Unbaited underwater video evidences the presence of previously unrecorded fish species, sea krait *(Laticauda sp.)* and a high frequency of sharks at a remote reef complex (Coral Sea Marine Park, Southwest Pacific)

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Abstract:

The Chesterfield-Bellona atolls and reefs are a vast reef complex located in the Coral Sea Marine Park, established in 2014 in the New Caledonian Economic Exclusive Zone. In 2013, the New Caledonia government supported the first assessment of fish and benthic habitats conducted in all habitats and over the entire area. The assessment provided a primary knowledge base for establishing the importance of these atolls in terms of biodiversity and fished resources. This comprehensive survey relied on the STAVIRO unbaited underwater video technique and collected 185 successful camera drops distributed over all shallow habitats in the atolls. The analysis of video footages revealed 18 fish species and one snake species that had not been previously reported in this area. Sharks were frequently observed (43% of stations) and to a lesser extent sea snakes (9% of stations). The overall list of observed species included the globally threatened sicklefin lemon shark and commercially important species. The findings of the survey supported the establishment of strongly protected areas at these atolls in 2018. These outcomes highlight the interest of unbaited underwater video for effective surveying of large areas, and for observing infrequent and shy species. Additionally, video provides actionable and shareable scientific evidence that can support further research, management and educational purposes.

Keywords: reef fish ; underwater video ; marine conservation ; marine protected area ; New Caledonia; Oceania ; Chesterfield ; Bellona

1. Introduction

The Coral Sea located in the southwest Pacific Ocean is one of the richest regions in the world for reef fish diversity and in this area, anthropogenic impacts have been relatively minor to date[1]. To protect its exceptional biodiversity, the transboundary Coral Sea Marine Park (CSMP) was declared in November 2012 by Australia, and in April 2014 by New Caledonia. This park encompasses a surface of 1.3 million square kilometers. The Chesterfield-Bellona reefs and islets are located within the CSMP, approximately mid-way between New Caledonia and the Great Barrier Reef of Australia. Their surface is 4765 km², which includes ca. 3500 km² of lagoon area. The lagoon is generally deeper than 60 m with scattered shallow coral pinnacles. Chesterfield and Bellona are submerged atolls with a number of uninhabited islets ranging from sand cays to vegetated islets. The total reef area is 1458 km² [2].

Mostly because they were remote from any inhabited land, Chesterfield and Bellona have seldom been surveyed. Kulbicki et al. (1994)[3] reported the findings of several expeditions conducted between 1959 and 1984. The data collected during these surveys were mainly obtained from fishing techniques (beam trawl, shrimp trawl and fish trawl), and secondarily three rotenone-based sampling stations and seven Underwater Visual Censuses (UVC) transects were collected. These data were compiled to establish a first checklist of the fishes of the Chesterfield Islands that included 795 species [3]. Following the CHESTER2010 expedition, 37 new species were added to this list, based on 38 UVC transects conducted exclusively on the Chesterfield atoll [4]. Clua and Imirizaldu [5] reported in 2011 the observation of the sicklefin lemon shark (*Negaprion acutidens*). Overall, existing knowledge about the fish assemblages of Chesterfield and Bellona remains limited, only covers a part of these vast and remote areas, mostly in rocky habitats, and does not mention whether the species were observed in Chesterfield or in Bellona.

This paper presents the first records in the area of eighteen fish species, and documents the frequency of occurrence of iconic species such as sharks, turtles and sea snakes, as observed during a comprehensive survey conducted in 2013 over the entire area to provide a baseline assessment of fish and benthic habitats.

