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An annotated list of parasites (Isopoda, Copepoda, Monogenea, Digenea, Cestoda and Nematoda) collected in groupers (Serranidae, Epinephelinae) in New Caledonia emphasizes parasite biodiversity in coral reef fish

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Abstract: Over a 7-year period, parasites have been collected from 28 species of groupers (Serranidae, Epinephelinae) in the waters off New Caledonia. Host-parasite and parasite-host lists are provided, with a total of 337 host-parasite combinations, including 146 parasite identifications at the species level. Results are included for isopods (5 species), copepods (19), monogeneans (56), digeneans (28), cestodes (12), and nematodes (12). When results are restricted to those 14 fish species for which more than five specimens were examined and to parasites identified at the species level, 109 host-parasite combinations were recorded, with 63 different species, of which monogeneans account for half (32 species), and an average of 4.5 parasite species per fish species. Digenean records were compared for 16 fish species shared with the study of Cribb et al. (2002); based on a total of 90 parasite records identified at the species level, New Caledonia has 17 new records and only seven species were already known from other locations. We hypothesize that the present results represent only a small part of the actual biodiversity, and we predict a biodiversity of 10 different parasite species and 30 host-parasite combinations per serranid. A comparison with a study on Heron Island (Queensland, Australia) by Lester and Sewell (1989) was attempted: of the four species of fish in common and in a total of 91 host-parasite combinations, only six parasites identified at the species level were shared. This suggests strongly that insufficient sampling impairs proper biogeographical or ecological comparisons. Probably only 3% of the parasite species of coral reef fish are already known in New Caledonia.

Keywords: Isopoda, Copepoda, Monogenea, Digenea, Cestoda, Nematoda, Serranidae, Epinephelinae, parasite biodiversity, coral reef, New Caledonia

Coral reefs are, with tropical rain forests, areas of maximum biodiversity (Reaka-Kudla 1997), and are currently threatened (Roberts et al. 2002, Jones et al. 2004). Biodiversity, here considered as the number of different species in an area, although generally presented to the general public with very visible and iconic examples such as birds and mammals, reveals its real importance when the number of small invertebrates is evaluated. Among these, parasites are often neglected in numerical evaluations of biodiversity (Whittington and Chisholm 2003, Poulin 2004, Bouchet 2006). With the paradigm that each free-living animal has at least one parasite species, and knowing that many parasite species are strictly specific to their host species, it follows that the number of parasite species is at least equal to the number of non-parasitic animal species, and thus that at least half of biodiversity is represented by parasites (Windsor 1998); parasitology should thus be an integral component of any program for biodiversity assessment (Brooks and Hoberg 2000).

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In this paper, we present results obtained on a single subfamily of coral reef fishes, the groupers (Serranidae, Epinephelinae) in an area centred around Nouméa, New Caledonia, South Pacific. The groupers are fish of considerable economic importance, especially in the Indo-Pacific (Ottolenghi et al. 2004) and diseases, including parasites, may threaten attempts to introduce these species to systems of aquaculture (Bondad-Reantaso et al. 2002).

Results are presented as a host-parasite list (Appendix 1), in which all parasites of a given host species are listed, and as a parasite-host list (Appendix 2), in which all hosts are listed for each parasite species. For possible future verification of the data presented, we give a list of specimens deposited in various international collections with their accession numbers (Appendix 3); we insist on the need for deposition of material for any parasitological study, the utility of which has been demonstrated in many cases (e.g. Hoberg et al. 2009, Justine et al. 2009a).

The current dataset includes 28 species of groupers. It is not easy to express the number of parasite species found because of the many cases of unidentified species: these can represent a single quasi-generalist species or a number of cryptic species. If we minimize the numbers by counting all cases of unidentified species as a single 'species', our results include 134 parasite 'species' (5 Isopoda, 19 Copepoda, 56 Monogenea, 28 Digenea, 12 Cestoda, 12 Nematoda, 1 Acanthocephala and 1 Turbellaria). The number of host-parasite combinations recorded (i.e. a parasite associated with a host) is 337, including 146 in which the parasite was identified at the species level.

We attempted to compare the results obtained here with comparable data sets available in the literature. It appeared that very few such data sets are available. Finally, we used only the general survey on parasites of Heron Island (Lester and Sewell 1989), a small coral cay in the southern Great Barrier Reef off Queensland, Australia (23°26′S, 151°54′E) at the same latitude and approximately 1,500 km West of New Caledonia. For brevity, no attempts were made to update this general paper with more recent literature, and no detailed attempt was made to discuss, for each fish or for each parasite, which parasites and which host records have been found elsewhere. This has been done, however, for *Epinephelus malabaricus* and *Ep. cyanopodus* (Justine and Sigura 2007, Sigura and Justine 2008).

MATERIALS AND METHODS

Collection of hosts

Over a 7-year period (2003–2009), fish were collected, generally by fishing with hook and line, sometimes by spear-fishing, and occasionally from the fish market of Nouméa. All specimens come from within the lagoon, the barrier reef or the outer reef slope in a radius of ca. 30 km around Nouméa. Live fish were kept in a container with seawater and immediately brought back to the laboratory. All fish were measured, weighed and photographed. A unique number (JNC) was assigned to each fish. The parasitological material was then assigned a corresponding JNC number linked to the respective fish host. Measurements of hosts (fork length, FL, in mm; weight, W, in g) were taken for possible future comparison of parasite prevalence and host age in other localities and because the monogenean fauna has been shown to change according to fish size (Hinsinger and Justine 2006a, Sigura and Justine 2008). However, for brevity these data are not given in this paper. Host names have been updated using FishBase (Froese and Pauly 2009).

Collection of parasites

Basically, we used two methods, targeting two different sets of organs, here designated as the 'gills' and the 'abdominal organs'. The two methods, 'gills' and 'abdominal organs' were sometimes used on the same fish, but often the fish were processed only with one method. There are several reasons for this; often, a given grouper species was examined for gill monogeneans (with other gill parasites collected incidentally) until the monogeneans were collected and described, and the collection of monogeneans was so time-consuming that the detailed study of other organs was not practical; later when the monogeneans were known and described, the same fish species was processed in detail for 'abdominal organs', but the gills were not carefully examined for monogeneans. Also, the examination method was adapted according to the colleagues visiting for collection of their particular group of parasites; in these cases, this group was collected as a priority and other groups were collected only partially, or not at all. In the host-parasite list, we counted separately the total number of fish collected, and the number of fish examined for 'gills' and for the 'abdominal organs'; ideally, the latter two numbers should equal the first, but they rarely do. These numbers are however important in understanding the significance of the results, especially when few parasites were collected from a few fish examined.

For the 'gill method', the gills from both sides were removed one by one by cutting them at their extremities and they were examined immediately in seawater. Parasites were collected under a binocular microscope. Monogeneans were removed alive with fine needles and immediately prepared for slides (Justine 2005a). Copepods and isopods were removed with fine pincers or with the help of a fine needle, and immediately fixed in 70% ethanol. Live gnathiid isopod larvae were sometimes kept in seawater in an attempt to obtain adults (Smit et al. 2003), but without significant results.

