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The sea snakes (Elapidae: Hydrophiinae) of Fujairah

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Abstract

True sea snakes of the subfamily Hydrophiinae are important yet barely known elements of the reef and coastal ecosystems of the Indian and Pacific oceans. We made a total of 100 boat trips between January 2015 and July 2018 with the aim of contributing to the body of knowledge on the marine elapid fauna of the Gulf of Oman off Fujairah. Of the nine species ever recorded from the territory of the United Arab Emirates, we confirmed the presence of eight in our study area. The most frequently encountered species was *Hydrophis platurus* (n = 106), followed by *H. ornatus* (n = 97) and *H. lapemoides* (n = 43). The observation of small juveniles and gravid females suggests that these three species also breed in UAE waters. The least common were *Microcephalophis gracilis*, *Hydrophis cyanocinctus* and *H. schistosus*, represented by as few as three, four and one individual(s), respectively.

Introduction

True sea snakes of the subfamily Hydrophiinae are advanced, morphologically and ecologically diverse proteroglyphous snakes related to cobras, coral snakes, kraits, and mambas. They are highly adapted to living in marine environments. For instance, their tail is flattened and paddle-like to provide propulsion, their ventral scutes are narrow for streamlining, the valves in their nostrils can

close to prevent ingress of water, their lung morphology allows them to stay underwater for prolonged periods of time and a specialised gland under their tongue eliminates excess salt (Heatwole 1999; Fig. 1). One species, the yellow-bellied sea snake, *Hydrophis platurus* is pelagic and considered one of the most widely distributed reptiles in the world. The rapid radiation of these ovoviviparous

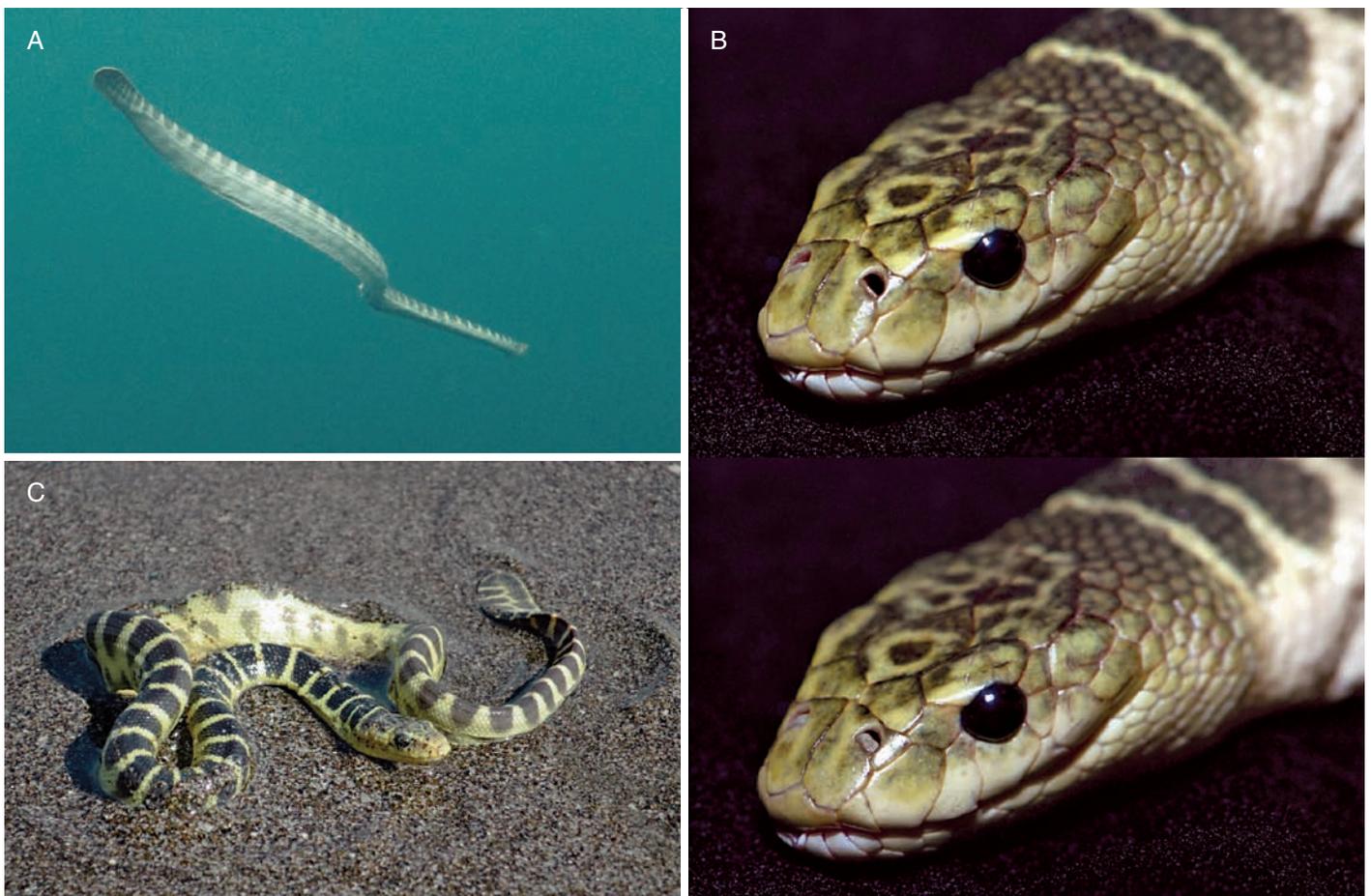


Figure 1. Adaptations of marine elapid snakes—such as the reduced ventral scales, the laterally compressed tail (A) and the valve-like nostril flaps (B) of *Hydrophis ornatus*—serve them well in the deep but render them virtually helpless on land (C; photos by Csaba Géczy [A, B] and Balázs Buzás [C]).

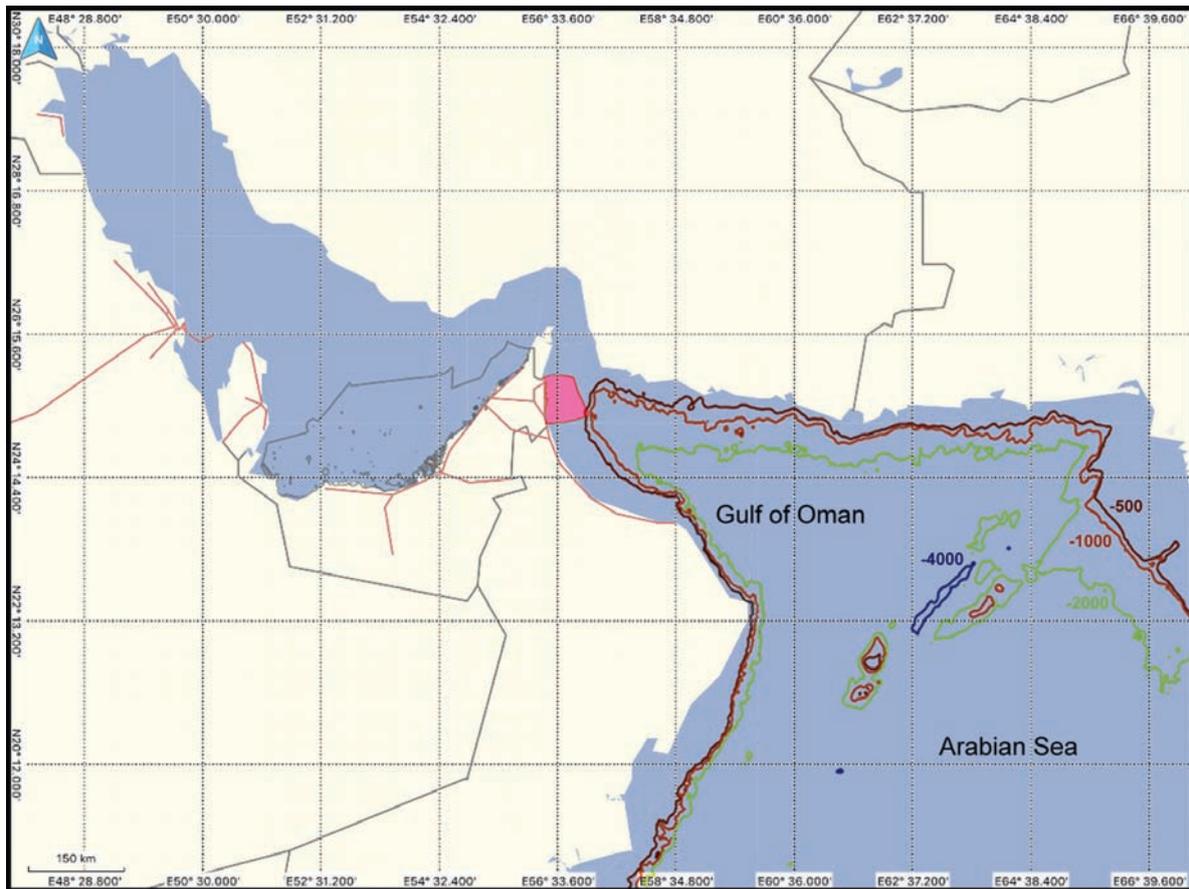


Figure 2. Bathymetry of the northwestern part of the Arabian Sea, with depth contours in metres (modified after Smith & Sandwell 1997). The Exclusive Economic Zone (EEZ) off the east coast of the UAE is highlighted with pink.

creatures is probably driven by dietary specialisation (Sherratt *et al.* 2018). While the majority of species is piscivorous, a few will also take invertebrates including gastropods, and some members of the genus *Aipysurus* eat nothing but fish eggs (Voris & Voris 1983, de Silva *et al.* 2011b). Nevertheless, they all play a crucial role in the trophic structure of reef and coastal ecosystems in tropical and subtropical waters of the Indian and Pacific oceans (Voris 1972, Rasmussen *et al.* 2011b). In general, however, the ecology of marine elapids is poorly known, mostly due to the difficulties associated with studying them, and several species—particularly those with a restricted range—appear to be in steep decline (Bonnet *et al.* 2016, Udyawer *et al.* 2018).

To this day, nine species—*Hydrophis curtus*, *H. cyanocinctus*, *H. lapemoides*, *H. ornatus*, *H. platurus*, *H. schistosus*, *H. spiralis*, *H. viperinus* and *Microcephalophis gracilis*—have been recorded from the territory of the United Arab Emirates (Gasperetti 1988, Soorae *et al.* 2006, 2010, Egan 2007, Gardner 2013). Whereas the Hydrophiinae fauna of the Arabian Gulf has received a reasonable amount of attention from herpetologists and conservationists from various countries (Volsøe 1939, Brown 1987, Gasperetti 1988, Soorae *et al.* 2006, Bishop & Alsaffar 2008, Safaei & Esmaili 2009, Rezaie-Atagholipour *et al.* 2012a, 2012b, 2013), the waters of the Gulf of Oman—and especially off the east coast of the UAE—remain largely unexplored. For the Iranian side of the Gulf, Rezaie-Atagholipour *et al.* (2016) published a major review of sea snakes recovered from the bycatch of

fishing trawlers (Hormozgan, Sistan and Baluchestan provinces) or collected in mangrove swamps off Jask (Hormozgan Province) as well as proved the occasional presence of yet another species, *M. cantoris*. However, apart from two *in situ* photographs of a *H. lapemoides* and a *H. spiralis* taken by Keith Wilson and featured in Gardner (2013), we are unaware of any work even superficially dealing with the hydrophiines of Fujairah.

Recent molecular phylogenetic studies of 39 sea snake species in 15 genera revealed *Hydrophis* to be broadly paraphyletic with respect to several other genera (Lukoschek & Keogh 2006, Sanders *et al.* 2013). Instead of erecting multiple new taxa, Sanders *et al.* (2013) proposed dismantling the mostly monotypic genera *Pelamis*, *Enhydrina*, *Astrotia*, *Thalassophina*, *Acalyptophis*, *Kerilia*, *Lapemis* and *Disteira*, and recognising a single genus for the core *Hydrophis* group. This classification system better reflects the history of the very rapid radiation of marine elapids and is followed by most subsequent authors (e.g., Lillywhite 2014, Rasmussen *et al.* 2014, Ukuwela *et al.* 2014, Udyawer *et al.* 2016, 2018, D'Anastasi *et al.* 2016, Rezaie-Atagholipour *et al.* 2016, Mirtschin *et al.* 2017, Sherratt *et al.* 2018) as well as ourselves in this paper.

The conservation status of every sea snake species recorded from the territorial waters of the UAE was recently assessed by a team of researchers, including the authors, at the UAE National Red List Workshop, applying strict IUCN criteria (Al Hantoubi *et al.* in prep.).

Study area

Unlike the other six emirates constituting the UAE that border the Arabian Gulf, Fujairah has a coastline only to the Gulf of Oman. Situated in the northwest corner of the Arabian Sea, the Gulf of Oman is a strait rather than an actual gulf that links the Indian Ocean with the Arabian Gulf via the Strait of Hormuz. Its circulation is affected by the Northeast (March–April) and Southwest (September–October) Monsoon seasons (Jackson 2004, Pous *et al.* 2004). As confirmed recently by Seaglider surveys, the Gulf of Oman contains the largest—and continuously expanding—oxygen-depleted “dead zones” in the world, covering almost 165,000 km², that cannot sustain marine wildlife. The cause is a combination of climate change and environmental pollution resulting from the runoff of chemical fertilisers and wastewater (Breitburg *et al.* 2018, Queste *et al.* 2018). Average monthly sea surface water temperatures in Fujairah vary between roughly 23 °C in winter and 31 °C in summer months, i. e., the maxima reached in July and August may sometimes be just too high for sea snakes to tolerate (seatemperature.info/fujairah-water-temperature.html): Dunson & Ehlert (1971) report the upper lethal limit for *Hydrophis platurus* to be 33 °C. The waters off Fujairah are part of an Exclusive Economic Zone (EEZ) of 4,370 km² (Fig. 2). There are four Marine Protected Areas (MPAs) within the territory of Fujairah, all defined by the Emiri decree No. 1 of the year 1995: the Al

Aqa MPA, the Dadna MPA, the Rul Dibba MPA, and the Al Bidiyah MPA (with the last one awaiting approval; see www.emiratesdiving.com/marine_protected_areas). The sole sea snake ever recorded in any of them is a stranded *H. spiralis* photographed by Csaba Varga on 19 August 2016 in the Al Aqa MPA.

