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Frontiers in Fishwatching Series
Gobies of the North-eastern Atlantic and the Mediterranean: *Gobius* and *Thorogobius*

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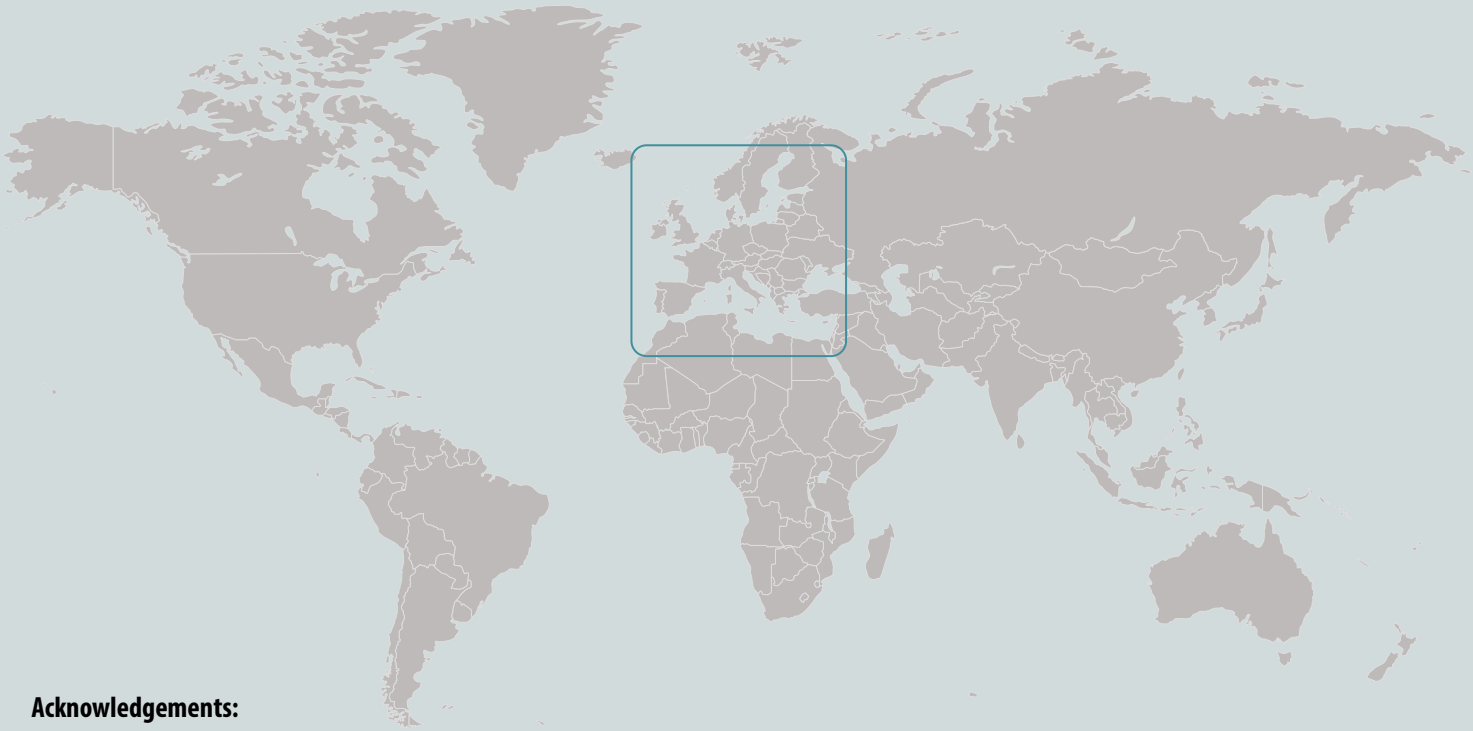

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• About Frontiers in Fishwatching Series

By Julien P. Renoult

"Fishwhat???" ...

You have certainly ever heard about birdwatching, this activity of observing birds through binoculars, photographying them, trying to identify species, age and sex individuals directly in the field, and searching for rare or overlooked species. Just replace 'bird' by 'fish', 'binoculars' by 'mask', and you now know what fishwatching is.

I mention birdwatching because this is truly what motivated me to initiate this series of fish identification guides. Like many, I started my naturalist career with birds. I started at an early age, with my brother, observing birds of my neighbourhood, and then as a member of the local association for the study and conservation of birds. For my studies, I then moved to southern France where I met new birdwatchers... but really 'serious' birdwatchers. Guys (unfortunately mostly guys!) who spend all their weekends and holidays in the field, constantly trying to improve their skills in visual and acoustic identification, and all their evenings studying photographs to discover new criteria to identify, sex, age birds, or to differentiate subspecies or detect geographic variations. They are tracking the latest scientific results in bird population genetics and phylogenetics, trying to meet the challenge of recognizing the so-called 'cryptic species', but they are also contributing to science by proposing new research hypotheses inspired by their own field observations. Actually, the community of people trying to push the limit of birdwatching is pretty large in Europe. While pioneers of this 'serious' approach to birdwatching were almost all from Great Britain in the middle of the XXth century, today, thousands of birdwatchers from all European countries are connected through social media and share in live their latest discoveries. The community is boosted also by several journals publishing articles in field identification, like Dutch Birding, British Birds or Birding World (now discontinued), and of course books. Notably, the great birdwatcher Martin Garner initiated a series of books before he passed away too early: the Birding Frontiers Challenge Series. The idea of the Frontiers in Fishwatching Series is directly inspired by Martin's books.

What about fishwatching? Well, almost everything remains to be done. I do not mean that nobody has ever worked at improving the field identification of fish. Patrick, with his popular Europe and Mediterranean Marine Fish Identification Guide, and others before him, have worked hard to render fish identification accessible to divers, fisher(wo)men and other nature lovers. But the gap between field identification and museum ichthyology is still huge. The Frontiers in Fishwatching Series aims at bridging this gap by providing identification guides specifically turned toward field identification. The Frontiers series has four goals:

• **First,** many ichthyologists identify fishes using characters that can be seen in preserved specimens only (for example, number of scales and rays, position of sensory papillae). They often consider that these characters only are reliable and they dismiss macroscopic criteria visible on photographs taken in the field. In their defense, many of the diagnostic macroscopic criteria are informally used by fishwatchers but they have never been published. The first goal of the Frontiers series is thus to make these criteria available to both the beginner and the advanced ichthyologist who mostly works with preserved specimens.

• **Second**, in addition to putting informal knowledge in writing, the Frontiers series also aims to produce new one. Some of the diagnostic criteria discussed here result from our personal investigations, and have never been published before. Importantly, however, we wish to stress that the Frontiers series are not scientific articles and are not intended to substitute them. They are identification guides, and scientists should treat several of our criteria as hypotheses that will have to be tested and validated by the statistical study of a sufficient number of individuals.

• **Third**, with this series we wish to entice people to push their own limits in fish identification. Identifying fish (or any other organisms) is in itself highly rewarding: the mere experience of matching visual information with knowledge learned in books elicits pleasure, and strengthens our connections with the underwater environment. Moreover, with little knowledge of identification, it is already possible to make great discoveries, such as describing new behaviour or extending the known geographical range of a species. All this new information can feed into citizen science databases (see section Documenting your records), and thus contribute to science; this is another source of rewards!

• **Fourth**, we hope to federate a community of people who want to push the limits of field identification of fish. I started to write the first line of this volume alone, then Patrick quickly joined to share his long experience in popularizing knowledge, then it became obvious that Roberto as an expert in field identification of gobies had to be part of the project, and last we needed an ichthyologist who knows to identify fish both in the field and in jars to validate our approach... who else but Dr goby Marcelo? Hopefully this booklet on *Gobius* and *Thorogobius* is the first in a long series. We plan to write more identification guides, but there is so much work to be done that we need help! We, the authors of this first guide and the Foundation Biotope for Biodiversity who edited it, welcome anyone interested in writing a new guide. Just send your proposals to the contact email on the first page.

Last but not the least, this work was made possible only through the help of photographers who shared their photos either on public databases or directly with us. Photos are crucial not only to illustrate the guides but also to prepare them, that is, to work out and validate new identification criteria. Thus, **if you enjoy this first guide, do not hesitate to post your photos on open databases or send them to us. The future of the Frontiers in Fishwatching Series depends also on your contribution!**

• Key to abbreviations and symbols

A	anal fin
ad	adult
approx.	approximately
C	caudal fin
cm	centimeter(s)
D1	first dorsal fin
D2	second dorsal fin
Fr	French
G	German
im	immature
It	Italian
juv	juvenile
LL	lateral line (or number of scales along the lateral midline)
m	meter(s)
max	maximum
min	minimum
mm	millimeter(s)
NA	not attributed
P	pectoral fin
QIG	Quick Identification Guide
SL	standard length (see topography)
Sp	Spanish
sp.	undetermined species
spp.	multiple undetermined species
TL	total length (see topography)
yrs	years
♂	male
♂♂	males
♀	female
♀♀	females

Incognito goby (*G. incognitus;* left), **Yellow-headed goby** (*G. xanthocephalus,* right). Unlike Yellow-headed goby, Incognito goby is insensitive to the venom of *Anemonia viridis*. It is the only «anemone fish» in our area. *Cerbère (France), Patrick Louisy.*

Glossary

amphiatlantic	occurring on both sides of the Atlantic Ocean
amphidromous	migrating between freshwater and the sea, but not to breed
band	either an oblique linear marking or a longitudinal stripe on dorsal and anal fins
bar	here, vertical marking
basal	portion of an appendage close to the body
blotch	poorly defined or irregular marking
compressed	flattened laterally
concave	curved inward
convex	curved outward
crinoid (ray)	not attached to the membrane (= free ray)
cryptic species	two or more species indistinguishable based on external characters
cryptobenthic	characterises a species which individuals spend most of their life hidden within or under elements of the seabed
ctenoid scale	scale with tooth-like spines at the posterior margin
cycloid scale	scale with a smooth posterior margin
dash	here, short line or stripe
demersal	living at or near the seafloor
depressed	flattened dorsoventrally
depth	applied to body, describes size along the dorso-ventral axis
distal	outer tip of an appendage
endemic	geographic distribution restricted to a given region
epibenthic	lives on or just above the surface of sediments at the bottom of the sea
euryhaline	describes an organism tolerating a wide range of salinity
eurythermal	describes an organism living in a wide range of ambient temperatures
free (ray)	not attached to the membrane (= crinoid ray)
gonochoric	state of having just one of at least two distinct sexes in any one individual organism
habitus	general aspect or appearance
height	applied to head, describes size along the dorso-ventral axis; applied to fins body, describes size along the baso-distal axis
hermaphrodite	state of having both male and female reproductive organs during an animal's lifetime
holotype	specimen used to describe a species in the original publication, and designed as the reference specimen representative of the species
iteroparous	state of having multiple reproductive cycles over the course of its lifetime
juvenile	immature individual with an overall resemblance to adults, but not to larvae
lateral line system	sensory organ that detects movement, vibration, and pressure gradients in the surrounding water.
line	here, thin marking of any orientation
median fins	axial, unpaired fins (dorsal, caudal and anal fins)
melanophore	cell containing melanin (dark) pigments
meristics	countable traits, for example scales and rays
mimicry	adaptive resemblance of two species that benefits one or both species
monogamy	reproduction system in which individuals have only one reproductive partner during their lifetime
nectonic	describes an actively swimming aquatic organism making significant movements independently of currents
paedomorphism	retention of juvenile characters in the adult
paratype	secondary specimens used to describe a species in the original publication, not listed as the holotype
pelagic	living in the water column or near the surface
phylogenetic	relative to the history of the species evolution and diversification
polygamy	reproduction system in which individuals have more than one reproductive partner during their lifetime
promiscuity	reproduction system in which individuals have multiple sexual partners and show little discrimination in the choice of partners
proximal	inner tip of an appendage, where it attaches to the body
semelparous	state of having only one reproductive cycle over the course of its lifetime
sensory papillae	here, external organ sensing disturbance in the water
sexual dimorphism	when females and males look different (in size, shape, colouration or patterning)
swim bladder	internal gas-filled organ allowing some fish to control their buoyancy
reticulate	markings forming a net-like pattern
saddle	marking across the back
sneaker	reproductive male that resembles a female, which allows him to approach females while avoiding attacks by other males (see *Gobius niger)*
speciation	the evolutionary process leading to two species from one ancestral species
speckles	marked with dots
spine	here, unbranched and rigid ray in a fin
spot	well defined circular marking
steep	here, usually used to describe a snout profile dropping abruptly
stripe	here, horizontal marking
sympatry	when two or more species occur in the same geographic area
upper bathyal	shallowest deep-sea zone between 200-600 m depth, part of continental slope just below continental shelf

Introduction

The world of gobies

Diversity and distribution of gobies

Gobies form an extraordinary diverse group of fish. In the broad sense, gobies refer to order Gobiiformes (gobioids in English), which presently includes 2,272 species divided into 323 genera. Gobioids represent 6% of the global fish diversity, whether at the species or genus level (Fricke et al. 2021, corrected by U. Schliewen, pers. com.). In the narrow sense, gobies usually refers to family Gobiidae (gobiids in English), which is also the most species-rich family of fish, with 2,042 currently recognized species (Fricke et al. 2021, corrected by U. Schliewen, pers. com.). While gobiids are found both in marine and freshwater environments, the few other fish families including more than a thousand valid species are all living in freshwater. Even if considering marine species only, gobiids are by far the most species-rich fish family in the seas and oceans of the world. Among fish, gobies are unparalleled for their ability to adapt to micro-habitats and specialize to novel ecological niches, leading to rapid speciation and adaptive radiations (Patzner et al. 2011). For example, gobies are the most specious fish lineage of coral reefs, which are already hotspots of marine fish diversity (Patzner et al. 2011).

Spotted algae-eating goby (*Sicydium cf. punctatum*). Gobies of former Sicydiinae subfamily reproduce in freshwater. After hatching, the larvae are carried out to sea, where they spend a few months before returning to freshwater as adults. *Guadeloupe (Caribbean), Thomas Menut.*

Despite their great adaptability, gobies are distributed heterogeneously in water habitats. Most freshwater species prefer streams and small rivers, or river mouths and estuaries in large drainage basins. Only a few species live permanently in brackish waters; examples in the Mediterranean basin are some species of genus *Knipowitschia*, which are remarkably tolerant to dramatic variations in salinity and temperature. Some other gobies are amphidromous, like cling gobies of former Sicydiinae subfamily, which perform amazing returns to their freshwater streams, at times traversing the face of 350 m waterfalls (Patzner et al. 2011). Regarding their geographical distribution, marine gobies occur mostly in tropical and warm temperate waters. The diversity of marine species decreases strongly in cold temperate seas and, with a few exceptions, there are no goby at latitudes greater than 50° (Kovačić & Svensen, 2019). As for the depth distribution, gobies live predominantly on the continental shelf. They are very common in the shallow coastal waters, including the intertidal zone like mangrove swamps and tidal pools. Though, in coastal waters they are most diverse in habitats of the upper continental shelf, like coral reefs in the tropics and rocky or mixed bottoms in the warm temperate seas. The diversity of gobies decreases as the continental shelf goes deeper, and is very limited below continental shelf break, at upper bathyal depths of a few hundred meter depth. Only one species, *Karsten totoyensis*, was found below the upper bathyal zone, at 1,122 m depth (Patzner et al. 2011).

Within the order Gobiiformes, the taxonomy has been in turmoil over the last decade, being constantly challenged and revised in the light of new phylogenetic discoveries, but no consensus has emerged about the correct classification of families and subfamilies (Gill & Mooi 2012, Agorreta et al. 2013, Thacker 2014, Thacker et al. 2015, Betancur-R et al. 2017, McCraney et al. 2020, Reichenbacher et al. 2020).

Phylogenetic studies have revealed that families and subfamilies that had been well established for decades (Sicydiinae, Oxudercinae, Amblyopinae, Kraemeriidae, Microdesmidae, Ptereleotrinae, Xenisthmidae, Schindleriidae), are actually nested within other families or subfamilies. Moreover, there has been no comprehensive attempt to clarify the taxonomy within families and subfamilies, even within those that include up to two hundred genera of very diverse fish (Fricke et al. 2021). The last morphology-based classification of gobiids was proposed by Gill & Mooi (2012), but their study did not review all Gobiiformes families and is thus incomplete. More recently, a handful of phylogenetic studies have suggested changes in gobiid classification, but they generally did not discuss which taxa should be accepted or not, or they made taxonomic proposals based on informal names for many of the lineages (Agorreta et al. 2013, Thacker 2014, Thacker et al. 2015, Betancur-R et al. 2017, McCraney et al. 2020). The last among these published studies recognizes eight extant goby families: Rhyacichthyidae, Odontobutidae, Milyeringidae, Eleotridae, Butidae, Thalasseleotrididae, Gobiidae and Oxudercidae, leaving the position of xenisthmine open (McCraney et al., 2020). But according to Agorreta et al. (2013), the last two families should be grouped into a unique Gobiidae family including two major clades (gobionelline-like and gobiine-like gobies). Last, Reichenbacher et al. (2020) recently resurrected an extinct goby family: the Pirskeniidae.

Biological and morphological characteristics of gobies

Gobies are typically benthic fish. In freshwater, they are most often seen dwelling on the bottom, or hiding below rocks or among water plants. In the sea, benthic gobies dwell on hard or soft bottoms, hide in crevices within the rock, below pebbles, boulders or biocover, or they occupy burrows in soft sediments. Some species hover in shoals, usually less than 1 m above the bottom (Kovačić 2003). A small number of gobioid species have evolved a pelagic lifestyle. This includes species that swim freely in the water column, as nectonic, or considering the limits of their swimming ability, more as planktonic species. Adults of planktonic species typically retain larval anatomical characteristics, which is termed paedomorphosis (La Mesa 2011). A remarkable example of paedomorphic gobies are the very common but rarely detected infantfishes (*Schindleria* spp.) from the Pacific, which have an elongate transparent body.

Gobies are generally considered small fish, exceptionally reaching 50 cm in length (hereafter, all sizes correspond to the 'total length', unless stated otherwise; see Glossary). They include some of the smallest extant vertebrates, like Midget dwarfgoby (*Trimmatom nanus*) with its maximum length of 11 mm, and the pelagic Stout infantfish (*Schindleria brevipinguis*) not exceeding 12 mm. Stout infantfish is also among the lightest vertebrates, weighing about 2 mg (Patzner et al. 2011).

Gobies are not just a highly diversified component of the tropical and warm temperate coastal fish community. Despite their small size and limited individual mass, they also account for a significant part of the energy flow in these ecosystems (Patzner et al. 2011). Due to their short lifespan and high reproductive rate, gobies are characterized by rapid generational turnover and high productivity, giving them a central position in the food webs and tropho-dynamics of coastal ecosystems.

Adorned dwarfgoby (*Eviota sigillata*). This goby has the shortest lifespan for a Vertebrate, living for at most two months. *Vatu-i-ra Island (Fiji), Mark Rosenstein.*

Most gobies are carnivorous, occasionally ingesting algae or other plants as secondary food items. However, some species feed on the mixture of plants and sessile animals that adhere to open surfaces, the so-called "Aufwuchs", and a few other species primarily feed on plants (Zander 2011a). For carnivorous species, the type of prey depends on size and way of life. Large species feed preferentially on large organisms, and small species on smaller ones. Accordingly, developmental growth is often associated with a change in diet (Zander 2011a). Because of their small size, gobies also represent an important food source for several predators of the higher trophic level, represented by larger fishes (including large conspecific individuals and other goby species), but also seabirds and marine mammals (Zander 2011a). Some gobies have a symbiotic relationship with other fishes, such as 'cleaners' feeding on ectoparasites of larger fishes, or "shrimp gobies" that share their burrow with alpheid shrimps (Patzner et al. 2011).

The reproduction of gobies is varied too. Their reproductive strategy varies from gonochoric to hermaphrodite, from monogamy to polygamy and promiscuity, and from semelparous to iteroparous (one versus multiple reproductions though the life; Patzner et al. 2011). The record of the shortest lifespan for a vertebrate is held by a goby. The small, tropical Adorned dwarfgoby (*Eviota sigillata*) spends one to two weeks as a pelagic larvae, two weeks to settle, and eventually dies after just three weeks and a half as an adult (Depczynski & Bellwood 2005). In contrast, the largest gobiid species can live up to ten or more years (Miller, 1986). Eggs of Gobiidae are benthic, generally ovoid to ellipsoid, but some are round and others pear-shaped, and many have filaments to attach to hard substrate (Borges et al. 2011). One character observed in most goby species is high egg parental care, with demersal eggs guarded by males (Patzner et al. 2011). The incubation period varies from a few hours to several weeks (Borges et al. 2011). Larvae are small planktonic organisms measuring between 1 and 8 mm in length depending on species. The duration of the pelagic larval stage also varies greatly across species, ranging from 13 to 214 days (Borges et al. 2011). Among gobies, amphidromous sicydiine species have a fascinating life cycle with a very long dispersal period: their embryonic developmental period is strongly reduced, lasting only a few hours, larvae hatch at much smaller size compared to all other gobies, measuring less than 1 mm in length, and they spend up to 7 or 8 months in the marine plankton before settling (Borges et al. 2011).

Barred mudskipper (*Periophthalmus argentilineatus*). Mudskippers are amphibious gobies living both in and out of waters. Among the many adaptations allowing this particular ecology, the modified pectoral fins are used to 'skip' across muddy surfaces. *Cairns (Australia), Julien Renoult.*

Gobiiformes show a large variation in morphology, in particular in body and head shape, and in the number and shape of fins, both being strongly determined by the way of life. One of the most peculiar characteristics of gobies is the fusion of both pelvic fins into a unique pelvic disk; yet, this character is actually found in only some lineages of gobiids, while other species of that family and other Gobiiformes families do not have it. Even among those lineages that have evolved a pelvic disk, the fusion can be secondarily lost. The typical gobiid body shape also includes strong pectoral fins, two dorsal fins, a rounded caudal fin and a more or less depressed head, but here again exceptions are common. One morphological trait is nevertheless shared among all gobies, except those of the basalmost family Rhyacichthyidae: the lateral line system is reduced on the body, and there is no lateral-line canal on each side of that body. Instead of this, rows of surface sensory papillae are present over the head and along the body, and sensory system canals with pores are present only on the head. The complex arrangement of rows of surface sensory papillae and of canals with pores are considered the most useful morphological characters for identifying dead goby specimens.

Some gobioid fishes have evolved a unique morphology in relation to their way of life. The retention of larval characters at adulthood (paedomorphosis) in pelagic gobies is achieved through heterochrony, a change in the rate and timing of developmental processes as compared to ancestral species (La Mesa 2011). Generally, paedomorphic pelagic gobies have a transparent body, sparsely distributed melanophores, persistence of the swimbladder, a short and straight alimentary canal, a reduced first dorsal fin, a change from ctenoid to cycloid scales and a more or less pronounced sexual dimorphism in dentition (La Mesa 2011). Other morphologically weird gobies are mudskippers of former subfamily Oxudercinae, with their morphology adapted to amphibious life. They have developed high motion abilities on land, gliding and leaping thanks to their powerful pectoral and caudal fins (Zander 2011b). The gills of mudskippers are partially reduced; they are replaced by several adaptations to breathe air, including an increased vascularization of skin extensions, of mouth and pharyngeal membranes and of opercular chambers (Zander 2011b). Their eyes are situated dorsally, protruding out of the head, and can be moved independently such that one looks at within the water when the other one watches on land. The larvae of mudskippers are bred in deep holes permanently filled with groundwater, even at low tide. These larvae breathe oxygen thanks to functioning gills and through their vascularized, thin skin, but when oxygen is lacking, the male brings air bubbles from the surface into the breeding chamber (Zander 2011b). Among those gobies with a strange morphology, we can also mention those of former families and subfamilies Microdesmidae, Kraemeriidae and Amblyopinae. These fishes are adapted to burrowing in soft sediments, and for doing so they have evolved an eel-like, elongate and laterally compressed body with a single long dorsal fin. Finally, gobies living in the intertidal zone, rock faults or caves, and those with a symbiotic way of life, all also show some specific morphological adaptations (Zander 2011b).

Gobies of the North-eastern Atlantic and the Mediterranean

With more than a hundred species, gobiid fishes are also the most species-rich family of the North-eastern Atlantic, the Mediterranean and the Black Sea (Kovačić & Patzner 2011, Kovačić 2020). From the standpoint of biogeography, this area covers the eastern part of the amphiatlantic Temperate North Atlantic realm sensu Spalding et al. (2007), which includes four eastern provinces: the Northern European Seas, the Lusitanian, the Mediterranean and the Black Sea. The area includes both cold-temperate and warm-temperate sea water zones, spreading from Norway in the north to either Râs Nouâdhibou (Cabo Blanco) in Mauritania (according to Spalding et al., 2007) or Cap Juby in Morocco (according to Briggs & Bowen, 2013) in the south; in this identification guide, we have followed Briggs & Bowen's southern boundary of the temperate North-eastern Atlantic region. The Lusitanian and the Mediterranean areas together represent the largest continuous warm temperate coastal zone on Earth. The entire North-eastern Atlantic, the Mediterranean and the Black Sea area is bordered by two zoogeographic areas: the Ponto-Caspian and European freshwaters, and the eastern tropical Atlantic coast along the African coast; however, their overlap in gobiid species composition is very limited. In the west, the area includes the Azores archipelago, and is separated from the Western Atlantic coast by the wide open ocean; in the north, it is delimited by the cold Arctic water where no species of Order Gobiiformes occurs (Kovačić & Patzner 2011). The North-eastern Atlantic is the only place in the world where gobiid species enter the Polar Circles, with some species even extending beyond 70° latitude. Elsewhere on Earth, only a few gobies beyond 50° latitude, either in the northern or southern hemisphere (Kovačić & Svensen, 2019).

Within the North-eastern Atlantic, the Mediterranean and the Black Sea (Kovačić & Patzner 2011, Kovačić 2020), the marine gobiid fish diversity consists of 109 species, among which 97 are native to the region and 12 are exotic immigrants (Kovačić & Patzner 2011, Kovačić 2020, Iglésias *et al.* 2021, Kovačić *et al.* 2021, Goren & Stern 2021). Currently, 73 species of Gobiidae are known to occur in the Mediterranean Sea (Kovačić 2020, Iglésias *et al.* 2021, Kovačić *et al.* 2021, Goren & Stern 2021), 45 species in the North-eastern Atlantic (Kovačić & Patzner 2011) and 33 species in the Black Sea (Kovačić & Patzner 2011). All Gobiiformes species recorded in the area to date, be they native or alien, belong to the Gobiidae family *sensu* Agorreta et al. (2013). Almost all of them, except most alien species and a few native ones living close to the Eastern tropical Atlantic coast, form two phylogenetic lineages within the Gobiinae subfamily, the *Gobius*-lineage and the *Aphia*-lineage, and one lineage of the Gobionellinae subfamily, the *Pomatoschistus*-lineage (Agorreta et al. 2013).
In this area, the fish diversity has been shaped by geological events, and for the Mediterranean and the Black Sea, by its present bathymetric and hydrographic characteristics. In the Mediterranean, the massive desiccation of the Messinian salinity crisis is the most important geological event affecting the marine ichthyofauna, because of the mass extinction it caused (Domingues et al. 2005). The Pleistocene ice ages, during which sea temperature widely oscillated between the glacial and interglacial states, are other geological events that have left their marks on fish diversity and distribution. Finally, the last major geological event in the region, which occurred during the late Quaternary, impacted the Black Sea: this water body turned from a freshwater lake into a semi-marine environment after the Mediterranean seawater entered the Black Sea basin, allowing it to host marine fishes again (Yanko-Hombach et al. 2007). But changes in the fish diversity are still taking place in the area, because of anthropogenic activities. Humans are notably responsible for a massive influx of non-native species into the region, especially in the Mediterranean Sea (Golani et al. 2016).

Most of the European marine gobies are benthic species, living on the seafloor. Only a few species are nectonic, swimming freely in the water column: Transparent goby (*Aphia minuta*), Crystal goby (*Crystallogobius linearis*) and Ferrer's goby (*Pseudaphya ferreri*; Kovačić & Patzner 2011). More than half of the benthic species live preferentially on soft bottoms, the remaining species occurring on hard bottoms (Kovačić & Patzner 2011). Some of hard bottom dwellers show a cryptic way of life, living in the hidden spaces (caves, cavities, holes, clefts, rock faults) inside the bottom or below cover (stones, boulders, shells): they are qualified 'cryptobenthic' (Kovačić et al. 2012). A few of the benthic species may hover above the bottom, usually less than 1 m from it (Kovačić 2003).

The European marine gobies are coastal species living on the continental shelf, with a few species extending their range down to the edge of the continental slope, that is, to the upper bathyal zone. However, two recently described species, Lombarte's goby (*Buenia lombartei*) and Gymnesian goby (*Gymnesigobius medits*) are likely exclusively bathyal species, with life style adapted to muddy continental slopes, as evidenced by their depth records (343 and 375 m and 344-364 m, respectively), morphology and colouration (Kovačić et al. 2018; 2019).

Like all gobies, our European representatives are small fish. About one third of species from the area measure less than 5 cm in length, one third are between 5 and 10 cm, and a last third exceed 10 cm (Kovačić & Patzner 2011). The smallest species in the area are Pygmaean goby (*Pomatoschistus nanus*; maximum length 1,98 cm), Grotto goby (*Speleogobius trigloides*, maximum length 2.26 cm) and Guillet's goby (*Lebetus guilleti*; maximum length 2.4 cm); the largest are Giant goby (*G. cobitis*; 27 cm) and Pinchuck's goby (*Ponticola cephalargoides*, 25 cm; Kovačić & Patzner 2011, Engin & Seyhan 2017).

All habitats are worth exploring. In this harbor bay where the seagrass is relatively damaged, three species of gobies, uncommon in the Western Mediterranean, benefit from an environment exceptionally sheltered from marine currents: Sarato's (*G. fallax*) and Couch's (*G. couchi*) gobies, and Large-headed goby (*Millerigobius macrocephalus*). *Saint-Mandrier-s/-Mer (83, France), Thomas Menut.*

Gobius and *Thorogobius* are two closely related genera belonging to the *Gobius*-lineage of the Gobiinae subfamily (Agorreta et al. 2013). These medium to large-sized gobies (as compared to other gobies) have the typical habitus of the family, but they show a marked variation in colouration and patterning across species (Miller 1986). They are distributed along the Eastern Atlantic, the Mediterranean Sea and, for some *Gobius* species only, in the Black Sea. They occur in cold temperate, warm temperate and tropical sea waters, from tidal pools down to the upper continental slope.

The taxonomy and nomenclature of the genus *Gobius* has a complex history. Several hundreds of gobiid species from around the world were assigned to that genus in ancient species descriptions of earlier centuries. While most of these assignments have been clarified and corrected, a few taxa inherited from this early approach are still dubiously treated as valid *Gobius* species. If we exclude the invalid *Gobius strictus* (now recognized by many as a junior synonym; Kovačić 2004), genus *Gobius* now includes 29 species (see Table below). These 29 species can be divided into one group of 6 species scattered around the world, whose assignment to *Gobius* is doubtful, and one group of 23 'real' *Gobius* species all originating from the Eastern Atlantic, the Mediterranean and the Black Sea. Most 'real' *Gobius* species have been already shown to branch within the *Gobius*-lineage of the Gobiinae subfamily in the gobiid phylogenetic tree (Agorreta et al. 2013, Iglésias *et al*. 2015). Last, the clarification of the relationship between genera *Gobius* and *Mauligobius* has not been published yet, thus it is worth mentioning that, in addition to *Gobius* species, two *Mauligobius* species are also presently valid (Froese & Pauly 2019).

Species of genus *Gobius* are, for many of them, relatively large-sized gobies, with Giant goby (*G. cobitis*) being the largest European marine goby (reaching 27 cm); but the genus also includes medium-sized species of 6 to 10 cm (Miller 1986, 1990). Among the 23 'real' *Gobius* species, 16 occur in warm temperate waters, of which only two, Black goby (*G. niger*) and Rock goby (*G. paganellus*), enter the cold temperate zone north of the United Kingdom. The Tropical Eastern Atlantic region is home to five exclusively tropical 'real' *Gobius* species, and three extralimital temperate species. Interestingly, these three temperate species include both species occurring in the cold temperate zone, evidencing their wide temperature tolerance. The third temperate species found in the tropical zone is the Red-mouthed goby (*G. cruentatus*), reported from Senegal (Miller 1990; though, this record would need confirmation).

***Gobius* species of the world and their geographical distribution.**
*Assignment to genus *Gobius* doubtful; £ assignment to family Gobiidae uncertain; $ species validity uncertain. NE: North-eastern; TE: Tropical-eastern.

Species	Distribution
G. ater Bellotti, 1888	Mediterranean
G. ateriformis Brito & Miller, 2001	Cape Verde
G. auratus Risso, 1810	Mediterranean
G. bontii Bleeker, 1849*	Indo-West Pacific
G. bucchichi Steindachner, 1870	Mediterranean, Black Sea
G. cobitis Pallas, 1814	NE Atlantic, Mediterranean, Black Sea
G. couchi Miller & El-Tawil, 1974	NE Atlantic, Mediterranean, Black Sea
G. cruentatus Gmelin, 1789	NE Atlantic, Mediterranean, Black Sea, TE Atlantic
G. fallax Sarato, 1889	NE Atlantic, Mediterranean
G. gasteveni Miller, 1974	NE Atlantic, Mediterranean
*G. geniporus V*alenciennes, 1837	NE Atlantic, Mediterranean
G. hypselosoma Bleeker, 1867*	Madagascar, Mascarene Islands
G. incognitus Kovačić & Sanda, 2016	NE Atlantic, Mediterranean
G. kolombatovici Kovačić & Miller, 2000	Mediterranean
G. koseirensis Klunzinger, 1871*,$	Egypt (Indian Ocean)
G. leucomelas Peters, 1868*,$	Erythrea (Indian Ocean)
G. niger Linnaeus, 1758	NE Atlantic, Mediterranean, Black Sea, TE Atlantic
G. ophiocephalus (Pallas, 1811)	Mediterranean, Black Sea
G. paganellus Linnaeus, 1758	NE Atlantic, Mediterranean, Black Sea, TE Atlantic
G. roulei de Buen, 1928	NE Atlantic, Mediterranean
G. rubropunctatus Delais, 1951	TE Atlantic
G. salamansa Iglésias & Frotté, 2015	Cape Verde
G. scorteccii Poll, 1961*	Somalia
G. senegambiensis Metzelaar, 1919	TE Atlantic
G. tetrophthalmus Brito & Miller, 2001	Cape Verde
G. tropicus Osbeck, 1765*,£	Ascension Island
G. vittatus Vinciguerra, 1883	Mediterranean
G. xanthocephalus Heymer & Zander, 1992	NE Atlantic, Mediterranean, Black Sea
G. xoriguer Iglésias, Vukič & Šanda, 2021	Mediterranean

The 23 'real' *Gobius* species all live on the upper continental shelf. Four of them further occupy the lower continental shelf, including *G. roulei* that also reaches the upper bathyal zone. *Gobius* species live on very variable bottoms, ranging from bedrock to various soft sediments, and in seagrass. They are benthic, laying their eggs on the bottom, or in burrows dug in soft sediments (Miller 1986).

Genus *Thorogobius* includes six valid species. Only two of them live in the North-eastern Atlantic and the Mediterranean region, the remaining four species occurring in the eastern tropical Atlantic along the African coast. While tropical *Thorogobius* species live in the deep waters of the lower continental shelf and even on the continental slope (Sauberer et al. 2018), the two species from European temperate waters occur dominantly on the upper shelf, with only a handful of deeper records (Stern et al. 2018). The fact that, on the one hand, most of the deep, tropical *Thorogobius* species have been described very recently (Sauberer et al. 2018) and, on the other hand, that the deep tropical waters of the Eastern Atlantic but also the upper shelf of tropical Africa are still virtually unexplored environments, together suggest that the tropics represent the center of diversification for that genus and that additional species remain to be discovered.

Thorogobius species are medium-sized gobiid fishes (6-13 cm in length). The live colouration is unknown for most of the tropical species, but both temperate species have a distinctive patterning made of oval and rounded blotches over the head and the body. The two European species are semicryptic, living in dim habitats, and usually rest on the bottom in front of a shelter ready to hide inside on any disturbance.

***Thorogobius* species of the world:** NE: North-eastern; TE: Tropical-eastern.

Species	Distribution
T. alveihmi Sauberer, Iwamoto & Ahnelt, 2018	TE Atlantic
T. angolensis (Norman, 1935)	TE Atlantic
T. ephippiatus (Lowe, 1839)	NE Atlantic, Mediterranean
T. laureatus Sauberer, Iwamoto & Ahnelt, 2018	TE Atlantic
T. macrolepis (Kolombatović, 1891)	Mediterranean
T. rofeni Miller, 1988	TE Atlantic

Constructing the guide

Source of information

The identification criteria presented in this book result both from personal research and readings of the scientific and naturalistic literature. Regarding distribution maps, we used information from various sources including citizen science databases and forums (DORIS, iNaturalist, Natura Mediterraneo, BioObs), scientific data repositories (museum catalogs, OBIS, GBIF, GenBank, BOLD), scientific articles, Louisy's (2015) Europe and Mediterranean Marine Fish Identification Guide, the IUCN website and Robert Patzner's website www.patzner.sbg.ac.at. We did not include all the records presented in these sources. Indeed, we tried to check the validity of all extralimital records, and retained only those for which sufficient information was provided to guarantee reliable identification. Excluded records typically concerned species that are listed in articles without any further information about their identification. We therefore think that our maps reflect the current state of knowledge on the distribution of *Gobius* and *Thorogobius* in the North East Atlantic and the Mediterranean. However, because hopefully these maps will be soon deprecated, we encourage the readers to regularly check Robert Patzner's excellent website that keeps updated distribution maps for the Mediterranean region.

Taxonomy and names

We followed Eschmeyer's Catalog of Fishes (www.calacademy.org) for the scientific names. Common names are retrieved from different sources depending on the language. We used Fishbase for English, Louisy (2015) for French, Lloris (2015) as a primary choice and Fishbase as a secondary choice for Spanish, Robert Patzner's website www.patzner.sbg.ac.at for German and Fishbase for Italian.

Sequence of species

The phylogenetic relationships between all *Gobius* and *Thorogobius* are still not fully resolved. For simplicity, the species accounts are thus presented in the alphabetical order. For the Quick Identification Guide, the sequence of species has been subjectively chosen to facilitate comparison between resembling species.

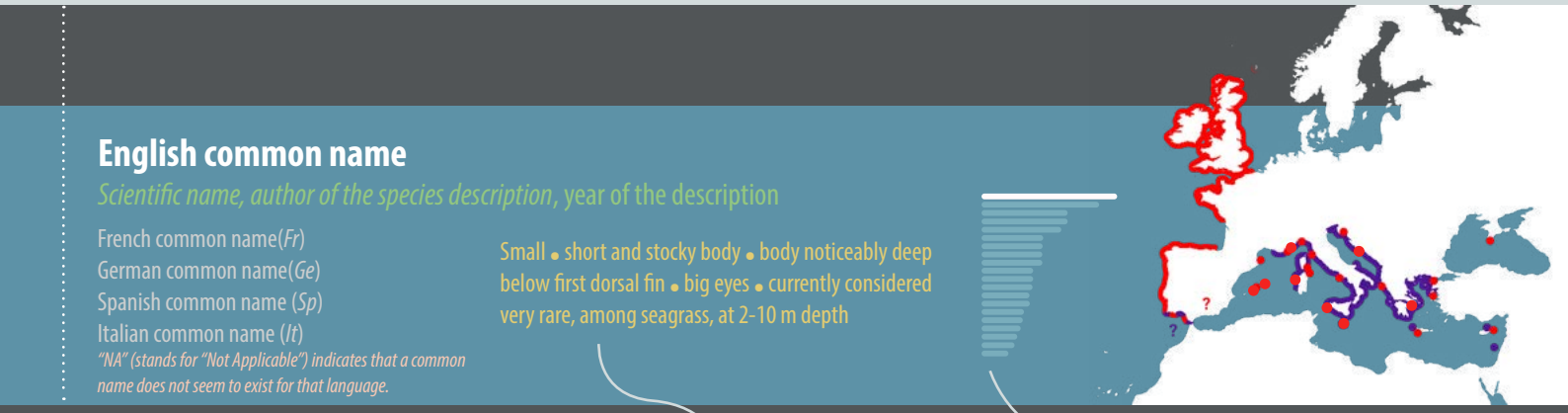
Quick Identification Guide

Our photographic guide starts with a Quick Identification Guide (QIG), which aims to help the reader to pre-select one or a few candidate species. The QIG provides the most important identification criteria for typical specimens in day colouration. Both females and males are represented for sexually dimorphic species; however, we did not represent juveniles and adults in night colouration.

The QIG is not exhaustive: we strongly encourage the user to read the species accounts in order to confirm an identification. For each species, size is given as a pictogram representing a histogram of size distribution for all twenty species of *Gobius* and *Thorogobius* included in the guide. The longest bar of the histogram corresponds to 22.5 cm (Giant goby), the shortest to 4.5 cm (Striped goby). Bar lengths are an indication of the average size of adults without distinguishing females and males. For more precise information on size, refer to the species accounts or to the Appendix. In addition to the twenty species of *Gobius* and *Thorogobius*, we represented a few other, potentially confusing species (indicated by the symbol ⚠). For these species, we only indicated the criteria necessary to avoid confusion with similar-looking *Gobius* and *Thorogobius* species.

Structure of the species accounts

Species accounts are all organized in the same way:



English common name

Scientific name, author of the species description, year of the description

French common name(*Fr*)
German common name(*Ge*)
Spanish common name (*Sp*)
Italian common name (*It*)
"NA" (stands for "Not Applicable") indicates that a common name does not seem to exist for that language.

Small • short and stocky body • body noticeably deep below first dorsal fin • big eyes • currently considered very rare, among seagrass, at 2-10 m depth

[You may notice that the authors of the species description and the year of the description can be between parentheses, or not. This is not a typo, but a convention in zoological nomenclature: parentheses indicate that the species was originally described with a different genus name, but was subsequently moved to its current genus following a taxonomic revision.]

[list of key characters • dominant habitats and most frequent depth range

distribution maps represent the land (in white) and marine waters(in blue-grey) of the studied area, with the exception of the Azores (where both Gobius *and* Thorogobius *occur), the extreme North of Europe and the Caspian Sea (where neither* Gobius *or* Thorogobius *has been recorded). A continuous species distribution is indicated by a continuous red band (or violet for Mediterranean Leopard-spotted goby) along the coastline, and geographically isolated records by a red spot. Question marks indicate that the species has been mentioned in the region but that there is no document (photo, collected specimen) certifying the identification, or that locality is uncertain.]*

[histogram of size distribution for all twenty species of Gobius *and* Thorogobius *(same as in QIG), and typical total length]*

- **Description**

[Provides a complete description of the morphological characters that are useful for field identification. By field identification, we also mean identification on pictures taken in the field. Although some of the presented characters are visible only in close-up photographs, most of them apply to any reasonably good photograph. We tried to follow the same order of characters for all species: size, general shape and structure, background colouration of the trunk, body patterning, background colouration of the head, patterning of the eyes, of the snout and then of the rest of the head, description of dorsal, caudal, anal, pelvic and pectoral fins, presence or not of scales on the nape and the opercle, presence or not of a dermal process terminating the anterior nostrils.]

Night colouration.

Sexual dimorphism.
[We only discussed characters visible on live specimens in the field. We thus did not discuss the shape of the genital papilla, which is often the most reliable external characters for sexing gobies but that is almost never visible in photographs. As a rule-of-thumb, the urogenital papilla is slender and conical in males, shorter and broader (more trapezoidal in females.]

Juveniles.
[Only describes those characters that allow aging individuals as juveniles or immatures as opposed to adults.]

- **Similar species**

[When relevant, starts with a list of characters that make the species unique among *Gobius* and *Thorogobius* species. Then, the section provides a comparative diagnosis of similar-looking species. In general, a diagnostic character is first provided for the similar species, then the corresponding character for the focus species is indicated between parentheses.]

English common name

description, year of the description

- **Distribution & status**

[Details the geographic distribution of the species within the entire studied region. This section complements the distribution map giving references for extralimital and other outstanding records, or discussing for example recent shifts in the distribution range. It also concisely provides information on the frequency of the species, categorised as 'abundant', 'common', 'rarely seen' or 'very rarely seen'.]

In *France*, ... [Details the geographic distribution and frequency of the species in France (for no better reason than two of the authors are French.]

- **Habitat**

[Usually starts with depth range, then provides a brief description of the main habitats occupied by the species.]

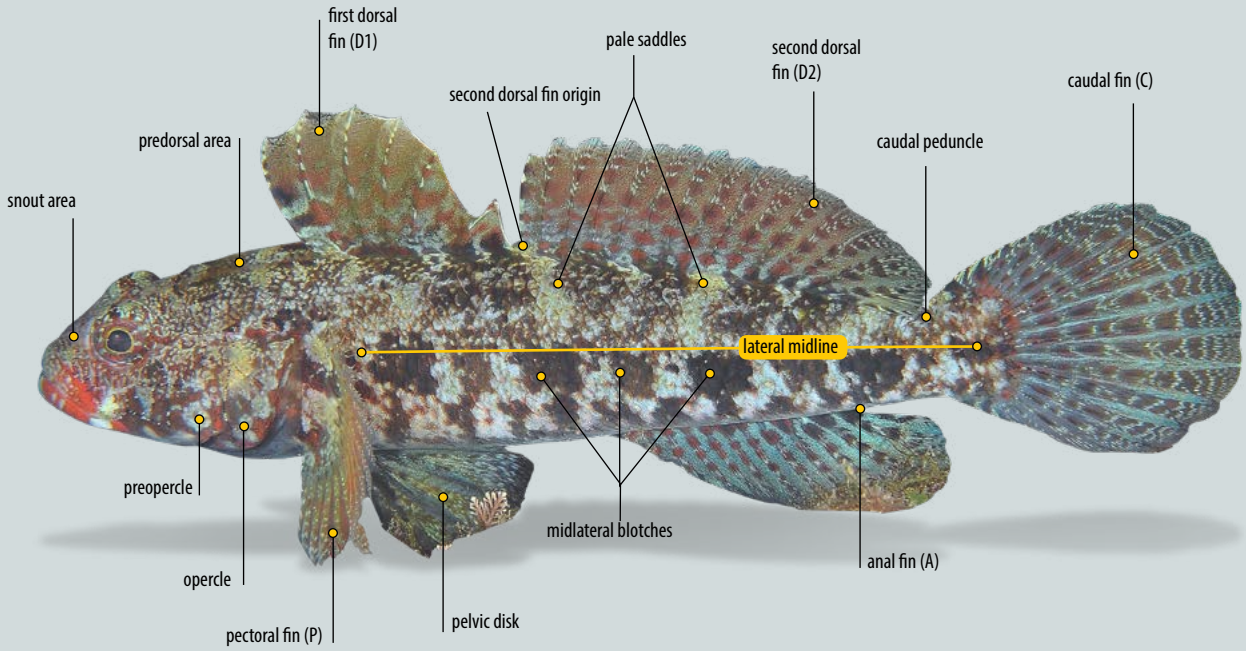
- **Miscellaneous**

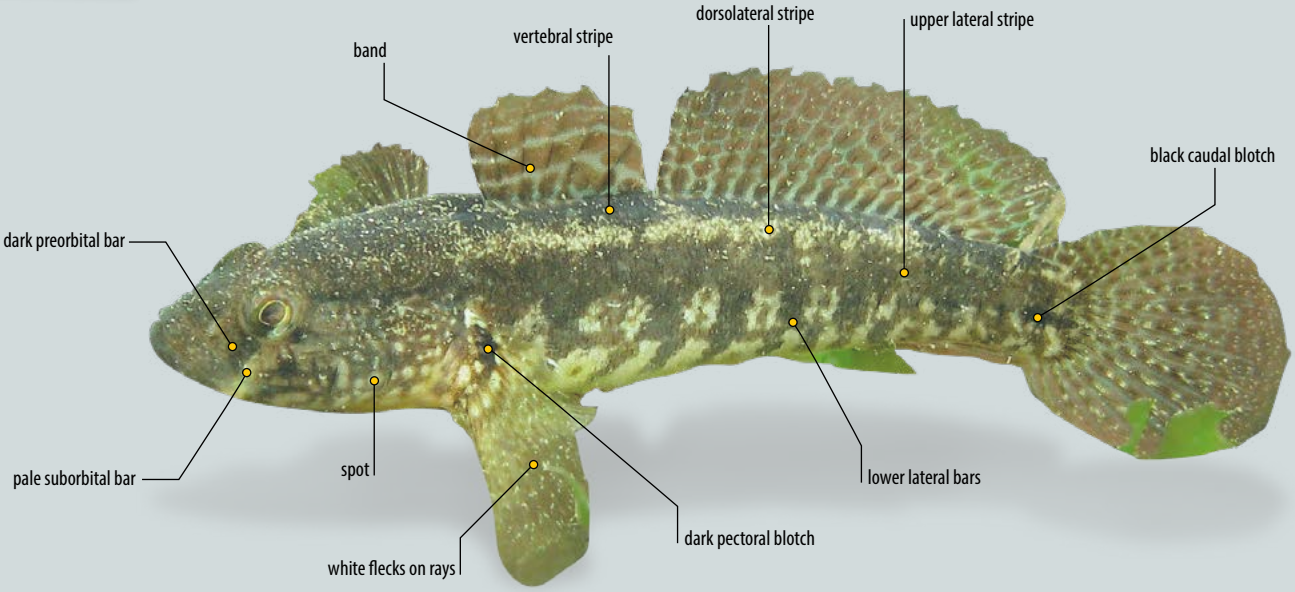
[Gives anecdotes on the natural history of the species.]

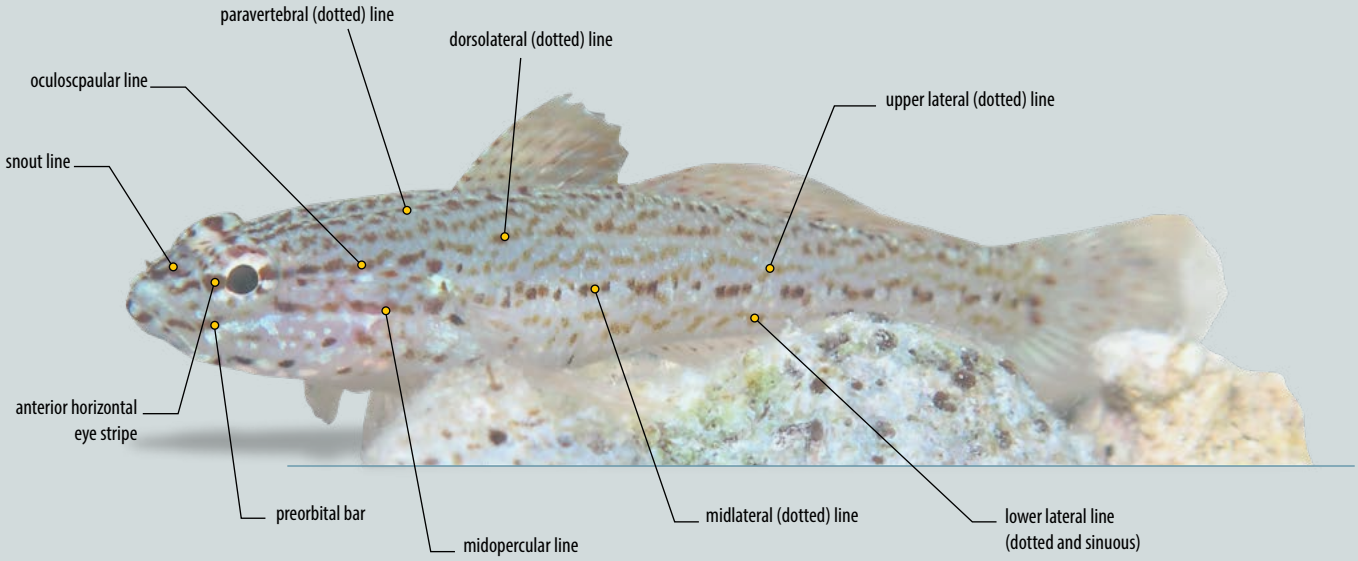
Photographs

We used photographs of live specimens in their natural environment as much as possible. Exceptionally, however, when we could not find suitable photographs, we included pictures of preserved specimens or of fish in a tank. The sequence of photographs usually follows this order: males (because they are often more easily identified than females), females, females or males in night colouration, juveniles, and last we present pairs or triads of pictures illustrating the focus species along with similar-looking species. Captions are always made of three parts. The first part gives information on the species name, sex and age when known, and position (e.g., 'top', 'bottom') for multi-panel images. The second part, the main body of the caption, is a short explanation of how to identify the fish, trying to focus on characters that are really visible in the corresponding photographs. The third part indicates the shooting date, the place of shooting with locality followed by country (preceded by department number for French localities), and the name of the photographer. In order to ease comparison between individuals, all fish are oriented with their heads to the left. When a photograph has been horizontally flipped to achieve this orientation, this is mentioned at the end of the caption.

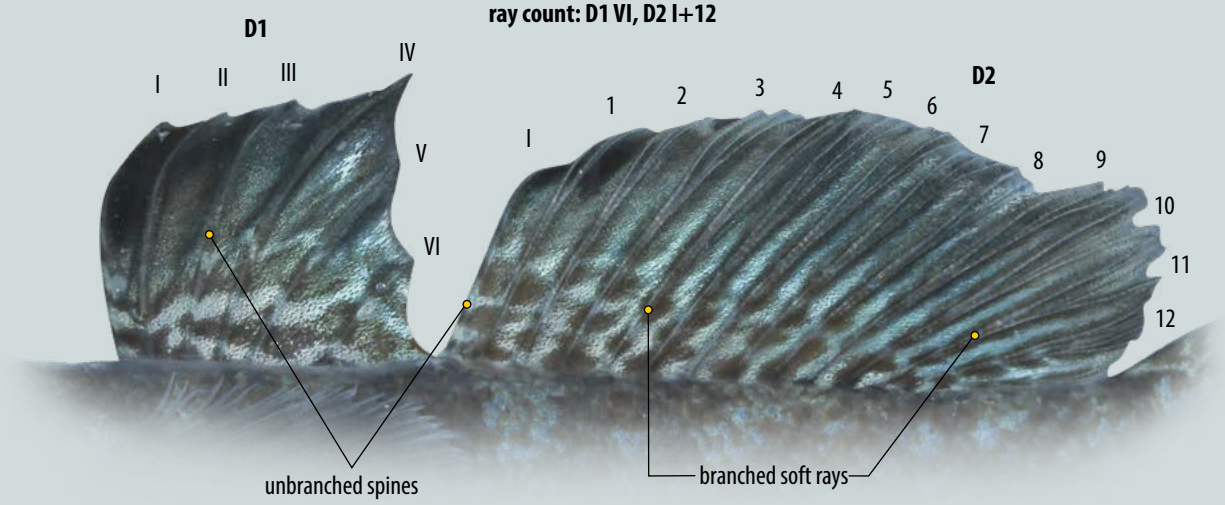
Fish topography

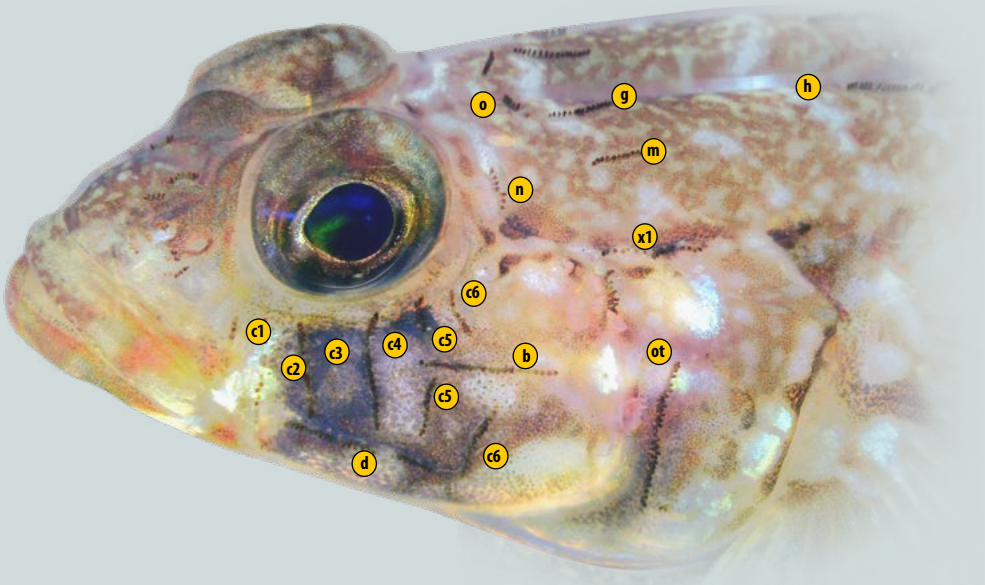


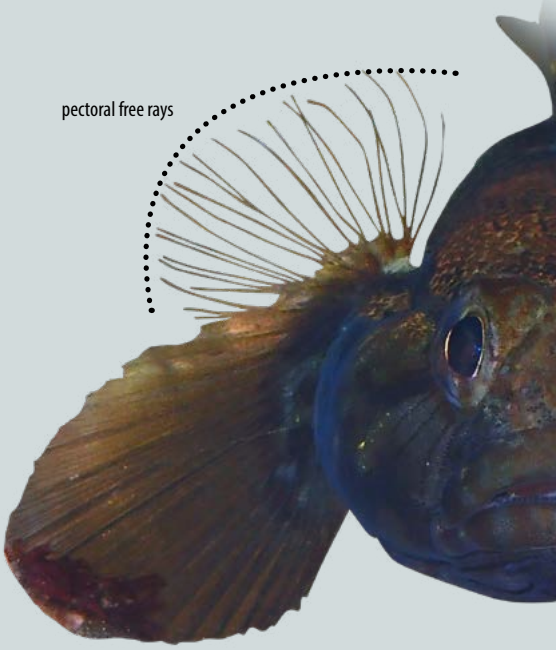


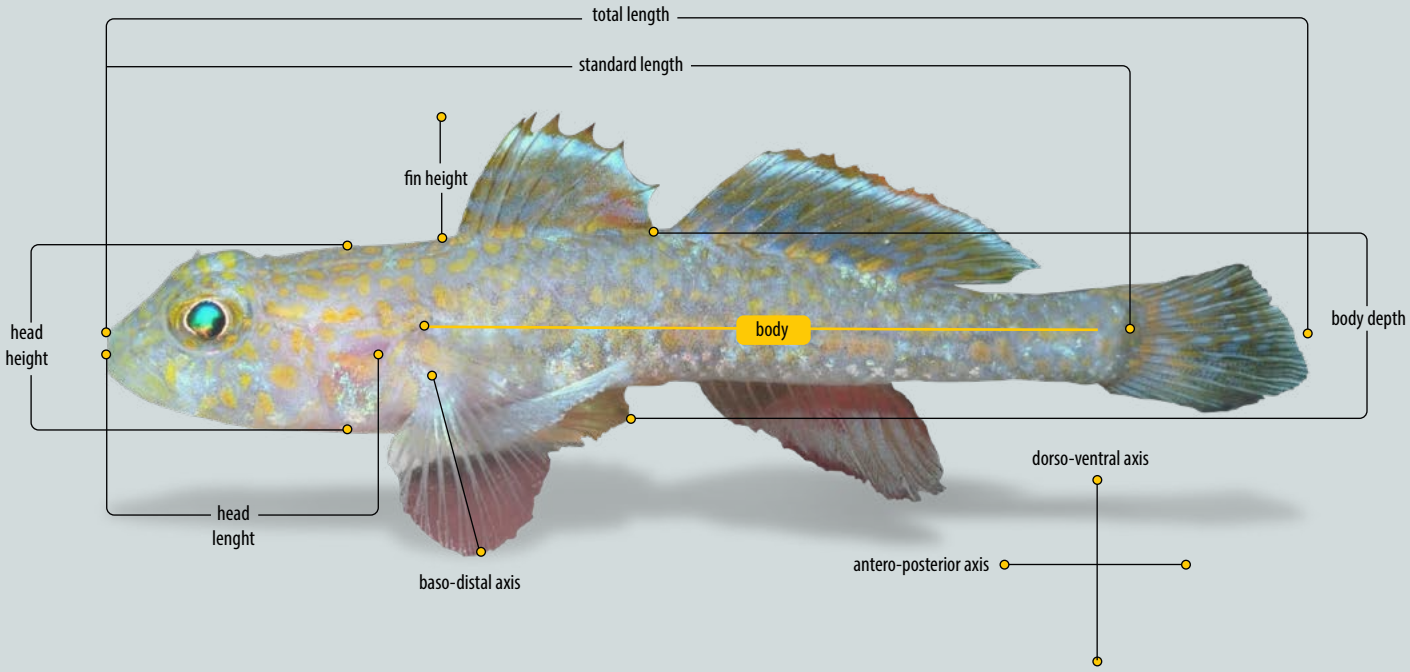


ray count: D1 VI, D2 I+12









Gobying: the art of watching and identifying gobies

Where and when to watch gobies?

Gobies can be searched anytime, anywhere. Indeed, one should not overstate our current knowledge of the ecology and geographic distribution of gobies. Even in rocky places with rich and colourful marine life, distributed between 0 m and 30 m depth and frequented daily by snorkelers and divers, the diversity of gobiids remains generally poorly known. The reasons are at least fivefold. First, not many people really pay attention to small, inconspicuous fish like gobies. While the affordable price of underwater digital cameras makes it possible to generously photograph all forms of marine life while diving, we usually only find what we are looking for. As proof: once the presence of a fish is revealed on a site, it is often surprising to see how common it finally is, to the point that one wonders how it could have gone unnoticed for so long.

Second, while many gobies are mostly active at night, night diving is still not very popular in Europe, even in heavily dived sites. Third, a significant proportion of gobies are cryptobenthic, spending most of their time under a stone or hidden deep in a rock fault. These fishes are hardly ever seen, even at night, although they can be locally abundant. For example, one study conducted in the Adriatic Sea sampled all fish in 50 one-square-meter quadrats randomly placed on a wall between 15 m and 45 m depth (Glavičić et al., 2016). The researchers counted epibenthic fish with a visual census, and captured cryptobenthic species using an anaesthetic solution. They found that the fish community was dominated by cryptobenthic species, and notably by Gobies which represented >60% of all species and >90% of all individuals. Remarkably, the two most frequent species, Liechtenstein's goby (*Corcyrogobius liechtensteini*) and Coralline goby (*Odondebuenia balearica*) are very rarely seen species despite they were present in 74% and 52% of quadrats, respectively (Glavičić *et al*., 2016). Another striking example is Large-headed goby (*Millerigobius macrocephalus*) in southern Corsica. Between 1988 and 1992, during four surveys using a methodology from another era, 197 specimens (!) of that species were collected after having dispersed a poisonous solution into two small coves (Bouchereau, 2002). Large-headed goby was no longer seen in Corsica until one of us found two specimens under a stone in summer 2020, after several days of prospecting. Fourth, some gobies are both cryptobenthic and truly rare species. This is certainly the case, for example, of Andromed goby (*Didogobius schlieweni*). The great French underwater naturalist Sylvain Le Bris, who has dived at night almost every week, all year round and for several years in the same cove in southern France, has encountered Andromed goby five times. Although Sylvain undoubtedly holds the world record for the number of sightings (with only 23 known records for that species overall), the frequency of observations is very low given that the species is most likely a local resident. Finally, the ecology of certain species is poorly known. Sylvain Le Bris again in the same cove only observed Tooth goby (*Deltentosteus collonianus*) three times, always at the end of winter. Contrary to Andromed goby, Tooth goby is not a cryptobenthic species and certainly not resident in that cove. Why it appears in shallow waters at this time of the year and where it lives the rest of the year is still unknown.

Apart from the rocky coasts, almost everything remains to be discovered. In Europe, very few people dive on purely soft bottom habitats, let alone at night. At first glance, soft bottom habitats often seem boring. However, they are home to several poorly known goby species, and as such they provide the most rewarding environment for those who want to take fishwatching a step further. Silty bottoms, in particular, host species whose field identification remains the most problematic, such as Lozano's goby (*Pomatoschistus lozanoi*) or Norway goby (*P. norvegicus*), or which have been rarely photographed alive, such as Fries's goby (*Lesueurigobius friesii*) in the Mediterranean. Another underexplored environment are the vast seagrass meadows. Despite their apparent homogeneity, seagrass meadows offer a diversity of microhabitats colonized by poorly known fish species. In particular, the root system of *Posidonia oceanica* would deserve further nocturnal explorations to search for the elusive Bellotti's goby (*G. ater*).