For the 'abdominal organ method', the body cavity was opened and all organs were removed. The liver and gonads were separated. The stomach, caeca and intestine were then opened longitudinally with scissors. For about half of the fish (2003–2006), the digestive tract was then examined under a binocular microscope and the parasites were removed with fine pincers or a pipette. For the other half, we used the 'gut wash method' (Cribb and Bray 2010) in saline (1/4 seawater, 3/4 tap water); this method proved to be more effective and faster than the direct examination method. The gonads were often, but not always, examined under a binocular microscope and were macerated in a small quantity of saline. Cysts of trypanorhynch cestodes were carefully opened with two fine pincers in saline under a binocular microscope, and the living larvae were immediately flattened between two slides or pipetted in boiling saline, to obtain everted tentacles. Digeneans and cestodes from the intestinal lumen were pipetted alive in near-boiling saline. Copepods and isopods were examined and dissected according to routine meth-

ods (Boxshall et al. 2008, Trilles and Justine 2010). Permanent slides were made from monogeneans, digeneans and cestodes according to routine methods (Justine 2005a, Bray and Justine 2006a, Beveridge et al. 2007, Kuchta et al. 2009a). Nematodes were fixed alive in near-boiling 4% formalin, or sometimes in boiling 70% ethanol or near-boiling saline, and later examined in glycerine; specimens were also prepared for scanning electron microscopy (Moravec and Justine 2005). Tetraphyllidean cestode larvae, which are impossible to identify morphologically, were generally fixed in near-boiling saline and kept in absolute ethanol for possible future molecular analysis.

Several organs were almost never examined. For possible comparison with other geographic localities or similar future studies in the same location, it is important to be explicit in describing the flaws in our sampling methods. Parts of the fish almost never examined include the branchiostegal membranes, the fins and the general surface of the body; this certainly decreased our findings of capsalid monogeneans and philometrid nematodes. The heart and blood system were almost never examined, and thus no aporocotylid digenean was recorded. The kidneys, the liver, the general muscle mass and the bones were not examined. The swim bladder was only occasionally examined. The nasal cavities were not opened. No metacercariae were sought in the muscle mass. Anisakid nematode larvae, which are often numerous on the surface of all internal organs, were only occasionally collected. The eyes and the orbits were examined in certain cases, but certainly not extensively; however, several philometrid nematodes were found in these organs. Only parasitic crustaceans and helminths are recorded here, no attempt was made to seek microscopic protistan or myxozoan parasites. The absence in the present results of several parasitic groups which are usually found in the neglected organs cited above is thus not significant. However, the absence of leeches (Hirudinea) in this study of serranids is significant because these parasites are easily found and were efficiently collected, using the same methods, in other families of fishes. The absence of copepods on the skin is also significant, because such parasites are easily spotted at the time of catch and were collected on fishes of other families.

The number of parasite specimens collected has generally been recorded, but for brevity is not mentioned in this study, which focuses on species-level biodiversity.

Identification of parasites

The specimens, generally collected by J.-L. Justine and his team of students, and sometimes by visiting colleagues, were forwarded to their respective specialists: I. Beveridge (trypanorhynch cestodes), G.A. Boxshall (copepods), R.A. Bray (digeneans), F. Moravec (nematodes), J.-P. Trilles (isopods), I.D. Whittington (capsalid monogeneans) and J.-L. Justine (other monogeneans). The names of cestode orders follow Khalil et al. (1994), updated by Kuchta et al. (2008) and Healy et al. (2009). Monogenean genera (*Haliotrema*, etc.) sometimes included in the Dactylogyridae are here considered as members of the Ancyrocephalidae. Many specimens have been deposited in recognized collections (Appendix 3); other specimens under study are still in the collections of the various authors but will be eventually deposited in the collection of the Muséum national d'Histoire naturelle (MNHN) and/or in other recognized, curated collections.

Many specimens were not identified to the species level, even in groups in which this is theoretically possible. Publication of this list could be delayed for several years to await better and more comprehensive accuracy; however, it was considered that enough significant data had already been accumulated to warrant publication. Data presented here were compiled in March 2009; results which were not in press at this date but are now published (Trilles and Justine 2010) have not been included.

Abbreviations

The following abbreviations are used in Tables and Appendices.
For all: **Unid**: Unidentified family.
Isop: Isopoda; Families: **Aegi**: Aegiidae; **Cora**: Corallanidae; **Cymo**: Cymothoidae; **Gnat**: Gnathiidae.
Cope: Copepoda; Families: **Cali**: Caligidae; **Diss**: Dissonidae; **Hats**: Hatschekiidae; **Lern**: Lernanthropidae; **Lerp**: Lernaeopodidae; **Penn**: Pennellidae; **Siph**: Siphonostomidae.
Mono: Monogenea; Families: **Ancy**: Ancyrocephalidae; **Caps**: Capsalidae; **Dipl**: Diplectanidae.
Dige: Digenea; Families: **Acan**: Acanthostomidae; **Apor**: Aporocotylidae; **Bive**: Bivesiculidae; **Buce**: Bucephalidae; **Dero**: Derogenidae; **Didy**: Didymozoidae; **Fell**: Fellodistomatidae; **Gorg**: Gorgoderidae; **Hemi**: Hemiuridae; **Hiru**: Hirudinellidae; **Lepo**: Lepocreadiidae; **Opec**: Opecoelidae.
Cest: unclassified Cestoda.
Tryp: Cestoda Trypanorhyncha; Families: **Laci**: Lacistorhynchidae; **Otob**: Otobothriidae; **Pseu**: Pseudotobothriidae.
Both: Cestoda Bothriocephalidea; Family: **Both**: Bothriocephalidae.
Tetr: Cestoda Tetraphyllidea (no family identified).
Nema: Nematoda; Families: **Anis**: Anisakidae; **Cama**: Camallanidae; **Capi**: Capillariidae; **Cucu**: Cucullanidae; **Phil**: Philometridae.
Acantho: Acanthocephala (no family identified).

Abbreviation in text and Tables: NHR: New host record; NGR: New geographical record. HPC: Host-parasite combination; SLIP: Species-level identified parasite; SLIP-HPC: Species-level identified parasite – host-parasite combination.

Institutions: MNHN, Muséum national d'Histoire Naturelle, Paris, France; BMNH, Natural History Museum, London, United Kingdom; USNPC, United States National Parasite Collection, Beltsville, USA; SAMA AHC, South Australian Museum Adelaide, Australian Helminthological Collection, Adelaide, Australia; HCIP, Helminthological Collection, Institute of Parasitology, Biology Centre, Academy of Sciences of the Czech Republic, České Budějovice, Czech Republic; SLZU, School of Life Sciences, Zhongshan University (Sun Yat-sen University), Guangzhou, China; ZRC, Zoological Collection of the Raffles Museum, Singapore; QM, Queensland Museum, Brisbane, Australia.

RESULTS AND DISCUSSION

The results are presented as a host-parasite list (Appendix 1), a parasite-host list (Appendix 2) and a list of material deposited (Appendix 3). The number of host-parasite combinations found in each fish species is given in Table 1.

Comments on each group

In these brief comments, we discuss the new records, and analyse our findings from the perspective of the numerical evaluation of biodiversity. In other words, we try to understand the significance of the number of species found in terms of actual parasite biodiversity.

Fish. Twenty-eight species of groupers were examined; they represent 68% of the 41 species known in New Caledonia (Fricke and Kulbicki 2007). However, several species mentioned in the ichthyological literature are rare and will probably escape parasitological investigation. In our study, a few large species were studied only on very small numbers of individuals, such as *Ep. coioides* (1), *Ep. fuscoguttatus* (2) and *Ep. malabaricus* (2); no doubt, better sampling would reveal significant additional numbers of parasite species. The giant species *Epinephelus lanceolatus* (Bloch, 1790) was not studied. There are 159 species of groupers in the world (Heemstra and Randall 1993) so the 28 species investigated represent 18% of the global fauna.

Isopoda. All three identified adult isopod species found belong to the family Corallanidae, and they were already known from throughout the Indo-West Pacific from a variety of localities (Delaney 1989) and hosts.

Argathona rhinoceros is already known from *Tetraodon leopardus*, *Ep. chlorostigma*, *Ep. tauvina*, *Va. louti*, *Ep. malabaricus*, and *Pl. leopardus* (Delaney 1989), and on *Ep. coioides* and *Ep. fuscoguttatus* in Indonesia (W. Thorsten, pers. comm.). It was found again on the gills of *Ep. malabaricus* and *Pl. leopardus* in New Caledonia. *Ep. coioides* and *Ep. cyanopodus* are new host records. New Caledonia is a new geographical record.