Materials and methods

We undertook on-water surveys by two motor boats (35 and 48 ft long) in the EEZ between January 2015 and July 2018, both during the day as well as after sunset. Initially, we concentrated our searches to sites pinpointed to us by knowledgeable local sources—professional and recreational fishermen—for their supposed “snake-richness,” including the northern part of the EEZ. However, from 2016 on we focused on areas that actually produced the most sightings of sea snakes in our first year, i. e., to a 10-km wide band off Fujairah municipality stretching from 25°9'40" to 25°5'50" N that we traversed in a large loose pattern from south to north at a speed of 5.5–8 knots (approximately 10–15 km/h). Altogether, we made exactly 100 trips, spent about 11,779 minutes (196.3 h) in the field and covered a total of 3,672.5 km during this period (Fig. 3). Snakes encountered underway were scooped up from the sea surface by using a dip net or—more rarely—collected by hand, immediately transferred to transparent plastic storage boxes containing sea water and normally brought to the laboratory for further processing. In addition to measuring their lengths and weights and determining their sex, we took blood and/or tissue samples of all individuals collected, photographed them and removed and preserved ectosymbiotic barnacles for later analysis. Cloacal—sometimes also buccal—swabs were also taken and regurgitated gut contents were preserved in order to be sent to specialists for identification (Fig. 4). For specimen and data acquisition, the protocols outlined by Bonnet *et al.* (2016) were followed. Snakes were typically released the next day, precisely at the site of collection. Individuals that could not be caught were counted only if their taxonomic identity was beyond any doubt. In addition, we visited all known diving sites off Fujairah and descended 10–50 m deep to search for sea snakes. A few specimens (about 1% of our sample) were found stranded or received from fishermen. These were preserved in alcohol and lodged at the Al Mayya Sanctuary. While lunar phases did not seem to have any effect on snake activity, wind forces above Beaufort #2 rendered detecting sea snakes on the surface considerably more difficult.

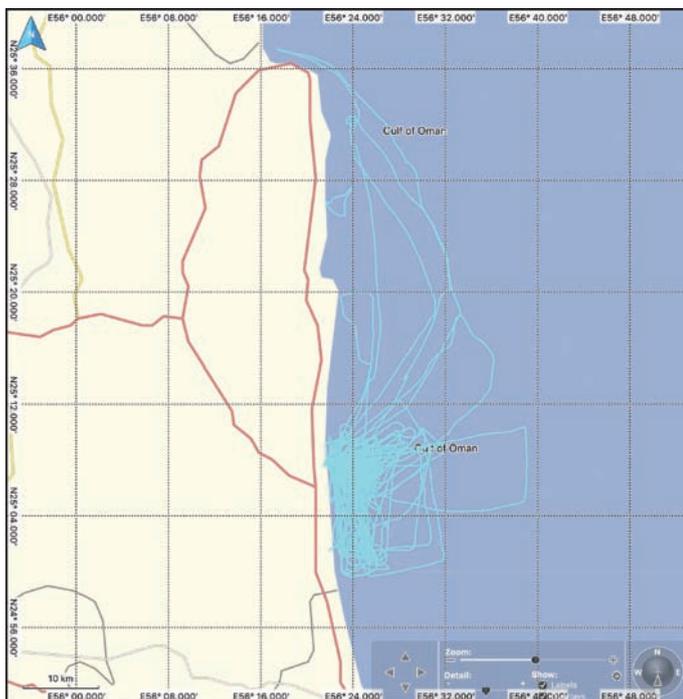


Figure 3. Map showing our boat trips undertaken between January 2015 and July 2018.

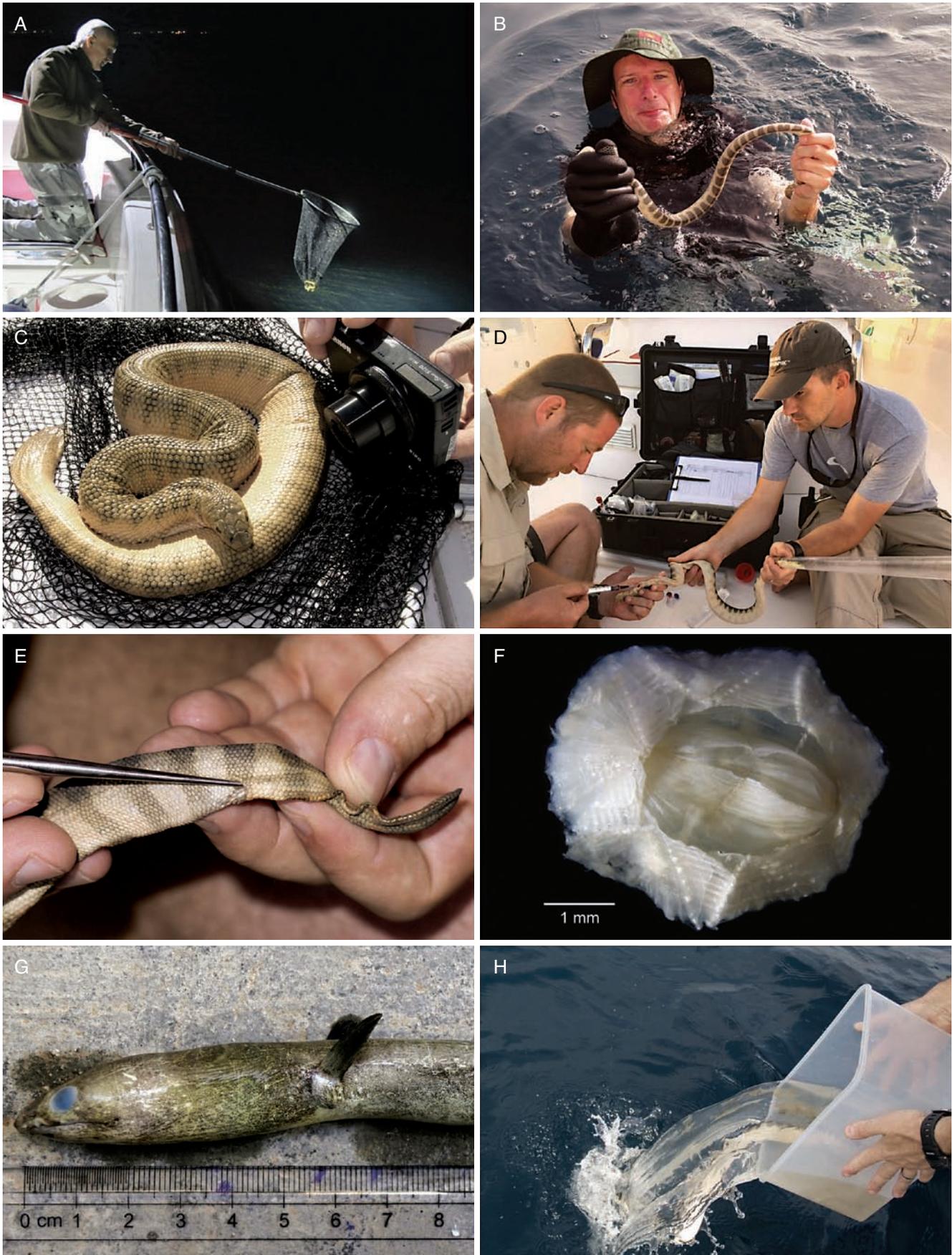


Figure 4. Acquisition of specimens and data. A: Visiting herpetologist Tamás Tóth scooping up a yellow-bellied sea snake, *Hydrophis platurus* from the sea surface by using a dip net (photo by Csaba Géczy), B: Visiting scientist Zoltan Takacs hand-collecting an ornate reef sea snake, *Hydrophis ornatus* (photo by Csaba Géczy), C: Male spine-bellied sea snake, *Hydrophis curtus* posing for a photograph (photo by Csaba Géczy), D: Two of the authors (CsG [left] and BB) tapping blood from a *Hydrophis ornatus* (photo by Eszter Gulyás), E: Sexing a female Arabian Gulf sea snake, *Hydrophis lapemoides* by cloacal probing (photo by Balázs Buzás), F: An ectosymbiotic barnacle, *Platylepas ophiophila* removed from the skin of a *H. ornatus* (photo by Andrew Hosie), G: An unidentified conger eel (Congridae) regurgitated by a yellow sea snake, *Hydrophis spiralis* (photo by Balázs Buzás), H: Returning a *H. ornatus* to the sea (photo by Csaba Géczy).



Figure 5. Colour pattern variation in spine-bellied sea snakes, *Hydrophis curtus* from the Gulf of Oman off Fujairah. A: Female, ss_UAE363, B: Male, ss_UAE032, C: ss_UAE104 just before shedding, D: ss_UAE157 (all photos by Balázs Buzás). Not to scale.

Species accounts

Hydrophis curtus (Shaw, 1802)

Spine-bellied sea snake, لافعى البحرية صغيرة الرأس

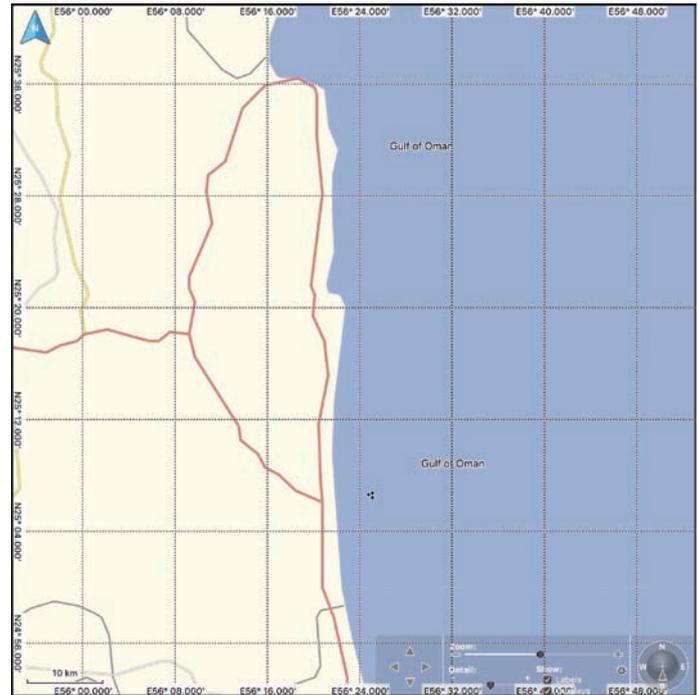
Diagnostic characters: Scales in the lowermost three or four lateral rows larger than the others. Scale rows around neck 23–38; scale rows around body 25–45. Ventrals small, 114–230, usually distinct anteriorly, very small or absent posteriorly. Maxillary teeth behind fangs 3–6 (Rasmussen *et al.* 2011a, Gardner 2013, Rezaie-Atagholipour *et al.* 2016).

Colouration: Body yellow, tan, olive, pinkish or light grey above, whitish below, with 45–55 narrow, light grey, dark greenish, brown or black—often diamond-shaped—bands, which sometimes fuse longitudinally dorsally, narrowing laterally. However, in some specimens the bands meet below and encircle the body. Juveniles typically have a yellow base colour, a blackish head adorned with a yellow curved mark above and incomplete black bands running the length of their body. Individual differences in tail pigmentation allow the field identification of *H. curtus* specimens (Gasperetti 1988, Egan 2007, Rasmussen *et al.* 2011a, Gardner 2013, Rezaie-Atagholipour *et al.* 2016; Fig. 5).

Size: 110 cm (Rasmussen *et al.* 2011a). According to Egan (2007), spine-bellied sea snakes may exceptionally reach 1 m but adults are typically closer to 80 cm in total length (TL). The 15 Iranian specimens measured by Rezaie-Atagholipour *et al.* (2016) had a mean TL of 716 mm, with the largest being 1015 mm (TL). The ten individuals we caught in the Gulf of Oman off Fujairah were between 65 and 94 cm long (TL). Our biggest male (94 cm TL, 344 g) surpassed our largest female (83 cm TL, 298 g) in both length and weight parameters. Nevertheless, the two sexes are capable of reaching approximately the same overall dimensions (Heatwole 1999).

Distribution: From the Arabian Gulf to Japan, the Philippines, Indonesia and the Australian region (Rasmussen *et al.* 2011a). Volsøe (1939) insisted that *H. curtus* is one of the most abundant sea snakes in the Iranian coastal waters of the eastern Arabian Gulf, and Rezaie-Atagholipour *et al.* (2016) confirmed it to be common in the western part of the Gulf (off Bushehr Province) as well. However, records from the marine territorial waters of the UAE are not very numerous. Soorae *et al.* (2006) reported this species from Abu Dhabi Island in the Arabian Gulf, while we encountered it relatively often along the southern part of the east coast, south of Fujairah city (Map 1).

Habitat: Wide range of tropical shallow-water habitats, including gulfs, bays and estuaries, over continental shelves and soft-sediments adjacent to coral reefs. *Hydrophis curtus* sometimes ascends rivers and thus also occurs in freshwater (Lukoschek *et al.* 2010, Gardner 2013). Udyawer *et al.* (2016) revealed this species to prefer slightly deeper seagrass habitats than *H. elegans* in Sri Lanka. From the Gulf of Oman, Rezaie-Atagholipour *et al.* (2016) mentioned a total of six specimens caught off Beris and Pasabandar, Iran at 20–40 m depth in



Map 1. Records of *Hydrophis curtus*.

August 2013. We encountered spine-bellied sea snakes up to 7 km off Fujairah, above depths of up to 55 m, where the bottom is sandy. However, the habitat associations of this species in the UAE are virtually unknown.