2. Materials and Methods

The survey was conducted between June 22th and July 5th 2013 (Fig. 1), from R.V. Amborella, a 24 m vessel operated by the New Caledonian Government. Fish and habitat data were collected using the underwater video protocol (STAVIRO)[6], part of Ocean Best Practices in Observation since 2022 (doi:http://dx.doi.org/10.25607/OBP-1755). The STAVIRO system consists of a Sony™ HDR-PJ 840 HD camcorder and a motor programmed to rotate the camera housing by 60° every 30 seconds (1 rotation ~ 3 min), yielding 6 contiguous fixed frames per 360° rotation. This relatively light-weight (6 kgs) lander was dropped from the Amborella's 5.6 m tender at the station location and set horizontally on the sea bed for fifteen to twenty minutes to record images over three complete undisturbed rotations. Because no bait nor underwater diver is required, the STAVIRO methodology provided minimal disturbance of mobile macrofauna during observation. This feature has proved useful to enhance the observations of shy and fishing target species. The short observation duration made it possible to achieve a large number of stations per day at sea. The sampling protocol was stratified according to reef geomorphology and reef zone, so that it covered the entire Chesterfield and Bellona atolls, and included observations on both inner and outer reef slopes (Figure 1).

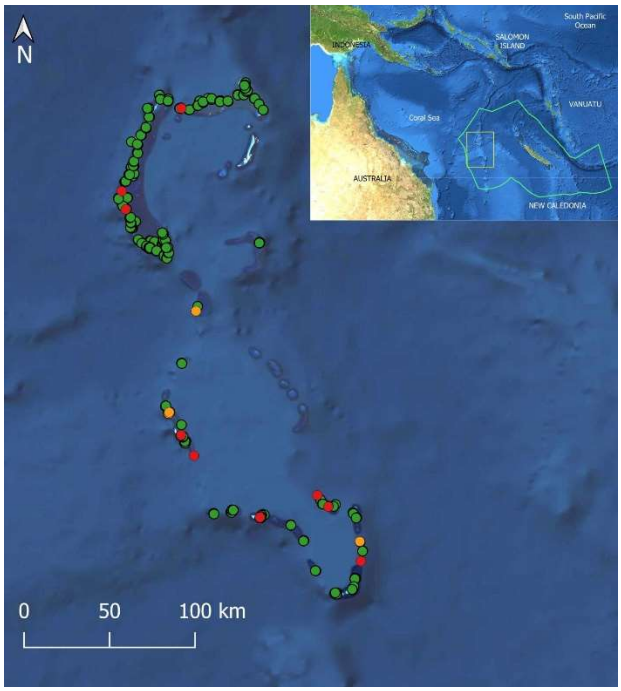

Figure 1. Distribution of the sampling stations at Chesterfield and Bellona (green: validated, red: not valid, orange: valid for habitat not for fish). Inset: Location of New Caledonia, with in green the delineation of the EEZ also corresponding to the external boundary of the Coral Sea Marine Park and in a yellow rectangle the Chesterfield and Bellona islands and reefs. Chesterfield and Bellona are respectively the northern and southern atolls. The two close stations between the atolls correspond to the Dumont d'Urville and Vauban deep reefs.

Over ten field days, 185 successful camera drops were validated (62 in Bellona and 123 in Chesterfield). Video sequences were validated when: i) the system was horizontal, ii) underwater visibility was at least 5 m, and iii) the field

of view was not obstructed by relief that would impede image analysis up to a 5 m distance. Images were analysed after the survey. Fishes and other large marine animals were identified at the most precise taxonomic level and counted on each frame and for each of three undisturbed rotations within a 5 m radius around the system. The reference species list for identification comprised 56 families (Appendix 1); it was derived from the revised checklist of fish species already observed in New Caledonia [7] by excluding species that cannot be identified and counted at a 5m distance using this video technique, i.e. cryptic and nocturnal species, as well as species with maximum length (Lmax) under 20 cm. Aside from fishes, iconic species such as turtles and snakes were also included in the list. As this was the first survey in the area, the presence of additional species not in the reference list was recorded too. In addition to counts, habitat descriptors were evaluated on each video [6]. In the following, only presence/absence data will be used.

The standardized procedure for sampling design, field operations, image annotation and data analysis was further described in Pelletier et al. [6].

3. Results

The analysis of the videos revealed 254 taxa belonging to 43 families (Appendices A and B). 123 and 232 species were respectively observed in Bellona and Chesterfield, with 101 species in common. 222 taxa out of the 254 belonged to the reference list, while the remaining 32 species were only recorded for their presence and not counted.