Argathona macronema is already known from *Ep. tauvina*, *Diagramma cinerascens*, *Pseudolabras* sp. [sic], *Trachichtodes affinis* [sic], *Cromileptes altivelis*, *Lutjanus argentimaculatus*, *Pl. maculatus*, and *Pl. leopardus* (Delaney 1989), on the eye of a sea turtle in Kenya (Monod 1975) and in an unidentified fish in Indonesia (W. Thorsten, pers. comm.); it is also known from coral reef rock, coral rubble and sand (Delaney 1989). It was found again on the gills of *Pl. leopardus* in New Caledonia. *Pl. laevis* is a new host record. New Caledonia is a new geographical record.

Lanocira zeylanica is already known from throughout the Indo-West Pacific, but no hosts have been indicated. The species has been collected from sponges (Monod 1933) and from corals (Monod 1933, Jones 1982). Delaney (1989) wrote "there is only one record (this study) of an unidentified *Lanocira* species collected as temporary parasite of a fish (*Variola louti*)". Our finding on the body of *Ce. boenak* is a new host record, and New Caledonia is a new geographical record.

All larval isopods found belonged to the family Gnathiidae. They were found on 12 of the 28 grouper species examined, but it is likely that all species are hosts for them. These larvae cannot be identified at the species level, and some attempts to obtain the adults from praniza larvae did not succeed. The number of gnathiid species represented in these findings could not be evaluated, but it is likely that more than a single species are involved.

Copepoda. Nineteen 'species' of copepods were recorded from the gills, but this number is reduced by siphonostomatoid and pennellid larvae which were each counted as a single 'species'. Seventeen species of adults were found which belong to the four families Caligidae (5 species), Dissonidae (1 species), Lernanthropidae (1 species) and mainly the Hatschekiidae (10 species). The host-parasite relationships of *Dissonus manteri* have been discussed (Boxshall et al. 2008).

Numerous specimens of hatschekiids were collected and only two described species could be identified, the other specimens representing eight new species (Fig. 1B–H). *Hatschekia plectropomi* is a distinctive species originally described from *Pl. leopardus* in Australian waters (Ho and Dojiri 1978). *Pl. laevis* is a new host record for this parasite. *Hatschekia cernae* (Fig. 1A) was originally described from *Ep. aeneus* in the Mediterranean (Goggio 1905), and was subsequently reported from *Ep. fasciatus* (as *Ep. alexandrinus*) and *Ep. marginatu*s (as *Ep. gigas*) off the West African coast (Nunes-Ruivo 1954, Capart 1959 – as *Hatschekia epinepheli*). It was first reported from the Pacific from *Epinephelus* sp. off Okinawa (Shiino 1957). The record from *Ep. morrhua* is new. There is clearly a radiation of *Hatschekia* within the groupers, and our evaluation of copepod biodiversity is probably an underestimate of the actual situation. The undescribed *Hatschekia* species include a generalist species, *Hatschekia* sp. 1 (Fig. 1B), found on the gills of eight species of hosts, and seven strictly-specific species (Fig. 1C–H) each found only on one host (six cases) or two hosts (one case). It is not unlikely that most species of groupers have their own *Hatschekia* species, sometimes in addition to the generalist species.

All species of the genus *Sagum*, with the exception of *Sagum texanum* and *S. vespertilio*, are specific to serranids of the genus *Epinephelus*. *Sagum epinepheli* was originally described from Japanese waters on *Ep. akaara* (Yamaguti and Yamasu 1960) and subsequently reported from *Epinephelus* sp. off Kerala, India (Pillai and Sebastian 1967). In our samples it occurred on *Pl. leopardus* and five species of *Epinephelus*, all of which are new host records.

Caligus asymmetricus is primarily a parasite of scombrids, and has been reported from more than ten host species taken across the Indo-Pacific (Kabata 1965, Lewis 1967, Cressey and Cressey 1980). It is rarely found on non-scombrid hosts and our report is a new host record.

Lepeophtheirus plectropomi was first discovered on *Ep. maculatus* in Madagascar (Nunes-Ruivo and Fourmanoir 1956) and was found again in Australia waters on the same fish (Kabata 1966) and on *Pl. leopardus* and *Ep. quoyanus* (as *Ep. megachir*) (Ho and Dojiri 1977). Our records of this parasite from *Ep. cyanopodus* and *Ep. malabaricus* are both new. However, we did not find *L. plectropomi* on *Ep. maculatus*; instead, this host, together

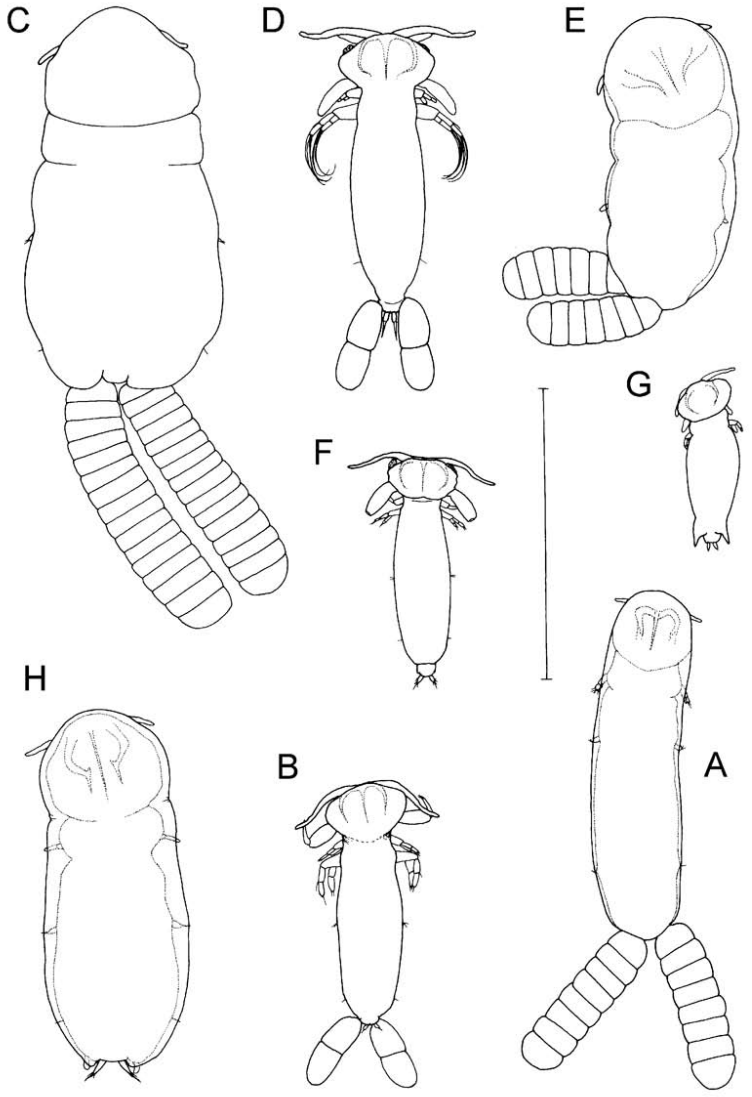

Fig. 1. Species of *Hatschekia*. **A –** *Hatschekia cernae* Goggio, 1905; **B –** *Hatschekia* sp. 1 (generalist species); **C –** *Hatschekia* sp. 11; **D –** *Hatschekia* sp. 5; **E –** *Hatschekia* sp. 10; **F –** *Hatschekia* sp. 4; **G –** *Hatschekia* sp. 8; **H –** *Hatschekia* sp. 2. All drawn to same scale. Scale bar = 1.0 mm.

with *Ep. coeruleopunctatus*, harboured *L. epinepheli*, first described from Australian waters on *Ce. cyanostigma*, *Ep. cyanopodus* (as *Ep. hoedti*) and *Ep. quoyanus* (as *Ep. gilberti*) (Ho and Dojiri 1977).

