CHAPTER 13. SYNGNATHIDS: SEADRAGONS, SEAHORSES, AND PIPEFISHES OF GULF ST VINCENT

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Figure 1. The male leafy seadragon (*Phycodurus eques*) carries about 300 eggs on a brood-pouch near the base of the tail (photo Brian Scupham).

Introduction

Gulf St Vincent (GSV) is at the centre of the longest temperate east-west coastline in the world, and provides a large variety of habitats, which support a high diversity of fishes from the Syngnathidae family. These habitats range from high-energy reefs and ocean beaches in the south and in Investigator Strait, to a variety of reef types with high algal cover, seagrass meadows, shallow sheltered mud flats, and extensive mangrove forests (Chapters 7, 8, 11, 20).

The name ‘syngnathid’ refers to these unique fishes’ jaws, which are united into a tube-shaped snout with a tiny mouth at the end. Other characteristics of syngnathids are the enclosure of their elongate bodies in bony armour and their small fins. Syngnathids of GSV include the leafy seadragon and weedy seadragon, two of the most spectacular of marine fish, and a variety of fascinating and beautiful seahorses, pipefishes, and a pygmy pipehorse.

Knowledge of the syngnathids of GSV, and across southern Australia, is limited due to the cryptic behaviour of many species, limited research and few surveys, and some cryptic species probably remain to be discovered. However, renewed interest by marine naturalists and scientists has led to the recent discovery of several syngnathid species and recent revisions of their taxonomy (Kuiter 2001; Browne & Smith 2007). Yet, the taxonomy of some syngnathids is in flux with different taxonomic schemes existing (Kuiter 2001; Lourie et al. 2004). Consequently, some species' names must be considered provisional (K. Martin-Smith, pers. comm.).

Syngnathids have become flagship species for the conservation of resident inshore fish, and environmental pressures in GSV provide challenges for their conservation (see 'Threats'). Yet, the iconic status of seadragons and seahorses, and the increasing popularity of all syngnathids in ecotourism, offer hope for their conservation (Fig. 1).

In this chapter, habitat, demographic, and reproductive information are taken mainly from: IFG (2007), SFI (2007), Baker (unpublished data, 2007a,b), Foster & Vincent (2004), Kuiter (1999, 2002, 2003), Dawson (1985), Gomon et al. (1994), Pogonoski et al. (2002), Scott et al. (1980), Waite (1923), and Waite & Hale (1908). Range and distributional data are taken mainly from OZCAM (2007), Baker (2007a,b), and Gomon et al. (1994). Table 1 gives a species' list, with information on geographic range, adult size and fecundity. Common names are from Yearsley et al. (2006).

Biogeography, Diversity and Endemism

GSV is central in the Flindersian biogeographic province of southern Australia, which has been long isolated from other land masses (Chapters 2, 10). The GSV region is transitional between the warm temperate faunal elements from WA and cool temperate elements from SE Australia. Consequently, the fauna includes species at the limits of their western and eastern ranges, as well as endemics and those with a broad Flindersian range (Table 1). About 75-95% of some fish groups (including syngnathid genera), as well as other phyla, are endemic to the region (Wilson & Allen 1987; Poore 1995), because of factors including biogeographic isolation, the sedentary behaviour of adults, and restricted larval dispersal of many species.

The family Syngnathidae currently has 54 genera and 278 species (Froese & Pauly 2007). Recent evidence suggests that the Syngnathidae originated in the Pacific about 40 Ma and then radiated out to other oceans (Wilson et al. 2001). Syngnathids range across the temperate and tropical oceans of the world, with southern Australia being a region of particularly high diversity. A peculiarity of southern Australia is the relatively high number of endemic syngnathid genera with few species. There are ~40 species of syngnathids in southern Australia, a similar number to other major coastal marine biogeographical regions of Australia.

Within GSV there are ~16 genera, 30% of known genera globally, and 27 species, including two species of seadragons, three seahorses, 21 pipefishes, and the southern pygmy pipehorse. Two pipefishes are endemic to GSV, the southern gulf pipefish and Verco's pipefish (Table 1).

Adaptation and Preferred Habitats

The rigid body conformation and small fins of syngnathids are not well adapted for rapid swimming, and thus escape from predators through 'flight' is rare. Syngnathids mainly avoid predation by camouflage—mimicking seagrass or macroalgae—or by sheltering in caves or crevices, or by their hard bony rings, plates and spines. Syngnathids' usage of a wide variety of habitats and their predator avoidance strategies have resulted in diverse body forms. In species from GSV, body forms range from the ancestral Port Phillip pipefish, to the elaborate leafy seadragon, the seagrass-mimicking spotted pipefish, and the red pipefish, which resembles a piece of filamentous red alga. Species like the leafy seadragon and weedy seadragon are so secure in their predator avoidance that even brooding males confidently swim in open water (DSE 2007). Seahorses, the pygmy pipehorses, and monkey tail pipefish (*Stigmatopora* spp.), have prehensile tails to grip structures, such as vegetation, sponges, and bryozoans (Foster & Vincent 2004). By anchoring, they maintain position in currents and during wave action. Even though exposed their shape, posture and colour provide good camouflage (Fig. 2; Kendrick & Hyndes 2003).