Among the 222 species, 18 fish species had not been previously reported at either Chesterfield or Bellona (Table 1, Figure 2, Appendix C). These included commercially important species: two species of snapper (*Lutjanus monostigma* and *Lutjanus rivulatus)* and an emperor *(Lethrinus atkinsoni)*. Most of the new species observed displayed relatively low occurrences (< 5 individuals in total over 185 camera drops). They were observed in three habitats: i) live coral-dominated; ii) debris-dominated; and iii) sandy bottoms.

Three snake species (*Laticauda laticaudata*, *Aipysurus laevis* and one species from the genus *Hydrophis*) and the green turtle (*Chelonia mydas*) were also recorded during the survey (Appendix C). Sea snakes were observed at 16 stations (8.6% of stations), more often in Bellona and on sandy bottoms. In comparison, *C. mydas* was observed at five stations only, all located in the live coral habitat in Chesterfield.

Five shark species (Appendix B) were observed with a very high frequency of occurrence (43% of stations), the most frequent species being *Carcharinus amblyrhinchos* (22% of stations) and *Triaenodon obesus* (16% of stations). The

sicklefin lemon shark *Negaprion acutidens* was also observed (Appendix C), and was reported in the same area by Clua and Imirizaldu (2017)[5]. *C. mydas* and *N. acutidens* are respectively classified as endangered (EN) and vulnerable (VU) in the IUCN Red List of Threatened Species due to pressure from overfishing of inshore populations (http://www.iucnredlist.org/details/41836/0). Recorded species also include two vulnerable species (VU): the camouflage grouper *Epinephelus polyphekadion* (https://www.iucnredlist.org/species/61339/100553967) and the harlequin filefish *Oxymonacanthus longirostris* (https://www.iucnredlist.org/species/70010721/115476659), and the near threatened (NT) butterflyfish *Chaetodon trifascialis* (https://www.iucnredlist.org/species/165712/6098323). According to Red List Assessments, the abovementioned species all exhibit decreasing trends.

Table 1. List of the 19 previously unrecorded fish species and the sicklefin lemon shark, including the number of individuals and numbers of stations where observed, the habitat at the camera drop locations were they were observed and the whether they were recorded at Chesterfield and/or Bellona.

Family	Species	# ind. observed	# stations observed (out of 185)	Depth or depth range (m)	Habitat(s)	Site(s)
Acanthuridae	*Paracanthurus hepatus*	7	5	9-20	Live Coral	Chesterfield
Balistidae	*Balistoides viridescens*	3	3	6-16	Live Coral & Sand	Chesterfield
	Pseudobalistes flavimarginatus	1	1	14	Sand	Chesterfield
	Rhinecanthus lunula	3	3	16-24	Live Coral, Debris & Sand	Bellona
Carangidae	*Carangoides orthogrammus*	4	3	2-25	Live Coral & Debris	Chesterfield
Carcharhinidae	*Negaprion acutidens*	1	1	6	Live Coral	Chesterfield
Chaetodontidae	*Forcipiger longirostris*	2	1	18	Live Coral	Chesterfield
	Hemitaurichthys polylepis	12	5	6-16	Live Coral	Chesterfield
Diodontidae	*Chilomycterus reticulatus*	1	1	10	Live Coral	Chesterfield
Labridae	*Hologymnosus annulatus*	2	2	18	Live Coral	Chesterfield
Lethrinidae	*Lethrinus atkinsoni*	2	2	2-3	Live Coral & Debris	Chesterfield
Lutjanidae	*Lutjanus monostigma*	1	1	9	Live Coral	Chesterfield
	Lutjanus rivulatus	3	3	2-11	Live Coral	Chesterfield & Bellona
Monacanthidae	*Aluterus scriptus*	3	3	4-10	Live Coral	Chesterfield
Pinguipedidae	*Parapercis xanthozona*	1	1	4	Sand	Chesterfield
Pomacanthidae	*Centropyge loricula*	5	3	6-7	Live Coral	Chesterfield
Scaridae	*Scarus flavipectoralis*	3	3	14-22	Live Coral & Sand	Chesterfield & Bellona
Scombridae	*Grammatorcynus bilineatus*	2	2	9	Live Coral	Chesterfield
Tetraodontidae	*Arothron hispidus*	1	1	10	Live Coral	Chesterfield

