will be a new species endemic to South Australia.

If this is the case, the Gulf pipefish is perhaps the rarest pipefish in Australia and one of particular conservation significance; 1) it has been recorded from only a few inshore few localities, 2) these are a rare mixture of rubbly/sandy bottom with seagrass in sheltered locations, 3) these are close to population centres, 4) because of its habitat it should be easy to find, 5) and none were found in offshore trawls which captured large numbers of other *Stigmatopora species*.

Specimens attributed to the Gulf pipefish have been recorded at Cape Jervis, Edithburg, Port Vincent, Port Victoria and Seacliff from 2-5m in association with rubble and seagrass *Amphibolus*.

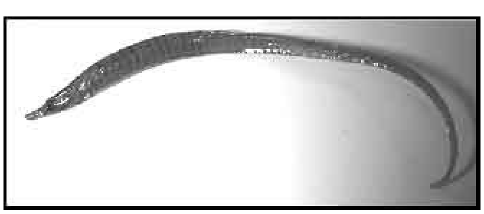
There are only two pipefish with high snouts, the Knifesnout pipefish and the Gulf pipefish *Stigmatopora sp. nov.* If possible specimens of both should be taken to the South Australian Museum. Besides its high and wide snout the Gulf pipefish has a distinctive pattern on its belly.



This Knifesnout pipefish Hypselognathus rostratus *was recently hand netted in less than one meter of water in seagrass at the Edithburgh Marina. This was the ninth specimen recorded. The lodging of this fresh specimen with the museum will its taxonomic status to be determined.*

Most known inshore seagrass/rubble pipefish species were identified by marine naturalists in the 1800s or early 1900s using shore based methods, most probably hand nets. The early identification of these species by few individuals shows that simple sampling methods such as hand nets or beach seines are suitable for sampling of these habitats. Although the other inshore demersal fish have not been rigorously investigated, the same probably applies. Overall, pipefish records, except for deepwater trawled species, were mostly from locations near Adelaide, leaving large gaps in our geographical knowledge of pipefish. This particularly applies from Port Lincoln west past Ceduna, where virtually no records exist.

Vercos pipefish, *Vanacampus vercoi,* is a species that has been of conservation concern. This species was previously common in Pelican Lagoon on Kangaroo Island, and was recorded at both Point Turton and Sultana Beach on Yorke Peninsula, as well as a few dredged sites in Spencer Gulf. Thus it has one of the most restricted distributions of any pipefish. It was previously considered as two species, one of which has only been identified from Pelican Lagoon. At this stage, the systematics and distribution of this type are uncertain. Investigation of recently trawled specimens and molecular analysis of specimens from Pelican Lagoon and other locations are needed to establish the conservation status of Vercos pipefish.



Vercos pipefish Vanacampus vercoi *is endemic to South Australia and is considered as one of most localized in Australia. However, taxonomic work is* *required to tell if it is one or more species, and its relationship to similar species.*

The efficiency of hand nets was shown by the diversity and number of pipefish species found. My hand net was one of the smallest prawn nets sold at fishing tackle shops, only 30cm diameter and of 3mm mesh. By netting *Zostera* seagrass for about one hour at low tide on 11 occasions, I was able to net about 200 pipefish from six species. Of course, most of these fish were released, after measuring and the determination of their breeding status. A few specimens from each location were vouchered for the confirmation of identification and molecular biology studies with the South Australian Museum.

The efficiency of this simple, low impact and enjoyable method was recently shown at the Edithburgh marina. Forty minutes of netting yielded the ninth specimen of the Knifesnout pipefish, *Hypselognathus rostratus,* found in Australia and the first preservation of its genetic material. Also found were two crested weedfish, two spotted pipefish and an unknown goby. Inshore netting has also recently recorded the novel Gulf pipefish at Seacliff. Therefore, anybody willing to spend a few hours with a hand net in the shallows can contribute a great amount to the knowledge of, and conservation of South Australian fish.

For condemning their males to be paternal perambulators, the Syngnathidae have been termed the first suffragettes, although even those worthy women never went so far as to suggest that human fathers should be subjected to lying-in, and their modern sisters would scornfully expect the immediate extinction of Homo sapiens if the male of the species had to carry the baby (Whitley and Allan, 1958).

The reproductive biology of the Syngnathids is particularly interesting as the males brood the eggs. Seahorses have well developed brood pouches, seadragons have brood patches, and pipefish have brood patches which are enclosed to varying degrees. The brooding of eggs by males means that acceptance of the female by the male is a limiting factor in conferring genes to the next generation. This infers that the females would be advantaged by competing for males by ornamentation, pairing, courting or aggression, and all these activities have been observed.

Courting is normal before mating in the Syngnathids, with complex courting rituals a pre-requisite to mating. In South Australia, females of both the Wide-bodied *Stigmatopora nigra* and Spotted pipefish court the males by displaying their chests which are barred. The chest of the Wide-bodied pipefish may be bright red. The South Australian Deep-bodied pipefish, *Kaupus costatus* has the greatest difference of form between males and females of any pipefish. The females are flattened sideways to display bright red and blue bars. Pairing is common in seahorses with pairs observed over long periods.