Biology: The stomachs of four specimens (out of 12) examined by Volsøe (1939) contained only fish remains, including those of a young king soldier bream (*Argyrops spinifer*, Sparidae), gobies (Gobiidae) and anchovies (*Stolephorus* sp., Engraulidae). Heatwole (1999) indicated *Hydrophis curtus* to be a generalised fish eater, whereas Lobo *et al.* (2005) found remains of fish assignable to five families in the guts of spine-bellied sea snakes, with Clupeidae and Cynoglossidae constituting the largest part of the prey along the western coast of India. Rezaie-Atagholipour (2012) stated them to consume fish referable to 33 families as well as squid and amphipods. Udyawer *et al.* (2016) confirmed the diet of these serpents to



Figure 6. Mating *Hydrophis curtus*, 27 March 2015 (photo by Abdullah Al Zaabi).

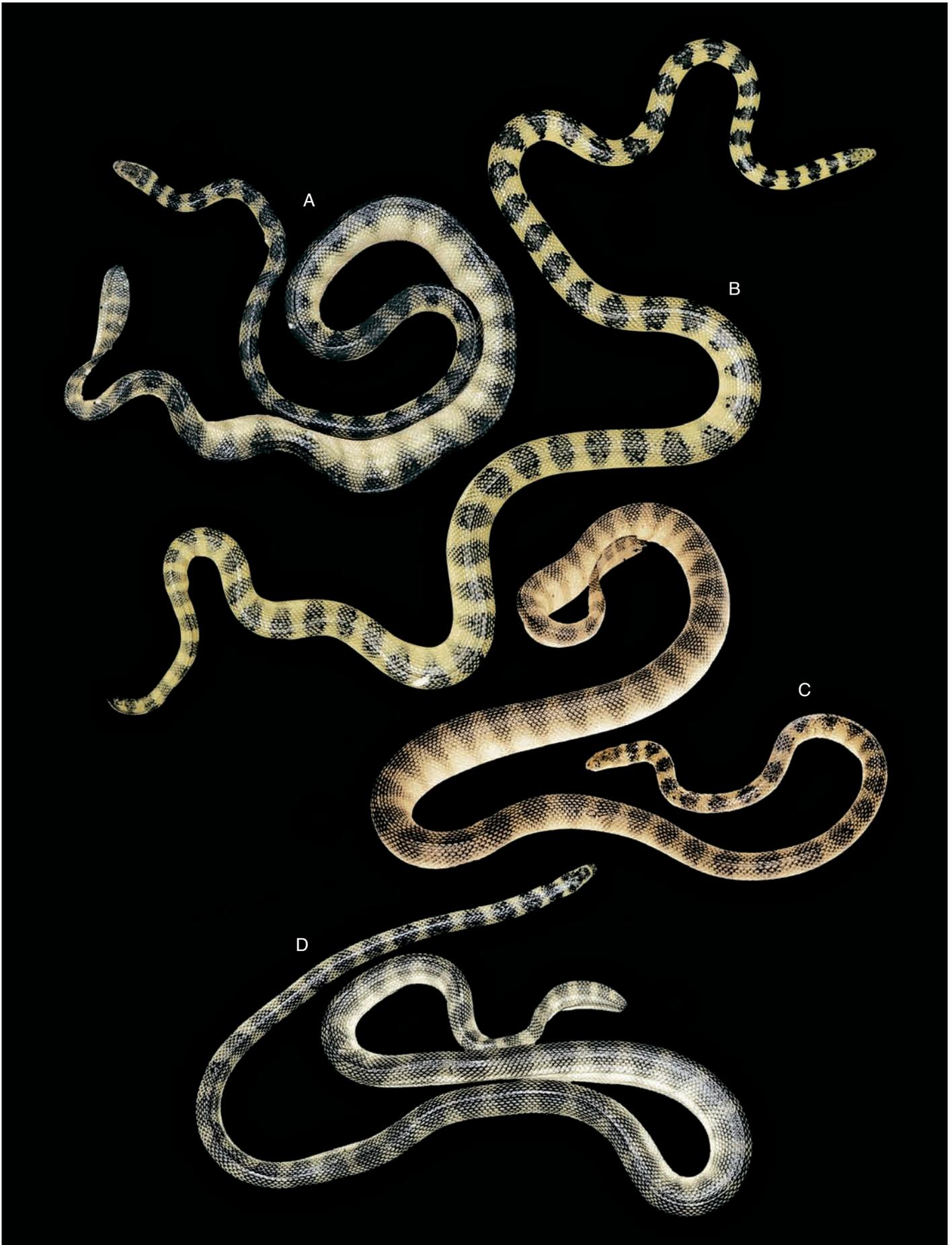


Figure 7. Colour pattern variation in blue-banded sea snakes, *Hydrophis cyanocinctus* from the Gulf of Oman off Fujairah. A: Female, ss_UAE280 (photo by Csaba Géczy), B: Male, ss_UAE260 (photo by Balázs Buzás), C: ss_UAE384 (photo by Nathanaël Maury), D: Male, ss_UAE514 (photo by Balázs Buzás). Not to scale.

comprise at least four families of fish in Sri Lanka and even found evidence of some level of intraspecific predation. De Silva *et al.* (2011b) were the first to report a sea snail, *Babylonia spirata* in the stomach of a male *H. curtus* caught off Valvettithurai, Sri Lanka. An 80-cm (TL) specimen collected by us regurgitated upon capture a 15–17 cm long fish that was too decomposed for identification. We encountered spine-bellied sea snakes on ten occasions, in the months January, February, March, April, June, September, November and December, both during the day and after dusk. Mating was observed once, in late March (Fig. 6). Litter sizes reported for Sri Lankan *H. curtus* were 4 and 10 (de Silva *et al.* 2011a), whereas Heatwole (1999) declared an average of 3.3 young (range 1–6) to be the “norm” in this species. To our experiences, *H. curtus* are usually inoffensive when pulled out of their element but we had one that literally “jumped” out of the transport box to get hold of a glove and also Heatwole (1999) described these snakes as very aggressive if provoked or handled. In any case, their venom contains postsynaptic neurotoxins and probably also myotoxins, and this species is to be considered relatively dangerous (www.toxinology.com). Spine-bellied sea snakes often live in association with sessile (*Platylepas ophiophila*) and pedunculate barnacles (*Conchoderma virgatum*) adhered to the end of their tails. Wounds inflicted by sea birds or predatory fish are also relatively frequent, sometimes appearing rather serious (field Nos. ss_UAE186, 427 and 562). A single voucher specimen of undetermined sex (ss_UAE104) is deposited at the Al Mayya Sanctuary, Fujairah.

Conservation status: Listed as “Least Concern (LC)” globally by the IUCN Red List of Threatened Species (Lukoschek *et al.* 2010), *Hydrophis curtus* was considered “widespread, common, taken as bycatch in trawl fisheries, harvested for skins, food and medicinal purposes” by Elfes *et al.* (2013). However, population size and trend within UAE waters are unknown.

***Hydrophis cyanocinctus* Daudin, 1803**
Blue-banded sea snake, الأفعى البحرية المخططة

Diagnostic characters: Scale rows around neck 27–35, rarely 25; scale rows around body 33–48; ventrals 279–397. Maxillary teeth behind fangs 5–8 (Gasperetti 1988, Rasmussen *et al.* 2011a, Gardner 2013).

Colouration: Very variable. Body silvery grey or pale yellow green above, whitish below. 50–75 dark bluish or black bands, which may be either encircling the body and broadest above, or encircling the body and of rather uniform width, or broadest above and narrowing out to dissolve laterally. On the posterior part of the body the bands are always wider dorsally than the interspaces between them. The young have an olivaceous or yellowish base colour ringed with bold black and often sport a ventral stripe. Their head is black or dark olive with or without a yellowish horseshoe-shaped mark on top. As age advances, the belly pattern disappears and also the back markings lose much of their definition (Gasperetti 1988, Egan 2007, Rasmussen *et al.* 2011a; Fig. 7).

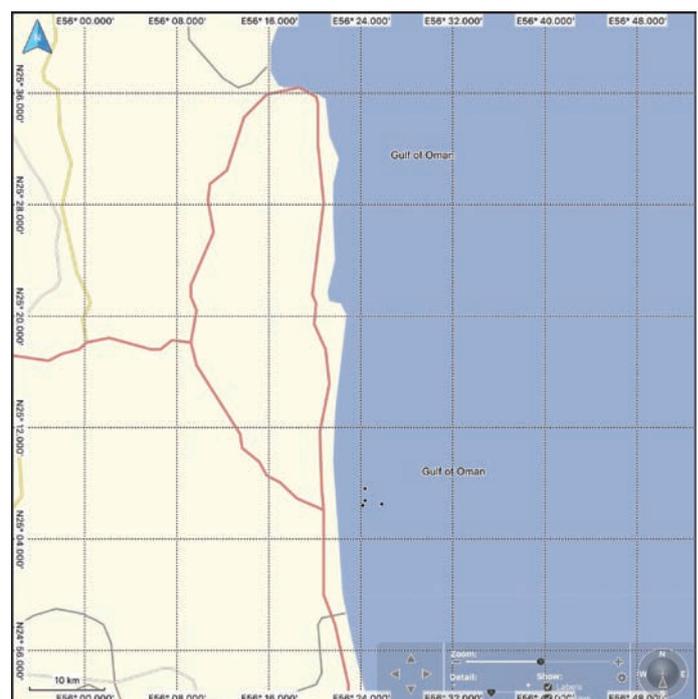
Size: 275 cm (Rasmussen *et al.* 2011a). Egan (2007) claimed that while *H. cyanocinctus* is capable of reaching

over 2 m TL, most specimens are between 1.5 and 1.7 m long in Arabia. For Iranian waters, Rezaie-Atagholipour *et al.* (2016) reported a mean SVL of 117 cm, with their largest female measuring 155 cm SVL and weighing 1019 g. The four individuals we caught in our study area off Fujairah ranged between 105 and 137 cm TL. Our largest confirmed male was 115 cm long (TL) and weighed 251 g, whereas our largest confirmed female had a TL of 133 cm and a body mass of 390 g.

Distribution: From the Arabian Gulf in the west to Japan in the east (Rasmussen *et al.* 2010c, 2011a). Gardner (2013) declared—probably on account of Wall’s (1921) and Gasperetti’s (1988) reports—this species to be abundant in the Arabian Gulf but less so in the Gulf of Oman, and also Rezaie-Atagholipour *et al.* (2012a) found *H. cyanocinctus* to be the dominant sea snake in the Hara Protected Area off the shores of Iran. However, its occurrence in the marine territorial waters of the UAE is poorly documented and presently available data indicate it to be less common than most other hydrophiines, with the only records from the Arabian Gulf originating from strandings on Dubai beaches. Besides, while such observations were more or less regular in the 1990s, their numbers declined strongly over the last decades. Evidences from along the east coast are more numerous but still relatively few (Al Hantoubi *et al.* in prep.).

Habitat: Warm, shallow waters over reefs, seagrass beds or sand; also in mangroves (Gardner 2013). We have encountered this species 4.5–7.2 km offshore in our study area.

Biology: According to Gardner (2013), *Hydrophis cyanocinctus* are often seen basking on the surface and they appear to be more active in the warm season (from April to November). We recorded blue-banded sea snakes on four occasions in our study area, in the months January, July and October, typically in the late afternoon or after dark (Map 2). Volsøe (1939) reported an Iranian



Map 2. Records of *Hydrophis cyanocinctus*.



Figure 8. Colour pattern variation in Arabian Gulf sea snakes, *Hydrophis lapemoides* from the Gulf of Oman off Fujairah. A: ss_UAE141, B: ss_UAE537, C: Female, ss_UAE275 (photos by Balázs Buzás), D: Male, ss_UAE525 (photo by Csaba Géczy). Not to scale.

specimen to have eaten five Indian Ocean slender mudskippers (*Scartelaos tenuis*), whereas also Rezaie-Atagholipour *et al.* (2013) found almost exclusively mudskippers (*Periophthalmus waltoni*, *Boleophthalmus dussumieri*, *Scartelaos tenuis*) and tail-eyed gobies (*Parachaeturichthys polynema*) ingested head first in the stomachs of 34 *H. cyanocinctus* examined by them. Although they detected a positive correlation between predator and prey length, large snakes occasionally consumed small fish as well. In other parts of the species' distributional range, also eels may feature in the diet of *H. cyanocinctus* (Voris 1972, Voris & Voris 1982, 1983). Karthikeyan *et al.* (2008) fed their captive blue-banded sea snakes striped eel catfish (*Plotosus lineatus*). Two specimens (130 and 137 cm TL) we caught regurgitated fish (30–50 cm long), one of them actually being a *P. lineatus*, while the other was an unidentifiable pike conger (Muraenesocidae). We are unaware of any data to confirm Egan's (2007) speculation about *H. cyanocinctus* taking cephalopods (in addition to smooth-bodied fish). Volsøe (1939) recorded two gravid females to contain four eggs, the largest being 65 x 29 mm in size, while Bergman (1943) declared this species to produce about ten embryos per mother each season. According to Karthikeyan *et al.* (2008), females off the Coromandel coast, southeastern India deliver 3–5 young, depending on their size, during January–February, with female offspring being considerably larger than males at birth (469 ± 37 mm vs 382 ± 56 mm TL). A 1285-mm TL female collected early May in Sri Lanka contained five fully developed embryos with a mean SVL of 287.83 mm (De Silva *et al.* 2011a). Clutch sizes reported by Heatwole (1999) ranged between 3 and 16. To our experiences, these snakes are completely inoffensive on land and do not attempt to bite, contrary to claims made by Egan (2007) and Gardner (2013). However, also the www.toxinology.com web site characterises them as “easily angered if provoked” and considers their bites relatively dangerous. Barnacle (*Platylepas ophiophila*) infestation was common among the individuals we collected, and also highly virulent bacteria of the *Burkholderia cepacia* complex were isolated from faecal material (Géczy *et al.* 2017).

Conservation status: Listed as “Least Concern (LC)” globally by the IUCN Red List of Threatened Species (Rasmussen *et al.* 2010c), *Hydrophis cyanocinctus* was described as “widespread, locally common, taken as bycatch in fisheries” by Elfes *et al.* (2013). However, population size and trend within UAE waters are unknown.