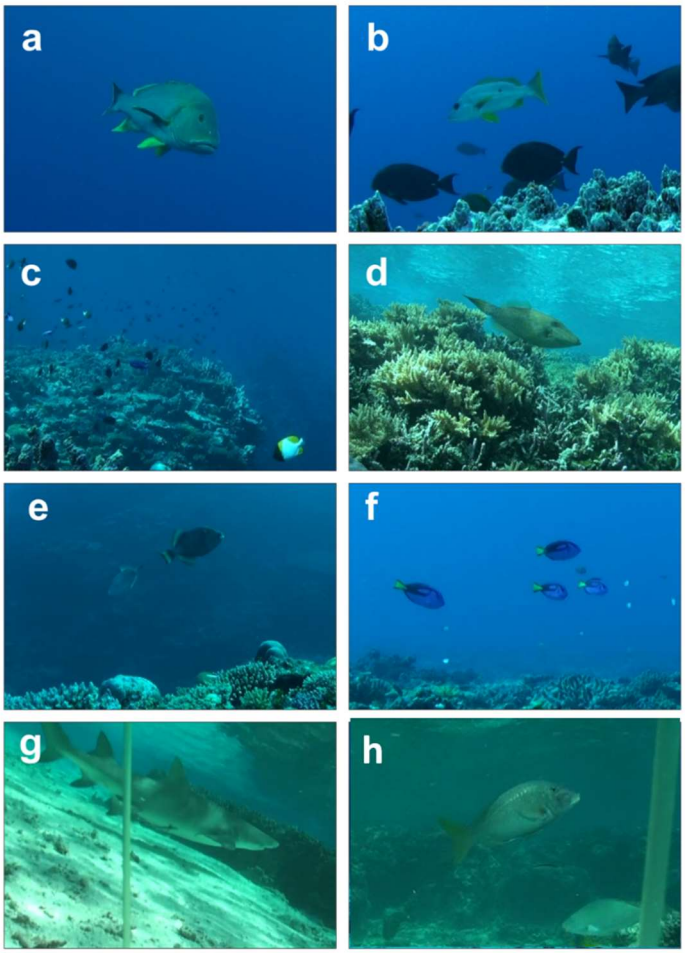

Figure 2. Screenshots of seven newly observed conspicuous species and the sicklefin lemon shark: (a) *Lutjanus rivulatus, (b) Lutjanus monostigma; (c) Hemitaurichtys polylepis; (d) Aluterus scriptus; (e) Balistoides viridescens; (f) Paracanthurus hepatus; (g) Negaprion acutidens; (h) Lethrinus atkinsoni.*

4. Conclusion

This first comprehensive baseline survey in both Chesterfield and Bellona quantified the diversity of the fish assemblage, the frequency of sharks, turtles and sea snakes, on both rocky and sandy bottoms, and completed the fish species list in this remote reef complex with eighteen new records. While the presence of these species at Chesterfield and Bellona is not surprising given their relatively wide distribution across the Indo-Pacific, these data contribute to complete species inventories in these remote locations, and to quantify occurrences at precise locations in the Coral Sea Marine Park. These findings bring the total number of fish species observed at Chesterfield and Bellona to 851 species.

Our findings document a high frequency of sharks in the area. The presence of *N. acutidens* at Chesterfield and Bellona is also noteworthy as it could provide support for the hypothesis that this site attached species uses oceanic reefs as stepping stones during rare dispersal events [8]. Such movements have been proposed as an explanation for the lack of genetic differentiation between *N. acutidens* populations in Australia and French Polynesia.