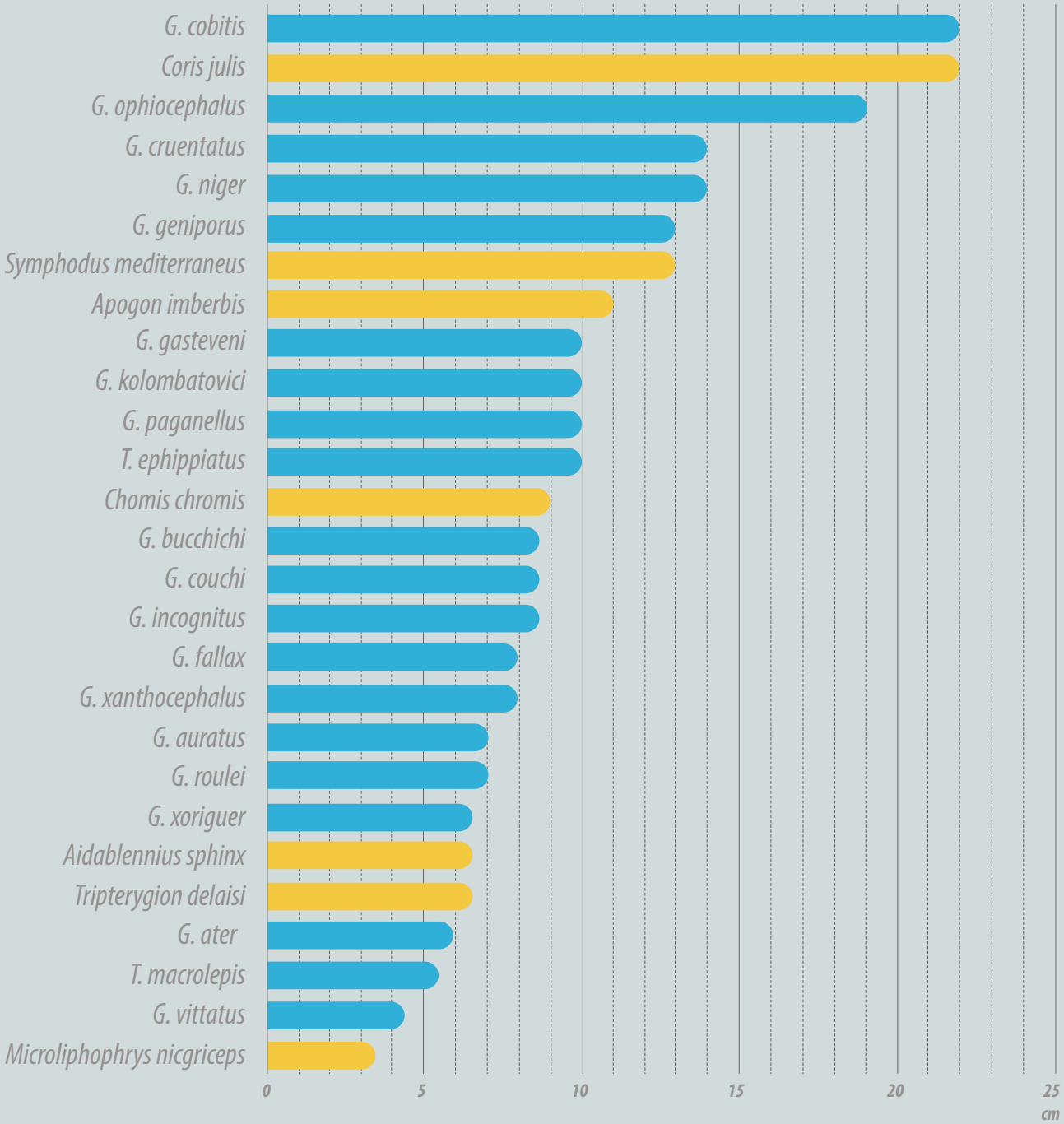
Identifying gobies

For many of us, the challenge of identifying fish is the most enjoyable part of fishwatching. Naturally, your first impression is important to the identification process and, in many cases, it can be enough. In general, however, it is better to adopt a more rigorous approach based on the two steps presented within each Species Accounts in this guide: a full description of the individual followed by a differential diagnosis. Regarding the description, stay objective, open-minded, trying to describe what you really see and not what you want to see based on your preliminary identification. Pay attention to the general structure (for example: short- *vs*. long-bodied), the shape of the head (for example: steep *vs*. shallow profile), the shape and relative size of fins (e.g., is D1 taller than D2?), body colours and patterns (separately describing body, head, eyes and lips) and of all fins. It is recommended, especially during an *in situ* observation, to always enumerate all characters the same order so as not to miss a decisive one.

The description should also include the size. Size assessment in photos is sometimes possible when external elements of known size are visible right next to the fish (for example a leaf of *Posidonia* seagrass, typically 1 cm wide). Underwater, evaluating size is notoriously challenging due to the optical properties of water, making objects look closer (3/4 the distance) and larger (4/3 the size) compared with our terrestrial benchmark. As a matter of fact, the field 'size' in databases of field observations is rarely filled in, or when it is, discussion with the observer often reveals that the size has been "adjusted" after verification in an identification guide. We encourage fishtwatchers to practice size assessment. With a little practice it becomes possible to give our underwater vision a new baseline, and then to get accurate size estimates. Before diving, measure the width of your hand with 2, 3 or 4 extended fingers. Then, during your dives, practice predicting the size of various objects or organisms and validate your prediction by comparing with your fingers. As a supplement, it is also useful to learn the typical adult sizes of some common fish and use them for comparison.

The table below gives the average size (total length) for the twenty studied species of *Gobius* and *Thorogobius* as well as some other common species.

Size (TL) of *Gobius* and *Thorogobius* species and a few common fishes (in yellow)



Only after you have exhaustively described your fish's appearance can you move onto the differential diagnosis. This second step of the identification process can be achieved after the dive. List all candidate species with several characters matching your description, and for each species, one after the other, write down the pros and cons. Evaluate the pros and cons as a whole and do not dismiss a candidate species just because a single character does not match: the photo or your memory may distort the truth, some natural variations in the species may simply be unknown, or the specimen can be an outlier for this character.

Because you are a fishwatcher, you should also take advantage of information that would not be available if, for example, you were to identify a preserved specimen in a museum. The behaviour, in particular, can be very informative. Somes species like De Buen's goby (*Buenia affinis*) are quite easy to approach while others, like Large-scaled goby (*T. macrolepis*) tend to be wary. Observing interactions with conspecifics (sexual display, aggression) can be helpful in interpreting a rarely reported colour or pattern. Other contextual information such as the associated fish community, habitat and geographic distribution should also be taken into account. If, being a beginner fishwatcher, you identify a species that has never been recorded in that region, habitat or depth before, you may consider going through the identification process again and evaluate the robustness of your clues.

Documenting your records

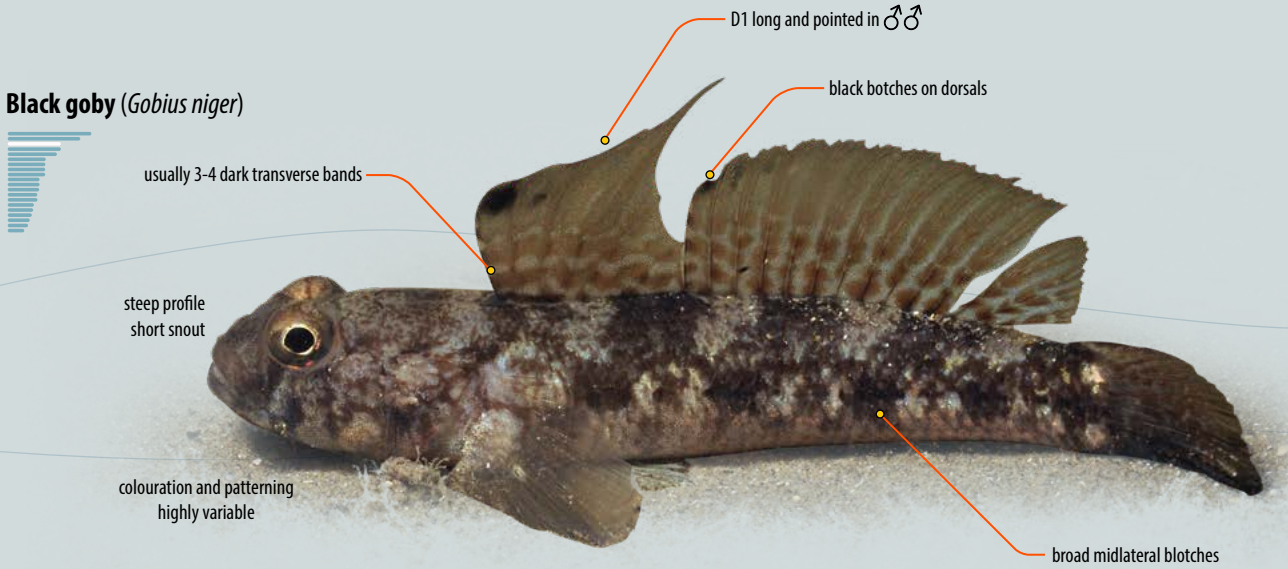
Whether or not you have successfully identified your fish, it is important to share your photos on a citizen science database. Such databases bring together many fish enthusiasts eager to help you advance in fish identification. Moreover, when they are associated with contextual data (at least date and location, and if possible time of the day, depth and habitat) your photos become valuable documents potentially carrying new information on distribution, habitat, or geographic variation. Your photos could even be used, with your permission, in one of the future identification guides of the Frontiers in Fishwatching Series! Above all, do not self-censor on the quality of pictures or the rarity of the fish. The greatest discoveries often started with a failed photo of a misidentified fish; all records are thus interesting.

Records can now be shared and stored on a number of websites. The Fish Watch Forum (www.fish-watch.org) is a great place to post fish records. This citizen science repository was launched in 2014 by Patrick Louisy and the Association Peau-bleue, and accepts all photos of fish from the North-eastern Atlantic and the Mediterranean region. The user interface may not appear as user-friendly as on some other websites, but the Fish Watch Forum is probably the database that will value your records the most. All records are validated (both identification and metadata) by a minimum of three persons, including one specialist of the recorded fish (often a professional ichthyologist). This careful validation guarantees the quality of the database. Another popular database is iNaturalist (www.inaturalist.org), which accepts records of any living organism from any location in the world. The database benefits from a large community and a blog-like interface allowing all users to propose identification and comment on others' observations. Other great ressources hosting observations of individual fishwatchers include the Ocean Biodiversity Information System (www.obis.org), and Observation.org (www.observation.org).

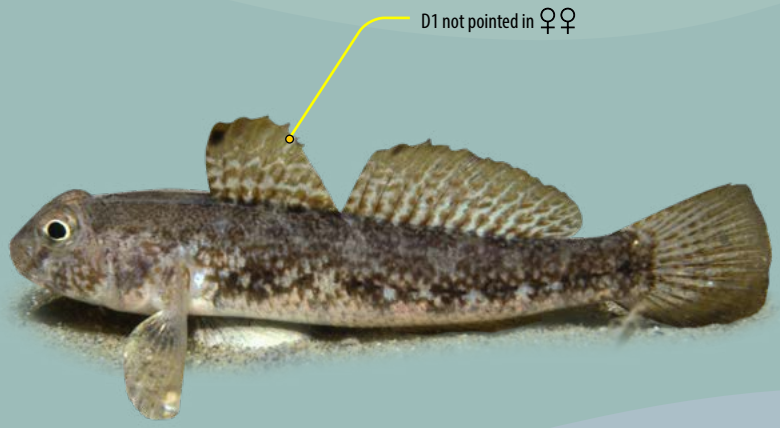
Social media are not ideal to store data as the constant flow of new information will bring your record to the Internet limbo. However, if you read or see interesting information on Facebook, such as a photo of an unidentified goby taken by your buddy while you were looking in the wrong direction, and posted on his wall, you can share it on the Marine Fish Identification - NE Atlantic and the Mediterraean group, which specifically aims to collect Facebook data before they get lost.

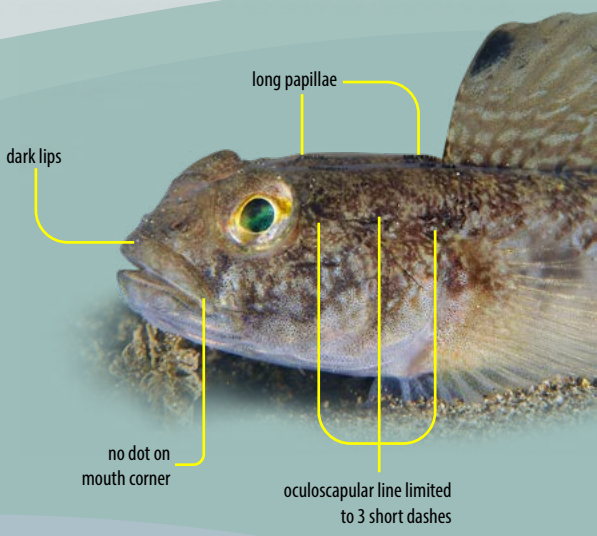
• Quick Identification Guide

Black goby (*Gobius niger*)

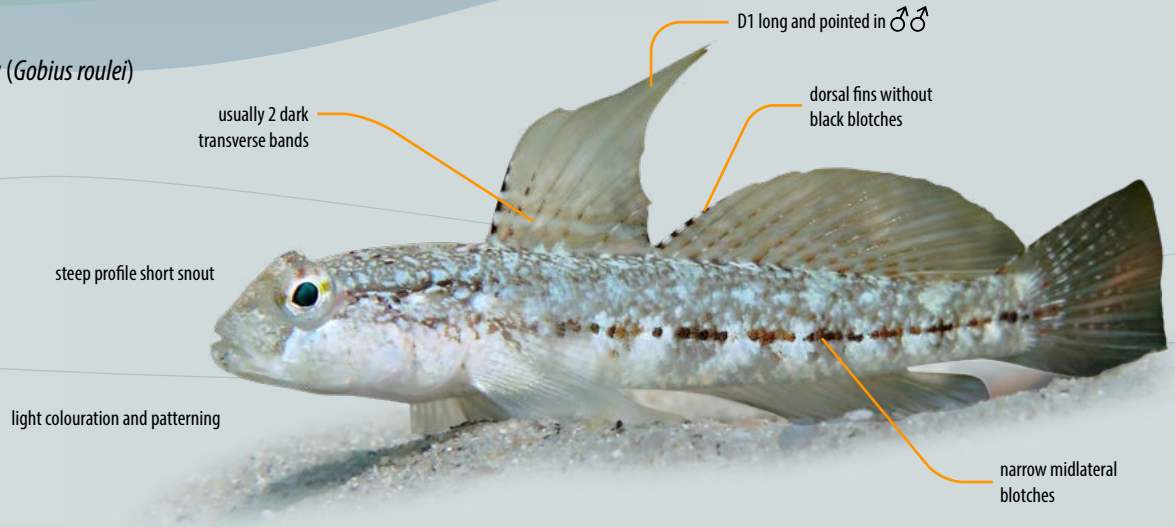


Black goby (*Gobius niger*)

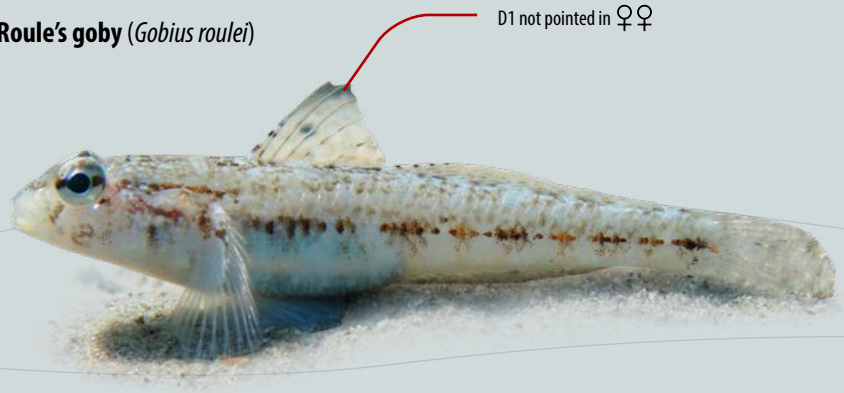


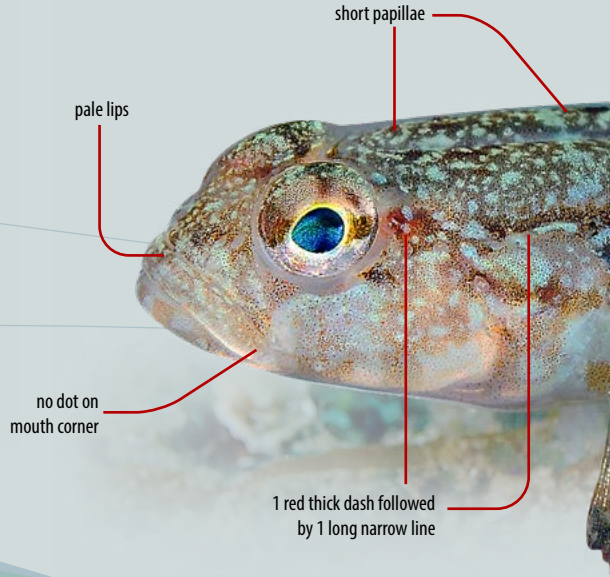


Roule's goby (*Gobius roulei*)

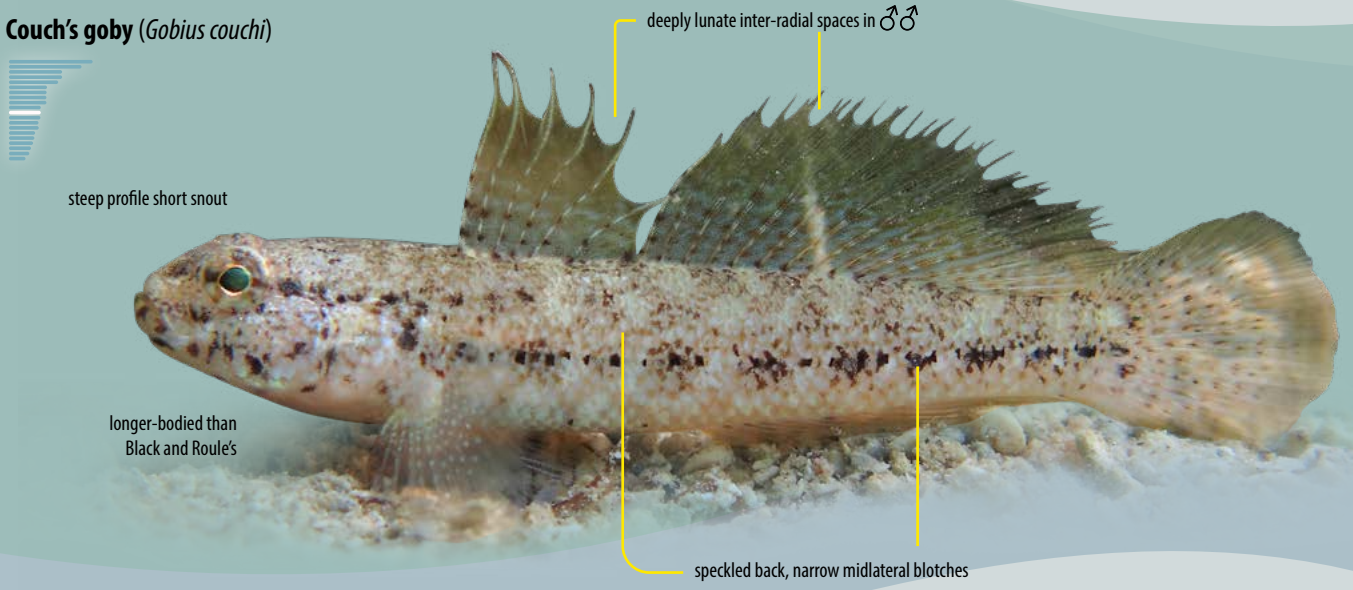


Roule's goby (*Gobius roulei*)

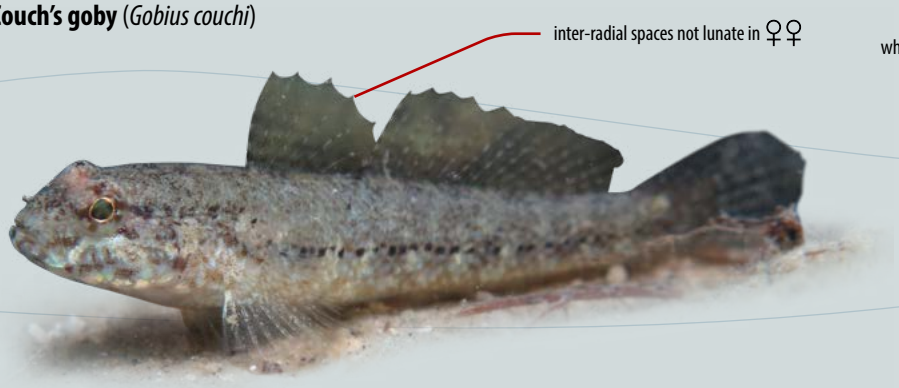


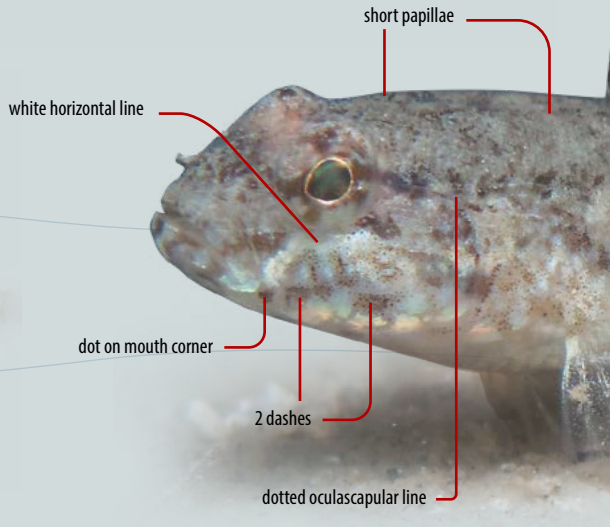


Couch's goby (*Gobius couchi*)

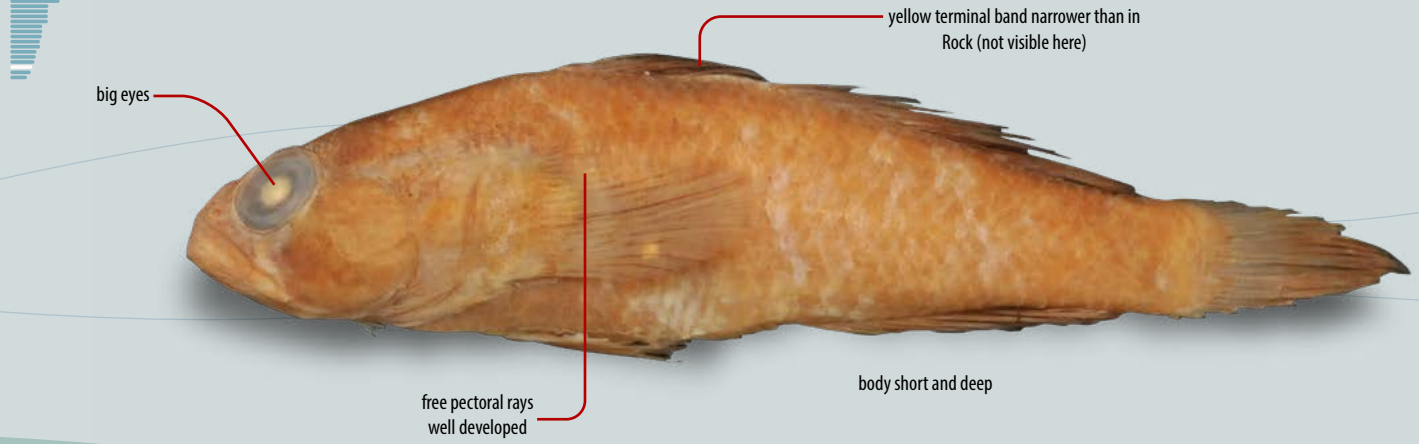


Couch's goby (*Gobius couchi*)

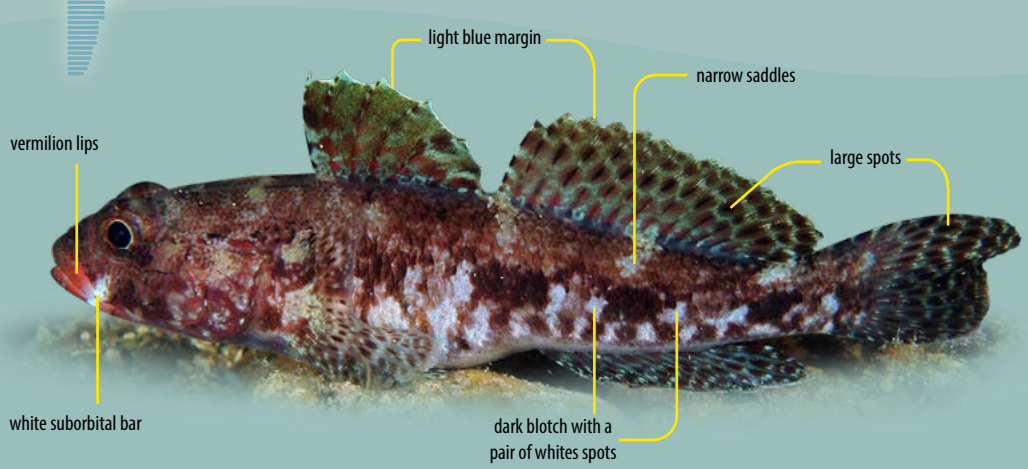


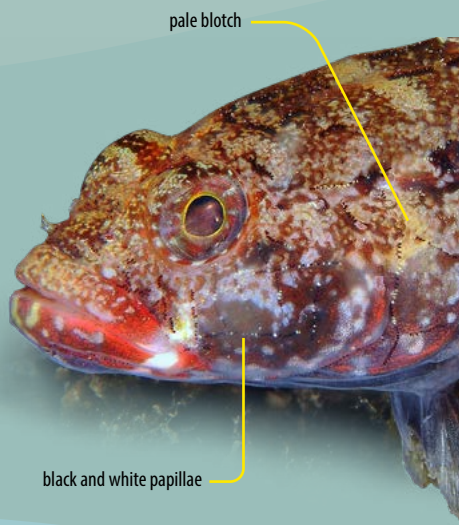


Bellotti's goby (*Gobius ater*)

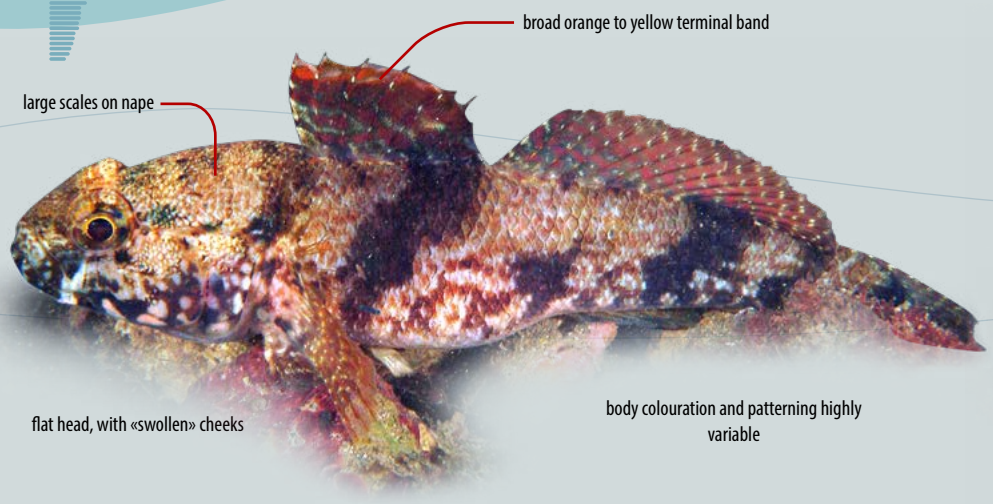


Red-mouthed goby (*Gobius cruentatus*)

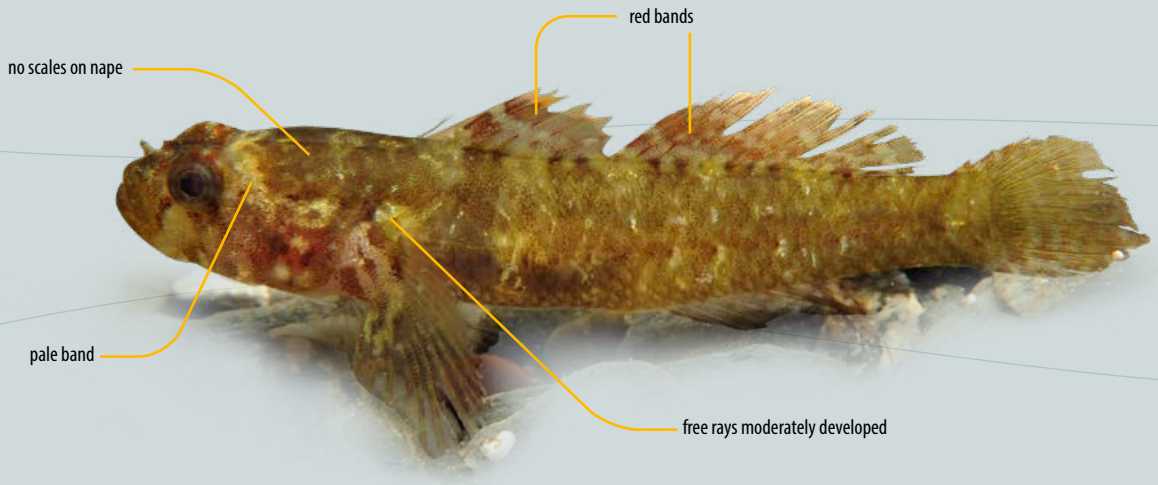




Rock goby (*Gobius paganellus*)



Zebra goby (*Zebrus zebrus* or *Z. pallaoroi*) ⚠



Round goby (*Neogobius melanostomus*) ⚠

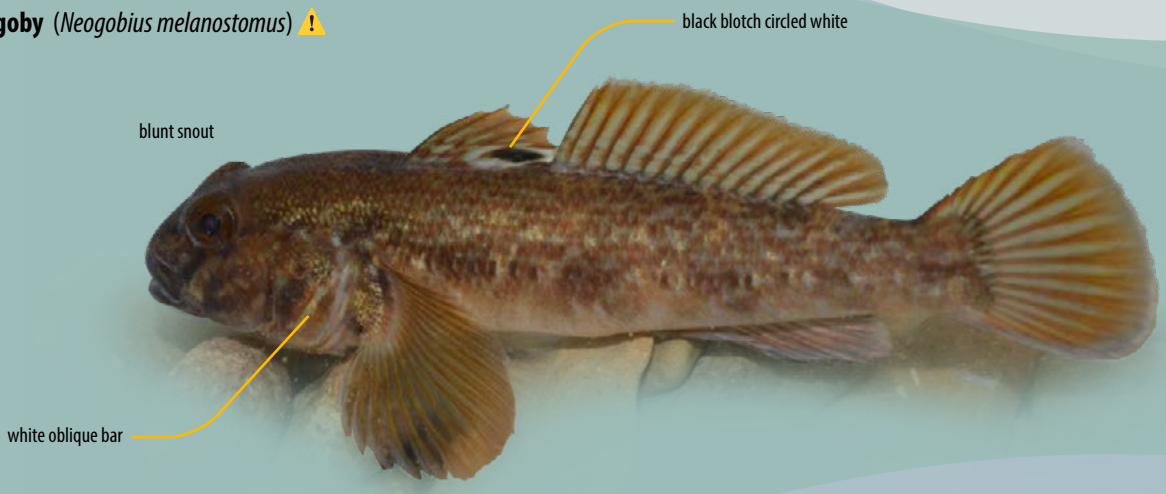
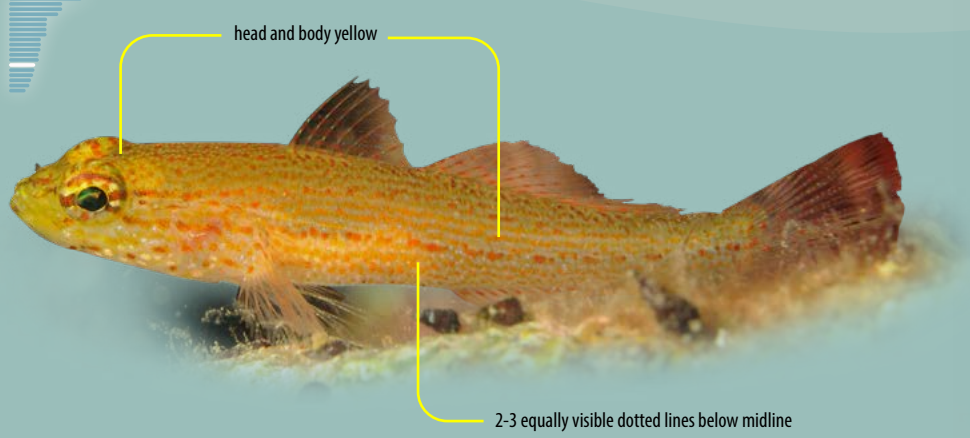
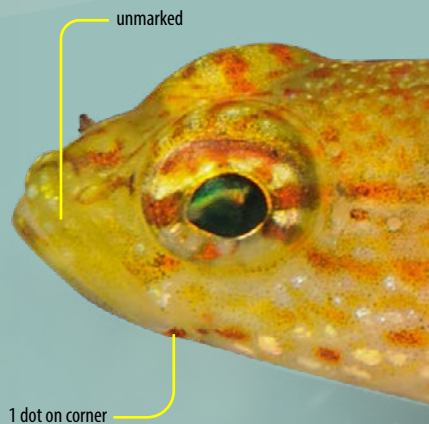


Photo credits (for the entire Quick Identification Guide): Harald Anhelt, Christophe Balisky, Lucas Bérenger, Stefano Guerrieri, Benjamin Guichard, Sylvain Le Bris, Thomas Menut, Anja Palandačić, Bernard Picton, Roberto Pillon, Julien Renoult, João Pedro Silva, Daniel Vaulot.
Watercolour: Samuel Iglésia

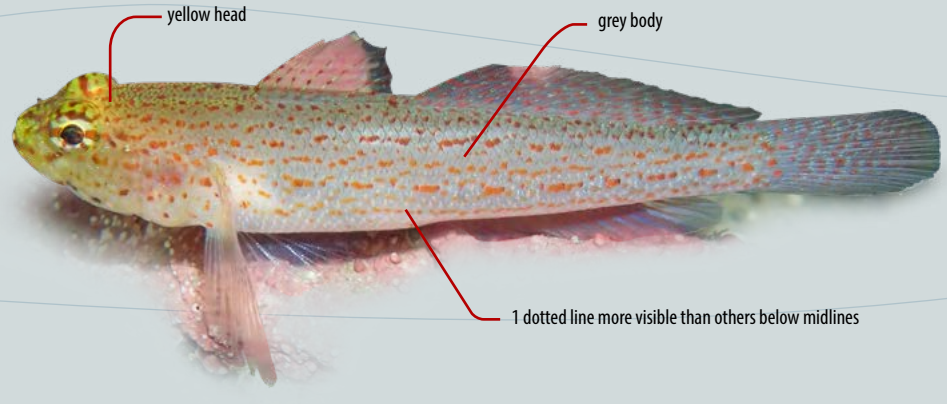
Golden goby (*Gobius auratus*)
plain morph

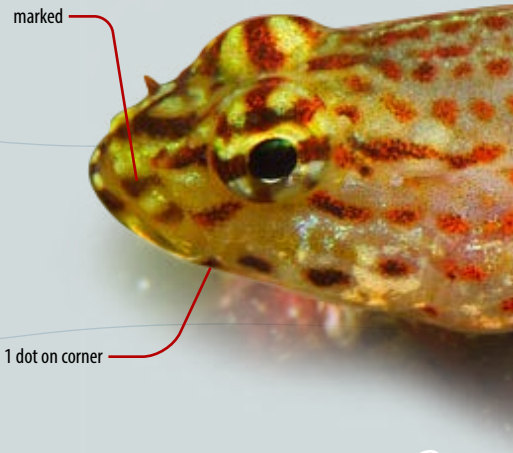
Golden goby (Gobius auratus)
dotted morph



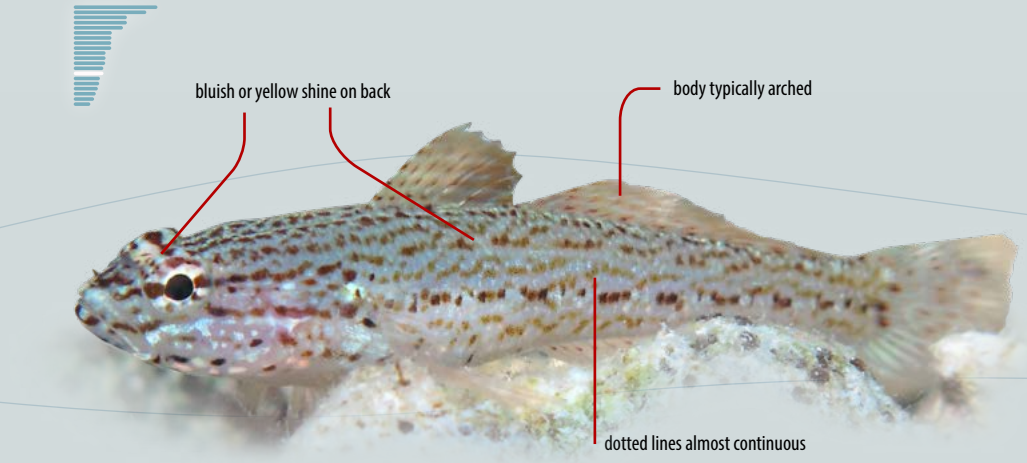


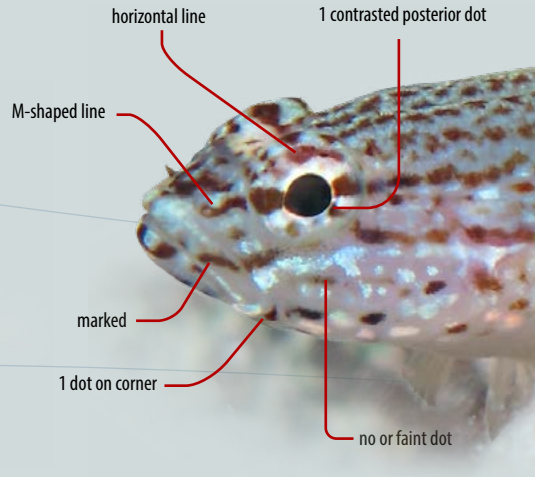
Yellow-headed goby (*Gobius xanthocephalus*)



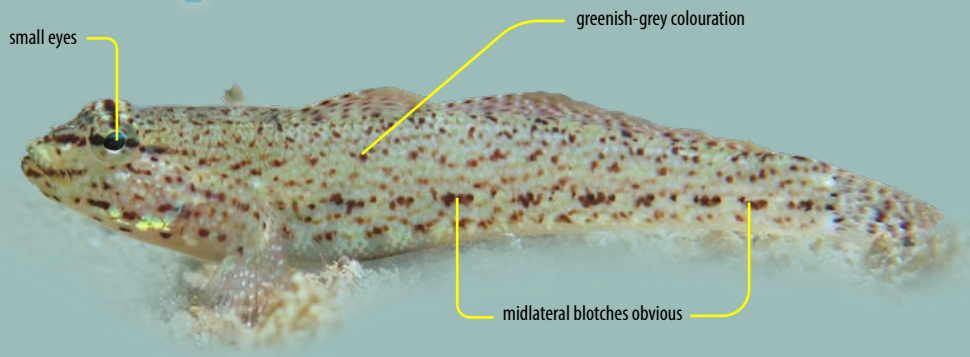


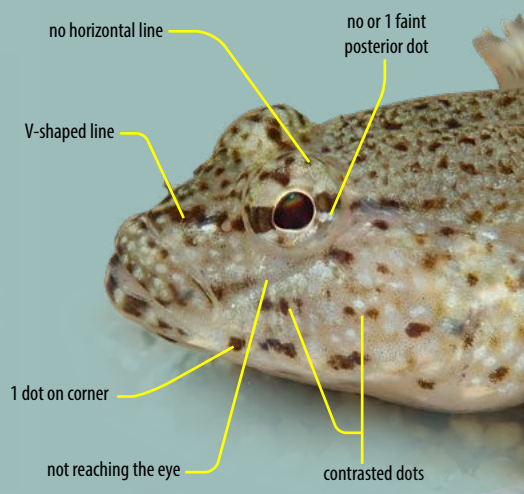
Sarato's goby (*Gobius fallax*)



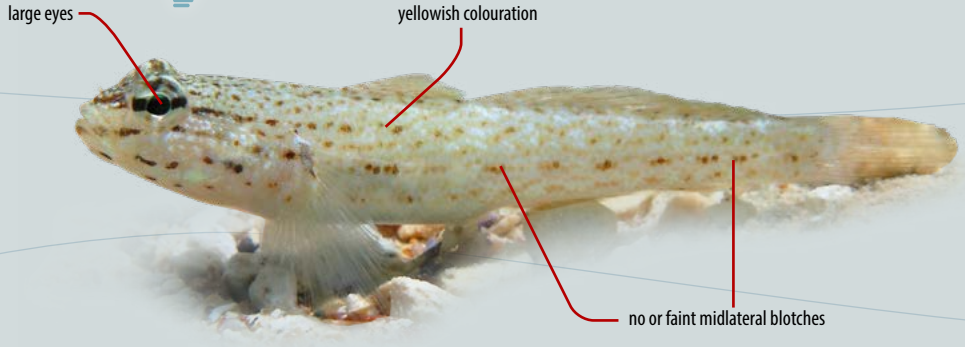


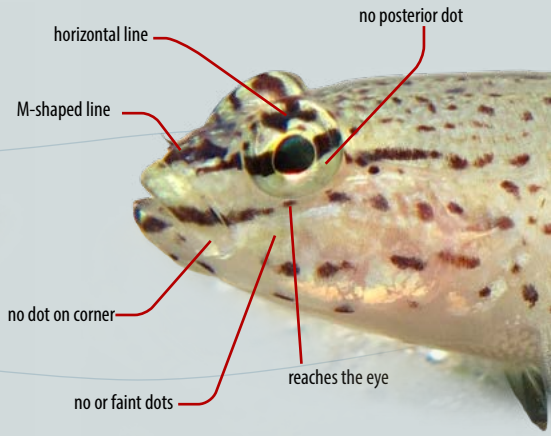
Incognito goby (*Gobius incognitus*)



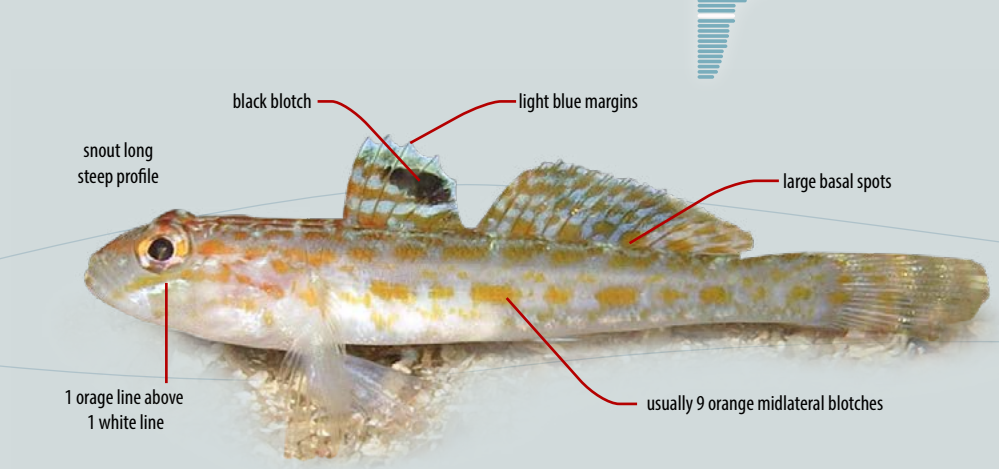


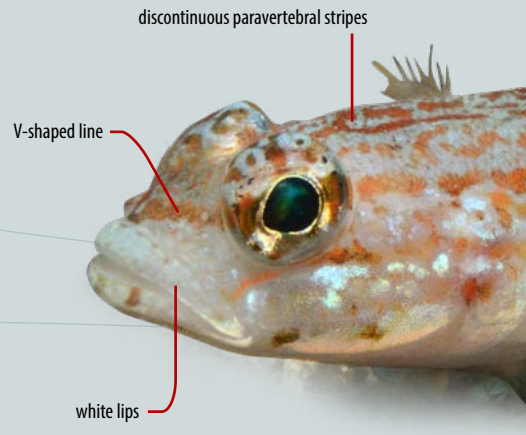
Bucchich's goby (*Gobius bucchichi*)



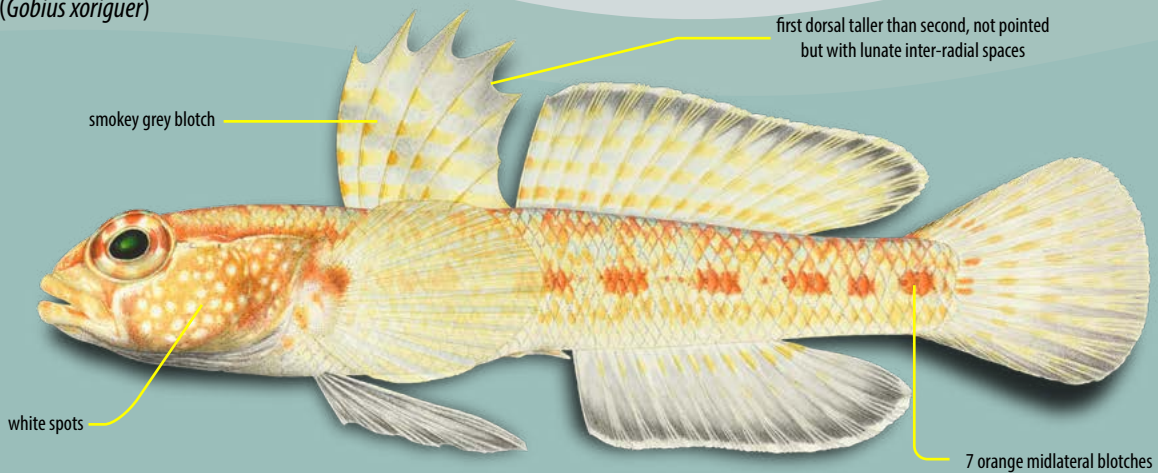


Kolombatovic's goby (*Gobius kolombatovici*)

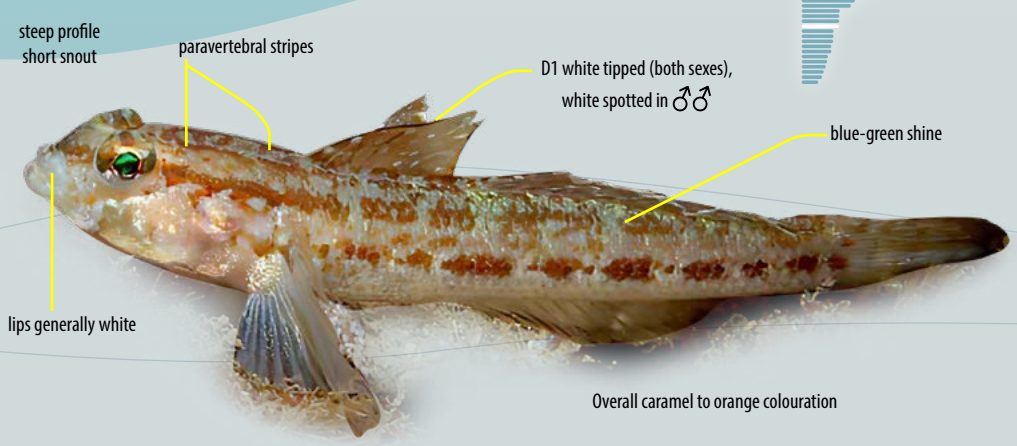


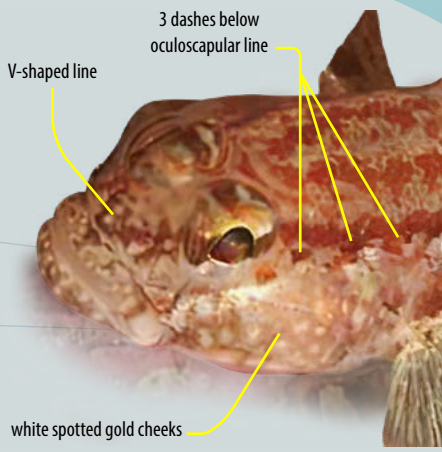


Kestrel goby (*Gobius xoriguer*)

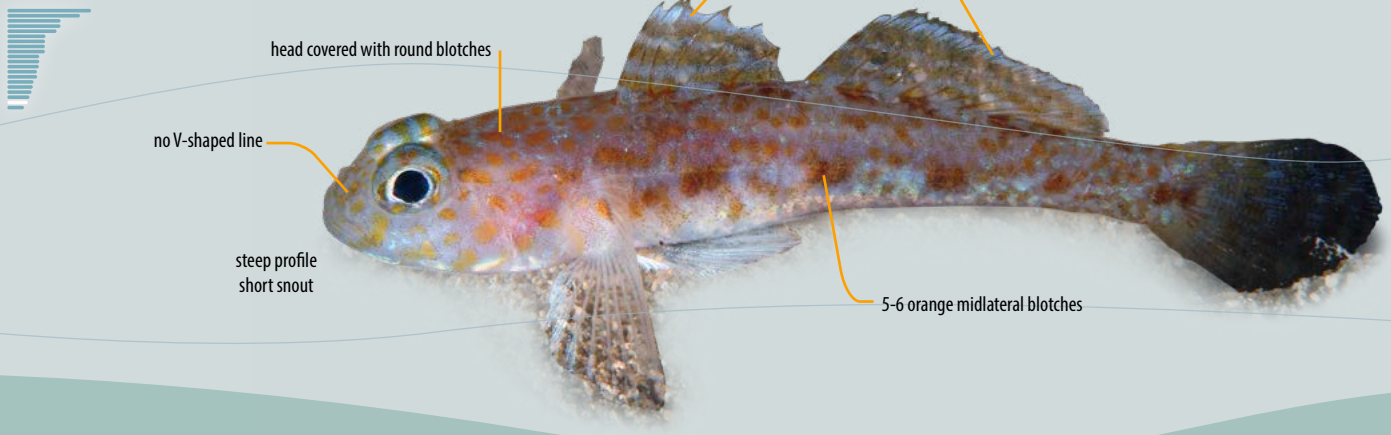


Steven's goby (*Gobius gasteveni*)

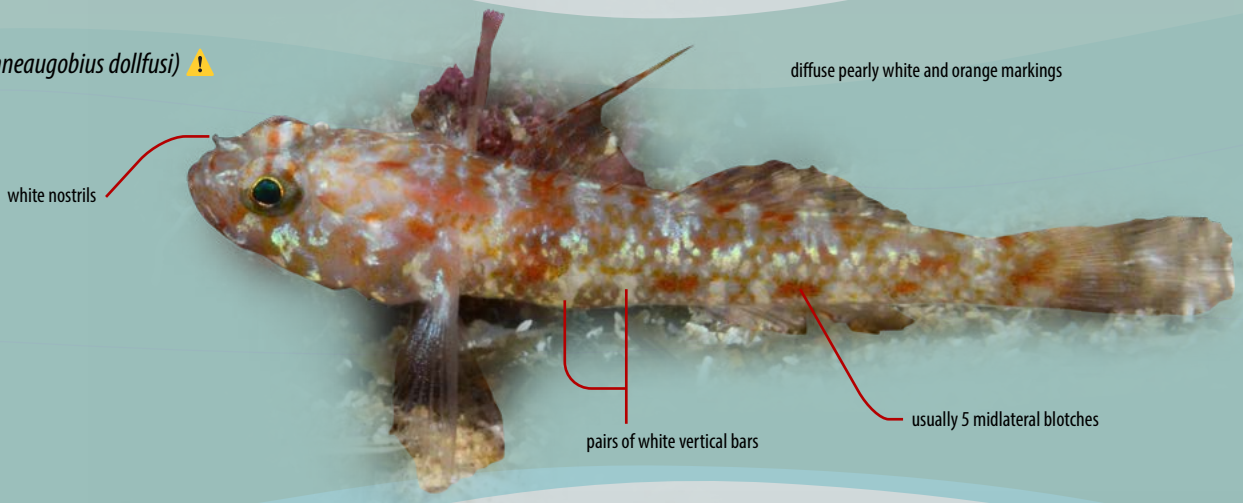




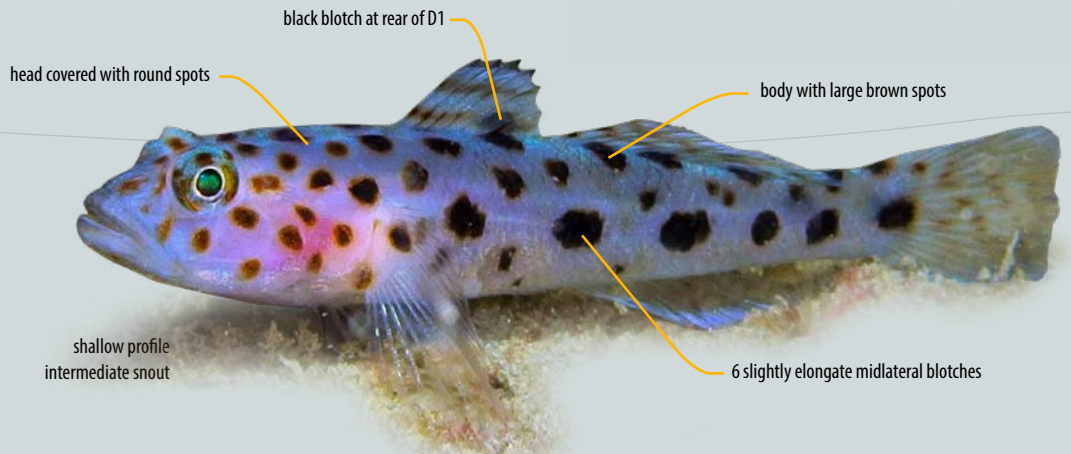
Large-scaled goby (*Thorogobius macrolepis*)



Dollfus' goby (*Vanneaugobius dollfusi*) ⚠

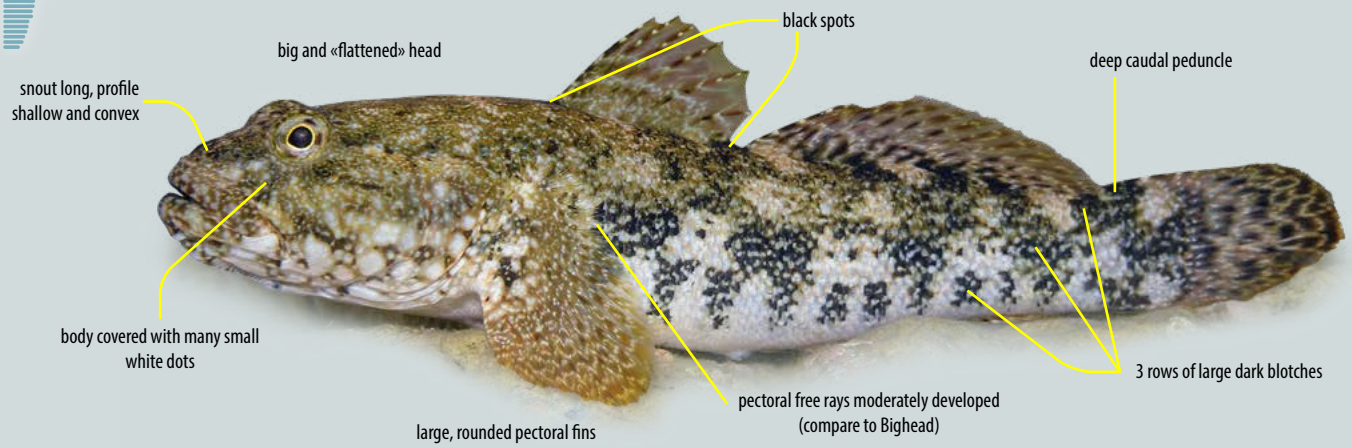


Mediterranean Leopard-spotted goby (*Thorogobius ephippiatus*)
comparison with the Atlantic form below

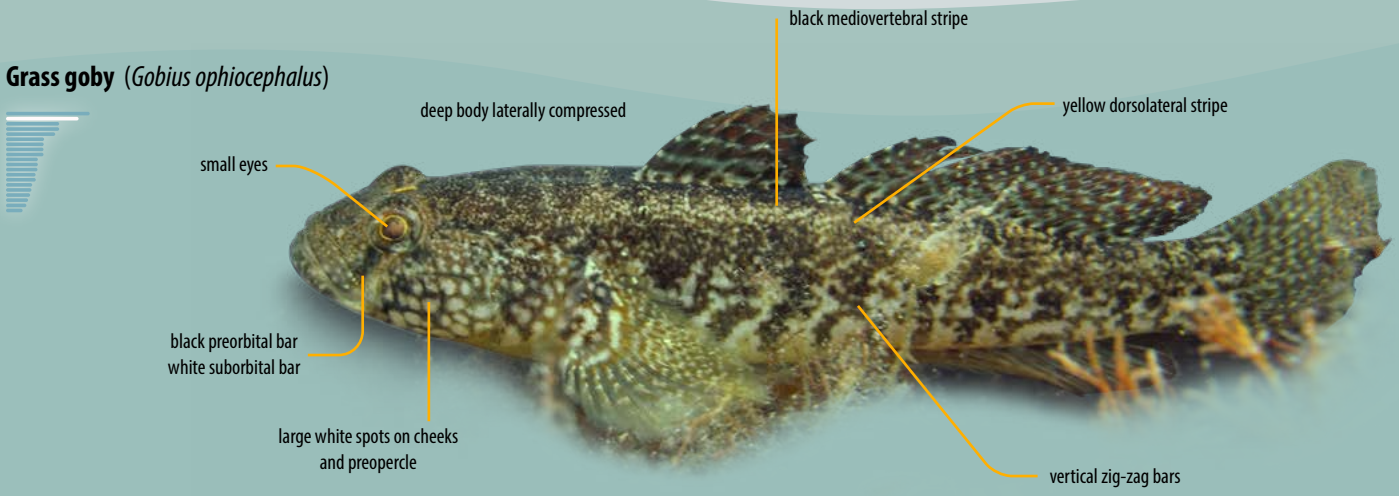


Atlantic Leopard-spotted goby
(*Thorogobius ephippiatus*)

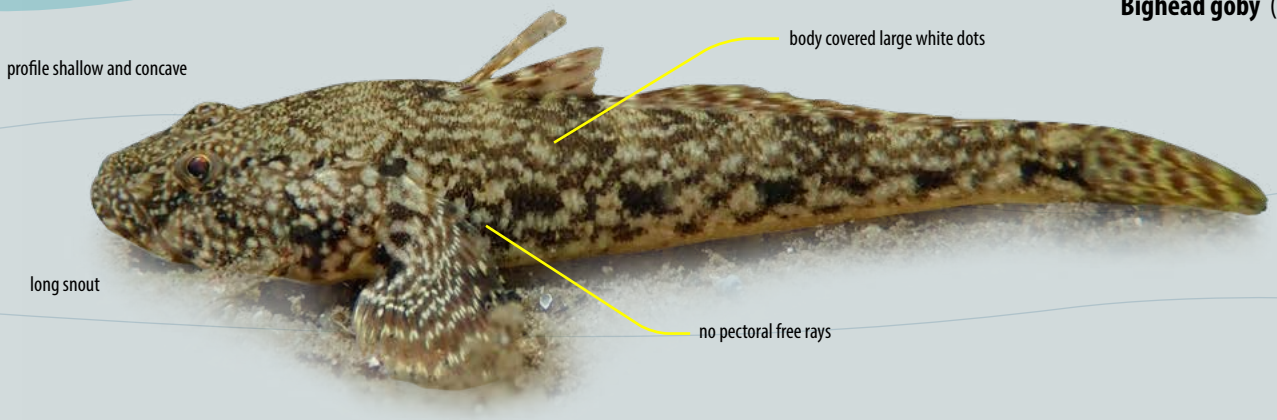
Giant goby (*Gobius cobitis*)



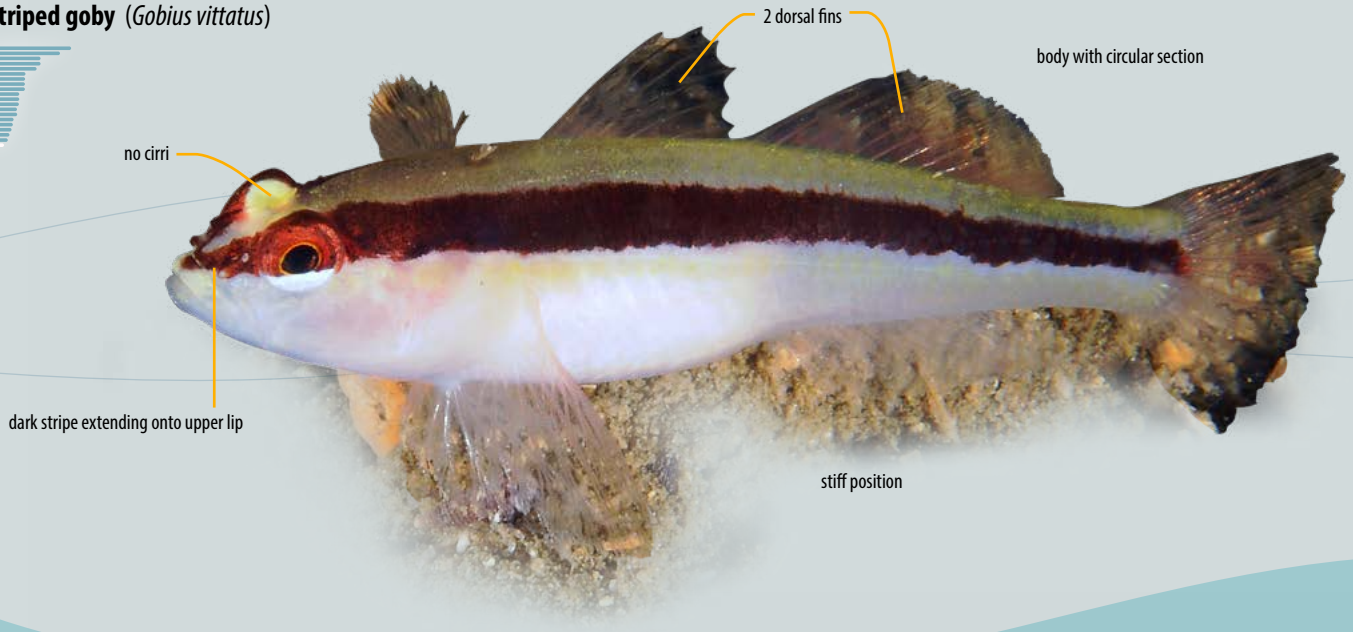
Grass goby (*Gobius ophiocephalus*)



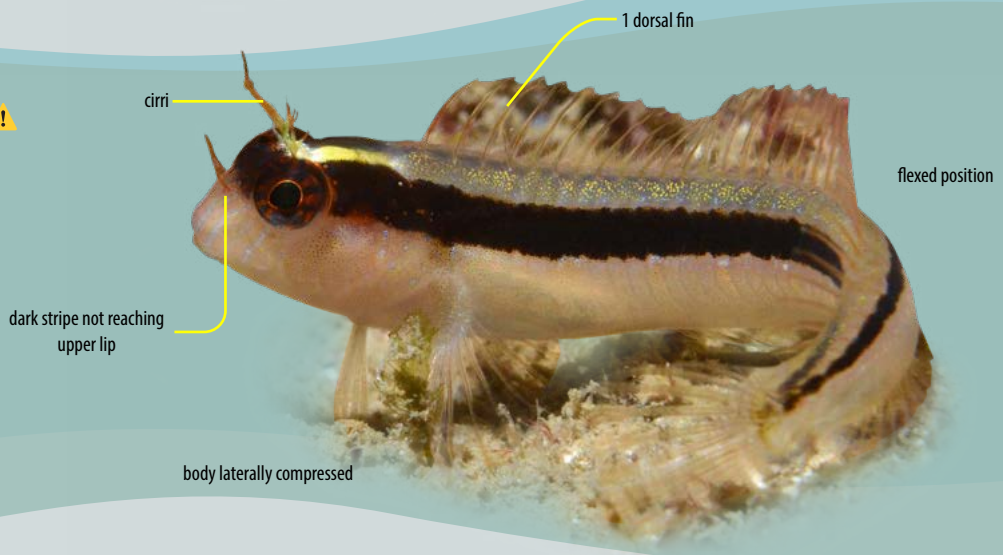
Bighead goby (*Ponticola kessleri*) ⚠



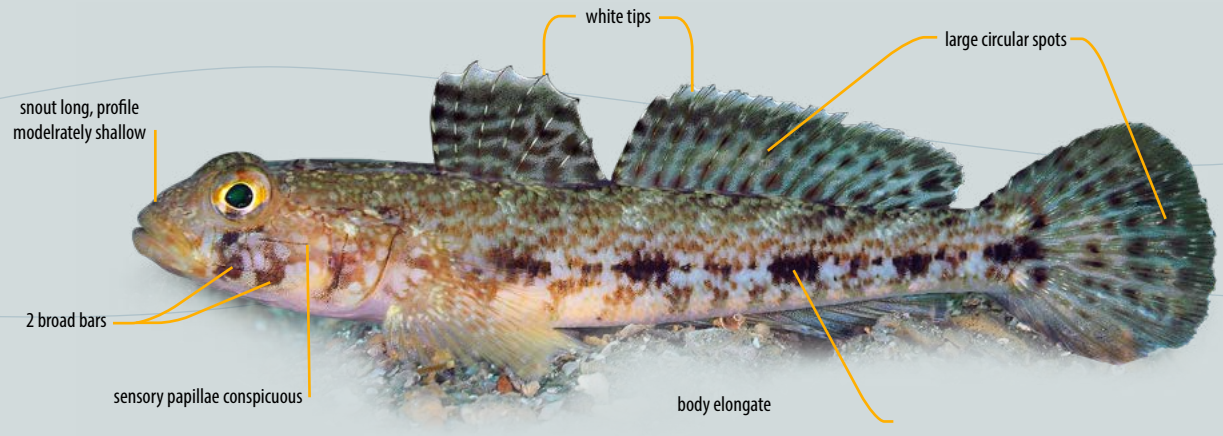
Striped goby (*Gobius vittatus*)



Striped blenny (*Parablennius rouxi*) ⚠



Slender goby (*Gobius geniporus*)



Bellotti's goby

Gobius ater Bellotti, 1888

Gobie de Bellotti (*Fr*)
Bellotti-Grundel (*Ge*)
Gobio escarabajo (*Sp*)
Gobide di Bellotti (*It*)

Small • short and stocky body • body noticeably deep below first dorsal fin • big eyes • dark colouration (live colours unknown) • first dorsal fin with pale margin • very well-developed upper pectoral free rays • large scales on nape • currently considered very rare, among seagrass, at 2-10 m depth

• Description

⚠ *The species has never been observed alive in its natural environment with certainty, and thus its description is based on preserved specimens only.*
Small goby of 5-6 cm not exceeding 8 cm, but with a characteristically stocky body (maximal body depth about four times in standard length, reached at the beginning of first dorsal fin). Predorsal area long (distance between eyes and first dorsal fin spine about as long as second dorsal fin base). Eyes large and set forward (their diameter much larger than snout length), not protruding over the head in side view.. In dorsal view, the interorbital space appears very small. Bellotti's goby has a dark body colouration, with faint series of black spots visible in some individuals. Breast with a lighter colour contrasting anteriorly with a darker head, and posteriorly with a dark patch at pectoral fin base. Some white spots on the head, more numerous on lower parts. From preserved specimens, Bellotti's goby seems to have a pale suborbital bar from lower eye to rear upper jaw. First dorsal fin dark with a thin pale (possibly yellow-orange) upper margin. Second dorsal fin, caudal and anal fins uniformly dark. Pectoral and pelvic fins dark with many small pale dots. Very well developed upper pectoral free rays. Predorsal area with 20 rows of scales smaller than those of the body, cheeks and opercles naked. Anterior nostrils tubular and terminated by a bifid tentacle.