No copepod was found on the skin of the serranids examined, although these are easily seen and collected on other families of fish.

Monogenea. Fifty-six 'species' of monogeneans were recorded. This number is an underestimate as groups of *Haliotrema* and *Pseudorhabdosynochus* were counted each as one 'species' but probably represent about 20 different species. Nevertheless, the monogeneans represent the richest group of parasites found in serranids. Only three families are represented: the Ancyrocephalidae, Capsalidae and Diplectanidae.

The Ancyrocephalidae includes many species reported here as *Haliotrema* but which might well represent an independent genus, characterised by tubular male copulatory organs. These species have not been studied in detail but it is likely that a significant number of different species is present.

The Capsalidae includes seven 'species' belonging to at least seven genera. Additional work will be needed, both at the morphological and molecular level, to characterize all the species involved (Perkins et al. 2009). It is also important to mention that the biodiversity of capsalids described here is restricted to the species from the gills; species from other sites such as the branchiostegal membranes, fins and skins were generally not collected, and would probably at least double the number of capsalid species found.

Table 1. Number of host-parasite combinations (HPCs) found in 28 species of serranids in New Caledonia.

Fish species	Number of fish examined			Host-parasite combinations										Identifications at species level
	Total number	For gill parasites	For abdominal organ parasites	Isop	Cope	Mono	Dige	Both	Tetr	Tryp	Nema	Others	Total	
Anyperodon leucogrammicus	3	2	1	0	1	2	0	0	0	0	0	0	3	0
Cephalopholis aurantia × *spiloparaea*	1	1	1	0	1	0	0	1	0	0	0	0	2	1
Cephalopholis argus	5	4	1	1	0	2	1	0	0	0	1	0	5	2
Cephalopholis boenak	59	42	18	2	0	0	1	0	1	2	1	0	7	4
Cephalopholis miniata	3	3	3	0	0	4	2	0	1	2	1	0	10	3
Cephalopholis sonnerati	8	7	5	0	1	4	0	0	1	1	1	0	8	3
Cephalopholis spiloparaea	2	1	2	0	1	0	0	0	1	1	0	0	3	0
Cephalopholis urodeta	38	32	19	1	1	2	4	0	1	2	1	0	12	5
Cromileptes altivelis	4	4	2	0	1	1	0	0	0	0	1	0	3	0
Epinephelus areolatus	14	9	12	1	0	3	3	0	1	0	3	0	11	3
Epinephelus chlorostigma	1	1	1	0	2	5	5	0	1	2	1	0	16	5
Epinephelus coeruleopunctatus	7	5	5	0	3	4	3	0	0	0	0	0	10	4
Epinephelus coioides	1	1	1	1	0	6	0	0	0	2	2	0	11	4
Epinephelus cyanopodus	25	21	14	2	7	9	7	0	1	2	3	0	31	20
Epinephelus fasciatus	92	45	61	0	2	3	9	0	1	2	3	1	21	10
Epinephelus fuscoguttatus	2	2	1	1	3	3	0	0	0	0	1	0	8	0
Epinephelus howlandi	24	23	3	1	0	2	0	0	0	1	1	0	5	3
Epinephelus maculatus	62	38	38	1	5	13	12	1	1	1	2	0	36	19
Epinephelus malabaricus	2	2	2	1	3	11	2	0	0	2	1	0	20	12
Epinephelus merra	64	58	18	0	4	3	2	0	0	0	0	0	9	4
Epinephelus morrhua	5	5	4	1	3	3	4	0	1	1	1	1	15	5
Epinephelus polyphekadion	8	6	3	1	1	4	2	1	0	1	0	0	10	1
Epinephelus retouti	2	1	2	0	0	1	3	0	0	1	2	0	7	2
Epinephelus rivulatus	14	14	8	1	1	3	2	0	1	2	1	0	11	5
Plectropomus laevis	14	14	6	1	3	2	3	1	0	3	2	0	15	8
Plectropomus leopardus	42	21	24	2	5	4	4	0	1	3	1	0	20	12
Variola albimarginata	4	4	2	1	2	1	1	0	0	0	3	0	8	2
Variola louti	34	28	18	1	3	2	6	0	0	4	4	0	20	9
Total	540	394	275	20	53	97	76	4	13	35	37	2	337	146

The Diplectanidae represents the major monogenean family in the serranids, with four genera, *Pseudorhabdosynochus* (33 identified species), *Diplectanum* (4 identified species), *Laticola* (2 species) and *Echinoplectanum* (5 species). Species from groupers included in *Diplectanum* have been only provisionally attributed to the genus and probably deserve their own genus (Justine 2007b,c, 2008a, Justine and Sigura 2007). Species of *Echinoplectanum* are found only in the coralgroupers (*Plectropomus* spp.) and never in the other groupers (Justine and Euzet 2006). Although the genus *Pseudorhabdosynochus* is the most species-rich of the diplectanids (Justine 2007b), our results underestimate diplectanid biodiversity because at least a dozen undescribed *Pseudorhabdosynochus* species were found (Appendices 1, 2). We found that some groupers have an outstanding monogenean biodiversity, with six to eight species of *Pseudorhabdosynochus* found in *Ep. cyanopodus*, *Ep. malabaricus*, and *Ep. maculatus* (Appendix 1). In total, 42 diplectanids were identified from the fish sampled in New Caledonia (Appendix 2); however, when all of the undescribed *Pseudorhabdosynochus* found here have been described, we believe that there will probably be 60 species known from the groupers off New Caledonia.

No *Lamellodiscus* spp. were found in the serranids examined; this suggests that records of members of this diplectanid genus in groupers are probably accidental (Justine 2009, Justine and Briand 2010). All fish examined here were taken from the wild and were not kept in tanks with other fish, a possible cause of accidental monogenean contamination (Justine 2009).

A significant absence in serranids was the polyopisthocotylean monogeneans, specimens of which were not found in our study.

Digenea. Twenty-eight 'species' of digeneans were recorded, but this number is greatly reduced by juvenile and adult didymozoids being counted as a single 'species'.

In contrast to all other digeneans cited in this study, which inhabit the lumen of the digestive system, the didymozoids are adults in closed cysts and have 'larvae' (or rather 'juveniles') which are found in the lumen of the digestive tract and occasionally on the gills. Adult didymozoids probably show a certain degree of host specificity, but all species recorded here in serranids have tangled filiform bodies which are extremely time-consuming to prepare for slides; it is likely that several species are present, but specimens have not been thoroughly examined to as-

certain this. Juvenile didymozoids are found in almost all families of fish and no attempt was made to separate the forms (Pozdnyakov and Gibson 2008) according to their morphology; it is likely that these juvenile didymozoids represent considerable biodiversity, but this is probably not specific to the serranids. Unidentified adult didymozoids, generally filiform species in cysts, were found in seven fish species. Juvenile didymozoids, generally free in the intestinal lumen or on gills, were found in six species; it is likely that these juveniles are in fact actually present in all serranid species, as they are in most other fish as well (unpublished observations).