Beyond fish species, this is also the first reported record of sea krait (*L. laticaudata)* in Chesterfield and Bellona. The species had not been documented in previous surveys in the area [9–11]. Sea snakes were observed relatively frequently in our survey compared to other surveys conducted with the same protocol in other remote reefs [6], but less frequently than in a video survey conducted, on sandy bottoms only, at the d'Entrecasteaux remote reefs and atolls (Coral Sea)[12]. The frequencies of both sea snakes and sharks indicate a good ecological condition of the fish community.

These observations of infrequent and shy species together with robust estimates of occurrence frequencies were made possible because the protocol used both enables high spatial replication, deployments in all reef and lagoon habitats, and non-obtrusive observations. At this site, rare species had not been detected in previous surveys that sampled few observations, whereas the STAVIRO underwater video protocol could survey such extensive areas and collect numerous observations. The results of this comprehensive survey[13] provided useful baseline knowledge for declaring in August 2018, no-take and integral (no-access) marine reserves in both Chesterfield and Bellona. In January 2024, the Bellona reef complex was further declared an integral marine reserve.

Finally, the recorded underwater videos are shareable for research and education purposes, thereby contributing to ocean literacy and to baseline knowledge on marine biodiversity.

Author Contributions: Conceptualization, DP, AP & WR; methodology, DP, WR, AP; validation, PL, WR, AP; formal analysis, WR, TB, DR; data curation, WR, TB, LC; writing—original draft preparation, DP & AP.; writing—review and editing, DP & AP; supervision DP; project administration, DP; funding acquisition, DP. All authors have read and agreed to the published version of the manuscript."

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Institutional Review Board Statement: This study did not require ethical approval.

Informed Consent Statement: Not applicable.

Data Availability Statement: The data presented in this study are openly available in archimer.ifremer.fr at https://image.ifremer.fr (see Appendix C) and http://dx.doi.org/10.12770/46679114-cbe7-4044-8125-d9dfdd34917e.

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Appendix A List of the 56 taxonomic families considered for counts in image analysis.

Species with Lmax smaller than 20 cm are not counted, except for Chaetodontidae. In italics, families that do not belong to Pisces, but have an iconic interest and are easily observed with the STAVIRO technique.

Acanthuridae	Gerreidae	Ostraciidae
Albulidae	Ginglymostomatidae	Pentacerotidae
Aulostomidae	Haemulidae	Pinguipedidae
Balistidae	Hemiramphidae	Plotosidae
Belonidae	Kuhliidae	Polynemidae
Caesionidae	Kyphosidae	Pomacanthidae
Carangidae	Labridae	Priacanthidae
Carcharhinidae	Lamnidae	Rhinchodontidae
Chaetodontidae	Leiognathidae	Rhinobatidae
Chanidae	Lethrinidae	Scaridae
Cheloniidae	Lobotidae	Scombridae
Chirocentridae	Lutjanidae	Serranidae
Dasyatidae	Malacanthidae	Siganidae
Diodontidae	Megalopidae	Sphyraenidae
Dugongidae	Monacanthidae	Sphyrnidae
Echeneidae	Mugilidae	Stegostomatidae
Elapidae	Mullidae	Tetraodontidae
Ephippidae	Myliobatidae	Zanclidae
Fistulariidae	Nemipteridae	

Appendix B List of the 254 distinct taxa observed from the videos at the Chesterfield and Bellona reef complex.

The families marked with an asterisk (*) do not belong to the list of Appendix A, but were easily identified from the images.

Family	Scientific name	Bellona	Chesterfield
Acanthuridae (26 species)	*Acanthurus albipectoralis*	•	•
	Acanthurus blochii	•	•
	Acanthurus dussumieri	•	•
	Acanthurus lineatus		•
	Acanthurus nigricans		•
	Acanthurus nigricauda		•
	Acanthurus nigrofuscus	•	•
	Acanthurus olivaceus	•	•
	Acanthurus pyroferus		•
	Acanthurus thompsoni		•
	Acanthurus triostegus		•
	Acanthurus xanthopterus	•	•
	Ctenochaetus binotatus	•	•
	Ctenochaetus cyanocheilus		•
	Ctenochaetus striatus	•	•
	Ctenochaetus strigosus		•
	Naso brevirostris	•	•
	Naso caesius		•
	Naso hexacanthus		•
	Naso lituratus	•	•
	Naso tonganus	•	•
	Naso unicornis	•	•
	Naso vlamingii		•
	Paracanthurus hepatus		•
	Zebrasoma scopas	•	•
	Zebrasoma velifer	•	•
Aulostomidae	*Aulostomus chinensis*	•	•
Balistidae (12 species)	*Balistapus undulatus*		•
	Balistoides conspicillum	•	•
	Balistoides viridescens		•
	Melichthys vidua		•