However, pairing does not always mean fidelity as a wide range of mating patterns are documented in the Syngnathids, including genetic monogamy (faithful pairs) in a seahorse, and polygynandry (more than one female mate) and polyandry (more than one male mate) in pipefish (Jones and Avise 2001).

The Sawtooth pipefish Maraubra perseratta *from Nourlunga Reef, South Australia. Image by Paul MacDonald. Courtesy of Seadragon Foundation Inc.*

Recent studies using molecular techniques to elucidate paternity have shown that polyandry is common in some pipefish species. Moreover, in these species the intensity of sexual selection on females rivals that of any other animals (Jones et al 2001). This, and more females than males, with some females never reproducing in some species, results in very different behavior between males and females; the males are faithful and the females are dedicated, if promiscuous, partners.

Male pipefish reject courting females other than their partner, maintaining the pair bond over seasons. This fidelity, and studies showing that even in primitive pipefish where external fertilization occurs, eggs exposed on the brood patch were all fertilized by the tending male, show the evolution of enclosed brood pouches is not a response to cuckoldry by sneaker males (McCoy et al 2001). Some have suggested that species which live amongst shelter which could brush away the eggs would have brood pouches. However, brood pouches are found in seahorses which do not violently interact with substrates, and brood patches in seadragons which have similar behaviours.

Why then do advanced pipefish have a brood pouch? In these species, the embryos are attached to a placenta-like tissue which seals the pouch folds. The most apparent reason would be to reduce predation. However, no evidence exists of this. One study showed that within this enclosed pouch concentrations of salt were lower than in seawater (Watanabe et al 1999), perhaps reducing the energy expenditure from the egg needed for osmoregulation resulting in fitter larvae from similar sized eggs. If this is the case it is a further transfer of reproductive effort from the female to the male.

Mate guarding by females has been suggested as the main mechanism for maintenance of monogamy in males of pipefish; males losing their partners re-mate within a few days. Females will mate with other males besides their mate during a breeding episode (McCoy et al 2001). However, for unknown reasons widowed females remain unmated for a considerable period (Matsumoto and Yanagisawa 2001). Females in their quest to reproduce with as many males as possible have larger home ranges and are more active in courtship displays (Matsumoto and Yanagisawa 2001). Some interesting benefits have been shown from competition for partners in the pipefish. Broods from preferred matings when either males or females were allowed to choose a partner are superior at escaping predators and grow faster (Sandvik et al, 2000).

The number of eggs in most species of pipefish is not documented. A number of males from the South Australian Museum carried eggs or had mature brood pouches. This has enabled the first tabling of the fecundity of many species. A surprising find was that most species of pipefish only had between 20-30 eggs. This is in contrast to many seahorses which lay hundreds of eggs. In the Wide-bodied pipefish, reproduction had been shown throughout the year. However, there were few species with enough specimens over the seasons to show seasonality from the South Australian records. In many other species, the presence of brood pouches showed few males and in some species no males were found. Brood pouches could be subjected to seasonal variation or these samples could include only female or juvenile pipefish. If this is the case, other un-sampled habitat may be needed for reproduction. Further knowledge will be gained on reproductive status of individuals by their dissection to show the sex and the maturity of gonads.

Although in many pipefish, hatching time and the period between batches is not known, hatching time generally varies from 10-30 days. Pipefish can have several broods in a season, with non-brooding intervals as short as a few days (Matsumoto and Yanagisawa 2001). Many species have been shown to reproduce throughout the year (Howard and Koehn 1985). However, even closely related species may vary in respect to seasonality. The most likely reason for seasonality is variation of the potential adult food and larval supply.

This study shows that more knowledge is needed before sound decisions can be made about the conservation of pipefish in South Australia. Some species are clearly widely distributed and common. Of the inshore seagrass/rubble and shallow seagrass species, these include the Spotted pipefish, Wide-bodied pipefish, Pug-nosed pipefish, *Pugnosa curtirostris*, Long-nosed pipefish, *Vanacampus poecilolaemus*, and the Brushtail pipefish, *Leptoichthys fistularius*. Our current knowledge of some species suggests conservation concern because they are of limited distribution or little known (Vercos pipefish), widely distributed but localized (Deep-bodied pipefish, *Kaupus costatus*), localized and rare (Gulf pipefish), or are little known (Tiger pipefish, Gales and Tryons pipefish, *Campichthys* spp.). However, our knowledge of many other seagrass types is limited to a few specimens and sightings; for example the Knifesnout pipefish. Few specimens and sightings applies generally to reef species where there are few records and many novel species probably exist. This precludes any assessment of their conservation status.

There are a number of characteristics that are desirable in a fish group providing the best environmental indicators of inshore habitats; 1) easy sampling, 2) a moderate number of species, 3) restriction to limited inshore habitat, 4) a short lifespan, 5) reproduced over a long season, 6) produced few large offspring, 7) had a low dispersal rate. Although different species of pipefish varied in these characteristics, generally in different members of the group these characteristics were well represented.