***Hydrophis lapemoides* (Gray, 1849)**
Arabian Gulf sea snake, افعى الخليج العربي البحرية,

Diagnostic characters: 29–35 scale rows on the neck, 40–51 scale rows at midbody; 300–404 ventrals. Maxillary teeth behind fangs 11 (Rasmussen 1987, Gasperetti 1988, Gardner 2013).

Colouration: Base colour light grey or pale yellow. The pattern is variable but typically consists of 44–64 blackish, grey or greenish bands, which are broadest dorsally and taper to points on the flanks. These rings fade towards

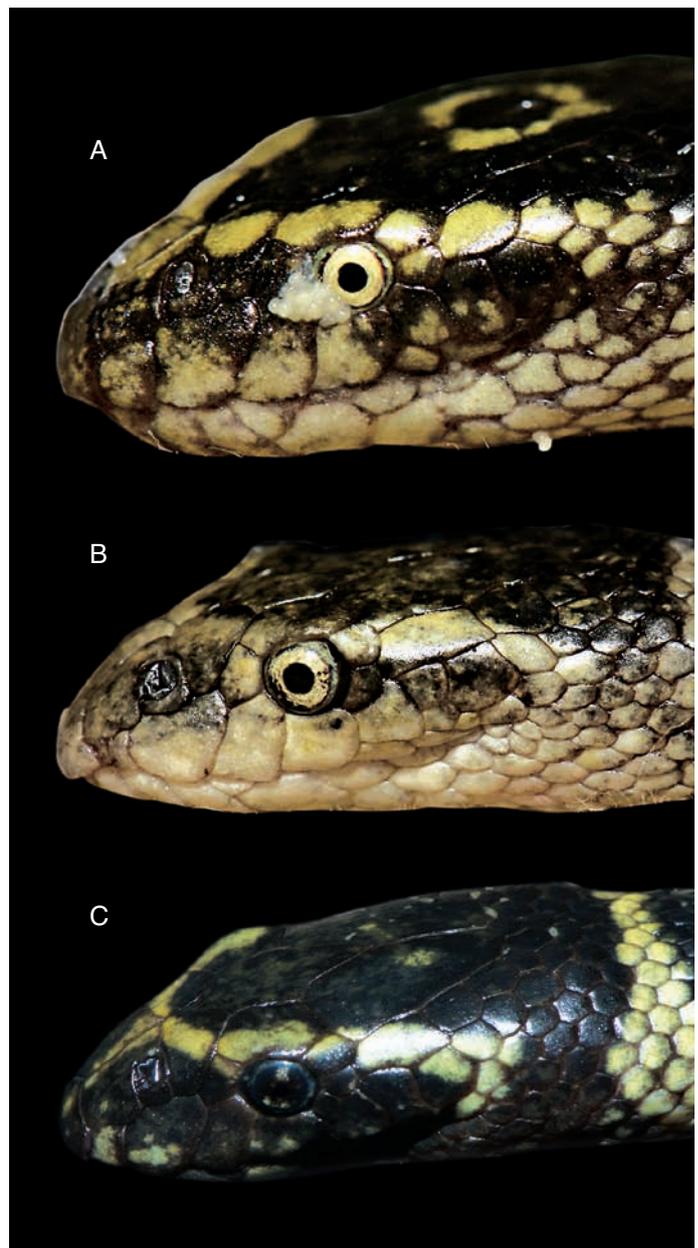


Figure 9. Variation in head pattern and scalation in *Hydrophis lapemoides*. A: ss_UAE141, B: ss_UAE139 (both photos by Balázs Buzás), C: Male, ss_UAE307 (photo by Csaba Géczy). Not to scale.



Figure 10. A *Hydrophis lapemoides* hunting for worm eels or gobies on the sea bottom in the Gulf of Oman off Fujairah (photo by Csaba Géczy).

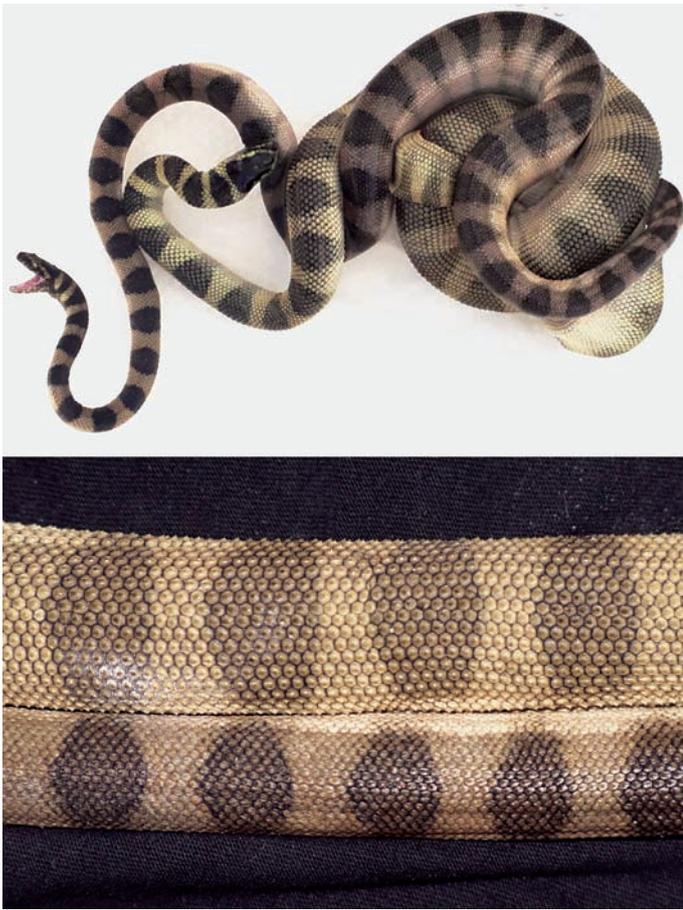
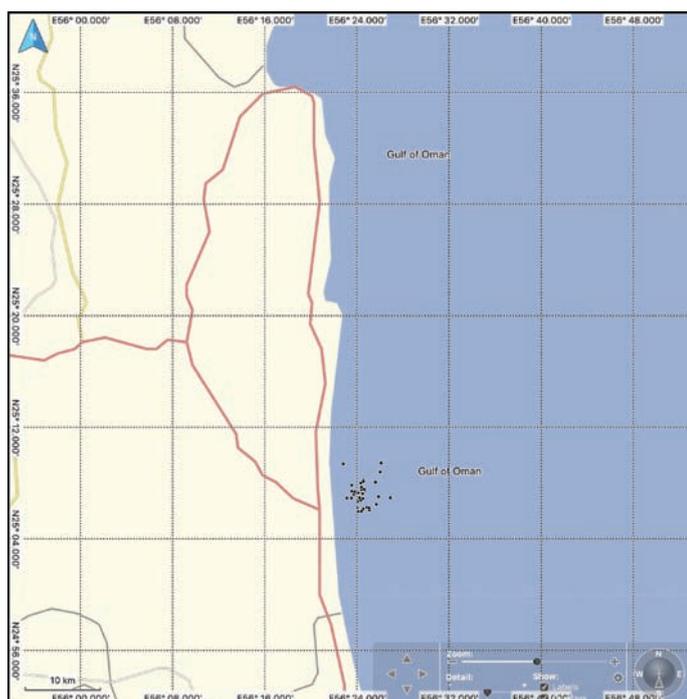


Figure 11. Mating *Hydrophis lapemoides* (male, ss_UAE219 and female, ss_UAE218) in the transport box (above, photo by Balázs Buzás) and dorsals of the same showing spine-like protuberances on the highly rugose scales of the bigger male, possibly serving as a gripping aid during copulation (below, photo by Csaba Géczy).

the ventral surface and may be completely absent in old individuals. Juveniles are white or bleached yellow with bold black bands. The head is black, usually with a



Map 3. Records of *Hydrophis lapemoides*.

yellowish or whitish horseshoe-shaped marking on top (Gasperetti 1988, Egan 2007, Gardner 2013, own data; Figs 8–9).

Size: The maximum size reached by males is 960 mm (TL), with a tail 90 mm long, whereas the largest female ever reported was 925 mm long (TL) and had a tail length of 70 mm (Gasperetti 1988). Egan (2007) claimed Arabian Gulf sea snakes to be capable of surpassing 1 metre in TL but he indicated adults of 80–90 cm to be more common. The single specimen available to Rezaie-Atagholipour *et al.* (2016) from the Gulf of Oman (Jask, Hormozgan Province, Iran) measured 775 mm TL. The 34 *H. lapemoides* we caught in our study area off Fujairah were between 33 and 86 cm long (TL), and the maximum weight we recorded was 227 g. Our largest male was just 2 cm longer than our biggest female (84 cm TL).

Distribution: From the Arabian Gulf through the Gulf of Oman to the western coast of peninsular Thailand, Melanesia and Singapore (Rasmussen 1993, Rasmussen *et al.* 2010d). *Hydrophis lapemoides* was one of the four species recorded by Soorae *et al.* (2006) from the Arabian Gulf off Abu Dhabi Emirate (Jernain Island).

Habitat: Warm shallow water—sometimes less than 3 m deep—over reefs, seagrass beds or sand, often very close to shore, found also in freshwater estuaries (Egan 2007, Gardner 2013).

Biology: Gardner (2013) characterised *H. lapemoides* as a shallow water species that feeds on a great variety of fish. Five individuals caught in Iranian territorial waters of the Arabian Gulf examined by Volsøe (1939) had remnants of fish, probably Gobiidae, in their guts. Voris & Voris (1983) mentioned worm eels as typical prey of this species, while Rasmussen (1993) recovered the remains of fish belonging to four families (Gobiidae, Labridae, Mullidae, and Pseudochromidae) from the stomachs of Arabian Gulf sea snakes in Thailand. Egan (2007) believed that the preferred food of these serpents is eels, gobies and flatfish due to their easier capture. One of us (CsG) actually observed an individual in 45 m depth “lurking” at the burrow of a worm eel or goby (Fig. 10), while one of the specimens we collected regurgitated an unidentifiable cardinalfish (Apogonidae). We encountered *H. lapemoides* in each month except March and July, both during the day as well as after dusk, at 2.7–9.7 km distance from the Fujairah coastline (Map 3). With a total of 43 individuals seen, this was the third most abundant hydrophiine species in our study area. Mating individuals were recorded in May (Fig. 11) and the smallest juvenile (33 cm TL) was caught in November. Gravid females from Phuket, Thailand collected between 3rd October and 4th November (1989) and examined by Rasmussen (1993) contained 1–4 full-term embryos each, whereas Heatwole (1999) reported clutch sizes to range between 2 and 5 in this species. These snakes are typically docile when taken out of water but Brown (1986) claimed that a 42-cm long specimen “was aggressive when moved, opening its mouth and hissing loudly. It was able to move the forward part of its body from side to side a little.” The venom of *H. lapemoides* contains postsynaptic neurotoxins and probably also myotoxins, and this species is considered relatively dangerous (www.toxinology.com). Barnacle

(*Platylepas ophiophila*) infestation was common among the individuals we collected, and several pathogenic bacteria (*Burkholderia cepacia*, *Pseudomonas aeruginosa*, *Pseudomonas luteola*) were isolated from faecal samples (Géczy *et al.* 2017). A single voucher specimen (male, ss_UAE064) has been deposited at the Al Mayya Sanctuary, Fujairah.

Conservation status: Listed as “Least Concern (LC)” globally by the IUCN Red List of Threatened Species (Rasmussen *et al.* 2010d), *H. lapemoides* was considered “widespread, taken as bycatch in trawl fisheries” by Elfes *et al.* (2013). This species seems to be very abundant within UAE waters.

***Hydrophis ornatus* (Gray, 1842)**

Ornate reef sea snake, الأفعى البحرية المبهرجة

Diagnostic characters: Scale rows around neck 34–41; scale rows around body 42–55; ventrals 235–312. Maxillary teeth behind fangs 9–13 (Rasmussen *et al.* 2011a, Gardner 2013).

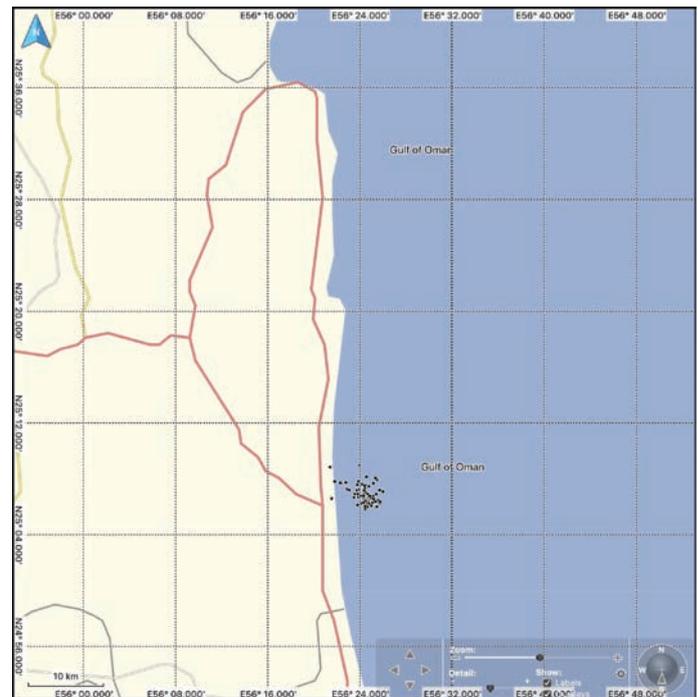
Colouration: Body pale grey, olivaceous, brown, dark yellow or almost white above, yellowish or whitish below. About 50 broad black or dark grey bands or rhomboidal spots separated by narrow interspaces that are almost equidistant anteriorly. Head olive green or greyish dorsally, yellow ventrally (Gasperetti 1988, Egan 2007, Rasmussen *et al.* 2011a, Gardner 2013; Fig. 12).