	Pseudobalistes flavimarginatus		•
	Pseudobalistes fuscus	•	•
	Rhinecanthus aculeatus		•
	Rhinecanthus lunula	•	
	Rhinecanthus rectangulus	•	•
	Sufflamen bursa	•	
	Sufflamen chrysopterum	•	•
	Sufflamen fraenatum	•	•
Belonidae	Not identified at species or genus level	•	
Caesionidae (4 species)	*Caesio caerulaurea*		•
	Pterocaesio digramma		•
	Pterocaesio tile	•	•
	Pterocaesio trilineata		•
Carangidae (10 species)	*Carangoides ferdau*		•
	Carangoides fulvoguttatus	•	
	Carangoides orthogrammus		•
	Caranx ignobilis	•	•
	Caranx lugubris		•
	Caranx melampygus	•	•
	Caranx sexfasciatus		•
	Decapterus macarellus	•	
	Pseudocaranx dentex	•	•
	Scomberoides lysan		•
Carcharhinidae (4 species)	*Carcharhinus amblyrhynchos*	•	•
	Carcharhinus melanopterus		•
	Negaprion acutidens		•
	Triaenodon obesus	•	•
Chaetodontidae (23 species)	*Chaetodon auriga*	•	•
	Chaetodon citrinellus	•	•
	Chaetodon ephippium		•
	Chaetodon flavirostris	•	•
	Chaetodon kleinii	•	•
	Chaetodon lineolatus	•	•
	Chaetodon lunulatus	•	•
	Chaetodon melannotus		•
	Chaetodon mertensii	•	•
	Chaetodon pelewensis	•	•
	Chaetodon plebeius		•
	Chaetodon reticulatus		•
	Chaetodon speculum		•

	Chaetodon trifascialis	•	•
	Chaetodon ulietensis		•
	Chaetodon unimaculatus	•	•
	Chaetodon vagabundus		•
	Forcipiger flavissimus		•
	Forcipiger longirostris		•
	Hemitaurichthys polylepis		•
	Heniochus acuminatus		•
	Heniochus chrysostomus	•	•
	Heniochus monoceros		•
Chanidae	*Chanos chanos*		•
Cheloniidae	*Chelonia mydas*		•
Cirrhitidae(*)	*Paracirrhites arcatus*		•
Dasyatidae	*Neotrygon kuhlii*	•	•
Diodontidae	*Chilomycterus reticulatus*		•
(2 species)	*Diodon hystrix*		•
Elapidae (3 species)	*Aipysurus laevis*		•
	Hydrophis sp.		•
	Laticauda laticaudata		•
Ginglymostomatidae	*Nebrius ferrugineus*	•	
Gobiidae(*)	*Amblygobius phalaena*		•
(2 species)	*Valenciennea strigata*		•
Haemulidae	*Diagramma pictum*		•
(2 species)	*Plectorhinchus picus*		•
Holocentridae(*)	*Myripristis kuntee*		•
Kyphosidae	*Kyphosus pacificus*	•	
(2 species)	*Kyphosus vaigiensis*		•
Labridae (38 species)	*Anampses femininus*	•	•
	Anampses neoguinaicus		•
	Bodianus loxozonus	•	•
	Bodianus perditio	•	•
	Cheilinus chlorourus	•	•
	Cheilinus trilobatus	•	•
	Choerodon jordani	•	•
	Cirrhilabrus laboutei		•
	Cirrhilabrus punctatus		•
	Coris aygula		•
	Coris batuensis	•	•
	Coris dorsomacula	•	•
	Coris gaimard	•	•