In addition to the didymozoids, the families represented include three species-rich families, the Bucephalidae, Hemiuridae and Opecoelidae. The Bucephalidae has six 'species', including *Prosorhynchus longisaccatus* in three hosts; unidentified *Prosorhynchus* species might represent additional biodiversity, since species in this genus show some degree of host specificity. Six 'species' of Hemiuridae were found. These include a series of unidentified *Lecithochirium* forms from six hosts. The Opecoelidae includes seven 'species', including *Cainocreadium epinepheli*, apparently a generalist digenean species, found in eight hosts species, and *Allopodocotyle epinepheli* and *Helicometra epinepheli* found respectively in three and two host species. Families represented by few species include the Acanthocolpidae, with the single species *Stephanostomum japonocasum* found in seven host species; the Bivesiculidae, with two 'species', *Bivesicula claviformis* in *Ce. boenak* and an unidentified *Bivesicula* species in three other fish species. The Derogenidae, Fellodistomatidae, Gorgoderidae and Lepocreadiidae, were each represented by a single species.

Further comment on the identity of the opecoelid species *Helicometra epinepheli* is desirable. Durio and Manter (1968b) in recording a *Helicometra* species from *Epinephelus* sp. off New Caledonia could see no reason for separating *H. epinepheli* from the apparently widespread species *H. fasciata*. Sekerak and Arai (1974) in their review of the genus concurred, but considered *H. pulchella* the valid name, with both *H. fasciat*a and *H. epinepheli* amongst a long list of synonyms (Sekerak and Arai 1974). However, enzyme electrophoretic studies in the Mediterranean indicated (Reversat et al. 1989, 1991, Reversat and Silan 1993) that morphologically indistinguishable *Helicometra* forms constituted a complex of three species. In view of this we consider it best to use the name *H. epinepheli* for the species from serranids believing that it is unlikely that they are conspecific with the forms from sparids, gobiids and anguillids in the Mediterranean Sea and Atlantic Ocean.

The digeneans allow further comparison because an extensive bibliographical study of the digeneans of groupers has been published (Cribb et al. 2002). The 10 digenean families found here represent more than half of the 17 families recorded in groupers. The 16 genera recorded here represent one third of the 50 genera recorded for all digeneans of groupers of the Indo-West Pacific. Most of 'missing' families have only a small number of genera and species recorded.

Table 2 summarises a comparison between our results and the general work of Cribb et al. (2002). Sixteen of the serranid species listed in Cribb et al. (2002) were also investigated in the present study. In the 16 fish species in common, Cribb et al. (2002) listed 73 digenean species and we found 24 species. The total number of species reported by Cribb et al. (2002) and in this study is 90, not 97 (73 + 24) because of the species in common. The striking result is that, of the 24 digenean species found in New Caledonia, 17 are new records and 7 have already been found in the same fish species.

Table 2. Comparison of digeneans recorded in groupers of the Indo-Pacific (Cribb et al. 2002) and present results. Fish which were not listed in Cribb et al. (2002) are not listed here (i.e. many new records are not indicated).

Fish species	Number of species in Cribb et al.	Number of species in NC (Present paper)	Total number of species	Species found in NC and already recorded	New records in NC
Cephalopholis boenak	2	1	3	0	1
Cephalopholis miniata	4	1	5	0	1
Cephalopholis sonnerati	4	0	4	0	0
Cephalopholis urodeta	0	2	2	0	2
Cromileptes altivelis	1	0	1	0	0
Epinephelus areolatus	7	2	9	0	2
Epinephelus chlorostigma	4	1	5	0	1
Epinephelus cyanopodus	6	4	10	0	4
Epinephelus fasciatus	13	4	14	3	1
Epinephelus fuscoguttatus	1	0	1	0	0
Epinephelus malabaricus	4	1	5	0	1
Epinephelus merra	11	2	12	1	1
Epinephelus polyphekadion	2	0	2	0	0
Plectropomus leopardus	7	1	7	1	0
Variola albimarginata	1	1	2	0	1
Variola louti	6	4	8	2	2
Total	73	24	90	7	17

Table 3 lists all new records and species which have already been found in the same fish species at other locations. Most species here are common species, such as *Cainocreadium epinepheli*, which have been recorded in many hosts. This suggests that the high number of new records in the present study is simply a consequence of better sampling, but sample sizes cannot be compared because no such information is available in the study by Cribb et al. (2002) which is based on a compilation of the literature. These major differences obtained for common species probably preclude any serious biogeographical conclusions on other digenean species and about the New Caledonian fauna of grouper digeneans.

Table 3. Digeneans in serranids: comparisons between the list of records (Cribb et al. 2002) and our records in New Caledonia, including new records and species already recorded.

Fish species	NC as new record	Found in NC, already recorded
Cephalopholis boenak	Bive: *Bivesicula claviformis*	
Cephalopholis miniata	Opec: *Cainocreadium epinepheli*	
Cephalopholis urodeta	Acan: *Stephanostomum japonocasum* Opec: *Cainocreadium epinepheli*	
Epinephelus areolatus	Acan: *Stephanostomum japonocasum* Buce: *Prosorhynchus longisaccatus*	
Epinephelus chlorostigma	Acan: *Stephanostomum japonocasum*	
Epinephelus cyanopodus	Buce: *Prosorhynchus longisaccatus* Hemi: *Erilepturus hamati* Opec: *Allopodocotyle epinepheli* Opec: *Cainocreadium epinepheli*	
Epinephelus fasciatus	Opec: *Cainocreadium epinepheli* Opec: *Helicometra epinepheli*	Lepo: *Lepidapedoides angustus* Opec: *Allopodocotyle epinepheli*
Epinephelus malabaricus	Buce: *Prosorhynchus maternus*	
Epinephelus merra	Opec: *Allopodocotyle epinepheli*	Opec: *Helicometra epinepheli*
Plectropomus leopardus		Opec: *Pacificreadium serrani*
Variola albimarginata	Buce: *Prosorhynchus serrani*	
Variola louti	Acan: *Stephanostomum japonocasum* Opec: *Cainocreadium epinepheli*	Buce: *Prosorhynchus serrani* Opec: *Pacificreadium serrani*

Cestoda Bothriocephalidea. A single case of an adult bothriocephalid was found in the 275 specimens of serranids examined for 'abdominal organs'. This extremely low percentage is certainly significant; adult bothriocephalids are found in only a few other families (Kuchta et al. 2009b). This single case in serranids was found in a fish which had the rare characteristics of being a hybrid of *Ce. aurantia* × *Ce. spiloparaea* (Randall and Justine 2008) and being a deep-sea fish of the outer slope of the reef. It is not known if one of these factors is significant in this discovery.

A few larval bothriocephalideans were found in the flesh or digestive tract and were impossible to identify to species.

Cestoda Tetraphyllidea. Larval tetraphyllideans were found in the digestive lumen of 13 of the species studied. Because these specimens are very small and easy to overlook, especially with the 'direct examination' method, we consider it is probable that *all* serranids harbour tetraphyllidean larvae; this is also the case for most carnivorous fishes of other teleost families (unpublished observations).

Tetraphyllideans are parasites of elasmobranchs as adults and their life cycle involves a crustacean and one or several successive teleost intermediate hosts (Euzet 1994). Adult tetraphyllideans have been found in most sharks and rays examined in New Caledonia (Euzet and Justine, unpublished).

Tetraphyllidean larvae are sometimes very small and were probably overlooked; it might be that some species of Lecanicephalidea or Rhinebothriidea are included within these collections.

The degree of biodiversity represented by these tetraphyllideans larvae is not known, but 31 morphotypes were found in labrids of the Great Barrier Reef (Chambers et al. 2000, Muñoz et al. 2007); there is no reason why our samples should not exhibit at least as much diversity.

Cestoda Trypanorhyncha. Eight 'species' of larval trypanorhynchs, including five identified to the species level, have been found; they belong to three families, namely Lacistorhynchidae, Pseudotobothriidae and Otobothriidae. The trypanorhynch larvae found have already been recorded from a number of teleosts hosts (Palm 2004). The detailed lists in Palm (2004) allowed the identification of new host records and new geographical records. All species were found in cysts located in various sites around the body cavity.