Table 1. The geographic range of the syngnathid species of GSV, listed by habitat type, range, maximum length (L), and average adult fecundity (F), in numbers of eggs. Grey shading and text indicate species' ranges across southern Australia, west and east of SA respectively. SAG = Gulf St Vincent, Spencer Gulf, Investigator Strait and Backstairs Passage, and indicates that the species is known only from that region.

Habitat / Species	Distribution West	SA	East	L (cm)	F
Seagrass and Macroalgal Habitat					
leafy seadragon *Phycodurus eques* (Günther, 1865)	WA to Abrolhos Is		Vic., poss. Nth. Tasmania	35	300
weedy seadragon *Phyllopteryx taeniolatus* (Lacepède, 1804)	WA to Abrolhos Is		NSW, Vic., Tas.	45	300
bigbelly seahorse *Hippocampus abdominalis* Lesson, 1908			Vic., Bass Strait Is., Tas.	30 – 35	400
shorthead seahorse *H. breviceps* Peters, 1870	Sth WA		Vic., Bass Strait Is., Tas.	12 – 15	75
southern gulf pipefish *Stigmatopora narinosa* Browne & Smith, 2007		SAG		15	98
widebody pipefish *Stigmatopora nigra* Kaup, 1856	WA to Shark Bay		Sthn. Qld., NSW, Vic., Bass Strait Is., Tas.	~ 16	25
spotted pipefish *Stigmatopora argus* (Richardson, 1840)	WA to Shark Bay		NSW, Vic., Bass Strait Is., Tas.	28	38
deepbody pipefish *Kaupus costatus* (Waite & Hale, 1921)			Vic., Bass Strait Is.	14	25
pugnose pipefish *Pugnaso curtirostris* (Castelnau, 1872)	Sth WA		Vic., Tas., Bass Strait Is.	~ 18	90
Port Phillip pipefish *Vanacampus phillipi* (Lucas, 1891)	Sth WA		NSW, Vic., Bass Strait Is., Tas.	20	30
longsnout pipefish *Vanacampus poecilolaemus* (Peters, 1869)	Sth WA		SA, Vic., Tas., Bass Strait Is.	30	61
knifesnout pipefish *Hypselognathus rostratus* Waite & Hale, 1921			Vic., Tas., Bass Strait Is.	40	
brushtail pipefish *Leptoichthys fistularius* Kaup, 1853	Sth WA		Vic., Tas., Bass Strait Is.	65	45
Reef habitat					
sawtooth pipefish *Maroubra perserrata* Whitley, 1948	Sth WA		Sth Qld., NSW, Vic., Bass Strait Is., Tas.	> 8	
red pipefish *Notiocampus ruber* (Ramsay & Ogilby, 1886)	Sth WA		NSW, Bass Strait Is., Tas., prob. Vic.	17	
southern pygmy pipehorse *Acentronura australe* Waite & Hale, 1921	Sth WA			6	
upside-down pipefish *Heraldia nocturna* Paxton, 1975	WA to Geographe Bay		NSW, Vic., Bass Strait Is. (poss. Tas.)	10	
Broken bottom habitat					
smooth pipefish *Lissocampus caudalis* Waite & Hale, 1921	Sth WA		Vic., Bass Strait Is., Tas.	10	54
javelin pipefish *Lissocampus runa* (Whitley, 1931)	Sth WA		NSW, Vic., Bass Strait Is., Tas.	10	
ringback pipefish *Stipecampus cristatus* (McCulloch & Waite, 1918)			Vic., Bass Strait Is.	25	
mother-of-pearl pipefish *Vanacampus margaritifer* (Peters, 1869)	Sth WA		Sth Qld, NSW, Vic.	~ 20	160
Verco's pipefish *Vanacampus vercoi* (Waite & Hale, 1921)		SAG		~ 11	29
tiger pipefish *Filicampus tigris* (Castelnau, 1879)	WA (temperate)		Nth NSW south to Vic.	~ 35	
Gale's pipefish *Campichthys galei* (Duncker, 1909)	WA (Shark Bay sth.)			> 6	
rhino pipefish *Histiogamphelus cristatus* (Macleay, 1882)	Sth WA			27	
crested pipefish / Brigg's crested pipefish *Histiogamphelus briggsii* McCulloch, 1914			NSW north to Seal Rocks	25	

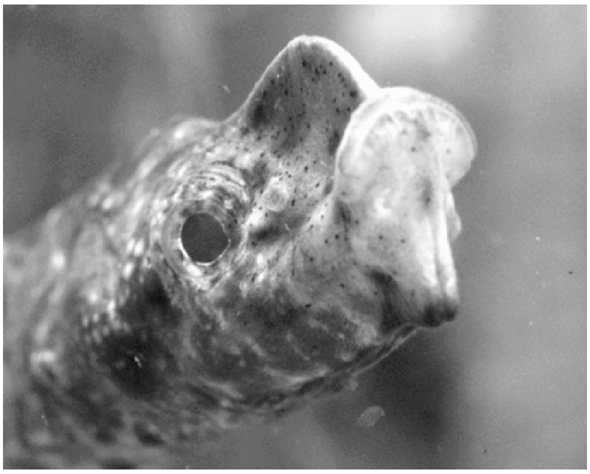

Figure 2. (left) Head of leafy seadragon (*Phycodurus eques*), showing the individually distinctive white markings on the snout and the spectacular ornamentation. The parasitic isopod visible on the upper body is common on several syngnathids from Gulf St Vincent (photo Graham Short).