Night colouration. Unknown
Sexual dimorphism. Unknown
Juveniles. Differ from adults by a dark basal spot in the posterior edge of the first dorsal fin.
Geographic variation. Unknown

Bellotti's goby (*G. ater*), ad ♂. The species has never been observed alive, thus only specimens from museum collections are shown here. *Summer 2008, St. Thomas Bay (Malta), Edwin Zammit (photographer: Marcelo Kovačić).*

• Similar species

Bellotti's goby should be identified in relation to other stout-bodied gobies, notably Rock goby (*G. paganellus*) and Black goby (*G. niger*). These two species have remarkable variation in colouration with patterns ranging from very light to almost all black. From our limited knowledge of Bellotti's goby, it seems that the species may normally exhibit a dark colouration only.

Dark **Rock goby** would nevertheless differ from Bellotti's by a larger adult size (9 *vs*. 5-6 cm), noticeably smaller body depth under the first dorsal fin (standard length more than five times the maximal body depth, *vs*. about four times in Bellotti's), relatively short predorsal area (its length much less than second dorsal fin base length *vs*. about as long in Bellotti's), more scales along the lateral line (> 46 *vs*. 38-40) and a broader and longer yellow-orange margin on the first dorsal fin (running over the entire fin length *vs*. restricted to the first four rays).

Black goby differs from Bellotti's by a much larger adult size (12-18 *vs*. 5-6 cm), a less deep body under the first dorsal fin, smaller eyes with a larger interorbital space, a steeper snout profile, smaller scales and conspicuous sensory papillae on the nape (barely visible in Bellotti's) and fewer pectoral free rays. A potentially overlooked pitfall is young Black gobies, which also have large eyes, and a dark basal spot in the posterior edge of the first dorsal fin as observed in juvenile Bellotti's. Paying attention to the overall body shape, the snout profile and the pectoral rays is necessary to clinch the identification.

Bellotti's goby

Gobius ater Bellotti, 1888

Grass goby (*G. ophiocephalus*) is another species to consider. Grass goby shows a characteristic pattern on the flanks (vertical zigzag markings) not found in Bellotti's; however, abnormally dark (i.e. melanistic) individuals can invite confusion due to their deep and compressed body. Moreover, males of Grass can show an orange marginal band on the first dorsal fin limited to the first three or four spines. However, Grass has a different body shape, with a longer body, deeper caudal peduncle (in Bellotti's, the depth of the caudal peduncle is distinctly less than that of the body at the level of the first dorsal fin, giving Bellotti's a rhomboïdal shape) and proportionally smaller eyes. Moreover, Grass has only a few free rays in pectoral fins, and anterior nostrils tubular without process from rim (*vs.* terminated by a bifid tentacle in Bellotti's).

• Distribution

Bellotti's goby occurs in the Mediterranean Sea from the Balearic Islands eastward to the Aegean Sea, and from Nice southward to Malta (see Table of records). The species is also cited from the Ria de Aveiro in Portugal, where it was recorded on three occasions during biodiversity censuses (Pombo *et al.*, 2002). These records would simultaneously extend the geographic distribution of the species to the Atlantic, and the ecological distribution to estuarine environments. However, the authors did not provide any description of the collected specimens: Bellotti's gobies are simply listed in tables along with other, more common species. Pending further information on its status in Portugal, we prefer considering Bellotti's as endemic to the Mediterranean basin. In *France*, Bellotti's is only known from Nice (06), which is the type locality (i.e. from where the specimens used to describe the species were collected). In addition to the >100 individuals collected in 1887 and studied by Bellotti, nine other individuals were collected around Nice in 1898 (Ahnelt, 2001). Two recent records from Antibes (06) and Marseille (13) are discussed below (see photographs).

All known records of Bellotti's gobies (*G. ater*).

Country	Locality	Coordinates	Dates	Habitat	Depth (m)	#In div.	Ref.
Spain	Palma (Majorca)	-	Dec 1907	-	-	-	(1)
Spain	Mahón (Menorca)	-	Sep 1917	-	-	-	(1)
Italy	Alghero beach (Sardinia)	40.572865°N / /8.308047°E*	Sep 1980	*Posidonia*	10	2	(2)
Italy	outside the port of Mazara del Vallo (Sicily)	-	Aug 1985, Oct 1989	*Posidonia*	2 , 3-5	3 , 5	(3)
Malta	Mellieha bay	35.97883°N / 14.36417°E	Sep 1998	*Posidonia*	3-10	2	(4)
Malta	St. Thomas bay	35.85583°N / 14.5705°E	Summer 2008	*Posidonia*	3-10	~50	(4)
Croatia	Split	-	1890	-	-	3	(5)
Greece	Palaia Epidavros (Peloponnese)	-	-	-	-	-	(6)
France	Nice (06)	-	Winter 1887 ,Jul 1898	-	-	>100 , 9	(9) , (5)
France**	Cap d'Antibes (06)	-	Jan 2005, Feb 2006	*Posidonia*	12-10	1	-
France**	Marseille (13)	43.22886°N / 5.34887°E	Nov 2021	*Peebles*	4	1	-
Portugal***	Ria de Aveiro	-	1988, 1999,2000	-	-	-	(7) , (8)

(1) (Lozano y Rey, 1919) , (2) (Tortonese & Chessa, 1982), (3) (Gramitto, 1993), (4) (Kovačić & Schembri, 2019), (5) (Ahnelt, 2001), (6) (Miller et al., 1986), (7) (Rebelo, 1992), (8) (Pombo et al., 2002), (9) (Bellotti, 1888).

** GPS coordinates estimated from the geographic information provided by the authors.*

*** Provisional: identification not certain*

**** Pending further information, we consider these Portugese records invalid.*

• Habitat

This goby is a coastal marine species occurring in shallow and sheltered bays, where it seems tightly associated with seagrasses (*Posidonia oceanica*). Records range from 2 to 12m of depth. Although Bellotti's goby's habits are still unknown, its big eyes suggest nocturnal activity, and/or that it is a "matte-dwelling" species, that is, it could be specialized to the extensive network of tunnels found in the matte of old *Posidonia* meadows.

Bellotti's goby

Gobius ater Bellotti, 1888

- **Miscellaneous**

☝ Bellotti's goby is one the most enigmatic of French Mediterranean gobies, a myth for gobiologists ! Bellotti described this goby from more than 100 specimens originating from Nice, which suggests that the species was either widespread or at least locally common and gregarious. The last known record for France, also from Nice, dates from 1898 (Ahnelt, 2001). So, where has Bellotti's goby gone? One explanation could be that it was once highly localized and then disappeared from this country. Alternatively, the species could still occur there, but would have remained overlooked over the past century. In our opinion, this second explanation is the more likely and Bellotti's gobies are just sitting somewhere, waiting for their rediscovery. We believe that more efforts should be made to explore old *Posidonia* meadows, especially at night.

Shallow *Posidonia* seagrass meadows seem to be the main (but not necessary unique) habitat of the enigmatic *Gobius ater*.

Bellotti's goby

Gobius ater Bellotti, 1888

Bellotti's gobies (*G. ater*), ad ♂♂. These three specimens were acquired by Bellotti himself in the fish market of Nice during winter 1887, and were part of the series he examined to describe the species. Although the original colours have vanished in these preserved specimens, encountering a goby with such a stocky body (the maximal body depth is below the beginning of the first dorsal fin; body length/body depth = 4.1 in top individual) and big eyes in a seagrass meadow should immediately raise hope for an encounter with the mythical Bellotti's goby.
Pictures courtesy of Anja Palandačić and Harald Ahnelt, Naturhistorisches Museum of Wien (Austria). , Coll. Cristoforo Bellotti, Nice (06), 1887. Bottom photo flipped horizontally.

Bellotti's gobies (*G. ater*), ♂♂ (x7) and ♀♀ (x2). These nine specimens also originate from Nice but were collected ten years after Bellotti's description. Note how stout-bodied all these individuals are. *Pictures courtesy of Anja Palandačić and Harald Ahnelt, Naturhistorisches Museum of Wien (Austria). Coll. Jacques von Begriaga, Nice (06), 19 Jul 1898.*

Bellotti's goby

Gobius ater Bellotti, 1888

Bellotti's goby *(G. ater)*, ad ♂. The species has never been observed alive, thus only specimens from museum collections are shown here. Note the particularly large eyes, short and deep body, and large scales. *Summer 2008, St. Thomas Bay (Malta), coll. Edwin Zammit (photographer: Marcelo Kovačić).*

Black goby (*G. niger*), ad ♂. There is no known published photograph of live Bellotti's goby; thus, comparison is based on the textual description of that species. Sexually active males of Black gobies can be very dark, thus approaching Bellotti's in colouration. Nevertheless, this individual is easily identified as Black based on the tall, narrow-tipped first dorsal fin (*vs*. not distinctively taller than the second dorsal and not pointed in Bellotti's), body shape (body length/depth = 5.5 *vs* ~4 in Bellotti's), head profile with small and protruding eyes, black colouration between the head and the pectoral fins (contrastingly lighter than adjacent regions in Bellotti's) and pectoral fins with a few, little-developed free rays (well developed in Bellotti's). Moreover, dark Black gobies almost always show light-coloured saddles on the back; this has never been described on Bellotti's. Last, Bellotti's would appear much smaller than this individual (here, ~10 cm), approaching a Marbled goby (*Pomatoschistus marmoratus*) in size (but not in structure). *27 Aug 2017, Sète (34), Julien Renoult.*

Bellotti's goby

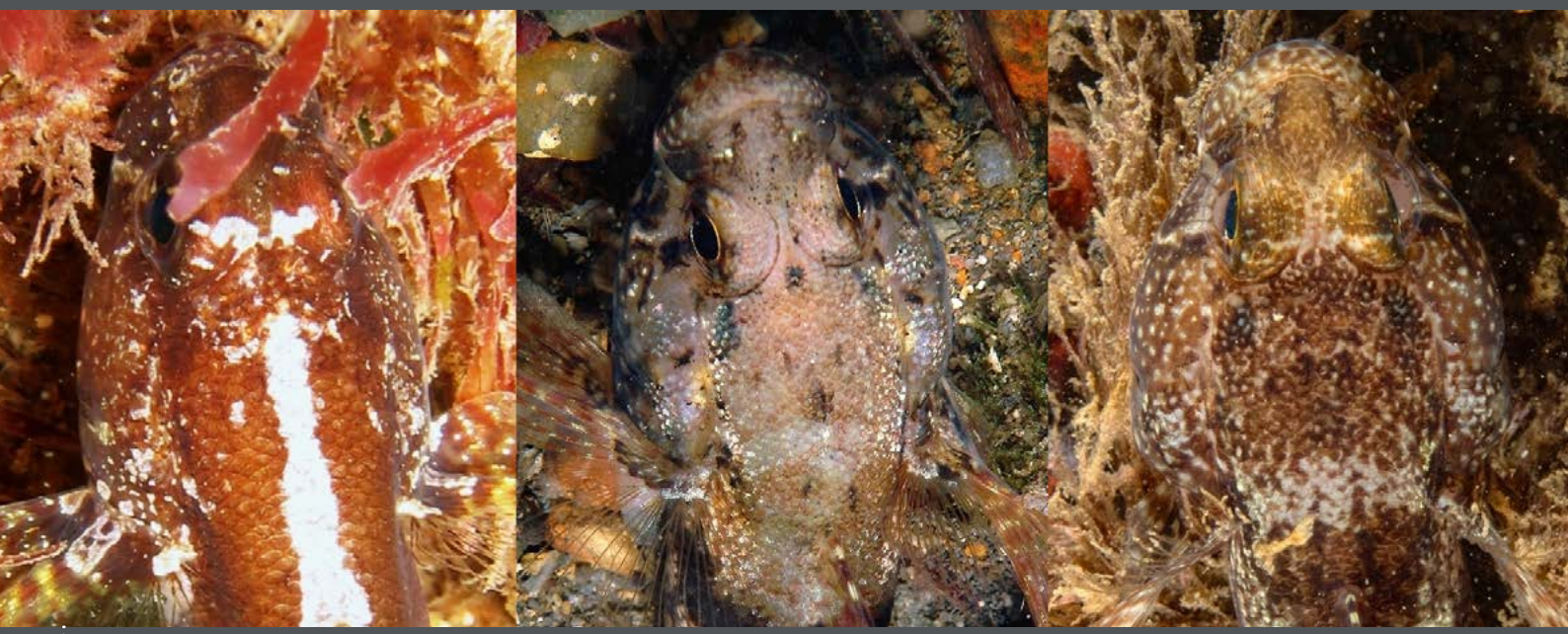
Gobius ater Bellotti, 1888

Rock goby *(G. paganellus)*, ad ♂. Some Rock gobies may display features of Bellotti's goby, including the black colouration, free and filamentous rays in pectorals and a yellow terminal band on the first dorsal fin. Here Bellotti's can be safely excluded, though, based on the body proportions (body length/depth = 4.8 *vs* ~4 in Bellotti's), and proportionally small eyes. Bellotti's should further exhibit a contrastingly dark head and a thinner yellow terminal band. However, keep in mind that variation in the live colouration of Bellotti's is virtually unknown, and thus colour patterns should be used with caution for a differential diagnosis. *28 Oct 2019, in an aquarium (captured as a juv 2.5 yrs earlier in Brétignolles-S/-mer), Julien Renoult.*

Probable **Bellotti's goby** (*Gobius* sp.). This picture, posted on the DORIS forum, represents a goby photographed at 12 m depth in the seagrass (*Posidonia oceanica*), during a night dive. Some gobiologists think this could be Bellotti's goby, based on the stocky appearance, large eyes and habitat. Some others raise concerns with this identification, because depigmented areas on the back have never been observed in preserved specimens of Bellotti's. *21 Jan 2005, Plage des ondes, Cap d'Antibes (06, France), Stéphane Jamme.*

Bellotti's goby

Gobius ater Bellotti, 1888



Probable **Bellotti's goby** (*Gobius sp.;* left); **Rock gobies** (*G. paganellus*), ad (center and right). Quite amazingly, the same observer photographed the same mystery species (but a different individual) a year later, in the same area. Comparison of nape scales between the mystery goby and Rock goby: Rock goby seems to have smaller, rounder and more overlapping scales than the mystery goby. *01 Feb 2006, Pointe du Graillon, Cap d'Antibes (06, France), Stéphane Jamme; 03 Jan 2009, Tuscany (Italy), Stefano Guerrieri; 27 Jan 2004, Tuscany (Italy), Alessandro Falleni.*

Probable **Bellotti's goby** (*Gobius ater*). Last-minute discovery! This 3 to 4 cm long individual was recently found under a stone, at 4 m depth, by the french diver and naturalist Sylvain Le Bris. It undoubtedly belongs to the same species as the two previous individuals photographed at Antibes (France). This individual has 38-40 scales along the lateral line, which is within the expected range for Bellotti's and which excludes Rock goby. added to the yellow marginal band at the first dorsal fin and the stocky body, we are now pretty confident that the three recent French records presented here correspond to Bellotti's gobies. *11 Nov 2021, Samena, Marseille (06, France), Sylvain Le Bris. Photo flipped*

Golden goby

Gobius auratus Risso, 1810

Gobie doré (*Fr*)
Goldgrundel (*Ge*)
Gobio dorado (*Sp*)
Ghiozzo dorato (*It*)

Small • yellow body covered with many orange to red dots (Northern Adriatic) or plain coloured (elsewhere) • upper lip unmarked • uncommon to locally common, in rocky habitats, usually at 10-30 m depth

• Description

Small to medium-sized goby reaching 9 cm in length, with a moderately elongate body, large head, and a short, slightly tipped and oblique snout. Entire body canary yellow, most vivid on the snout and between the eyes. Depending on mood (e.g., when excited) and possibly time of the day, tiny red dots forming longitudinal lines can cover the body but they are visible only very close, and are hardly ever visible in the field. Eyes yellow, with red markings on the rim in some individuals. The red gills underneath the translucent opercule give a pink colouration to the opercular region. Upper base of pectoral fins sometimes with a black or metal blue blotch, variable in size and shape. Dorsal fins mostly transparent, sometimes with a reddish hue. The two dorsal fins are separated by a narrow space without membrane. Caudal fin transparent, slightly emarginate (rounded in the largest specimens). Anal fin and pelvic disk transparents. Pectoral free rays moderately developed. Predorsal area covered with small scales; cheeks and opercles naked. Anterior nostrils tubular and terminated by a triangular lappet.

Golden goby (*G. auratus*), ad. *30 Jul 2017, Port-Cros (83, France), Patrick Louisy.*

Night colouration. Overall similar to day colouration but darker, with five to six paler narrow saddles visible on the back.

Sexual dimorphism. Not visible, except that breeding males may have a longer second dorsal fin, with rear tip reaching caudal origin, and a white margin to both dorsal fins (Herler et al., 2005). In aroused males, the black pectoral blotch may extend forwards onto the head, which can become entirely black. This occurs in females too, though less frequently.

Juveniles. Similar to adults.

Geographic variation. Golden gobies of the Northern Adriatic have a distinct patterning (Herler et al., 2005), referred to here as the 'dotted' morph as opposed to the 'plain-coloured' morph previously described. They are yellow with numerous orange or red-brown dots forming distinct longitudinal lines on the head, the body and on median fins. The most distinct dotted line runs along the lateral midline; it is discontinuous and made of a dozen red-brown dashes sometimes separated by white markings. Dorsolaterally, another well-marked line of red-brown dots runs all along the body and continues anteriorly as an almost continuous oculoscapular line. Three rows of lighter orange dots run between the lateral midline and the dorsolateral line. Above the dorsolateral line, two to three rows of dark orange dots run from behind the eyes to the base of the caudal fin. Below the lateral midline, three to four longitudinal rows of light orange dots. Eyes with a horizontal stripe, two oblique bars in the lower half, and three oblique bars in the upper half that often coalesce into a single arched longitudinal marking on top. The region anterior to the eyes is patterned with a M-shaped snout line and a preorbital line.
These lines do not extend onto the lips. The preorbital line reappears behind the eye, forming a series of dashes between the eye and the upper base of the pectoral fin (these dashes extend the lateral midline anterior to the pectoral fin Upper lip plain-coloured, without red dots. Lower lip with a W-shaped red pattern in its center. One dot on the corner of the mouth. Three or four brown to black dots are arranged longitudinally between the labial commissure and the lower-posterior border of the cheek. Besides these few dots, the cheek is unmarked below the eye. A large brown to black blotch can be visible at the base of the pectoral fin; it is sometimes edged with white above and below. Dorsal fins clear to yellowish with five or six longitudinal rows of red dots. Dorsal rays striped yellow and red. Caudal fin clear or yellowish, with six to eight vertical series of red dots. Pectoral fins with a clear membrane, and with rays that are either entirely reddish or with a few red dots.

• Similar species

'Plain-coloured' morph of Golden unmistakable among gobies of the Nort-eastern Atlantic and the Mediterranean.

Patterning of the 'dotted' morph very similar to that of both Yellow-headed goby (*G. xanthocephalus*) and Sarato's goby (*G. fallax*). Although Yellow-headed and 'dotted' Golden are usually considered to have non-overlapping geographic distributions, it is important to carefully separate these species as a few 'dotted' Golden gobies sporadically occur among western 'plain-coloured' populations, especially as juveniles. **Yellow-headed** has a proportionally shorter head, yellow colouration limited to the head (*vs*. yellow colouration extending onto the entire body in Golden), dots and dashes darker brown on the head and lighter orange on the body (*vs*. concolourous), one line of dots more visible than the others below the lateral midline (vs. two to three equally visible lines of dots), and brown spots on the upper lip (*vs*. plain upper lip).

'Dotted' golden goby and **Sarato's goby** co-occur in the Northern Adriatic, possibly with hybrids. Sarato's has a shorter head, and deeper (less cylindrical) and stouter body. Moreover, in Sarato's, body colouration is much paler with possible traces of yellow only on the top of the head and on the back. Dots and dashes tend to be darker brown (vs. lighter orange in Golden), below the lateral midline the most visible line of dots is distinctly sinuous (vs. two to three straight lines in Golden) and the upper lip has a brown mark (plain-coloured in Golden). In juveniles and immatures, caudal fin often shows a slight emargination in Golden, while it is truncated in Sarato's and Yellow-headed (Herler et al., 2005).

In the Adriatic, Golden could also be confused with either **Bucchich's goby** (*G. bucchichi*) or **Incognito goby** (*G. incognitus*) goby. These two species do not show a yellow ground colouration and their dots are browner and sparser (especially in Bucchich's).

In the Mediterranean Sea, the only other bright yellow benthic fish is the yellow morph of **Ringneck blenny** (*Parablennius pilicornis*), which should be quickly identified by its single dorsal fin, compressed head-shape typical of blennies, and flexed position. Excited males of Golden goby with a dark hood can superficially resemble reproductive males of **Black-faced triplefin** (*Tripterygion delaisi*); though this fish has three dorsal fin (*vs*. two in gobies), a deeper black and more persistent hood, a more pointed head.

• Distribution & status

Golden goby has a fragmented distribution along the northern coast of the Mediterranean from the Provence basin in France westwards to west of Antalya in Turkey (Francour et al., 2007). Discontinuities in its distribution could be due to insufficient exploration or specific global habitat requirements. Some museum catalogues mention records of Golden goby along the Mediterranean coast of Spain and in the Atlantic, but these most probably refer to Yellow-headed gobies collected before description of that species in 1992. Nevertheless, the exact distribution of Golden goby in the Mediterranean remains to be clarified. In the Adriatic, the transition between the 'dotted' morph and the 'plain coloured' morph is located in the Zadar region in Croatia.

In *France*, the westernmost known population of Golden gobies is in Port-Cros Island (83, France). The species also occurs along the western coast of Corsica, with records close to the Scandola Nature Reserve (2B) in the north (Francour et al., 2010), and around Campomoro (2A) in the south (CARTHAM program; INPN).

Golden goby

Gobius auratus Risso, 1810

- **Habitat**

Golden goby inhabits hard substrata at depths between 8 and 80 m, but it is observed mostly below 20 m. In Tremiti Archipelago (Italy), adults are most frequent at relatively deep levels (25-30 m depth) dominated by coralligenous assemblage (red encrusting algae, bryozoans and cnidarians) while juveniles occupy shallower levels (12-15 m depth) covered with erect macroalgae (*Halimeda tuna, Sphaerococcus coronopifolius, Codium bursa*; Bussotti and Guidetta, 2005).

Golden goby (*G. auratus*) is typically associated to coralligenous habitat. *20 Jun 2021, Agay (83, France), Patrick Louisy.*

- **Miscellaneous**

☝ Kolombatović (1891) discussed variation among *G. auratus*, and described the variety *luteus* that was later raised to species level *G. luteus* by Miller and El-Tawil (1974). *Gobius luteus* is now considered invalid and a synonym of *G. auratus.*

☝ Golden goby and Sarato's goby share the same genetic haplotypes of the mitochondrial control region, the most variable portion of mitochondrial DNA that is generally used to evaluate the genetic divergence between closely related species or subspecies (Herler et al., 2005). Differences in mitochondrial genome with Yellow-headed goby are also very limited (Iglésias et al., 2021). For these reasons, Golden, Sarato's and Yellow-headed are thought to have diversified only very recently, and thus are treated in the literature as a species complex (Herler et al., 2005; Miller & El-Tawil, 1974; Iglésias et al., 2021).

☝ The taxonomic status of 'dotted' Golden gobies from the Northern Adriatic is still unclear. It is currently placed among *Gobius auratus* based on meristic data, the shape of the pelvic disk (deeply emarginate in Golden, but not in Yellow-headed), arrangement of head sensory papillae, and genetic results showing no difference in mitochondrial DNA with 'plain-coloured' Golden gobies (Herler et al., 2005). However, 'plain-coloured' Golden gobies are also poorly genetically differentiated from both Yellow-headed and Sarato's, which indicates that all three species have been separated very recently. Herler et al. (2005) report the presence of a transition zone between 'dotted' and 'plain-coloured' morphs, e.g., near the Croatian island of Zut in the Southern Adriatic. Only a genetic study of the transition zone could evaluate the extent of the nuclear gene flow between the two morphs, which is necessary to clarify the taxonomic status of 'dotted' Golden gobies.

Golden goby

Gobius auratus Risso, 1810

Golden gobies (*G. auratus*), ad. Throughout most of its range, Golden goby shows a plain canary yellow colouration that is found in no other goby from the North-eastern Atlantic or the Mediterranean. Only the red gills underneath the semi-transparent opercles and, in some individuals, fin rays, are coloured red. *30 Jul 2016, Port-Cros, 83 (France), Thomas Menut; 15 Sep 2011, Giglio Island (Italy), Stefano Guerrieri. Both photos flipped horizontally.*

Golden goby

Gobius auratus Risso, 1810

Golden gobies *(G. auratus)*, ad. Golden gobies from the Northern Adriatic have red dots on the entire body, described as the 'dotted' morph. Bottom individual is probably a female, based on its swollen belly. *29 Apr 2012, Zadar (Croatia), Thomas Menut; 07 Jun 2013, Krk (Croatia), Thomas Menut.*

Golden goby (*G. auratus*), ad (top); **Golden goby** (*G. auratus*), juv (bottom). Although the top individual was photographed during day time, it shows traces of night colouration with a darkened body, vertical light bands between the nape and the base of the caudal fin, and a very faint dark pectoral blotch. This individual also has red markings in the eyes, red sensory papillae, a few orange dots on the body and red dots on both dorsal fins, which is not uncommon among 'plain-coloured' Golden gobies of the Western Mediterranean. What seems truly uncommon, however, is this bottom individual with a 'dotted' patterning normally found only in the Northern Adriatic. Such individuals should not be mistaken for Yellow-headed goby (*G. xanthocephalus*). Among other diagnostic characters (see captions below), note the plain-coloured upper lip (vs. upper lip with a red dot in Yellow-headed). *31 Aug 2013, Cap d'Antibe (France), Thomas Menut; 19 Sep 2020; La Roche St Nicolas (Monaco), Sylvain Le Bris.*

Golden goby

Gobius auratus Risso, 1810

Golden goby (*G. auratus*), ad; **Yellow-headed goby** (*G. xanthocephalus*), ad; **Sarato's goby** (*G. fallax*), ad. All three species have very similar dotted patterns. Compared to Yellow-headed, Golden has a yellow colouration extending onto the entire body, the dotted lines below lateral midline are equally visible, and the upper lip is plain-coloured without a red-brown mark. Compared to Sarato's, Golden has a more vivid yellow colouration, more cylindrical and less stout body, regularly aligned dots below the lateral midline and the upper lip is plain-coloured without a brown mark. Moreover, Golden has a distinctly longer head than the other two species.
30 Jul 2016, Rijeka (Croatia), Alessandro Falleni; 31 Aug 2008, Thau lagoon (34, France), Thomas Menut; 05 May 2019, Olbia-Tempio (Sardegna, Italy), Timothy Cameron.

Golden goby

Gobius auratus Risso, 1810

Golden goby *(G. auratus*), ad; **Ringneck blenny** (*P. pilicornis,* yellow morph), ad. These two species are the only benthic fish in the Mediterranean with an entirely bright yellow body. The blenny has a single dorsal fin and a deeper head, but even at a distance, the difference in habits makes identification straightforward: compared to blennies, Golden gobies rest with a stiff body, and have a more positive buoyancy and thus are often seen hovering a few centimeters above the floor. *30 Jul 2017, Port-Cros (83, France), Patrick Louisy; 12 Sep 2020, Banyuls-sur-Mer (66,France), Patrick Louisy. Bottom photo flipped horizontally.*

Bucchich's goby

Gobius bucchichi Steindachner, 1870

Gobie de Bucchich (*Fr*)
Bucchichi-Grundel (*Ge*)
Gobio de ortiga (*Sp*)
Ghiozzo rasposo (*It*)

Medium-sized • whitish body with many brown dots • no dot on the corner of the mouth • M-shaped marking on the snout • commonly an irregular horizontal line along the upper margin of the orbital rim • usually two longitudinal rows of dots on the cheek • locally common, in sub-horizontal stony habitats, usually at 0.5-5 m depth

• Description

Medium-sized goby of 8-9 cm, with a moderately long body, large head, short, slightly tipped and oblique snout. Ground body colouration homogeneously pale grey, pale yellowish, or yellowish brown; only specimens with very dark ground body colour may display lighter patches on the back. Upper lip often tinged with yellow. Patterning of the head and body made of longitudinal lines of brown dots. Dots are the broadest and the darkest along the lateral midline; they are organised in well-aligned dashes, sometimes separated by white spaces. The dashed lateral midline runs from the base of the pectoral fin to the base of the caudal fin. The second most distinct dots are aligned dorso-laterally; they are usually concolourous with the midlateral dots but are much more sparse, barely forming a line. Elsewhere on the body and the nape, dots are numerous but lighter brown, fainter, and irregularly aligned. Eye diameter 0.82–1.04 in snout length (Kovačić & Šanda, 2016). Eyes with a conspicuous horizontal stripe, an irregular longitudinal marking on top, and a variable number of additional markings in the dorsal half of the orbit. Ventral half of the orbit unmarked (sometimes with a small dot in its anterior portion). Snout with a dark M-shaped line, and a preorbital oblique bar below it. Anteriorly, the preorbital bar extends onto the upper, and then lower lip. This preorbital bar connects the upper lip to the antero-ventral border of the orbit (it usually touches the orbit, but occasionally stops just before). It reappears behind the postero-ventral border of the eye (only rarely running along the ventral side of the eye), extending rearwards as a midopercular line of dots on the cheek, the preopercle and the opercle until the base of the pectoral fin (at the same level as the lateral midline located posterior to that fin). A second line starts posterior to the corner of the mouth with two dashes bordering the cheek ventrally below the eye (there is no dot at the rear corner of the mouth), continues slightly higher (thus parallel to the above row of dots) with another dash on the posterior cheek and a last one, even further up, on opercle. The cheek area between the eye and the two ventral dashes is usually unmarked. The oculoscapular line extends the horizontal eyestripe rearwards, becoming dotted or dashed above the peopercle and opercle. Dorsal fins mostly transparent with a few dark dots aligned longitudinally. The first (spinous) ray of both dorsal fins shows alternating dark and light transverse stripes. Caudal fin rounded, transparent, with dark reddish-brown dots more or less aligned transversally. Anal fin transparent or whitish, plain-coloured or with a basal longitudinal row of brown dots. Pelvic disk pearly white. The pectoral blotch, when visible, is usually limited to a thickened brown dash. Pectoral free rays moderately developed. Nape and predorsal area covered with small scales. Anterior nostrils tubular and terminated by a triangular lappet, or a tentacle.

Bucchich's goby (*G. bucchichi*), ad. 29 Aug 2019, *Pag (Croatia)*, *Roberto Pillon*

Night colouration. At night, the ground colouration turns dark brown with light saddles on the back and irregular white blotches along the lateral midline, on the lower lateral side and on the head. The characteristic dot patterning remains visible. The pectoral blotch is broad, dark brown, sometimes royal blue.

Sexual dimorphism. Reproductive males are distinctly larger than females, have a broader pectoral dash sometimes forming a black spot, and the dorsal fins are wider and more vividly coloured, with a yellow or pale orange membrane and three to five pale longitudinal bands on the first dorsal fin and pale vertical stripes on the second dorsal fin. The first dorsal fin can be edged with a whitish upper band. Some individuals, usually large males, occasionally show one or two dots (rarely three or four) in the anterior part of the cheek (normally unmarked).

Juveniles. Similar to adults but with proportionally bigger eyes.

Geographic variation. Unknown.

• Similar species

The risk of confusion is by far the greatest with **Incognito goby** (*G. incognitus*), which was only recently distinguished and described (Kovačić & Šanda, 2016). Head patterning is critical for a correct identification, and includes three main characters. (1) Incognito has three longitudinal rows of dots on the cheek: one on the ventral edge of the cheek and another one starting with the oblique preorbital bar, as in Bucchich's, plus a third row in between, in the center of the cheek. The center of the cheek is generally unpatterned in Bucchich's. Rarely, some Bucchich's gobies (mostly large males; see Sexual dimorphism) have dots in the center of the cheek. Thus, when faced with a goby with three rows of dots on the cheek, the following criteria should also be evaluated to confidently exclude Bucchich's: (1a) the median row of dots extends posteriorly to below rear eye (vs. dots are well marked only in the anterior portion of the cheek in Bucchich's), (1b) dots of the median row have irregular spacing and shape and the row runs parallel to the lower one (vs. dots very close to each other, and the median and lower rows not parallel in Bucchich's); (1c) the oblique preorbital bar (=upper row) is faint and stops well before the antero-ventral border of the orbit (in Bucchich's gobies with dots in the center of the cheek, the preorbital bar is well-marked and reaches the orbit); (2) the lower row of dots, which runs along the ventral edge of the cheek, starts with an isolated dot at the corner of the mouth (vs. this row starts with two horizontal dashes beginning shortly after the corner of the mouth in Bucchich's; these dashes are not preceded by a dot); (3) upper vertical eye-bar simple, sometimes flanked by small brown dots, but with no longitudinal marking on top (vs. generally an irregular horizontal line runs along the upper margin of the orbital rim in Bucchich's); (4) in Incognito, the snout is patterned with a V-shaped line, while in Bucchich's it is a M-shaped line. More precisely, Incognito's 'V' does not touch the eye, it is separated from the orbit by an isolated dot. This dot corresponds to the upper part of the vertical leg of Bucchich's' M. In addition to these four primary characters, five secondary characters can help clinch the identification: (5) along the lateral midline, dots often agglomerate to form dark blotches separated by blank spaces (vs. dots remain separated and generally form a continuous lateral midline with no marked blank spaces in Bucchich's); (6) ground colouration of the body light greenish grey (vs. pale yellowish); (7) upper lip the same colour as the rest of the head (vs. upper lip sometimes yellowish); (8) relatively smaller eyes: eye diameter 1.08-1.32 in snout length (vs. larger eyes in Bucchich's: eye diameter 0.82–1.04 in snout length; Kovačić & Šanda, 2016); (9), Incognito has a close relationship with the anemone *Anemonia viridis*, being insensitive to its poison (it is the only "anemonefish" in the Mediterranean; see Miscellaneous section).

The second biggest challenge is to separate Bucchich's from **Sarato's goby** (*G. fallax*). Sarato's is best identified first by its different body shape, being distinctly stouter and deeper-bodied. Moreover, Sarato's has numerous and tightly packed dots on the body, which form almost continuous longitudinal lines (vs. fewer dots forming more irregular lines in Bucchich's), the posterior portion of the ventral half of the eye always has a brown dot (vs. ventral half of the eye unmarked, or with a dot in its anterior portion), there is an isolated brown dot at the rear corner of the mouth, just anterior to the first horizontal dash of the lower row of dots (vs. no dot at the corner of the mouth anterior to the first dash), some individuals have a bluish sheen on the back (never found in Bucchich's), and in mature males the first dorsal fin is banded over its entire depth (vs. distal part of the first dorsal fin plain-coloured). Last, Sarato's has a neutral buoyancy, sometimes standing 10-30 cm above the seabed or barely touching the floor, while Bucchich's tends to rest on the seabed.

At night, **Yellow-headed goby** (*G. xanthocephalus*) can look very similar to Bucchich's goby, when its distinctly yellow head and reddish dots loose their colour. Yellow-headed has no median row of dots on the cheek (thus like Bucchich's), but contrary to Bucchich's, the lower row of dots begins with an isolated dot at the corner of the mouth (thus like Incognito). Moreover, Yellow-headed has two oblique bars in the ventral half of the eye (ventral half of the eye unmarked or with only a single dot in Bucchich's).

Last, when displaying a very dark colouration (typically at night or on dark background), Bucchich's goby may be confused with **Slender goby** (*G. geniporus*), since in both species the first dots of the median and lower rows tend to merge into a dark large spot on the cheek. Yet the dot patterning along the body, the strong patterning on the tail with broad and dark vertical bands (small dots in Bucchich's) and the different morphology (more elongate body in Slender) usually facilitate identification.

Note that Bucchich's goby being usually gregarious, if you encounter an individual difficult to tell apart from other goby species in the field, you may easily find other individuals with more typical features.

- **Distribution & status**

Determining the actual distribution of Bucchich's goby is made difficult by its recent split from Incognito goby (*G. incognitus*). Thus, in most publications and museum collections, Bucchich's goby includes both *G. bucchichi* as redescribed in 2016, and *G. incognitus* (Kovačić & Šanda, 2016). Currently, Bucchich's goby is considered endemic to the Eastern Mediterranean. The 2016 redescription was based on specimens from the Eastern Adriatic and the Northern Ionian, from Selce, Kvarner area, Hvar (Croatia) and Butrint (Albania; Kovačić & Šanda, 2016). The species is locally common to very common in this part of the Mediterranean. More recently, Bucchich's goby has been recorded further north in Medulino, Pula and Fasana (Istria, Croatia; Roberto Pillon, Fishbase), in Piran (Slovenia; Tiralongo & Pillon, 2020; Julien Renoult, iNaturalist) and in the Gulf of Trieste (Italy; Tiralongo & Pillon, 2020). In 2019, Bucchich's goby was photographed for the first time in the Aegean Sea, in Kondyli Beach on the Eastern side of the Peloponnese (Greece; Tiralongo & Pillon, 2020). In 2021, it was photographed also in the Gulf of Arta (Greece; solarboot-projekte, www.inaturalist.org). The species has been photographed also in the Black Sea (Crimea; Oleg Kovtun, https://youtu.be/xAdWzBGStog; Andrey Nekrasov, www.alamy.com, www.agefotostock.com; Kurakin Alexander, www.shutterstock.com). Clearly, our knowledge of the geographic distribution of Bucchich's goby is deficient and more data is needed from the Eastern Mediterranean and the Black Sea.

In *France*, Bucchich's goby has never been recorded (all previously known records are *G. incognitus*). It is the only species of *Gobius* and *Thorogobius* that has never been observed in this country.

- **Habitat**

Bucchich's goby can be observed at depths between 0.5 m and 8 m. It typically inhabits sub-horizontal bottoms covered with stones or boulders, often near gravel, muddy or coarse sand (it does not seem to appreciate habitats dominated by fine sand). The species is most abundant in bays and other sheltered areas. It is gregarious and can be found in dense populations.

- **Miscellaneous**

☝ This species was recognized as distinct from the pan-Mediterranean Incognito goby as recently as in 2016 (Kovačić & Šanda, 2016). Thus, most of the literature on the ecology of Bucchich's goby probably refers to either Bucchich's or Incognito, and thus has become largely useless. For example, although several articles discuss the association between Bucchich's goby and the sea anemone *Anemonia viridis*, thus far we have not been able to find a single photographic evidence supporting this association, which should be considered specific to Incognito goby until proven otherwise (see Tiralongo *et al.*, 2020).

Bucchich's gobies (*G. bucchichi*), ad. This gregarious species if generally found in shallow, well-lit habitats with numerous shelters. *24 May 2016, Rab (Croatia), Roberto Pillon.*

Bucchich's goby

Gobius bucchichi Steindachner, 1870

Bucchich's gobies (*G. bucchichi*), ad. Typical specimens with well-visible, well-aligned brown dots grouped into dashes along the lateral midline; within dashes dots remain distinct and do not coalesce into a unique continuous line or patch. Note also the typical head pattern, with two almost continuous longitudinal rows of dots on the cheek. The upper row starts from the mouth as an oblique preorbital bar, reaches the antero-ventral border of the eye, runs below the eye and continues rearwards as a midopercular dotted line. The lower row begins with two horizontal dashes not preceded by a dot, and continues backwards, rising slightly upwards. The center of the cheek is plain, without dots. Note also the M-shaped snout line.

12 Jul 2018, Pula (Croatia), Roberto Pillon; 29 Aug 2019, Pag (Croatia), Roberto Pillon. Bottom photo flipped horizontally.

Bucchich's goby

Gobius bucchichi Steindachner, 1870

Bucchich's gobies (*G. bucchichi*), ad. These typical individuals represent the first records for Slovenia, Italy and Greece, respectively. In addition to the characters listed in previous captions, note the longitudinal marking (here, slightly arched and irregular) at the upper edge of the orbit. *30 Aug 2017, Piran (Slovenia), Roberto Pillon; 24 Aug 2018, Muggia (Italy), Roberto Pillon; 07 Jul 2019, Kondyli Beach (Greece), Roberto Pillon. Top photo flipped horizontally.*

Bucchich's goby

Gobius bucchichi Steindachner, 1870

Bucchich's goby (*G. bucchichi*), ad. Individual with an atypical head patterning. It shares with previous individuals all the characteristics of that species, but also has an additional short row of dots in the anterior middle part of the cheek (here only two dots, but some individuals have more). These dots are aligned, close to each other, and equally distant from the upper and lower rows. In these 'dotted-cheeked' specimens, the upper row is well-marked and it always clearly touches the orbit. Also note that there is no spot at the rear corner of the mouth. *04 Sept 2019, Pag (Croatia), Roberto Pillon. Photo flipped horizontally.*

Bucchich's goby (*G. bucchichi*), ad. Until recently, Bucchich's goby in day colouration was thought to be more homogeneously coloured than its relative Incognito goby. However, as illustrated here, Bucchich's goby can also have an irregular dark ground colouration with light saddles on the back. *20 May 2018, Rab (Croatia), Roberto Pillon. Photo flipped horizontally.*

Bucchich's goby

Gobius bucchichi Steindachner, 1870

Bucchich's gobies (*G. bucchichi*), ad, ♂♂. Males in courtship display develop more vivid colouration, with numerous orange dots and a yellow ground colour, or a strong patterning with a dark ground colour marbled white. The royal blue pectoral blotch becomes visible. The first dorsal fin is also taller and more opaque than in non reproductive males. *19 May 2011, Rab (Croatia), Roberto Pillon; 30 May 2012, Rab (Croatia), Roberto Pillon. Bottom photo flipped horizontally.*

Bucchich's goby

Gobius bucchichi Steindachner, 1870

Bucchich's gobies (*G. bucchichi*), ad, ♂♂. Males in fighting display. Bucchich's is a territorial species displaying numerous agonistic interactions with same-sex conspecifics during the reproductive period. They then develop the same colour and patterning as in courtship displays. *30 May 2012, Rab (Croatia), Roberto Pillon; 24 May 2016, Rab (Croatia), Roberto Pillon. All photos flipped horizontally*

Bucchich's goby

Gobius bucchichi Steindachner, 1870

Bucchich's gobies (*G. bucchichi*), ad, ♀♀ (top, center and bottom right); **Bucchich's goby** (*G. bucchichi*), ad ♂ (bottom left). Females are distinctly smaller, have shorter and more transparent dorsal fins, and never develop orange colouration as courting males do. *27 May 2017, Rab (Croatia), Roberto Pillon; 19 Jul 2020, Pag (Croatia), Roberto Pillon; 22 May 2016, Rab (Croatia), Roberto Pillon. Center photo flipped horizontally.*

Bucchich's goby

Gobius bucchichi Steindachner, 1870

Bucchich's goby (*G. bucchichi*), juv. Juveniles are similar to adults, and very early on during development (this one is 1.5-2 cm long) they show diagnostic characters including: only two rows of dots on the cheek, lower row begins with two dashes and not with an isolated dot at the corner of the mouth, a longitudinal marking at the upper edge of the eye and a M-shaped snout line. Compared to adults, note however the proportionally bigger eyes and shorter, more pointed snout. *10 Jul 2020, Pag (Croatia), Roberto Pillon.*

Bucchich's gobies (*G. bucchichi*), ad. Bucchich's goby is a gregarious species living in dense populations. *07 Jul 2019, Kondyli Beach (Greece), Roberto Pillon. Photo flipped horizontally.*

Bucchich's goby

Gobius bucchichi Steindachner, 1870

Bucchich's goby (*G. bucchichi*), ad.(top); **Incognito goby** (*G. incognitus*), ad (bottom). Top individual is an atypical Bucchich's goby with an additional row of dots in the center of the cheek, thereby resembling Incognito. It can nevertheless be separated from Incognito by the following characters: the median row is not parallel to the lower row (vs. parallel in Incognito), the oblique preorbital bar (=upper row) reaches the orbit (vs. stops before touching the orbit), the lower row of dots starts with two horizontal dashes (vs. starts with a dot at the corner of the mouth), the M-shaped snout line (here, the vertical leg of the 'M' is particularly short, but the pattern still differs from Incognito's V-shaped line), the dorsal half of the eye has an irregular longitudinal marking at the edge of the orbital rim (vs. this marking missing), the dots forming the long dashes of the lateral midline are distinctly separated (vs. they coalesce into continuous dashes), ground body colouration is yellowish (vs. greenish grey). See Incognito's species account for additional pictures comparing the two species. *24 Aug 2018, Muggia (Italy), Roberto Pillon; 26 Jun 2018, Methoni (Greece), Roberto Pillon. Both photos flipped horizontally.*

Bucchich's goby

Gobius bucchichi Steindachner, 1870

Bucchich's goby (*G. bucchichi*), ad. (top); **Sarato's goby** (*G. fallax*), ad (bottom). To separate Bucchich's and Sarato's, pay attention to Bucchich's more elongate and slender body (*vs*. stouter and deeper especially at the level of the first dorsal fin in Sarato's), the fewer dots on the body forming more loosely defined lines (*vs*. numerous and tightly packed dots forming almost continuous longitudinal lines), the unmarked ventral half of the eye (vs. a dot in the posterior portion of the ventral half), the longitudinal marking on the upper margin of the orbital rim is thin and limited to the posterior part (*vs*. thicker and longer), the lower row of dots on the cheek begins with a horizontal dash starting posterior to the corner of the mouth (vs. begins with an isolated dot at the corner of the mouth). *07 Jul 2011, Cres (Croatia), Roberto Pillon; 24 Aug 2018, Muggia (Italy), Roberto Pillon. Bottom photo flipped horizontally.*

Bucchich's goby

Gobius bucchichi Steindachner, 1870

Bucchich's gobies (*G. bucchichi*), ad. (top); **Sarato's goby** (*G. fallax*), ad ♂ (bottom). In addition to the diagnostic characters listed in the previous caption, note the difference in patterning in the first dorsal fin: the distal part of the fin is plain-coloured in Bucchich's, while it is banded in Sarato's. Here, Sarato's isolated dot at the corner of the mouth is hardly visible but nonetheless present. *05 Oct 2017, Rijeka (Croatia), Stefano Guerrieri; 29 May 2013, Rab (Croatia), Roberto Pillon. Both photos flipped horizontally.*

Bucchich's goby

Gobius bucchichi Steindachner, 1870

Bucchich's gobies (*G. bucchichi*), ad ♂ (left); **Sarato's goby** (*G. fallax*), ad ♂ (right). It is not infrequent to see interspecific agonistic interactions between territorial males. Bucchich's lacks the bluish sheen of Sarato's males. *14 July 2012, Hvar (Croatia), Roberto Pillon.*

Bucchich's gobies (*G. bucchichi*), ad. Individual in its typical, stony habitat. *27 May 2016, Rab (Croatia), Roberto Pillon, photo flipped horizontally.*

Bucchich's goby

Gobius bucchichi Steindachner, 1870

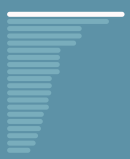
Bucchich's goby (*G. bucchichi*), ad; **Yellow-headed goby** (*G. xanthocephalus*), ad. These two species co-occur at least in the Black Sea. Separating them when in night colour pattern (as here) can be very challenging, but note the different head patterning, and notably the presence of a dot on the corner of the mouth in Yellow-headed but not in Bucchich's. *01 Oct 2017, Rijeka (Croatia), Stefano Guerrieri; 17 Jun 2020, Frontignan (34, France), Patrick Louisy.*

Giant goby

Gobius cobitis Pallas 1814

Gobie à grosse tête (*Fr*)
Riesengrundel (*Ge*)
Gobito de roca (*Sp*)
Giozzo testone (*It*)

Very large • big head with a long snout and thick lips • 'salt-and-pepper' variegated body with large dark blotches • common to very common, in rocky habitats, at 0-3 m depth



• Description

Very large goby up to 27 cm long (Sparta, 1950), with a large and sturdy head, thick lips and an elongate snout. From above, the cheeks appear distinctly swollen. Ground body colouration grey-beige or grey-green with dark blotches speckled white ('salt-and-pepper') above, along and below the lateral midline. The dark blotches are the largest on the back, where they form 3 to 5 saddles, with colours alternating between black and dark olive from one saddle to the next. Along the lateral midline, the blotches (usually 5) are smaller but still relatively large compared to in other *Gobius*; they are circular to rectangular in shape. Blotches are the smallest and the most numerous (8 to 12) below lateral midline. Black spots often present on the dorsum, usually one at the base of the first ray of the first dorsal fin, and a few others along the base of the second dorsal fin. Head with a 'salt-and pepper' colouration. An horizontal stripe crosses the eye. Snout with a very faint V-shaped line (invisible in old individuals). The lips are speckled white and black, except the posterior part of the lower lip, which is plain white. A dark, ill-defined horizontal stripe runs rearwards from the corner of the mouth, ending behind the eye; it is made sinuous by the large white circular spots that border the ventral edge of the cheek and opercle. An oblique, dark preorbital bar connects the eye to the lip; it usually extends over the lip. The preorbital bar is often bordered posteriorly by a white suborbital bar connecting the eye to the white posterior part of the lower lip. Often a dark marking at the ventroposterior edge of the eye; in adults it is sometimes prolonged posteriorly by a thin, black horizontal line. Rays of both dorsal fins with light and dark transverse stripes along their whole length. On the membrane, thin, irregular light bands alternate with broader, dark grey to reddish bands. Caudal fin usually blackish or reddish with thin light vertical bands. Anal fin similar to second dorsal fin, though less strongly patterned. Pelvic disk generally not visible in live individuals. Pectoral fins large and rounded, with well-developed but short free (filamentous) rays. In most individuals, pectoral rays are heavily speckled white from the base to their distal tip (rarely, pectoral fins are hyaline). Predorsal area with scales. Anterior nostril terminated by a long tentacle, often digitate.

Giant goby *(G. cobitis)*. ad. *28 May 2020, Thau lagoon (34, France), Patrick Louisy. Photo flipped horizontally.*

Night colouration. Individuals may darken at night, but overall they display the same markings as during the day.

Sexual dimorphism. Sexually mature males tend to have more colourful fins (deeper red membranes), sometimes with a light blue marginal band in dorsal fins. There is no size dimorphism between the sexes (Gil et al. 1997).

Juveniles. Their overall colouration is similar to that of adults, but with more diffuse dark blotches on the body, and better defined markings on the head. Notably, a V-shaped line is well visible on the snout (it fades away as individuals get older), and the side of the head has two irregular but visible black horizontal lines below eye level. The lower bar runs from the corner of the mouth to slightly behind the eye; it is also visible in adults but is not fused with other dark markings in juveniles. As in adults, this lower bar has an irregular shape because of the white (pearly in juveniles) spots along the ventral edge of the cheek. The median bar begins where the lower bar ends; it runs rearwards on the posterior part of the cheek, the preopercle and the anterior part of the opercle. In addition, an interrupted oculoscapular line extends rearwards from the eyestripe as a series of irregular and ill-defined black spots, until reaching the upper base of the pectoral fin (this is rarely visible in adults). As in adults, there is generally a dark, small, oblique rectangle at the ventroposterior edge of the eye, but contrary to adults it does not extend rearwards as a thin horizontal dark line.

Geographic variation. Unknown.

- **Similar species**

Giant goby is the largest of all North-eastern Atlantic and Mediterranean gobies.

It is most likely to be confused with Rock goby (*G. paganellus*), and to a lesser extent, Grass goby (*G. ophiocephalus*). **Rock goby** is best identified by its nape entirely covered with large scales (vs. small scales in Giant), the presence of scales on the upper posterior corner of the cheeks (vs. cheeks naked), more developed and longer pectoral free rays, reaching to near origin of first dorsal fin (fall short of first dorsal fin in Giant), more contrasting and darker body colours with larger blotches below the lateral midline, midlateral blotches rectangular (vs. mostly circular), and a slightly shorter snout and steeper snout profile. Moreover, adult males Rock often have a yellowish to orange marginal band to the first dorsal fin. Juveniles are typically more difficult to tell apart, especially as very young Rock can have no visible scale on the predorsal area and pectoral free rays are not fully developed yet. Juveniles of Rock nevertheless differ by a poorly defined V-shaped snout line (vs. well defined in Giant), a darker ground body colouration (vs. always light creme or whitish), a distinctly shorter snout with a steep head profile, a posterior blue spot on the first dorsal fin (absent in Giant), the presence of dark markings all around the pupil (vs. only a transverse horizontal stripe), and the black spot at the ventroposterior border of the eyes continues horizontally rearwards (vs. isolated dark mark at the ventroposterior border of the eye in Giant). According to Pinchuk and Strautman (1977), Rock and Giant gobies can hybridize.

Giant goby can resemble **Grass goby** in overall colouration and size, but it has a different patterning. Typically more slender than Giant, Grass goby has a yellowish-beige to green-grey background colour with a rather regular dark mottling, a characteristically reticulated pattern on cheeks, and two pale dorsolateral stripes on the back, one each side. These stripes start from behind the eye and end at the base of the caudal fin. Grass goby lives only in shallow coastal lagoons, often in brackish waters (Giant lives both in brackish and saltwater).

The invasive **Bighead goby** (*Ponticola kessleri*) can also look similar to Giant goby, sharing with that species: a large head, the head and body covered with many light dots, strongly patterned pectoral fins, and dark markings of various sizes, including blackish saddles and dark blotches along and below the lateral midline. However, Bighead occurs in freshwater in Western Europe, and in the Black Sea where it originates from; it can live in brackish waters but with very low salinity (<2ppt). It is thus unlikely to be found in areas typically occupied by Giant goby. Bighead differs from Giant goby, notably by: (1) a very distinct head shape, depressed and with a concave snout profile, the lower lip projecting beyond the upper lip; (2) no free rays in pectoral fins, (3) larger light dots producing a reticulated pattern (speckled in Giant).

In the subtropical Atlantic, **Madeira goby** (*Mauligobius maderensis*) should be considered a potential pitfall even if it is not currently known to co-occur with Giant goby (but this could change with global warming). The high similarity between these two species mostly concerns adults, juveniles of Madeira being invariably dark-backed with narrow pale saddles. In adults, key differences are: the head is slender and has a shorter snout in Madeira; although both species have white dots on the head and the body, these dots are more clearly defined in Madeira, especially on the body (the white dots are often indistinct on Giant's body); the dark blotches below the lateral midline and those along lateral midline are of similar size (vs. blotches below midline are smaller in Giant); and the dorsal and caudal fins are less variegated, with markings dominated by distinct white dots on rays and with only faint dark spots (vs. in Giant, the dorsal and caudal fins are strongly patterned with irregular reddish bands and black spots, and to a lesser extent with inconspicuous white dots).

Giant goby

Gobius cobitis Pallas 1814

- **Distribution & Status**

Giant goby occurs in the North Sea (Suffolk), the English Channel (Southern Cornwall), the Eastern Atlantic from the Isles of Scilly in England to Agadir in Morocco, the whole Mediterranean and Black Sea. The species has immigrated to the Gulf of Suez, in the Red Sea (Goren & Klausewitz, 1978).

In *France*, Giant goby is a common species (although locally, it is rarely the most common goby) occuring in any shallow rocky area of the Atlantic, the Channel and the Mediterranean Sea (including in Corsica).

- **Habitat**

Giant goby can be observed at depths from 0.1 m to 35 m but it is more frequent in the first 3 m. It lives on hard bottoms (rock, pebbles), but young individuals can be seen on soft bottoms to avoid competition with adults. It preferentially occupies sheltered areas, both in the sea and in lagoons with limited variation in salinity.

- **Miscellaneous**

☝ Giant goby is omnivorous but it would become more and more herbivorous as it ages (Kara & Quignard, 2018).

☝ Historically, the species was often referred to as *Gobius capito* Valenciennes, 1837. However, *G. capito* was also used to describe Rock Goby (*G. paganellus*), which has caused confusion in the ancient literature. Yet, Giant goby was originally thought to be endemic to the Mediterranean until its discovery in the Bay of Concarneau in French Brittany in 1898 (Boulenger, 1999). The first record for Britain was made in 1903.

Giant goby *(G cobitis)*. Juvenile.

Giant goby

Gobius cobitis Pallas 1814

Giant gobies (*G. cobitis*), ad, ♂ (top) and type ♀ (bottom)**.** Bodycolouration can vary from grey-green to grey-beige or cold black-and-white, but patterning typically consists in three longitudinal series of dark blotches: large blotches on the back (saddles), medium blotches along the lateral midline, and smaller blotches below that line. In big bulls like this top individual, this pattern is made indistinct by the large extent of speckling - another feature of Giant goby. Reproductive males have strongly patterned dorsal fins. *18 Aug 2016, Palasca (Corsica, France), Julien Renoult; 09 Jun 2019, Banyuls-sur-Mer (66, France), Julien Renoult. Both photos flipped horizontally.*

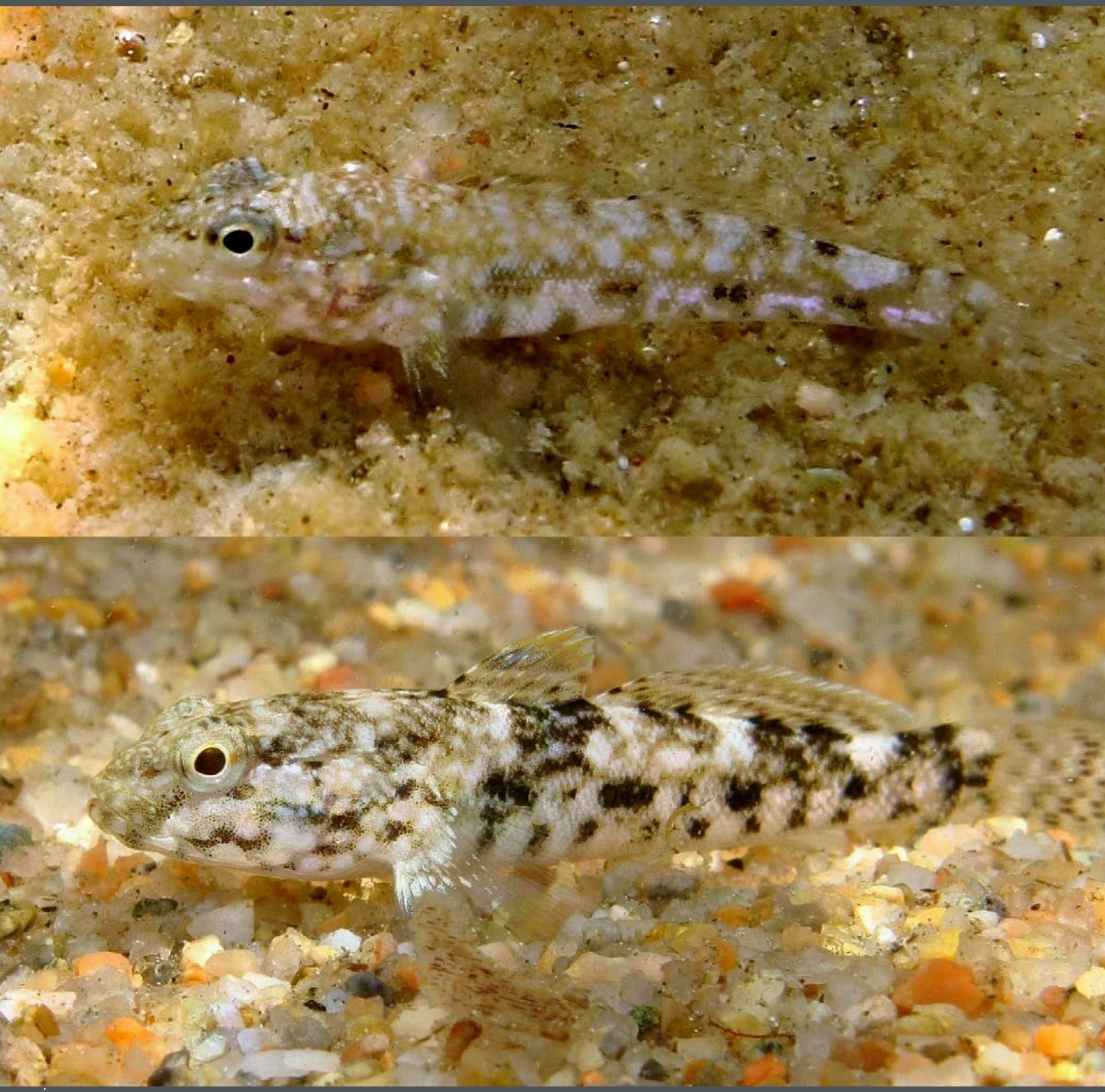
Giant goby

Gobius cobitis Pallas 1814

Giant gobies (*G. cobitis*), ad (top) and ad ♂ (bottom) photographed from out of the water. This species is characterized by a large and sturdy head, thick lips, by rounded pectoral fins strongly speckled and with well developed but short free rays. Many individuals further show black spots at the base of dorsal fins, including one often well-visible at the spine base of the first dorsal fin. Reproductive males sometimes exhibit a beautiful white to light-blue marginal band to dorsal and caudal fins. *10 Jun 2010, Livorno (Italy), Stefano Guerrieri; 06 Jun 2019, Trédez-Locquémeau (22, France), Corentin Morvan. Both photos flipped horizontally.*

Giant goby

Gobius cobitis Pallas 1814



Giant gobies (*G. cobitis*), juv. Two different stages of development, with the top individual the younger. They are very similar to adults but have smaller blotches and a more distinct V-shaped snout line. *04 Jun 2013, Sardinia (Italy), Roberto Pillon; 4 Jun 2013, Sardinia (Italy), Roberto Pillon. Top photo flipped horizontally.*

Giant goby

Gobius cobitis Pallas 1814

Giant goby (*G. cobitis*), ad (top); **Rock goby** (*G. paganellus*), ad (center); **Grass goby** (*G. ophiocephalus*), ad (bottom). Rock differs from Giant by a deeper, less depressed head, a shorter and steeper snout, a nape completely covered with large scales, free rays of pectoral fins longer and more developed, a less distinct patterning on the dorsal and caudal fins, and the first dorsal fin edged orange (subtle here). Also, Rock's body markings are more contrasting, lacking the "pepper-and-salt" appearance of Giant, but they are less well organised (in particular, the dark saddles are relatively indistinct). Compared to Giant goby, Grass goby has a different patterning with disorganised and smaller dark markings on the body and reticulated cheeks. The two clear longitudinal stripes on the upper parts (one on each side) that normally characterise that species are barely visible in this individual. *30 May 2012, Rab (Croatia), Roberto Pillon; 06 Jun 2009, Sardinia (Italy), Roberto Pillon; 14 Jul 2018, Pomer (Croatia), Roberto Pillon.*

Giant goby

Gobius cobitis Pallas 1814

Giant goby (*G. cobitis*), ad (top); **Bighead goby** (*Ponticola kessleri*), ad (bottom). Both species have a large head, strongly marked pectoral fins, and light dots on the head and the body. However, in Bighead the head is even more depressed (flattened) and has a concave snout profile. In addition, Bighead has much larger light dots , forming a reticulate pattern more than speckled one (as in Giant), and its pectoral fins have no free rays. *20 Jun 2013, Sardinia (Italy), Roberto Pillon; 15 Sep 2019, La Moder, Neuhaeusel (67), France, Julien Renoult.*

Giant goby

Gobius cobitis Pallas 1814

Giant goby (*G. cobitis*), im (top); **Madeira goby** (*Mauligobius maderensis*), ad (bottom). Misidentifying one of these species for the other is an overlooked pitfall that may be worth considering given ongoing shifts in their distribution range. The larger head and longer snout of Giant are not visible here. In Madeira, note the better-defined white dots on the head, body and second dorsal fin. In Giant, note the well-defined black markings on dorsal fin rays, and the row of blotches below the lateral midline that are distinct from (and smaller than) the midlateral blotches. *08 Jun 2019, Banyuls-sur-Mer (66, France), Julien Renoult; 15 Jan 2016, Tenerife (Canary Islands, Spain), Xavier Rufray.*

Giant goby

Gobius cobitis Pallas 1814

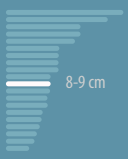
Giant goby (*G. cobitis*), juv (top); **Rock goby** (*G. paganellus*), juv. (bottom). Juveniles of Giant have a longer snout with a more attenuated profile, a better-defined V-shaped snout line, more visible dark markings below the lateral midline, an unpigmented area on the cheek below the eye (vs. tiny black pigments in Rock), and the eyes have a clearly visible horizontal transverse stripe but they lack any other markings (vs. oblic markings). The pattern on Giant's cheeks characterises juveniles of that species, with a lower horizontal line in the front part (below the eye), a median line in the rear part and on the opercle, and a small dark marking at the ventro-postero border of the eye that is not connected to the median line (the marking and the median line are connected in adult Giant and Rock, and in juvenile Rock only slightly older than the bottom individual). Also, in Rock note the faint but visible blue spot at the posterior part of the first dorsal fin. Older immatures of Rock are more easily told apart by their large scales on the nape (not developed yet here). *Both photos: 01 Jul 2020, Corsica (2A, France), Julien Renoult. Both photos flipped horizontally.*

Couch's goby

Gobius couchi Miller & El-Tawil, 1974

Gobie de Couch (*Fr*)
Couch-grundel (*Ge*)
NA (*Sp*)
Gobide di Couch (*It*)

Small • colour pattern variable but usually with a mottled back or reticulated markings • free ray tips in first dorsal fin well-developed in males • one dot on the corner of the mouth usually followed by two short horizontal lines • uncommon, in sheltered areas, on sand among seagrass, at 2-10 m depth



• Description

Relatively small goby about 7 cm long (maximal size 9 cm) with a medium-sized body and a short snout with a steep profile. Background colouration grey, light brown or olive. The lateral midline is always darker but varies depending on substrate: a line of small square dots in light environments, or a single, larger dark stripe on dark bottoms. Dorsal to this line, the back has dark mottling or reticulated markings forming an irregular pattern. Below the lateral midline, the belly is whitish grey, often speckled dark. Eyes usually with five markings: two horizontal stripes (one each side), one vertical stripe in the dorsal half and two oblique stripes (often limited to dots) in the lower half. There may be several additional markings around the orbit. Snout pattern variable but generally includes a dark mottled triangle. Just before the eye, there is almost always a black spot extending in a very short black line; a white mark is generally present between the dark triangle and this black spot. A black or dark-brown preorbital bar connects the eye to the upper lip. In some individuals, the preorbital bar extends onto both lips and on the chin: most often, however, the lower lip has dark spots or patches while the upper lip has many white dots or speckles. The black preorbital bar is bordered posteriorly by a white suborbital bar, which continues horizontally below the eye and then may run downwards towards the ventroposterior part of the preopercle, thus forming a white boomerang on the cheek. The area below this white boomerang is dark. The lower part of the cheek bears three black markings: one black spot at the corner of the mouth, usually followed by two short horizontal lines. The preopercle and the opercle can have white circular spots. Most individuals have a black spot in the middle of the opercle, just posterior to the preopercle. A dark oculoscapular line runs between the eye and the upper base of the pectoral fin; it is split into three to four segments. Dorsal rays with dark transverse bands. Distal part of dorsal fin rays free from the membrane in adults, most noticeably in the first dorsal fin. Membrane of the dorsal fins mostly transparent. Caudal fin rays with alternating dark and white spots not aligned vertically and thus not forming clear vertical bands. Anal fin transparent or greyish with only a few brown dots at the base. Pelvic disk pearly white. Pectoral fins mostly hyaline, with many white dots on the rays; moderately developed free (filamentous) uppermost rays. Dark blotch usually well visible on the upper part of the pectoral base, deeper than longer and with a whitish posterior border. Predorsal area scaled. Anterior nostrils rather long, tubular, terminated by a triangular process.