Pseudogilquinia pillersi was found in four host species. Three hosts have already been recorded (Beveridge et al. 2007); *Pl. leopardus* is a new host record. This species is known from Sri Lanka, Australia and New Caledonia.

Pseudolacistorhynchus heroniensis was found in seven host species. *Ep. cyanopodus* has already been recorded (Sigura and Justine 2008); *Ce. boenak*, *Ep. chlorostigma*, *Ep. fasciatus*, *Ep. howlandi*, *Ep. polyphekadion* and *Ep. rivulatus* are new host records. This species is known only from the east coast of Australia and New Caledonia.

Callitetrarhynchus gracilis was found in four host species, *Ce. boenak*, *Ep. chlorostigma*, *Ep. rivulatus* and *Va. louti*, which are all new host records. New Caledonia is a new geographical record for this cosmopolitan species.

Floriceps minacanthus was found in six host species. *Ep. cyanopodus* has already been recorded (Sigura and Justine 2008); *Pl. leopardus* has been recorded from Heron Island, Australia (Palm 2004) and *Va. louti* from Egypt, Red Sea (Abdou and Palm 2008) and various locations in the Pacific (Eniwetok, Kiribati) (Palm 2004); New Caledonia is a new geographical record for this species. *Ce. miniata*, *Ce. urodeta*, and *Pl. laevis* are new host records.

Pseudotobothrium dipsacum was found in 10 host species. *Ce. sonnerati*, *Ep. malabaricus* and *Va. louti* have already been recorded from Zanzibar, East Africa (Beveridge et al. 2000) and *Ep. coioides* and *Pl. leopardus* have already been recorded on Heron Island, Queensland, Australia (Beveridge et al. 2000); New Caledonia is a new geographical record for all these species. *Ce. miniata*, *Ce. urodeta*, *Ep. fasciatus*, *Ep. retouti* and *Pl. laevis* are new host records.

Trypanorhynchs are parasite of elasmobranchs as adults, and their life cycle involves a crustacean and one or several successive teleost intermediate hosts (Campbell and Beveridge 1994, Palm 2004). *Pseudogilquinia pillersi* is apparently restricted to large predatory serranids, suggesting that a smaller fish is involved as the previous host in the life cycle (Beveridge et al. 2007). For the four other species (*Pseudolacistorhynchus heroniensis*, *C. gracilis*, *F. minacanthus* and *Pseudotobothrium dipsacum*), a main characteristic of the larvae is their absence of host specificity; it is likely that an exhaustive search would find that *all* serranid species harbour *all* of these four trypanorhynch species. These four species have also been found in New Caledonia in many carnivorous fishes other than serranids, including lutjanids and lethrinids (Beveridge and Justine, unpublished).

Hosts of adults of *C. gracilis* and *F. minacanthus* are sharks, including carcharhinids (*Carcharhinus* spp.) which are abundant in New Caledonian waters. Adult *C. gracilis* and *F. minacanthus* have also been collected in the hemigaleid *Triaenodon obesus* (Rüppell) in New Caledonia (Beveridge and Justine, unpublished). The adult of *Pseudolacistorhynchus heroniensis* has been found (Beveridge and Justine 2007) in the leopard shark, *Stegostoma fasciatum* (Hermann), while the host of the adults of *Pseudotobothrium dipsacum* remains unknown.

Nematoda. Nematodes recorded belong to five families, the Anisakidae, Camallanidae, Capillariidae, Cucullanidae and Philometridae.

The Anisakidae is represented by larvae only, generally encapsulated on the surface of organs or free in the lumen of the digestive tract. Generally, no effort has been made to identify these larvae at the generic level, but some of them were found to belong to the genera *Anisakis*, *Hysterothylacium* and *Terranova*. Specific identification of such larvae on the basis of morphological characters is impossible. These anisakid larvae are found in almost all teleosts and show very little specificity at this stage (Williams and Jones 1994). Fishes harbouring these larvae serve only as paratenic hosts, being apparently, however, the main source of infection for the definitive hosts, mainly piscivorous elasmobranchs, teleosts, marine reptiles and marine mammals (Anderson 2000, Moravec 1994, Williams and Jones 1994).

The Camallanidae includes *Procamallanus variolae*, found in two host species. Specimens of Capillariidae have been found only in coralgroupers, *Plectropomus* spp., and have not yet been identified at the species level. Cucullanidae species have been found in the two species of *Variola* only and have not yet been described.

The Philometridae found here includes three species, which exhibit two distinct specificity strategies. Philometrids from the eye and orbit of five hosts all correspond to the apparently non-specific single species *Philometra ocularis*, but philometrids from the gonads show a higher degree of host specificity (Moravec and Justine 2008). Until recently, gonad-infecting philometrids from many species of marine teleosts, including some groupers, were reported from various geographical regions as *Philometra lateolabracis*, a species inadequately described from Japan, with unknown males (Moravec 2006). The recent discovery of the male of *P. lateolabracis* from the type host and type locality (Quiazon et al. 2008a) has made it possible to distinguish this species from other related congeners on the basis of male morphology and thus contributed greatly to the taxonomy of the important gonad-infecting philometrids in general (e.g. Moravec and Justine 2008, 2009, Quizon et al. 2008a,b). Since little or no attention has so far been paid to the examination of the body skin, mouth cavity and fins of New Caledonian serranids, it can be expected that additional representatives of Philometridae will be found in these hosts. Philometrids (species of *Philometra*, *Philometroides* and *Spirophilometra*) utilising these locations within the host are known from serranid fishes in other geographical regions (Moravec 2006; unpublished).

Turbellaria. A single case of a parasitic turbellarian has been found on the gills of *Ep. fasciatus*. These parasitic forms are very difficult to study because they are fragile and have no sclerotised parts. Similar forms in an acanthurid (Justine et al. 2009b) were referred to *Piscinquilinus* (Genostomatidae) but the species from the serranids has not been studied in sections and it is not possible to refer it to this genus or to *Paravortex* (Dalyelliidae). These turbellarian parasites are extremely rare and have been found in only 0.3% of the fish of various families examined in New Caledonia (Justine et al. 2009b).

Acanthocephala. A single specimen has been found in the deep-sea grouper *Ep. morrhua*.

A numerical evaluation of parasite biodiversity in serranids

Table 1 was built by counting each parasitological finding (i.e. each line in Appendix 1) as a host-parasite combination (HPC). Table 1 details the number of HPCs found in each fish species, and indicates how many fish specimens have been examined.

The number of HPCs is different from the actual number of parasite species, for two reasons (a) a parasite species present in several hosts is counted as several

HPCs; and (b) HPCs in Table 1 enumerate findings which widely range in systematic precision. HPCs may designate:

– species-level identified parasites (SLIPs);

– parasite species identified at the generic level only, but which probably represent only a single species (examples: several digeneans);

– parasite species identified at the generic level only, but for which we already know that they represent a number of different species (example: the monogeneans *Pseudorhabdosynochus* spp.); these probably represent a total of about 30 species;

– parasite species identified at the family or upper level, for which we know that abundant biodiversity is hidden within this HPC. This includes unidentifiable larvae such as gnathiid isopods, anisakid nematodes, didymozoid digeneans and tetraphyllidean metacestodes. These probably represent about 50 species.

The 337 HPCs shown in Table 1 represent a ratio of about 12 HPCs per fish species. It is likely that better parasite species identification would probably boost the total to over 400 HPCs for the 28 fish species in Table 1, with a ratio of about 14 HPCs per fish species.