Figure 3. (right) The rhino pipefish (*Histiogamphelus briggsii*) has a very short and square snout with a relatively large mouth (photo Graham Short).

Food Webs, Feeding, and Predators

In marine food webs, syngnathids are primary, and perhaps significant, predators on zooplankton and nekton. However, their importance as a food to secondary predators has been considered minor. Nevertheless, syngnathids are often abundant, and they can often be the most numerous resident fish. For example, the spotted pipefish is often abundant in *Posidonia* seagrass, and the widebody pipefish, and deepbody pipefish can reach high densities in shallow *Zostera* seagrass beds (Hammer 2006a; Martin-Smith 2007; R. Browne, unpublished data). Syngnathids are demersal and often cryptic, and most are found in shallow to moderate depths in upper shelf waters, perhaps because of their need for concentrations of small crustaceans. Syngnathids' feeding strategies also correspond with their preferred habitat and food source (Fig. 3; Kendrick & Hyndes 2005).

Syngnathids use their elongate tubular snouts to consume small animals, mainly planktonic and nektonic crustaceans and their larvae. They actively position themselves to capture prey, either through swimming or by anchoring with a prehensile tail, and then suck in prey by a bellow action into the snout. Species with short snouts feed on invertebrates in vegetation or among detritus on the seafloor, while those with longer snouts target prey such as mysid crustaceans and other invertebrates in the water column (Branch 1966; Bergert & Wainright 2004; Kendrick & Hyndes 2005).

Kendrick & Hyndes (2005) showed that 12 syngnathid species from shallow, seagrass meadows in WA fed mainly on small crustaceans, and their diets varied with feeding behaviour, snout shape and feeding locations. Of those species also found in GSV, those with long snouts, including monkeytail pipefishes, leafy seadragons and weedy seadragons, and the longsnout pipefish, fed on more mobile prey than those with short snouts, such as Brigg's crested pipefish (Fig. 4) and the rhino pipefish (Fig. 5). The seadragons with long snouts actively hunted mysid crustaceans, which often aggregate above the seagrass (Kendrick & Hyndes 2005). Seadragons also often target mysid crustacean swarms in sand patches within or at the edges of *Ecklonia* or *Macrocystis* forests (K. Martin-Smith, pers. comm.). Shorthead seahorses anchor themselves with a stiff, prehensile tail, have a short pounce range, and consume slow-moving prey.

Pipefishes with good mobility, including the brushtail pipefish and the knifesnout pipefish, feed on a variety of prey found on sediment, seagrass surfaces or in the water column (Howard & Koehn 1985; Kendrick & Hyndes 2005). Of pipefishes found in GSV, the spotted pipefish and widebody pipefish have the most elongate snouts, enabling them to feed on passing prey from their seagrass holdfasts (Kendrick & Hyndes 2005). Syngnathids are food for flathead, snapper, Australian salmon, mullet and other demersal fish, birds, and predatory crustaceans including crabs (Kuiter 2003; K. Martin-Smith, pers. comm.).

Figure 4. (left) Brigg's crested pipefish (*Histiogamphelus cristatus*) is a south-eastern species, found as far west as Gulf St Vincent and Kangaroo I. At Normanville in Gulf St Vincent they are found associated with rhino pipefish (*H. briggsii*) over sand. They have a snout of medium length and appear to feed over worm casts accumulated in the base of ripples (photo Graham Short).

Figure 5. (right) The spotted pipefish (*Stigmatopora argus*) is long and dorsally compressed to provide camouflage in its habitat of *Posidonia* seagrass. This species also has a very long, narrow and tubular snout. The spotted pipefish anchors to the weed with its prehensile tail, and reaches out to capture passing prey (photo Graham Short).

Reproduction

Some syngnathid species have elaborate courtship displays, including dancing and weaving movements (Berglund et al. 1986, 2005; Vincent 1994; Masonjones & Lewis 1996; Koldewey 2004), whilst other species do not obviously display or move vertically during courtship.

Most seahorses are socially and genetically monogamous within each breeding cycle, but may change partners between breeding cycles. Most seahorses have normal sex roles; however, the bigbelly seahorse has sex-reversed roles (Wilson & Martin-Smith 2007). The reproductive roles of many pipefish are also the reverse of those of most fish and other vertebrates, in that females usually initiate reproduction, and in some species compete to place their eggs with males. Pipefish tend to be less monogamous than seahorses, and males may have eggs from several females in the pouch at one time (Vincent et al. 1992; Foster & Vincent 2004; Wilson 2006). In some pipefishes, quivering by the female during courtship is followed by egg transfer to the male, and a subsequent embrace by the pair (Monteiro et al. 2002).

Some syngnathids are sexually dimorphic, and the female is much larger and more brightly coloured than the male. For example, the female deepbody pipefish, which is common in GSV, is vertically compressed and displays spectacular, bright alternating blue and red/yellow bands on the body. Females of other common species in GSV, the spotted pipefish and widebody pipefish, have flattened their already horizontally compressed bodies for display, and female wide-body pipefish display bright red bands on their ventral surface during courtship.