Couch's goby (*G. couchi*). *25 may 2018, Rab (Croatia), Roberto Pillon.*

Night colouration. Very distinctive night colouration and patterning. The body is divided into three differently coloured regions: the light cream or yellowish lower body parts, a dark brown midlateral region, and uniformly grey upperparts. The black spots on the lateral midline are generally visible under the dark brown midlateral stripe. The dark midlateral stripe is typically broadened in its anterior section, forming a black blotch posterior to the pectoral fin. The grey upperparts can have dark mottling and white saddles in young adults. The oculoscapular line is also broadened, especially at its posterior tip, forming another black blotch located just dorsal to the base of the pectoral fin. The cheeks are darkened too.

Sexual dimorphism. Males have a slender body, a larger size and more developed free ray tips in dorsal fins. Reproductive males can have very long free ray tips, giving the impression that the first dorsal fin is torn. These reproductive males often have blue and yellow reflections on dorsal fins.

Juveniles. Similar to adults, but with more numerous white markings. Notably, they have many white circular spots on the preopercle and the opercle, and pearly white markings on the back and the lower body parts. Their night colouration is similar to that of adults, but the back is browner and with more visible white saddles.

Geographic variation. Unknown.

• Similar species

Reproductive males of Couch's goby are easily separated from all other Mediterranean gobies by the distal tips of the first dorsal fin that are free from the membrane. In species with a long first dorsal fin (males of Black and Roule's goby), rays are connected to the membrane over their entire length. Only **Kestrel goby** (*G. xoriguer*) has a markedly elongate first dorsal fin with deeply lunate interradial membranes, and thus can approach Couch's in dorsal fin shape. But Kestrel has an otherwise very distinctive appearance, with big eyes and orange midlateral blotches. At night, adult Couch's has a diagnostic colouration that makes its identification relatively straightforward (see *Night colouration* above). So, identifying Couch's goby can be challenging "only" for non-reproductive males, females and juveniles during the day, and for juveniles at night.

By far, the greatest risk of confusion is with **Black goby** (*G. niger*). In many cases, Black is readily identified by its diagnostic dark blotch at the anterior distal corner of the first dorsal fin (absent in Couch's). In other cases, the following combination of characters should be used. (1) Black has a stockier body, a shorter snout and a larger head, and can be much larger than Couch's (15 cm vs. 9 cm). (2) In Black, the body is covered with large and poorly defined dark spots (vs. dark mottling or reticulation in Couch's). (3) The corner of the mouth does not have an isolated black spot (contrary to Couch's), and the ventral edge of the cheek can have diffuse black markings but does not have the two well-delineated short horizontal lines of Couch's. (4) The oculoscapular line is barely visible (vs. more distinct in Couch's). (5) The cheek bears evenly distributed, yet poorly defined, light and dark spots (vs. the upper part of the cheeks is always dominantly white, and the lower part dominantly dark in Couch's). However, some Black have a white boomerang below the eye that is very similar to that of Couch's; thus this character alone should not be considered diagnostic. (6) Nape sensory papillae are long and clearly visible (vs. shorter and not always visible in Couch's), and row d (sometimes visible on close-up pictures) is continuous (vs. split into two sections in Couch's). (7) In Black, contrary to Couch's, only rarely a black dot touching the anterior border of the eye between the V-shaped line and the preorbital bar can be seen, and when present it is almost never prolonged frontally with a short, thin black line. This last criterion is tentative and needs to be evaluated further. At night, juveniles of Couch's are more variegated than adults and they may lack the characteristic tricoloured patterning of the body. Young Couch's can nevertheless be separated from young Black by their cheek and snout patterning that is already characteristic of the species (see above), but also by the presence of a large black blotch in the anterior part of the trunk, just posterior to the pectoral fin.

Incognito goby (*G. incognitus*) is another potential though less likely pitfall. Like Couch's, Incognito is slender-bodied, and the ventral part of its head is similarly patterned with a dot at the corner of the mouth followed by two short horizontal lines (the presence of a dot on the corner readily excludes Bucchich's). However, Incognito has a well-marked V-shaped snout line, more dots on the head and a regularly patterned body.

• Distribution & Status

Couch's goby has been found in the North-eastern Atlantic, Mediterranean and Black Sea. In the Atlantic, it is known from Ireland and the south of Great Britain (from where the species has been described: Miller & El-Tawil, 1974; see also Baldock & Kay 2012), and French Brittany.

In the Mediterranean Sea, there are several records from France, Continental Spain (Cadaquès, Renoult et al., 2021; Cartagena, José Luis Alcaide, www.joseluisalcaide.com); Mallorca Island, Marcel Montanyès, 2020, iNaturalist), Italy (Liguria, Liu et al., 2009a; Ischia Island, Stefanni & Mazzoldi, 1999; published photography in Libourne, Tuscany, Stefano Guerrieri, 2016; Sardinia, photo by Egidio Trainito, 2011), Malta (Kovačić. et al., 2013), Croatia (Kovačić, 2001a; Kovačić et al., 2012; published photography by Roberto Pillon, 2010-2019), Greece (Corfu Island, Šanda and Kovačić, 2009; Crete, Kovačić et al., 2011), Cyprus (Kovačić & Golani, 2007) and Turkey (southern part of the Dardanelles Strait, Ozen et al., 2009). Couch's goby was recently discovered in Crimea, in the Black Sea (Karpova & Boltachev, 2018).

In *France*, the first record of Couch's goby dates back to 2004 in Port-Vendres (Mediterranean, 66, photo published in Louisy, 2005). The second is a specimen caught on 30 August 2011 in Plouézec, in Brittany (22; Florence Gully and Marc Cochu, estran22). The species was then photographed elsewhere in Brittany, in Saint-Malo (35; Patrick Louisy, 2018) and Brest (29; Samuel Iglésias, juveniles caught in 2019). In the Mediterranean, it is currently known from four sites: Port-Vendres, Cerbère (66, Patrick Louisy, 2021), Saint-Mandrier-sur-Mer (83; Benjamin Adam et al., 2019, DORIS and iNaturalist), and Santa Manza in Corsica (2A; photo by Lucas Bérenger, pers. com., 2020).

- **Habitat**

Couch's goby can be observed at depths from less than 1 m to 20 m. Its typical habitats are sedimentary bottoms (usually sand, sometimes covered with a thin layer of mud), with algae or marine plants and shelters such as rocks and holes. According to Miller and El-Tawil (1974), at Helford (England) the species is common in the intertidal area, "in small patches of water beneath flat stones on muddy shelly sand, with numerous small pebbles, overgrown by much Ulva and red seaweeds". In the Mediterranean, it is typically associated with the seagrass *Cymodocea nodosa* where it finds shelter by digging dens between roots or under the stones. Couch's goby occurs preferentially in calm waters such as in artificial harbors or in well sheltered bays. In Brittany, sheltered bays with a maerl bed would be suitable habitats for juveniles of both Couch's and Steven's gobies (Samuel Iglésias, pers. comm.).

- **Miscellaneous**

☝ Couch's goby is rarely recorded, especially in the Mediterranean. In France, for example, it is known from only four locations (including one in Corsica). But this rather nondescript fish is certainly much more common than currently thought. We strongly encourage photographers to carefully check every picture of "Black goby" photographed in sheltered bays. Underwater, the gregarious behaviour of the species can draw attention. To become familiar with this species, a reliable site in France is the beach of La Vieille in Saint-Mandrier-sur-Mer (83; GPS coordinates: 43.083652°N, 5.921707°E). A population was discovered there in June 2019 and was visited again in August the same year. Snorkel or dive during the day the first 50 m from the beach, and look for gobies at depths between 1 m and 5 m. Alternatively, visit Croatia where the species seems to be quite frequent (e.g., at sites with the following GPS coordinates: 44.7628279°N,14.7112996°E; 45.0962067°N,14.4488011°E; 44.6109302°N,14.5168969°E; 44.5203283°N,14.9879141°E).

☝ Couch's goby was described in 1974 from specimens collected in the United Kingdom. It was already known from that region since the 50's, but was listed as Golden goby (*G. auratus*). Steven's goby (*G. gasteveni*) was described the very same year. Knowledge on their field identification has increased over the last few years, leading to a rapid expansion of their known distribution area.

Couch's goby

Gobius couchi Miller & El-Tawil, 1974

Couch's gobies (*G. couchi*), ad ♂♂. In reproductive males the shape of the first dorsal fin is characteristic of the species, with free ray tips and deeply concave interradial membranes. Note also the mottled back, the well visible oculoscapular line and dark markings on the lower part of the head, with one isolated dot at the corner of the mouth followed posteriorly by two dark markings (normally, two horizontal lines as in the bottom individual, but occasionally two spots as in the top individual). *Both photos: 19 Jun 2020, Rab (Croatia), Roberto Pillon. Both photos flipped horizontally.*

Couch's goby

Gobius couchi Miller & El-Tawil, 1974

Couch's gobies (*G. couchi*), ad ♀♀. Females are more difficult to identify since dorsal fin rays are not conspicuously free at their tip, contrary to males. However, the mottled back without any well-defined patterns, slender body shape, small head with a white "boomerang" below the eye, and the dot at the corner of the mouth followed by two short horizontal lines, together identify these individuals as Couch's. Females appear distinctly smaller than males, have a more swollen belly and are surrounded by males during the reproductive season. *24 May 2014, Rab (Croatia), Roberto Pillon; 26 May 2018, Rab (Croatia), Roberto Pillon; 21 May 2021, Cerbère (66, France), Patrick Louisy.*

Couch's goby

Gobius couchi Miller & El-Tawil, 1974

Couch's goby (*G. couchi*), ad. A specimen from the Atlantic. Dorsal free rays are not obvious (the free tips are nevertheless visible) but the specimen shows a characteristic marbled brown-olive back without stripes, dark spots along the lateral midline that do not agglomerate into distinct blotches, an almost continuous oculoscapular line, a spot at the corner of the mouth followed by two horizontal lines, and a M-shaped snout line. *09 Aug 2018, La Rance, Pleurtuit (35), France, Patrick Louisy. Photo flipped horizontally.*

Couch's goby is frequently observed on the sand-seagrass interface. *Patrick Louisy.*

Couch's goby

Gobius couchi Miller & El-Tawil, 1974

Couch's gobies (*G. couchi*), ad. Couch's nocturnal colouration is characteristic: the body is tricoloured with light cream or yellowish lower parts, a dark brown midlateral region and grey upperparts, and the regions dorsal and posterior to the pectoral fin are darkened. Note also the overall slender appearance of the fish, the shape of the dorsal fin with deeply concave interradial membranes, the white boomerang on the cheek below the eye, the black dot at the corner of the mouth followed by two horizontal lines, the black dot anterior to the eye prolonged frontally by a thin line, and the white flecking on pectoral fin rays. *10 Jun 2016, Livourne (Italy), Stefano Guerrieri; 19 Sep 2013, Cadaqués (Spain), Thomas Menut.*

Couch's goby

Gobius couchi Miller & El-Tawil, 1974

Couch's gobies (*G. couchi*), im. The main diagnostic features of adults are already visible in the top juvenile, including the elongate body, the black dot at the corner of the mouth, the white boomerang below the eye, the dark horizontal line at the base of the pectoral fin and the largely grey and brown colouration. The bottom individual is older (more strongly marked dorsal fin, opaque body) and was photographed at night. Note the darkened areas above and posterior to the pectoral fin. Compared to adults, young specimens have many pearly white markings on the body and white spots on the head. *26 May 2018, Rab (Croatia), Roberto Pillon; 29 Aug 2020, Cadaquès (Spain), Julien Renoult. Top photo flipped horizontally.*

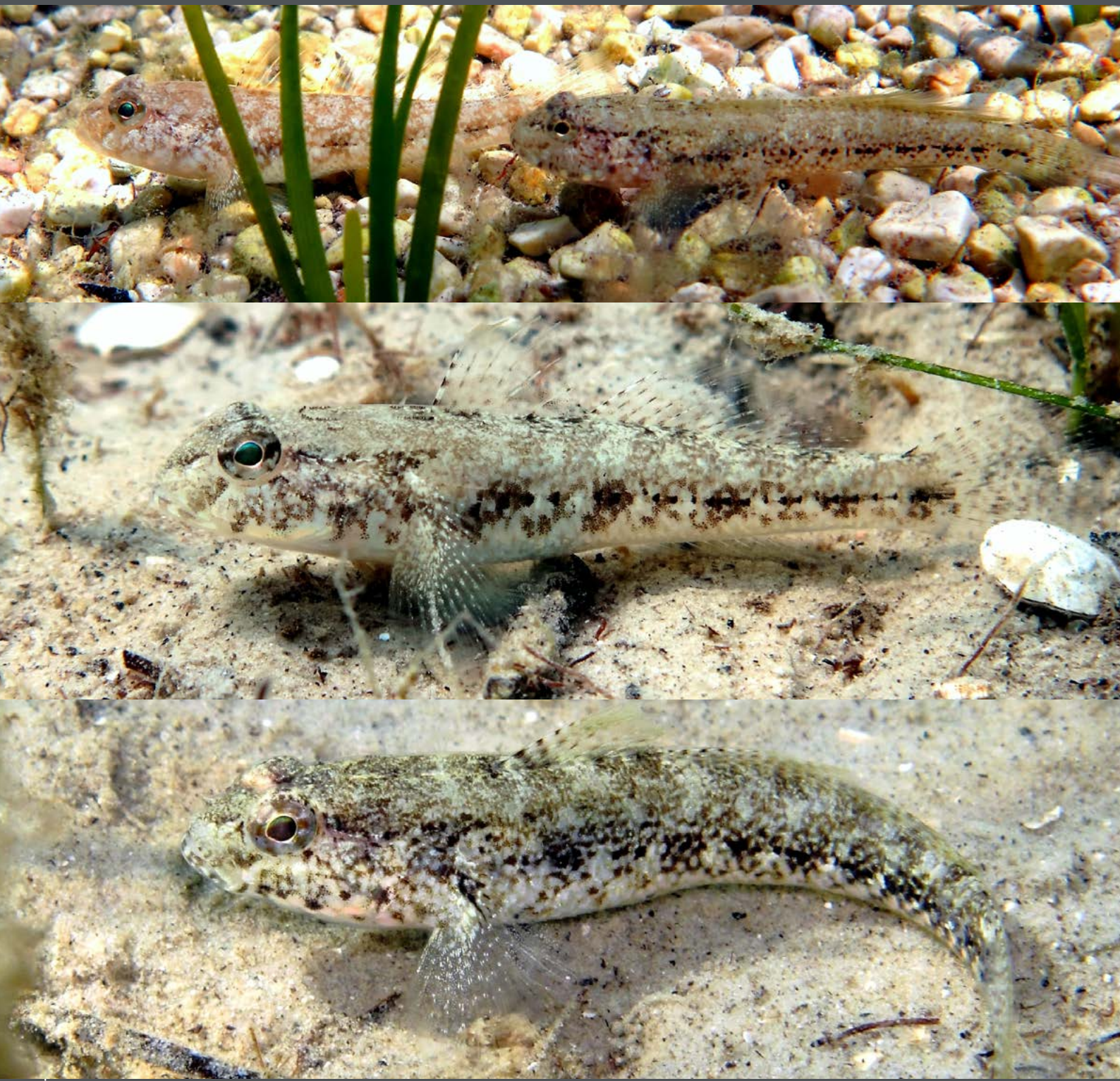
Couch's goby

Gobius couchi Miller & El-Tawil, 1974

Couch's gobies (*G. couchi*). Couch's goby enjoys calm waters like sheltered bays, where it occupies varied habitats. Top photo illustrates habitat rich in red algae, center photo an individual on gravel, bottom photo a gravel bottom where dens are dug under the roots of *Cymodocea nodosa*. *09 Aug 2018, Pleurtuit (35), France, Patrick Louisy; 19 Aug 2019, Saint-Mandrier-sur-Mer (83, France), Lucas Berenger; 14 Jun 2020, Rab (Croatia), Roberto Pillon. Top photo flipped horizontally.*

Couch's goby

Gobius couchi Miller & El-Tawil, 1974



Couch's gobies (*G. couchi*), ad (top right & bottom); **Black gobies** (*G. niger*) ad (top left) and im (center). Both species have an overall similar colouration and both have white pectoral speckles. However, compared to Black, Couch's is slenderer- and longer-bodied, has a more attenuated snout profile, usually a more homogeneous and smoother patterning on the back (not obvious here), a black spot at the corner of the mouth followed posteriorly by two well-defined, short horizontal lines (the first line is split into two in bottom Couch's), a horizontal white line just below the eye (in these Black, dark pigments almost reach the ventral border of the eye), and a more continuous oculoscapular line. Comparing center and bottom individuals, note also the less visible sensory papillae on Couch's nape, and the presence of a black spot in front of the eye that is prolonged frontally by a thin line. *25 May 2018, Rab (Croatia), Roberto Pillon; 21 May 2018, Rab (Croatia), Roberto Pillon; 24 May 2014, Rab (Croatia), Roberto Pillon. Bottom photo flipped horizontally.*

Couch's goby

Gobius couchi Miller & El-Tawil, 1974

Couch's goby (*G. couchi*), ad ♂ (top); **Black goby** (*G. niger*) ad ♂ (bottom). Besides the criteria mentioned in the previous caption (train yourself to find them all), the pattern and shape of the first dorsal fin clinches the identification. In adult Couch's, interradial membranes are characteristically deeply lunate. Adult Black has a characteristic black spot in the upper anterior corner of the first dorsal fin. Compared to in previous photos, the difference in back patterning is more obvious here, with a finer-grained pattern in Couch's back. *21 May 2018, Rab (Croatia), Roberto Pillon; 16 Jun 2016, Sardinia (Italy), Roberto Pillon.*

Couch's goby

Gobius couchi Miller & El-Tawil, 1974

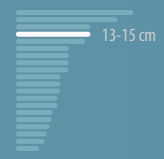
Couch's goby (*G. couchi*), ad ♂ (top); **Incognito goby** (*G. incognitus*) ad (bottom). On soft bottoms, some Incognito gobies have an olive colouration and lack the usually well visible dotted lines along the body, and thus they can be very similar to Couch's gobies. Moreover, both species have a dot at the corner of the mouth followed by two horizontal lines. However, Incognito has a different head shape with a longer snout. The cheek patterning is clearly different too, with three rows of dots and dashes below Incognito's eye, and a white boomerang below Couch's eye. The horizontal dark blotch at the base of the pectoral fin is attenuated but still visible in this Couch's. A close view of the head allow checking the suborbital sensory papillae: the black longitudinal row b does not cross row 5 anteriorly, which fits Couch's but not Incognito. *24 May 2014, Rab (Croatia), Roberto Pillon; 29 May 2012, Rab (Croatia), Roberto Pillon. Top photo flipped horizontally.*

Red-mouthed goby

Gobius cruentatus Gmelin, 1789

Gobie à bouche rouge (*Fr*)
Blutmund-grundel (*Ge*)
Gobio de boca roja (*Sp*)
Ghiozzo boccarossa (*It*)

Large • red lips (may not be visible without a lamp) • white suborbital bar • variegated body with white saddles on the back and large, black blotches along body sides • common, in rocky habitats, usually at 3-30 m depth



• Description

Large goby 13-15 cm long (maximum size: 18 cm) with a moderately long snout, moderately steep snout profile, large lips, stout body and short but deep caudal peduncle. Background body colouration usually dark with large black midlateral blotches generally longer than wide (but sometimes square or circular) and flanked by two white spots. Back with four broad dark bands separated by thin white saddles; the first (below the first dorsal fin) and third bands being darker than the second and fourth bands. Below the lateral midline, the lower body parts are marked with alternating white and dark brown blotches. Reproductive individuals often show red dots over the body. Nape with same colour as the second and fourth dorsal bands, and with a white saddle in the middle. Elsewhere, the head is reticulated brown, red and white. Lips vermillion (although this may not be detectable because of the ambient blue light below 5 m depth). Iris red, with a golden margin around pupil, and with several white radiating stripes. Orbital rim mottled brown and white, with a conspicuous brown transverse bar connecting the eyes dorsally. No distinct V-shaped line or dark triangle on the snout; no preorbital bar. An outstanding white suborbital bar runs from below the eye to the base of the lower lip, thus crossing the upper lip. The white bar extends horizontally below the eye then runs oblically towards the ventroposterior corner of the preopercle. Overall, the white mark below the eye forms a pale boomerang but only the anteriormost suborbital bar is conspicuously white. Rest of the cheek dark brown, or with a vermillion background, and irregular white markings. A whitish blotch in the anterodorsal corner of the opercle. First dorsal fin only slightly taller than second dorsal fin. The membrane of both dorsal fins is highly variegated, mixing irregular patches of red, dark brown and bluish colouration. There are hardly any regular patterns on the first dorsal fin; the second dorsal fin can be densely speckled with large brown circular markings centered on the rays. In older individuals, the two dorsal fins are edged white, sometimes bluish. Rays dark brown with white transverse stripes, especially conspicuous on the first (spinous) rays. Two white spots are generally clearly visible between ray I and ray II of the first dorsal fin: they correspond to extensions onto the membrane of the basalmost white transverse stripes of the spine.

Red-mouthed goby (*Gobius cruentatus*), *01 Jun 2017, Tuscany (Italy), Stefano Guerrieri.*

Patterning of the caudal fin somewhat similar to that of the second dorsal fin. Base of the caudal fin with two white spots dorsoventrally aligned. Anal fin similar to the second dorsal fin, but with smaller spots and whithout a blue margin. The pelvic disk, rarely visible, is pearly white or blue (both the membrane and the rays), with brown spots on the rays. Pectoral fins with a hyaline membrane; pectoral rays alternating white and brown (or red) dots over their entire length. Base of pectoral fins with four blotches arranged vertically (from top to bottom): light-dark-light-dark (sometimes with a fifth bottommost white blotch). The upper pectoral free rays are short and moderately developed. Predorsal area and cheeks scaled. Anterior nostrils short, tubular, terminated by a flap or a tentacle. The rows of sensory papillae are conspicuous all over the head, being long and pigmented black and white.

Night colouration. Often paler than day colouration, with a more contrasting patterning; the red markings may be less obvious.

Sexual dimorphism. Unknown.

Juveniles. Juveniles are markedly different from adults. They do not have red lips, and their body is slender, translucent and speckled brown and white. The white blotch in the anterodorsal corner of the opercle tends to be more conspicuous than in adults, and they have a hint of V-shaped snout line. When very small, they are also more pelagic, typically swimming well above the floor. Soon during development, however, the brown transverse stripe connecting the orbits, the two white spots at the front edge of the first dorsal fin, the white-brown-white-brown base of pectoral fins, and the dark midlateral blotches flanked by two white spots become clearly visible. Note that each brown midlateral blotch is split into two brown spots in very young individuals; they coalesce when individuals get older. Juveniles are likely to be seen only in spring.

Geographic variation. Unknown.

- **Similar species**

The vivid red lips of Red-mouthed goby is a unique feature found in no other goby of the Mediterranean and North-eastern Atlantic. But beware that, in natural light, one can easily get puzzled by this dark, strongly patterned goby which may not appear red at all! Red-mouthed is also unique among large gobies in having conspicuous black and white sensory papillae.

In natural light, **Rock goby** (*G. paganellus)* can ressemble Red-mouthed in structure and patterning. These two species are the only European *Gobius* with scales on the upper posterior corner of the cheeks. Rock, however, has more developed pectoral free rays, larger and more numerous scales on the nape, the head sensory papillae are all black (vs. black and white in Red-mouthed) and less conspicuous notably on the nape (vs. well visible on the nape). Juveniles of Rock differ by the patterning of the first dorsal fin, with typically a blue blotch at the front edge of the fin (vs. no blue blotch but two white spots in Red-mouthed), a whitish ground colouration of the iris (vs. reddish), a less conspicuous white suborbital bar, hardly visible sensory papillae (vs. black and white papillae already well visible in juvenile Red-mouthed), and fainter white spots flanking the brown midlateral blotches.

Given the high resemblance between juvenile Rock goby and juvenile **Giant goby** (*G. cobitis*), this latter species can logically be mistaken for Red-mouthed goby as well. Giant, however, has a longer snout with a more attenuated profile, more uniformly-coloured whitish iris with anonly horizontal eyestripe onlys (vs. reddish iris with many radiating stripes), an opaque body with no pearly white markings (vs. largely transparent with pearly white markings), a dark line in the middle of the preopercle and the opercle, and a V-shaped snout line.

Immature individuals of **Couch's goby** (*G. couchi*) could be confused with same-aged Red-mouthed if the head is not clearly visible, as both species have pearly white markings on the body, and a conspicuous white "boomerang" on the cheek below the eye. Couch's has a different head patterning with a black spot at the corner of the mouth followed by two horizontal lines along the ventral edge of the cheek, its lower body parts are speckled brown (vs. large black markings in Red-mouthed) and the pectoral patch has only one dark transverse bar (vs. two).

Canarian goby (*Vanneaugobius canariensis*) also shows some similarities with immature Red-mouthed. Canarian goby occurs in the Canary Islands, in Madeira, in Cape Verde, but also in Guinea in continental Africa. Thus, it would be prudent to separate Canarian goby when encountering a Red-mouthed goby in Western Sahara, or even further south. Canarian has no obvious transverse bar on the top of the eyes, the head profile is steeper and the snout shorter, the nape is naked and homogeneously coloured (in immatures of Red-mouthed, scales are not always visible but the nape is more strongly patterned), it does not have a white blotch on the opercle (at most a small white dot), and has only one brown patch at the base of pectoral fins (vs. two dark patches in Red-mouthed).

Most other transparent gobies with many dark markings on the body, like **sand gobies** (*Pomatoschistus* spp.), **Toothed goby** (*Deltentosteus collonianus*) or **Four-spotted goby** (*D. quadrimaculatus*), differ from juvenile Red-mouthed by frequently having white saddles on the back, no white spots at the anterobasal border of the first dorsal fin, an unpatterned snout (vs. diffuse V-shaped line in Red-mouthed), a well-visible preorbital bar (vs. very faint), not white spots at the base of the caudal fin but a conspicuous black blotch stretched longitudinally (vs. two white spots arranged vertically but no black blotch).

- **Distribution & Status**

Red-mouthed goby lives in the North-eastern Atlantic, the Mediterranean, and has been recently found in the Black Sea (Engin et al., 2007). In the Atlantic, it occurs from the counties of Cork and Kerry in Ireland to Western Sahara (Miller et al., 1986). Records in Mauritania and Senegal need confirmation. In the Mediterranean, it occurs all along the northern coast, and along the southern coast in Morocco, Algeria, Tunisia, as well as in Benghazi in Libya (Al-Hassan & El-Silini, 1999).

In *France*, Red-mouthed goby occurs in the Bay of Biscay, where it is more common in the south. The precise distribution in the English Channel is unclear. There is one confirmed record from Carantec (29; iNaturalist), and another record from Le Havre (76, BioObs). It is relatively common all along the French Mediterranean coast including in Corsica.

- **Habitat**

Red-mouthed goby can be observed at depths from 1 m to 40 m. It is common in inshore rocky habitats, sand with stones and boulders, and in seagrass meadows. Contrary to adults, which are strictly benthic, juveniles can be epibenthic, swimming or hovering in schools 10-30 cm above the seabed.

- **Miscellaneous**

☝ Epibenthic juveniles are not uncommon in gobies. For example, Giant goby's (*G. cobitis*; Gil et al., 1997) and Grass goby's (*G. ophiocephalus*; Privileggi et al., 1997) shift from epibenthic to benthic life occurs 22 and 26 days after hatch, respectively, when they reach 4–5% of their maximum length. However, in Red-mouthed goby the juvenile epibenthic stage lasts exceptionally long, with the shift to benthic life occurring two months after becoming juvenile, that is, when individuals are approx. 30% of their maximum length (Kovačić 2004a). Moreover, during this epibenthic stage, juveniles undergo major changes in the arrangement of the head lateral line canals. While it remains unknown why this particular life cycle has evolved in Red-mouthed goby, it has generated a great deal of taxonomic confusion in the past. Because the arrangement of head canals is an important feature for goby identification, juvenile Red-mouthed gobies have been recurrently mistaken for other gobiid species, or even described as a new species. For example, juvenile Red-mouthed were often identified as Kner's gobies (*Pomatoschistus knerii*; besides differences in patterning -see Similar species above- Kner's goby has fewer rays in the second dorsal fin). Now and until proven otherwise, Kner's goby is considered endemic to the Adriatic. Schmidt's goby (*G. strictus*), which is still sometimes listed as a valid species in the modern ichthyological literature (e.g., Lloris 2015; Eschmeyer Catalogue of Fish and Fishbase on the date of Dec 5th 2020), could have been described from a juvenile Red-mouthed goby. For example, Kovačić (2004a) wrote: "The differing characters of *G. strictus* such as: absence of cheek scales, relatively larger eyes, row 1 oblique, uppermost pectoral rays separated from membrane just at their tips, the fourth branched pelvic ray about one ninth longer than the fifth branched pelvic ray (Miller, 1967), turn out to be just juvenile characteristics of *G. cruentatus*, as observed on the specimens in the 33.9 to 42.0 mm LS size range. The only difference between the data for *G. strictus* (Miller, 1967, 1986) and juvenile *G. cruentatus* remains the vestigial anterior membrane of G. strictus. This single, variable character is not enough evidence to justify the validity of *G. strictus*, so that *G. strictus* is probably a juvenile form of *G. cruentatus*". On the same topic, see also Iglésias et al. (2021).

Red-mouthed goby

Gobius cruentatus Gmelin, 1789

Red-mouthed gobies (*Gobius cruentatus*), ad. Typical individuals immediately identified by their vermilion lips contrasting with a white suborbital bar. Other characteristic features include the black midlateral blotches flanked by two white spots, thin white saddles on the back, and large circular brown spots on the second dorsal and caudal fins. Note also the light-coloured blotch at the anterodorsal corner of the opercle, two white spots arranged vertically at the base of the caudal fin, and the two white spots at the front of the first dorsal fin. The difference in body shape suggests that top individual is a ♂ and bottom individual could be a ♀ (note the swollen belly). Yet, more work is needed to know if this species is sexually dimorphic or not. *21 May 2010, Tuscany (Italy), Stefano Guerrieri; 28 May 2010, Tuscany (Italy), Stefano Guerrieri. Both photos flipped horizontally.*

Red-mouthed goby

Gobius cruentatus Gmelin, 1789

Red-mouthed goby (*Gobius cruentatus*), ad. In addition to the red lips and the white suborbital bar, interesting features to note are: scales on the upper posterior cheek (shared only with Rock goby, *G. paganellus* among large gobies of the studied region) and on the predorsal area, conspicuous black and white sensory papillae, short upper pectoral rays, pectoral free rays moderately developed, and white-brown-white-brown(-white) vertically arranged patches at the base of the pectoral fin. Train yourself to name the head canal pores and sensory papillae (see Introduction). The following combination is diagnostic of Red-mouthed goby: row d continuous, row x1 extending forward to pore β, rows c2 and c3 arising very close to the lower border of the eye. *28 May 2010, Tuscany (Italy), Stefano Guerrieri.*

Red-mouthed goby

Gobius cruentatus Gmelin, 1789

Red-mouthed gobies (*Gobius cruentatus*), ad. Extreme variations in adult colouration. Note the diagnostic red mouth in the dark individual; the black and white head sensory papillae and the scaled cheeks in the pale individual. On both individuals, the first interradial membrane of the first dorsal fin has two white spots (less visible but still present in the top individual), and the base of pectoral fins has a light-dark-light-dark pattern. *04 Aug 2007, Selce (Croatia), Anne Frijsinger & Mat Vestjens; 02 Jun 2017, Rijeka (Croatia), Stefano Guerrieri. Top photo flipped horizontally.*

Red-mouthed goby

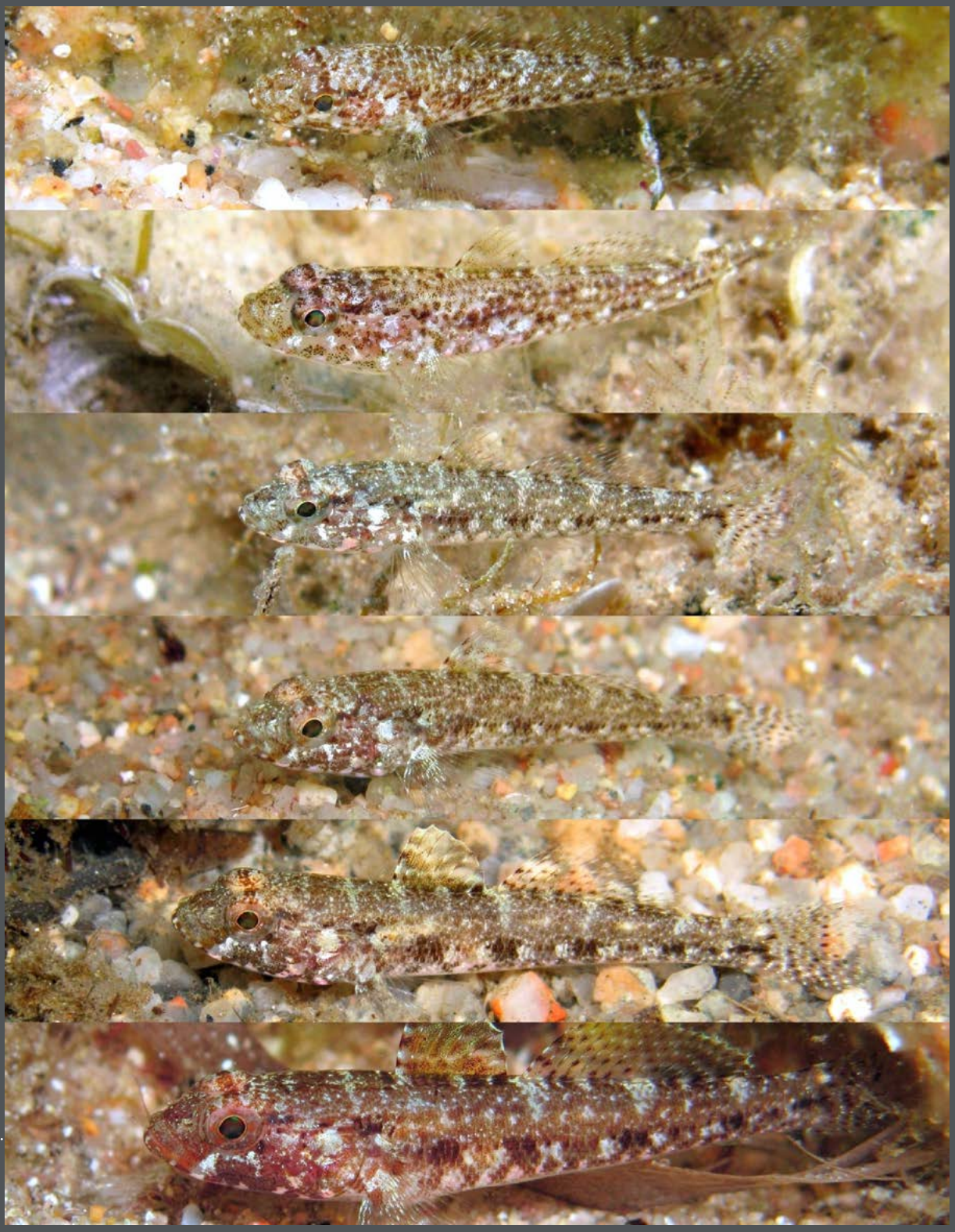
Gobius cruentatus Gmelin, 1789

Red-mouthed goby (*Gobius cruentatus*), ad. Be careful that the red colouration is visible only when illuminated by white lighting. This individual was photographed with a white-light strobe. Bottom picture illustrates its appearance under a natural, deep-sea lighting, here artificially reconstructed with a computer. *30 May 2015, Tossa de Mar (Spain), Patrick Louisy.*

Red-mouthed goby

Gobius cruentatus Gmelin, 1789

Red-mouthed gobies (*Gobius cruentatus*), juvs. Juveniles of Red-mouthed goby are very different from adults. They are best identified by their elongate body speckled white and brown, a dark transverse bar connecting both eyes on the top of the head, two white spots at the front edge of the first dorsal fin, two other white spots at the base of the caudal fin, a conspicuous white opercular bloch, and pairs of dark midlateral dots. Such gobies have been frequently mistaken for Kner's goby (*Pomatoschistus knerii*), notably because of their truncate tail, but Kner's has <11 soft rays at the second dorsal fin, while Red-mouthed has >12 rays (here: 13 and 14 for top and bottom individuals, respectively). Bottom individual is probably older than top individual, with overall body shape resembling that of adults. *10 May 2019, Olbia-Tempio, Sardegna (Italy), Timothy Cameron; 22 May 2019, Rab (Croatia), Roberto Pillon.*



Red-mouthed gobies (*Gobius cruentatus*), juvs (ranging from approx. 3 to 6 cm TL). This plate illustrates the development of benthic juveniles (different individuals depicted). The red colouration of the lips appears late during development; however, the dark transverse line connecting both eyes, the white blotch on the opercle, white suborbital bar, and white spots flanking the dark midlateral blotches are well visible even at these early ages. Note how each dark midlateral blotch in adults results from the fusion of two dark spots in juveniles, but that only even pairs of dark spots lead to a dark blotch, uneven pairs progressively fading away. *11 Jun 2011, Sardinia (Italy); 21 May 2011, Rab (Croatia); 8 Jun 2011, Sardinia (Italy); 8 Jun 2011, Sardinia (Italy); 8 Jun 2011, Sardinia (Italy); 11 Jun 2011, Sardinia (Italy); all photos by Roberto Pillon. Second, 3rd, 4th, 5th and 6th photos flipped horizontally.*

Red-mouthed goby

Gobius cruentatus Gmelin, 1789

Red-mouthed gobies (*Gobius cruentatus*), juvs. Juveniles of Red-mouthed goby have a remarkably long epibenthic life period during which they are gregarious, have a neutral buoyancy, and typically swim or stand 10-30 cm above the floor. This habit is frequently observed in other smaller goby species, for example *Pomatoschistus quagga*, and *P. bathi*. However, even at a distance, these sand goby species are easily identified by their dark markings along the body, in particular at the base of the caudal peduncle, and because they don't have tiny white speckles all over the body. *28 Apr 2014, Olbia-Tempio, Sardegna (Italy), Agostini Maria.*

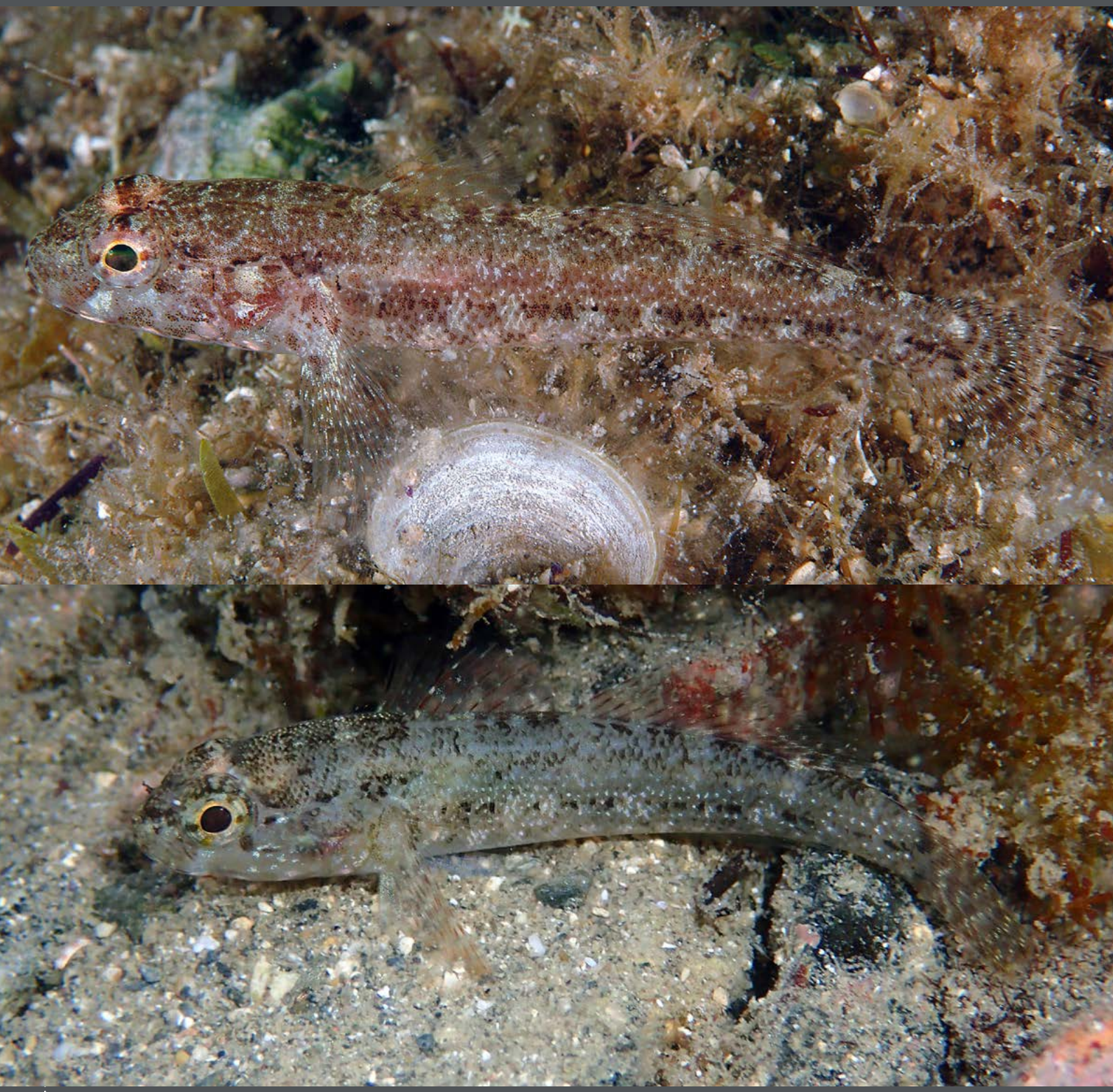
Red-mouthed goby

Gobius cruentatus Gmelin, 1789

Red-mouthed goby (*Gobius cruentatus*), im; **Couch's goby** (*G. couchi*), im. This young Red-mouthed goby has a black-and-white colouration and a white boomerang below the eye, recalling young Couch's at night. However, Red-mouthed goby has a conspicuous black transverse bar on the top of the eyes (vs. indistinct in Couch's), each midlateral blotch is flanked by two white spots (*vs*. one white mark separating two dark blotches), the lower parts of body are strongly patterned with large black spots (visible in the front part of the body; *vs*. only brown flecks in Couch's), and there are two dark blotches at the base of the pectoral fin (*vs*. only one). Moreover and contrary to Couch's, Red-mouthed does not have a black dot at the corner of the mouth followed by two short horizontal lines. *08 Jul 2011, Cres (Croatia), Roberto Pillon; 29 Aug 2020, Cadaqués (Spain), Julien Renoult. Bottom photo flipped horizontally.*

Red-mouthed goby

Gobius cruentatus Gmelin, 1789



Red-mouthed goby (*Gobius cruentatus*), juv; **Rock goby** (*G. paganellus*), juv. Compared to Rock, Red-mouthed has better-defined dark transverse line connecting both eyes, a white patch on the opercle, a white suborbital bar below the eye, light-dark-light-dark base of pectoral fin, two white spots at the front edge of the first dorsal fin and two other white spots at the base of the caudal fin. Note also the large scales on the nape of Rock goby (but be aware that younger Rock may not have well-developed nape scales). *05 Jun 2011, Porto Badisco (Italy), Stefano Guerrieri; 29 Aug 2020, Cadaqués (Spain), Julien Renoult. Both photos flipped horizontally.*

Red-mouthed goby

Gobius cruentatus Gmelin, 1789

Red-mouthed goby (*Gobius cruentatus*), juv; **Canarian goby** (*Vanneaugobius canariensis*). Juveniles of Red-mouthed are immediately separated from Canarian by their dark transverse line connecting both eyes, and by a large white blotch on the opercle (small white dots in Canarian). In addition, in Red-mouthed the nape is more variegated and can have scales already visible (*vs*. nape naked and homogeneously coloured with only small white dots in Canarian), the head profile is shallower with a longer snout, and the base of pectoral fin has two dark patches (one above the other, vs. only one brown patch in Canarian). *17 Jun 2020, Rab (Croatia), Roberto Pillon; 09 Mar 2021, Lanzarote (Canary Islands, Spain), Julien Renoult. Bottom photo flipped horizontally.*

Red-mouthed goby

Gobius cruentatus Gmelin, 1789

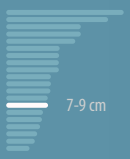
Red-mouthed goby (*Gobius cruentatus*), juv; **Sand goby** (*Pomatoschistus* cf. *marmoratus*), ad. The dark transverse bar on the top of the eyes, the faint but visible V-shaped snout line, and the absence of a black blotch at the rear of the caudal peduncle (not visible in the top individual) are important characters separating juvenile Red-mouthed goby from other gobies with a transparent and flecked brown body. *07 May 2019, Olbia-Tempio, Sardegna (Italy), Timothy Cameron; 19 Jun 2020, Palavas-les-flots (34, France), Julien Renoult.*

Sarato's goby

Gobius fallax Sarato, 1889

Gobie de Sarato (*Fr*)
Sarato-grundel (*Ge*)
Gobio de Sarato (*Sp*)
Ghiozzo fallace (*It*)

Medium-sized • whitish body covered with numerous and well-defined brown dotted lines • blue or yellow reflections on the back • one dot on the corner of the mouth • an irregular horizontal line along the upper margin of the orbital rim • one well-defined brown dot in the ventroposterior part of the eye • uncommon, in rocks or stones not far from soft bottoms, usually at 3-20 m depth



• Description

Medium-sized goby 7 to 9 cm long, with a moderately elongate body, large head, snout moderately steep and shorter than eye diameter. Background colouration light grey, usually with clearly visible blue or yellow reflections on the back. Head and body covered with longitudinal lines of well-defined brown dots. Dots are the broadest along the lateral midline; they are organised in dark-brown dashes, sometimes separated by white spaces. This dashed lateral midline runs from the base of the pectoral fin to the base of the caudal fin. The second most distinct row of dots forms a dark-brown dorsolateral dotted line. A sinuous, upper lateral row of lighter-brown, sometimes orange or yellowish dots runs between the lateral and the dorsolateral rows. On the back, dorsal to the dorsolateral row, the many dark-brown dots form one (sometimes two) destructured line running from the interorbital space to the upper base of the caudal fin. Below the lateral midline, one (sometimes two) row of light orange dots runs along the lower lateral side. Ground colouration of the head similar to that of the body colouration, although sometimes more yellow. The eyes have seven brown stripes radiating from the pupil to the orbital rim: two forming a broad horizontal stripe across the pupil, two oblique stripes in the lower half, and three stripes in the upper half, more or less connected by an irregular horizontal line on the rim. Lower lip with a median W-shaped mark. Snout with a M-shaped line and an oblique preorbital bar. The preorbital bar connects the upper lip to the anteroventral border of the orbit. It then reappears at the posteroventral border of the orbit, and runs rearwards as a midopercular line between the eye and the base of the pectoral fin (at the same level as the lateral midline posterior to that fin). A second, line of dots runs along the ventral edge of the cheek; it starts by a dot at the corner of the mouth and continues rearwards as two horizontal dashes, followed by three or four shorter lines or dots running slightly further dorsally on the preopercle and the opercle, parallel to the upper row of dots.

Sarato's goby (*Gobius fallax*). *23 Jun 2021, Gulf of Arta (Greece), Roberto Pillon.*

The cheek area below the eye and above the two ventral horizontal lines is either unmarked or has a very faint "middle" row of dots. Last, the horizontal eyestripe extends rearwards as an almost continuous oculoscapular line. Dorsal fins mostly transparent with four to six longitudinal rows of brown dots. First ray of each dorsal fin with white and dark-brown transverse markings. The two dorsal fins are separated by narrow space without membrane. Caudal fin rounded, rarely truncated, transparent with five to eight vertical series of brown dots. Anal fin transparent or whitish, plain-coloured or with a basal longitudinal row of brown dots. Pelvic disk transparent or pearly white. A dark, bluish pectoral blotch is rarely visible in day colouration. Pectoral free rays moderately developed. Nape and the predorsal area covered with small scales. Anterior nostrils tubular and terminated by a triangular flap.

Night colouration. Becomes darker, rarely almost entirely black but with the dotted pattern of day colouration still visible. This dark colouration can also be observed during day time, when resting on a dark seabed; although the lower body parts generally remain light-coloured. The pectoral blotch tends to be more visible.

Sexual dimorphism. Compared to females, males have a stronger bluish reflection on the back and appear larger. During the breeding season, the second dorsal fin is slightly taller, especially in males (Herler et al., 2005).

Juveniles. Overall similar to adults but with proportionally bigger eyes.

Geographic variation. Unknown.

- **Similar species**

Sarato's goby was once considered very difficult to identify in photographs. However, with the recent advances in its field identification, we are confident that Sarato's can now be recognized in most cases. It is likely to be mistaken only with other light-coloured species having a dotted patterning. To tell these species apart, a careful examination of this patterning is necessary. In addition, with some experience the particular habit of Sarato's goby can be very helpful for identification: Sarato's has a neutral buoyancy, frequently standing 10-30 cm above the seabed, or resting just above the floor but barely touching it.

The first resembling species to consider is **Incognito goby** (*G. incognitus*), which is slender-bodied and has a slightly longer snout. Moreover, Incognito has three rows of dotted lines on the cheek, with a median row running below the eye in the center of the cheek. In contrast, Sarato's generally has only two rows of dots, with no median row. When this median row is present, it is relatively faint. In addition: body lines have a few dots forming irregular patterns (*vs*. numerous and tightly packed dots on the body, which form almost continuous longitudinal lines in Sarato's); the posterior part of the ventral half of the eye exceptionally has a brown dot (*vs*. a brown dot is always present in Sarato's, most frequently forming a radiating stripe); Incognito's back does not show a bluish sheen (Sarato's often does); and the snout bears a V-shaped line (*vs*. M-shaped in Sarato's).

The second most likely pitfall is **Bucchich's goby** (*G. bucchichi*), which until recently was considered conspecific with Incognito goby. Bucchich's is slender-bodied and has a slightly longer snout, dots on the body are sparse and form irregular lines (*vs*. numerous and tightly packed dots forming almost continuous longitudinal lines in Sarato's), the ventral half of the eye is unmarked or has a dot in its anterior part (*vs*. dots or stripes in both the anterior and posterior parts of the ventral half), there is no dot at the corner of the mouth (*vs*. one dot in Sarato's), and the back does not show a bluish sheen (*vs*. often shows a bluish sheen in Sarato's). Note that both species have a M-shaped snout line.

A third species to consider is **Yellow-headed goby** (*G. xanthocephalus*), whose resemblance with Sarato's should not be dismissed. Actually, the patterning of the head and the eyes are strictly similar, and the patterning of the body is so overlapping that it is most often useless. Identification thus relies mostly on colouration and body shape. In Yellow-headed, the yellow colouration is restricted to the head, while in Sarato's, when a yellow colouration occurs on the head it also extends onto the back. Yellow-headed further has more reddish dots on the body (vs. browner in Sarato's, but there is much overlap). At night, when individuals are very dark and colouration is hardly visible, the difference in body shape can be the only relevant criterion. Yellow-headed is distinctly more slender and longer-bodied, and proportionally shorter-headed.

Last, **Golden gobies** (*G. auratus*) from the Northern Adriatic (and exceptionally from the Western Mediterranean) have a dotted patterning similar to that of Sarato's but have a more vivid yellow colouration, two to three equally visible lines of dots below the lateral midline (*vs*. one row of loosely aligned dots below the lateral midline) and the upper lip is plain-coloured with no dark marking (*vs*. upper lip with a brown mark).

Sarato's goby

Gobius fallax Sarato, 1889

• Distribution & Status

Sarato's goby is nearly endemic to the Mediterranean. A single record outside the Mediterranean Sea corresponds to three specimens collected off the southern shore of Gran Canaria, in the Canary Islands (Dooley et al., 1985). In the Mediterranean, it has been recorded in many places from the Balearic Islands to Turkey (Fricke et al., 2007), for example in Crete (Kovačić et al., 2011), Cyprus (Kovačić & Golani, 2007) and Libya (Al-Hassan, 1999). It can be locally gregarious and live in dense populations, especially in the Adriatic.

In *France*, the species is considered rare, with only a handful of records. In the French Pyrenees, the species is known from a single specimen collected in Port-Vendres (66) in 1898, currently preserved in Paris at the MNHN collection (we did not check the identity of that specimen). Sarato's has been recorded also in Nice (06) from where it was described in 1889 (type specimens are preserved at the MNHN collection), around Figari (2A; Daniel Pavon; Fish Watch Forum), la Revelatta in Calvi (2B; BioObs), the Eden Rock in Erbalunga (2A; BioObs), the bay of Portissol in Sanary-sur-Mer (83; Lucas Bérenger; Fish Watch Forum), "la Vieille" beach in Saint-Mandrier-sur-Mer (83, Lucas Bérenger et al.; Fish Watch Forum), la pointe de la Galère in Hyères (83; Sylvain Le Bris; Fish Watch Forum), la Pointe Madame in Saint-Jean-Cap-Ferrat (06; Xavier Rufray; Fish Watch Forum) and Cap d'Antibes (06; Zeineb Alhaidari; DORIS).

• Habitat

Sarato's goby can be observed on horizontal bottoms from 1 m to 32 m depth, but it is more frequent in shallow waters between 3 m and 20 m depth. Its typical habitat is made of rock crevices or stones nearby soft bottoms, sometimes among seagrass and algal residues.

• Miscellaneous

☝ Kolombatović (1891) described different varieties in Golden goby, including *G. auratus* var. *ruginosa* that is now considered a synonym of *G. fallax*. Actually, genetic studies based on the mitochondrial DNA (a portion of the genome that is widely used to quantify the genetic divergence between closely related species and subspecies) found no or extremely small differences between Sarato's and Golden, and only limited differences between Sarato's and Yellow-headed goby (Herler et al., 2005; Iglésias et al., 2021). These three species are thus thought to have diversified very recently, and are treated in the literature as a species complex (Miller & El-Tawil, 1974).