Precise comparisons of parasite faunas could only be achieved based on counts of species-level identified parasites (SLIPs) and our sampling (Table 1) was sometimes limited to a small number of fish. Table 4 includes only those fish species for which at least five specimens were studied for both the gills and the abdominal organs and for which SLIPs are available. Accumulation curves (Cribb 1998) show that about half of the digenean diversity found in a sample of 30 fish is found with a sample of five (see also Dove and Cribb 2006). We do not know if these accumulation curves are valid for other groups. Monogeneans generally have species with high prevalence, with the consequence that smaller samples are needed to detect a significant proportion of diversity than for digeneans; on the other hand, sampling has often demonstrated the presence of very rare monogenean species, found only in a few specimens compared to thousands of specimens of the abundant species (Hinsinger and Justine 2006a, Sigura and Justine 2008, Justine and Euzet 2006, Poulin and Justine 2008).

Table 4 shows a total of 109 species-level identified parasite–host-parasite combinations (SLIP-HPCs) for 14 fish species (ca. 7.8 per fish). As with Table 1, the total number of SLIP-HPCs is different from the actual number of different parasite species because certain parasites are found in several fish species. The number of different parasite species was 63 (4.5 per fish).

The ratio of the number of SLIP-HPCs to the number of different parasite species is also shown in Table 4: it differs drastically among parasite groups. Trypanorhynch larvae, with 21 combinations and only five species (4.2 combinations, i.e. as many hosts per species) exemplify a group composed of species with low host specificity. We hypothesise above that probably all serranids harbour all of the four major species, so an exhaustive search would probably find an even higher ratio. Monogeneans, with 34 combinations and 32 species (1.06 combinations per species) exemplify a parasite group which is known to display strong host specificity. Additional cases are found in the other groups. Copepods have 14 combinations and six species, but when the different *Hatschekia* species are described, will show a very much lower number of combinations per species. The SLIP-HPCs:parasite species ratio calculated from Table 4 for all groups is 1.71 (109/63) which means that parasite species are generally found in more than one host.

Table 4. Number of species-level identified parasites (SLIPs) found in those 14 serranid species for which at least 5 specimens were studied for both gills and abdominal organs in New Caledonia.

Fish	Isop	Cope	Mono	Dige	Tryp	Nema	Total
Cephalopholis boenak	1	0	0	1	2	0	4
Cephalopholis sonnerati	0	0	2	0	1	0	3
Cephalopholis urodeta	0	0	1	2	2	0	5
Epinephelus areolatus	0	0	0	2	0	1	3
Epinephelus coeruleopunctatus	0	2	1	1	0	0	4
Epinephelus cyanopodus	1	4	7	4	2	2	20
Epinephelus fasciatus	0	0	2	4	2	2	10
Epinephelus howlandi	0	0	2	0	1	0	3
Epinephelus maculatus	0	2	10	7	0	0	19
Epinephelus merra	0	1	1	2	0	0	4
Epinephelus rivulatus	0	0	2	0	2	1	5
Plectropomus laevis	1	2	2	0	3	0	8
Plectropomus leopardus	2	3	3	1	3	0	12
Variola louti	0	0	1	4	3	1	9
Number of SLIP-HPCs	5	14	34	28	21	7	109
Number of different parasite species	5	6	32	11	5	4	63
Number of SLIP-HPCs: number of different parasite species Ratio	1	2.33	1.06	2.54	4.2	1.5	1.71
Number of different parasite species:number of fish species Ratio	0.36	0.42	2.29	0.79	0.36	0.29	4.5

An attempted prediction of parasite biodiversity in groupers

Our data include fish with various sample sizes (from 1 to more than one hundred). Table 5 shows that the numbers of HPCs, SLIP-HPCs and different parasite species increase with the quality of sampling. The most extensively sampled fish had 17.9 HPCs / fish species, 9.0 SLIP-HPCs / fish species and the number of different parasite species was 6.3 / fish species. This latter number was computed from Appendix 1 and counts only once the parasite species found in several fish: it is thus an estimate of the total parasite biodiversity.

However, we have seen above that this number is an underestimate because many parasite species are yet undescribed and because several groups were not identified

Table 5. Effect of fish sampling on the number of parasites found. Number of HPCs and SLIP-HPCs are from Table 1; number of different parasite species computed from Appendix 1.

Sampled fish number	n	Total fish number	HPCs	HPCs per fish species	SLIP-HPCs	SLIP-HPCs per fish species	Parasite species	Parasite species per fish species
n < 5	11	25	91	8.27	29	2.64	23	2.09
n = 5–29	10	124	121	12.10	54	5.40	41	4.10
n > 29	7	391	125	17.86	63	9.00	44	6.29
All fish	28	540	337	12.04	146	5.21	76	2.71

Table 6. Predictions of biodiversity in serranids.

	All 28 serranids / fish	7 species with n > 9 / fish	Prediction / fish	Prediction, all 41 groupers of New Caledonia	Prediction, all 159 groupers of the World
HPCs	12	17.9	30	1230	4770
Different parasite species	2.7	6.3	10	410	1590

Table 7. Size of selected fish and number of parasite species. Fish lengths according to Kulbicki et al. (2005).

Fish	Maximum length	Number of host-parasite combinations	Number of parasite species (identified at species level)
Small species			
Ep. merra	25	9	4
Ep. fasciatus	36	21	10
Large species			
Ep. maculatus	60	36	19
Ep. cyanopodus	76	31	20

at the species level. Also, for six of the seven fish species with the maximum sampling effort (n > 29), the number of fish examined for gills and/or for abdominal organs was below 29 and thus these fish certainly cannot be considered as well sampled. Thus, in Table 6, we propose to predict parasite biodiversity in serranids by multiplying the results obtained by approximately 2. Predictions are 30 HPCs and 10 different parasite species per fish, thus 1230 HPCs and 410 different parasites species for all the 41 groupers of New Caledonia.

Epinephelus fasciatus has been reasonably well sampled (n = 92) and has 10 parasite species identified at the species level (Table 1), but several of these species are found in other fish. Again, this number of 10 is an underestimate because of the several parasite groups in which species were not identified with precision or there were other limitations (stated above). We consider that the case of *Ep. fasciatus* is exemplary of the serranids, and confirms our prediction of 10 different parasite species per serranid species.

Monogeneans constitute a major part of the parasite biodiversity encountered. In Table 4, monogeneans constitute half of the SLIPs (32:63). For the seven best sampled fish (n > 29), there are 18 monogeneans among the 44 SLIPs (40%). This is certainly of significance, because it is known that monogeneans show high biodiversity and generally strict host specificity (Euzet and Combes 1980). The monogeneans identified to species-level of the seven best sampled fish show a ratio of 2.57 monogeneans per fish (18:7). Although impressive, this ratio falls below other published estimates of 3:1 (Lim 1998) and 5:1 (Whittington 1998). Appendix 1 shows that about half a dozen undescribed monogenean species are present in these seven 'well sampled' fish species, and additional monogenean species could certainly be found in 'neglected' organs such as branchiostegal membranes and fins. We may thus estimate that only half of the true monogenean biodiversity has been found, and that a ratio of *five monogenean species per serranid should be expected*. To fully document all monogeneans would require a significant effort both in sampling and in descriptive taxonomy, because most of the species are new to science.

An attempted prediction of parasite biodiversity in other fish of the Lagoon

Our results on serranids can be extrapolated to all fish families, but with some precautions. Parasite biodiversity can differ in other fish families because of different body sizes and because of phylogenetic or ecological differences.

In Table 7, we compared the number of parasite species on a small subset of our results, limited to fish species with a significant sample size (n > 29 for both gills and abdominal organs except *Ep. cyanopodus*, n = 22) and in which the monogeneans have been extensively described. This analysis shows that large fish have more parasite species than small fish, as expected (Luque and Poulin 2007). *Ep. fasciatus* (maximum length 36 cm) has a mean length similar to the mean length of ca. 400 species of lagoon fishes of New Caledonia (Kulbicki et al. 2005). Therefore

Table 8. Available references on the parasites of serranids in the Indo-Pacific Region.