Size: 115 cm (Rasmussen *et al.* 2011a). Gardner (2013) reported the maximum length to be at least 950 mm (TL) in *H. ornatus*, while Egan (2007) stated that although this species may exceptionally reach 100 cm, most individuals are between 80–90 cm long (TL). The maximum TL given by Smith (1926) was 950 mm for males and 860 mm for females. The six specimens caught by Rezaie-Atagholipour *et al.* (2016) had a mean TL of 988 mm, with the largest being 1200 mm long (TL). The 50 individuals of this species we measured in our study area ranged between 36 and 99 cm TL and the highest weight we recorded was 578 g. Our largest male (86 cm TL) was actually just 1 cm longer than our biggest female (85 cm TL) but weighed nearly 30 g more (578 vs 557 g). It is normal for males of this species to attain larger dimensions than females (Heatwole 1999).

Distribution: From the Arabian Gulf in the west to Japan, the Philippines, Indonesia, New Caledonia and the Australian region in the east (Rasmussen *et al.* 2011a).

Habitat: According to Heatwole (1999), these snakes prefer coral reefs, turbid inshore waters and estuaries. We have seen and collected them at 0.6–8 km distance from the Fujairah coast. Their depth range is unknown but potentially extends to 45 m below sea level in our study area. We have observed a single specimen underwater while diving at the Inchcape 10 ship wreck (Fig. 1A).

Biology: Even though Egan (2007) believes this species to be locally fairly rare, it is in fact reasonably abundant along the east coast of the UAE. We have observed 97 specimens off Fujairah during our study period (Map 4), in every month, both in the course of the day as well as at night. As such, *Hydrophis ornatus*



Map 4. Records of *Hydrophis ornatus*.

was the second most common species after *H. platurus*. Interestingly, also Rezaie-Atagholipour *et al.* (2016) had relatively few—just three—specimens at their disposal from the Gulf of Oman, caught off Beris and Pasabandar, Iran at 20–40 m depth in August (2013). The food of ornate sea snakes consists of a wide range of fish, including free-swimming species, which they probably attack at night, while sleeping (Gardner 2013). Although *H. ornatus* are occasionally found basking in the sun, they are more commonly seen at night, just below the surface (Egan 2007). The typical clutch size is 2–5 young and there is evidence of synchronised annual reproduction (Rasmussen 1989). The presence of small juveniles—observed by us between December and February—points to breeding off the UAE east coast. Ornate reef sea snakes are defensive and try to bite when taken out of water. However, they are not considered very dangerous, even though their venom contains postsynaptic neurotoxins and probably also myotoxins (www.toxinology.com). We maintained a young male (38 cm) in an aquarium for 33 days, when it was released. During this time it did not consume any of the southern platyfish (*Xiphophorus maculatus*) offered as food but shed its skin once. Fish regurgitated by freshly caught individuals were identified as eel catfish (*Plotosus lineatus*) and threadfin breams (Nemipteridae). One specimen (ss_UAE140) disgorged a small clump of gelatinous material that appeared to be a jellyfish. Sessile barnacles (*Platylepas ophiophila*) were found living in association also with these snakes, and one had several lepadids (*Conchoderma virgatum*) growing on its head, ventral scales and tail (ss_UAE552; Fig. 13). Additionally, hemiurid trematodes were recovered from the oesophagus, while faecal material of some individuals contained the bacteria *Chromobacterium violaceum* and *Photobacterium damseale* (Géczy *et al.* 2017). Two injured specimens (ss_UAE498 and ss_UAE573) were found as well. Three

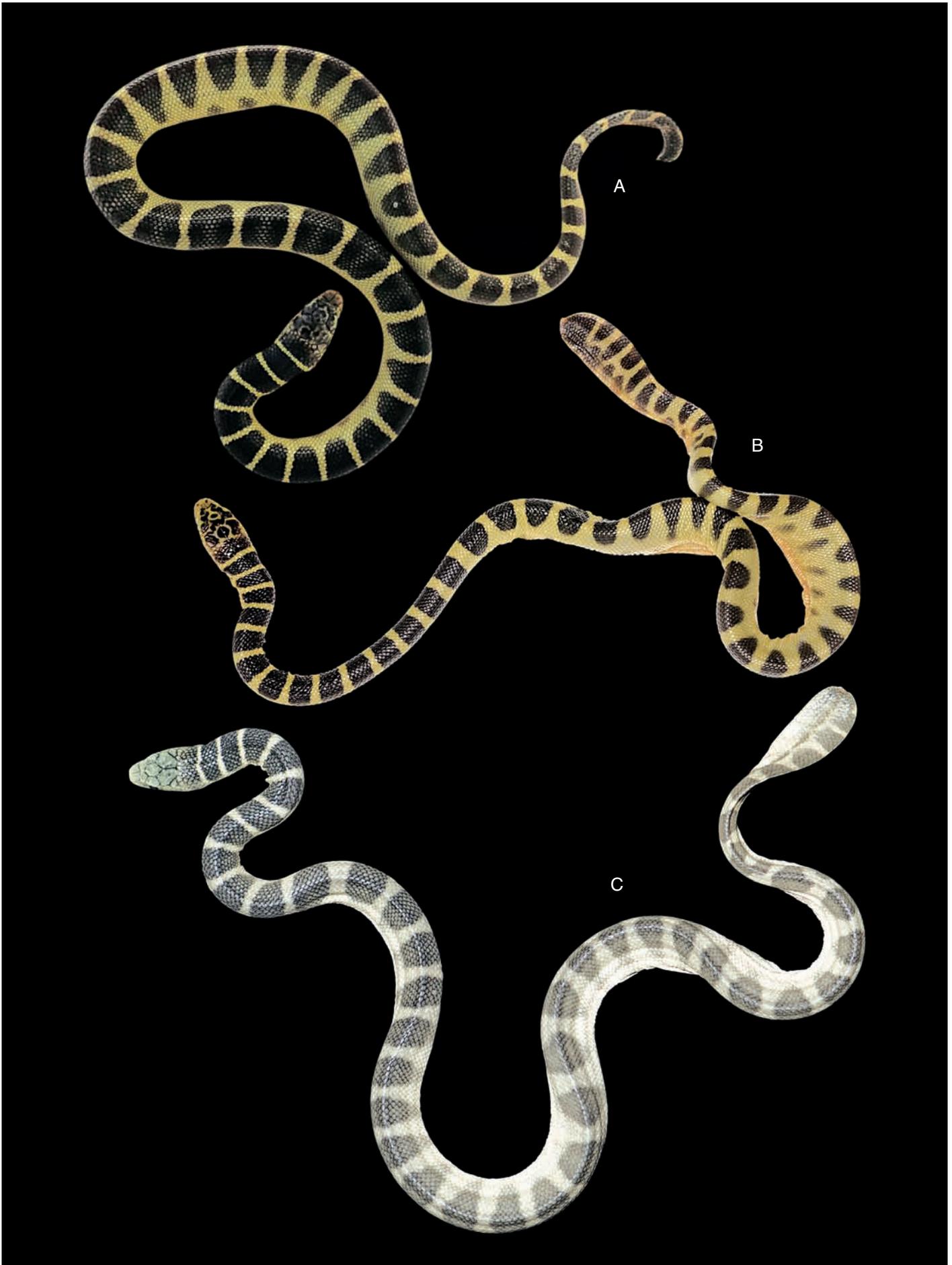


Figure 12. Colour pattern variation in ornate reef sea snakes, *Hydrophis ornatus*. A: Juvenile, ss_UAE020 (photo by Balázs Buzás), B: ss_UAE302 (photo by Nathanaël Maury), C: ss_UAE291 (photo by Csaba Géczy). Not to scale.

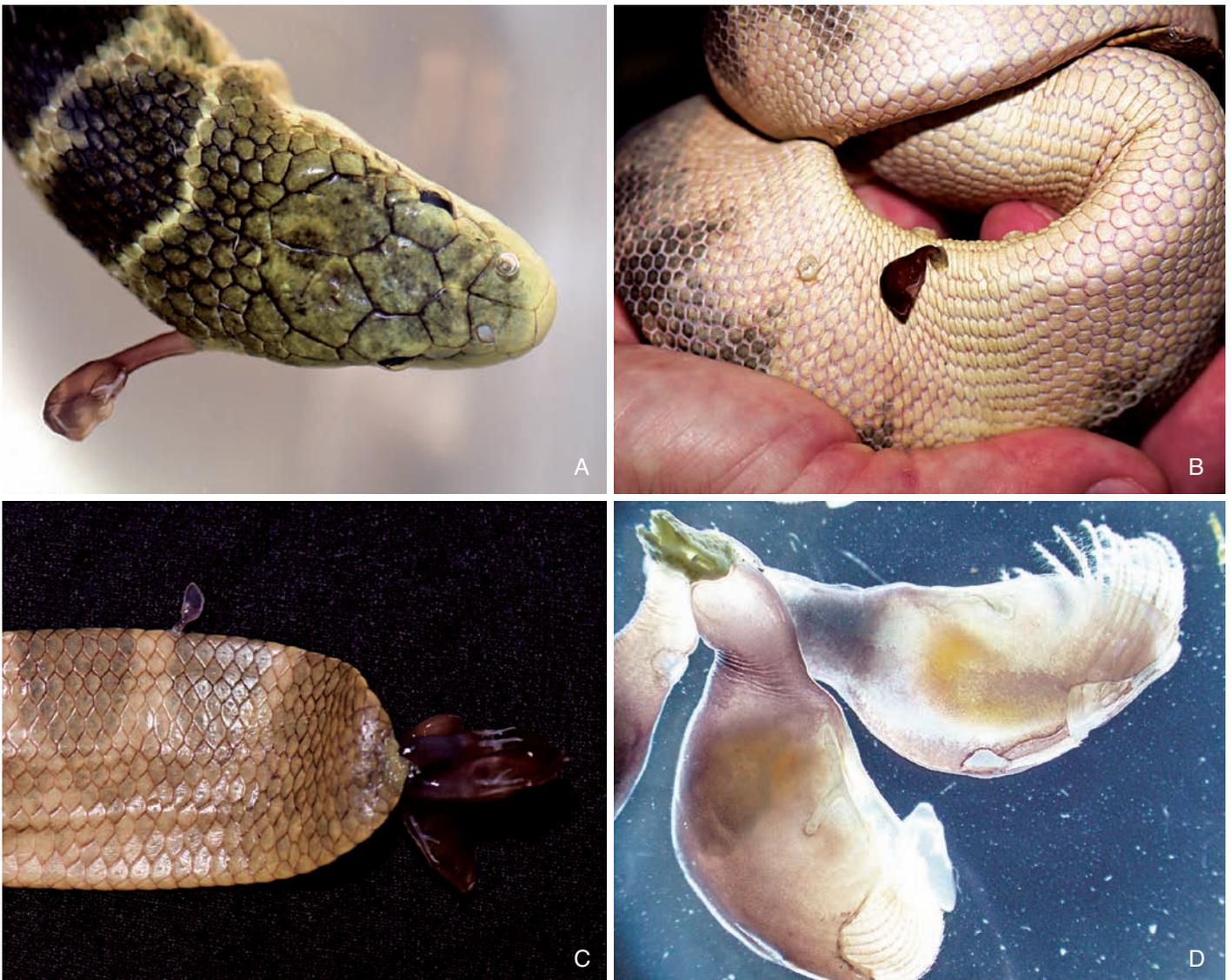


Figure 13. Pedunculate barnacles (*Conchoderma virgatum*) attached to various body regions of a *Hydrophis ornatus* (ss_UAE552) (photos by Balázs Buzás [A], Balázs Farkas [B, C] and Rolf Schuster [D]).

vouchers (female, ss_UAE297, male, ss_UAE528 [head only], female [?], ss_UAE571, unknown sex, ss_UAE573) have been deposited at the Al Mayya Sanctuary, Fujairah.

Conservation status: Listed as “Least Concern (LC)” globally by the IUCN Red List of Threatened Species (Rasmussen *et al.* 2010b), *H. ornatus* was considered “widespread, taken as bycatch in trawl fisheries” by Elfes *et al.* (2013). This species seems to be reasonably abundant within UAE waters.

***Hydrophis platurus* (Linnaeus, 1766)**

Yellow-bellied sea snake, افعى المحيطات

Diagnostic characters: Scale rows around body 49–67; ventrals 264–440 or broken up and similar to adjacent scales. Maxillary teeth behind fangs 7–11 (Joger 1984, Rasmussen *et al.* 2011a).

Colouration: Extremely variable but distinct from all other sea snakes; body black, blackish green or dark brown above, yellow or light brown below. These colours meet along the sides but the exact level varies. Posteriorly (mostly on the tail) the black and yellow areas are broken

up to form spots or even irregular hour-glass-shaped transverse bands (Gasperetti 1988, Rasmussen *et al.* 2011a; Figs 15–18). A nearly uniform yellow form reaching a smaller maximum size was recently described from the Golfo Dulce, Costa Rica as a separate subspecies, *H. platurus xanthos* (Besessen & Galbreath 2017).

Size: 88 cm (Rasmussen *et al.* 2011a). Gardner (2013) erroneously indicated 1000 mm as the maximum length attained by this species. The 28 individuals—some proven to be sexually mature—we measured were between 35 and 65 cm long (TL), with females just barely surpassing males in length (65 vs 61 cm TL). The maximum weight of males was 114 g, of females 154 g.

Distribution: The Indian and Pacific oceans, including the Arabian Gulf and the Gulf of Oman (Rasmussen *et al.* 2011a, Gardner 2013). *Hydrophis platurus* was one of the four species recorded by Soorae *et al.* (2006) from the Arabian Gulf off Abu Dhabi Emirate (Abu Dhabi Island).

Habitat: Yellow-bellied sea snakes are most plentiful in clear, warm, shallow water where surf and currents are weak but may also be found far out at sea, lying on the water surface and drifting with the currents (Gasperetti



Figure 14. Yellow-bellied sea snakes, *Hydrophis platurus* often venture close to shorelines. This one was encountered off Fujairah City (photo by Balázs Buzás).