Sarato's goby

Gobius fallax Sarato, 1889

Sarato's goby (*G. fallax*), ad (top); **Sarato's goby** (*G. fallax*), ad ♂ (bottom). In Sarato's, the dots are so tightly packed that they form almost continuous lines along the body. The lateral midline is no exception. Note the stocky body and bright colouration with yellow or blue hues on the upperparts. The ♂ is sexed based the intense bluish colouration, size, and its proximity to a female (not visible here). *29 May 2013, Rab (Croatia), Roberto Pillon; 30 Aug 2019, Pag (Croatia), Roberto Pillon. Both photos flipped horizontally.*

Sarato's goby (*G. fallax*), ad. Three individuals from France showing variation in patterning. In the top, a typical dark-coloured individual, with a bluish hue on the body, longitudinal lines of well-defined brown dots, and an almost continuous lateral midline. In the center, a typical Sarato's yet without a blue sheen, and probably younger. In the bottom, another typically stout individual with a yellowish colouration on the head, and with brown and rather homogeneous colours and less well-defined rows of dots on the back. *25 Jul 2015, Figari (2A, Corsica, France), Daniel Pavon; 19 Aug 2019, Saint-Mandrier-sur-Mer (83, France), Lucas Bérenger; 24 Jul 2015, Figari (2A, Corsica, France), Daniel Pavon (Fish Watch Forum). All three photos flipped horizontally.*

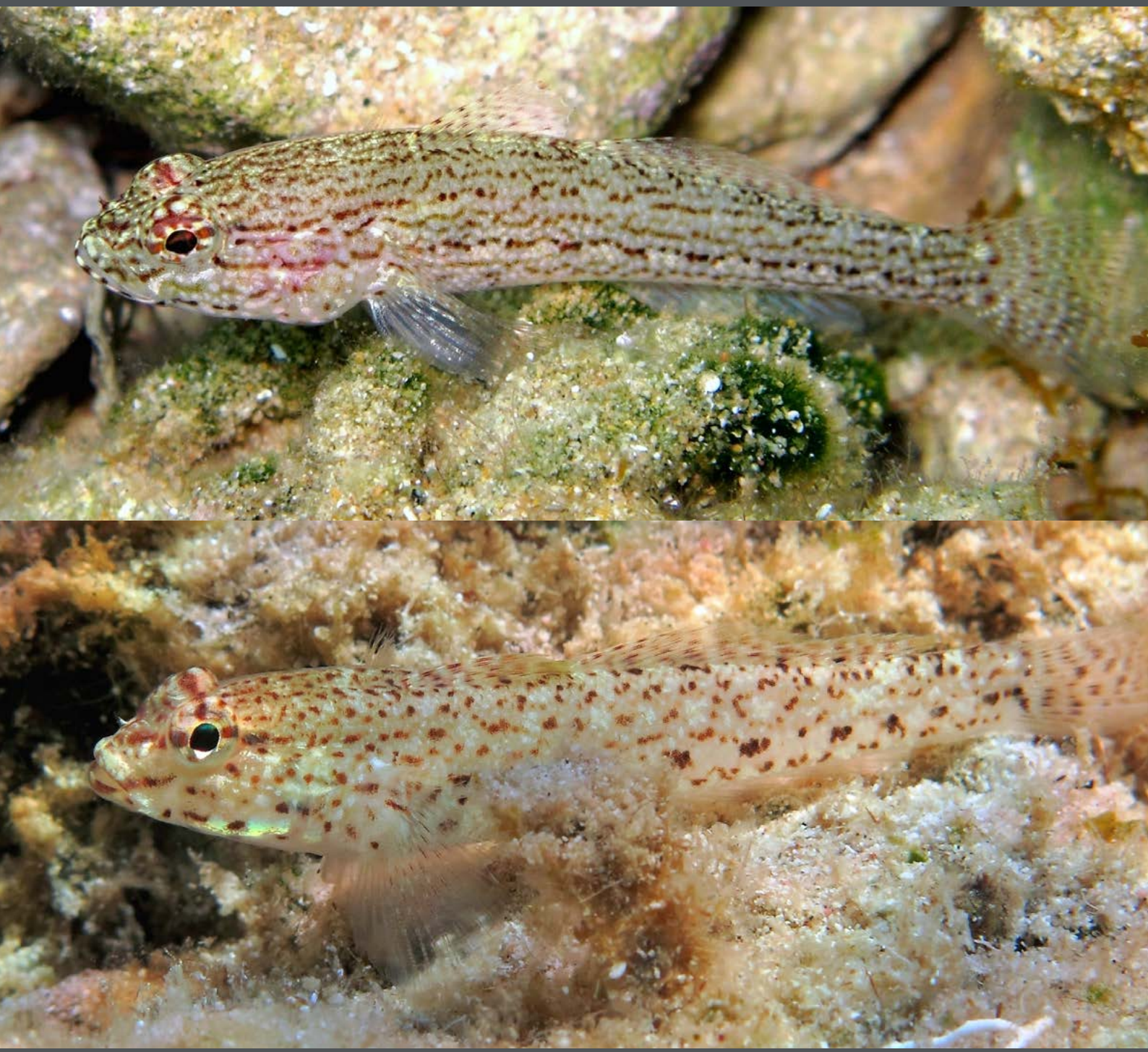
Sarato's goby

Gobius fallax Sarato, 1889

Sarato's gobies (*G. fallax*). Sarato's have a neutral buoyancy, and are often seen hovering 10-30 cm above the seabed. When resting, they usually barely touch the bottom. *14 Jul 2012, Hvar (Croatia), Roberto Pillon (top photos); 12 Jul 2018, Pula (Croatia), Roberto Pillon.*

Sarato's goby

Gobius fallax Sarato, 1889



Sarato's goby (*G. fallax*), ad (top); **Incognito goby** (*G. incognitus*), ad (bottom). Compared to Incognito, Sarato's has a deeper body shape and more numerous dots forming better-defined lines on the body. In particular, the lateral midline is almost continuous in Sarato's, while it has dark markings separated by large blanks in Incognito. In addition, note in Sarato's eye the longitudinal line on the upper rim (vs. no such line in Incognito), and the very faint, light orange middle row of dots/dashes on the cheek below the eye (*vs*. distinct brown dots). Note also the brown dot in the ventroposterior part of the eye, while this region is unmarked in Incognito (in the ventral half of the eye, Incognito has a brown dot only in the anterior part). Habit is also different: Sarato's has a typically arched body with fins barely touching the bottom (vs. straight body resting on the floor). *15 Jul 2012, Hvar (Croatia), Roberto Pillon; 23 Sep 2018, Elafonissos (Greece), Roberto Pillon.*

Sarato's goby

Gobius fallax Sarato, 1889

Sarato's goby (*G. fallax*), ad (top); **Incognito goby** (*G. incognitus*), ad (bottom). These two species can display a dark colouration even during daytime. Again, Sarato's is recognised by its stocky body and short snout, lined body, bluish reflections on the back, pale cheek below the eye (vs. darkened by the additional median row of dots in Incognito), a longitudinal line in the upper half of the eye (vs. no such line in Incognito), and a M-shaped snout line (vs. V-shaped line; though the vertical leg of the M is short here). Here, Sarato's midlateral blotches are separated by white markings, but these are relatively short compared to those of Incognito. *29 May 2013, Rab (Croatia), Roberto Pillon; 21 Sep 2012, Minorca (Spain), Roberto Pillon.*

Sarato's goby

Gobius fallax Sarato, 1889

Sarato's goby (*G. fallax*), ad (top); **Bucchich's goby** (*G. bucchichi*), ad ♀ (bottom). Females of Bucchich's could be very similar to Sarato's as they both have a thin (not blotchy) lateral midline and a nearly unmarked cheek below the eye. Yet Sarato's appears distinctly stockier, shorter snouted, it has numerous and tightly packed dots forming almost continuous longitudinal lines (*vs*. sparse dots forming irregular lines in Bucchich's), the ventral half of the eye is marked with an anterior and a posterior brown dot (*vs*. unmarked, or with only an anterior dot in Bucchich's), a brown dot at the corner of the mouth (*vs*. corner of the mouth unmarked) and a darker and more bluish back colouration. Although both species have a M-shaped snout line, in Sarato's the vertical legs of the M is possibly separated further away from the central V-part of the M (this criterion needs to be further studied). This Bucchich's goby was sexed as a ♀ based on size comparison and proximity with a big male, and its rounded belly. *20 May 2018, Rab (Croatia), Roberto Pillon; 27 May 2017, Rab (Croatia), Roberto Pillon. Top photo flipped horizontally.*

Sarato's goby

Gobius fallax Sarato, 1889

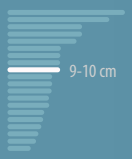
Sarato's goby (*G. fallax*), ad ♂ (top); probable **Yellow-headed gobies** (*G. xanthocephalus*), ad (center and bottom). Differentiating these two species can be extremely challenging when in dark colour pattern (at night or when excited), as they share a similar patterning and a blue/black blotch at the base of pectoral fins (not well-visible here in the bottom picture). Top individual is confidently identified as Sarato's based on its stocky appearance and metallic yellow reflections extending onto the back. The middle individual was photographed in a well known population of Yellow-headed; the identification is confirmed by its elongate body and large white areas between the dark midlateral blotches. The bottom individual is most likely a Yellow-headed goby, because we know that the species is abundant there; otherwise only the proportionally short head points towards that species. The Sarato's is sexed based on intense bluish colouration and big size. The photo was taken in a dark and sheltered place during the day. The individual, initially blue in colour, quickly turned black when it saw the photographer. *29 May 2013, Rab (Croatia), Roberto Pillon; 26 May 2017, Etang de Thau (34), France, Cathy Serval-Roquefort; 18 Oct 2018, île Tiboulen de Maïre (13), France, Sylvain Le Bris. Top and bottom photos flipped horizontally.*

Steven's goby

Gobius gasteveni Miller, 1974

Gobie de Steven (*Fr*)
Stevens grundel (*Ge*)
NA (*Sp*)
Ghiozzo di Steven (*It*)

Medium-sized • whitish body with orange to red markings and longitudinal lines on the nape • V-shaped line on the snout • dark continuous oculoscapular line • golden cheeks with white spots • dorsal fins with white spots and white margin in males • rare to locally common, on various soft bottoms, usually at 10-120 m depth



• Description

Medium-sized goby 7 to 10 cm long (maximum 12 cm), with a moderately long body and a short snout with a steep profile. Background colouration of the body light pink to light grey, with gold and greenish reflections on the back. Lateral midline with 6 to 11 rectangular, orange to dark brown blotches. Below the midline, the body is uniformly pale, white or pinkish. Above the midline, the body is irregularly speckled with orange to red or brown dots, paler than the lateral blotches. Some of these dots coalesce to form a discontinuous dorsolateral stripe. Further dorsally, a paravertebral stripe starts behind the eyes with a V-shaped line (formed by the junction of the stripes from each side) and continues rearwards through the dorsal sensory papillae until reaching a point level with the last ray of the first dorsal fin. Ground colouration of the head similar to that of the body. Eyes with a conspicuous horizontal eyestripe, a thinner vertical bar and sometimes a few additional markings in the dorsal half; ventral half unmarked. Lips white, or light grey or gold with white spots; upper lip sometimes marked with three faint dark spots. Snout with a well-defined V-shaped line (more rarely M-shaped), which can extend onto the upper lip. Cheeks white, light pink, often with a gold sheen. One red dot at the posteroventral border of the eye; another one, larger but more diffuse on the median posterior tip of the preopercle. Oculoscapular line usually continuous between the posterior border of the eye and the upper base of pectoral fin, broad, dark (same colour as the midlateral blotches), and ventrally bordered by three short horizontal dashes, red in colour, the middle one often with an inverted "L" shape (because the anterior tip of this horizontal dash joins the dorsal tip of a red-coloured, vertical row of sensory papillae). First (spinous) ray of both dorsal fins dark brown with 2-3 white transverse stripes. Membrane of both dorsal fins translucent orange with white, elongate or rounded spots, tipped with a white marginal band.

Steven's goby *(Gobius gasteveni). 01 Oct 2021, Bay of Agay (83, France), Julien Renoult.*

Uppermost rays of the caudal fin stripped dark brown and white. The ventral half of that fin is plain-coloured, without any dot. At the base of the caudal fin, a light red to pinkish spot prolongs the lateral midline. A small red dot or dash frequently occurs above that spot. Anal fin hyaline, with a few red dots at its base, and occasionally a faint dark submarginal band. Pelvic disk hyaline, greyish or pearly white, sometimes weakly striped. Pectoral fins mostly hyaline, with a white basal patch radiating on the lower and median rays, and further dorsally a dark, longitudinal diabolo-shaped mark. Pectoral fins without or with poorly developed filamentous rays; only the tips of the dorsal-most fin rays are free from the membrane. Predorsal area and breast covered by small scales; cheek and operculum naked. Anterior nostril terminated by a thin tentacle, usually equal to at least half the length of the tube.

Night colouration. The body is considerably darkened but the blue-green reflections are still visible on the back. The head is dark too, but usually with a white spot dorsal to the corner of the mouth.

Sexual dimorphism. Males in nuptial colouration have dorsal, anal and pelvic fins coloured dark (but pectoral and caudal fins remain largely hyaline). The white spots on dorsal fins are more conspicuous in males than in females. The origin of the anal fin is located between the first and second articulated rays of the second dorsal fin in males, and between the second and third articulated rays in females (Alberto et al., 1999). In reproductive individuals, the cheek is not plain white but gold and grey with white circular spots and with a pearly white line below the eye. Cheek patterning may be stronger in males than in females.

Juveniles. Quite different from adults. The body is dark orange-yellow with faint white vertical bars; fins yellow; dorsal fins with white transverse bands; cheeks black below the eye, contrasting with white lips tinted yellow above the corner of the mouth; black blotch at the upper base of pectoral fins. Some characteristic criteria present in adults already visible in juveniles, such as the white marginal band bordering the first dorsal fin, the brown first ray of the first dorsal fin with only two white spots in the basal half, and the ventral third of the caudal fin plain-coloured contrasting with the dotted dorsal two-thirds. Immature individuals resemble adults but have white cheeks (not golden with white spots) and browner (less vivid orange) markings.

Geographic variation. Unknown.

- **Similar species**

Some Steven's gobies can strongly resemble **Roule's goby** (*G. roulei*), as both species share a reddish patterning, an elongate dark pectoral patch, white lips, plain coloured inter-blotch spaces along the lateral midline and plain coloured lower body parts. However, Roule's lacks both the well-defined V-shaped snout line and the paravertebral stripe of Steven's. Moreover, dorsal fins are banded horizontally (vs. spotted in adult Steven's; the fin is banded in juvenile Steven's but contrary to Roule's, it has a white marginal band), the ventral third of the caudal fin is marked with brown dots (vs. plain-coloured in Steven's), and the first dorsal fin is long and pointed in reproductive males.

Adult Steven's can be very similar to red-coloured juveniles of **Slender goby** (*G. geniporus*), which typically appear red coloured below 20 m depth. Evaluating size can be very helpful to separate both species: while Steven's-like Slender should be 3-4 cm long, at this size true Steven's are also juveniles and thus they should have a colouration quite different from that of adults. In addition, juveniles of Slender can be identified by their longer snout with a more attenuated profile, transparent window in the white area of the pectoral fin (vs. transparent window absent in Steven's), and the different colouration of the first spinous ray of the first dorsal fin (dominantly dark with two white stripes in its basal half in Steven's, the opposite in Slender). Moreover, Slender has only two red rectangles (or dashes) bordering the ventral side of the oculoscapular line, with the foremost rectangle missing; rarely this rectangle is present but then it is limited to a simple dot (vs. three red dashes bordering the lower edge of the oculoscapular line, but the foremost dash is as long as the other two in Steven's).

Another potential pitfall is **Couch's goby** (*G. couchi*), but this species is slightly smaller, overall colouration is brown or olive (*vs.* brick red in Steven's) with a reticulated pattern on the back (*vs.* broad blotches on the back), it has no well-defined dorsolateral stripe, has a dark spot at the corner of the mouth followed by two short horizontal lines on the ventral edge of the cheek, below the eye (*vs.* plain white or with irregular dark markings in Steven's), a white boormerang-shaped marking on the cheek below the eye (*vs.* plain white cheek or with a long oblique pearly white line below the eye in Steven's), it never shows circular white spots on the cheeks, the preopercle and the dorsal fins, in reproductive males the first dorsal fin has deeply lunate interradial spaces, the body below midline is flecked and mottled gold (*vs.* plain whitish in Steven), and the dark patch on the upper part of the pectoral base is broader than longer (the opposite in Steven's) and has a pale posterior border (*vs.* no or very faint pale border). Last, Couch's has fewer pectoral fin rays (15-18 vs. 18-22 in Steven's), which can be appreciated only on close-up photographs.

Incognito goby (*G. incognitus*) occasionally has red markings, but it has a longer snout giving the impression of a shallower head profile; head patterning is different with dots on the cheek below the eye, a dot at the corner of the mouth followed be two short, dark horizontal lines along the ventral border of the cheek (vs. plain coloured cheeks or a dark diffuse pattern without well-defined dots or short lines in Steven's). Moreover, Incognito's goby's dorsal fins have dark markings (homogeneous orange with white spots in Steven's) and body lower parts are dotted brown (plain in Steven's).

See also the species account of **Kestrel goby** (*G. xoriguer*).

• Distribution & Status

Steven's goby is known from the Atlantic coast of Scotland, Ireland, England, France, Spain and Portugal, from Madeira and the Canary Islands, in the English Channel to Belgium eastward, as well as the in Western Mediterranean Sea in the Alboran and Balearic Islands (Ahnelt & Dorda, 2003), in the Gulf of Genoa in Italy (Ahnelt et al., 2011), and in Malta (Kovačić & Schembri, 2019). The easternmost record for the species is a juvenile from Porto Badisco (Italy) in the Ionian Sea, a few kilometers south of the Ionian-Adriatic limit (see photo below).

In *France*, most records come from surveys with scientific vessels equipped with a bottom trawl: one specimen in the bay of Biscay, 20 km off Les Sables-d'Olonne (85) in Oct 2013 (preserved at the MNHN collection, possibly the first record for France), and 14 specimens in the English Channel within the French territory, between La Pointe du Cotentin and Boulogne-sur-Mer (notably in Les Ridens, 62, where the species seems relatively common), in January and October 2017 (Iglésias *et al*., 2019). In the area of Boulogne-sur-Mer, the BioObs database also indicates several observations in various sites. In Brittany, one adult was photographed in Ploumanac'h, Perros-Guirec (22; Muriel Duhau; Fish Watch Forum), juveniles were caught in the Bay of Morlaix (29; Samuel Iglésias), and several photographic observations were made in the Gulf (Rade) of Brest (29; DORIS) and Groix Island (56; Véronique Lamare; DORIS). As for the French Mediterranean coast, the species is known from the Bay of Agay in St Raphaël (83, Muriel Duhau; Fish Watch Forum), and from Marseille (13; Sylvain Le Bris, unpublished photos taken in Nov 2021). There are non-documented (i.e. no photography, no specimen collected) records from Corsica and the Cap d'Antibes (BioObs).

• Habitat

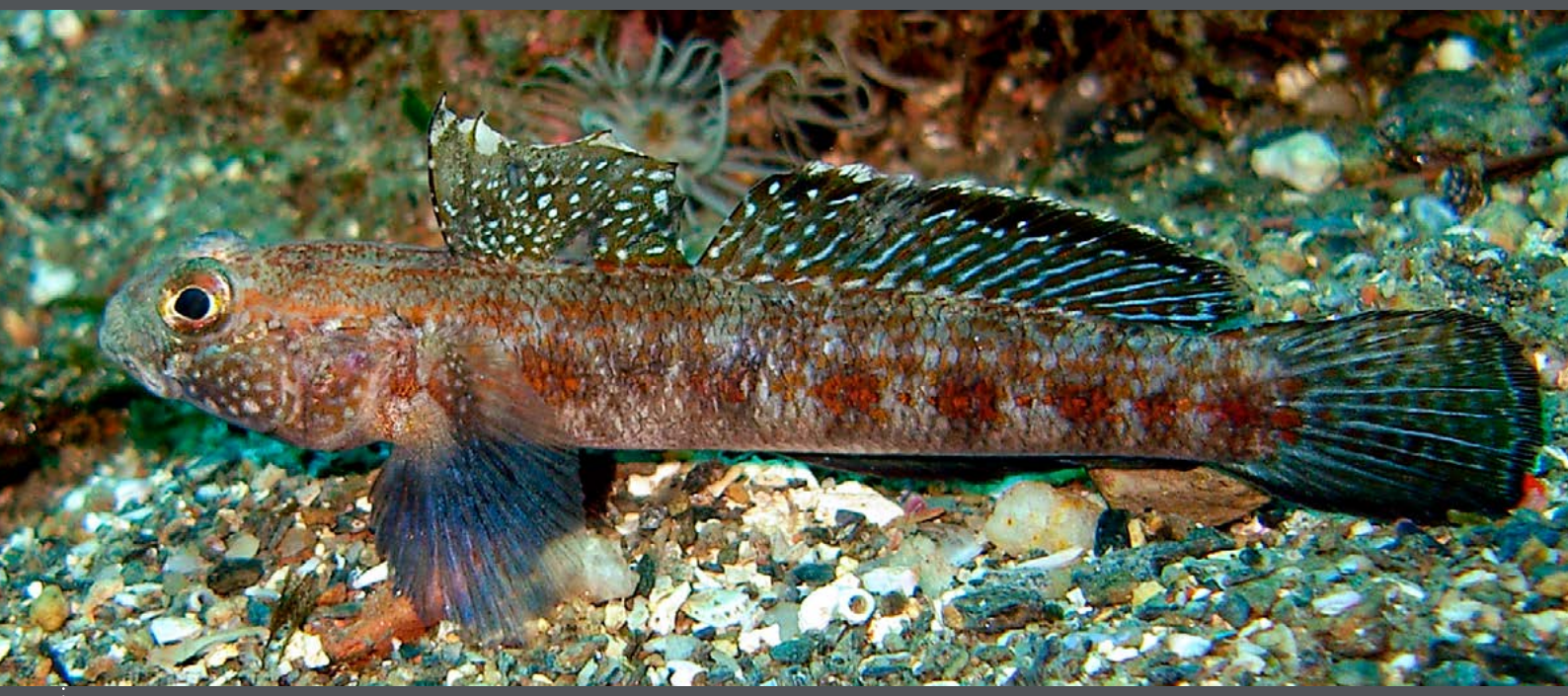
The depth distribution of Steven's goby varies strongly depending on local conditions. Specimens from the 2017 survey in the English Channel were caught between 26 m and 65 m depth (Iglésias et al., 2019). The observation from Perros-Guirec (22, France) was made in relatively shallow waters (8 m depth; yet the observer made a single observation in several dozen dives at this site). The juveniles from the Bay of Morlaix were collected between 3.5 and 5.1 m depth. Most records around Brest (29, France) were made around 20 m depth and at the Groix Island (56, France), the specimen was photographed at 31 m. In continental Spain, Alberto et al. (1999) surveyed three sites: Steven's gobies were found at depths of 12-30 m, 10-20 m and 5-10 m in the first, second and third site, respectively. Close to the strait of Gibraltar, individuals were caught at depths between 55-75 m, but recently it was photographed along the shore, in shallow waters (Manuel Martínez Chacón, iNaturalist, see photo below). Further east in the Mediterranean, fish were collected at 70-120 m and 77 m depth in the Gulf of Genoa and in Malta, respectively; however, the juvenile from the Ionian-Adriatic limit was photographed at only 10 m depth.

Steven's goby lives on soft bottoms with mud, sand, silt, shell or small-stone deposits. The juveniles from the Bay of Morlaix were found on maerl bed. In the Spanish sites surveyed by Alberto et al. (1999), the species was found in large numbers among mussels on trays and was mostly absent from areas without mussel cultures. The authors suggested that, in that region, the occurrence of Steven's goby is largely determined by the availability of its main food, the small crab *Pisidia longicornis*.

Steven's goby

Gobius gasteveni Miller, 1974

Steven's goby (*G. gasteveni*), ad. A typical individual with a pinkish ground colouration, gold sheen on the back, plain-coloured lower parts of the body and the head, a brick red paravertebral stripe most visible on the nape, 9-10 midlateral blotches, a V-shaped line on the snout, white lips, and a continuous oculoscapular line darker than the dorsolateral stripe but concolourous with the midlateral blotches. Note also the red mark at the base of the caudal fin and the small red dash dorsal to this mark, and the three red dashes bordering the lower edge of the oculoscapular line. *25 Jul 2015, Ploumanac'h, Perros-Guirec (22, France), Muriel Duhau (Fish Watch Forum).*



Steven's goby (*G. gasteveni*), ad ♂. Adult male showing all diagnostic characters (detailed in next photo), but with a particularly dark overall colouration. *02 Apr 2007, Almuñécar (Spain), Luis Sánchez Tocino. Photo flipped horizontally.*

Steven's goby

Gobius gasteveni Miller, 1974

Steven's goby (*G. gasteveni*), ad ♂. Here, the paravertebral stripe and the V-shaped snout line are replaced by a reticulated pattern. Yet, the species is readily identified by its golden-grey cheek with many white circular spots and a pearly white oblique line below the eye, the largely white lips, the orange dorsal fin spotted white, the plain white lower parts on the body, and the unmarked ventral third of the caudal fin. Note also the three bright red rectangles just below the oculoscapular line (a feature characteristic of Steven's goby), as well as the orange spot at the posteroventral border of the eye (a feature shared with several other species, notably Roule's goby). The pectoral fin is mostly hyaline with, ventrally, a whitish basal patch radiating onto the lower and median rays and, dorsally, a dark mark longer than broader. *06 Mar 2017, Algeciras (Spain), Manuel Martínez Chacón (iNaturalist). Photo flipped horizontally.*

Steven's goby (*G. gasteveni*), ad ♂. In this picture it is possible to appreciate the beautiful and characteristic patterning of the first dorsal fin, with white freckling and a white marginal band. This individual has at least 20 pectoral fin rays, which matches the mean value in that species. *06 Jun 2010, Sesimbra (Portugal), João Pedro Silva. Photo flipped horizontally.*

Steven's goby

Gobius gasteveni Miller, 1974

Steven's goby (*G. gasteveni*), ad type ♀ (top); **Roule's goby** (*G. roulei*), ad ♀ (bottom). Steven's and Roule's both have white lips and plain-coloured ventral and lower lateral sides (contrary to, for example, Black goby, *G. niger*), but they have different colouration of the cheeks (gold with white circular spots in Steven's *vs*. plain white in Roule's with just a whiter suborbital bar), colouration and patterning of the first dorsal fin (spotted with a white marginal band vs. dark basal transverse bands) and snout patterning (M-shaped line in Steven's only, though it is not well visible here). Note also the contrast between the stripped dorsal two-thirds of the caudal fin and the unmarked ventral third, typical of Steven's goby (in Roule's, the ventral third of the caudal fin is marked). This Steven's goby is tentatively sexed as a female based on its swollen belly. The upper lateral stripe between the midlateral and the dorsolateral stripes is not frequent. *12 May 2016, Duc d'Albe, Brest (29), Benjamin Guichard; 25 Jun 2019, Sithonia (Greece), Roberto Pillon. Top photo flipped horizontally.*

Steven's goby

Gobius gasteveni Miller, 1974

Steven's goby (*G. gasteveni*), juv (top) ; **Slender gobies** (*G. geniporus*), juv (center and bottom). Juveniles of these two species can be very similar. In Steven's, note the gold sheen of the back (vs. pearly white in Slender, but never gold), the short snout (longer in Slender), the faint vertical stripe in the upper half of the eyeball (vs. vertical stripe as conspicuous as the horizontal stripes), the first dorsal fin with a white marginal band (absent in Slender) and a dominantly brown first ray with only two white basal spots (vs. ray white with two or three brown spots in Slender), the three red dashes bordering the ventral edge of the oculoscapular line, and paravertebral stripes most visible on the nape. In both species the ventral third of the caudal fin is unpatterned. *18 Sep 2013, Sesimbra (Portugal), João Pedro Silva; 16 Jun 2016, Sardegna (Italy), Roberto Pillon; 11 Sep 2010, Tuscany (Italy), Stefano Guerrieri. All photos flipped horizontally.*

Steven's goby

Gobius gasteveni Miller, 1974

Steven's goby (*G. gasteveni*), juv. Here, the shape of the oculoscapular line with three broadened dashes, the white marginal band of the two dorsal fins, the colouration and patterning of the first ray of the first dorsal fin, the unmarked ventral third of the caudal fin and the gold cheek colouration, all point towards Steven's goby. Crucially, this individual has 22 pectoral fin rays (counted with a magnifying lens), which excludes both Couch's goby (max: 18) and Black goby (max: 20). Maerl bed (the pink calcareous algae visible here) seems particularly attractive to juveniles of that species. In many species, individuals inhabiting maerl bed tend to have an unusual colouration and patterning, but the picture from Italy below suggests that this colouration is not specific to maerl. *30 Aug 2019, Bay of Morlaix (29, France), Samuel Iglésias.*

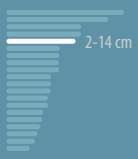
Steven's goby (*G. gasteveni*), juv. This picture illustrates the easternmost record of the species: a young individual with an estimated size of approx. 5 cm, found on large debris of seashell at 10 m depth. The diagnostic criteria are (in order of importance): the white marginal band to dorsal fins, a well-marked oculoscapular line bordered ventrally by three orange dashes not touching that line, red paravertebral stripes visible on the predorsal area, the ventral half of the caudal fin unmarked, the yellow colouration on the back and on the head, and a V-shaped snout line. Note how the white bands on dorsal fins start to disintegrate into flecks. The number of pectoral fin rays (19 visible here) is within the expected range for Steven's, but it fits several other species too. However, another picture of the same individual shows that none of these rays are free from the membrane, which is a unique feature among *Gobius* species. The circular inset (top left) shows a close-up of the anterior nostril: the thin tentacle on the upper rim fits Steven's goby perfectly; this appendage is a lappet or large tentacle in either Roule's or Slender gobies. *08 Jun 2011, Porto Badisco, Lecce (Italy), Stefano Guerrieri. Photo flipped horizontally.*

Slender goby

Gobius geniporus Valenciennes, 1837

Gobie svelte (*Fr*)
Schlankgrundel (*Ge*)
Gobio galano (*Sp*)
Ghiozzo geniporo (*It*)

Large • snout moderately long • whitish body with beige to pale brown mottling • dorsal and caudal fins with brown spots • head sensory papillae well visible • common, on sandy and gravel bottoms, usually at 2-20 m depth



• Description

Large goby about 12-14 cm long (maximum length 16 cm) with a long body and a proportionally small head with an attenuated snout profile. Body ground colouration whitish with beige to pale brown speckling and, along the lateral midline, a longitudinal series of five dark brown to black rectangular blotches alternating with smaller, paler and less rectangular brown markings. Below the lateral midline, body white with diffuse brown speckles, or with a longitudinal series of brown blotches (smaller than the midlateral blotches). Two white spots on the caudal pedoncule, at the base of the caudal fin. Eyes with three stripes: two horizontal (one each side) and one vertical in the dorsal half; ventral half of the iris plain white. These stripes can be very faint in old specimens. Eye pupil usually with vivid green sheen (more rarely blue). Snout without any distinct marking or only a very faint V-shaped line. Below the eye, the cheek is black. The extent of black is variable: in some individuals, it is limited to two horizontal dashes along the ventral edge of the cheek, while in others, it consists of two broad vertical bars connecting the eye to the ventral border of the cheek. A white suborbital bar borders the black patch anteriorly. No clear oculoscapular line; when present the oculoscapular line is limited to three indistinct, disconnected horizontal dashes. Dorsal fins strongly patterned with large brown to reddish spots sometimes coalescing to form horizontal bands (more often in the first dorsal fin). Dorsal fins terminated by a white horizontal band. First rays of both dorsal fins striped brown and white, the white stripes being the largest (especially in younger individuals). Anterior edge of dorsal fins with two (rarely three) dark brown to black spots starting on the first ray and spilling over the first interradial membrane. The tips of first dorsal fin rays appear to extend beyond the membrane; this is an illusion due to these rays being black-tipped and the membrane transparent where it inserts on ray tips. Patterning of the caudal fin partly similar to that of the second dorsal fin, with large circular brown to reddish spots in the dorsal two-thirds, but plain pearly white in the ventral third. Caudal fin without white marginal band. Anal and pelvic fins pearly white, sometimes with a blue or violet sheen. Upper pectoral free rays short and moderately developed. Pectoral rays transparent or brown (in older individuals), dotted white. Base of pectoral fins with a dark horizontal stripe. Predorsal area scaled but usually appears naked in photographs. Cheeks naked. Anterior nostril terminated by a lappet or a tentacule. Head sensory papillae (genipores) black and well visible, at the origin of the species' scientific name.

Slender goby (*Gobius geniporus*). *12 Jun 2021, Cerbère (66, France), Julien Renoult.*

Sexual dimorphism. Apparently limited but poorly known.

Juveniles. Differ from adults by a paler ground colouration, brown dots above the lateral midline more regularly aligned and more numerous, the back with many pearly white blotches, a conspicuous V-shaped snout line, outstanding eyestripes, an almost continuous oculoscapular line, and pectoral fins with a characteristic pattern made of a transparent mushroom-shaped window within a large white basal area bordered dorsally by a dark horizontal line.

Geographic variation. Unknown.

• Similar species

The most common pitfall is **Incognito goby** (*G. incognitus*) in night colouration, which can display a black patch below the eye resembling that of Slender goby. However, Incognito's patch has a different shape, originating from the first dots of the median and lower rows of dots, which are enlarged and tend to merge together (in Slender, the patch is typically made from two broad vertical bars). A careful examination of the head should reveal the original dot patterning in Incognito, as well as many other dots that are typical of that species but absent in Slender. Incognito also has a shorter snout and shorter body, and lacks the white marginal band to dorsal fins as observed in adult Slender. Some Slender gobies can be superficially similar to **Couch's gobies** (*G. couchi*), notably when the tips of dorsal rays extend beyond the membrane. However, this extension is far more pronounced in Couch's compared to Slender. Moreover, Couch's has a characteristic cheek patterning with a white boomerang-shaped marking touching the ventral border of the eye (in Slender, the white marking is limited to a preopercular bar, the ventral border of the eye being usually black), and has much smaller brown spots on the second dorsal fin and the caudal fin. Young Slender gobies can be mistaken for several other species with a light body colouration. Species with dotted lines along the body, such as **Sarato's** (*G. fallax*), **Incognito** and **Bucchich's** (*G. bucchichi*) gobies, can be told apart by their more numerous, smaller and rounder dots (vs. elongate in juvenile Slender), their indistinct head stripe (vs. a conspicuous stripe running from the snout tip to the upper base of the pectoral fin in Slender), and a poorly defined vertical eyestripe (conspicuous in Slender). **Roule's goby** (*G. roulei*) and light morphs of **Black goby** (*G. niger*) are distinguished by their shorter and steeper snout, the presence of one black preorbital bar anteriorly to the white suborbital bar (vs. only one white suborbital bar in Slender) and by different patterns on dorsal and caudal fins. Adult **Steven's goby** (*G. gasteveni*) can be very similar to juveniles of Slender (which typically appear red coloured below 20 m depth). Evaluating size can be very helpful to disentangle the two species: while Steven's-like Slender should be 3-4 cm long, at this size true Steven are juveniles and thus have a colouration very different from that of adults. In addition, Steven's can be identified by its steeper snout profile, the lack of a transparent window in the white basal patch of pectoral fins, and the different colouration of the first ray of the first dorsal fin (dominantly dark with two white stripes in its basal half in Steven's goby; the opposite in Slender goby). Steven's goby has three red horizontal dashes bordering the lower edge of the oculoscapular line, but the foremost dash is as long as the other two; in Slender goby, the foremost dash is either missing, or limited to a simple dot. Last, young Slender gobies can resemble **Kolombatović's goby** (*G. kolombatovici*); notably, both species have well visible oculoscapular and V-shaped snout lines, and horizontal and upper vertical eyestripes. However, kolombatović's has is coloured orange (vs brick red in Slender), the back is patterned with a dorsolateral series of orange rectangles (vs. reticulated or, when a dorsolateral row of dots occurs, these dots never form distinct rectangles), the predorsal area is marked with conspicuous paravertebral stripes (vs. dark markings on the nape limited to pigmented sensory papillae), and the suborbital bar extends horizontally under the eye (not the case in the Slender). See also the species account of **Kestrel goby** (*G. xoriguer*).

• Distribution & Status

Slender goby lives only in the Mediterranean including the Sea of Marmara. The westernmost records are from around Granada in Spain (Luis Sánchez Tocino, https://litoraldegranada.ugr.es). Along the African coast, Slender goby is known from Tunisia and Algeria.

In *France*, Slender goby is common in every suitable habitat all along the Mediterranean coast of mainland and Corsica.

• Habitat

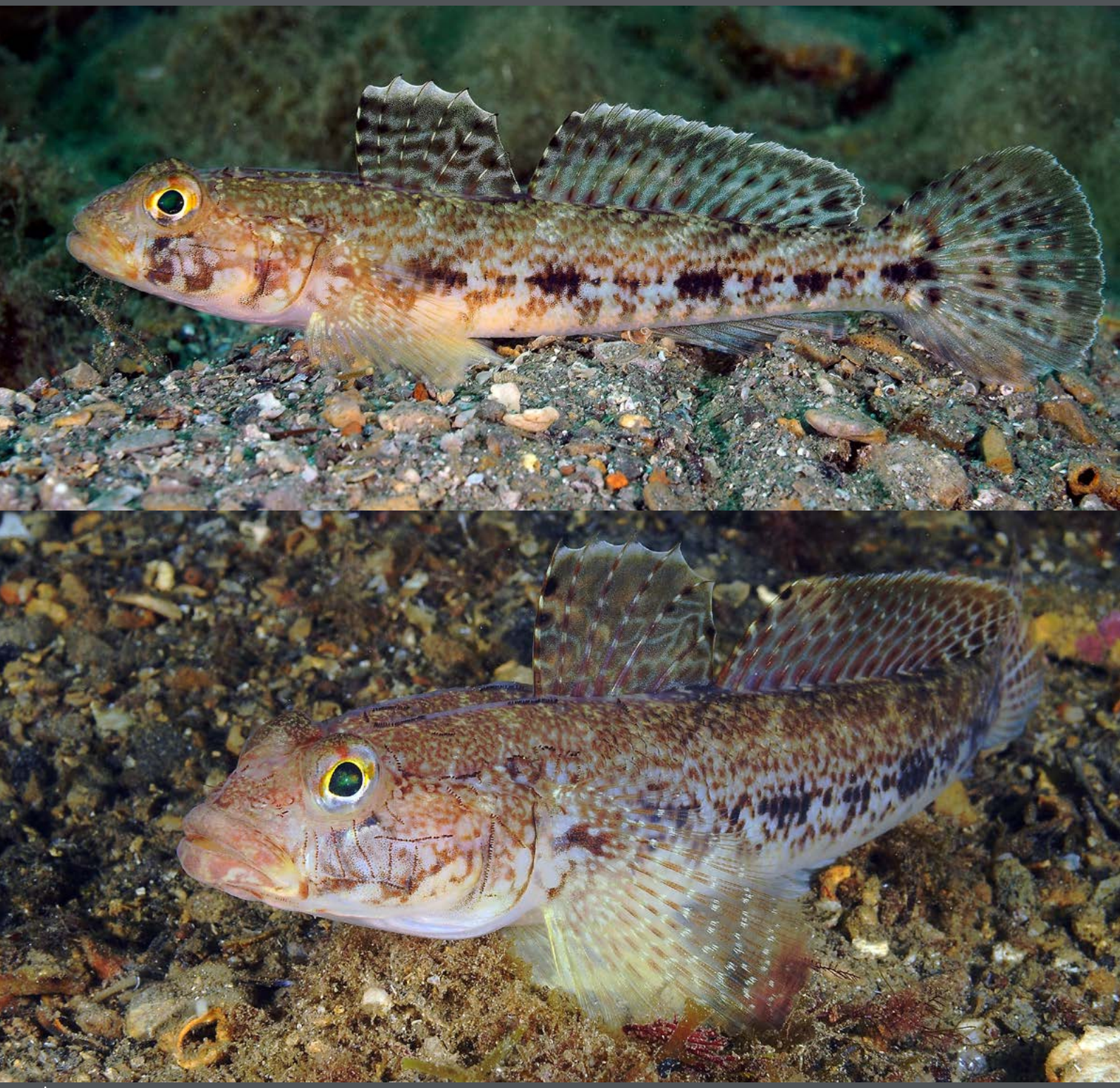
Slender goby can be observed at depths from 1 m to 40 m. It is mainly seen on sandy or gravel bottoms nearby rock beds of seagrass. Young individuals are often found exposed in large sandy areas, whereas adults stay close to shelters.

• Miscellaneous

☝ The juvenile stage of the Slender goby was erroneously described as a separate species, *Gobius arenae* (Bath, 1972).

Slender goby

Gobius geniporus Valenciennes, 1837



Slender gobies (*G. geniporus*), ad. Typical individuals with an elongate body and attenuated snout profile, beige ground colouration with brown speckling on back, dark blotches along the lateral midline, a large and irregular dark patch below the eye, and well-visible black sensory papillae on the head. Note also the two dark spots at the front edge of the first dorsal fin, white-tipped and strongly patterned dorsal and caudal fins, and the horizontal dark blotch at the base of pectoral fins. *29 May 2017, Rijeka (Croatia), Stefano Guerrieri; 01 Oct 2017, Rijeka (Croatia), Stefano Guerrieri. Bottom photo flipped horizontally.*

Slender goby

Gobius geniporus Valenciennes, 1837

Slender goby (*G. geniporus*), im. A pale individual with poorly defined midlateral blotches and a subdued dark blotch below the eye. Yet, the first dorsal fin alone identifies it as Slender, showing a unique combination of white marginal band, black spots at the front edge and ray tips extending beyond the membrane (an effect visually reinforced by the transparent colouration of the membrane distally). The overall elongate structure and transparent window within the white area of the pectoral fin are additional distinctive characters. *21 Sep 2012, Minorca (Spain), Roberto Pillon.*

Slender goby (*G. geniporus*), im. At night, the dark patch below the eye is well-visible and often made of two broad vertical bars. This individual is easily identified as Slender goby by its long snout, broad midlateral blotches, black spots on the front edge of the dorsal fins, ray tips extending beyond the membrane in the first dorsal fin, and its characteristic patterning on the pectoral fin (see details in previous caption). *05 Sep 2015, Rosas (Spain), Thomas Menut. Photo flipped horizontally.*

Slender goby

Gobius geniporus Valenciennes, 1837

Slender gobies (*G. geniporus*), juvs. Juveniles are usually readily identified by their attenuated snout profile, outstanding V-shaped line on snout, well-defined horizontal eyestripe and vertical bar in the upper half of the orbit, an almost continuous oculoscapular line, and a characteristic pectoral patterning with a transparent mushroom-shaped window within a large white area bordered dorsally by a dark horizontal line. Note also the already visible black spots on an otherwise white-coloured spinous ray at the first dorsal fin. Some individuals, especially the youngest, have diagnostic black, broad and rectangular blotches along the lateral midline. *30 Jun 2004, Tuscany (Italy), Stefano Guerrieri; 24 Jun 2016, Algajo, 2B (Corsica), Thomas Menut; 18 Sep 2016, Tuscany (Italy), Stefano Guerrieri. Top photo flipped horizontally.*

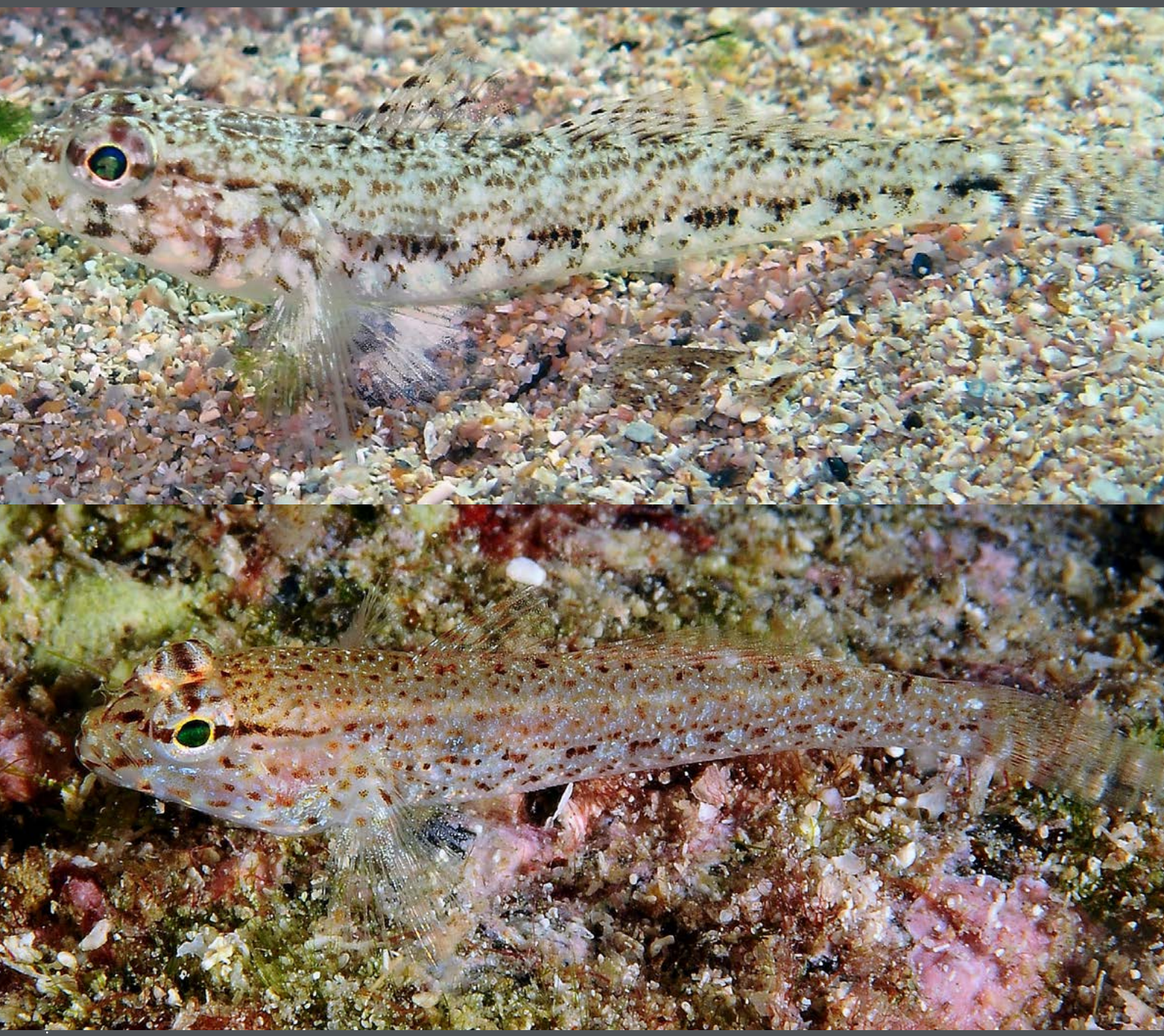
Slender goby

Gobius geniporus Valenciennes, 1837

Slender goby (*G. geniporus*), ad. (top); **Incognito goby** (*G. incognitus*), ad probably ♂ (bottom). Two individuals in night colouration. Top individual has rows of dots on the back that can cause confusion with Incognito goby. Though, it can be identified as Slender by the white marginal bands and black anterior spots on dorsal fins, and the well-visible rows of sensory papillae on the head. Bottom individual has a dark patch below the eye similar to that of Slender; however, a careful examination of the head reveals many dots including three horizontal rows of dots below the eye that are characteristic of Incognito goby (those dots are blacker and broader than in day colouration). The body is further covered with many orange dots under the black mottling. *06 Oct 2017, Rijeka (Croatia), Stefano Guerrieri; 09 Jan 2009, Tuscany (Italy), Stefano Guerrieri. Top photo flipped horizontally.*

Slender goby

Gobius geniporus Valenciennes, 1837



Slender goby (*G. geniporus*), juv; **Incognito goby** (*G. incognitus*), juv. Even in day colouration, juvenile Slender gobies can be very similar to Incognito gobies. The identification is based on the following characters. 1) Head pattern: Slender has fewer, bigger and longer dots and lacks the three rows of dots on the posterior cheek that is typical of Incognito; the oculoscapular line is better defined, Incognito but not Slender has a dot at the corner of the mouth. 2) Body pattern: Slender has larger, darker and more densely distributed dots. 3) Pectoral pattern: Slender has a white area surrounding a transparent window and a dark horizontal mark. 4) First dorsal fin: Slender has clearly visible black spots at the front edge. *09 Sep 2012, Minorca (Spain), Roberto Pillon; 22 Sep 2016, Tuscany (Italy), Stefano Guerrieri. Bottom photo flipped horizontally.*

Slender goby

Gobius geniporus Valenciennes, 1837

Slender goby (*G. geniporus*), ad ♂ (top); **Couch's goby** (*G. couchi*), ad ♂ (bottom). Top individual has upperparts finely speckled brown, as typically observed in Couch's. Moreover, Slender often has ray tips extending beyond the membrane in the first dorsal fin, a feature shared only with Couch's goby in the considered region. However, the free dorsal rays remain less developed compared to in Couch's goby, the cheek area below the eye is entirely dark (*vs*. with a white bar in Couch's), there is no distinct mark along the ventral border of the cheek (*vs*. a dark dot at the corner of the mouth followed by two horizontal lines), and the dorsal and caudal fins are strongly patterned with large dark spots (vs. only faint bars in the basal half). All these features, in addition to the long, attenuated snout profile, identify the top individual as a Slender goby. *11 Aug 2016, Torkul (Croatia), Thomas Menut; 21 May 2018, Rab (Croatia), Roberto Pillon. Bottom photo flipped horizontally.*

Slender goby

Gobius geniporus Valenciennes, 1837

Slender goby (*G. geniporus*), im (top); **Roule's goby** (*G. roulei*), ad (bottom). Both individuals were photographed at night. Compared to Roule's, Slender has a longer and more attenuated snout profile, conspicuous black spots at the front edge of the first dorsal fin, larger and browner spots on the dorsal and caudal fins, and it lacks a dark preorbital bar (Slender only has a white suborbital bar). *29 Mar 2015, Lido (06, France), Thomas Menut; 12 Jun 2017, Rijeka (Croatia), Stefano Guerrieri.*

Slender goby

Gobius geniporus Valenciennes, 1837

Slender goby (*G. geniporus*), im (top); **Roule's goby** (*G. roulei*), im (bottom). Roule's is distinguished by shorter and steeper snout and a different oculoscapular line made of two parts: one short, broad and generally light orange dash just posterior to the eye, followed by a thinner and darker brown line reaching the base of the pectoral fin. *30 Jun 2004, Tuscany (Italy), Stefano Guerrieri; 26 Oct 2019, St-Raphael (83 France), Lucas Berenger. First photo flipped horizontally.*

Slender goby

Gobius geniporus Valenciennes, 1837

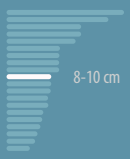
Slender goby (*G. geniporus*), im (top); **Steven's goby** (*G. gasteveni*), ad (bottom). Juvenile Slender can be very similar to adult Steven's, but it is much smaller, has a more attenuated snout profile, a transparent window in the white area of the pectoral fin, a V-shaped snout line (vs. M-shaped in Steven's), a well-defined vertical eye stripe (vs. faint in Steven's), and a white spinous ray of the first dorsal fin with two dark stripes extending onto the membrane (vs. spinous ray dominantly dark with white stripes). *27 Jul 2007, Tuscany (Italy), Stefano Guerrieri; 25 Aug 2018, Plougastel (29, France), Benjamin Guichard.*

Incognito goby

Gobius incognitus Kovačić & Šanda, 2016

Gobie mystère (*Fr*)
Anemonen-Grundel (*Ge*)
NA(*Sp*)
Ghiozzo incognito (*It*)

Medium-sized • whitish body with many brown dots • one dot on the rear corner of the mouth • V-shaped marking on the snout • one vertical stripe in the dorsal half of the orbit • three longitudinal rows of dots on the cheek • common to locally very common, in rocky or mixed habitats, usually at 0.5-5 m depth



• Description

Medium sized goby of 8-10 cm, with a moderately elongate body, large head, short, slightly tipped and oblique snout. Background colouration homogeneously greenish grey to pale grey or brown (varies with the substrate), sometimes with brownish or light purplish shades. Back often darker with light saddles (more visible in dark individuals). Head and body patterned with longitudinal lines of brown dots. The dots are broadest, darkest and most numerous along the lateral midline; they are organised in well-aligned dashes or blotches separated by white spaces. This dashed lateral midline runs from the base of the pectoral fin to the base of the caudal fin. The second most distinct dots are aligned dorsolaterally; they are usually concolourous with the midlateral dots but are much sparser and form a loosely defined line. Elsewhere on the body and the nape, dots are numerous but lighter brown, fainter, and irregularly aligned. Eye diameter 1.08-1.32 in snout length (Kovačić & Šanda, 2016). Eyes with a conspicuous horizontal stripe, a vertical bar often with small additional brown dots in the upper half, and no or only 1 or 2 dots in the lower half. Snout with a brown V-shaped line that usually does not touch the orbit: it is separated from the eyes by one isolated dot on each side. Below the V-shaped line, a preorbital bar connects the upper lip to the eye. In its anteroventral end, the preorbital bar extends onto both the upper and lower lips. In its posterodorsal end, the bar fades away well before the orbit (thus it never touches the eye). The preorbital bar corresponds to the first section of what is hereafter named the "upper row" of dots on the cheek (there are three rows in total). The second section of this upper row starts from the posteroventral edge of the eye and forms a midopercular horizontal line of dots, running rearwards on upper cheek, preopercle and opercle until reaching the base of the pectoral fin (at the same level as the lateral midline located posterior to that fin). The lower row of dots begins with an isolated dot at the corner of the mouth, usually followed by two short horizontal dashes. These dashes border the cheek ventrally, below the eye. The lower row continues slightly further up (thus parallel to the upper row of dots) with one more dash on the posterior border of the cheek. The third, median row, more or less regularly crosses the center of the cheek between the upper and the lower row; it is parallel to the lower row. Last, the horizontal eyestripe is prolonged posteriorly by an oculoscapular line, continuous on the cheek, dotted or dashed on the peopercle and opercle. Dorsal fins mostly transparent with a few dark dots aligned longitudinally. First (spinous) ray of both dorsal fins with dark and white transverse markings. Caudal fin rounded in shape, transparent with dark reddish-brown dots more or less aligned transversally. Anal fin transparent or whitish, plain-coloured or with a basal longitudinal row of brown dots (especially in males). Pelvic disk pearly white. Pectoral blotch usually limited to a thickened brown dash. Pectoral free rays moderately developed. Nape and predorsal area covered with small scales. Anterior nostrils tubular and terminated by a triangular lappet, or a tentacle.

Incognito goby (*Gobius incognitus*). *13 Jun 2021, Corfu (Greece), Roberto Pillon. Photo flipped horizontally.*

Night colouration. At night, the ground colouration turns dark brown with light saddles on the back and irregular white blotches along the lateral midline, on the lower body sides and on the head. The characteristic dot pattern remains visible, but the cheeks often become darker with the first dots of the median and the lower rows sometimes merging into a large dark spot. The pectoral blotch is broad, dark brown, sometimes royal blue.

Sexual dimorphism. Reproductive males are distinctly larger than females, have a broader pectoral dash sometimes forming a black spot, and the dorsal fins are taller and more vividly coloured. The first dorsal fin can be bordered by a white marginal band. Territorial males often display a less contrasting pattern, possibly with shades of purple or caramel.

Juveniles. Similar to adults but with proportionally bigger eyes. The first dot of the lower row, at the corner of the mouth, can be elongated.

Geographic variation. Unknown.

- **Similar species**

Among the different 'spotted' gobies of the region, **Buccchich's goby** (*G. bucchichi*) is the most similar species. To exclude Bucchich's, it is critical to carefully examine the pattern of the head, in particular three main characters. (1) Bucchich's has two longitudinal rows of dots on the cheek, with the median row missing (*vs*. three in Incognito, with a median row present). In Bucchich's, there is therefore a large unmarked area in the center of the cheek, below the eye, while this area is dotted in Incognito. However, be aware that, rarely, some Bucchich's may show a few dots in the center of the cheek. When these median dots are present, three additional characters should be checked: (1a) in these atypical Bucchich's, the median row of dots is limited to the anterior part of the cheek (*vs*. extends posterior to the eye level in Incognito); (1b) dots of the median row are very close to each other, and the median and lower rows are not parallel (*vs*. dots have irregular spacing and shape and the median row runs parallel to the lower row); (1c) the oblique preorbital bar (= first section of the upper row) is well-marked and reaches the orbit (*vs*. this bar is faint and stops well before the anteroventral border of the orbit). (2) The lower row of dots, which runs along the ventral edge of the cheek, starts with two horizontal dashes beginning shortly after the corner of the mouth in Bucchich's; these dashes are not preceded by a dot (*vs*. this row starts with an isolated dot at the corner of the mouth). (3) A dorsal, irregular longitudinal dark marking runs along the upper margin of the orbital rim (vs. the dorsal half of the eye does not have any horizontal line). (4) In Bucchich's, the snout is patterned with a M-shaped line, while it is a V-shaped line in Incognito. More precisely, the two vertical legs of Bucchich's 'M' correspond to frontwards extensions of the isolated dots separating the 'V' from the eyes in Incognito. In addition to these three primary characters, five secondary characters can help confirm the identification: (5) along the lateral midline, dots remain separated and generally form a continuous lateral midline with about no blank spaces (vs. dots often agglomerate to form dark blotches separated by blank spaces in Incognito), (6) ground colouration of the body is pale yellowish (vs. light greenish grey); (7) upper lip are sometimes yellowish (vs. of same colour as the rest of the head); (8) Bucchich's has relatively bigger eyes: eye diameter 0.82–1.04 in snout length (vs. smaller eyes in Incognito: eye diameter 1.08-1.32 in snout length; Kovačić & Šanda, 2016); and (9), until proven otherwise, Bucchich's does not associate with the sea anemone *Anemonia viridis* (contrary to Incognito).

The second most resembling species is **Sarato's goby** (*G. fallax*). Sarato's is best separated first by its different body shape, being distinctly stouter, deeper bodied. Moreover, Sarato's usually has only two rows of dots on the cheeks, with the median raw missing. When this median row is present, it is relatively faint (vs. three rows with an always well-marked median row in Incognito). Sarato's also has numerous and tightly packed dots on the body, which form almost continuous longitudinal lines (vs. fewer dots forming more irregular lines in Incognito), the posterior part of the ventral half of the eye always has a brown dot (vs. brown dot almost never present in Incognito), some individuals have a bluish sheen on the back (bluish sheen absent in Incognito), and the snout displays a M-shaped line (vs. a V-shaped line in Incognito). Last, Sarato's has a neutral buoyancy, sometimes standing 10-30 cm above the seabed or barely touching the floor, while Incognito tends to rest on the bottom.

At night, **Yellow-headed goby** (*G. xanthocephalus*) can show marked resemblance with Incognito goby, when its yellow head and reddish dots and dashes become less obvious. However, Yellow-headed lacks the median row of dots on the cheek of Incognito. Moreover, Yellow-headed has two oblique stripes in the ventral half of the eye (ventral half of the eye unmarked or only a single dot in Incognito).

When displaying a very dark colouration (typically at night or on dark bottoms) Incognito goby may be confused with **Slender goby** (*G. geniporus*); in both species, a dark, large blotch usually appears on the cheek. Yet the dot patterning along the body, the strong tail patterning with broad, dark vertical bands (small dots in Incognito) and the different morphology (more elongate body in Slender) usually make identification relatively straightforward.

Incognito goby

Gobius incognitus Kovačić & Šanda, 2016

- **Distribution & Status**

Incognito goby is mainly a Mediterranean species. Its recent description was based on a few specimens caught in Southern France, Crete, Israel, Albania and Croatia (Kovačić & Šanda, 2016). Actually, after reexamining the numerous photos of *Gobius incognitus/bucchichi* posted on various websites (e.g., www.biodiversidadvirtual.org, www.inaturalist.org, www.fish-watch.org), we can now ascertain that Incognito goby is widespread throughout the Northern Mediterranean, and is probably common in most places. To our knowledge, the westernmost photos are from Cadiz (Spain), on the Atlantic side of the Strait of Gibraltar (www.biodiversidadvirtual.org). Along the African coast, records of Bucchich's gobies from Morocco (Bouchereau et al., 2000), Libya (Elbaraasi et al., 2019) and Egypt (Ibrahim & Soliman, 2001) likely refer to Incognito gobies. The presence of Incognito in Algeria, mentioned by Chaoui et al. (2006), was confirmed by a photograph (iNaturalist, 2020). It is currently unknown whether this species occurs in the Black Sea and in the Sea of Marmara, where it may be confused with Bucchich's goby.

In *France*, the species appears very common in suitable habitats all along the Mediterranean coast, including in Corsica.

- **Habitat**

Incognito goby can be seen at depth from 0.5 m to 12 m. It occupies a wide range of habitats, mostly on shallow and sub-horizontal floors with sand and stones or rocks. At low depths it is typically associated with the sea anemone *Anemonia viridis*.

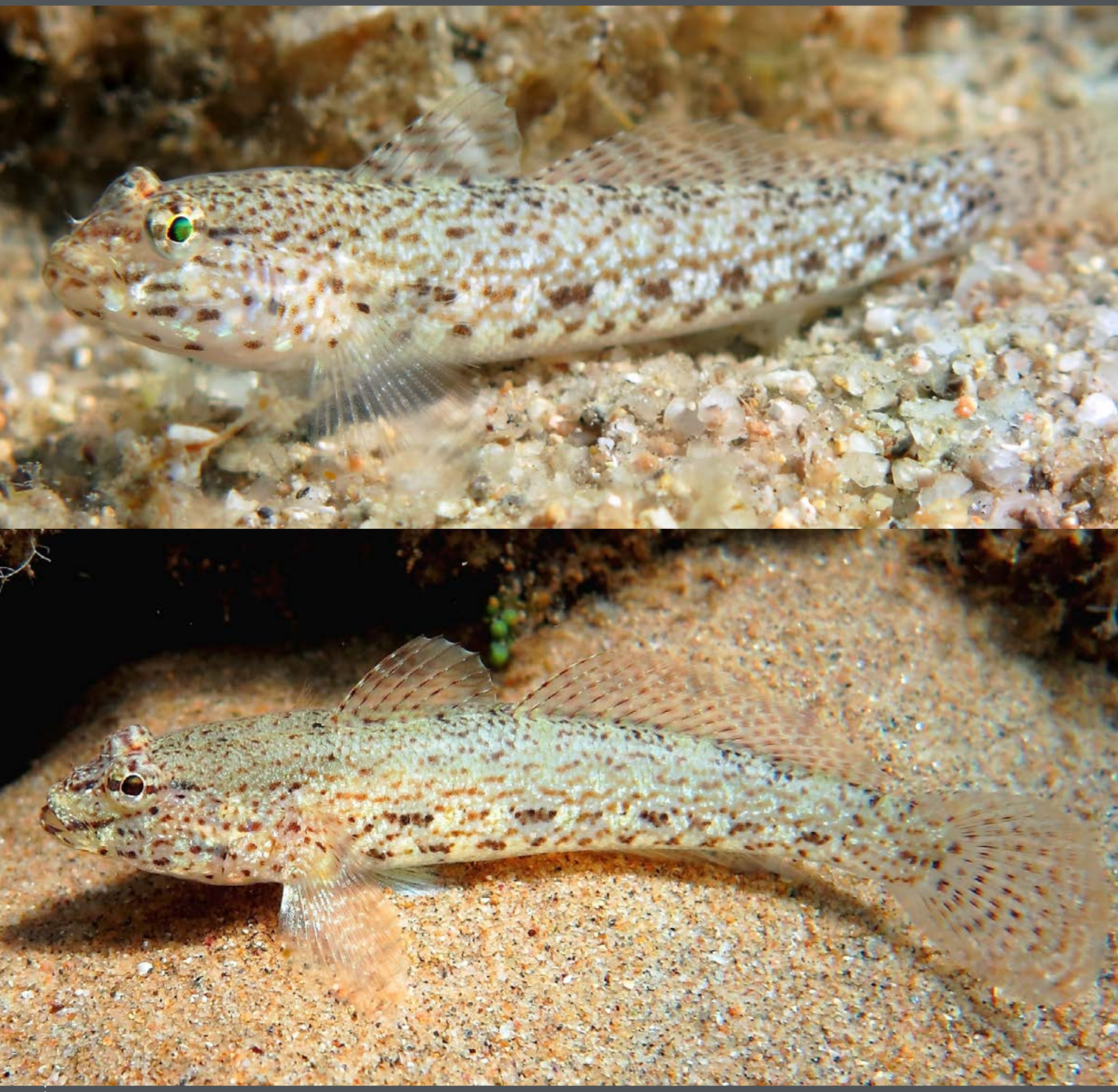
- **Miscellaneous**

☝ This species was described in 2016 following the discovery of two genetically and morphologically distinct groups within *Gobius bucchichi*. The fact that Bucchich's and Incognito gobies occur sympatrically in the Adriatic Sea (i.e., they can be found together in the same place), and that they do not seem to hybridize, is a strong evidence that Bucchich's and Incognito are valid separate species. When looking for information on the ecology of these fish, keep in mind that most of the literature on Bucchich's goby actually refers to Incognito goby.