A peculiarity of syngnathids is the brooding by male syngnathids of relatively large eggs in a brood pouch or on a brood patch (Avise et al. 2002). This reproductive strategy protects the relatively few, large eggs, and in some seahorses enables investment of energy or nutrients to the developing eggs by the male (Carpucino et al. 2002). The display and competition pattern may be reversed, when compared with most vertebrates, with ornamented females displaying to and competing for males (Berglund et al. 1986, 2005). However, there is a range of display behaviours, and competition and mate selection are not exclusive to females or males. Reversed sex roles in many syngnathids are limited to species with relatively more competition between females than males, and greater choice by males for partners (Wilson & Martin-Smith 2007).

The development of male brooding structures is thought to be associated with the major evolutionary radiation of the syngnathids (Wilson et al. 2001). It has also been hypothesized that in some seahorses selective mating might influence speciation (Jones 2004). Corresponding with their diverse ancestry, the syngnathids of GSV display a full range of brood pouch types, from elaborate, fully enclosed pouches in the shorthead seahorse, to a semi-enclosed pouch in the deepbody pipefish, to anterior, ventral exposed brood patches in the leafy seadragon (Fig. 1) and weedy seadragon (Fig. 6; Wilson et al. 2001, 2003).

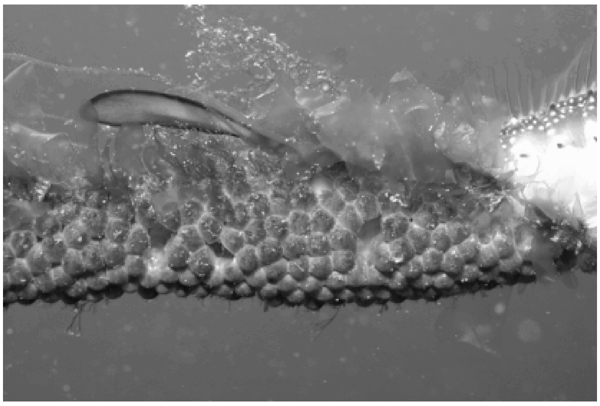

Figure 6. The weedy seadragon (*Phyllopteryx taeniolatus*) carries its approximately 300 eggs exposed under the base of the tail. Other syngnathids have various morphologies to brood the eggs, with the seahorse having a completely enclosed pouch on its belly, and most pipefish having eggs below the tail in semi-enclosed to completely enclosed but unsealed pouches (photo Graham Short).

Seahorse egg numbers vary according to adult size and age, and range from 100-1500 (Foster & Vincent 2004). In pipefish, the number of eggs can vary from 20-200, and eggs are larger than those of seahorses relative to adult size (Table 1; Takahashi et al. 2003). Seadragon broods range from 250-300 eggs (Kuiter 2003). Some male seahorses may physiologically support larval development, and male body size, and pouch size and function, may influence the future fitness and survival of the offspring (Carpucino et al. 2002; Dzyuba et al. 2006).

In pipefishes, the males of some species substantially contribute to egg development, through mechanisms, such as osmoregulation and gaseous exchange functions (Carpucino et al. 2002). Pipefish egg numbers and size do not correspond to adult size, and are much more variable than those of seahorses (Monteiro et al. 2005). The hatching period of syngnathids is between ~20 and 40 days, and has been shown for some species to shorten at higher temperatures (Silva et al. 2006a).

Many syngnathids will brood multiple batches of eggs during most seasons. For instance, in deepbody pipefish from GSV, high percentages of males with eggs were observed throughout the year, except from July to August (R. Browne, unpublished data). In weedy seadragons, Sanchez-Camara et al. (2005) showed that the eggs may be brooded over half of the year, with a summer peak in numbers of brooding males, and some males may have two “pregnancies” in one year.

Syngnathid hatchlings are free-swimming, and begin feeding almost immediately after hatching. There is no parental care or recognition, and seahorse parents may even ingest their own hatchlings (Silva et al. 2006a,b). Early to late juveniles of some species live as nekton for some time. Others immediately adopt the behaviour and habitat of their parents (Silva et al. 2006b).

Some species of syngnathids, including the knifesnout pipefish, have juveniles that disperse, and in other species the adults migrate (Kuiter 2003; Monteiro et al. 2006). Almost nothing is known about the juvenile migratory patterns of syngnathids, including those in GSV. However, for some species of pipefish and seahorses in other regions, very limited dispersion of larvae may affect conservation outcomes (Foster & Vincent 2004; Silva et al. 2006a).

Range, Distribution, and Habitat

Syngnathid species may exist over a broad geographical range. However, within this range their distribution is limited to suitable habitat, which is determined by factors such as species’ camouflage, size, food source, behaviour, and reproduction (Foster & Vincent 2004). Many areas and habitat types in GSV have not been well surveyed for their fish fauna. However, recent surveys have greatly increased our knowledge of the preferred habitats of syngnathids in GSV. Survey methods have included hand and seine netting from shore, and in deeper water, diving and underwater photography, the latter of which can aid the recording of species, their sex, and habitat (see Kuiter 2004; IFG 2007).

Some syngnathids are abundant in their preferred habitat type, but can occur sparsely in other habitats, whereas other species are restricted to specialised habitats. Of pipefishes in GSV, examples of habitat specialists are the sawtooth pipefish and the red pipefish; generalists include the spotted pipefish, Port Phillip pipefish, and pugnose pipefish. The seadragons and seahorses can exist in a variety of different inshore habitat types, and in Table 1 we list species and provide distributional information according to three major habitat types described below.