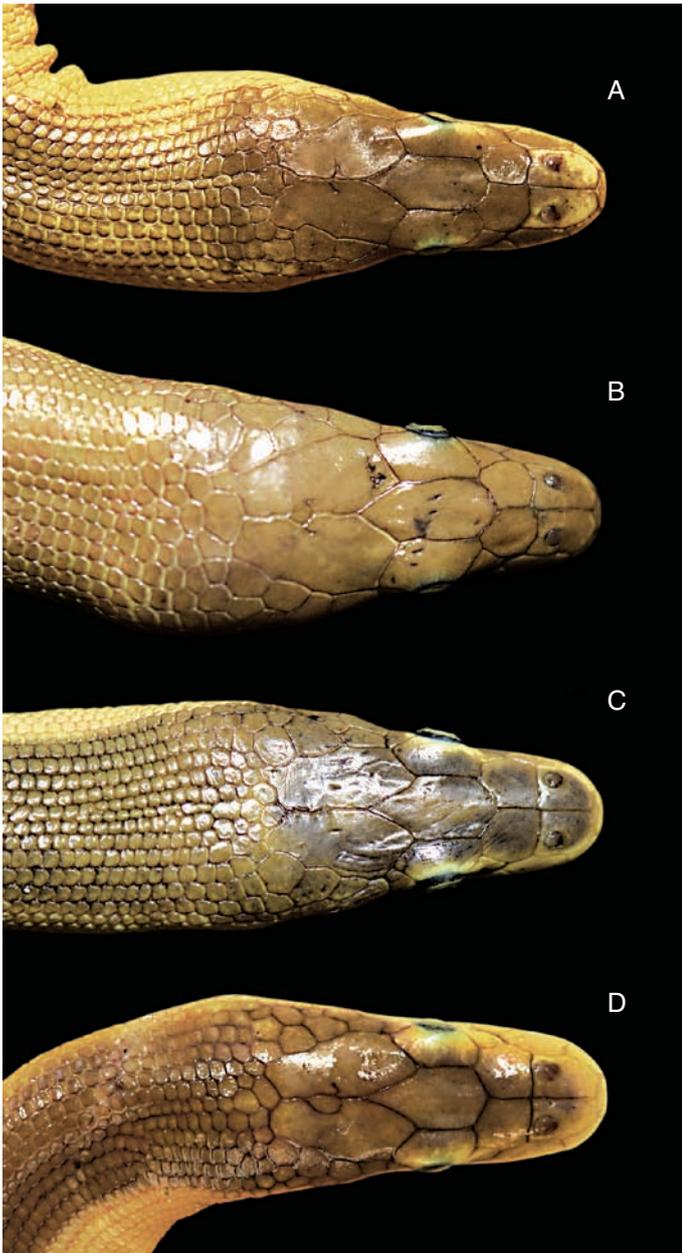
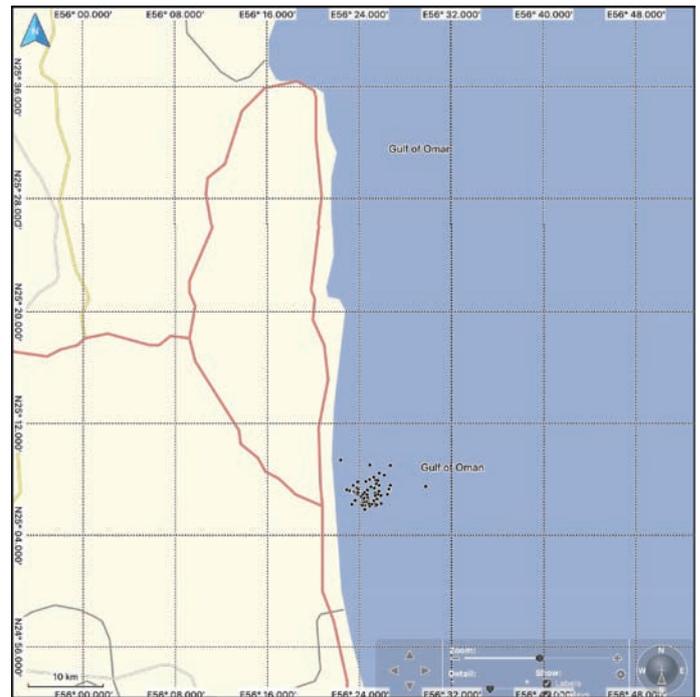


Figure 15. Variation in head scalation and pigmentation in *Hydrophis platurus* collected in the Gulf of Oman off Fujairah. A: ss_UAE143, B: ss_UAE540, C: ss_UAE542, D: ss_UAE556 (all photos by Balázs Buzás). Not to scale.



Figure 16. One of three near-term *Hydrophis platurus* embryos recovered from a female found dead (ss_UAE368; photo by Balázs Buzás).



Map 5. Records of *Hydrophis platurus*.

1988, Gardner 2013). We have met specimens in the upper 0–5 m range of the water column (Fig. 14). Out in the open ocean, *H. platurus* often occur in substantial numbers in association with flotsam or organic debris.

Biology: Although a rapid, graceful and agile swimmer, *H. platurus* is a pelagic species. We encountered it on 106 occasions (Map 5), in every month of the year, both during the day as well as after dusk. Most were seen between 1.6–8.9 km offshore, but some were observed as far as 13.8, 34.5, 44 and 78 km from the coastline. Yellow-bellied sea snakes are surface feeders that lie in ambush for small shoaling fish. If surrounded by a shoal, a repetitive random striking technique is employed. If a single fish is targeted a more precise method is used (Gardner 2013). Reproduction is not known from the marine territorial waters of the UAE but may be assumed. We caught our smallest juvenile (31 cm TL) in May, and a larger one (40 cm TL) in January. A 60-cm dead female (ss_UAE368) contained three well-developed young (22–23 cm TL) in January (Fig. 16). Heatwole (1999) indicated clutch size to range between 1 and 6 (mean 3.3) in this species. We maintained a 32-cm juvenile in an aquarium for two months. It readily accepted southern platyfish (*Xiphophorus maculatus*) as food and shed once during this period. These snakes will bite when provoked and are considered dangerous (Heatwole 1999, www.toxinology.com). We never found sessile barnacles (*Platylepas ophiophila*) growing on the bodies of *H. platurus* but *Conchoderma virgatum* were often attached to their tail ends. Also various bacteria (*Enterobacter* sp., *Kluyvera* sp., *Klebsiella oxytoca*, *Pseudomonas aeruginosa*, *Vibrio fluvialis*) were cultured from faecal matter (Géczy *et al.* 2017) and a single individual (ss_UAE199) bore wounds. One voucher specimen (female, ss_UAE368, head only) from our study area is available at the Al Mayya Sanctuary, Fujairah.



Figure 17. Colour pattern variation in yellow-bellied sea snakes, *Hydrophis platurus* from the Gulf of Oman off Fujairah. A: ss_UAE556 (photo by Balázs Buzás), B: ss_UAE009 (photo by Csaba Géczy), C: ss_UAE143 (photo by Balázs Buzás). Not to scale.



Figure 18. Portrait of a *Hydrophis platurus* (ss_UAE143) collected in the Gulf of Oman off Fujairah (photo by Balázs Buzás).

Conservation status: Listed as “Least Concern (LC)” globally by the IUCN Red List of Threatened Species (Guinea *et al.* 2017), *H. platurus* was characterised as the “most widely distributed sea snake [that] occurs in coastal as well as open ocean habitats, occasionally taken as bycatch in trawl” by Elfes *et al.* (2013). This species seems to be relatively abundant within UAE waters.

***Hydrophis schistosus* (Daudin, 1803)**
Beaked sea snake, الافعى البحرية المنقارية

Diagnostic characters: Mental narrow, elongated and hidden in a groove. Scale rows around neck 40–55; scale rows around body 49–99; ventrals small but distinct, sometimes missing in the most anterior part of body, 239–354. Maxillary teeth behind fangs 3–4 (Volsøe 1939, Gasperetti 1988, Egan 2007, Rasmussen *et al.* 2011a, Gardner 2013).

Colouration: Body grey, bluish grey or olive above, whitish below, with about 40 dark grey or black bands, which fade and usually disappear with age. Juveniles are whitish with vivid black or olive bands (Egan 2007, Rasmussen *et al.* 2011a, Gardner 2013; Fig. 19).

Size: 150 cm (Gardner 2013). Gasperetti (1988) reported average TL to be in the range of 950–1150 mm. The mean TL of 14 Iranian specimens collected mostly in the Gulf of Oman was given by Rezaie-Atagholipour *et al.* (2016) as 1036 mm, and the maximum TL as 1230 mm. The only individual we had access to measured 103 cm. Females attain larger sizes than males in this species (Heatwole 1999).

Distribution: From the Arabian Gulf through India, Sri Lanka, the Indo-Malayan Archipelago, the South China Sea and Indonesia to the Australian region, where it is replaced by the recently described *H. zweifeli* (Rasmussen *et al.* 2011a, Ukuwela *et al.* 2013). Gardner (2013) stated *H. schistosus* to be relatively common in the Gulf of Oman but rare in the Arabian Gulf. However, as the two specimens collected by Rezaie-Atagholipour *et al.* (2012a) and the single individual obtained by Rezaie-Atagholipour *et al.* (2016) all originated from the Strait of Hormuz, they cannot be strictly allocated to either population. Even though Safaei & Esmaili (2009) and Rezaie-Atagholipour *et al.* (2016) claimed *H. schistosus* to be one of the most abundant species of sea snakes along the Iranian coast of the Gulf of Oman, we managed to observe and catch just a single individual off Fujairah, 6.3 km from the shore.

Habitat: Beaked sea snakes prefer near-shore shallow waters with a sandy or muddy substrate where they may be seen on the surface at night. They also enter estuarine areas, lagoons and harbours (Egan 2007, Rasmussen *et al.* 2010f, Gardner 2013). Redfield *et al.* (1978) specified the depth range of *H. schistosus* as 3.7–22.2 m.

Biology: Voris *et al.* (1978) reported the prey of *H. schistosus* to consist for about 80% of tachysurid catfish and 15% of eeltail catfish (Plotosidae) and puffers (Tetraodontidae) at the mouth of the Muar River in Malaysia. However, Egan (2007) argued that beaked sea snakes would take almost any small fish but preferred gobies (particularly shrimp gobies) and eels—apparently due to their easy capture. Mating beaked sea snakes were seen floating on the surface by Rezaie-Atagholipour

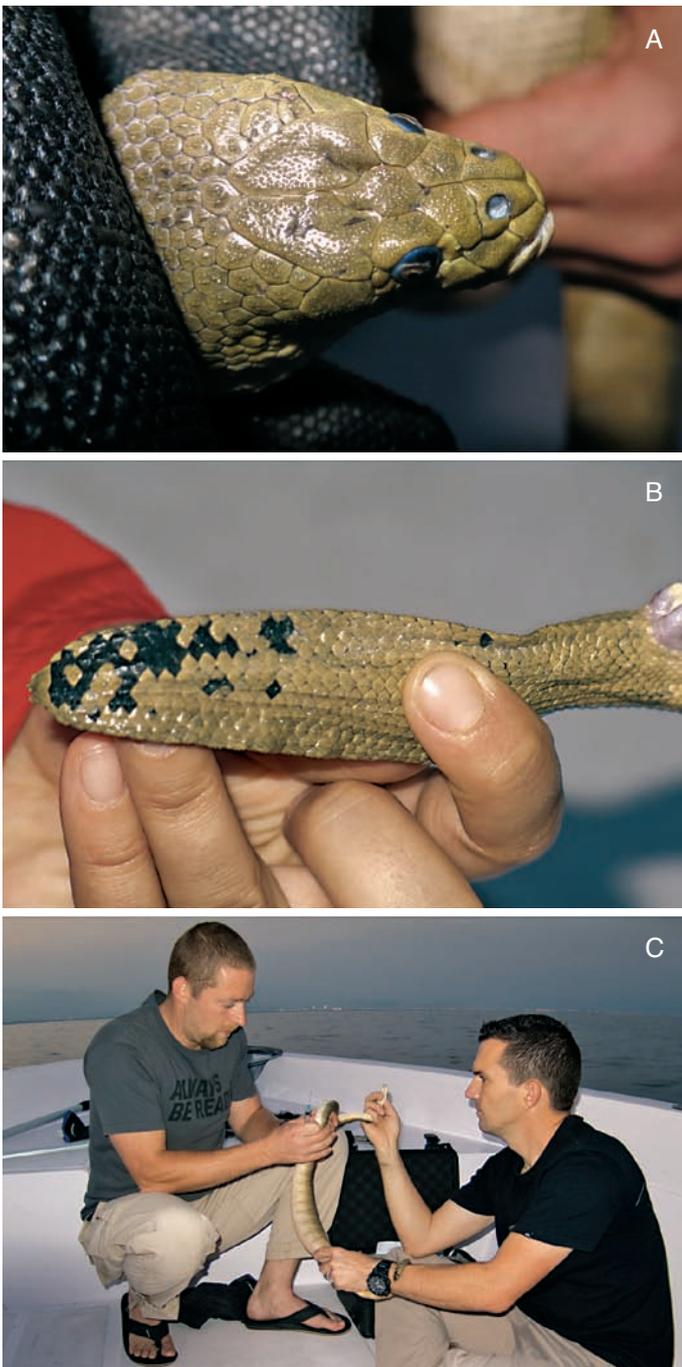
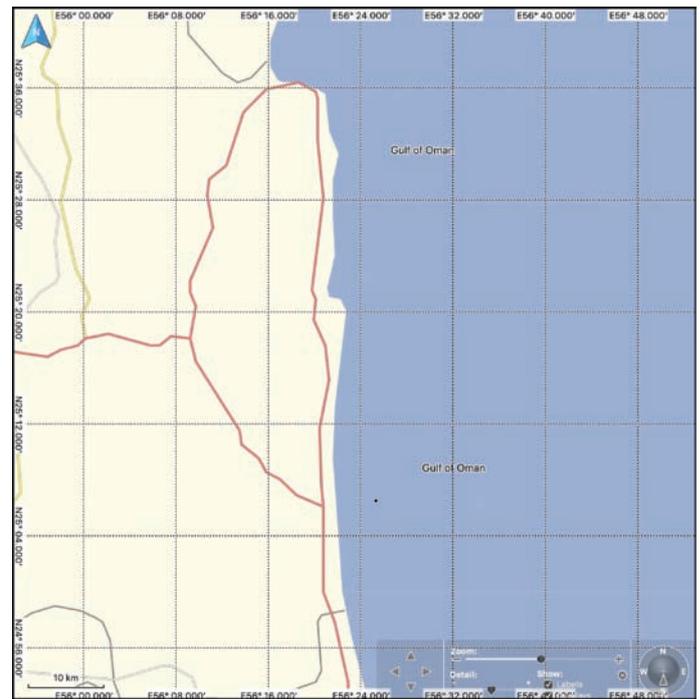


Figure 19. A beaked sea snake, *Hydrophis schistosus* caught in the Gulf of Oman off Fujairah. A, B: Details of specimen ss_UAE010 (both photos by Balázs Buzás), C: Two of the authors (CsG [left] and BB) taking a blood sample for molecular studies (photo by Eszter Gulyás).

et al. (2016) in December (2013) off the Iranian coast in the Gulf of Oman. Of three specimens taken at the end of March and examined by Volsøe (1939), two were gravid females containing four or five eggs 45 mm in length, near ovulation. Also Bergman (1943) attested this species to produce five embryos per mother each season, while Razzaque Sarker *et al.* (2017) found ten eggs measuring 9–16 x 18–25 mm in a gravid female obtained as fisheries bycatch in Cox’s Bazar District, Bangladesh in September–October (2013). The egg numbers of females collected in June 2010 from two different locations in the Puttlam Lagoon, Sri Lanka ranged between 7 and 16 (de Silva *et al.* 2011a). On the other hand, Heatwole (1999) reported



Map 6. Record of *Hydrophis schistosus*.