Incognito goby (*Gobius incognitus*). ad. *22 May 2021, Cerbere (66, France), Patrick Louisy.*

Incognito goby

Gobius incognitus Kovačić & Šanda, 2016



Incognito gobies (*G. incognitus*), ad. Typical specimens with a light greenish-grey body colouration, three distinct rows of dots on the cheek, the lower row starting with an isolated dot at the corner of the mouth, the median and lower rows parallel to each other, a V-shaped snout line, no horizontal line on the upper margin of the orbit, and a lateral midline marked with darker rectangular blotches (individual dots within blotches are not clearly visible, especially in bottom individual) separated by blank spaces. *12 Sep 2016, Andros (Greece), Roberto Pillon; 22 Jun 2016, Sardinia (Italy), Roberto Pillon. Both photos flipped horizontally.*

Incognito goby

Gobius incognitus Kovačić & Šanda, 2016

Incognito gobies (*G. incognitus*), ad. Top individual has only a few and poorly aligned dots on the cheek and an atypical pattern along the lateral midline, with a thin longitudinal row of well separated dots. However, the small eyes (proportionally to snout length), the dot at the corner of the mouth, the absence of longitudinal marking along upper eye rim and the V-shaped snout line clinch the identification. The bottom specimen is even more atypical, with no distinct dots on the cheek and a messy eye pattern. But the dot at the corner of the mouth, the V-shaped line, small eyes, broad dark markings along the lateral line and light greenish-grey body colouration together help identifying it as Incognito. *12 Jul 2018, Pula (Croatia), Roberto Pillon; 28 Jun 2019, Sithonia (Greece), Roberto Pillon. Top photo flipped horizontally.*

Incognito goby

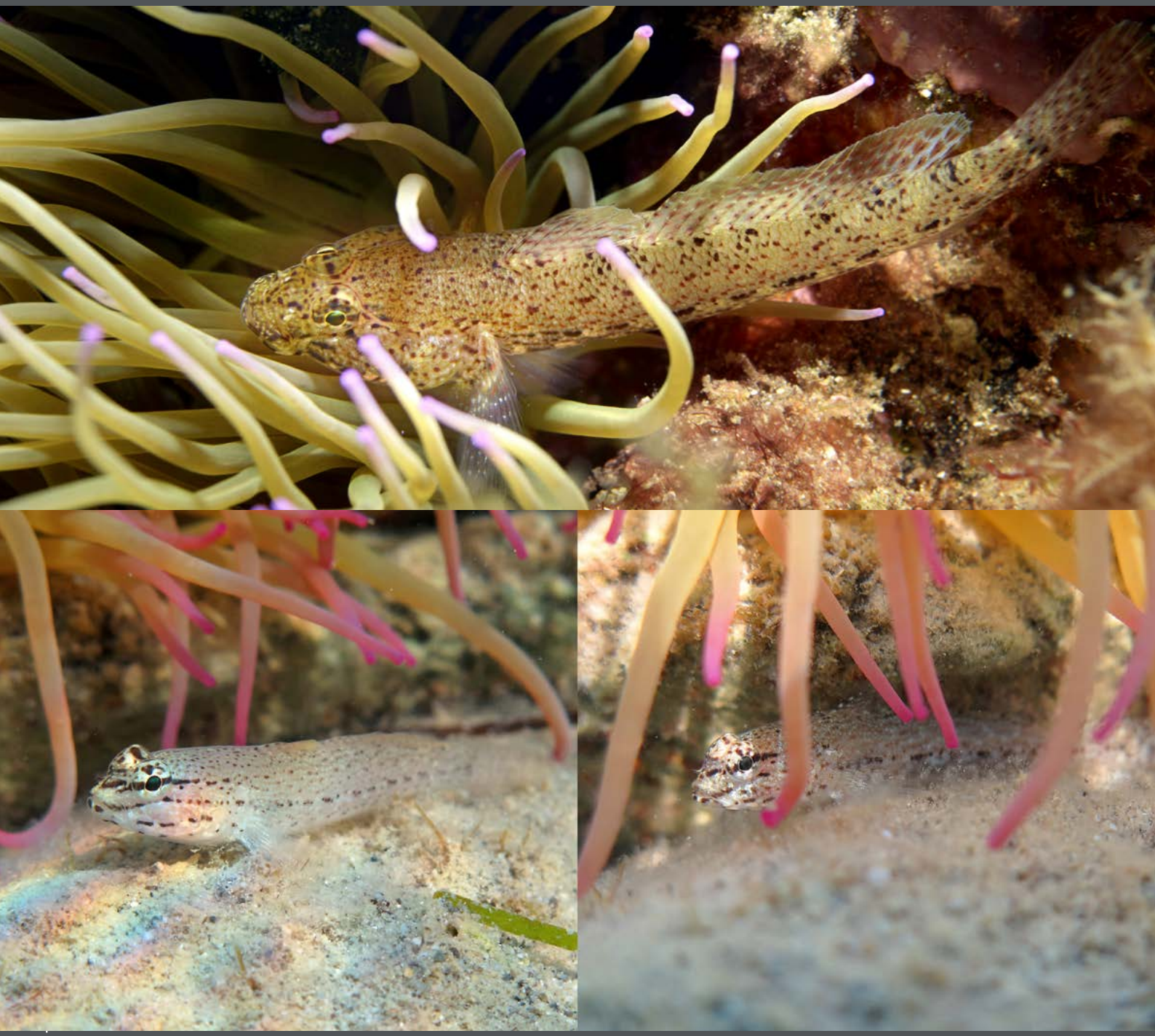
Gobius incognitus Kovačić & Šanda, 2016

Incognito goby (*G. incognitus*), ad., night colouration. Apart from the median row of dots on the cheek (obscured by the dark suborbital area), all the characteristic features of Incognito goby described previously remain visible on this individual in night colouration. *10 Aug 2019, Banyuls-sur-Mer, (66), Julien Renoult.*

Incognito goby (*G. incognitus*), ad., night colouration. *18 Sep 2020, Fontvieille (Monaco), Patrick Louisy.*

Incognito goby

Gobius incognitus Kovačić & Šanda, 2016



Incognito gobies (*G. incognitus*), ad. (top); **Incognito goby** (*G. incognitus*), im. (bottom right); **Bucchich's goby** (*G. bucchichi*), im. (bottom left). Incognito goby is known to live in association with the sea anemone *Anemonia viridis*, being able to rest safely among the stinging tentacles. The two bottom photos were taken at the same time, in the same anemone, after frightening the individuals and forcing them to escape toward the anemone. Incognito goby immediately took refuge in the anemone; in contrast, Bucchich's goby never touched the anemone. *31 Aug 2016, Tossa de Mar (Spain), Patrick Louisy; 01 Sep 2019, Pag (Croatia), Roberto Pillon.*

Incognito goby

Gobius incognitus Kovačić & Šanda, 2016

Incognito gobies (*G. incognitus*), juvs. Juveniles of Incognito goby are very similar to adults but have proportionally larger eyes. Train yourself retrieving all the characteristic features described in the previous captions. *07 Jul 2019, Nafplio (Greece), Roberto Pillon; 10 Jul 2020, Fontvieille (Monaco), Patrick Louisy; 27 May 2016, Rab (Croatia), Roberto Pillon. Center and bottom photos flipped horizontally.*

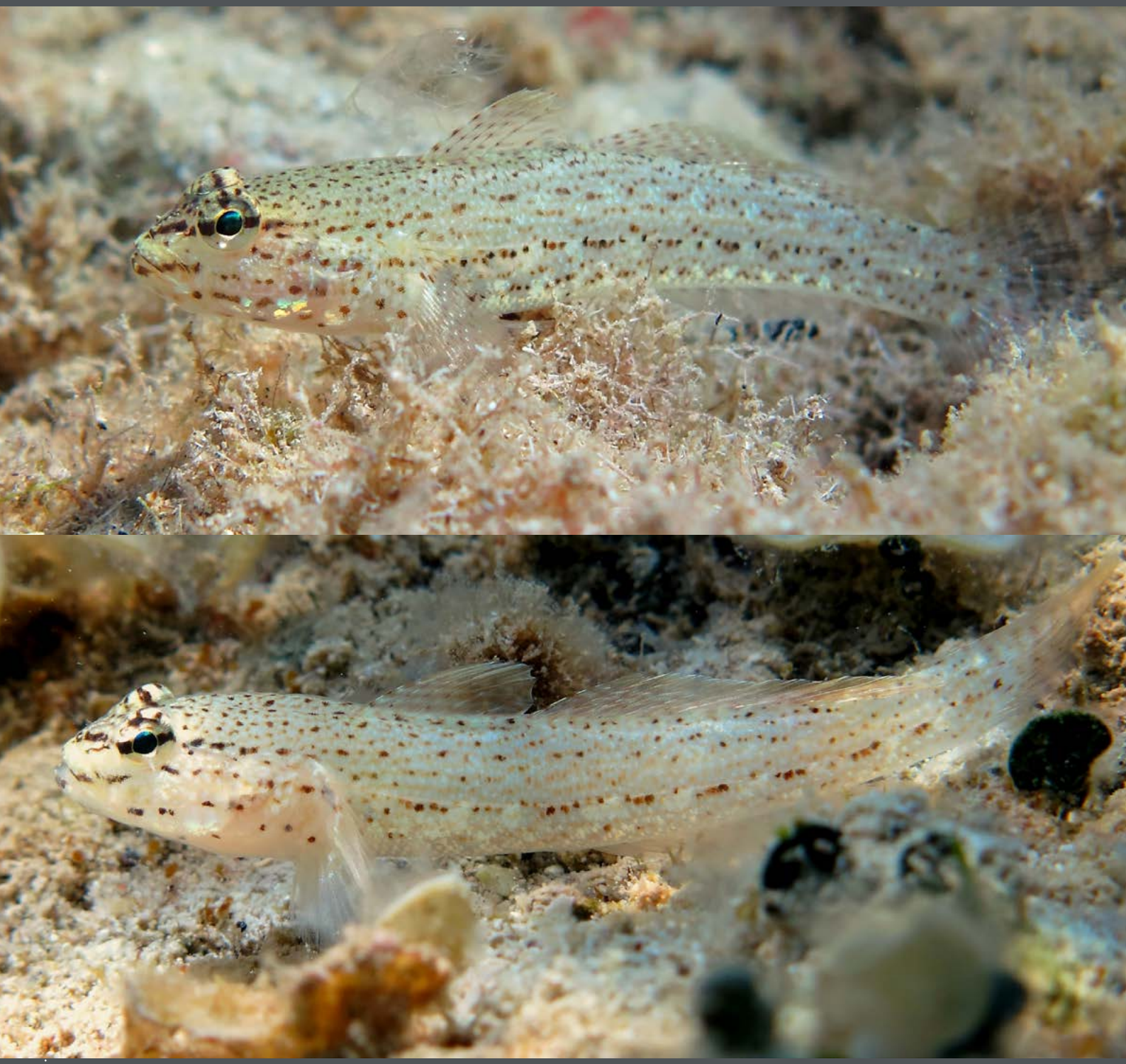
Incognito goby

Gobius incognitus Kovačić & Šanda, 2016

Incognito goby (*G. incognitus*), ad (top); **Sarato's goby** (*G. fallax*), ad (bottom). Compared to Sarato's, Incognito has a slender body with more loosely aligned dots, a longer snout, a discontinuous lateral midline (groups of dots are separated by clear spaces, while in Sarato's it is almost continuous) and a V-shaped snout line (vs. a M-shaped line in Sarato's: here, the central part of the M is not clearly visible but the discriminant vertical legs are). In Sarato's, further note the blue-yellow sheen on the back, the brown mark on the posterior part of the ventral half of the eye, and the horizontal marking on the dorsal margin of the eye (missing in Incognito). *13 Sep 2017, Menorca (Spain), Roberto Pillon; 15 Jul 2012, Hvar (Croatia), Roberto Pillon.*

Incognito goby

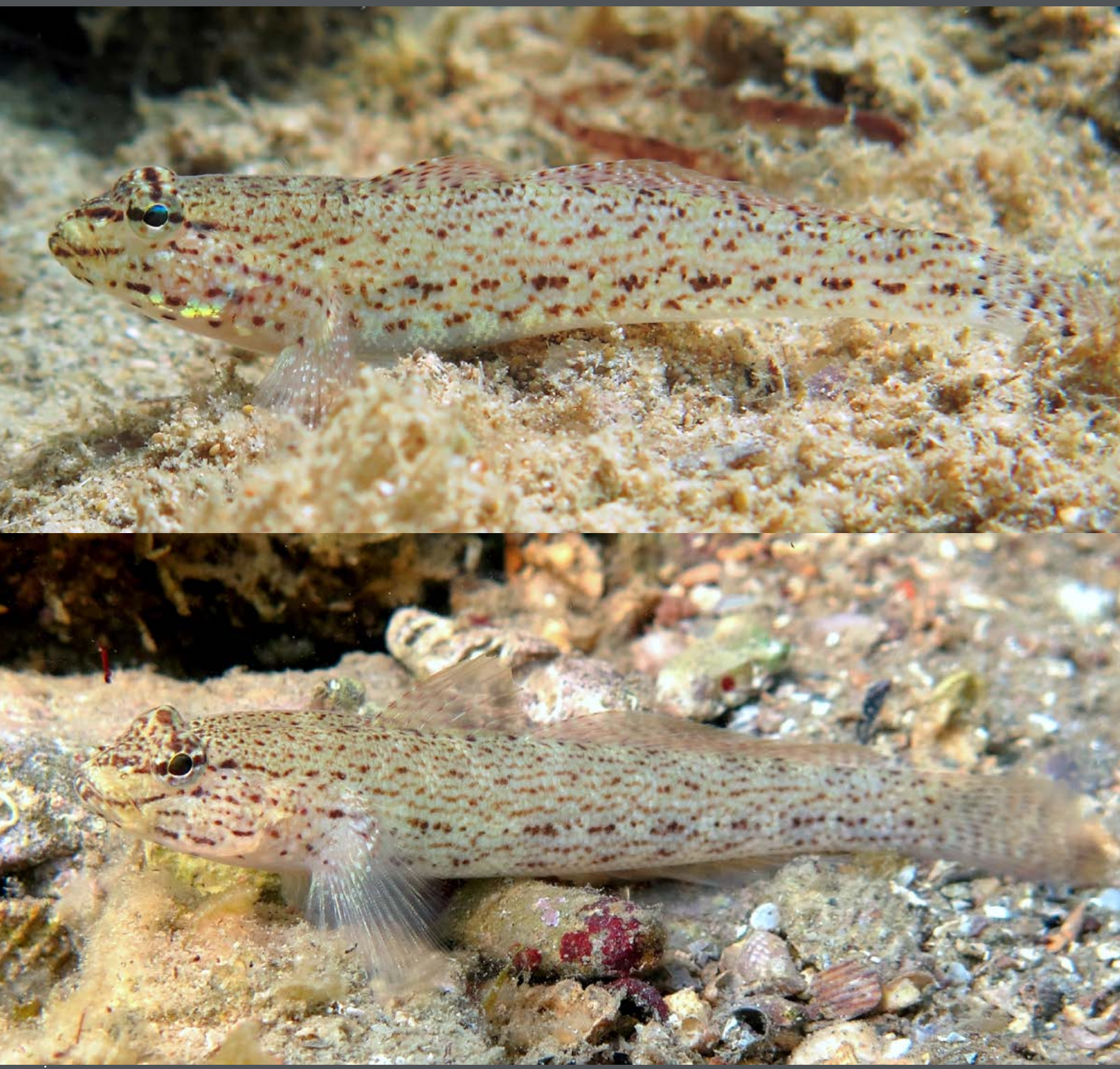
Gobius incognitus Kovačić & Šanda, 2016



Incognito goby (*G. incognitus*), ad (top); **Bucchich's goby** (*G. bucchichi*), ad (bottom). Incognito typically has a light greenish-grey body colouration, small eyes, three parallel rows of dots on the cheek with the upper row fading away before reaching the eye and the lower row starting with a dot at the corner of the mouth, a 'V' snout line, and no horizontal line on the upper margin of the eye. In contrast, Bucchich's has a paler grey body colouration, bigger eyes, only two rows of dots on the cheeks (the upper rows reaches the antero-ventral border of the eye, the lower row starts with two horizontal lines posteriorly to the corner of the mouth), a 'M' on the snout, and a longitudinal marking along upper eye margin. Furthermore, as visible here, Bucchich's goby often has fewer dots on the body. *14 Sep 2018, Kefalonia (Greece), Roberto Pillon; 12 Jul 2018, Pula (Croatia), Roberto Pillon.*

Incognito goby

Gobius incognitus Kovačić & Šanda, 2016



Incognito goby (*G. incognitus*), ad (top); **Bucchich's goby** (*G. bucchichi*), ad (bottom). Some Bucchich's gobies can be very confusing, having an unusual cheek patterning made of 3-4 small dots in the center of the cheek, thus forming a third, median row. However, In Bucchich's this median row is equidistant to the upper and to the lower rows (it is closer to the lower row in Incognito) and it is not parallel to the lower row (it is parallel in Incognito). Other cues allowing to exclude Incognito in bottom individual are: no isolated dot at the corner of the mouth, the upper row touches the eye, a M-shaped line on the snout, and the radiating stripes in the dorsal half of the eye connected by an irregular mark (not connected in Incognito). *10 Sep 2018, Kefalonia (Greece), Roberto Pillon; 24 Aug 2018, Muggia (Italy), Roberto Pillon.*

Incognito goby

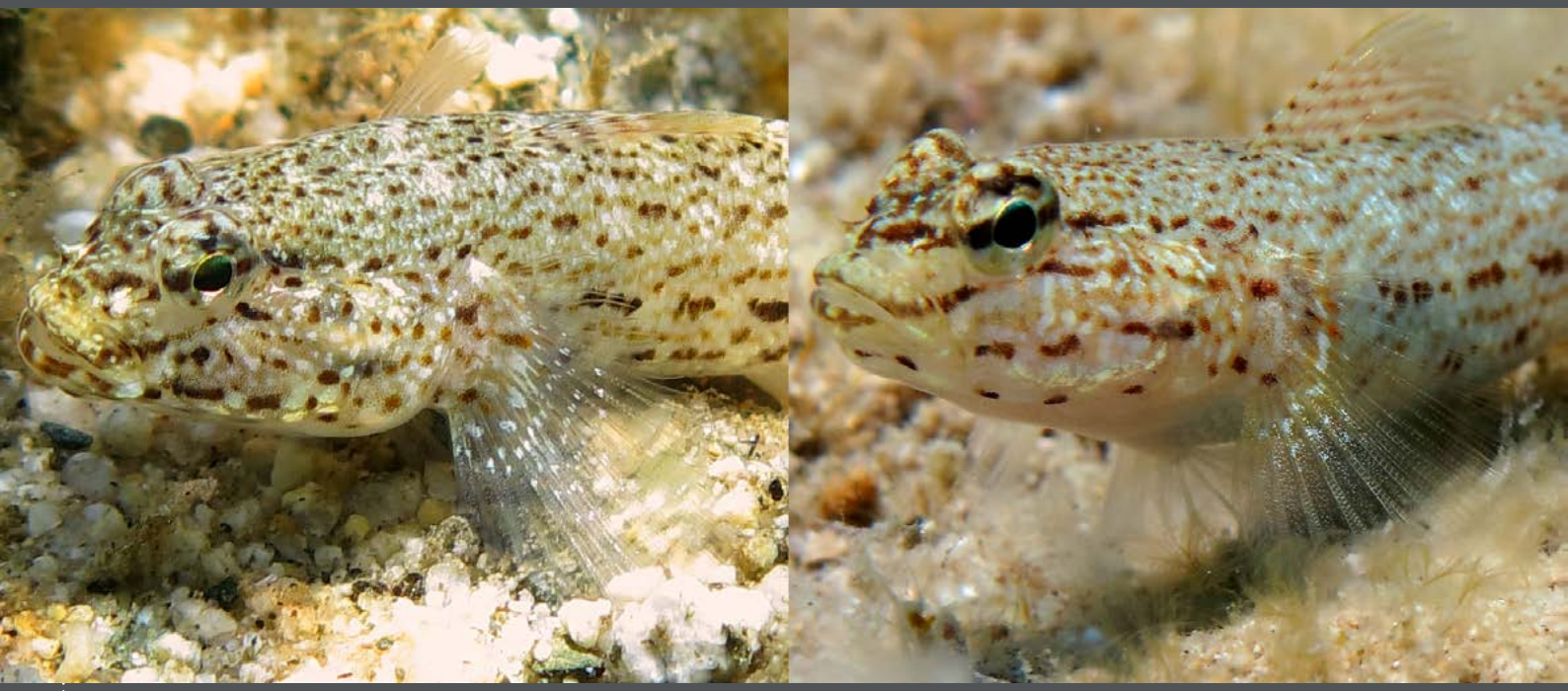
Gobius incognitus Kovačić & Šanda, 2016

Incognito goby (*G. incognitus*), ad (top); **Bucchich's goby** (*G. bucchichi*), ad (bottom). Two specimens with fight colouration. When fighting, dots on Incognito's cheeks often fade away, increasing resemblance with Bucchich's. The identification of the top individual is nevertheless secured by the upper row not reaching the eye, the typical dot at the corner of the mouth, the V-shaped snout line, the broad midlateral blotches, and the patterning of the dorsal half of the eye with no bar interconnecting the radiating stripes. *01 Jun 2012, Rab (Croatia), Roberto Pillon; 07 Jul 2011, Cres (Croatia), Roberto Pillon. Bottom photo flipped horizontally.*

Incognito goby

Gobius incognitus Kovačić & Šanda, 2016

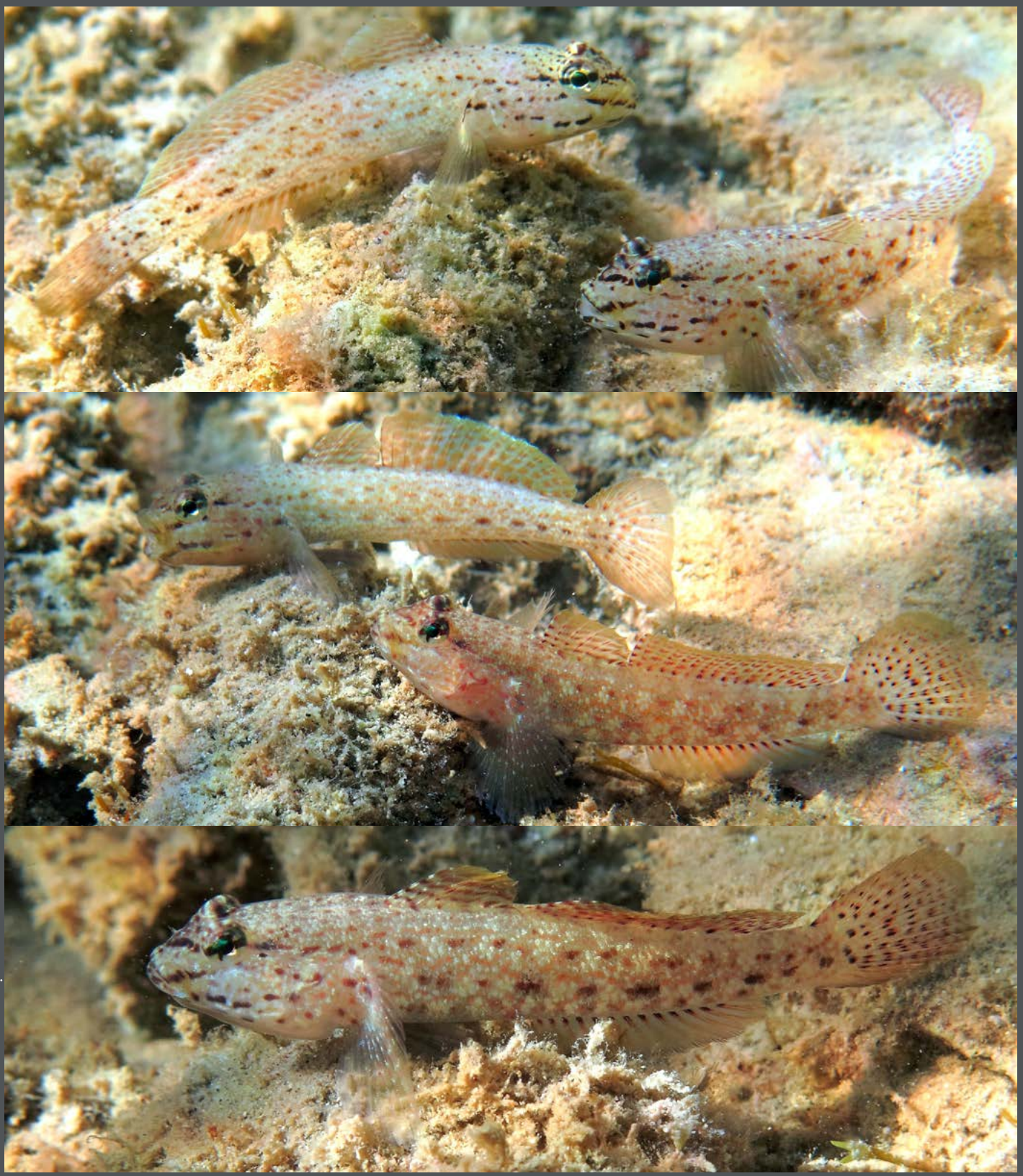
Incognito goby (*G. incognitus*), ad (left); **Bucchich's goby** (*G. bucchichi*), ad (right). Retrieve all the differences in cheek, snout and eye patterning discussed in the previous captions. *11 Sep 2018, Kefalonia (Greece), Roberto Pillon; 27 May 2017, Rab (Croatia), Roberto Pillon.*



Incognito goby (*G. incognitus*), ad (left); **Bucchich's goby** (*G. bucchichi*), ad (right). Both species have free rays in upper pectoral fins but they are visibly more developed in the Incognito goby. *25 Jun 2019, Sithonia (Greece), Roberto Pillon; 27 May 2017, Rab (Croatia), Roberto Pillon. Right photo flipped horizontally.*

Incognito goby

Gobius incognitus Kovačić & Šanda, 2016



Incognito gobies (*G. incognitus*), ad (top right, center right and bottom); **Bucchich's gobies** (*G. bucchichi*), ad (top left, center left). Do not identify groups of individuals too quickly! The two species are often found together, even interacting with each other especially to compete for a territory. Moreover, Incognito's median cheek row often fades away when males are fighting, rendering the scene even more confusing. Here, note the differences in cheek, snout and eye patterning (see previous captions), the presence/absence of a dot at the corner of the mouth, and the difference in eye size (smaller in Incognito goby). *All three pictures: 04 Sep 2019, Pag (Croatia), Roberto Pillon.*

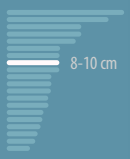
Incognito gobies (*G. incognitus*), ad (top & center); **Slender goby** (*G. geniporus*), ad (bottom). During the night (top) or when fighting (center), Incognito gobies may display a strongly contrasting pattern on head and body. Notably, the foremost dots of the median and lower rows on cheeks merge into a large spot similar to that of Slender goby in night colouration. Incognito differs from Slender by retaining some visible dots on the head and/or the body, having smaller and fainter spots on dorsal and caudal fins, more numerous midlateral blotches, and a distinct dot at the corner of the mouth. *23 Mar 2019, Marseille (13), Julien Renoult; 01 Jun 2012, Rab (Croatia), Roberto Pillon; 19 Jun 2013, Sardinia (Italy), Roberto Pillon.*

Kolombatović's goby

Gobius kolombatovici Kovačić & Miller, 2000

Gobie à taches oranges (*Fr*)
Kolombatović-Grundel (*Ge*)
NA(*Sp*)
Ghiozzo di Kolombatović i (*It*)

Medium-sized • whitish body with orange blotches • orange V-shaped marking on the snout • black blotch on the first dorsal fin • cheeks white with a horizontal pearly white line • rare to locally common, on rocky habitats, below 15 m depth



• Description

Medium-sized goby reaching 11 cm in length. Snout moderately short but longer than the eye, with a moderately steep profile. Ground colouration pale to fawn on the head and the back, with a blue metallic sheen, ventral parts pearly white. The body is covered with irregular orange blotches arranged in longitudinal series. The most conspicuous and darkest series alternates 9 long and short blotches along the lateral midline (the short blotches being frequently also the palest). Another dark and conspicuous series runs dorsolaterally, and includes thinner but longer blotches forming an irregular and discontinuous stripe. An irregular and generally discontinuous, but sometimes continuous, upper lateral line of light-coloured orange dots runs between these midlateral and dorsolateral series. Additional spots, dots or dashes between the dorsolateral series and dorsal fins, irregularly arranged except on the predorsal area where they form two rows of paravertebral orange dashes. Ventrally to the lateral midline, a single series of light orange and thin blotches; frequently these blotches extend ventrally as dark vertical bars. Eyes with a broad horizontal stripe, two oblique bars and one vertical stripes in the upper half of the eye, sometimes coalescing into an arched bar. The horizontal eyestripe connects anteriorly to a conspicuous V-shaped orange snout line touching the upper lip. Posteriorly, the horizontal eyestripe extends into a well-marked orange oculoscapular line that runs continuously between the orbit and the upper base of the pectoral fin. A preorbital orange bar extends from the upper lip to the eye, borders the lower corner of the eye and continues posteriorly parallel to the oculoscapular line to reach the base of the pectoral fin. This line is bordered ventrally by a horizontal, pearly white line starting at the corner of the mouth and terminating at the level of the posterior border of the eye. Below the eye, the cheek is bordered ventrally by two brown horizontal lines (sometimes limited to dots). Opercle and space between the oculoscapular and the paravertebral stripes with irregular orange spots. First dorsal fin semicircular in shape, with four orange horizontal bands separated by three blue-grey, thinner horizontal bands, plus one blue-grey marginal band, which cover both the membranes and the rays. Posterior half of the first dorsal fin with a distinct black oval blotch between the 3rd and 4th (or 5th) interradial spaces. Second dorsal fin blue-grey with many orange spots, including 4 to 6 larger dots at finbase. Caudal fin blue grey with three large orange spots at the base followed by three vertical rows of smaller orange spots. Anal fin blue-grey or hyaline with one horizontal row of 11 small orange dots near finbase. Pelvic disk blue grey. Origin of the pectoral fin pearly white, except one orange to brown horizontal mark on the upper half. Otherwise, pectoral fin largely hyaline, with no or a few dots on rays. Pectoral free rays moderately developed. Predorsal area scaled. Cheek naked, opercle naked or with up to 20 scales. Anterior nostrils tubular and terminated by a triangular lappet.

Kolombatović's goby (*Gobius kolombatovici*). *01 Jul 2012, Marseille (13, France), Patrick Louisy.*

Night colouration. Similar to day colouration but with very broad dark saddles on the back and a dark shading on cheeks.

Sexual dimorphism. Apparently absent.

Juveniles. Poorly known. Differs from adults by a semi-transparent body, and by fewer, proportionally larger and redder blotches on the body. The black blotch on the first dorsal fin is already visible in young individuals.

Geographic variation. Not documented.

• Similar species

kolombatović's goby should be readily identified by the combination of orange markings on the body and a conspicuous black blotch on the first dorsal fin.

Only a few other gobies in the region have a black blotch on that fin: Round, Leopard-spotted and Dollfus' gobies. The invasive Ponto-Caspian **Round goby** (*Neogobius melanostomus*) is brown, olive or beige, but it never shows the orange blotches of Kolombatović's, and it leaves in a very different habitat (brackish or fresh waters, vs. purely marine habitats for Kolombatić's goby). **Leopard-spotted goby** (*Thorogobius ephippiatus*) exceptionally has orange body markings in place of the normal black markings; however, these markings form very large blotches including on the head, which thus lack the V-shaped snout line and oculoscapular line of kolombatović's . **Dollfus' goby** (*Vanneaugobius dollfusi*) is the only of the three species both with a black mark on the first dorsal fin and an orange colouration. However, in Dollfus' the black mark is only present on some individuals, and when it occurs, it is much fainter than in most Kolombatovic's and is further located basally on the dorsal fin. In addition, Dollfus' is noticeably smaller (max 7 cm), is more uniformly coloured with subdued midlateral blotches, it has pairs of white vertical bars on the body below midline, contrasting white nostrils, and it lacks the V-shaped snout line and oculoscapular line of Kolombatović's goby. Moreover, ♂♂ Dollfus' have an elongate and pointed first dorsal fin.

Although other species with orange colouration have no black blotch on the first dorsal fin, their differential identification needs to be discussed because the dorsal fin is not always visible, and in a few Kolombatović's gobies the blotch is missing. Young **Slender gobies** (*G. geniporus*) of deep waters (which typically appear redder than shallow water individuals), can be very similar to Kolombatović's goby; notably, both species have outstanding oculoscapular and V-shaped snout lines, and horizontal and upper vertical eyestripes. However, Slender has a brick red colouration (*vs*. orange in Kolombatović's), the back is reticulated or, when a dorsolateral row of dots occurs, these dots never form distinct rectangles. Moreover, in Slender the dark markings on the nape are limited to pigmented sensory papillae (*vs*. more conspicuous paravertebral stripes), and the suborbital bar does not extend horizontally below the eye.

Large-scaled goby (*T. macrolepis*) is distinctly smaller, its head is covered with many circular blotches including on the snout and the cheeks (*vs*. V-shaped snout line and cheeks white with a single horizontal line below the eye in Kolombatović's goby), has a pale blue marginal band in both dorsal fins, and fewer midlateral blotches (5 *vs*. approx. 9) with larger interspaces.

Steven's goby (*G. gasteveni*) has a steeper snout profile, different patterning of dorsal fins (orange membrane with white spots vs. bands in Kolombatović's goby), the first (spinous) ray of the first dorsal fin brown with two white basal stripes (*vs*. alternates light and dark stripes over its entire length) the dorsolateral stripe is almost continuous (vs. form separated rectangles), and cheeks are frequently gold with white spots (*vs*. white with a horizontal pearly white line).

Last, an orange-coloured **Roule's goby** (*G. roulei*) could be told apart by its ill-defined midlateral blotches (*vs*. distinctly rectangular), plain white lower body parts (*vs*. orange markings), back patterning (reticulated without a clear dorsolateral stripe vs. dorsolateral stripe of rectangular blotches) and the first dorsal (banded only on the ventral half, vs. banded from the base to the tip in Kolombatić's goby) and, in mature males, the shape of the first dorsal fin (elongate *vs*. semi-circular).

See also the species account of **Kestrel goby** (*G. xoriguer*).

• Distribution & Status

Kolombatović' goby is an endemic Mediterranean species first described from the Adriatic in Krk Island (Kovačić & Miller, 2000). Since then, the species was found elsewhere in the Adriatic, for example in San Nicola di Tremiti Island (Italy, iNaturalist). Elsewhere, the species occurs in the Columbretes Islands in Spain (the westernmost record; Kersting & Ballesteros, 2010), the Balearic Islands (Iglésias et al., 2016), along the eastern Mediterranean coast of France (see below), in the Ligurian Sea (Monaco, Francour & Mangialajo, 2007), Tyrrhenian Sea (Giannutry Island, Italy,

iNaturalist; Northern Sicily, www.patzner.sbg.ac.at; and Ustica Island, Muriel Duhau, pers. obs.), Ionian Sea (Sicily, Tiralongo & Pagano, 2015) and Aegean Sea (Saros Bay, Turkey; Bilecenoğlu, 2013). Kolombatović' goby may have been overlooked and probably has a more continuous distribution than currently recognized. It is usually considered rare, but when present it is locally common and easy to spot (but it is shy and difficult to approach).

In *France*, the species has been noted from the western (Francour & Bodilis, 2010) and eastern (Iglésias *et al*., 2016) coasts of Corsica (2B), Cassis (13; Francour & Mangialajo, 2007), Marseille (13; Sylvain Le Bris, Fish Watch Forum), Port-Cros island (83, Francour & Mangialajo, 2007), Hyères, Saint-Raphaël and Saint-Mandrier-sur-Mer (83; several records on Fish Watch Forum), and Villefranche S/ Mer (06, Francour & Mangialajo, 2007).

- **Habitat**

Kolombatović' goby is a strictly marine species inhabiting rocky areas between depths of 12 m (Selce, Adriatic; www.natuurlijkmooi.net) and 90 m (Thyrrenean; www.patzner.sbg.ac.at). It is often found laying on detritic coarse sand and gravel, without or with only a limited proportion of silt and mud, not far from a shelter (Kovačić & Miller, 2000). Around Marseille in France, it is typically observed at the entrance of mini-caves at the foot of vertical rock walls, or among boulders not far from the foot of walls. The associate fish community is typical of coralligenous habitats: *Thorogobius macrolepis, Gobius vittatus* and *Parablennius rouxi* (Francour & Mangialajo, 2007).

Kolombatović's gobies (*G. kolombatovici*), ad. kolombatović's is gregarious and quite common where it occurs. Individuals are typically found on detritic coarse sand and gravel, at the entrance of mini-caves at the foot of vertical rock walls. *21 Aug 2016, Marseille (13, France), Sylvain Le Bris.*

Kolombatović's goby

Gobius kolombatovici Kovačić & Miller, 2000

Kolombatović's gobies (*G. kolombatovici*), ad. Typical adults readily identified by the combination of a black botch on the posterior border of the first dorsal fin (small but visible in bottom individual), a dorsolateral row of orange rectangular spots on the body, a conspicuous V-shaped snout line, a preorbital orange bar extending from the upper lip to the eye, bordering the lower corner of the eye and continuing posteriorly parallel to the oculoscapular line until it reaches the base of the pectoral fin, and a horizontal pearly white stripe below the eye. Strongly patterned dorsal fins with a large black blotch and a blue marginal band may be characteristic or reproductive males. *16 May 2016, Port-Cros (83, France), Sylvain Le Bris; 09 Jun 2018, Marseille (13, France), Thomas Menut. Both photos flipped horizontally.*

Kolombatović's goby

Gobius kolombatovici Kovačić & Miller, 2000

Kolombatović's goby (*G. kolombatovici*), ad. Night colouration is similar to day colouration but with a dark shading on the back and the cheeks. *22 May 2010, Selce (Croatia), Mat Vestjens & Anne Frijsinger. Photo flipped horizontally.*

Kolombatović's goby (*G. kolombatovici*), im. Aged by a semi-transparent body, proportionally large eyes and thin lips. Note the dark blotch on the first dorsal fin and the light blue marginal band already visible. *23 May 2010, Krk (Croatia), Mat Vestjens & Anne Frijsinger. Photo flipped horizontally.*

Kolombatović's goby

Gobius kolombatovici Kovačić & Miller, 2000

Kolombatović's goby (*G. kolombatovici*), ad (top); **Large-scaled goby** (*Thorogobius macrolepis*), ad (bottom). It is not infrequent to encounter Kolombatović's goby with no black on the first dorsal fin. Kolombatović's and Large-scaled gobies have a very different head patterning, with a V-shaped snout line and a continuous oculoscapular line characterising the former, and circular orange spots in the latter. Also, Kolombatović's has more numerous midlateral blotches, is twice the length of Large-scaled and has a more elongate, less stubby body. *06 Jul 2019, Marseille (13, France), Thomas Menut; 31 Aug 2013, Car d'Antibes (06, France), Thomas Menut. Bottom photo flipped horizontally.*

Kolombatović's goby

Gobius kolombatovici Kovačić & Miller, 2000

Kolombatović's goby (*G. kolombatovici*), ad (top); **Steven's goby** (*G. gasteveni*), ad (bottom). When the black dorsal botch is not visible, do not mistake Kolombatović's goby for the rarer Steven's goby. Compared to Steven's, Kolombatović's is more vividly coloured with bright red markings on the anterior parts and orange markings in the posterior parts, both midlateral and dorsolateral blotches are better-defined, there is an orange line on the preopercle running parallel to the oculoscapular line, and the snout is patterned with a conspicuous V-shaped line (vs. less conspicuous M-shaped line in Steven's). *23 Jun 2019, Marseille (13, France), Sylvain Le Bris; 17 Oct 2020, St Raphaël (83, France), Sylvain Le Bris. Photo flipped horizontally.*

Kolombatović's goby

Gobius kolombatovici Kovačić & Miller, 2000

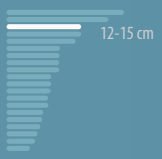
Kolombatović's goby (*G. kolombatovici*), ad (top); **Slender goby** (*G. geniporus*), juv. (bottom). In Kolombatović's goby, body markings are darker on the head than on the body (*vs*. concolourous in juveniles of Slender), the dorsolateral markings form distinct horizontal lines (*vs*. irregular markings), paravertebral stripes are well-visible on the predorsal area, and the white suborbital bar extends horizontally below the eye. *15 Aug 2016, Marseille (13, France), Sylvain Le Bris; 19 Jul 2013, Cadaqués (Spain), Thomas Menut. Top photo flipped horizontally.*

Black goby

Gobius niger Linnaeus, 1758

Gobie noir (*Fr*)
Schwarzgrundel (*Ge*)
Chaparrudo (*Sp*)
Ghiozzo nero (*It*)

Large • steep head profile • first dorsal fin long and pointed in males • black blotch in the upper-anterior corner of dorsal fins • variable colouration, ranging from light cream to black • black preorbital bar and white suborbital bar • black and well visible sensory papillae on the nape • very common, mostly on soft bottoms, at 1-30 m dept



• Description

Large goby up to 18 cm long with a medium-length body, proportionately large head with a characteristically short and steep snout. Ground colouration varies from light cream to olive (on seagrass) to black (in nesting males). In light-coloured individuals, the body has dark mottling on the back, 5 to 6 black midlateral blotches and white ventral side with a few scattered black dots. The body of darker males can be entirely black. In intermediate individuals the back varies from dark mottling to all black but it has 4 white saddles between beginning of the first dorsal fin and tail base. Orbit uniformly coloured, or with an ill-defined horizontal eyestripe and brown speckles on the upper half. Head colour variable, usually mottled brown with one light saddle on the nape. A preorbital black bar between the eye to the upper lip, extending onto both the upper and lower lips. Posterior to the preorbital bar, a pearl white suborbital bar extends from the corner of the mouth to the orbit, continues posteriorly below the eye and, at the level of the posteroventral border of the eye, runs downwards towards the ventral border of the cheek. This boomerang-shaped white mark surrounds a dark area on the cheek. However, in many individuals, only the suborbital white bar is visible. Lips mottled dark grey or brown. Oculoscapular line limited to three inconspicuous black or brown dashes. First dorsal fin semicircular in shape, or long and pointed in nesting males. In dark colour display, fin rays black with 3 or 4 white intudinal stripes. Membrane black with a blue or green sheen in the distal half, reddish in the proximal half. First dorsal fin with 3 irregular, white horizontal bands within the reddish proximal half; second dorsal fin with 1 or 3 white or bluish horizontal bands sometimes replaced by vertical interadial bands. Black blotch at the upper anterior corner of both dorsal fins. Caudal fin with a similar pattern as second dorsal fin (except the black blotch). Anal fin uniformly black, with a bluish sheen. Pelvic disc pearly black. In light morphs, the pattern is similar but the ground colouration of membranes is light grey to pearly white in all membranes (except the pelvic disk that turns black in excited individuals), and yellowish in the distal half of dorsal fins. Upper base of pectoral fins marked with a black horizontal stripe, which tends to broaden distally. Base of pectoral fins white; white flecks on fin rays. Pectoral free rays moderately developed. Predorsal area covered with small scales, not always visible in photos. Rows of sensory papillae well developed and clearly visible on the nape. Cheeks naked. Anterior nostrils tubular and terminated by a triangular flap.

Black goby (*Gobius niger*). *17 Jun 2013, Tuscany (Italy), Stefano Guerrieri.*

Night colouration. Variable. Similar to day colouration in dark morphs, but light morphs have a darker head, with black cheeks, and sometimes a grey shading on the body, including on the underparts. On silt, the back is mottled brown, often with a copper sheen, and light saddles on the back are indistinct.

Sexual dimorphism. Well marked, at least between females and nesting males: females lack the black colouration of nesting males, and their first and second dorsal fins are of similar height (first dorsal fin longer and pointed in nesting males). Non-nesting reproductive males, called 'sneakers', resemble females in colouration and dorsal fin shape (Mazzoldi & Rasotto, 2002), and tend to be smaller than nesting males. With current knowledge, they are undifferenciable from females. In general, males smaller than 8 cm are sneakers (sexed in hand by the shape of the urogenital papilla), while males above 10 cm are nesting males.

Juveniles. Juveniles have an overall transparent body with poorly marked yet visible blotches along the lateral midline, back with scale margin pigmented brown and pearly white markings in very young individuals, a few scattered brown dots on the underparts. Lower part of the head with three bars: a thin preorbital bar, two broader but less distinct (sparse black dots) vertical bars below the eye. Area between first and second bar unpigmented. First dorsal fin transparent with two horizontal dark stripes, and often a dark spot at the posterobasal border. Second dorsal fin with several (between 4 and 6) ill-defined stripes made of brown dots centered on fin rays. One-year old individuals measure 7-8 cm, while individuals older than 3 yrs are usually longer than 12 cm (Rasotto & Mazzoldi, 2002).

Geographic variation. Individuals inhabiting lagoons tend to be smaller, darker and have bigger eyes compared to those of open sea populations (De Girolamo, 1994). In addition, small differences have been noted between Mediterranean and North-eastern Atlantic populations. Mediterranean fish would have larger and intricate scales on nape, while Atlantic fish have smaller scales forming an incomplete nape coverage (Miller, 1986). Mediterranean fish also appear larger, especially at one year old (Bouchereau & Guelorget, 1998).
Linnaeus (1758) originally described two species: *G. niger* and *G. jozo*. Some authors proposed that marine populations belong to *G. niger* and lagoon populations to *G. jozo*. Others rather suggested that *G. niger niger* describes Atlantic populations, and *G. niger jozo* Mediterranean populations. Currently, the taxon jozo either as a specific or subspecific epithet is considered invalid and treated as a synonym of *niger*. Although we could not find consistent differences between Atlantic and Mediterranean fish from our photographs, we think that an in-depth genetic and morphological investigation is still needed to clarify the status of *jozo*.

• Similar species

Separating Black goby and **Roule's goby** (*G. roulei*) can be challenging. Roule's has an overall similar structure as Black; notably, both species share a short and steep head profile, have a similar patterning and they are the only *Gobius* with a pointed and elongate first dorsal fin. However, adults of Roule's are distinctly smaller (6-8 cm vs. 12-18 cm in Black) and more slender, have proportionally bigger eyes, thinner and less well differentiated blotches along the lateral midline, a more uniform colouration of the underparts (Black goby has brown speckles below the lateral midline, notably below inter-blotch regions), a more defined oculoscapular line made of three dashes, the rearmost two usually connected and the foremost one more reddish (vs. only three disconnected, poorly marked and concolourous dots or dashes in Black), white lips and white cheeks (both mottled in Black). In addition, horizontal bands on dorsal fins are fainter in Roule's. Contrary to some Black, Roule's never has dark blotches at the upper anterior borders of dorsal fins. Also, Roule's is not known to display the whole black body colouration of Black nesting males, even at night. Roule's lacks scales on the nape and the predorsal area; however this criterion should be used with caution as scales are often invisible in photos of Black, and are not developed in juveniles. The pattern of sensory papillae on the nape and predorsal area, visible on good photos, is also different (see *Roule's* account for details).

Differentiating Black from **Couch's gobies** (*G. couchi*) can be challenging too, especially as the two species share similar habitats (in particular, sheltered bays). Couch's goby can be unambiguously excluded when the black blotches are present at the front edge of the dorsal fins or when the first dorsal fin is distinctly elongated and pointed. Otherwise, the following criteria should be assessed. (1) Couch's is slender and longer bodied, has a longer snout and a smaller head, and is smaller than Black (9 cm vs. 15 cm). (2) In Couch's, the back is mottled or reticulated (vs. covered with large and poorly defined dark spots in Black). (3) The corner of the mouth has an isolated black spot (no such dot in Black), and the ventral edge of the cheek has two well-delineated horizontal lines (vs. diffuse black markings). (4) The oculoscapular line is more visible (vs. barely visible).

(5) The upper part of the cheeks is always dominantly white, and the lower part dominantly black (vs. the cheek has evenly distributed yet poorly defined light and dark spots). Note that, some Black gobies have a white boomerang below the eye that is very similar to that of Couch's goby; thus this character alone should not be considered diagnostic. (6) Sensory papillae on the nape are short and not always visible (vs. long and always well-visible), and row d of papillae (sometimes visible on close-up pictures) is split into two sections in Couch's (vs. continuous un Black). (7) In Couch's and contrary to Black, a black dot touches the anterior border of the eye between the V-shaped line and the preorbital bar, and is prolonged frontally by a short, thin black line. This last criterion is tentative and needs to be evaluated further. At night, juveniles of Couch's are more variegated than adults and they may lack the characteristic tricoloured appearance of the trunk. Young Couch's can nevertheless be separated from young Black by their cheek and snout patterning already characteristic of the species (see above), but also by the presence of a large black blotch in the anterior part of the trunk, just posterior to the pectoral fin.

In Madeira, the Canary Islands, but also along the western African coast, **Canarian goby** (*Vanneaugobius canariensis*) should be considered as a potential pitfall. Canarian has an overall body shape similar to that of Black, in particular, both species have a steep head profile. However, Canarian can be separated from Black by: a slightly shorter snout, reddish markings (*vs*. usually brown or grey markings in Black, but some Black are red and some Canarian are black), the nape is naked and with short sensory papillae (*vs*. scaled nape with long sensory papillae), the nape tends to be contrastingly darker than the upper preopercle and opercle, with the oculoscapular line marking the limit between the two regions (*vs*. preopercle, opercle and nape concolourous), below the eye, the lower part of the cheek tends to be distinctly darker than the upper part (*vs*. both lower and upper parts pigmented black), the first dorsal fin has deeply lunate inter-radial spaces (*vs*. not or slightly lunate), the distal half of the first dorsal is fin transparent (*vs*. distal half opaque), and the ventral half of the orbit has oblique, orange stripes (vs. lower half unmarked).

The enigmatic **Bellotti's goby** (*G. ater*), shares with Black goby a stocky body and dark colouration. Bellotti's, however, has a deeper body, bigger eyes with a smaller interorbital space, a shallower head profile, a nape with larger scales and without conspicuous series of pores, and more free rays in pectoral fins.

Some adult Black can show the salt-and-pepper appearance of **Giant goby** (*G. cobitis*), as well as broad black markings on the flanks and the back. Yet Giant has a different structure with a bigger head and a longer snout, the tiny white dots covering the head and the body are more visible than in Black, dorsal and caudal fins have broad dark spots (vs. unmarked or faintly marked fins in Black), and pectoral fins are broader, with a more fleshy base (*vs*. more delicate fins).

In brackish waters, Black goby can be confused with the Ponto-Caspian **Round goby** (*Neogobius melanostomus*), which is invasive in several rivers and estuaries of Central Europe. Like Black, Round goby is variable in colouration, with variegated individuals and all black mature males. However, adult Round is stouter-bodied, has a larger head, a convex but tapered snout, a black spot at the rear of the first dorsal fin (*vs*. at front edge in Black) that is often circled white, the two dorsal fins are always of similar height (*vs*. first dorsal fin longer in reproductive males), the second dorsal, caudal and anal fins are tipped grey-blue, and nape sensory papillae are barely visible. Contrary to juveniles of Black, in Round the black spot at the rear of the first dorsal fin does not touch the trunk.

Monkey goby (*Neogobius fluviatilis*), another invasive Ponto-Caspian goby, has a slender and longer appearance, proportionally shorter head, more attenuated snout profile, higher number of midlateral blotches (> 10, *vs*. 5 to 6 in Black), and barely visible nape sensory papillae.

Black goby can be also confused with **Grass goby** (*Gobius ophiocephalus*), and both species can co-occur in brackish waters. Grass has a different head shape with proportionally smaller eyes and a shallower snout profile. Grass further has pale dorsolateral stripes, its midlateral blotches form vertical or zigzag bars.

Last, juveniles of Black should not be mistaken for sand gobies, notably **Common goby** (*Pomatoschistus microps*). Common goby lacks the black spot at the posterior border of the first dorsal fin (*vs*. typically present in very young Black), it frequently shows a white spot, has a shallower snout profile and a concave nape (a feature of all sand gobies, which gives an impression of more delicate fish compared to stouter young Black with a convex nape) and a thinner caudal peduncle.

- **Distribution & Status**

Black goby occurs in the North-eastern Atlantic, in the Baltic, the Mediterranean, the Black Sea and the Sea of Azov (Miller, 1986). In the Atlantic, it has a continuous distribution from Norway to Mauritania (Banc d'Arguin; Campredon & Schrieken, 1985). It is known from the Canary Islands (Brito et al., 2002), Selvagens Islands (Almada et al., 2015) and Madeira (Araújo & Wirtz, 2015). In the Mediterranean, the species is widespread, occurring along both the northern and southern coastline and in all large islands. The species is still in expansion in the Black Sea (Tserkova et al., 2016). Black goby is an anti-lessepsian fish, present in the Gulf of Suez (Miller & Murdy, 2016).

In *France*, Black goby is common along all coasts.

Black goby

Gobius niger Linnaeus, 1758

• Habitat

Black goby lives in marine and brackish lagoons and estuaries. In marine open waters, it is found from the surface to 80 m depth, but is most common above 30 m and is rare below 50 m depth. It occupies a wide range of soft habitats, but avoids purely rocky grounds. It is common in many coastal lagoons on silty-muddy patches among seagrass. In marine areas, it also lives on bare silty and fine sands, more rarely on coarse sand and gravel. Nests are built under hard substrates like rocks, stones or artificial objects (reviewed in Kara & Quignard, 2018).

• Miscellaneous

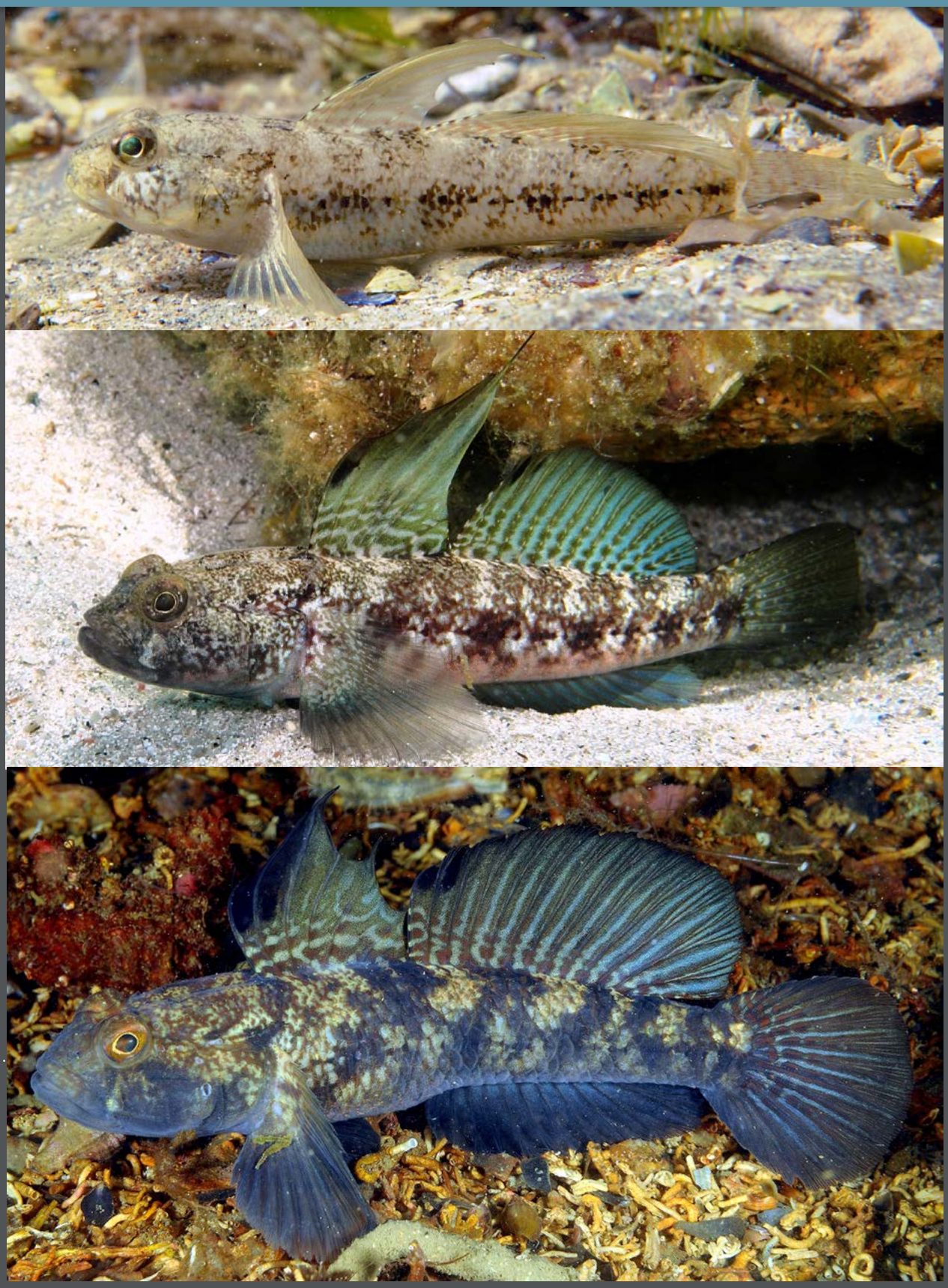
☝ Nesting males dig small cavities during the breeding season, which usually extends from April to September. Females lay their eggs on the ceiling and walls of the cavity. After fertilization, males defend the clutch until hatching (Rasotto & Mazzoldi, 2002). Sneakers do not build nests, but they try to enter nests to fertilize eggs out of sight of the nesting male. This "parasitic" behaviour is facilitated by their female-like appearance. Yet the distinction between nesting males and sneakers is not dichotomous, and intermediate males do exist; these males can shift between a sneaking and a nesting strategy depending on the environmental and the social context (Immler et al., 2004). The biology of the Black goby is reviewed in Kara & Quignard (2018).

☝ Black goby is the type-species of genus *Gobius*, that is, this species was chosen by Carl von Linné to describe the genus.

Black gobies (*G. niger*), ad ♂ and ♀. The female (in the background) has just layed her eggs, which are being fertlized by the male (in the foreground). *21 May 2012, Thau lagoon (34, France), Patrick Louisy.*

Black goby

Gobius niger Linnaeus, 1758



Black gobies (*G. niger*), ad ♂♂. Despite the great variation in colouration, ranging from light cream to black, adult males Black are unmistakable: no other Gobius has a pointed and elongate first dorsal fin with a black blotch at its anterior border (less visible but still present on top individual). *19 May 2013, Thau lagoon (34, France), Thomas Menut; 20 Jun 2013, Sardegna (Italy), Roberto Pillon; 17 Jun 2013, Taranto, Mar Piccolo (Italy), Stefano Guierieri. Top photo flipped horizontally.*

Black goby

Gobius niger Linnaeus, 1758

Black gobies (*G. niger*), ad ♂♂. Black colouration indicates nesting males (but nesting males are not necessarily black). Black gobies emit sounds to court females and to intimidate competitors (Malavasi et al., 2008). *31 Jul 2011, Thau lagoon (34, France), Thomas Menut.*

Black goby

Gobius niger Linnaeus, 1758

Black gobies (*G. niger*), ad ♂♂ or ♀♀. In both individuals, note the very short and steep snout, compact shape (contrary to Couch's goby), and dark mottling on the underparts (excluding Roule's goby). In the top individual, the black preorbital bar bordered posteriorly by a white suborbital bar is well visible. Both individuals were photographed at night. *23 Jun 2020, Palavas-les-Flots (34, France), Julien Renoult; 22 Jun 2014, Nice (06, France), Thomas Menut. Both photos flipped horizontally.*

Black goby

Gobius niger Linnaeus, 1758

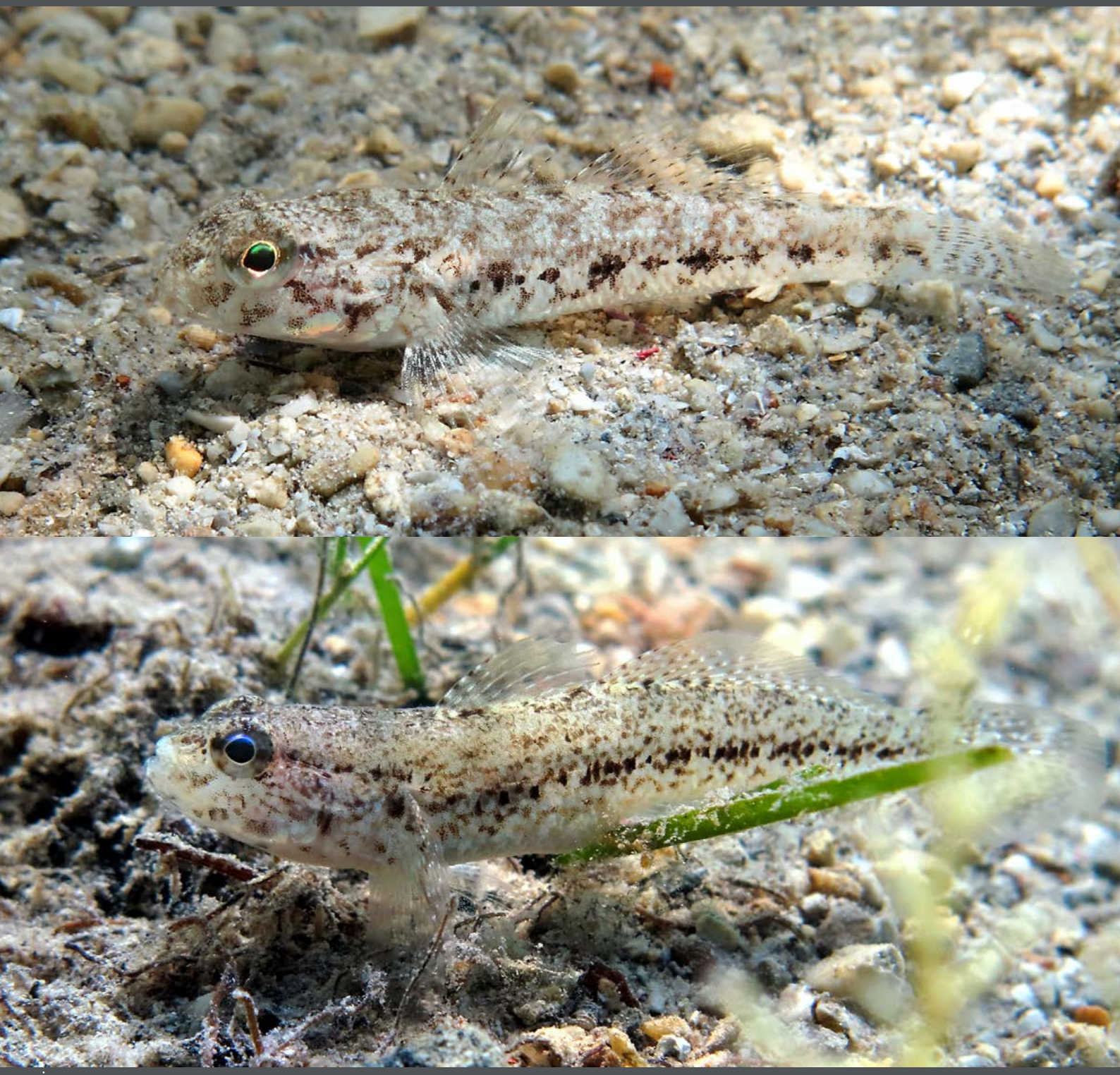
Black goby (*G. niger*), very early on during development, when juveniles reach 3 cm in length, the characteristic black spot at the upper front border of the first dorsal fin becomes visible. Photographed at night. *08 Apr 2014, Thau lagoon (34, France), Thomas Menut. Photo flipped horizontally.*

Black goby (*G. niger*), im. The dark spot at the rear of the first dorsal fin here indicates an immature individual. *08 Aug 2021, Narbonne Plage (11, France), Patrick Louisy.*

Black goby (*G. niger*), ad ♂ (top); **Roule's goby** (*G. roulei*), ad ♂ (middle); **Black goby** (*G. niger*), ad ♀ or young ♂ (bottom). The black spot at the front edge of the first dorsal fin is diagnostic of Black. However, separating the two species can be challenging when this part of the dorsal fin is not well visible, as in the middle individual. In this Roule's goby in typical night colouration, note the proportionally larger eyes, only one (or two) distinct white stripes on the first dorsal fin (which, at night, is often a dark ochre to mustard yellow colour), no checkerboard pattern below the lateral midline and homogeneously coloured lips. See Roule's goby account for more comparative pictures. *28 Aug 2020, Castelló d'Empúries (Spain), Julien Renoult; 11 Aug 2015, La Ciotat (13), Sylvain Le Bris; 10 May 2016, Livorno (Italy), Stefano Guerrieri. Top and bottom photo flipped horizontally.*

Black goby

Gobius niger Linnaeus, 1758



Black goby (*G. niger*), juv (top); **Couch's goby** (*G. couchi*), ad ♀ (bottom). Without information on the context (like the presence of more characteristic individuals nearby), identifying these individuals can be highly challenging. However, note that Black is shorter-bodied and stouter, has a larger head and proportionally bigger eyes, the oculoscapular line is split into three parts (vs. it is more continuous in Couch's), the midlateral blotches are better defined (vs. form a more continuous stripe in Couch's), Black has no dark dot at the corner of the mouth (contrarily to Couch's) and the nape sensory papillae are more visible. In Couch's, rays extend beyond the membrane in the first dorsal fin. A hint of black in the posterobasal corner of the first dorsal fin definitively identifies the top individual as a Black goby, and ages it as a juvenile. *18 Jun 2020, Rab (Croatia), Roberto Pillon; 13 Jun 2020, Rab (Croatia), Roberto Pillon.*

Black goby

Gobius niger Linnaeus, 1758

Black goby (*G. niger*), ad ♂ (top); **Couch's goby** (*G. couchi*), ad ♂ (bottom). Be aware that during the reproductive season, when males fight to defend their territory, it is not uncommon to see Black gobies with injured fins showing ray tips free from the membrane, a feature normally diagnostic of Couch's goby. In Black, note the dark blotch in the first interradial space and the fewer and more irregular transverse stripes. *19 Dec 2020, Thau lagoon (34, France), Julien Renoult; 26 May 2018, Rab (Croatia), Roberto Pillon.*

Black goby

Gobius niger Linnaeus, 1758

Black goby (*G. niger*), ad (top); **Couch's goby** (*G. couchi*), juv (bottom). Note the difference in body shape, with Black being stockier and larger-headed. Furthermore, in Black the black markings on the cheek radiate from the eye while in Couch's, they are limited to two horizontal lines preceded by a black dot at the corner of the mouth. The grey colouration of the back contrasting with a dark midlateral band is characteristic of Couch's in night colouration. *19 Jun 2019, Thau lagoon (34, France), Julien Renoult; 29 Aug 2020, Cadaqués (Spain), Julien Renoult. Bottom photo flipped horizontally.*

Black goby

Gobius niger Linnaeus, 1758

Black goby (*G. niger*), ad ♀ or ♂ (top); **Canarian goby** (*Vanneaugobius canariensis*), ad (bottom). Despite their overall resemblance, Black goby can be immediately separated from Canarian goby by its black spot on the first dorsal fin (in Canarian, the upper half of that fin is transparent). In Black, note also the slightly longer snout, the scaled nape (vs. naked nape in Canarian), the upper preopercle and opercle of similar colour as to the nape (*vs*. nape darker), the upper part of the cheek below the eye pigmented black (*vs*. generally a pale area just below the eye in Canarian), and the long sensory papillae (*vs*. short and hardly visible). *01 Jul 2016, Cagnes S/Mer (06, France), Thomas Menut; 05 Apr 2021, Lanzarote (Canary Islands, Spain), Dennis Rabeling. Both photos flipped horizontally.*

Black goby

Gobius niger Linnaeus, 1758

Black goby (*G. niger*), ad ♂ (top); **Giant goby** (*G. cobitis*), im (bottom). Some Black gobies can have pepper-and-salt appearance, broad black midlateral blotches and saddles on the back, thereby resembling Giant goby. Though, Black should be easily distinguished by the following characters: shorter snout and steeper head profile, black preorbital and white suborbital bars, no or very small dark markings on dorsal and caudal fins, small dark markings below the lateral midline, well-visible black sensory papillae on the nape, shorter and more delicate pectoral fins. *06 Jul 2012, Livorno (Italy), Stefano Guierieri; 08 Jun 2019, Banyuls-sur-Mer (66, France), Julien Renoult.*

Black goby

Gobius niger Linnaeus, 1758

Black goby (*G. niger*), ad (top); **Round goby** (*Neogobius melanostomus*), ad (bottom). Round goby should be readily identified by the black spot in the rear of the first dorsal fin; however, be careful with some Black gobies who retain a posterior black spot at adulthood (this spot is normally present in juveniles and immatures only). The black dorsal spot seems particularly common in populations of the Kattegat and in the Eastern Baltic. Yet, in Black this spot is located more basally on the fin, almost touching the trunk. In any case, Round goby can be separated from Black goby by its different cheek and preopercular patterning (here, note the characteristic light-coloured oblique bar on the preopercle), longer and more convex snout, light-coloured margin of second dorsal, caudal and anal fins, and inconspicuous sensory papillae on the nape. *26 Sep 2020, Schwedeneck (Germany), Rita Jansen. 14 Sep 2019, Alsace (67, France), Thomas Menut. Top photo flipped horizontally; bottom individual photographed in a tank.*

Black goby

Gobius niger Linnaeus, 1758

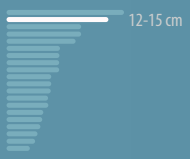
Black goby (*G. niger*), juv (top); **Common goby** (*Pomatoschistus microps*), ad ♀ (bottom). Compared to sand gobies (including Common goby), juveniles of Black have a distinctly steeper snout profile, proportionally bigger eyes, a convex nape (*vs*. usually concave in sand gobies). *29 Jul 2019, Concarneau (29, France), Julien Renoult; 15 May 2019, Esnande (17, France), Julien Renoult. Both individuals photographed in a tank.*

Grass goby

Gobius ophiocephalus Pallas, 1811

Gobie-lote (*Fr*)
Grasgrundel (*Ge*)
Gobi bavos (*Sp*)
Ghiozzo gò (*It*)

Very large • deep body • greenish colouration • usually a pale dorsolateral stripe along the trunk • large white spots on cheeks and opercles • numerous dark and white markings below lateral midline • locally common, in sheltered areas like lagoon, at 0.1-3 m depth



• Description

Very large goby reaching 25 cm in length. Body stout and distinctly compressed laterally for a *Gobius* species, giving the appearance of a deep body especially at the level of the caudal peduncle. Snout moderately long and with a moderately steep profile. Ground body colouration grey-green to pale fawn dorsally, whitish to yellow-green ventrally. Lateral midline covered with 10-14 dark blotches dorso-ventrally elongated. These blotches coalesce with other, slightly smaller vertical blotches below the lateral midline, but the two rows of blotches being slightly offset from one another, the side of the trunk is typically patterned with zigzag markings. Above the lateral midline, a broad and uniform olive-brown upper lateral stripe runs from the upper base of the pectoral fin to the caudal fin. Further dorsally, a dorsolateral stripe crosses the trunk; it is also uniformly coloured but contrastingly lighter and slightly thinner than the upper lateral. Occasionally, this stripe is indistinct (back is uniformly dark) or interrupted by dark saddles. Last, a very dark vertebral stripe begins before the first dorsal fin and ends on the caudal peduncle. This general pattern with three longitudinal stripes above the lateral midline can be partly obscured by a strong mottling. Black spot generally visible in the center of the caudal peduncle. A pale transverse bar on nape. Eyes variegated with yellow, red and brown in the upperparts, white and black in the lower parts. Snout and lips with the same mottled colouration as the nape and the back. One black preorbital bar not extending ventrally onto the lips (or extending as a very faint bar) but extending dorsally onto the iris. One white suborbital bar extending onto the corner of the mouth. Cheek and preoperculum brown-olive with white spots, generally circular but sometimes longitudinally elongated. Cheek sensory papillae pigmented black and thus often forming a grid pattern. Oculoscapular line barely visible or very thin. First dorsal fin reddish with 4 grey-blue transverse bands (which extends onto the rays). First spinous ray dark brown with light transverse stripes. Second dorsal fin with the same colour as the first dorsal fin but with grey-blue irregular markings not forming clearly defined bands, and with many small white dots. Patterning of the caudal fin similar to that of the second dorsal fin. Anal fin grey-brown or yellowish with grey-blue longitudinal bands. Pelvic disk grey-brown or yellowish. Pectoral fins broad, mostly hyaline with white dots on rays. Only a few uppermost rays free from the membrane. The base of pectoral fin alternates black, white and sometimes red semi-circular bands arranged dorsal-ventrally. Black pectoral blotch often present. Predorsal area scaled, cheek naked. Anterior nostrils tubular, without process from rim.