Seagrass and macroalgae

The two seadragon species are the best known syngnathids from southern Australia, and are often seen by divers in GSV. Both species are large, striking and elaborately ornate, and these characteristics make them a favourite species for divers. Both the leafy seadragon and the weedy seadragon are abundant in SA, and the latter is sometimes named the 'common seadragon' (Fig. 7). The leafy seadragon is fairly common in the GSV region, and occurs in most inshore habitat types, including seagrass meadows, macroalgal-dominated reefs and mixed algal and seagrass areas, but not open areas of sand or mud (Connolly et al. 2002b). These authors reported a leafy seadragon density of ~57 ha^{-1} in seagrass meadows. Seagrass is the most extensive inshore habitat in GSV, but is infrequently explored by divers.

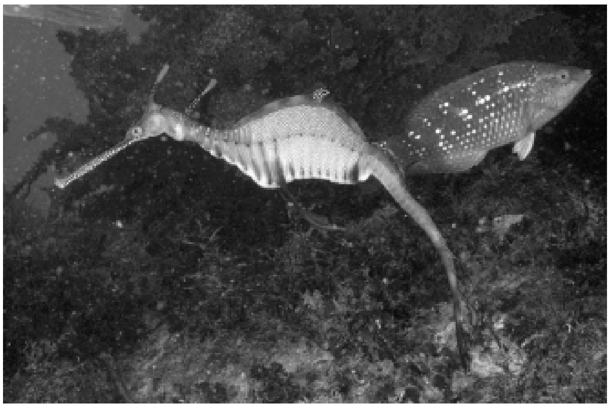

Figure 7. Weedy seadragons (*Phyllopteryx taeniolatus*) are not as ornamented as leafy seadragons (*Phycodurus eques*), but have brighter and more distinct patterns (photo Graham Short).

Abundances of both seadragons are difficult to estimate accurately because of their cryptic camouflage. In SA, an estimate of leafy seadragon densities was obtained in seagrass meadows at West I., Encounter Bay, where, in a long-term monitoring program, Connolly et al. (2002a) used the unique patterns of facial markings of individual seadragons for identification (Fig. 8). Photographic evidence established that of nine individuals recorded over a one-year period, all but one were resident in the study area.

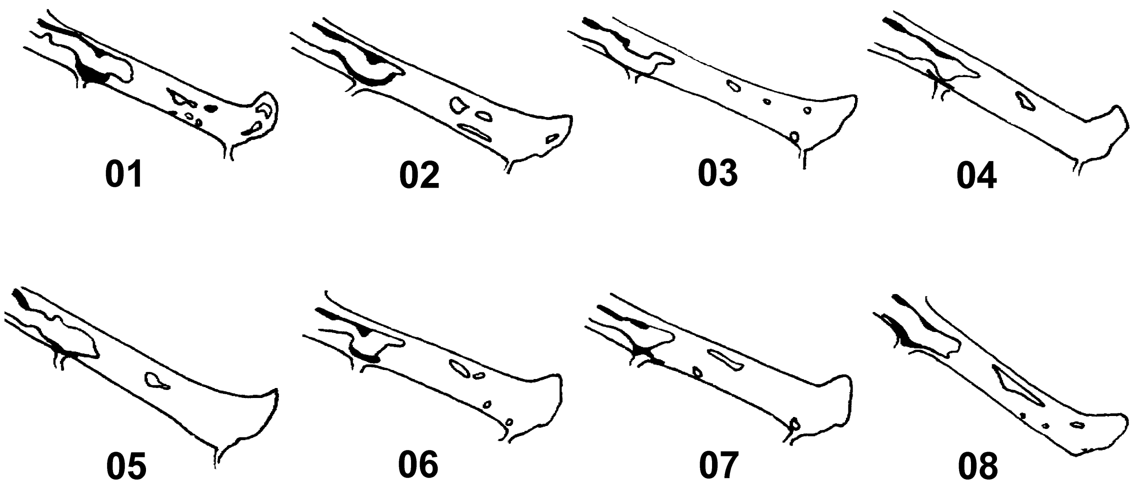

Figure 8. Differences in snout markings among eight individual leafy seadragons (*Phycodurus eques*) in one area in Encounter Bay, South Australia (from Connolly et al. 2002a).

The long appendages and absence of a caudal fin mean that seadragons swim weakly. Connolly et al. (2002b) described patterns of movement by adult leafy seadragons at West I. over periods up to 14 days. All except one of the nine tagged leafy seadragons moved within well-defined home ranges of up to 5 ha, and some stayed within <1 ha (Fig. 9). Short bursts of movement were punctuated by long periods of several days without movement. One leafy seadragon proved an exception, by moving in an almost straight line from its tagging location, at a maximum speed of ~150 m hr^{-1}. A study of weedy seadragons in NSW has shown that most individuals, in common with leafy seadragons, also stay within a home range of <1 ha (Sanchez-Camara & Booth 2004).