	Epibulus insidiator		•
	Gomphosus varius	•	•
	Halichoeres chloropterus	•	
	Halichoeres hortulanus	•	•
	Halichoeres margaritaceus	•	
	Halichoeres melanurus		•
	Halichoeres trimaculatus	•	•
	Hemigymnus fasciatus		•
	Hemigymnus melapterus		•
	Hologymnosus annulatus		•
	Labrichthys unilineatus		•
	Labroides bicolor		•
	Labroides dimidiatus		•
	Labroides pectoralis		•
	Labropsis australis		•
	Novaculichthys taeniourus	•	•
	Oxycheilinus digramma		•
	Oxycheilinus unifasciatus	•	•
	Stethojulis bandanensis		•
	Thalassoma amblycephalum		•
	Thalassoma hardwicke	•	•
	Thalassoma lunare	•	•
	Thalassoma lutescens	•	•
	Thalassoma nigrofasciatum	•	•
	Thalassoma quinquevittatum		•
Lethrinidae (11 species)	*Gnathodentex aureolineatus*		•
	Gymnocranius euanus	•	•
	Lethrinus atkinsoni		•
	Lethrinus lentjan		•
	Lethrinus miniatus	•	•
	Lethrinus nebulosus		•
	Lethrinus obsoletus		•
	Lethrinus olivaceus	•	•
	Lethrinus rubrioperculatus		•
	Monotaxis grandoculis	•	•
	Monotaxis heterodon		•
Lutjanidae (10 species)	*Aprion virescens*	•	
	Aphareus furca		•
	Lutjanus bohar	•	•
	Lutjanus fulvus		•

	Lutjanus kasmira		•
	Lutjanus monostigma		•
	Lutjanus rivulatus	•	•
	Lutjanus russellii		•
	Lutjanus sebae	•	•
	Macolor niger	•	•
Malacanthidae	*Malacanthus brevirostris*	•	•
Microdesmidae(*)	*Nemateleotris magnifica*	•	•
(2 species)	*Ptereleotris evides*	•	•
	Aluterus scriptus		•
	Amanses scopas	•	
	Cantherhines dumerilii	•	•
Monacanthidae	*Cantherhines fronticinctus*		•
(7 species)	*Cantherhines pardalis*	•	•
	Oxymonacanthus longirostris		•
	Pseudalutarius nasicornis		•
	Mulloidichthys flavolineatus	•	•
	Mulloidichthys vanicolensis		•
	Parupeneus barberinoides		•
Mullidae	*Parupeneus barberinus*	•	•
(8 species)	*Parupeneus cyclostomus*	•	•
	Parupeneus multifasciatus	•	•
	Parupeneus pleurostigma	•	•
	Upeneus tragula	•	
Muraenidae(*)	*Gymnothorax javanicus*		•
(2 species)	*Gymnothorax meleagris*		•
Nemipteridae	*Pentapodus aureofasciatus*		•
(2 species)	*Pentapodus caninus*		•
Ophichthidae	*Myrichthys sp.*		•
	Parapercis australis		•
Pinguipedidae	*Parapercis hexophtalma*	•	•
(4 species)	*Parapercis millepunctata*	•	
	Parapercis xanthozona		•
	Centropyge bicolor		•
	Centropyge bispinosa	•	•
	Centropyge flavissima	•	•
Pomacanthidae	*Centropyge heraldi*	•	•
(10 species)	*Centropyge loricula*		•
	Centropyge tibicen	•	•
	Centropyge vrolikii		•