—based on various sources—a mean clutch size of 18.3 and a range of 4–11 in this species. Our single specimen was caught late in the afternoon (Map 6). On account of this individual we can confirm previous claims that beaked sea snakes are easily angered and aggressively defend themselves on land (Heatwole 1999, Gardner 2013, Kularatne *et al.* 2014, Rezaie-Atagholipour *et al.* 2016). With its venom containing postsynaptic neurotoxins and systemic myotoxins, *H. schistosus* is to be regarded as the most dangerous marine elapid in the region (www.toxinology.com).

Conservation status: Listed as “Least Concern (LC)” globally by the IUCN Red List of Threatened Species (Rasmussen *et al.* 2010f), *H. schistosus* was considered “widespread and common, taken as bycatch in trawl fisheries” by Elfes *et al.* (2013). However, this species appears to be a rare vagrant within UAE waters.

***Hydrophis spiralis* (Shaw, 1802)**

Yellow sea snake, الأفعى البحرية الصفراء

Diagnostic characters: Scale rows around neck 25–32; scale rows around body 29–39; ventrals 295–373. Maxillary teeth behind fangs 6–7 (Gasperetti 1988, Egan 2007, Rasmussen *et al.* 2011a, Gardner 2013).

Colouration: Body yellow, mustard or brown above, pale yellow or white below, with 30–60 narrow black bands. Interspaces broader than bands, at least posteriorly. Sometimes there is a black ventral line. Head of adults usually yellow above, paler below; that of young with a yellow horseshoe-shaped mark on dark ground (Gasperetti 1988, Egan 2007, Rasmussen *et al.* 2011a; Figs 20–22).

Size: 275 cm, but most specimens are below 2 m TL (Rasmussen *et al.* 2010g, 2011a). Yellow sea snakes reported from Arabian waters were less than 2,200 mm long (Gardner 2013) or much smaller (1.6–1.9 m; Egan 2007). The longest of the six individuals we caught in our

study area, a gravid female, measured 186 cm TL. The largest male weighed 422 g, the biggest female 576 g. Females attain larger dimensions than males in *H. spiralis* (Heatwole 1999).

Distribution: From the Arabian Gulf eastwards to Vietnam, Indonesia and New Caledonia (Rasmussen *et al.* 2011a). There are very few confirmed records of this species from UAE waters.

Habitat: Generally found in shallow waters over coral reefs or sandy substrates, down to 50 m depth (Rasmussen *et al.* 2010g, Gardner 2013). In the Gulf of Oman, we have observed yellow sea snakes at 3.2–6.5 km distance from the Fujairah coast (Map 7).

Biology: Very little is known about the natural history of these serpents. They are occasionally seen close to shore, basking at the surface on calm days (Egan 2007). We encountered *H. spiralis* on nine occasions, in the months January, April, July, September and December, both during the day as well as after dark. The food of yellow sea snakes is claimed to consists of eels and other slender hole-dwelling fish (Gardner 2013). Volsøe (1939)

reported a male with a total length 1100 mm, tail 85 mm having swallowed an approximately 300-mm long snake eel, *Pisoodonophis hoevenii*, whereas a 140-cm individual we collected regurgitated an undeterminable, 25-cm long conger eel (Congridae; Fig. 4G). Heatwole (1999) reported clutch sizes ranging between 5 and 14 in this species. A 186-cm long gravid female received by us for autopsy from Ra's al-Khaimah (Arabian Gulf) contained 15 eggs in January. Yellow sea snakes are, as also we can confirm, easily irritated and have a rather aggressive disposition, therefore to be regarded as dangerous (Heatwole 1999, www.toxinology.com). A single voucher specimen (male, ss_UAE330, Figs 20C and 21D) is deposited at the Al Mayya Sanctuary, Fujairah.

Conservation status: Listed as “Least Concern (LC)” globally by the IUCN Red List of Threatened Species (Rasmussen *et al.* 2010g), *H. spiralis* was considered “widespread, taken as bycatch in trawl fisheries” by Elfes *et al.* (2013). However, population size and trend within UAE waters are completely unknown.

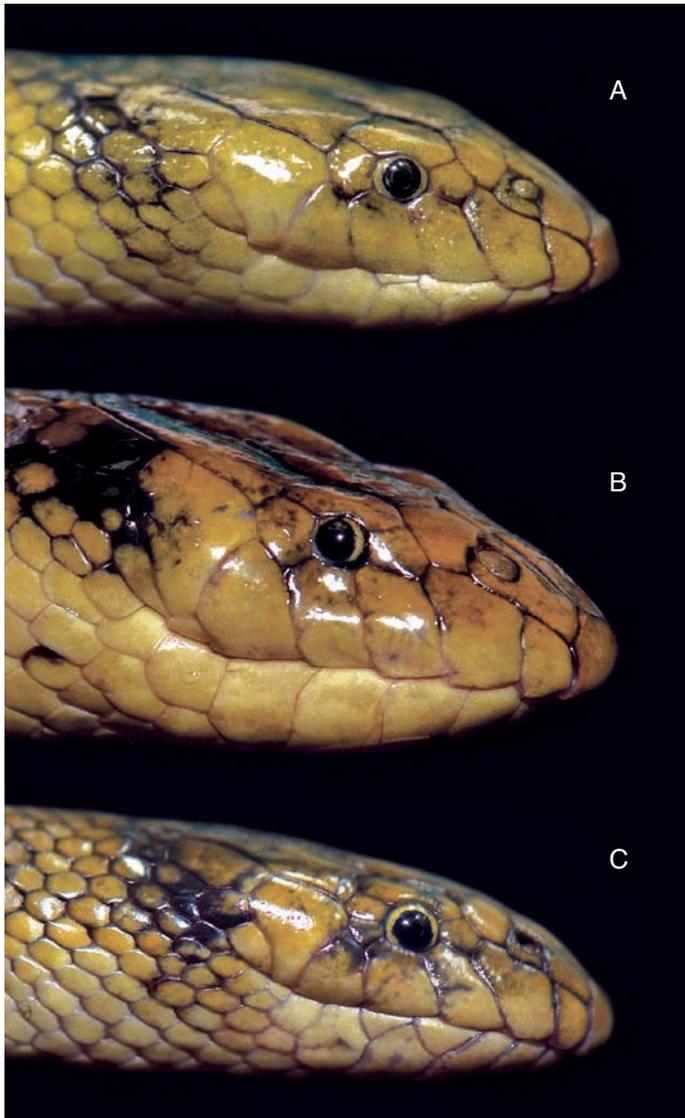


Figure 20. Variation in head and neck scalation of *Hydrophis spiralis*. A: Male, ss_UAE313, B: Female, ss_UAE320, C: ss_UAE330 (all photos by Balázs Buzás). Not to scale.

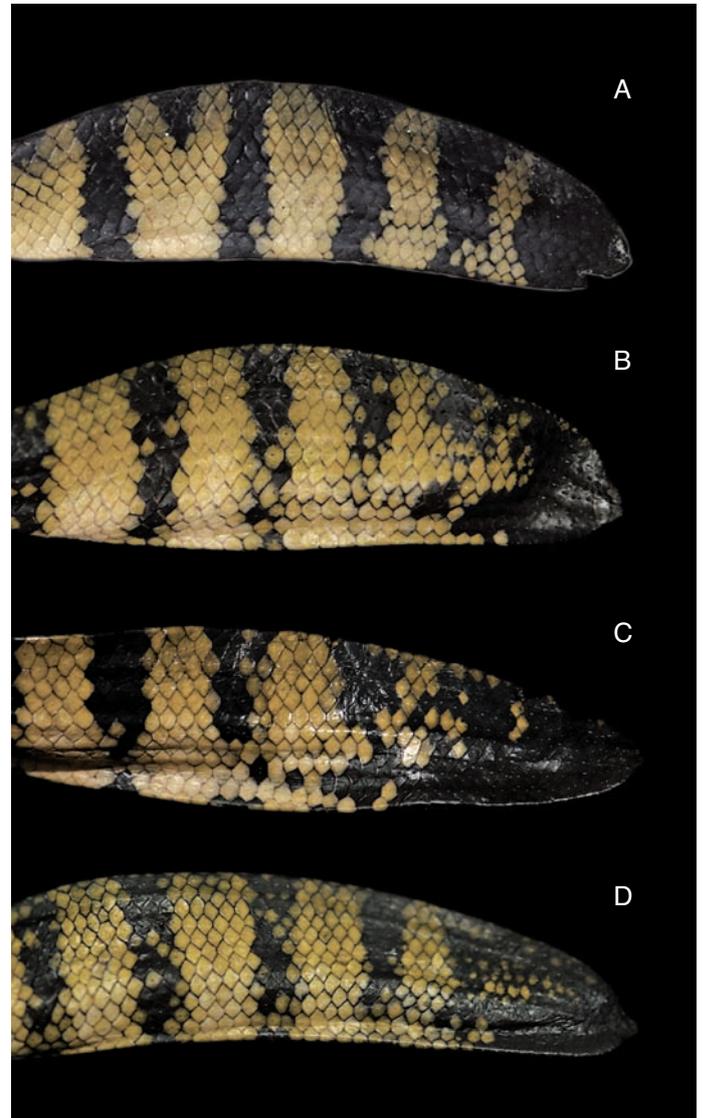


Figure 21. Tail pattern differences and wounds allow the field recognition of *Hydrophis spiralis* individuals. A: ss_UAE166, B: Male, ss_UAE313, C: Female, ss_UAE320, D: ss_UAE330 (photos by Balázs Buzás). Not to scale.