It is clear that the community can greatly contribute, as they have in the past, to our knowledge of pipefish and other inshore demersal fish. Knowledge gained through this process will directly contribute to the conservation of the marine environment. This information can be used to formulate policy in respect to conservation and marine bioregions. Also, observing fish and the excitement of discovering novel species is fun and will provide individuals with an opportunity for environmentally constructive marine recreation.

Community contribution can be through observation or photographic records by divers; or by the collecting of specimens preferably fresh or frozen, and promptly lodged with the South Australian Museum. Once a reliable identification system is established through an extensive knowledge of species, there is no need for further vouchering of specimens. Collected fish can be reliably identified then released. A thorough knowledge of the species and their identification will enable the production of accurate regional keys and identification boards for divers.

Studies of the pipefish have shown that they, and other inshore demersal fish, are an ideal group for engagement of the community in both the diversity and distribution of fish, and for the monitoring of inshore habitat change. The need to monitor future changes in the inshore environment requires the establishment of a series of reference locations to be sampled regularly over the years. These locations should preferably have a mixture of substrates and vegetation types growing in shallow sub-littoral locations. In these locations a number of pipefish species could provide environmental indicators.

As general indicators, these species include the Spotted pipefish and Wide-bodied pipefish. Habitat specialists of value include the Deep-bodied pipefish, Port Phillip pipefish and Gulf pipefish. In addition, a number of other inshore demersal fish could also be successfully sampled with the simplest of means such as hand nets or small beach seines. The community could easily contribute to this sampling and long-erm records from suitable locations would provide a wonderful opportunity for a field and web based marine conservation project.

The information in this essay and much more will be included in a document detailing the Sygnathid species of South Australia, and the current knowledge of their range, distribution, ecology, and biology. This document will be advertised through all marine societies and made publically available. A complimentary web site produced to facilitate community involvement in the proposed South Australian Fish Biodiversity Project will also be produced.

However, in synchrony with increased fieldwork is the need for adequate provision of resources by the government for the systematics of species.

Therefore, besides contributing to conservation through observations, photographs or the provision of specimens, marine conservationists must also enthusiastically lobby the South Australian Government to redress this lamentable situation.

Acknowledgements:

Many thanks to the Marine Life Society of South Australian and the Scuba Divers Federation for their endorsement; and the Dept of Environment and Heritage, South Australian Museum, and the Dept of Primary Industry and Resources for their encouragement of this project. Particular thanks to Steve Reynolds (MLSSA) for the editing of this article, and Ralph Forster (SA Museum) and Micheal Hammer (Native Fish Australia SA) for their assistance, and the South Australian Museum for access to their Sygnathid collection and the provision of facilities. Interstate assistance was provided by Rudie Kuiter (Managing Editor, Zoonetics erBOOKS, www.zoonetics.com), Barry Hutchins (Western Australian Museum), and Martin Gammon (Museum Victoria).

References:

Dawson CE. 1985. Indo-Pacific pipefishes: Red Sea to the Americas. The Gulf Coast Research Laboratory, Ocean Springs, Mississippi, USA.

Howard RK, JD Koehn. 1985. Population dynamics and feeding ecology of pipefish (Syngnathidae) associated with eelgrass beds of Western Port, Victoria.. Aust. J. Mar. Freshwat. Res. 36(3): 361-370.

Jones AG, JC Avise. 2001. Mating systems and sexual selection in male-pregnant pipefishes and seahorses: insights from microsatellite-based studies of maternity.
J Hered. 92(2):150-8.

Jones AG, D Walker, JC Avise. 2001. Genetic evidence for extreme polyandry and extraordinary sex-role reversal in a pipefish. 1: Proc R Soc Lond B Biol Sci. 268(1485): 2531-5.

Kuiter RH. 2000. Seahorses, pipefishes and their relatives: a comprehensive guide to the Syngnathiformes. TCM Publishing, Chorleywood, UK.

Matsumoto K, Y Yanagisawa. 2001. Monogamy and sex role reversal in the pipefish Corythoichthys haematopterus. Anim Behav. 61(1):163-170.

McCoy EE, AG Jones, JC Avise. 2001. The genetic mating system and tests for cuckoldry in a pipefish species in which males fertilize eggs and brood offspring externally. Mol Ecol. 10(7): 1793-800.

Pogonoski JJ, DA Pollard, JR Paxton. 2002. Conservation overview and action plan for Australian threatened and potentially threatened marine and freshwater fishes. National Heritage Trust.

Sandvik M, G Rosenqvist, A Berglund. 2000. Male and female mate choice affects offspring quality in a sex-role-reversed pipefish. Proc R Soc Lond B Biol Sci. 267(1458): 2151-5.

Watanabe S, T Kaneko, Y Watanabe. 1999. Immunocytochemical detection of mitochondria-rich cells in the brood pouch epithelium of the pipefish, Syngnathus schlegeli: structural comparison with mitochondria-rich cells in the gills and larval epidermis. Cell Tissue Res. 295(1): 141-9.

Whitley G, J Allen. 1958. The sea-horse and its relatives. The Griffin Press, Adelaide.