	Chaetodontoplus conspicillatus	•	
	Pomacanthus imperator	•	
	Pygoplites diacanthus		•
Pomacentridae(*) (20 species)	*Abudefduf sexfasciatus*		•
	Amphiprion akidynos		•
	Amphiprion rubrocinctus		•
	Chromis agilis		•
	Chromis atripectoralis		•
	Chromis flavomaculata	•	
	Chromis fumea	•	
	Chromis iomelas	•	•
	Chromis ternatensis		•
	Chrysiptera biocellata		•
	Chrysiptera tricincta	•	
	Dascyllus aruanus	•	•
	Dascyllus reticulatus	•	•
	Plectroglyphidodon dickii		•
	Plectroglyphidodon johnstonianus	•	•
	Plectroglyphidodon lacrymatus		•
	Pomacentrus lepidogenys		•
	Pomacentrus vaiuli	•	
	Stegastes gascoynei	•	
	Stegastes nigricans		•
Priacanthidae	*Priacanthus hamrur*		•
Scaridae (19 species)	*Cetoscarus bicolor*		•
	Cetoscarus ocellatus	•	•
	Chlorurus microrhinos	•	•
	Chlorurus sordidus	•	•
	Hipposcarus longiceps	•	•
	Scarus altipinnis	•	•
	Scarus chameleon	•	•
	Scarus flavipectoralis	•	•
	Scarus forsteni		•
	Scarus frenatus		•
	Scarus ghobban	•	
	Scarus globiceps		•
	Scarus longipinnis	•	•
	Scarus niger		•
	Scarus oviceps		•

	Scarus psittacus		•
	Scarus rivulatus		•
	Scarus rubroviolaceus		•
	Scarus schlegeli	•	•
Scombridae	*Grammatorcynus bilineatus*		•
Serranidae (10 species)	*Cephalopholis argus*		•
	Cephalopholis urodeta	•	•
	Epinephelus cyanopodus	•	•
	Epinephelus maculatus	•	•
	Epinephelus merra		•
	Epinephelus polyphekadion		•
	Plectropomus laevis	•	•
	Plectropomus leopardus	•	•
	Pseudanthias pascalus		•
	Variola louti	•	•
Siganidae (2 species)	*Siganus argenteus*	•	•
	Siganus punctatus	•	•
Sphyraenidae	*Sphyraena barracuda*	•	
Synodontidae(*)	*Synodus variegatus*		•
Tetraodontidae (4 species)	*Arothron hispidus*		•
	Arothron nigropunctatus		•
	Canthigaster bennetti(*)		•
	Canthigaster valentini(*)	•	•
Zanclidae	*Zanclus cornutus*		•

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Appendix C Video clips for newly observed species, sea snakes, turtles and the sicklefin lemon shark.

The clips are posted on the Marine Videos Portal of Ifremer (https://image.ifremer.fr/). For each species, the DOI is provided and an indication of the location on the frame where the species appears at first. The frame is divided into nine parts, numbered from bottom to top and from left to right.

Species	DOI	Part of the frame
Paracanthurus hepatus	https://doi.org/10.24351/78698	5
Balistoides viridescens	https://doi.org/10.24351/78687	3
Pseudobalistes flavimarginatus	https://doi.org/10.24351/78701	7
Rhinecanthus lunula	https://doi.org/10.24351/78702	3
Carangoides orthogrammus	https://doi.org/10.24351/78688	7
Negaprion acutidens	https://doi.org/10.24351/78071	5
Forcipiger longirostris	https://doi.org/10.24351/78691	9
Hemitaurichthys polylepis	https://doi.org/10.24351/78693	9
Chilomycterus reticulatus	https://doi.org/10.24351/78690	8
Hologymnosus annulatus	https://doi.org/10.24351/78694	9
Lethrinus atkinsoni	https://doi.org/10.24351/78695	8
Lutjanus monostigma	https://doi.org/10.24351/78696	2
Lutjanus rivulatus	https://doi.org/10.24351/78697	2
Aluterus scriptus	https://doi.org/10.24351/78685	1
Parapercis xanthozona	https://doi.org/10.24351/78699	3
Centropyge loricula	https://doi.org/10.24351/78689	3
Scarus flavipectoralis	https://doi.org/10.24351/78703	1
Grammatorcynus bilineatus	https://doi.org/10.24351/78692	4
Arothron hispidus	https://doi.org/10.24351/78686	4
Chelonia mydas	https://doi.org/10.24351/78070	7, 8 & 1 (3 clips)
Aipysurus laevis	https://doi.org/10.24351/78070	8
Laticauda laticaudata	https://doi.org/10.24351/78070	8

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