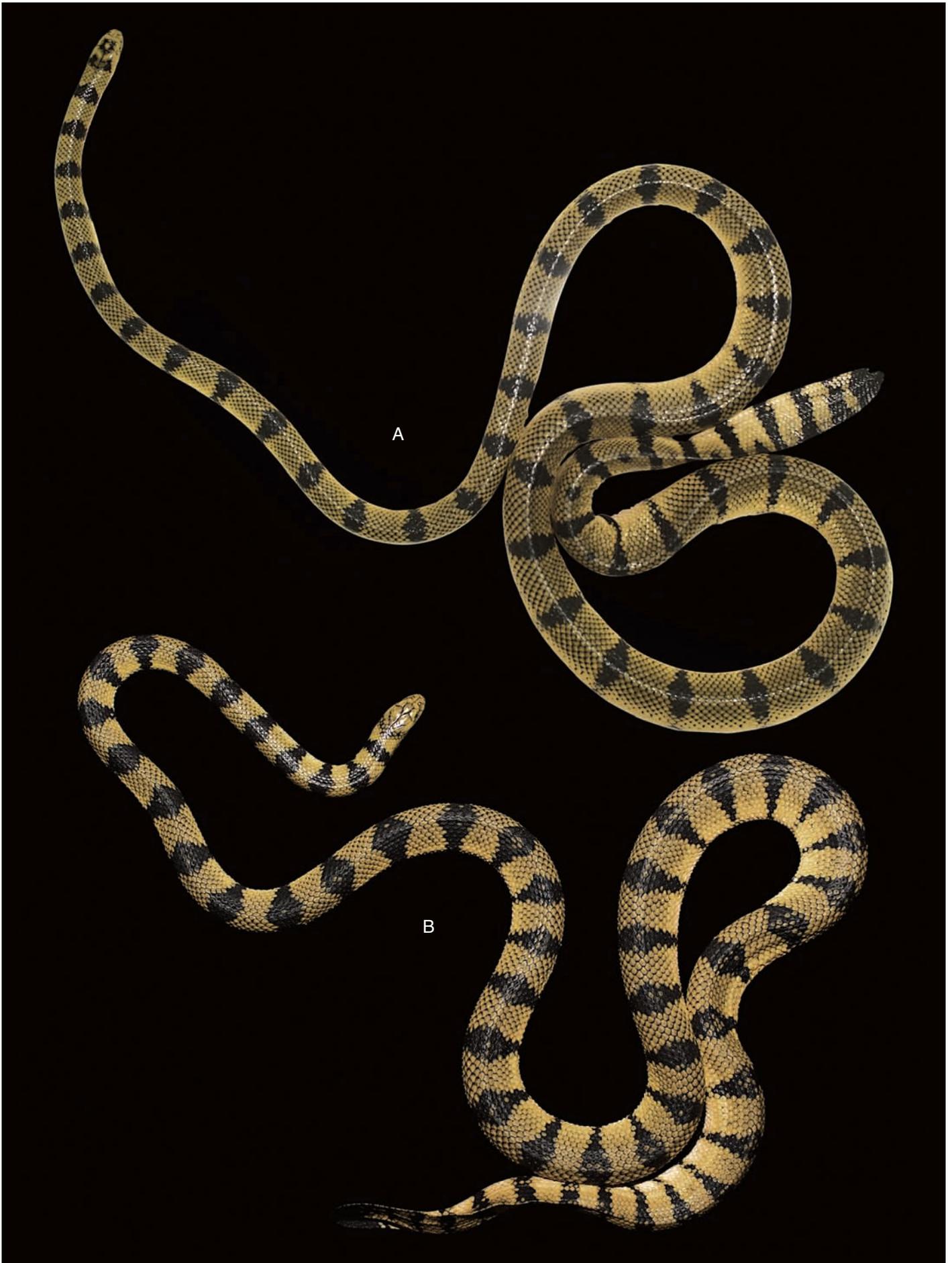
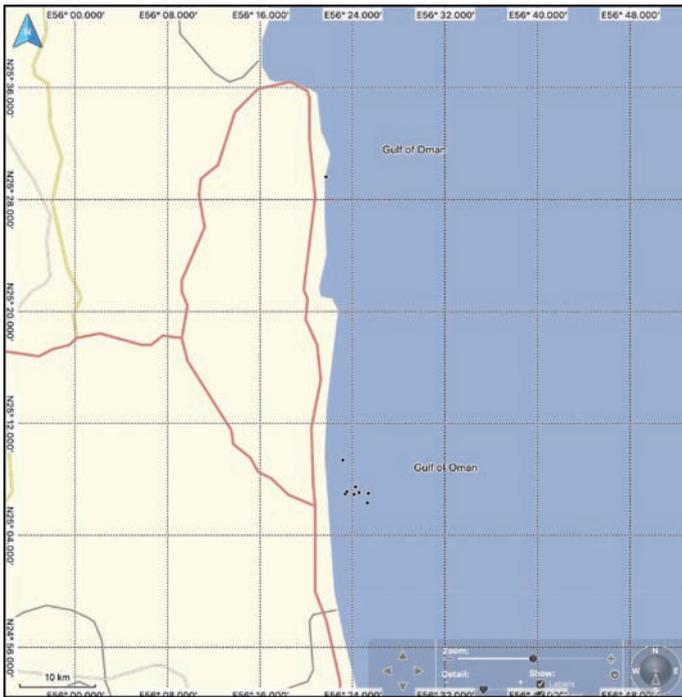
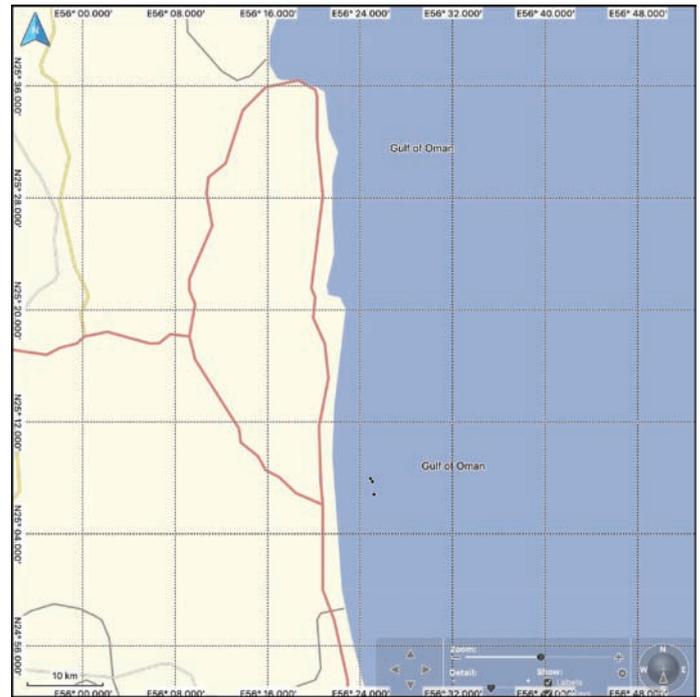


Figure 22. Colour pattern variation in yellow sea-snakes, *Hydrophis spiralis* from the Gulf of Oman off Fujairah. A: ss_UAE166, B: Male, ss_UAE313 (both photos by Balázs Buzás). Not to scale.



Map 7. Records of *Hydrophis spiralis*.



Map 8. Records of *Microcephalophis gracilis*.

Microcephalophis gracilis (Shaw, 1802)

Graceful small-headed sea snake, الافعى البحرية صغيرة الرأس

Diagnostic characters: Ventrals entire anteriorly, more or less completely divided by a longitudinal furrow posteriorly. Head small. Body slender anteriorly. Scale rows around neck 17–23; scale rows around body 29–43; ventrals 215–350. Maxillary teeth behind fangs 5–6 (Gasperetti 1988, Rasmussen *et al.* 2011a, Gardner 2013).

Colouration: Anterior part of body black, dark olive or dark grey, with whitish lateral patches or complete pale transverse bands. Posterior part of the body with more unbroken alternating black and whitish bands. The young are black with a series of whitish dorsal bands or oval spots on the slender part of the body and more or less complete bands posteriorly, 40–60 spots or bands in total. With age the dorsal colour fades to grey or bluish grey and the markings become indistinct (Gasperetti 1988, Egan 2007, Rasmussen *et al.* 2011a, Gardner 2013; Figs 23–24).

Size: 122 cm (Rasmussen *et al.* 2011a). Egan (2007) claims that whereas this species may exceptionally reach 110 cm TL, adults of around 85 cm are more common. The longest female from Arabia reported by Gasperetti (1988) was 1025 mm long (TL). The three individuals we caught in our study area off Fujairah had total lengths of 85–94 cm, with the largest weighing 166 g at capture. Females attain larger sizes than males in this species (Heatwole 1999).

Distribution: From the Arabian Gulf through the South China Sea, Indonesia, the Arafura Sea to the Gulf of Papua (New Guinea; Rasmussen *et al.* 2011a). The presence of this rarely seen species in the Arabian Gulf is proven only by a small number of strandings, while it is known from as few as four records on the east coast of the UAE, probably due to its bottom-dwelling habits and/or low population densities. The depth range is not certain

but graceful small-headed sea snakes are likely to be found to approximately 55 m below sea level off Fujairah (Al Hantoubi *et al.* in prep.).



Figure 23. Two views of the head of a female *Microcephalophis gracilis* (ss_UAE374) from the Gulf of Oman off Fujairah (both photos by Nathanaël Maury).



Figure 24. Graceful small-headed sea snakes, *Microcephalophis gracilis* from the Gulf of Oman off Fujairah. A, B: Female, ss_UAE374 (both photos by Nathanaël Maury), C: ss_UAE548 (photo by Balázs Buzás). Not to scale.

Habitat: *Microcephalophis gracilis* inhabits clear coastal waters with a sandy or coral substrate down to 30 (Volsøe 1939) or 50 m depth (Gardner 2013) but is typically observed further offshore than any other sea snake. We recorded specimens at 5.9–6.2 km distance from the Fujairah coast (Map 8).

Biology: As a specialist feeder on slender bottom-dwelling fish such as snake eels and gobies, *M. gracilis* presumably dives deeper than almost all other species of Hydrophiinae. Its tiny head allows it to investigate little holes and narrow crevices in search of prey (Egan 2007, Gardner 2013). The stomachs of three individuals (out of nine) examined by Wall (1921) contained maimed worm eel (*Muraenichthys schultzei*) remains. We encountered this species on as few as three occasions during our study period, in the months January, February and November, exclusively after dark, at a distance of 5.9–6.2 km from the shoreline. Females produce 1–16 eggs per season (Heatwole 1999). Reported to be inoffensive by Egan (2007), *M. gracilis* often wriggle wildly and attempt to flee when taken out of water. Although graceful small-headed sea snakes have a potent venom containing postsynaptic neurotoxins (www.toxinology.com), they are not considered particularly dangerous due to their small gapes.

Conservation status: Listed as “Least Concern (LC)” globally by the IUCN Red List of Threatened Species (Guinea *et al.* 2010), *Microcephalophis gracilis* was typified as “widespread, locally common, taken as bycatch in trawl fisheries” by Elfes *et al.* (2013). However, population size and trend within UAE waters are unknown.

The following two species are included here for completeness. Although both are known from the Gulf of Oman, there are no confirmed records of either of them from the territorial waters of the UAE.

***Hydrophis viperinus* (Schmidt, 1852)**

Viperine sea snake, الافعى البحرية الشعبانية

Diagnostic characters: Easy to identify by its ventrals, which are broad anteriorly and narrow posteriorly. Scale rows around neck 27–38; scale rows around body 37–50; ventrals 226–291. Maxillary teeth behind fangs 5 (Gasperetti 1988, Rasmussen *et al.* 2011a, Gardner 2013, Rezaie-Atagholipour *et al.* 2016).

Colouration: Body dark grey dorsally, dirty white ventrally, with or without pale bands (Fig. 25).

Size: Approximately 97 cm (Rasmussen *et al.* 2010e). Males reach larger sizes than females in this species (Heatwole 1999).

Distribution: From the Arabian Gulf to the South China Sea, Borneo and Java (David & Ineich 1999, Rasmussen *et al.* 2011a). Even though Smith (1926) and Wall (1921) claimed the Arabian Gulf to be the westernmost distribution limit of this species, Volsøe (1939) and Rezaie-Atagholipour *et al.* (2016) expressed their doubts about its occurrence there. Reports of its presence in UAE marine territorial waters have been repeatedly questioned but Gasperetti (1988) mentioned a museum specimen allegedly collected off Sir Abu Nu’ayr (Emirate of Abu Dhabi) by the crew of



Figure 25. Viperine sea snake, *Hydrophis viperinus* caught in Iranian coastal waters of the western Gulf of Oman (photo by Mohsen Rezaie-Atagholipour).

the HMS Dalrymple (British Royal Navy) around 1963. We have not encountered a single individual in the Gulf of Oman off Fujairah, but *H. viperinus* is known from adjacent waters near Muscat in Oman (Volsøe 1939; the holotype of *Hydrophis jayakari* Boulenger, 1887, a junior synonym of *H. viperinus*, originated from there) and from off Beris and Pasabandar in Iran (Rezaie-Atagholipour *et al.* 2016; Fig. 25).

Habitat: According to Rasmussen *et al.* (2010e), *H. viperinus* frequents 15–30 m deep waters. Gardner (2013), on the other hand, reported warm, shallow waters over reefs, seagrass or sand as typical habitat for the species and noted viperine sea snakes to enter estuaries, lagoons and creeks. From the Gulf of Oman, Rezaie-Atagholipour *et al.* (2016) mentioned two specimens collected between 20–40 m depth off Beris and Pasabandar, Iran in August 2013.

Biology: *Hydrophis viperinus* is a poorly known species. Due to its rectangular-shaped and enlarged ventrals it is reportedly more mobile on land than most other sea snakes. The prey consists of dragonets (*Callionymus* sp.), spiny flatheads (*Kumococius rodericensis*), gobies and eels (Volsøe 1939, Voris & Voris 1983, Rasmussen *et al.* 2010e). Females typically give birth to three large young (Lemen & Voris 1981, Heatwole 1999). A female collected at the end of March in Iranian waters carried three eggs, about 23 mm long and nearly ripe for ovulation (Volsøe

1939). Females caught in the northern coastal regions of Sri Lanka in late April and early May (2010) contained between two and six embryos measuring on average 227.56 mm SVL (de Silva *et al.* 2011a). The venom of *H. viperinus* has powerful myotoxic components, and even though viperine sea snakes are not considered particularly aggressive, they are capable of delivering a lethal bite (www.toxinology.com).

Conservation status: Listed as “Least Concern (LC)” globally by the IUCN Red List of Threatened Species (Rasmussen *et al.* 2010e), *H. viperinus* was considered “widespread, rare [and] occasionally taken as bycatch in trawl fisheries” by Elfes *et al.* (2013).

***Microcephalophis cantoris* Günther, 1864**
Gunther’s sea snake, الافعى البحرية جنثر,

Diagnostic characters: Ventral scales divided by a longitudinal fissure. The third supralabial usually contacts the prefrontal. Head small. Body slender anteriorly. Scale rows around neck 21–25; scale rows around body 41; ventrals 404–468. Maxillary teeth behind fangs 5–6 (Leviton *et al.* 2003).

Colouration: Head and neck dark greenish olive or yellow dorsally and yellowish ventrally; anterior part of body with 20–28 blackish bands—paler above and darker below—that merge on the back and the belly, posterior part unpatterned (Günther 1864, Rezaie-Atagholipour *et al.* 2016; Fig. 26).



Figure 26. Gunther’s sea snake, *Microcephalophis cantoris* caught in Iranian coastal waters of the western Gulf of Oman (photo by Mohsen Rezaie-Atagholipour).

Size: 1450 mm in males and 1880 mm (TL) in females (Leviton *et al.* 2003). The single voucher specimen taken in Iranian territorial waters of the Gulf of Oman measured 1124 mm in length (TL; Rezaie-Atagholipour *et al.* 2016). Females reach larger sizes than males in this species (Heatwole 1999).

Distribution: The Indian Ocean from the Gulf of Oman to the Malay Archipelago (Heatwole 1999).

Habitat: Shallow coastal waters over soft bottom substrates down to 20 m depth (Leviton *et al.* 2003, Rasmussen *et al.* 2010a).

Biology: Inadequately known but probably similar to that of *M. gracilis*. The mean clutch size of females is 6 (Heatwole 1999).

Conservation status: Listed as “Data Deficient (LC)” globally by the IUCN Red List of Threatened Species (Rasmussen *et al.* 2010a), *M. cantoris* was considered “poorly known, considered rare, probably restricted to Andaman Sea” by Elfes *et al.* (2013).

Remarks: Safaei & Esmaili (2009) were the first to record this species from the Gulf of Oman on account of four individuals collected off Jask (Hormozgan Province, Iran) but they were not taken seriously until Rezaie-Atagholipour *et al.* (2016) found another specimen among the bycatch of a fishing trawler working in the same area in October–November 2013 (Fig. 23). *Microcephalophis cantoris* is morphologically very similar to and can thus potentially be mistaken for *M. gracilis*, another small-headed sea snake species known from but infrequently encountered in Fujairah waters.

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