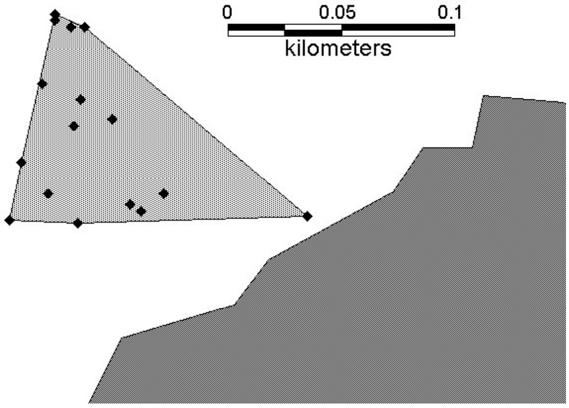

Figure 9. Recorded positions (•) and home range for an individual leafy seadragon (*Phycodurus eques*) in seagrass next to the coastline of West I. Encounter Bay, SA (lower right) (redrawn from Connolly et al. 2002b).

The Dragon Search program provided 15 years of community diver observations of leafy seadragons and weedy seadragons across southern Australia. From these observations, information was derived on seadragon distribution, relative abundance, habitats, breeding seasonality, and behaviour (Baker unpublished data). In the GSV region, leafy seadragon sightings were most numerous in the Rapid Bay and Second Valley area of Fleurieu Peninsula, followed by Encounter Bay, and then the metropolitan coastline. The majority of sightings on the metropolitan coastline were at Seacliff reef; the patch reefs off Glenelg; the artificial tyre reefs off Glenelg and Grange; and jetties along the western coastline of GSV, i.e., Edithburgh, Klein's Point, Port Giles and Wool Bay (Baker unpublished data).

Prior to Dragon Search, historical records of seadragons were of beach-washed specimens on northern Adelaide beaches, and from early dive surveys from Outer Harbour to Port Parham, in which weedy seadragons were observed between 5 m and 15 m depths, usually in *Posidonia* and *Amphibolis* seagrass (S. Shepherd, pers. comm.). No records from northern GSV have been received in recent years, and possibly seadragon populations have declined there, due to pollution or loss of seagrass habitat (Baker 2004).

GSV supports two described species of seahorses, the bigbelly seahorse and shorthead seahorse. A novel form, of interest due to mass strandings but of uncertain taxonomic status, is the 'Willyama seahorse' (IFG 2007). Generally, the bigbelly seahorse is found to ~35 m deep, often near reef edges attached to *Ecklonia* kelp holdfasts, sponges, bryozoans and artificial structures such as mooring chains and netting (Fig. 10; Kuiter 2003; Martin-Smith & Vincent 2005). The shorthead seahorse populates moderate- to low-energy inshore habitats, often in *Ecklonia* kelp or *Sargassum*, or mixed patches of macroalgae and seagrass, to about 15 m. The shorthead seahorse is also found on sponge reef in deeper water, amongst floating macroalgae or around jetties (Kuiter 2003).

The 'Willyama seahorse', so named after a mass stranding in 2006 on southern Yorke Peninsula, is similar in appearance to shortsnout seahorses, but has a different number of rings under the dorsal fin, and a coronet with five radial spines instead of the four in the shortsnout seahorse. The Willyama seahorse could be a morphotype, and its status is currently under study (IFG 2007).

Some pipefish species live in shallow inter- to sub-tidal areas, and inhabit vegetated habitats, which are subject to environmental extremes, including changes in salinity, temperature, and disruptive storms. These conditions tend to produce patchy habitats, often of limited extent, with unstable substrates and structures. Often, patches of different seagrass associations on silt or sand are mixed with patchy macroalgae on rocks. The common syngnathids here are the deepbody pipefish, widebody pipefish, southern gulf pipefish, pugnose pipefish, and Port Phillip pipefish. The widebody pipefish, pugnose pipefish, and Port Phillip pipefish are not restricted to shallow inter- to sub-tidal areas, but are also found in seagrass meadows in deeper water.

The deepbody pipefish forms large populations in shallow, low energy *Zostera* seagrass flats on silty substrates (Chapter 11), and is especially common in northern GSV. The species can tolerate suspended sediment during storms, and periodic inflows of storm water, and surprisingly, can survive in fresh water for several hours, and temperatures >30ºC (Browne, unpublished data). The deepbody pipefish also inhabits *Posidonia* and *Amphibolis* seagrass beds at moderate depths (B. McDonald, pers. comm.).

Figure 10. Bigbelly seahorses (*Hippocampus abdominalis*) are less frequently observed by divers than shorthead seahorses (*Hippocampus breviceps*) in Gulf St Vincent (photo Graham Short).

Figure 11. The southern gulf pipefish (*Stigmatopora narinosa*) is a recently described species found in only metres of water off metropolitan Adelaide beaches in Gulf St Vincent. The recent description of the southern Gulf pipefish shows how little is known of the syngnathids and other inshore fish in the region (photo Graham Short).

In GSV, the widebody pipefish is common in the Onkaparinga Estuary, and from the Section Bank/Outer Harbour on the east coast, and from Port Giles on the west coast, northwards. The widebody pipefish is abundant in *Zostera* seagrass, e.g. in the Onkaparinga Estuary (Hammer 2006a), and often occurs in dense *Posidonia* seagrass with its close relative, the spotted pipefish (Kendrick & Hyndes 2003; Smith & Hindell 2005).