Grass goby (*Gobius ophiocephalus*). *27 Jun 2020; Pomer (Croatia); Roberto Pillon.*

Night colouration. Not significantly different from the day colouration.

Sexual dimorphism. Males tend to be larger than females. Nesting males differ from non-nesting reproductive males ('sneakers') and from females by longer rays in the second dorsal fin (this fin thus appears higher than the first dorsal fin), more vividly coloured dorsal fins with deeply lunate interradial membranes, sometimes with ray tips free from the membrane.

Juveniles. Ressemble diminutive adults.

Geographic variation. Populations from the Adriatic are genetically distinct and potentially correspond to a different species (Iglésias et al., 2021). We have not studied their colouration and patterning yet; however, they seem to frequently have dark saddles on the back, rather than the dark upper lateral, pale dorsolateral and black vertebral stripes described previously.

• Similar species

Grass goby has quite a unique appearance within the genus, with a noticeably deep body especially at the level of the first dorsal fin and at the caudal peduncle, and proportionally small eyes. This general appearance should be sufficient to identify Grass goby in most cases. Grass goby could nevertheless be confused with other gobies showing dark markings below the lateral midline.

Giant goby (*G. cobitis*), another large-sized goby, can resemble Grass goby; however, Giant has a proportionally larger and depressed head with swollen cheeks, a longer snout, a trunk with a circular section (*vs*. laterally compressed in Grass), larger and more contrasting dark markings on the body (notably, it has distinct black saddles on the back, as well as large and circular midlateral blotches), a 'pepper-and-salt' appearance (i.e., body and head heavily speckled white), and has no pale dorsolateral stripes. Moreover, Giant does not show a grid pattern on the cheeks.

Grass gobies can also be confused with **Black gobies** (*G. niger*), as both species may co-occur in brackish waters. Black has a different head shape with much bigger eyes and a steeper snout profile. Black further has no pale dorsolateral stripes, its midlateral blotches do not form vertical or zigzag bars, the anterior edge of dorsal fin has a black spot (and the first dorsal fin is typically pointed in reproductive males), black sensory papillae are well visible on the nape.

Rock goby (*G. paganellus*) is told apart by its well developed pectoral free rays (vs. poorly developed in Grass), large and well-visible scales on the nape (vs. small scales) and a depressed head (vs. deeper head in Grass).

Like Grass, **Bellotti's goby** (*G. ater*) lives in the seagrass and is deep-bodied, but it is much smaller (max 8 cm), short-bodied, presumably mostly black and has a thin yellow marginal band on the first dorsal fin.

• Distribution & Status

Grass goby lives in the Mediterranean, Adriatic, Black Sea and Sea of Azov. Along the African coasts, there are confirmed records from Libya and Tunisia (Hajji et al., 2013).

In *France*, Grass goby is locally common in the Thau lagoon (34) and in Corsica (2A, 2B), where it is abundant in Diana and Urbino, rarer in Biguglia (Kara & Quignard, 2019). Two species syntypes (specimens used to describe the species) are noted from "Martigues" (13), and Grass goby is recurrently mentioned from the Berre lagoon in the literature; however, to our knowledge there is no recent record in that place. Currently, it seems that Thau is the only confirmed locality with Grass gobies still present. Overall, there are many uncertainties about the precise distribution of Grass goby in France and elsewhere, which highlights the importance for photographers to publish pictures on citizen science databases.

• Habitat

Grass goby occurs from 0.1 m to 3 m depth. It is eurythermal and euryhaline (salinity ranging from 5‰ to 40‰), living in estuaries and coastal lagoons. It is generally associated with soft bottoms covered with marine phanerogams.

• Miscellaneous

☝ See the general introduction on genus *Gobius* for a discussion of the former name *Zosterisessor*.

☝ Grass goby digs two types of burrows: a tubular one for protection (notably for wintering) and another one with a chamber for nesting. The tunnel leading to the chamber can be up to 2.3 m long, and the chamber 0.5 m wide. There are two types of reproductive males, depending on whether they dig a nest or not. Nesting males are morphologically different from females (see above), contrary to non-nesting males. Non-nesting males are called 'sneakers': they stay among females outside the nests and wait for a moment of inattention from the owner to rapidly enter the nest and drop a trail of sperm. For a comprehensive review of the fascinating biology of Grass goby, see Kara & Quignard (2019).

Grass goby

Gobius ophiocephalus Pallas, 1811

Grass goby (*G. ophiocephalus*), ad ♂. This nesting male displays all the features characteristic of Grass goby: a stout and deep, laterally compressed body, small eyes, green ground colouration, black vertebral, light dorsolateral and olive upper lateral stripes, broad dark marks below the lateral midline and white circular spots on the cheek and the opercle. The tall second dorsal fin (taller than the first dorsal fin), dark pectoral blotch and yellow belly sign the sex and reproductive status of this individual. *04 May 2016, Taurus beach, Mèze, Thau lagoon (34), Patrick Louisy. Photo flipped horizontally.*

Grass goby (*G. ophiocephalus*), ad ♂. Another nesting male showing the same species, sex and reproductive characteristics as the previous individual. Grass goby has a neutral buoyancy and is frequently seen levitating over or among the vegetation. *07 Jun 2014, Thau lagoon (34, France), Thomas Menut. Photo flipped horizontally.*

Grass goby

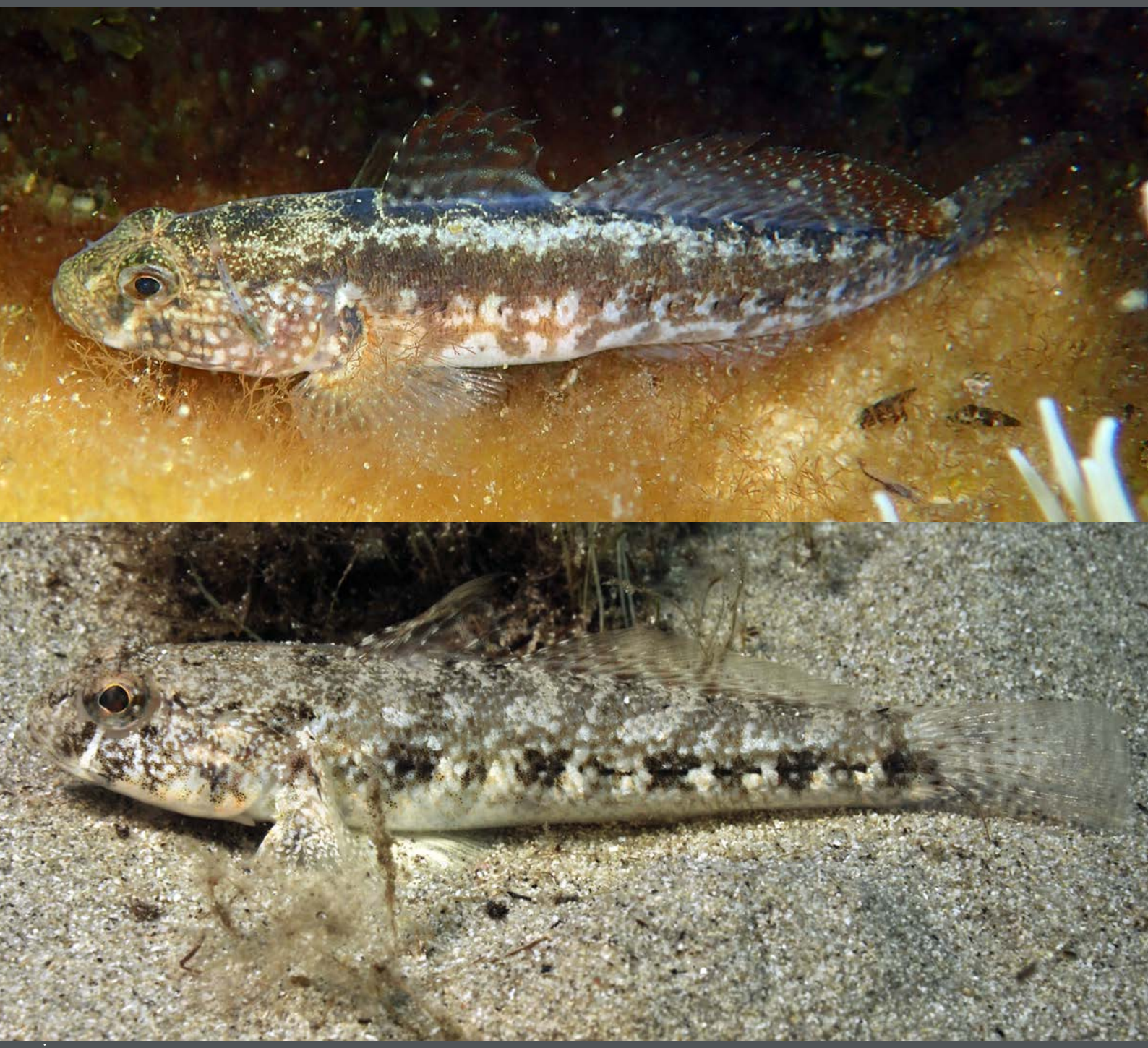
Gobius ophiocephalus Pallas, 1811

Grass goby (*G. ophiocephalus*), ad type ♀. Note the laterally compressed body, olive and yellow colouration, light dorsolateral stripe, vertical bars along the trunk, and the black spot on the caudal peduncle. The black preorbital and white suborbital bars are well visible here too. This individual could be a female or a young, non-nesting male. They both differ from nesting males notably by shorter rays in the second dorsal fin. *13 Jul 2018, Pomer (Croatia), Roberto Pillon.*

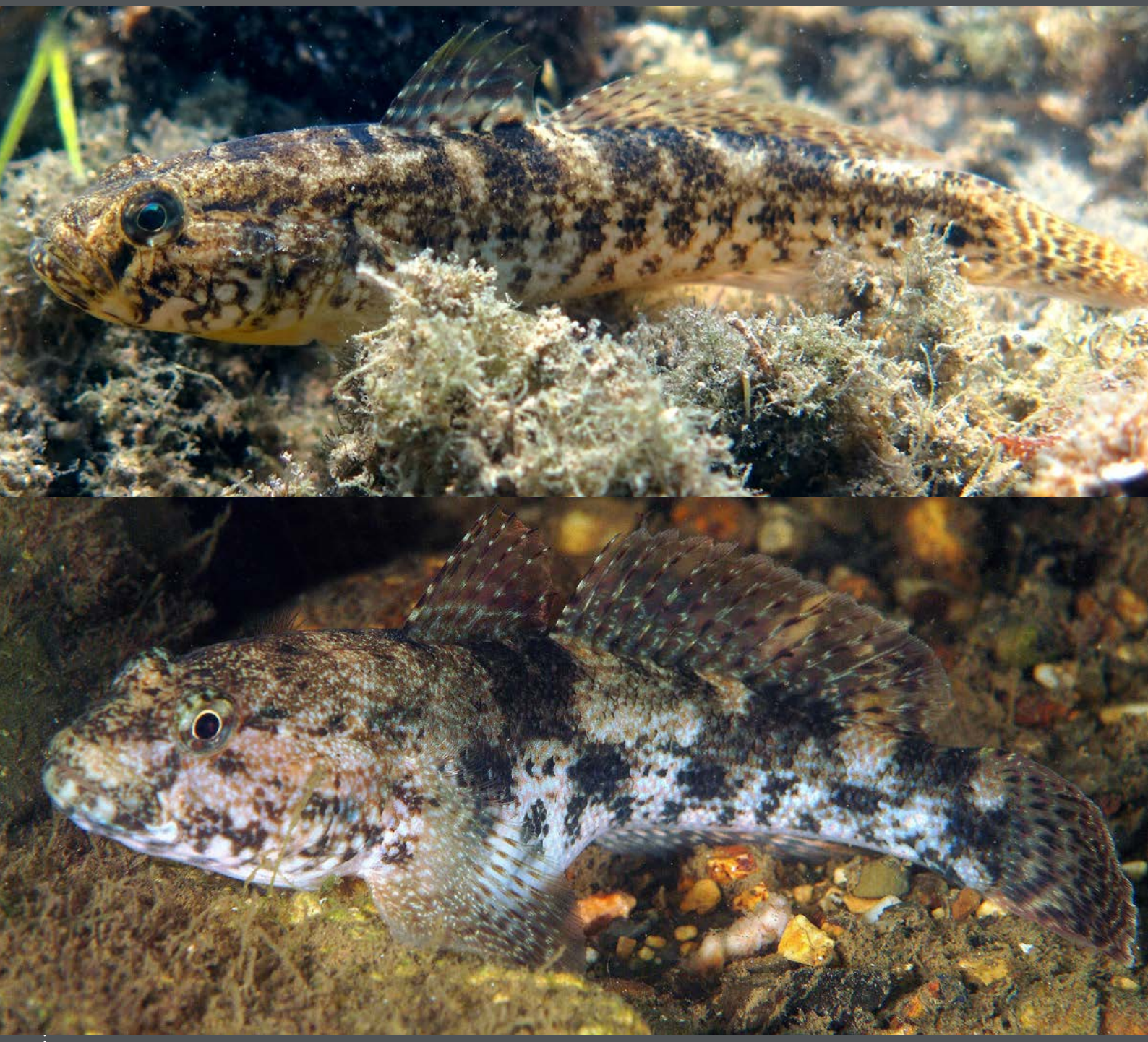
Grass goby (*G. ophiocephalus*), im. Young Grass gobies are simply diminutive versions of adults. *13 Jul 2018, Pomer (Croatia), Roberto Pillon. Photo flipped horizontally.*

Grass goby

Gobius ophiocephalus Pallas, 1811



Grass goby (*G. ophiocephalus*), ad (top); **Black goby** (*G. niger*), ad (bottom). Black goby is often mistaken for Grass goby in lagoons; however: Grass usually has a distinct dorsolateral light stripe along the body, the black pectoral blotch is dorsoventrally elongate (vs. longitudinally elongate in Black), the fish is tinted olive (vs. rarely the case in Black, which typically has browner markings), it has white circular spots on the cheeks (vs. irregular white markings in Black), and the sensory papillae are more visible on cheeks than on the nape (similarly conspicuous in Black). Note also the difference in overall structure, with Grass having a deeper and longer body (vs. more cylindrical and shorter in Black), smaller eyes, and a slightly longer snout with a shallower profile. *30 Jun 2016, Thau lagoon, Frontignan (34), Julien Renoult; 12 May 2014, Cagliari (Sardegna, Italy), Thomas Menut. Both Photos flipped horizontally.*



Grass goby (*G. ophiocephalus*), im (top); **Giant goby** (*G. cobitis*), ad (bottom). Grass gobies from the Adriatic often lack the dark upper lateral, light dorsolateral and black vertebral stripes characteristic of individuals from the Western Mediterranean. Instead, they have dark saddles on the back, potentially causing confusion with Giant gobies; however, the small midlateral blotches dorso-ventrally elongate, circular spots on cheeks, well-distinct preorbital bar and proportionally small head, here help recognizing a Grass goby. *13 Jul 2018, Pomer (Croatia), Roberto Pillon; 31 Oct 2011, Tuscany (Italy), Stefano Guerrieri.*

Rock goby

Gobius paganellus Linnaeus, 1758

Gobie paganel (*Fr*)
Felsengrundel (*Ge*)
Bobi (*Sp*)
Ghiozzo paganello (*It*)

Medium-sized • short snout and moderately steep head profile • large scales on nape • first dorsal fin with yellow or orange margin • very well-developed upper pectoral free rays • common to very common, in rocky habitats, usually at 0.5-10 m depth

• Description

Medium-sized goby 8-12 cm long (maximum 15 cm) with a proportionally short and stocky body. Head wide, moderately depressed; from above, the cheeks appear swollen. Ground body colouration highly variable, ranging from light beige to dark brown or even plain brick red. The most common colouration shows an alternance of large black and thin white saddles on the back, medium-sized dark blotches along the lateral midline and small dark markings on a light background below the midline. However, some individuals are entirely black, while others have a dominantly light back and thin black saddles. Midlateral blotches sometimes flanked by a pair of white spots. Two white spots on the caudal pedoncule, at the base of the caudal fin. Eyes without clear horizontal stripes but with separated dark markings all around the orbit. Head all black, or light-coloured with various dark markings and usually a large white circular spot at the ventral border of the cheek followed by another white mark on the preopercle. In light-coloured individuals, the dark markings are: an ill-defined V-shaped snout line (most often invisible); a preorbital line between the upper lip and the eye (generally bordered ventroposteriorly by a white suborbital bar, which can be either absent or very conspicuous; this white bar extends onto the corner of the mouth); a sinuous horizontal line starting from behind the corner of the mouth and running rearwards along the dorsal side of the white ventral cheek spot; a short oblique line running rearwards from the posteroventral border of the eye, prolonged by a thin horizontal line; and an oculoscapular line made of three separated black spots. First dorsal fin dark brown with two to three light transverse bands on both the membrane and the rays, and one broad orange to yellow terminal band. Second dorsal fin with a more marbled pattern, where light markings do not form distinct bands. This fin is also edged by a yellow band that is much thinner than on the first dorsal fin. In very dark individuals, both dorsal fins can be edged blue. Caudal fin transparent, or brown with rays dotted white, or all black. Two dark spots at the base of the caudal fin, covering both the membrane and the rays. Anal fin almost plain-coloured, smoky-grey. Pelvic disk lighter and pearly grey. Upper pectoral free rays very well developed, long and strongly divided. Base of pectoral fins often with a vertical serie of 5 light-dark-light-dark-light patches; the uppermost patch distinctly whiter. Pectoral fin rays typically dotted white. Predorsal area and nape entirely covered with large scales. Cheeks most often naked, but some individuals have a few scales on the upper posterior corner. Body scales large. Anterior nostril with a strongly digitate process longer than the nostril tube, or rarely a flattened tentacle. Head sensory papillae well visible, pigmented black.

Rock goby (G. *paganellus*). *27 Jun 2020; Pomer (Croatia); Roberto Pillon.*

Night colouration. Not significantly different from day colouration (which is already extremely variable).

Sexual dimorphism. Sexually mature males differ from females by a broad yellow to orange terminal band on the first dorsal fin; they also tend to be darker and have a more purple colouration.

Juveniles. Proportionally bigger eyes, large nape scales not always visible in very young individuals, more transparent and poorly patterned fins (but very early on during development, some juveniles can show the characteristic yellow-orange terminal band at the first dorsal fin margin) and an iridescent blue or dark grey blotch at the posterior border of the first dorsal fin.

Geographic variation. Unknown.

• Similar species

Young rock gobies can be confused with immature **Red-mouthed gobies** (*G. cruentatus*), when this species has not yet developed its diagnostic red lips. Structure and patterning can be similar between these species, which are furthermore the only European *Gobius* that can show scaled cheeks. Red-mouthed goby differs from Rock goby by a slightly deeper head and less swollen cheeks when seen from above, smaller scales on the nape, short and moderately developed pectoral free rays (vs. long and very well developed in Rock goby), conspicuous black and white sensory papillae on the head including on the nape (*vs*. sensory papillae black only, and barely visible on the nape), and larger, more squarish midlateral blotches. Juveniles of Red-mouthed differ by the patterning of the first dorsal fin, with two white spots at the front edge (*vs*. no white spots but a blue posterior blotch in Rock), a reddish ground colouration of the iris (*vs*. withish), more conspicuous white suborbital bar and sensory papillae, and more visible white spots flanking the brown midlateral blotches.

Giant goby (*G. cobitis*) is another potential pitfall, but it has a larger head with a longer snout, smaller scales on the nape, well developed (though less than in Rock) but shorter pectoral free rays, usually larger and blacker blotches along the lateral midline, more heavily speckled pectoral fins, and more numerous white dots over the head and the trunk ('pepper-and-salt appearance'). According to Pinchuk and Strautman (1977), Rock and Giant gobies can hybridize.

Grass goby (*G. ophiocephalus*) is distinguished by its poorly developed pectoral free rays (*vs*. well developed in Rocks), small and hardly visible scales on the nape (*vs*. large and well visible) and a compressed head (*vs*. rather depressed in Rock) with proportionally smaller eyes.

Juveniles of Rock goby are often mistaken for **Zebra gobies** (*Zebrus zebrus* and *Z. pallaoroi*; adult Rock are easily distinguished by their nape covered with large scales, while the nape is naked in Zebra). Zebra usually has a white collar on the nape running down oblically toward the base of pectoral fins, zebra stripes on the snout and between the eyes, less developed pectoral free rays, and red bands on dorsal fins (vs. dorsal fins largely transparent, sometimes with a metallic blue spot on the posterior border in juvenile Rock). Moreover, Zebra goby has a more depressed head compared to juvenile Rock goby, and shows alternating light and dark vertical bands on the body.

Large-headed goby (*Millerigobius macrocephalus*) strongly resembles Zebra goby and thus could be potentially confused with juvenile Rock goby. Part of the differentiating characters are those previously cited for Zebra goby: white collar on the nape running down oblically toward the base of pectoral fins, less developed pectoral free rays, red bands on dorsal fins and light and dark vertical bands on the body. In addition, in Large-headed goby pectoral rays are free from the membrane (only at the tips of the uppermost rays); vs. pectoral free rays well developed in Rock) and are less numerous (14-16 vs. >18), head is speckled white (vs. not in Rock), and tubular nostrils have no tentacle (vs. terminated by a thin tentacle).

Last but not the least, **Bellotti's goby** (*G. ater*) should always be considered when encountering a dark Rock-like goby in the seagrass. Live colouration of Bellotti's is not known for sure but it is probably very dark with lighter areas on head underparts, and like Rock it has a yellow marginal band at the first dorsal fin. However, Bellotti's has a shorter (5-6 vs. > 8 cm) and deeper body, bigger eyes, shorter pectoral free rays and smaller scales on the nape. In addition, the yellow marginal band is thinner. When possible, check the number of scales along the lateral midline: 38-40 in Bellotti's vs. > 46 in Rock.

• Distribution & Status

Rock goby occurs in the North-eastern Atlantic from the Shetland Islands in Scotland to the Western Sahara (and in Senegal according to Delais, 1951), as well as in the Azores, the Canary Islands and Madeira. It is present on both sides of the English Channel. In the North Sea, it reaches Rotterdam harbour in the Netherlands (see waarneming.nl). Rock goby occurs all around the Mediterranean basin and in the Black Sea (Engin & Seyhan, 2009).

It has been reported from the Gulf of Aqaba and thus is listed as an anti-Lessepsian migrant (Miller, 1986); however, we are not aware of any recent record in the Red Sea.

In *France*, it is very common along all rocky shores of the English Channel, the Atlantic, and the Mediterranean coasts. It also occurs in coastal lagoons; for example in Palo, Biguglia, Diana and Urbino in Corsica, Thau and Berre in mainland.

- **Habitat**

Rock goby can be observed at depths from 0.5 m to 20 m. It lives on hard bottoms, particularly among rocks covered with algae. It likes the shade and is often seen in holes, cracks and small caves. It is one of the most common benthic fish in the intertidal pools of the North-eastern Atlantic. In the Mediterranean, juveniles are frequently seen among pebbles. Adults can be found in larger caves, sometimes among orange sponges and red bryozoans and sponges (they can then sport an unusual brick red colouration). In Corsican lagoons, Rock goby lives among sea grasses on soft and muddy bottoms (Kara & Guignard, 2018).

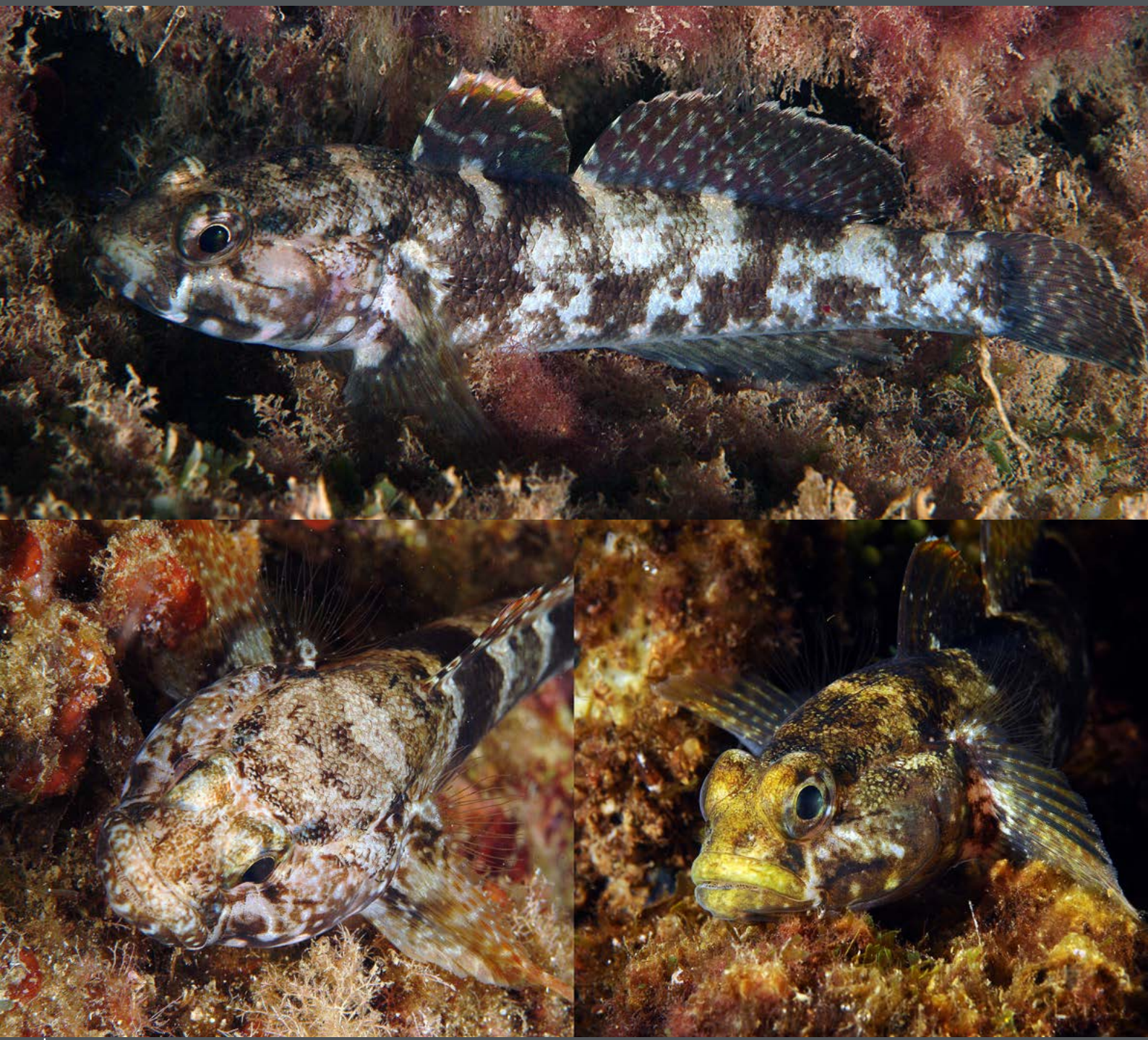
- **Miscellaneous**

☝ The determinisms of colour variation in Rock goby is not fully understood. It is likely that the different patterns are determined by sex, age, season and mood. Additional work is needed to disentangle the potential roles of these factors in Rock goby's colouration. Everyone can contribute to increasing knowledge by posting pictures with information on location, date, time of the day and behaviour on one of the public databases cited in the Introduction chapter.

Rock goby (*G. paganellus*). With its large mouth, Rock goby is a voracious predator of shallow waters, here eating a sand smelt. *01 Jun 2021, Thau laggon (34, France), Patrick Louisy.*

Rock goby

Gobius paganellus Linnaeus, 1758



Rock gobies (*G. paganellus*), ad ♂♂ . The two most important characters identifying these fish as Rock gobies are the large scales on the nape and the numerous and well developed (i.e. strongly divided) upper pectoral rays free from the membrane. Other noticeable criteria include a wide head with swollen cheeks when seen from above; a yellow marginal band at dorsal fins, larger on the first dorsal fin; circular white spots on the ventral border of the cheeks; dark preorbital and postorbital bars, the latter ending in a thin line, the postorbital line running rearward horizontally (on top of papillae row *b*), the preorbital bar and postorbital line being bordered posteriorly and anteriorly, respectively, by white suborbital bars connected by a white area just below the eye; a marbled patterning of the trunk; and the base of pectoral fins coloured light-dark-light-dark-light. In the bottom right individual, note also the scales on cheeks, a feature found only in Rock and Red-mouthed gobies in the region. *04 Nov 2006, Tuscany (Italy), Stefano Guerrieri; 20 Aug 2011, Tuscany (Italy), Stefano Guerrieri; 16 Jun 2013, Tuscany (Italy), Stefano Guerrieri. Top photo flipped horizontally.*

Rock goby (*G. paganellus*), ad ♂. 'Djoba', the pet goby of one of the authors, photographed in an aquarium. These two pictures, taken less than a day apart, illustrate the important intra-individual variation in patterning. Rock gobies can change colouration in a matter of seconds; here 'Djoba' turned black when 'Drac' the blenny entered its territory. On the light colouration, note the characteristic cheek patterning of Rock described in the previous caption. *28 Oct 2019, fish caught in Bretignolle-sur-Mer (85, France), Julien Renoult. Bottom photo flipped horizontally.*

Rock goby

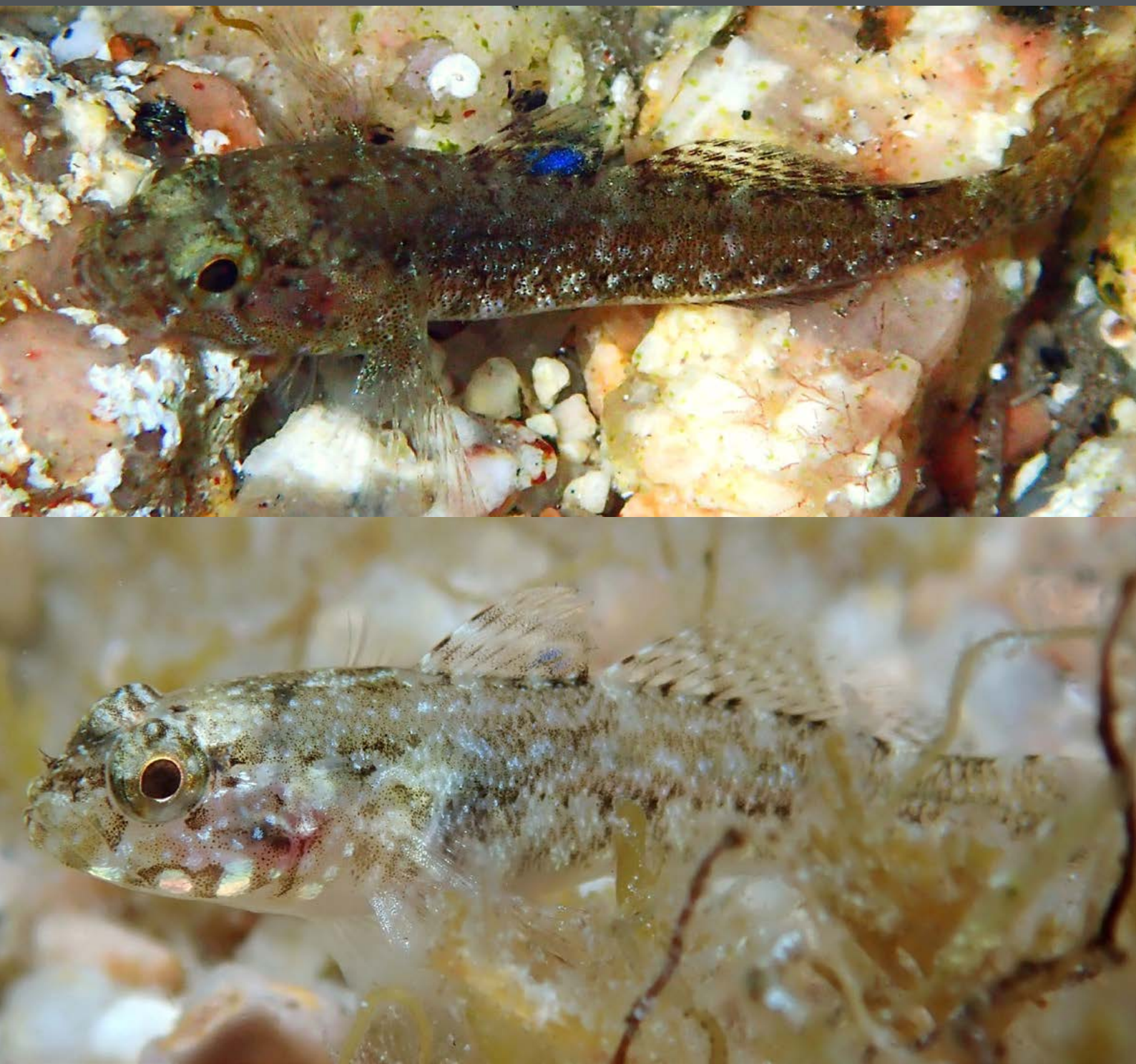
Gobius paganellus Linnaeus, 1758

Rock goby *(G. paganellus),* ad. A very pale individual identified by the large nape scales, well developed pectoral free rays, stubby appearance and the two black spots at the base of the caudal fin. *02 Jul 2015, Hersonissos, Crete (Greece), Nicolas Bailly (Fish Watch Forum). Photo flipped horizontally.*

Rock goby *(G. paganellus)*, im. A young individual (4 cm long) with an unusual yellow colour. *15 Jul 2013, Tuscany (Italy), Stefano Guerrieri.*

Rock goby

Gobius paganellus Linnaeus, 1758



Rock gobies (*G. paganellus*), juvs. The metallic blue spot at the rear of the first dorsal fin is characteristic of juvenile Rock goby. The large scales on the nape, the pectoral free rays (visible on the high-resolution image) and cheek patterning clinch the identification. *05 Jul 2020, A Testa, Corsica (France), Julien Renoult; 02 Jul 2020, A Testa, Corsica (France), Julien Renoult.*

Rock goby

Gobius paganellus Linnaeus, 1758

Rock goby (*G. paganellus*), ad (top); **Giant goby** (*G. cobitis*), ad (bottom). Compared to Giant, Rock has a nape entirely covered with large visible scales, pectoral fins have more developed (more divided) and longer pectoral free rays, snout is shorter, midlateral blotches are rectangular (vs. circular in Giant), and the cheeks are scaled. *06 Jun 2013, Krk (Croatia), Thomas Menut; 24 Jun 2014, Marseillan (34, France), Thomas Menut.*

Rock goby

Gobius paganellus Linnaeus, 1758

Rock goby (*G. paganellus*), juv (top); **Red-mouthed goby** (*G. cruentatus*), juv (bottom). In Rock goby, note the large scales on the nape, white patch at the upper base of the pectoral fin (when present, the white patch is at the front edge of the opercle in Red-mouthed). In Red-mouthed, note the already reddish lips and reddish iris, the two white spots at the front edge of the first dorsal fin that extends onto the first interradial space (in Rock, white is either on the rays only, or it forms bands extending across the entire fin), and the white-pigmented sensory papillae on the cheek. *02 Jul 2019, Sithonia (Greece), Roberto Pillon; 30 Jul 2015, Port Lligat (Spain), Thomas Menut.*

Rock goby

Gobius paganellus Linnaeus, 1758

Rock goby (*G. paganellus*), juv (top); **Giant goby** (*G. cobitis*), juv (bottom). Be careful with very young Rock gobies that have not developed large nape scales yet. Compared to juvenile Giant (which is a diminutive version of adult Giant), juvenile Rock has a shorter snout with a steeper profile, no V-shaped snout line (vs. snout line usually well visible in young Giant), and the eyes have various dark markings in the dorsal and ventral half of the iris (vs. only horizontal stripes). *03 Aug 2019, Les Sables d'Olonne (85, France), Julien Renoult; 17 Jun 2013, Sardinia (Italy), Roberto Pillon. Top photo flipped horizontally.*

Rock goby

Gobius paganellus Linnaeus, 1758

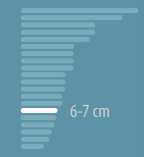
Rock goby (*G. paganellus*), juv (top); **Zebra goby** (*Zebrus zebrus* or *Z. pallaoroi*), ad (bottom). Zebra goby is smaller (max 7 cm, has no visible scales on the nape (large nape scales in Rock), a white collar on the nape and less developed pectoral free rays. In Zebra, note also the alternating light and dark vertical bands on the side. *30 Jul 2015, Port Lligat (Spain), Thomas Menut; 21 Jul 2013, Cadaqués (Spain), Thomas Menut.*

Roule's goby

Gobius roulei De Buen, 1928

Gobie de Roule (*Fr*)
Roule-grundel (*Ge*)
Gobio de Roule (*Sp*)
Ghiozzo di Roulei (*It*)

Small • steep head profile • first dorsal fin long and pointed in males • light ground colour with reddish-brown mottling on back • white lips • well visible oculoscapular line generally made of two parts • light orange or pink dash just posterior to the eye • uncommon, on soft bottoms, at 2-30 m depth



• Description

Small goby 6-7 cm long (maximum size: 8.7 cm; Kovačić, 2001) with a medium-length body, proportionally large head with a short and steep snout. Ground colouration white, greyish or pale orange. Lateral midline covered with an almost continuous line of black or dark brown dots between the pectoral and the caudal fin; the line is slightly broadened at regular intervals to form 5 to 6 midlateral blotches. Back mottled orange to dark brown, with white or grey patches sometimes forming thin saddles. In some individuals, an indistinct dorsolateral stripe extends the oculoscapular line rearwards. Underparts almost uniformly light cream, with only faint greyish markings below the midlateral blotches giving the impression that blotches bleed ventrally. Orbit uniformly coloured, but some individuals have a well defined horizontal eyestripe and/or a vertical stripe in the upper half of the orbit. Head with a variable colouration, usually a reddish brown mottling with one pale, thin saddle on the nape. Frontal side of the snout most often unpatterned, sometimes with an indistinct V-shaped line. One brown preorbital bar not extending onto the upper lip. This preorbital bar is bordered posteriorly by a faint, light suborbital bar extending from the orbit to the corner of the mouth. Lips uniformly coloured white (always in upper lip, the lower lip can have ill-defined dark spots). Oculoscapular line generally made of two parts: one short, broad and generally light orange or pink dash just posterior to the eye, followed by a thinner and darker brown line reaching the upper base of the pectoral fin. Reddish-brown longitudinal markings often seem to extend the lateral midline in front of the pectoral fin. First dorsal fin semicircular in shape, or long and pointed in mature males. First spines of both dorsal fins with dark transverse stripes. Dorsal membranes white, with a yellow shading on the distal half, and 2 to 3 (first dorsal fin) or 3 to 4 (second dorsal fin) faint, darker transverse bands on the proximal half. Caudal fin either transparent, or speckled brown and white. Anal fin transparent or plain white. Pelvic disk pearl white. Base of pectoral fins white; white flecks on fin rays. The upper base of pectoral fins is marked with a brown or orange horizontal stripe, which tends to split into two parts that are either disconnected, or connected by a thinner dark area, thus forming a diabolo-shaped marking. Pectoral free rays moderately developed. Predorsal area naked, without scales. Body scales large, with width about 5% of standard length. Anterior nostrils tubular and terminated by a triangular lappet.

Roule's goby *(Gobius roulei)*, ad ♂. *21 Jun 2021; Agay (83, France); Patrick Louisy.*

Night colouration. Darker than in day colouration, in particular: cheek area below the eye uniformly blackish and preorbital bar black, thus making the white suborbital bar more contrasting; ventral part of the opercle black, the preopercle thus becoming a contrasting pale area between the cheek and the opercle; back darker, making white saddles more apparent; midlateral blotches broader.

Sexual dimorphism. In mature males, the pelvic disk and the anal fin tend to be darker than in females, and the first dorsal fin is characteristically elongate and pointed (rays 3-4 of the first dorsal fin the longest), reaching rays 5-7 of the second dorsal fin when depressed.

Juveniles. Body largely transparent with pearly white spots on the back, head pearly white; otherwise, patterning resembling that of adults, but light orange. Dorsal fins transparent with a few white dots, a yellow pigmentation in the distal half, sometimes an orange marginal band, and two dark spots (transverse ray stripes extending onto the membrane) at the fore edge of the first dorsal fin, proximally. Upper base of pectoral fins marked with two well separated orange spots.

Geographic variation. Not documented.

• Similar species

Roule's goby differs from all other *Gobius* species by its naked predorsal area, and proportionately larger body scales (Kovačić & Golani, 2006). These features are not easily visible in pictures, though, and identification generally relies on body shape, colouration and patterning.

Roule's goby is most likely to be confused with **Black goby** (*G. niger*) as both species have a steep head profile (although it appears less steep in Roule's), dark transverse stripes on the spinous ray of dorsal fins, and an elongate first dorsal fin in reproductive males (Roule's and Black gobies are the only *Gobius* with a pointed and elongate first dorsal fin). However, adult Black are distinctly larger (total length 16-20 vs. 6-8 cm in Roule's), have thicker and more clearly differentiated blotches along the lateral midline, underparts with pigmented scales below the inter-blotch spaces (these areas are unmarked in Roule's), an oculoscapular line uniformly coloured and split into 3 parts (vs. into 2 parts in Roule's: the first part, a short dash just posterior to the eye, broader and lighter than the second part), and dark-pigmented lips (vs. white in Roule's). Furthermore, Black has more horizontal bands (typically 3, *vs*. 2 in Roule's goby), these bands are more distinct at the base of the dorsal fins, and the distal parts have limited yellow shading (vs. dominantly yellow). Contrary to some Black, Roule's never has dark blotches in the upper front edge of the dorsal fins, and it is not known to display the whole black colouration of Black nesting males, even at night. The nape sensory papillae differ between the two species and can be used to confirm identification on good-quality photographs. Papillae are longer in Black, and their arrangement is different. In Black, oblique rows *o* are distinctively longer, antero-posterior rows *g, h* and *m* are slightly longer (difference most visible in *m*), and rows *h* are always continuous (sometimes split into two parts in Roule's). The horizontal eyestripe is usually indistinct in Black (*vs*. often conspicuous). At night, the discriminant features are the same as in daytime, plus Black has preopercles marbled brown (preopercles light-coloured in Roule's). Juveniles of Black and Roule's are very similar, not always separable with current knowledge. Check the colour of the lips (white in Roule's) and of the first dorsal fin (more yellowish in Roule's). Moreover, young Roule's is typically patterned orange while young Black is browner.

Steven's goby (*G. gasteveni*) differs from Roule's by a more reddish colouration, a distinctive V-shaped snout line (*vs*. indistinct in Roule's), 3 body stripes (*vs*. 2) with a paravertebral stripe in addition to the midlateral and dorsolateral stripes, and a different patterning of the first dorsal fin (spotted white in Steven's vs. banded brown). In addition, the shape of the oculoscapular line is different: continuous in Steven's, often underlined with black, and bordered ventrally by three orange dashes not touching the oculoscapular line (line in 2 parts in Roule's, no dash ventrally). With the exception of the 2 paravertebral stripes, the nape tends to be more uniform, not as marbled as in Roule's. Juveniles of Steven's have black melanophores on lips (*vs*. white lips), black oculoscapular line (*vs*. red), dorsal fins more yellow with an outstanding white marginal band (vs. dorsal fin yellow in the distal half, or white with an orange marginal band), a single black pectoral blotch (*vs*. two red pectoral blotches) and a cheek more contrastingly black below the eye.

Rock goby (*G. paganellus*) has large, well visible scales on the nape (nape nacked in Roule's), a more robust body with a larger head, outstanding pectoral free rays, a marbled colouration below midline and usually larger and more visible bands on dorsal fins.

Incognito goby (*G. incognitus*) has a more elongate snout with a shallower head profile, dark brownish dots on the entire body including below midline, and a dark lower lip. Young Roule's goby could to be confused with juvenile **Slender goby** (*G. geniporus*). Juvenile Slender goby differs by a well-marked V-shaped line on the snout (absent in young Roule's goby), a continuous, uniformly coloured oculoscapular line (*vs*. oculoscapular line split into 2 parts in Roule's, the first part lighter than the second part) and a slightly longer snout.

See also the species account of **Kestrel goby** (*G. xoriguer*).

Roule's goby

Gobius roulei De Buen, 1928

• Distribution & Status

Roule's goby is mainly a Mediterranean species, occurring only in the southern tip of Portugal in the Atlantic (Maul, 1976). It was described in 1919 from a specimen collected in the Bay of Palma, in the Balearic Islands (De Buen, 1928), and since then it has been recorded in many places of the Northern Mediterranean from Gibraltar to Malta (Kovačić & Schembri, 2019) and Cyprus (Kovačić & Golani, 2006), including in the Adriatic (Kovačić, 1995; Lipej *et al*., 2005), Ligurian (Liu *et al*., 2009b), Aegean and Levantine (Bilecenoglu *et al*., 2014) seas. It has never been found along the African coast yet.

In *France*, the first record of Roule's goby is from Scandola Nature Reserve in Corsica (2B), where one individual was photographed in 1999 (Francour et al., 2010). A scientific survey conducted in the same place in 2009 revealed the presence of several individuals (Francour *et al*., 2010); at the time identified as Steven's gobies (*G. gasteveni*). Next observation is from Tarco beach, in Corsica again, in May 2011 (2A; Thomas Menut; Fish Watch Forum). Today, the species remains relatively rare, with certified records from Argelès-S/-Mer (66, Julien Renoult, photo); Cerbère (66, Patrick Louisy, Photo), Cap Caveau in Marseille (13; Sylvain Le Bris; DORIS), Anse de Figuerolle in La Ciotat (13; Fish Watch Forum), Calanque de Méjean in Ensuès-la-Redonne (13; Béatrice Lanza et al., DORIS) and le Graillon in Antibes (06; Xavier Rufray; Fish Watch Forum). Roule's goby is probably largely overlooked, being mistaken for Black goby.

• Habitat

Roule's goby is most often observed between 3 m and 30 m depth, but the Atlantic record from Portugal is from an individual fished between 300 m and 400 m depth (Maul, 1976). It is a marine species usually found on large patches of sand among seagrass or bedrocks. The sand is typically mixed with scattered seashells, stones and pebbles that are used for egg-laying (from May to August in Croatia; Kovačić, 2001b). In the deeper Corsican sites, it is found on coarse sand in the vicinity of the coralligenous (Francour et al., 2010). In general, the species favours good-quality habitats with clear water and clean sand, and avoids muddy bottoms.

• Miscellaneous

☝ Roule's goby can be a gregarious species, sometimes found in dense populations in suitable habitats. Adults are most frequently observed nearby holes that they dig under isolated stones or pebbles.

☝ Although it has been suggested that the species is most frequent at night, in France at least observations are made both during day and night. In that country, records span from May to September, which matches the reproductive season, but also the diving season. Yet, in the Kvarner area (Croatia), invidiuals were observed and sampled all year around for a study on their biology (Kovačić, 2001).

Roule's goby

Gobius roulei De Buen, 1928

Roule's goby (*G. roulei*), ad ♂ (top); **Roule's goby** (*G. roulei*) ad ♀ (bottom). Both individuals are readily identified as Roule's by the short snout with a steep profile, light ground colouration, white lips and cheeks, poorly marked front, thin midlateral blotches, unmarked underparts below inter-blotch spaces, oculoscapalar line mostly continuous. Sexed based on the shape of the first dorsal fin, elongate only in ♂♂. *17 Jun 2016, Maddalena (Italy), Roberto Pillon; 15 June 2016, Maddalena (Italy), Roberto Pillon.*

Roule's goby

Gobius roulei De Buen, 1928

Roule's goby (*G. roulei*), ad ♂. The predorsal area is naked, without scales, which is a unique character among *Gobius* species. Note also the white lips and the conspicuous horizontal eyestripe. *15 Jul 2012, Hvar (Croatia), Roberto Pillon. Photo flipped horizontally.*

Roule's goby

Gobius roulei De Buen, 1928

Roule's goby (*G. roulei*), ad ♀ . The white cheek appearance is due to whitespots visible on this close-up photo. The combination of pale ground body colouration, continuous oculoscapular line extending posterior to the pectoral fin, dark transverse stripes on the spinous ray of dorsal fins, clear white belly and plain coloured snout without a V-shaped line identifies it as Roule's goby. Aged based on size in the field, and sexed based on the shape of the first dorsal fin (given that it is an adult). *22 Jun 2016, Maddalena (Sardinia, Italy), Roberto Pillon Photo flipped horizontally.*

Roule's goby (*G. roulei*), ad ♂, night colouration. The shape of the first dorsal fin points toward either Black or Roule's goby (but keep in mind that beyond genus *Gobius*, other gobies have a pointed first dorsal fin, notably *Didogobius splechtnai* that nevertheless differs by having no blotch on lateral midline, and by showing complete brown vertical bands, not just saddles as here). Roule's goby is identified based on the white lips, the yellowish tint of the first dorsal fin, the region below inter-blotch spaces being unmarked and the pale area between the dark cheek below the eye and the dark opercular blotch. *30 May 2015, Tossa de Mar (Spain), Patrick Louisy.*

Roule's goby

Gobius roulei De Buen, 1928

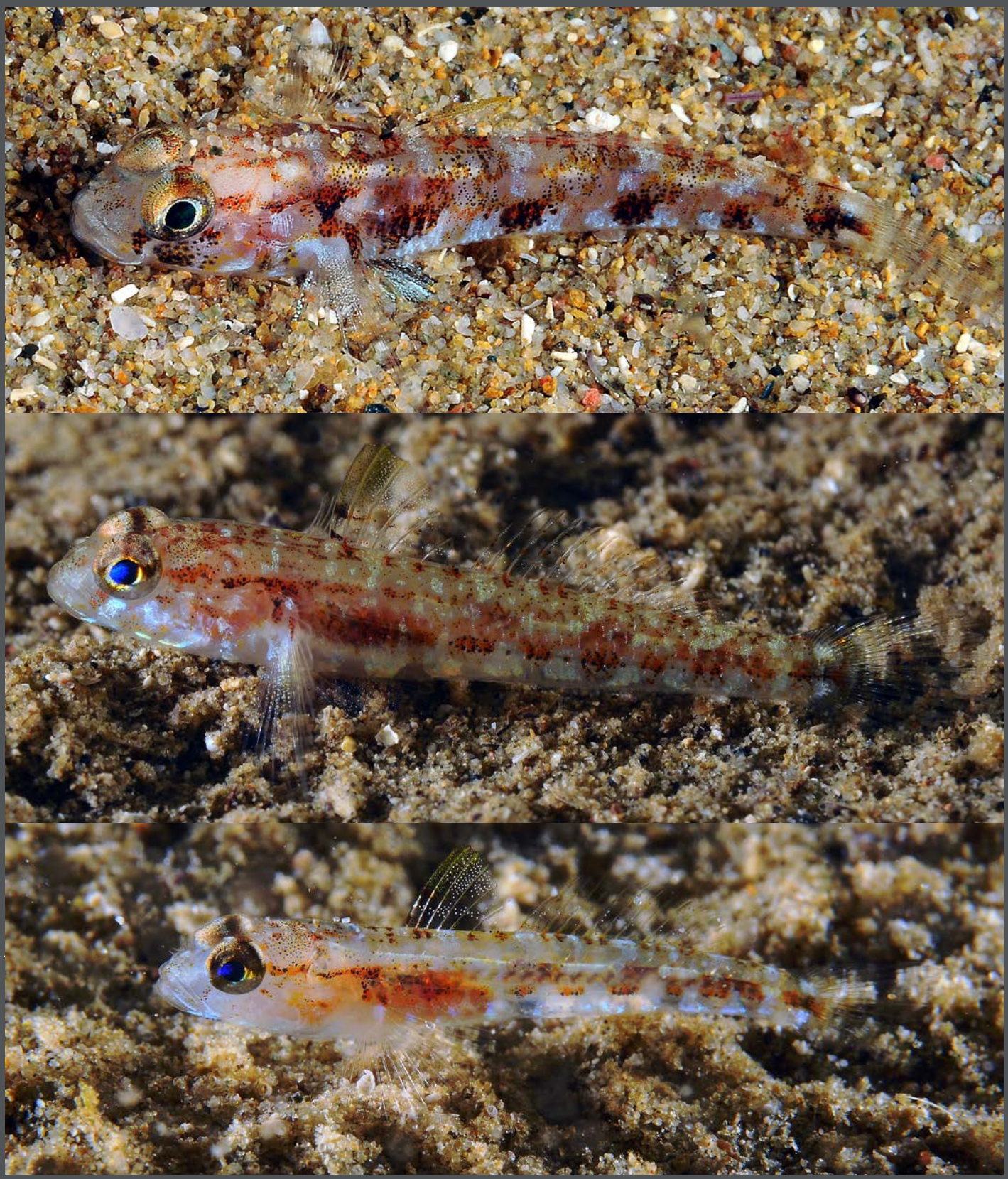
Roule's gobies (*G. roulei*), ad ♂ (top & center); **Roule's goby** (*G. roulei*), ad ♀ (bottom). Compared to diurnal colouration, this night colouration is overall darker, midlateral blotches are broader and the cheek is pigmented black below the eye. Characters used to identify Roule's in day colouration also apply to night colouration: short snout, light ground colouration, white lips, no markings on the underparts below inter-blotch spaces, oculoscapalar line largely continuous, only 2 transverse bands on the first dorsal fin, first dorsal fin tinted yellow, and predorsal area naked. The pale area between the dark cheek below the eye and the dark patch on the opercle confirms the identity. Top individual sexed by the pointed first dorsal fin; *23 Jun 2006, Tuscany (Italy), Stefano Guerrieri; 31 May 2017, Rijeka (Croatia), Stefano Guerrieri; 15 Sep 2011, Tuscany (Italy), Alessandro Falleni. Bottom photo flipped horizontally.*

Roule's goby (*G. roulei*). Another individual photographed at night, with all the diagnostic traits; see previous captions. *26 Nov 2006, Tuscany (Italy), Stefano Guerrieri. Photo flipped horizontally.*

Roule's goby (*G. roulei*), im. This young individual photographed at night can be identified as Roule's by its white lips, pale area between the cheek and the opercle, continuous oculoscapular line beginning anteriorly by a broad, light orange rectangle, no pigmented scales on the underparts below inter-blotch spaces, only 2 transverse bands on the first dorsal fin, first dorsal fin tinted yellow. At night, the midlateral blotches appear broad but the main, darker pattern along the lateral midline is typically thin and shows isolated dots. Aged by the proportionally big eyes. *18 Sep 2019, Samena, Marseille, (13), France, Sylvain Le Bris.*

Roule's goby

Gobius roulei De Buen, 1928



Roule's gobies (*G. roulei*), juv. Juveniles are patterned like adults but are typically transparent with brighter orange markings. Note the pattern of the first dorsal fin, with two dark transverse bars at fin base (similar to adults), many tiny white dots on the membrane, which is otherwise tinted yellow. The white lips and cheeks are characteristic of the species. *26 Nov 2011, Tuscany (Italy), Stefano Guerrieri; 01 Oct 2017, Rijeka (Croatia), Stefano Guerrieri (center & bottom).*

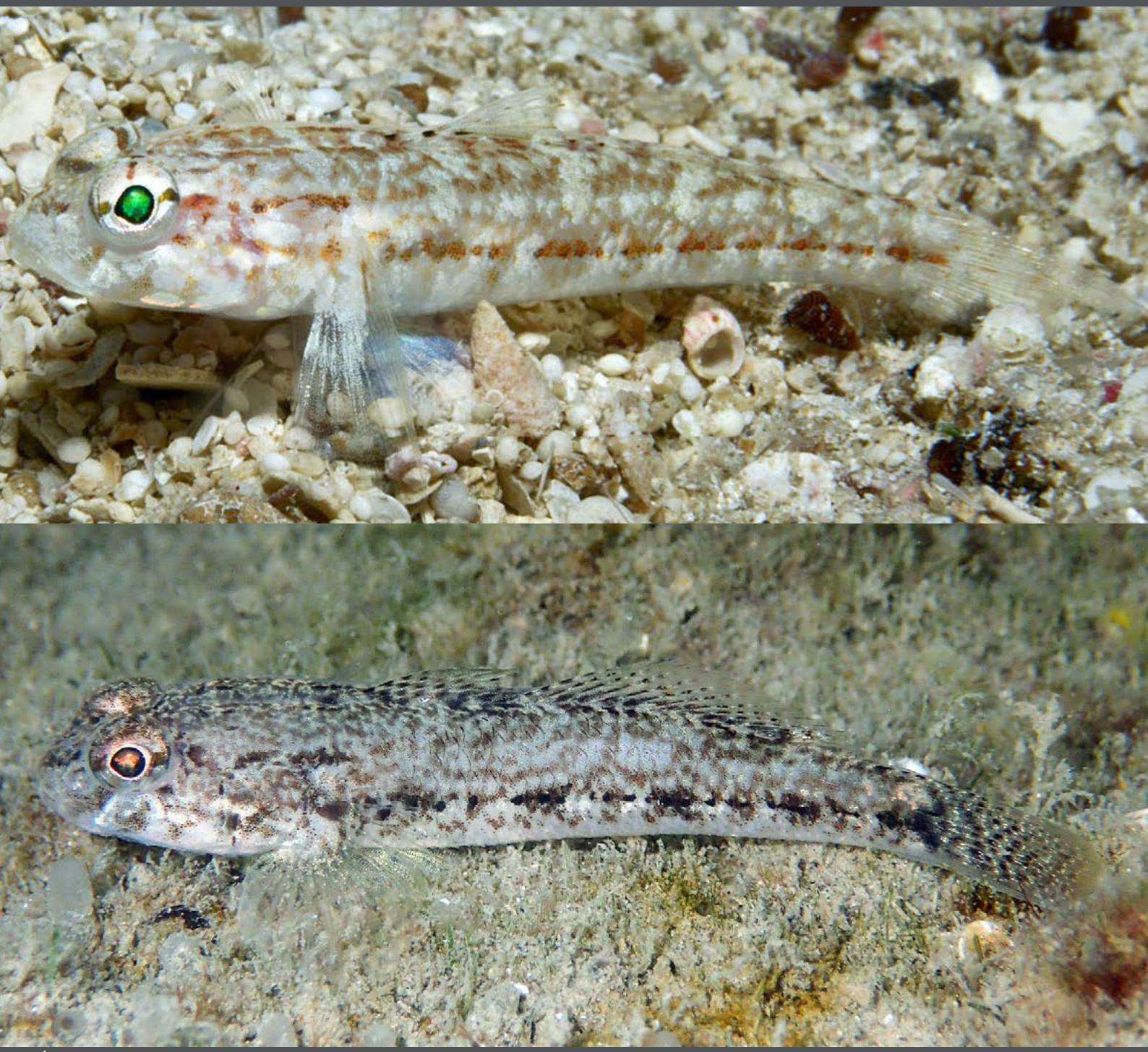
Roule's goby

Gobius roulei De Buen, 1928

Roule's gobies (*G. roulei*), ad ♂ (top & center); **Black goby** (*G. niger*), ad ♂ (bottom). Separating Roule's goby from Black goby can be challenging; however, Roule's usually differs by its overall warmer colouration, thinner body, slightly longer snout and bigger eyes, paler and more uniformly coloured lips, oculoscapular line continuous in its posterior two-thirds (vs. typically 3 disconnected bars in Black), fewer (typically 2 vs. 3, not well visible in this Roule's) dark transverse bands at the base of the first dorsal fin, and thinner midlateral blotches. The conspicuous horizontal eyestripe, reminiscent of Slender goby (*G. geniporus*; but without a V-shaped snout line), is an additional cue in favor of Roule's. Sexed as males based on the pointed first dorsal fin. *31 May 2015, Tossa de Mar (Spain), Patrick Louisy; 19 Jun 2019, Frontignan (34, France), Julien Renoult. Bottom photo flipped horizontally.*

Roule's goby

Gobius roulei De Buen, 1928



Roule's goby (*G. roulei*), ♀ (top); **Black goby** (*G. niger*), ♀ (bottom). The rather steep snout profile points towards either Roule's or Black. Compared to Black, in Roule's note the warmer brown body markings and whiter ground colouration, white lips, pale area between the cheek below the eye and the opercle, a distinct horizontal eyestripe, oculoscapular line almost continuous and the broadest in the area just posterior to the eye, inter-blotch spaces below the lateral midline clean white (vs. many black-pigmented scales in Black). *09 Oct 2016, Kas (Turkey), Patrick Louisy; 02 Oct 2016, Frontignan (34), France, Julien Renoult.*

Roule's goby

Gobius roulei De Buen, 1928

Roule's goby (*G. roulei*), ad ♂ (top); **Black goby** (*G. niger*), ad ♂ (bottom). At night, Roule's goby typically has richer yellow dorsal fins and a more strongly patterned trunk, with white saddles contrasting with black midlateral blotches. On the top individual, the identification is confirmed further by only 2 dark transverse bands on the first dorsal fin (vs. 3 in Black), an almost continuous oculoscapular line, white lips, and a contrasting pale area on the posterior border of the cheek. Last, note the difference in rows of sensory papillae on the predorsal area: in Roule's, oblique rows *o* (foremost rows on the nape) and longitudinal rows *h* (just anterior to the first dorsal fin) are shorter than in Black. *15 Sep 2011, Isola del Giglio (Italy), Stefano Guerrieri; 10 May 2016, Tuscani (Italy), Stefano Guerrieri. Top photo flipped horizontally.*

Roule's goby

Gobius roulei De Buen, 1928

Roule's goby (*G. roulei*), ad ♀ (top); **Black goby** (*G. niger*), ad ♀ (bottom); both in night colouration. The key discriminative features here include the shape of the oculoscapular line (2 parts in Roule's, the first part as a short rectangle just posterior to the eye, broader and lighter than second part, *vs*. 3 short horizontal dashes in Black), colouration of the upper lip (white in Roule's *vs*. pigmented in Black), colouration of inter-blotch spaces below the lateral midline (unmarked in Roule's *vs*. pigmented in Black), colouration of the posterior cheek (white in Roule's *vs*. pigmented in Black). *20 May 2015, Tossa de Mar (Spain), Lucas Berenger; 15 Apr 2016, Palavas-les-Flots (34, France), Julien Renoult. Both photos flipped horizontally.*

Roule's goby (*G. roulei*), ad ♂ (top); **Steven's goby** (*G. gasteveni*), ad ♂ (center); **Slender goby** (*G. geniporus*), ad (bottom). Adult males with reddish colouration are easy to identify because Black goby –the only other Gobius with a pointed first dorsal fin– does not display this type of colouration. If the first dorsal fin is not well visible, or with females, Steven's goby should be considered. The white lips and continuous oculoscapular line of this Steven's may initially lead to confusion; however, the first dorsal fin white spotted (vs. banded in Roule's), the paravertebral stripes (mostly visible on the nape here; absent in Roule's), and the V-shaped snout line (plain snout in Roule's) clinch the identification. Rarely, Slender goby can also have a reddish colouration. However, it has a more elongate body, longer snout with a more attenuated profile, rectangular midlateral blotches, pigmented lips, two dark vertical bars below the eye that are significantly more distinct ventrally, and the white patch of the pectoral fin has a characteristic transparent window. *30 Jun 2014, Algéciras (Spain), Manuel Martínez Chacón; 07 Jul 2010, Plymouth (England), Bernard Picton; 10 Aug 2016, Saint-Raphaël (83, France), Muriel Duhau. Top photo flipped horizontally.*

Striped goby

Gobius vittatus Vinciguerra, 1883

Gobie rayé (*Fr*)
Streifengrundel (*Ge*)
Gobio de banda negra (*Sp*)
Ghiozzo listato (*It*)

Small • body whitish with a broad, black lateral stripe between snout and tail base • locally common, on rock bottoms, at 15-40 m depth

• Description

Small goby 4-5 cm long (maximum length 6 cm) with a short and stout body. Striped goby is the smallest *Gobius* species within the studied area (possibly along with the newly described Kestrel goby). A broad dark-chestnut to black stripe between the snout and the caudal fin, passing through the eyes. Dorsal to that stripe, back shimmering light yellow to grey-green. Ventral to the stripe, belly white. The lateral stripes of both sides meet above the upper lip, forming a V-shaped snout line that slightly extends onto the upper lip medially. Eyes entirely covered by the chestnut stripe except the ventral border, which is white-coloured, and a triangle on top of the eyeball, coloured yellow. Cheeks with a light pinkish tint. Fins mostly clear and unmarked, yet often with a light pink colouration on rays and on the membrane. Base of pectoral fins sometimes with a limited pearly white patch. A small pink dot at the base of the caudal fin terminates the lateral stripe posteriorly. Pectoral fins with reduced free rays. Predorsal area with very small scales; cheeks naked. Anterior nostril terminated by a lappet or a tentacle.