The southern gulf pipefish appears to be endemic to the SA gulfs, with a very restricted distribution in moderately sheltered, shallow open water of 2-5 m depth, and occasionally in large numbers (Browne & Smith 2007). So far it has only been recorded from Seacliff, and the mid to lower western coast of GSV, and lower Spencer Gulf. The known habitats are seagrass beds and mixed habitats of brown macroalgae and rubble/rock substrate within seagrass, as well as small patches of seagrass (*Zostera* and *Posidonia*) with sandy substrate, amongst stands of brown macroalgae (Figs 11, 12; Browne & Smith 2007).

In deeper seagrass beds Port Phillip pipefish becomes abundant. Two main colour morphs of the Port Phillip pipefish are present in the Gulf region, chocolate-brown and pale; the morphs also differ in trunk depth, striping, and colour. The most frequent morph in the mid- to northern Gulf is chocolate-brown, with distinct blue streaks along the sides, perhaps reflecting their dark and muddy substrate. The pale type occurs over sandy habitats, for which it is well camouflaged. There is no evidence that the colour morphs are fixed (IFG 2007).

Many syngnathid species live in and above the vast seagrass meadows of the Gulf. These seagrass meadows are not uniform, and include a mixture of *Posidonia*, *Zostera/Heterozostera* and *Amphibolis* species (Chapter 11). Large areas of seagrass meadows are interspersed with sponge and razor fish beds, or are mixed with rock patches with macroalgae. Common species are the knifesnout pipefish, brushtail pipefish, spotted pipefish, widebody pipefish, and longsnout pipefish; less frequently found in subtidal seagrass meadows are the inshore species, the pugnose pipefish, and Port Phillip pipefish.

The knifesnout pipefish ranges from the mid to lower regions of GSV. Sub-adult and adult knifesnout pipefish inhabit a wide variety of marine habitats. In the Gulf, hand netting has revealed the knifesnout pipefish in shallow (40 cm deep) *Zostera* seagrass, and in Spencer Gulf it is common in deeper water trawls

(P. Jennings, pers. comm.). The knifesnout pipefish has pelagic juveniles, which have been recorded associated with jellyfish (Kuiter 2003; Moran et al. 2003).


Figure 12. (left) A close up of the body and head of the southern gulf pipefish (*Stigmatopora narinosa*). The saddle shaped markings and the solid snout separate *S. narinosa* from the other *Stigmatopora* species (photo Kevin Smith).

Figure 13. (right) Sawtooth pipefish (*Maroubra perserrata*) inhabit caves and crevices in inshore reefs. Photographs by divers have greatly increased our knowledge of the distribution of this species (photo Paul MacDonald).


Figure 14. (left) One of the few records of a southern pygmy pipehorse (*Acentronura australe*) from South Australia, showing the contribution that divers can make to our knowledge of inshore fish (photo Steve Leske).

Figure 15. (right) The rhino pipefish (*Histiogamphelus cristatus*) and Brigg's crested pipefish (*H. briggsi*) on sand flats close inshore at Normanville. The rhino pipefish is on top (photo David Muirhead).

The brushtail pipefish is the longest pipefish known, and is found in the seaward aspect of estuaries and bays within extensive seagrass meadows, generally 2-20 m deep (Dawson 1985). Small juveniles have been observed swimming well above the substrate, along reef slopes, sometimes in small aggregations, perhaps seeking suitable habitat for settling or feeding on crustaceans (Kuiter 2003). In Spencer Gulf, the brushtail pipefish is common in beam trawl samples (P. Jennings, pers. comm.), in *Posidonia* seagrass.

The spotted pipefish is the most widely distributed and abundant pipefish in the shallower *Posidonia* seagrass meadows of GSV, and lives in high densities in seagrass beds without silt, down to ~20 m depth. The spotted pipefish is well adapted to mimic the long strap-like leaves of *Posidonia* seagrass (Kendrick & Hyndes 2003). The longsnout pipefish inhabits seagrass beds in low-energy habitats in clear water, from 1−10 m depth, and occasionally deeper. In GSV, it has been found on shallow subtidal *Zostera* seagrass among shallow reefs.

Reef Habitat

Four syngnathid species, the sawtooth pipefish (Fig. 13), upside-down pipefish, red pipefish, and the southern pygmy pipehorse (Fig 14.), are known to be dependent on reef substrates in the GSV region. The sawtooth pipefish is common in GSV, and occurs close inshore, usually in caves or at the back of crevices, sometimes in shelter in pairs or small groups, behind sea urchins (Fig. 11; Dawson 1985; Gomon et al. 1994; Kuiter 2003). The western upside-down pipefish has different colour and markings, and a smaller caudal fin than the eastern Australian form, and lives to ~30 m depth in low energy bays with little sediment. The species associates with the sawtooth pipefish, often as pairs swimming upside down on the roofs of caves or ledges, or around jetties (Paxton 1975; Dawson 1985).

Although widely ranging geographically (Table 1), the red pipefish is a small, rarely seen species, occurring to ~20 m depth, among red macroalgae. The enigmatic southern pygmy pipehorse has been rarely recorded, but from the few known records, its habitat is among macroalgae and seagrasses, where it is well camouflaged, to ~ 20 m depth.