Striped Goby (*G.vittatus*). *01 Jun 2017, Rijeka (Croatia), Stefano Guerrieri.*

Night colouration. At night, or when frightened even during the day, Striped goby can display 6 to 8 broad vertical bars on the back between the neck and the caudal peduncle, as well as 4 to 6 vertical bars on the side below the lateral stripe. The dorsal and ventral bars have the same intensity and width, but are offset from each other.

Sexual dimorphism. Unknown.

Juveniles. Not described in the literature.

Geographic variation. Unknown.

• Similar species

The colouration of Striped goby is unique among *Gobius* of the studied area.

Confusion can nevertheless occur with **Striped blenny** (*Parablennius rouxi*). The two species are very similar in colouration, sharing a white-yellowish body with a broad dark lateral stripe along the sides, and light pink fin rays. Nevertheless, the goby and the blenny obviously differ in lateral view, since like all blennies Striped blenny has a single, long and continuous dorsal fin (*vs*. 2 dorsal fins in gobies), a laterally compressed body (*vs*. body with a circular section), well developed cirri above the eyes (branched tentacles; absent in gobies), and pelvic fins forming 2 crutches very different from the gobies' pelvic fins fused into a disk. In dorsal view, the two species are more difficult to separate, but crucially, Striped blenny has a tendency to rest in a relaxed flexed or curved position, while Striped goby typically rests with a stiff, straight body. Striped blenny is also slightly larger (up to 8 cm in length). Moreover, in Striped blenny the two lateral stripes meet on the snout between the eyes, forming a broad band that does not reach the upper lip (in Striped goby, the stripes form a V-shaped line touching and even extending onto the upper lip). Like Striped goby, Striped blenny has a fright colouration with vertical bars, but the bars are well-defined only on the back; below the lateral stripe, the bars form ill-defined markings. Contrary to Striped goby, in Striped blenny the night colouration is different from the fright colouration: the lateral stripes are faded away and the back shows ill-defined markings.

Another potential pitfall is **Ringneck blenny** (*P. pilicornis*), which can exhibit a white morph with a black lateral stripe similar to Striped goby. These Ringneck blennies can be easily identified by their additional black vertebral stripe running under the dorsal fin. Moreover, the lateral stripes meet on the snout between the eyes (as in Striped blenny, but different from Striped goby), and the face almost always displays a honeycomb pattern characteristic of that species.

• Distribution & Status

Striped goby lives only in the Mediterranean, where it has been recorded, from west to east, from the Strait of Gibraltar in Spain to Livorno in Italy, in the Gulf of Tarente and the Gargano Peninsula (Italy), Eastern Adriatic, the Greek and Turkish coasts of the Aegean Sea and the State of Palestine. It also occupies the Balearic Islands, Corsica, Sardinia, Sicily, Malta and Crete. To our knowledge, the species has never been recorded along the African coast yet.

In *France*, Striped goby is rarely abundant but is not uncommon in suitable habitats. There are confirmed records along all the rocky shores of both mainland and Corsica.

• Habitat

In France, Striped goby is most frequently found between 15 m and 40 m depth, but it has been recorded down to 85 m depth. The species would be more and more frequent above 30 m (Francour et al., 2010), except in Scandola Nature Preserve (Corsica), where according to Francour et al. (2010) Striped goby is relatively common below 40 m but absent or very rare above 30 m depth. In the cooler waters of the Adriatic, it is most frequent at depths of 5 to 34 m, and has been noted at very shallow depth (2.5 m; Kovačić & Pijevac, 2008). Yet, in the warmer waters of the Eastern Mediterranean basin, the species is also found up to 2 m depth (Francour et al., 2010). Striped goby is typically found on steep to medium rocky slopes. In France, and particularly in the Pyrenean coast, it prefers coralligenous bottoms formed by calcareous red algae of the families Corallinaceae and Peyssonneliceae (Heymer & Zander, 1978). In the Adriatic, Striped goby occupies more varied habitats: mixed bottoms of rock and sand (Kovačić, 2004b).

• Miscellaneous

☝ Not only Striped goby and Striped blenny are similar in colouration, they are also frequently observed together. For these reasons, the two species could represent a form of mimicry. However, it has remained unknown what benefits this mimicry would convey. Based on the observation that the two species are similar also in fright colouration, but not in nightdress, Heymer and Zander (1978) proposed that mimicry would have a defensive function. Moreover, in fright colouration only the back is similar, that is, the body region most likely to be seen by predators. In animals, conspicuous stripes and bars are often used by animals to advertise venomousness or unpalatability. In the future, it would be interesting to analyse whether either or both species metabolise toxic proteins.

Striped goby

Gobius vittatus Vinciguerra, 1883

Striped gobies (*G. vittatus*), ad. Typical individuals showing the brown lateral stripe; a unique feature among European *Gobius*. The swollen belly suggests that the bottom individual is a female. *07 Oct 2017, Rijeka (Croatia), Stefano Guerrieri; 01 Jun 2017, Rijeka (Croatia), Stefano Guerrieri.*

Striped goby

Gobius vittatus Vinciguerra, 1883

Striped blenny (*Parablennius rouxi*), ad (top); **Ringneck blenny** (*P. pilicornis*), ad (bottom). These two species resemble Striped goby but they have a single dorsal fin, laterally compressed body, cirri above the eyes, disjoint pelvic fins, and a relaxed body position. Ringneck blenny further differs from Striped goby by its vertebral black stripe and a characteristic honeycomb head pattern. *10 Aug 2019, Banyuls-sur-Mer (66, France), Julien Renoult; 19 Aug 2012, Sète, (34, France), Thomas Menut.*

Striped goby

Gobius vittatus Vinciguerra, 1883

Striped goby (*G. vittatus*), ad (right); **Striped blenny** (*P. rouxi*), ad (left). In the goby, the body is held straight and appears cylindrical. Note also the difference in how the two lateral stripes meet on the snout. *03 Oct 2017, Rijeka (Croatia), Stefano Guerrieri.*

Striped gobies (*G. vittatus*), ad. Top individual displays the rarely seen 'nightdress', with vertical bands above and below the lateral stripe. Bottom individual was photographed during daytime; it exhibits the beginning of a fright colouration similar to the nightdress. *20 Aug 2004, Selce (Croatia), Anne Frijsinger & Mat Vesjens; 18 Sep 2016, Sec serpent, Agay (83, France), Thomas Menut. Top photo flipped horizontally.*

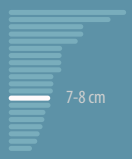
Striped blenny (*P. rouxi*), ad. Frightened Striped blennies display clear vertical bands on the back, but poorly-defined markings below the lateral stripe, as shown in this individual photographed during daytime. Contrary to Striped goby, at night the lateral stripes of Striped blenny are faded and the transverse bands on the back are limited to poorly-defined markings. *10 Jun 2012, Caro, 13 (France), Sylvain Le Bris.*

Yellow-headed goby

Gobius xanthocephalus Heymer & Zander, 1992

Gobie à tête jaune (*Fr*)
Gelbkopf-Grundel (*Ge*)
Gobio de cabeza dorada (*Sp*)
Ghiozzo testa gialla (*It*)

Medium-sized • head yellowish, trunk greyish • body covered with many brick-red to orange dots • locally common, on rocks or coarse sand, at 3-15 m depth



• Description

Small to medium-sized goby reaching 9 cm in length, with a moderately elongate body, large head, short, slightly tipped snout. Trunk colouration light-grey, slightly darker and bluish on the back, and whiter on the underparts. The whole body except the belly is covered with dots, which are either dark red or light orange. The dark red dots are organized into two rows that run all along the body; dots are grouped into dashes separated by spaces at least as long as the dashes. The lower row of dark red dots runs along the lateral midline. The upper row of dark red dots runs dorsolaterally and is connected anteriorly to the oculoscapular line; this row generally includes a few dashes only. The light orange dots are smaller than the dark red dots and do not merge into dashes; rather, they are either tightly aligned and thereby form an almost continuous longitudinal line (for example, between the two rows of dark red dots), or they are scattered and loosely aligned (for example, on the underparts, below the lateral midline). Dorsal region of the head yellow, more intensely on the snout and in the interorbital space. Yellow colouration extends from the upper lip to the base of the first dorsal fin. Gular region white. Eyes with seven brown stripes radiating from the pupil to the orbital rim: two making up a broad horizontal stripe across the pupil, two oblique stripes in the lower half, and three in the upper half of the eye, which often coalesce into an arched longitudinal line. All markings on the head are brown, red or dark orange (usually the same colour as the lateral midline). Lower lip with a W-shaped mark. Snout with a M-shaped line; the vertical legs of the 'M' are generally separated from the central 'V' part and can be limited to a single dot. One preorbital bar between the upper lip and the eye, extending onto the upper and lower lips anteriorly, and disappearing just before reaching the eye posteriorly. This line continues behind the eye as a midopercular line, forming a series of horizontal dashes reaching the upper base of the pectoral fin, where it is aligned with the lateral midline. One isolated dot at the corner of the mouth followed by 2 short horizontal lines on the ventral border of the cheek. Besides these 2 short lines, the cheek is unmarked below the eye. Posterior to these 2 short lines but slightly further up, three dashes or dots run longitudinally on the peropercle and the opercle. Dorsal fins white (or transparent in young individuals), with five to six orange transverse bands. The first dorsal fin, and to a lesser extent the second dorsal fin, are tipped white (or pale). First ray of each dorsal fin with transverse alternate white and dark-brown markings. Interdorsal space narrow and without a membrane. Caudal fin transparent, white or bluish, with 6 to 8 vertical series of red dots; rounded in shape. Anal fin and pelvic disk pearly white or bluish. Pectoral free rays moderately developed. A black or royal blue blotch often visible at the base of the pectoral fins, sometimes bordered white posteriorly. The blotch may be invisible or limited to a horizontal line. Predorsal area covered with small scales, cheeks naked. Anterior nostrils tubular and terminated by a triangular flap.

Yellow-headed goby (*Gobius xanthocephalus*). *12 Jun 2021, Argelès-sur-Mer (66, France), Julien Renoult.*

Night colouration. Ground colouration is more contrasted than during the day; yet, the head often remains distinctly yellowish, and the dark red and orange dots covering the entire body remain visible among the dark pigmentation. The body turns dark brown with four longitudinal rows of 7 to 10 white circular blotches: one row along the lateral midline, one row on the underparts, one dorsolateral row and one vertebral row. In some individuals, the upper two and the lower two rows coalesce to form only two rows of white blotches (the upper blotches then forming conspicuous saddles). The head turns black except for a few scattered white dots, and sometimes a bright white suborbital bar between the eye and the corner of the mouth. Lower base of pectoral fins with white; upper base with a black or royal blue pectoral blotch generally more conspicuous than during the day.

Sexual dimorphism. Not visible, except that breeding males may have a longer second dorsal fin with rear tip reaching caudal origin, and a white upper margin to both dorsal fins.

Juveniles. Very similar to adults but with a more transparent body, and fewer and proportionally larger red dots.

Geographic variation. Unknown.

• Similar species

Yellow-headed goby is most likely to be confused with other dotted gobies, especially its close relatives Sarato's and Golden gobies with which it shares a very similar patterning, but also with Incognito and Bucchich's gobies.

Separating Yellow-headed from **Sarato's goby** (*G. fallax*), in particular, can be very tricky especially at night as the two species have a similar head and eye patterning, and body patterning is so overlapping that it is most often useless. Identification may thus rely only on colouration and body shape. In Sarato's, the possible yellow head colouration also extends onto the back, while in Yellow-headed it is restricted to the head. Sarato's further has browner dots on the body (vs. more reddish in Yellow-headed). At night, when individuals are very dark and colouration is barely visible, difference in body shape may be the only relevant criterion. Sarato's is distinctly stouter and shorter-bodied, and proportionally longer-headed. Moreover, Sarato's has a neutral buoyancy and thus it is often seen hovering a few centimeters over the floor, or touching the floor with its caudal fin only (possibly only during the day). Heymer and Zander (1992) stated (with no more detail) that Sarato's lacks the characteristic iris patterning of Yellow-headed; however, after checking numerous live photos of both species, we couldn't detect any clear difference of this patterning between the two species.

Regarding **Golden goby** (*G. auratus*), only individuals from the dotted morph ('dotted' Golden hereafter) could cause confusion. 'Dotted' Golden occurs in the Northern Adriatic, where Yellow-headed is absent, but some 'dotted' looking Golden gobies may also occasionally be found in the Western Mediterranean where Yellow-headed might be present (although this may concern only juveniles of Golden gobies). 'Dotted' Golden have an entirely yellow body, distinctly longer head, transparent opercles. Their dots and dashes are all of the same colour (*vs*. darker brown on the head and lighter orange on the trunk in Yellow-headed) and are more tightly packed, thus forming almost continuous lines (*vs*. more sparsely distributed), with two to three equally visible lines of dots below the lateral midline (*vs*. one line of dots more visible than the others). In 'dotted' Golden, upper lips are unmarked (*vs*. with brown markings). Golden also typically lives in deep waters while Yellow-headed may occur quite shallow.

At night, when the yellow head and reddish dots are less discernible, Yellow-headed can strongly resemble **Incognito goby** (*G. incognitus*). However, Incognito has a median row of dots on the cheek (absent in Yellow-headed). Moreover, in Incognito the ventral half of the eye is unmarked or has a single dot (vs. ventral half of the eye with two oblique stripes in Yellow-headed), and below the lateral midline the dots do not form an almost continuous line.

Bucchich's goby (*G. bucchichi*) is another potential pitfall especially at night. Like Yellow-headed, Bucchich's has no median row of dots on the cheek. However, Bucchich's differs by having no dot at the corner of the mouth. Moreover, in Bucchich's the ventral half of the eye is unmarked or has only a single dot, while in Yellow-headed the ventral half of the eye has two oblique stripes.

Yellow-headed goby

Gobius xanthocephalus Heymer & Zander, 1992

• Distribution & Status

Yellow-headed goby occurs in the Atlantic and in the Mediterranean. In the Atlantic, the northernmost documented records are from Galicia in Spain (Villegas-Ríos & Bañón, 2010; older records of *G. auratus* from Galicia probably refer to that species too; e.g., De Buen, 1918); but the species also occurs further east, reaching San Sebastian (Luis Martínez Artola, 2020, iNaturalist). Yellow-headed probably has a continuous distribution between Galicia and the Strait of Gibraltar. Further south in the Atlantic, Yellow-headed has been recorded from the Canary Islands, in Gran Canaria (Wirtz and Herrera, 1995) and Lanzarote (Castillo & Brito, 1982; identified as *G. auratus* by then). In the Mediterranean, the species occurs continuously between the Strait of Gibraltar and the Gulf of Genova in Italy (Balma, in Herler et al., 2005). Yellow-headed has been found in the Balearic island of Ibiza (Fisher et al., 2007) and in Corsica (Francour et al., 2010). Isolated populations have been reported in the Black Sea, in Crimea (Boltachev et al., 2009; specimens captured in Sevastopol in 1967 also probably belong to that species; Vasil'eva and Bodorodsky, 2004) and further east in the town of Gantiadi (Vasil'eva and Bodorodsky, 2004). The species was also photographed by one of us (Patrick Louisy) in the Sea of Marmara, close to the Bosphorus. Two specimens from Israel initially identified as *G. bucchichi* have been recently re-identified as *G. xanthocephalus* based on their mitochondrial DNA (Barcode of Life Data System; www.boldsystems.org); however, given the very limited genetic differentiation on mitochondrial DNA between *G. fallax* and *G. xanthocephalus*, it seems difficult to exclude *G. fallax* without examining the specimens further.

In *France*, the species is common in suitable habitats all along Mediterranean mainland and on the eastern coast of Corsica (in the south, to the Bay of Ajaccio). It is rarer from Marseille eastwards. To our knowledge, it remains to be found on the Atlantic coast, which should happen sooner or later in the context of ocean warming.

• Habitat

Yellow-headed goby is most frequently observed in shallow waters at depths from 3 m to 15 m (between 1 m and 30 m depth in the Canary Islands; Wirtz and Herrera, 1995; down to 35 m depth in Ibiza, Fischer et al., 2007; 36 m in southwestern France; Heymer and Zander, 1992). It prefers horizontal or gentle slopes, where it is associated with hard or mixed bottoms, for example sandy patches with pebbles, boulders or bedrock. It is also found among seagrass, especially *Posidonia oceanica*, in which it shelters at night. Around Banyuls (66, France), the species remains relatively common at 30 m depth and possibly further down, where it is typically associated with coralligenous bottoms formed by calcareous red algae.

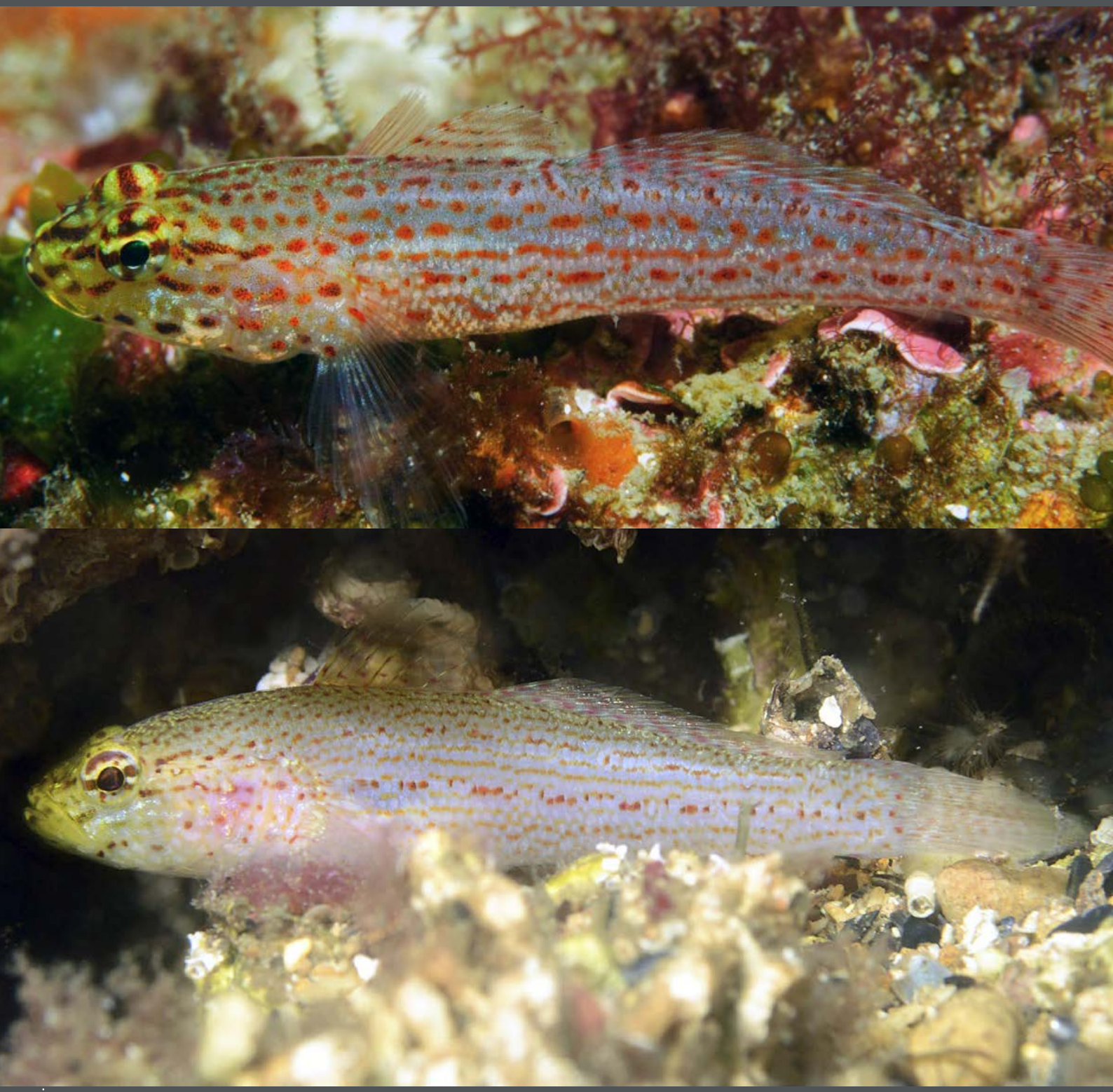
• Miscellaneous

☝ Yellow-headed goby was described less than thirty years ago. Presently, it could sound incomprehensible to fishwatchers that such a common and distinctive species has remained overlooked for so long. Actually, specimens of Yellow-headed had been examined by ichthyologists all along the twentieth century and even earlier, but these were generally identified as Golden gobies. At that time, ichthyologists were studying preserved specimens only. In alcohol, once diagnostic colours have vanished, Yellow-headed, the 'dotted' Golden and Sarato's gobies have very similar patterning. Moreover, the plain coloured morph of Golden gobies has meristic and morphological traits overlapping with the other three taxa. For these reasons, Yellow-headed, the two morphs of Golden and Sarato's were thought to represent mere variations of a single species.

☝ Differences in mitochondrial genome between Yellow-headed, Golden and Sarato's gobies are very limited, indicating that the three species have diversified only very recently. However, the well-marked morphological differences and the lack of documented intermediate individuals (at least between Yellow-headed and the other two species) suggest that reproductive isolation is already in place.

Yellow-headed goby

Gobius xanthocephalus Heymer & Zander, 1992



Yellow-headed gobies (*G. xanthocephalus*), ad. Typical individuals with diurnal colouration, with a pale beige to greyish trunk and yellow head, and brick-red to orange dots that are the darkest on the head. *11 Aug 2011, Setúbal (Portugal), João Pedro Silva; 16 Sep 2019, Burgazadasi (Turkey, Sea of Marmara), Patrick Louisy.*

Yellow-headed goby

Gobius xanthocephalus Heymer & Zander, 1992

Yellow-headed goby (*G. xanthocephalus*), ad. Typical individual with nocturnal colouration, with a dark trunk and four rows of white blotches (the most ventral row barely visible here) and a conspicuous royal blue pectoral blotch. In most individuals, the yellow head and the orange dots remain visible at night. *11 Jun 2014, Collioure (66, France), Lucas Berenger.*

Yellow-headed goby *(G. xanthocephalus)*, ad. Another individual in night colouration, with a slightly fainter pattern. *31 May 2021, Thau lagoon (34, France), Patrick Louisy. Photo flipped horizontally.*

Yellow-headed goby

Gobius xanthocephalus Heymer & Zander, 1992

Yellow-headed goby (*G. xanthocephalus*), juv. Compared to adults, juveniles of Yellow-headed have fewer and proportionally larger red dots, and a transparent body. *07 Aug 2013, Leiria (Portugal), João Pedro Silva.*

Yellow-headed goby (*G. xanthocephalus*), im. Photographed during the day, this all dark individual is possibly in fright colouration. The yellow tint of the head and the bright red dots make the identification straightforward. The slender head with proportionally big eyes suggest an immature. *28 Dec 2011, Leiria (Portugal), João Pedro Silva.*

Yellow-headed goby

Gobius xanthocephalus Heymer & Zander, 1992

Yellow-headed goby (*G. xanthocephalus*), ad (top); **Sarato's goby** (*G. fallax*), ad (bottom). Separating these two species at night can be extremely challenging. Yet, in Yellow-headed, dots on the trunk look redder (browner in Sarato's) and a yellow tint is visible between the eyes. Note also the difference in body shape, with Yellow-headed having a slender and longer body, and a shorter head (proportionally to the trunk). *22 Mar 2020, Marseille (13, France), Thomas Menut; 31 May 2012, Menorca (Spain), Stefano Guerrieri. Top photo flipped horizontally.*

Yellow-headed goby

Gobius xanthocephalus Heymer & Zander, 1992

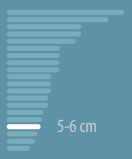
Yellow-headed goby (*G. xanthocephalus*), ad (top); **Golden goby** (*G. auratus*), ad (bottom). Exceptionally, Yellow-headed gobies can have a yellow colouration covering the whole body. These individuals are very similar to the dotted morph of Golden goby. The two species can nevertheless be told apart by the preorbital bar extending onto the upper lip in Yellow-headed only. Other differences, not visible here, include a proportionally shorter head and one line of dots more visible than the others below the lateral midline (vs. two to three equally visible lines in Golden goby). *31 Jul 2012, Leiria (Portugal), João Pedro Silva; 07 Jun 2013, Krk (Croatia), Thomas Menut. Top photo flipped horizontally.*

Kestrel goby

Gobius xoriguer Iglésias, Vukič & Šanda, 2021

Gobie crécerelle (*Fr*)
Falken-Grundel (*Ge*)
Gobio cernícalo (*Sp*)
Ghiozzo gheppio (*It*)

Small • whitish with orange markings • first dorsal taller than second dorsal fin, with deeply lunate interradial spaces, and with a smokey grey blotch • white dots on cheeks • on coralligenous bottoms, below 60 m depth



⚠ *The species has never been observed alive in its natural environment. The description of colouration and patterning is based on a watercolour by Samuel Iglésias, who interpreted the possible appearance of live individuals from freshly collected specimens. The species is currently known from only three specimens, thus variation in both appearance and ecology has remained poorly documented.*

• Description

Small goby reaching 6.5 cm in length with a moderately long body and distinctly large eyes. Snout short (shorter than the eye), with moderately steep and rounded profile. Ground colouration orange-beige, dark-brown or whitish, with orange markings, and paler and almost unmarked underparts. Seven orange, rectangular midlateral blotches. Back marbled with orange, underparts paler, almost unmarked. Head orange to dark brown. The eyes have stripes radiating from the pupil to the orbital rim: a broad horizontal stripe, two thinner stripes on the dorsal half and two fainter stripes in the ventral half. The horizontal eyestripe connects anteriorly to a V-shaped orange snout line. Posteriorly, it connects to an orange oculoscapular line that runs continuously from the orbit to the upper base of the pectoral fin. One indistinct orange preorbital bar. Lips unmarked. Cheeks and opercles orange, possibly smoked grey in some individuals, and covered with numerous pearly white, rounded spots. First dorsal fin tall, with a maximal height at the level of the third ray, and lunate (or deeply emarginate) interradial membranes. Membrane pale blue grey, transversed by four orange horizontal bands that also cover the rays. On the anterior half of the fin, an oblique, smokey grey blotch seems to extend from the distal half of the fin anteriorly to its base posteriorly, touching the trunk in the middle of the fin; however, the exact position of this blotch seems uncertain. Second dorsal fin not as tall as first dorsal fin, with a linear edge without lunate interradial spaces. Membrane pale blue grey, transversed by three to four orange horizontal bands, which also cover the rays as in the first dorsal fin. Distinct blackish marginal band. Caudal fin pale, darker along the ventral edge, and with small orange dots. Anal fin pale grey with one orange transverse band in the basal half, and a distinct blackish marginal band. Pelvic disc dark (may be light-coloured in live individuals). Upper base of pectoral fins with an orange blotch; otherwise these fins appear essentially hyaline, with no or a few dots on rays. Uppermost pectoral fin rays essentially contained into the membrane: no or reduced free rays. Predorsal area scaled; cheeks and opercles naked. Anterior nostrils tubular and terminated by a triangular lappet.

Night colouration. Unknown.

Sexual dimorphism. The enlarged first dorsal fin may be a character of mature males. Similarly, and by comparison with related species, the anal and pelvic fins may be darker in mature males than in females.

Juveniles. Midlateral blotches may potentially be lighter in immature individuals (yellow vs. orange in adults).

Geographic variation. Unknown.

• Similar species

With current knowledge, the field identification of Kestrel goby can only be tentative. To make the first observation a Kestrel goby in its natural environment, it will be necessary to meticulously exclude all other orange-toned gobies. Though, any small orange goby (but be careful with immatures of other species) showing a first dorsal fin distinctly taller than second dorsal fin, with lunate interradial spaces and a smoky grey blotch should be considered carefully since this combination of characters seems diagnostic of Kestrel goby among the Mediterranean gobies.

The first species to be excluded is **Steven's goby** (*G. gasteveni*). Kestrel and Steven's gobies both share orange body markings, orange cheeks and opercles covered with white rounded spots and a relatively short snout. However, Steven's is slightly larger (9-10 cm vs. 6 cm), has smaller eyes and well-visible paravertebral stripes on the predorsal area (*vs*. no stripes other than the oculoscapular line in Kestrel). Crucially, the shape and colouration of the first dorsal fin are different: in Steven's it is only marginally taller than the second dorsal fin (*vs*. much taller in Kestrel), the interradial membrane is slightly emarginate (vs. lunate), rays are tipped black (vs. not in Kestrel), the fin is edged white (*vs*. no white marginal band) and, in mature males, has many white spots (*vs*. orange bands). Moreover, ray tips are dark brown at the dorsal edge of the caudal in Steven's, not in Kestrel.

Kolombatović's goby (*G. kolombatovici*) is another species to consider. Kolombatovci's is significantly larger (10-11 cm vs. 6 cm), and most individuals should be immediately recognized by their characteristic black blotch in the first dorsal fin. Though, in some individuals that blotch is totally absent, and in some others it is very faint: it could thus be reminiscent of the smokey grey blotch of Kestrel (but the blotch is located on the rear half of the fin in Kolombatovic's, while it is in the front half in Kestrel). Luckily, all Kolombatović's gobies should be differentiated from Kestrel goby by the more numerous midlateral blotches (typically 9 vs. 7), the presence of a dorsolateral series of orange blotches and vertebral orange spots extending onto the base of the second dorsal fin (vs. only midlateral blotches in Kestrel), and by a distinctive orange line on the head, which starts from above the side of the upper lip and reaches the lower edge of the orbit (thus forming an oblique preorbital bar), continues rearwards parallel to the oculoscapular line located more dorsally, and reaches the base of the pectoral fin (vs. no such line in Kestrel).

Two other orange gobies deserve consideration because of their small size similar to that of Kestrel goby: **Large-scaled goby** (*Thorogobius macrolepis*) and **Dollfus' goby** (*Vanneaugobius dollfusi*). Large-scaled goby should be identified by the many circular orange spots on the predorsal area and the head, including on the snout (*vs*. orange head with white spots and a V-shaped snout line in Kestrel), the first and second dorsal fin of similar height (*vs*. the first dorsal fin much taller), the second dorsal fin with a white marginal band (*vs*. dark marginal band), and anterior nostrils without a dermal process (*vs*. triangular process). Dollfus' goby should be identified by a pointed first dorsal fin in males (*vs*. tall but not pointed in Kestrel), the unpatterned membrane of dorsal fin (*vs*. with transverse bands), pearly white markings on the head and the body, some forming white saddles on the back, some others forming vertical bands on the flanks (*vs*. no pearly white markings), snout without a V-shaped line but with white nostrils contrasting with a pink or reddish ground colour (*vs*. V-shaped snout line, and nostrils and snout concolourous).

The last two species that would need to be excluded in a differential diagnosis are **Slender goby** (*G. geniporus*) and **Roule's goby** (*Gobius roulei*). These species are not typically orange but some individuals, especially Roule's, can show this colouration when in deep waters where Kestrel is most likely to be found. Adult slender are less problematic given their very large size (up to 16 cm), both dorsal fins of similar height, and dorsal and caudal fins tipped white and with many conspicuous brown spots. Juvenile Slender can be more tricky, being smaller and having unpatterned fins, but they should differ from Kestrel by a longer snout with a more attenuated profile (*vs*. short and steep in Kestrel), two dark short horizontal lines on the cheeks, below the eye (also present in adults; vs. unpatterned cheeks except the white circular spots), a conspicuous V-shaped snout line (*vs*. ill-defined V-shaped line even in juvenile Kestrel), and two eyestripes, one horizontal and one vertical in the upper half of the orbit only (*vs*. two oblique stripes in the upper half of the orbit). Roule's goby is a small species (6 cm) with a short snout and steep head profile, and relatively large eyes. Adult males are not of a concern given their pointed first dorsal fin. Females and young individuals, however, need to be excluded based on their indistinct midlateral blotches often limited to a dotted line regularly thickened (vs. board, distinctive midlateral blotches in Kestrel), and the first dorsal fin shaded yellow on the distal half in juveniles (vs. shaded grey) or transversed by two to three bands only in the proximal half in adults (*vs*. transverse bands in the distal half). Moreover, Roule's has no scale on the predorsal area, contrary to Kestrel. Last, like Slender goby, Roule's has only one vertical bar in the upper half of the orbit in addition to the horizontal stripe (*vs*. 2 oblique bars).

• Distribution & status

Kestrel goby is known from only three individuals: one specimen collected off *Ghisonaccia* in Corsica (Tyrrhenian Sea; holotype), another one off Banyuls-sur-Mer (66, France) in the Gulf of Lion (paratype), and a last one in Es Caracol in the the Balearic island of Menorca.

• Habitat

Kestrel goby lives on a deep coralline beds composed of fixed or unattached (Rhodoliths, maerl) calcareous red algae, including *Phymatolithon calcareum*, *Lithothamnion* spp. and *Mesophyllum* spp. Its bathymetric distribution ranges from 62 m (possibly up to 51 m; in Menorca) to 102 m depth (possibly down to 104 m; in the Gulf of Lion).

- **Miscellaneous**

☝ With all three records below 50 m depth, most underwater naturalists may consider encountering Kestrel goby as unlikely. However, in southern France, the fish enthousiast Muriel Duhau recently discovered a site at 40 m depth with a whole community of fishes that were previously considered rare or restricted to deep waters. This includes *Speleogobius trigloides, S. llorisi, Lebetus* sp., *Buenia affinis, B. massutii, Gobius gasteveni, Vanneaugobius dollfusi, Microchirus ocellatus, Cepola macrophthalma* and *Lepidotrygla cavillone*. Interestingly, *S. llorisi* and *B. massutii* were described very recently from specimens collected on coralline beds in the Balearic Islands. This is where Kestrel goby was collected. Would Kestrel goby be part of that community too? Soft bottoms and coralline beds are only starting to be explored by recreational divers. As new, easily accessible sites get discovered, the chances of spotting gobies that were unknown only a few years ago become real.

☝ A goby depicted in Lloris (2015) under the name *G. strictus* probably represents a fourth specimen of Kestrel goby.

Kestrel gobies (*G. xoriguer*), ad ♂♂. These dead but fresh specimens are the only two adult Kestrel gobies known to date. The species is characterised by large eyes, and an enlarged first dorsal fin taller than second dorsal fin (possibly only in males) with lunate interradial spaces and a smoky grey blotch. Top individual is the holotype collected off Corsica on 27 May 2012, bottom individual the paratype collected in the Gulf of Lion on 20 June 2018. *Pictures courtesy of Samuel Iglésias, Muséum National d'Histoire Naturelle (France).*

Kestrel gobies (*G. xoriguer*), juv. This 23 mm long individual is the only known juvenile of Kestrel goby. It shows the large eyes and grey blotch on first dorsal fin characterizing the species, but compared to the two adults above it has lighter midlateral blotches. *28 Sep 2010, Menorca, Balearic Islands (Spain), picture courtesy of Samuel Iglésias, Muséum National d'Histoire Naturelle (France).*

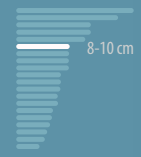
Kestrel gobies (*G. xoriguer*), ad ♂ (top); **Steven's goby** (*G. gasteveni*), ad ♂ (middle); **Kolombatović's goby** (*G. kolombatovici*), ad ♂ (bottom). Kestrel and Steven's both have white circular spots on the cheeks and the preopercles. However, in Kestrel note the large eyes, the tall first dorsal fin with lunate interradial membranes, grey oblique blotch in the anterior half of the first dorsal fin, and grey margin of second dorsal and anal fins. *Watercolour and colour pencil illustrations courtesy of Samuel Iglésias, Muséum National d'Histoire Naturelle (France).*

Leopard-spotted goby

Thorogobius ephippiatus Low, 1839

Gobie léopard (*Fr*)
Leopardengrundel (*Ge*)
Gobido leopardo (*Sp*)
Ghiozzo leopardo (*It*)

Medium-sized • body blue-grey with large and round dark spots • locally common, in shady rocky habitats, generally at 5-30 m depth



• Description

Medium-sized goby reaching 13 cm in length with a proportionately large head. Ground colouration greyish with a blue-green sheen on the back and large black, dark brown or orange rounded blotches on both the head and the body. The typical pattern consists of 6 blotches slightly longer than deep along the lateral midline posterior to the pectoral fins, usually with the fourth blotch smaller than the other ones. Additional smaller blotches can occur between midlateral blotches and below the lateral midline. Above lateral midline, the body is covered by a variable number (from 7 to 15) of mostly circular blotches smaller than the midlateral blotches. The blotches of both sides rarely coalesce on the back. Three pairs of blotches on the nape, the middle one generally coalesced into a single transverse bar, the foremost pair smaller. A dozen blotches on each side of the face; usually lighter and redder than body blotches. One oblique preorbital bar, often limited to a spot. The red gills underneath the translucent opercule give a pink colouration to the opercular region. Orbit blue-grey with a golden ring around the pupil; three dark spots on the upper half of the eye rim. First dorsal fin semicircular in shape, blue-gray in colouration with two brown transverse bands (sometimes limited to brown spots) and a light blue marginal band. Tip of rays black. One black basal blotch at the rear edge, on the 5th and 6th interradial membranes (occasionally also on the 4th). Second dorsal fin similar to the first one, but the brown transversal bands are less distinct, and the dorsal body blotches generally extend onto the membrane. Caudal fin blue grey with a light blue margin too, and with three spots forming an oblique line on the basal half and additional spots aligned vertically in the distal half. Bottom third of the fin plain coloured; yet, in some individuals the entire caudal fin is plain coloured. Anal fin blue grey without spots, but with a light blue margin. Pelvic disc plain transparent grey. The upper base of pectoral fins has a black spot extending onto the membrane. Rest of the fins transparent, with no flecks on rays. The uppermost pectoral fin rays are contained into the membrane: there are no free rays. Predorsal area without scales. Anterior nostril tubular, with no dermal process from its rim.

Leopard-spotted goby (*Thorogobius ephippiatus*). Atlantic form. *25 Apr 2015, Ploumanac'h (22, France), Patrick Louisy.*

Night colouration. Similar to day colouration.

Sexual dimorphism. Reproductive males are darker; they can be almost all black, except the conspicuous light blue margin of median fins.

Juveniles. Similar to adults but with a semi-transparent body. Blotches are also slightly more diffuse, with a less clear-cut outline, and redder especially on the head.

Geographic variation. The above description corresponds to Leopard-spotted gobies from the Atlantic, but individuals from the Mediterranean are visually distinct. Mediterranean Leopard-spotted differ from Atlantic Leopard-spotted by the size and number of blotches: they only have 5 midlateral blotches circular in shape (*vs*. 6 elongate blotches in the Atlantic); only 5 or 6 blotches above the lateral midline (excluding predorsal blotches), occasionally 7 with one small spot on the distal tip of the caudal peduncle (*vs*. typically more than 8 blotches, exceptionally 7); those blotches are large and coalesce on the back with the corresponding blotches of the other side (*vs*. blotches of both sides separated); and the 4th midlateral blotch (starting from the front) is almost always connected to the blotch on the top of the caudal peduncle by an oblique bar (vs. this occurs only occasionally in individuals from the Atlantic). To our knowledge the distinctive appearance of Mediterranean Leopard-spotted gobies has not been mentioned yet. Only Schultz (1975), when comparing specimens from the Adriatic with data on Atlantic individuals published by Miller (1969), noted a higher number of rays at the anal fin of Adriatic individuals (I+12 versus I+10; see Appendices for interpreting a fin ray formula). However, the author cautioned about driving conclusions on this difference, because of the limited number of studied specimens (n=3). Eventually, the discontinuous variation in patterning, in addition to possible differences in meristic characters and a sharp geographic transition between the two forms raise the question whether the two forms could be separate species.

Leopard-spotted gobies from the Macaronesian islands are visually similar to the Atlantic form described previously. Miller (1984) noted that Macaronesian individuals have on average more pectoral rays than individuals from the Northern Atlantic. Meristic and genetic analyses are now needed to better understand the systematics of Leopard-spotted goby.

Leopard-spotted goby *(Thorogobius ephippiatus). 07 Aug 2009, Tuscany (Italy), Stefano Guerrieri.*

- **Similar species**

Leopard-spotted goby has a unique pattern of very large and dark blotches over the entire body and the head; the vast majority of individuals are thus unlikely to be mistaken for any other goby.

A few individuals can have unusually light orange blotches and thereby superficially resemble the congeneric **Large-scaled goby** (*T. macrolepis*); moreover, both species have blue marginal bands on dorsal fins. Large-scaled is distinctly smaller, has more numerous spots on the head (> 20 *vs*. a dozen in Leopard-spotted), only the two dorsal fins have a light blue marginal band (*vs*. all four median fins), it lacks the black blotch at the rear of the first dorsal fin, and blotches above the lateral midline are small spots grouped by series of 3 or 4 and forming short dotted-line segments (*vs*. large and irregular blotches).

Moreover, Large-scaled goby has small, rectangular midlateral blotches while Mediterranean Leopard-spotted goby, with which Large-scaled co-occurs, has noticeably large and circular midlateral blotches.

Sexually active males can be very dark and even appear almost all black when hidden in a crevice. There is then a risk of confusion with excited individuals of **Rock goby** (*G. paganellus*), which can also be all black and further have a very similar structure. Rock, however, has well visible scales on the predorsal area (*vs*. predorsal area naked in genus *Thorogobius*, but be careful that scales are not always visible in black Rock gobies), free uppermost pectoral rays (*vs*. no free rays), and a yellow marginal band to dorsal fins (*vs*. blue in Leopard-spotted). When visible, pay attention to the anterior nostril, which has a dermal process in Rock (*vs*. process missing in Leopard-spotted).

• Distribution & Status

Leopard-spotted goby is a widespread species known from the North-eastern Atlantic and the Northern Mediterranean. The northernmost known location is currently around Trondheim in Norway (Viktor Grøtan; iNaturalist), but the species appears to extend its distribution northward. In the north, it also occurs all around Great Britain including in the Shetland islands, southwestern Sweden (Holm and Mattson, 1981) and in the Baltic sea in Vilm island (Rügen, Germany, GEO-Hauptveranstaltung Bodden). Further south, it is found along the French coast, in Asturias (photo available on asturnatura.com), all along the Portuguese coast and in southwestern Spain (Cadix, see details below). The southernmost locations are in the Canary Islands (Gran Canaria, Fuerteventura; Fish collection of Louisiana State University Museum of Natural Science). Elsewhere in Macaronesia, it is also known from Madeira, from where the species was described (Low, 1839; Miller, 1984), the Salvage island (Miller, 1984) and in the Azores (Azevedo et al., 1990), the westernmost location for this species. In the Mediterraean, Leopard-spotted goby occurs along the Spanish coasts (from Malaga to Cap de la Nao, then further north around the French border), in France, in most of the Ligurian, Thyrrean and Adriatic coasts of Italy, in the Eastern Adriatic (Schultz, 1975, Kovačić et al., 2012, Trkov et al., 2019), the Aegean sea (Gerovasileiou, 2015) as well as the Levant basin eastwards (Cyprus and Israel; Stern et al., 2018). The species is probably present in the Black Sea (www.youtube.com/watch?v=Hcluya5CkR4)

In *France*, Leopard-spotted goby has been found in the Channel from Calais (62; BioObs) to Brittany, where it is quite common, in the Bay of Biscay to at least La Rochelle in the south. It is less common in the Mediterranean, where it was photographed in Banyuls-sur-Mer (pers. obs.), in most diving sites between Marseille and the Italian border (see various data of Fish Watch Forum, DORIS, and in Escoubet & Murgia, 1981), as well as along the eastern coast of Corsica (Fish Watch Forum; Francour et al., 2010).

The respective geographic distributions of the Atlantic and Mediterranean forms around the Strait of Gibraltar remain to be determined. East of the Strait, the single photo that we could examine was taken between the Spanish towns of Malaga and Almeria: it depicts an individual seemingly intermediate between the Atlantic (8 midlateral blotches) and the Mediterranean form (some of the blotches are broad and circular in shape). West of the Strait, we could examine two photos from around Tarifa: the first photo shows a typical specimen of the Atlantic form; the second a typical specimen of the Mediterranean form. Further work is needed to determine the exact shape of the contact zone and thus to unravel the taxonomic status of these forms. A sharp transition from one form to the other with no or few intermediates, and/or a region with the two morphs living together with no or few intermediates would both indicate reproductive isolation consistent with two distinct species. Conversely, a clinal variation from one morph to the other, extending over a few hundreds of kilometers, would indicate that the two morphs should be best regarded as two subspecies of the same species. Your photos can be highly valuable aid (see *Documenting your records* in the Introduction)!

• Habitat

Leopard-spotted goby inhabits rocky bottoms from about 2 m (in the Azores) to more than 150 m depth (120 m depth in Madeira, Miller, 1984; 139 m in Corsica, Fourt et al., 2017; 156 m in Israel, Stern et al., 2017), but it is most common deeper than 5 m in the Northern Atlantic and than 15 m in the Mediterranean. In the Atlantic, it is occasionally found in pools at low tide. This species is typically found near crevices, beneath overhangs, in deep gullies, caves, or concrete blocks of piers, sitting on muddy sand, gravel or detritic substrata.

• Miscellaneous

☝ Leopard-spotted goby was described as a new species under the name *Gobius forsteri* by Corbin (1958). Following a re-examination of this species, Miller (1961) concluded that *G. forsteri* is similar to the Madeiran *Gobius ephippiatus* Lower 1839, but also to the Mediterranean *Gobius thori* De Buen 1928 described from a single specimen originating from the Aegean sea. The same author described a new genus, *Thorogobius*, with *G. ephippiatus* as a type species (Miller, 1969). The genus name comes from the Danish research vessel *Thor* on whose 1910 cruise *G. thori* was caught.

Leopard-spotted goby

Thorogobius ephippiatus Low, 1839

Atlantic Leopard-spotted gobies (*T. ephippiatus*), ad. Leopard-spotted goby has a unique pattern of very large and dark blotches over the entire body and the head. Note the naked nape, which differentiates *Thorogobius* spp. from *Gobius* spp. (except *G. roulei*), and the blue marginal band of dorsal fins. *15 Aug 2014, Trébeurden Triagoz (22, France), Benjamin Guichard; 24 Sep 2018, Basse Dinan (29, France), Benjamin Guichard. Top photo flipped horizontally.*

Leopard-spotted goby

Thorogobius ephippiatus Low, 1839

Mediterranean Leopard-spotted gobies (*T. ephippiatus*), ad. Differ from Atlantic Leopard-spotted goby by having only 5 midlateral blotches (vs. 6 in Atlantic), midlateral blotches circular in shape (*vs*. longitudinally elongate); only 5 or 6 blotches above the lateral midline (excluding predorsal blotches), with one small spot on rear upper caudal peduncle (*vs*. typically more than 8 blotches); those blotches are large and coalesce on the back with the corresponding blotches of the other side (*vs*. blotches of both sides separated); and the 4th midlateral blotch (starting from the front) is almost always connected to the blotch on the top of the caudal peduncle by an oblique bar (*vs*. rare in the Atlantic form). *07 Aug 2009, Tuscany (Italy), Stefano Guerrieri; 06 Jul 2014, Hyères (83, France), Lucas Bérenger.*

Leopard-spotted goby

Thorogobius ephippiatus Low, 1839

Atlantic Leopard-spotted goby (*T. ephippiatus*), juv; **Mediterranean Leopard-spotted goby** (*T. ephippiatus*), juv. Juveniles are similar to adults but with a somewhat transparent body. The difference in patterning between the two forms is already visible in these very young individuals. *20 Mar 2018, Lanzarote (Canary Islands, Spain), Muriel Duhau; 13 Jun 2018, Vis (Croatia), Muriel Duhau. Both photos flipped horizontally.*

Leopard-spotted goby

Thorogobius ephippiatus Low, 1839

Atlantic Leopard-spotted goby (*T. ephippiatus*), ad (top); **Large-scaled goby** (*T. macrolepis*), ad (bottom). Some Leopard-spotted gobies have orange blotches and thus resemble Large-scaled goby. However, they have noticeably fewer blotches on the trunk, and a black spot in the posterobasal corner of the first dorsal fin. *16 Sep 2012, Cornwall (England), David Fenwick (www.aphotomarine.com); 10 Feb 2008, Tuscany (Italy), Stefano Guerrieri. Both photos flipped horizontally.*

Large-scaled goby

Thorogobius macrolepis Kolombatovic, 1891

Gobie à grandes écailles (*Fr*)
Kleine Leopardengrundel (*Ge*)
Gobido escamoso (*Sp*)
Ghiozzetto grosse squame (*It*)

Small • orange blotches on the trunk, smaller orange spots on the head • no V-shaped mark on the snout • dorsal fins tipped light-blue • uncommon, on sand, close to rocky shelter, generally at 15-40 m depth

• Description

Small goby reaching 7 cm in length with a relatively short body and a steep snout profile. Ground colouration white to light grey with pearly white markings on the lower lateral side and a light blue sheen on the back, and with numerous light orange markings on the trunk and the head. Five brick red midlateral blotches, two to three times longer than deep, each blotch sometimes appearing as two contiguous spots. Inter-blotch spaces pearly white. Many short line segments, horizontal or oblique, made of 3 to 5 light orange dots, above the lateral midline. Back with 6 to 8 broader and darker spots along the vertebral line, the same color as midlateral blotches and often grouped by pair, that may extend onto the membrane of the dorsal fins. Lower body whitish with only a pair of orange dots at the level of the first dorsal fin. Head (including the predorsal area) covered with many orange spots (between 20 and 30 on each side of the face) larger than dots of the back but smaller than midlateral blotches. One of these spots forms an oblique preorbital bar that extends onto the upper lip; otherwise the lips are white. Snout with many orange spots. The red gills underneath the translucent opercule give a pink colouration to the opercular region. Orbit blue-grey with a golden ring around the pupil and many orange spots on the eye rim. First dorsal fin semicircular in shape, blue-gray in colouration with three orange transverse bands and a broader and light blue marginal band. Tip of rays black. Patterning of the second dorsal fin similar to the first dorsal fin. Caudal fin also blue grey with 3 to 4 orange vertical, sinuous bars. Anal fin blue grey and plain coloured. Pelvic disc pearly white. Upper base of pectoral fins with an orange horizontal line. In some individuals, below this orange bar, a pearly white patch radiates onto base of pectoral rays and membrane. In other individuals, the fin is transparent except for a pearly white ventral edge. The uppermost pectoral fin rays are contained into the membrane: there are no free rays. Predorsal area without scales. Anterior nostril tubular, with no a dermal process from its rim.

Large-scaled goby (*Thorogobius macrolepis*). *20 Jun 2021, Agay (83, France), Patrick Louisy.*

Night colouration. Overall, similar to day colouration but the whole body and the head are covered with tiny black dots (melanophores), which are denser below the first dorsal fin, thus forming a dark saddle.

Sexual dimorphism. During the reproductive period, males are distinctly darker than females (Ahnelt & Kovačić, 1997).

Juveniles. Similar to adults but with a semi-transparent body. Blotches are also slightly more diffuse, with a less clear-cut outline, and redder especially on the head.

Geographic variation. Unknown.

• Similar species

Large-scaled goby is the only species of the region with numerous light orange spots on the head.

A few **Leopard-spotted gobies** (*T. ephippiatus*) can have orange spots in place of the usual dark brown or black spots, and both species have blue marginal bands in dorsal fins. Leopard-spotted is distinctly larger, has fewer spots on the head (approx. one dozen vs. > 20 in Large-scaled goby), all four median fins have a light blue margin (only on the two dorsal fins in Large-scaled), it has a black blotch at the rear of the first dorsal fin (*vs*. no black blotch), and blotches above the lateral midline are large and rounded (*vs*. small spots grouped by series of 3 or 4 and forming short dotted-line segments). Moreover, Mediterranean Leopard-spotted (with which Large-scaled co-occurs) has noticeably large and circular midlateral blotches (small rectangular blotches in Large-scaled).

Large-scaled goby is often found along with **Kolombatović's goby** (*G. kolombatovici*), which shares a similar orange colouration. Kolombatović's is noticeably larger, has a conspicuous black blotch on the first dorsal fin (*vs*. no black blotch in Large-scaled), a V-shaped snout line and a continuous oculoscapular line (*vs*. circular spots on the snout and the oculoscapular region), a cheek white below the eye (*vs*. orange spots) and a transparent margin of the second dorsal fin (*vs*. blue margin).

Dollfus' goby (*Vanneaugobius dollfusi*) is another orange species with 5 rectangular midlateral blotches, that occurs in the same habitats as Large-scaled goby. Dollfus' has a more uniform salmon colouration with orange and white marbling, light saddles on the back (*vs*. spots on the head and short dotted line segments), short vertical white bars on the lower side, and only an inconspicuous mark at the base of pectoral fins (*vs*. noticeable horizontal line in Large-scaled).

A last potential pitfall is **Slender goby** (*G. geniporus*), which tends to be orange under 20 m depth. However, Slender either has a conspicuous V-shaped snout line and horizontal eyestripe when juvenile, or a marbled colouration with black markings on the cheek when adult.

See also the species account of **Kestrel goby** (*G. xoriguer*).

• Distribution & Status

Large-scaled goby is an endemic Mediterranean species first described from around the Croatian town of Split in the Adriatic (Kolombatović, 1891). Elsewhere in the Adriatic, it has been found also in different sites around Rijeka, in Croatia (Ahnelt & Kovačić, 1997; Fish Watch Forum), in Slovenia (Trkov et al., 2019) and in Italy, around Venice (www.tegnue.it) in South-eastern Apulia and Tremiti Archipelago (Guideti et al., 2006). In the Eastern Mediterranean, there are documented records from all along the Turkish Aegean coast (Francour et al., 2007; Bilecenoğlu & Yokes, 2016), and further east in that country in the Levant basin near the town of Kekova (the easternmost record; Bilecenoğlu & Yokes, 2016). In the Western Mediterranean, Large-scaled goby occurs in Corsica, all along the northern coast between Tuscany in Italy (Fishbase) and Marseille in France, including MonacoMocano (Francour, 2007), off Barcelona in Spain (Colección de referencia de otolitos, Instituto de Ciencias del Mar-CSIC via GBIF), in the Balearic island of Ibiza (Spain, Ahnelt & Kovačić, 1997) and in Lipari (Italy, photo by Muriel Duhau).

In *France*, Large-scaled goby has been observed in different sites all along the rocky shore from Marseille (13; Sylvain Le Bris on DORIS) eastwards; in particular in Port-Cros and Saint-Rapahël (83; Fish Watch Forum), Nice, Antibes and Saint-Jean-Cap-Ferrat (06; Fish Watch Forum), where it is locally not uncommon. In Corsica, there are documented records from Lumio (Fish Watch Forum) and Scandola Nature Preserve (Francour et al., 2010). It has been recently observed and photographed close to the Spanish border in Cerbère or Port-Vendres (66, Renoult & Louisy pers. obs.).

Large-scaled goby

Thorogobius macrolepis Kolombatović, 1891

- **Distribution & Status**

Large-scaled goby is a strictly marine species inhabiting rocky areas between 6 m and 60 m depth (maximum depth recorded in Croatia; Glavičić & Kovačić, 2016), but it is most frequent between 15 m and 40 m depth. It leaves on detritic coarse sand and gravel with no or little silt or mud, always close to rocky shelters. It is typically found in front of mini-caves at the foot of vertical walls, or on sandy balconies in very steep walls. In Marseille (France), Large-scaled is often seen in association with Kolombatović's goby, and with Dollfus' goby at the foot of vertical walls. It is very wary, quickly hiding into crevices when approached too closely.

- **Miscellaneous**

☝Large-scaled goby was first described under the name *Gobius macrolepis* Kolombatovic, 1891. However, De Buen (1923) proposed that *G. macrolepis* is a Mediterranean form of the Atlantic *G. friesii*, now named *Lesueurigobius friesii* (Malm, 1874). This was corrected by Miller (1969), who recognized that *G. macrolepis* is closely related to *Thorogobius ephippiatus* (Low, 1839) and thus renamed the species *T. macrolepis*.

Large-scaled goby *(T. macrolepis)*, ad. An individual in its typical habitat, at 32 m depth, resting on the soft ground but ready to disappear in a crack of the rock. A Coralline goby (Odondebuenia balearica) is also visible on this photo, can you spot it? *20 Jun 2021, Agay (83, France), Patrick Louisy.*

Large-scaled goby

Thorogobius macrolepis Kolombatović, 1891

Large-scaled gobies (*T. macrolepis*), ad. Large-scaled goby is the only goby species of the region with numerous light orange spots on the head. The naked nape distinguishes the genus *Thorogobius* from all *Gobius* species except Roule's goby (*G. roulei*). Another remarkable character is the light blue margin of both dorsal fins. *31 Aug 2013, Cap Antibes (06, France), Thomas Menut; 06 Oct 2017, Rijeka (Croatia), Stefano Guerrieri. Bottom photo flipped horizontally.*

Large-scaled goby

Thorogobius macrolepis Kolombatović, 1891

Large-scaled gobies (*T. macrolepis*), ad. (top); **Atlantic Leopard-spotted goby** (*T. ephippiatus*), ad. (bottom).
26 Sep 2012, Krk (Croatia), Anne Frijsinger & Mat Vestjens; 10 Oct 2018, Ouessant (29, France) Julien Renoult. Bottom photo flipped horizontally.

Large-scaled goby

Thorogobius macrolepis Kolombatović, 1891

Large-scaled goby (*T. macrolepis*), ad (top); **Dollfus' goby** (*Vanneaugobius dollfusi*), ad (bottom). The clear orange spots on Large-scaled's head quickly distinguish it from Dollfus'. Moreover, Lage-scaled has fewer pearly white markings on the head and the body, and does not have vertical bars on lower flank. Even from a distance, Large-scaled can be differentiated by its steeper snout profile and bigger eyes. Last, note the difference in dorsal fin patterning. *26 May 2007, Tuscany (Italy), Stefano Guerrieri; 31 May 2020, Marseille (13, France), Sylvain Le Bris. Both photos flipped horizontally.*

Large-scaled goby

Thorogobius macrolepis Kolombatović, 1891

Large-scaled gobies (*T. macrolepis*), ad (in the back) with **Kolombatović's goby** (*G. kolombatovici*), ad (front left). Large-scaled and Kolombatović's are often found together at the foot of walls. Large-scaled is distinctly smaller, has orange spots on the snout (*vs*. V-shaped line in Kolombatovic's), in the oculoscapular region (*vs*. a continuous line) and on the cheek (vs. plain white). Large-scaled also has fewer midlateral blotches. *17 Jul 2013, Marseille (France), Sylvain Le Bris.*

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*References in **bold** characters are original species descriptions.*

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• Appendices

Table 1. Meristic characters of *Gobius* spp. and *Thorogobius* spp.

D1: first dorsal fin, D2: second dorsal fin, A: anal fin, P: pectoral fin, LL: scales along lateral midline, Arabic figures: number of spinous rays, Roman figures: number of articulated rays. Max size is total length expressed in mm. Range without parentheses gives most frequent values; range between parentheses gives extreme values. *Data compiled from various sources.*

Species	D1	D2	A	P	LL	max size
G. ater	VI	I+12-14	I+11	18(18-19)	38-40	71
G. auratus	VI	I+14(13-15)	I+13(12-14)	18-19(17-20)	43(42-47)	100
G. bucchichi	VI	I+14	I+13(13-14)	18(17-18)	52(51-59)	100
G. cobitis	VI	I+13(13-14)	I+11(10-12)	20-21(19-22)	59-67	270
G. couchi	V-VI	I+13(12-14)	I+12(11-13)	16-17(15-18)	40-41(35-45)	90
G. cruentatus	VI	I+14	I+(12-13)	20-21	52-58	180
G. fallax	VI	I+(14-16)	I+(13-15)	18	39-48	90
G. gasteveni	V-VI	I+14(12-15)	I+13(11-14)	20(18-22)	44(37-49)	120
G. geniporus	VI	I+12-14	I+11-12	17-19	50-55	160
G. incognitus	VI	I+14(13-14)	I+12-13	19-20(19-20)	51-59	100
G. kolombatovici	VI	I+14(13-14)	I+13	17-19	54(52-57)	110
G. niger	VI(V-VII)	I+12-13(11-13)	I+11-12(10-13)	17-19(15-20)	35-41(32-42)	180
G. ophiocephalus	VI(V-VII)	I+14-15(13-16)	I+14-15(12-16)	18-19(17-20)	59-64(53-68)	245
G. paganellus	VI	I+13-14(12-15)	I+11-12(10-13)	20-22(18-23)	50-55(46-59)	120
G. roulei	VI	I+13(12-14)	I+12	17(17-19)	33(32-35)	87
G. vittatus	V	I+11-13	I+11-13	17(15-18)	32-36	58
G. xanthocephalus	VI	I+15(13-16)	I+14(13-15)	19(18-20)	46-48(42-48)	95
G. xoriguer	VI	I+14	I+13	19-18	50-51	65
T. ephippiatus	V-VI	I+11(10-12)	I+10	17-19(17-20)	36-38(33-42)	130
T. macrolepis	VI	I+11	I+10	17-18	27-28	65

Table 2. Morphological characters of *Gobius* spp. and *Thorogobius* spp.

P filam.: extent of filamentous ray development, row *d*: number of sections in this row of sensory papillae, nostril process: shape of the process extending from the rim of the anterior nostril. *Data compiled from various sources.*

[1] Small scale generally invisible on *in situ* photographs.
[2] Very large scales.

Species	P filam	row *d*	nape	cheek	nostril process
G. ater	well	2 sections	scaled	naked	bifid tentacle
G. auratus	moderately	2 sections	scaled	naked	triangular lappet
G. bucchichi	moderately	continuous	scaled	naked	triangular/tentacle
G. cobitis	well	continuous	scaled	naked	long tentacle/digitate
G. couchi	moderately	2 sections	scaled	naked	triangular lappet
G. cruentatus	moderately	continuous	scaled	scaled	flap/tentacle
G. fallax	moderately	2 sections	scaled	naked	triangular flap
G. gasteveni	no/reduced	2 sections	scaled	naked	thin tentacle
G. geniporus	moderately	continuous	scaled	naked	lappet/tentacle
G. incognitus	moderately	2 sections	scaled[1]	naked	tentacle/triangular/bifid
G. kolombatovici	moderately	continuous	scaled	naked	triangular lappet
G. niger	moderately	continuous	scaled	naked	flap
G. ophiocephalus	poorly	continuous	scaled	naked	no process
G. paganellus	very well	2 sections	scaled[1]	naked	digitate
G. roulei	moderately	continuous	scaled[2]	naked/scaled	triangular lappet
G. vittatus	reduced	reduced	naked	naked	lappet
G. xanthocephalus	moderately	2 sections	scaled	naked	triangular flap
G. xoriguer	no/poorly	3 sections	scaled	naked	triangular lappet
T. ephippiatus	no	continuous	scaled	naked	no
T. macrolepis	no	continuous	naked	naked	no

• Gobies of the North-eastern Atlantic and the Mediterranean: *Gobius* and *Thorogobius*

Among the gobiid family, *Gobius* and *Thorogobius* include the largest and the most common species of the region. Nevertheless, their field identification is still challenging because their live aspect has rarely been described, and never compared within a single, comprehensive work. This photographic guide, the first of the Frontiers in *Fishwatching Series*, aims at pushing the limits of Gobies' identification.

- Covers all 20 species of *Gobius* and *Thorogobius*
- Features 390 underwater photos with detailed captions
- Describes key features in a Quick Identification Guide
- Species Accounts provide comprehensive descriptions and comparisons with similar species, information on habitats, status and geographic distributions.
- Illustrates night colouration, both sexes, juveniles and geographic variation

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Patrick Louisy is a renowned ichthyologist, aquarist and underwater photographer. He wrote more than 30 books on fish and marine life and many scientific articles. He holds a PhD in Oceanology and is the scientific director of the association Peau-Bleue and the founder of the Fish Watch Forum.

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