Broken bottom/ rubble habitat

The term ‘broken bottom’ refers to a mixed mosaic of margins of seagrass meadows, shelly or rubbly bottom, and sandy bottom with patchy seagrass or detritus, and disturbed areas. Species living in these habitats are listed in Table 1. In addition, species, such as the pugnose pipefish and longsnout pipefish, listed as living in seagrass and macroalgae (Table 1), may also occur in this habitat. None of these species are common in trawl or inshore netting surveys.

The smooth pipefish, occasionally found in GSV, lives in shallow water habitats, often 3-4 m deep, where it mimics the exposed roots of *Amphibolis* and *Zostera* (Dawson 1985). The javelin pipefish is more specialised for rubble habitats than the smooth pipefish, and is found in intertidal rock pools to 18 m depth (Dawson 1985). The ringback pipefish has been recorded from clean sandy bottom with sparse seagrass, and near tidal channels in large estuaries at depths of 3-15 m (Kuiter 2003).

The pugnose pipefish is widely distributed in GSV, from low tide level to ~11 m depth, in habitat types, such as mangrove-lined tidal creeks, seagrasses, broken bottom and rubble, and as juveniles in decaying vegetation (Dawson 1985). It is less abundant than the deepbody pipefish and the widebody pipefish.

The mother-of-pearl pipefish is found mostly among vegetation over sand and rubble, to a depth of ~10 m (Dawson 1985). Verco’s pipefish is an endemic species known from <10 sites in the SA gulfs; in Pelican Lagoon, Kangaroo I. it lives in shallow macroalgae and seagrass in tidal channels at ~3 m depth, and at Pt Turton (lower Spencer Gulf) and elsewhere, in tide pools, *Zostera* seagrass and shallow shelly bottom (B. McDonald, pers. comm.). The preferred habitat of Verco’s pipefish is probably on shell and rubble in seagrass beds, on low to moderate energy coastlines. The tiny Gale’s pipefish is found in shallow rubble substrates in Spencer Gulf, and likely occurs in GSV in similar habitat.

Rhino pipefish and Brigg’s crested pipefish (Fig. 15) are often found together in GSV, variously in shallow estuarine seagrass beds, in patchy *Posidonia* seagrass and rubble substrates (K. Martin-Smith, pers. comm.) and open sandy areas around worm casts (Smith 2005; Muirhead 2007). Juvenile Rhino pipefish have been recorded among algal drift (Kuiter 2003). The tiger pipefish is found in upper Spencer Gulf (D. Currie, pers. comm.), and may exist in GSV.

Ecotourism and Conservation

The leafy seadragon is the most popular syngnathid for eco-tourism, and as an iconic species is also SA’s Marine Emblem (DPCPU 2007). Similarly, the weedy seadragon is Victoria’s marine emblem (DSE 2007). Dive sites for viewing seadragons are popular, and those in GSV include the jetties at Rapid Bay, Wool Bay, Kleins Point and Edithburgh. A diving code of conduct for viewing of seadragons has been promoted by government.

Community projects, such as Dragon Search, the Seadragon Foundation (SFI 2007), and the annual leafy seadragon festival at Yankalilla have increased public awareness and education about seadragons and syngnathids in general, and a seahorse breeding facility (SASMS 2007) is a popular tourist attraction with educational significance. Public aquaria, which often display syngnathids, also have value for tourism and education, but as yet none exist in SA (Koldewey 2004; IFG 2007).

The family Syngnathidae is protected under State and federal legislation, and their export strictly controlled. Both species of seadragons are classified as Near Threatened in the IUCN Threatened Species Red List, with habitat loss partly contributing to the status (IUCN 2006).

Threats

Despite formal protection, many threats to syngnathids remain (Whitfield 1998; Bruce et al. 1999; Jackson et al. 2001; Orr et al. 2005; Roessig et al. 2005; Martin-Smith & Vincent 2005, 2006).

Species with juveniles that have limited dispersal are vulnerable to local extinction especially if their habitats are fragmented (Higgins & Lynch 2001; Fagan et al. 2002; Pogonoski et al. 2002; Foster & Vincent 2004; Cushman 2006). The deepbody pipefish, whose preferred habitat is in estuarine *Zostera* seagrass beds (IFG 2007) lives close inshore near urban and industrial areas, or in rural areas, with fertiliser run-off and other pollutants. This species may be particularly susceptible to habitat modification from increased water temperature, silt and pollutants (Borum 2003; Foster & Vincent 2004). Recent mass strandings, through unknown causes, of seahorses on lower Yorke Peninsula are also of conservation concern (IFG 2007).

Methods to address threats in GSV include: biodiversity surveys to record species' distribution, abundance and habitats (Browne & Smith 2007); monitoring of populations of vulnerable species to detect declines (Browne 2003; Hammer 2006b); improving taxonomic knowledge (Browne & Smith 2007); and, where threatening declines are observed, the development of captive breeding techniques (Holt et al. 2003; IDRC 2007); and genetic resource banking (Holt et al. 2003; IDRC 2007).

Recent improvements in husbandry techniques have enabled the commercial production of seahorses (Koldewey 2004). However, most syngnathids of GSV have never been reared in captivity and development of their husbandry techniques should be encouraged. With *ex situ* conservation programs, provision must be made to safeguard natural genetic fitness and flow, prevent the introduction of diseases from captive-bred syngnathids into the wild, and avoid interruption to community dynamics (Bruce et al. 1999; Holt et al. 2003; IDRC 2007).

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