Reference	Parasite groups	Locality	Number of serranid species mentioned	Number of serranid species in common with the present study	Number of parasites mentioned in these species
Zhang et al. 2003	Monogeneans	China	ca. 11	4	4
Rigby et al. 1999	all	French Polynesia	2	4	13
Yang 2007	Cestodes	China	0	0	0
Arthur and Te 2006	all	Viet Nam	4	1	1
Arthur and Lumanlan-Mayo 1997	all	Philippines	5	3	7
Arthur and Ahmed 2002	all	Bangladesh	0	0	0
Yamaguti 1968	Monogeneans	Hawaii	1	0	0
Yamaguti 1970	Digeneans	Hawaii	2	0	0
Beumer et al. 1983	all	Australia	8	4	15
Lester and Sewell 1989	all	Heron Island, Queensland, Australia	10	5	54

it is reasonable to consider that the results found for this fish (10 parasite species per fish species) could be extrapolated to all fish of the lagoon (but see below for limits).

Other fish families of the lagoon of New Caledonia have not been sampled as extensively as the serranids. However, we already know examples of parasite biodiversity in other families that are similar to that of serranids, such as digeneans of balistids (Bray and Justine 2006b, 2007, Bray et al. 2009a, b), monogeneans of lutjanids (Kritsky et al. 2009), monogeneans (Justine 2007d, Rascalou and Justine 2007, Justine et Briand 2010) and nematodes (Moravec and Justine 2010) of lethrinids, and monogeneans (Řehulková et al. 2010) and digeneans (Bray and Justine 2008) of mullids. Because monogeneans often constitute a major part of parasite biodiversity, families with few monogeneans could significantly decrease parasite biodiversity: this could be expected for the labrids (Lim and Justine 2007, Munoz et al. 2007) or gobiids. It might be also that carnivorous fish such as labrids have increased opportunities to obtain parasites than fish with other diets. However, our prediction of 10 parasite species per fish being minimal, we believe that several families with higher parasite biodiversity would compensate for families with lower diversity. For the ca. 1,700 fish species in the lagoon of New Caledonia (Fricke and Kulbicki 2007), *we may thus predict about 17,000 different parasite species and 2–3 times more (34,000–51,000) host-parasite combinations*.

To obtain these predicted numbers, a tremendous sampling effort would be necessary. At least 30 specimens would have to be examined for each fish species, and the number of individual parasites examined would be enormous. This is simply another manifestation of the taxonomic impediment. These figures include only metazoans (helminths and parasitic crustaceans), but it is likely that microscopic protistan and myxozoan parasites would greatly increase these numbers: for example, the examination of five serranid species from the Great Barrier Reef has revealed seven species of ceratomyxid myxozoans (Gunter and Adlard 2009).

On the basis of simple calculations mainly based on monogenean diversity, a prediction of 20,000 parasite species (including metazoans and protozoans) has been made for the 1,000 fish species of Heron Island in the Great Barrier Reef (Rohde 1976). Our prediction is similar to Rohde's estimate, taking into account the proportion of microscopic parasites present.

New Caledonia exemplifies the need for taxonomic studies on fish parasites. A compilation of 107 publications provided a list of 371 species of fish parasites in New Caledonia (Justine 2010), which does not include the newly published serranid parasites of the present paper. This means that *about 2% (370:17,000) of the total predicted fish parasite biodiversity has been recorded so far*. For the evaluation of tropical forest biodiversity, and without targeting parasite groups, a major problem is that "the proportion of 'morphospecies' that cannot be assigned to identified species and the number of 'scientist-hours' required to process samples both increase dramatically for smaller-bodied taxa" (Lawton et al. 1998). This situation applies perfectly to the parasites of coral reef fishes.

An attempt at biogeographical comparison

The availability of these numerically important data on the biodiversity of parasites of serranids in New Caledonia should allow us to make comparisons with the parasitic faunas of the same fish species in other locations. Most of the serranid species mentioned in this study have a wide geographical distribution (Heemstra and Randall 1993, Froese and Pauly 2009) and it might be expected that we would find copious records of their parasitic fauna. To our great disappointment, we found very few similarly comprehensive studies in the literature.

Several studies investigated the fauna of monogeneans on various coral reefs of the Indo-Pacific, but these have been restricted to a few genera (Plaisance et al. 2005, 2008) or a few species (Justine 2005a, Marie and Justine 2006, Justine et al. 2009a); a few digeneans have also been compared in various locations (Lo et al. 2001). A few studies have used more than one parasite group, but on the basis of vague comparison (Williams et al. 1996)

Table 9. *Cromileptes altivelis*: comparison of its parasitic fauna in Heron Island (HI) (Lester and Sewell 1989) and New Caledonia (NC) (present study).

Cromileptes altivelis	HI	NC
Isop: Aegi: *Aega lethrina*	+	
Isop: Cora: *Argathona macronema*	+	
Cope: Cali: *Dentigryps litus*	+	
Cope: Siph: Larvae		+
Mono: Ancy: *Haliotrema cromileptis*	+	+
Dige: Acan: *Mitotrema acanthostomatum*	+	
Dige: Buce: *Prosorhynchus* sp.	+	
Nema: Anis: Unidentified larvae		+
Total: 8, 1 in common including 1 identified at species level	6	3

Table 10. *Epinephelus fasciatus*: comparison of its parasitic fauna in Heron Island (HI) (Lester and Sewell 1989) and New Caledonia (NC) (present study).

Epinephelus fasciatus	HI	NC
Cope: Phil: *Colobomatus* sp.	+	
Cope: Cali: *Caligus* n. sp.		+
Cope: Hats: *Hatschekia* sp. (n. sp. 1 in NC)	+	+
Mono: Caps: *Benedenia* cf. *epinepheli*		+
Mono: Dipl: *Pseudorhabdosynochus youngi* *	+	+
Mono: Dipl: *Pseudorhabdosynochus caledonicus*		+
Mono: Ancy: *Haliotrema epinepheli*	+	
Cest: *Scolex polymorphus*	+	
Dige: Bive: *Bivesicula* sp.		+
Dige: Didy: Unidentified adults		+
Dige: Didy: Unidentified larvae		+
Dige: Gorg: *Phyllodistomum* sp.		+
Dige: Hemi: *Lecithochirium* sp.		+
Dige: Lepo: *Lepidapedoides angustus*		+
Dige: Opec: *Allopodocotyle epinepheli*		+
Dige: Opec: *Cainocreadium epinepheli*		+
Dige: Opec: *Helicometra epinepheli*		+
Tetra: Unid: Larvae	+	+
Tryp: Laci: *Pseudolacistorhynchus heroniensis*		+
Tryp: Pseu: *Pseudotobothrium dipsacum*		+
Nema: Anis: *Terranova* sp.	+	
Nema: Anis: Unidentified		+
Nema: Cama: *Procamallanus variolae*		+
Nema: Philo: *Philometra fasciati*		+
Turbellaria: Unid: Unidentified species		+
Total: 25; 3 in common, including 1 identified at species level; * as *Diplectanum cupatum* in HI (Justine et al. 2009a)	7	21

Table 11. *Epinephelus malabaricus*: comparison of its parasitic fauna in Heron Island (HI) (Lester and Sewell 1989) and New Caledonia (NC) (present study).

Epinephelus malabaricus	HI	NC
Isop: Cora: *Argathona rhinoceros*		+
Cope: Hats: *Hatschekia* n. sp. 6		+
Cope: Cali: *Lepeophtheirus plectropomi*		+
Cope: Siph: Chalimus larvae		+
Mono: Ancy: *Haliotrema* sp. 1		+
Mono: Ancy: *Haliotrema* sp. 2		+
Mono: Ancy: Unidentified species*	+	
Mono: Caps: *Allosprostonia tauvinae*	+	
Mono: Caps: *Allobenedenia* sp.		+
Mono: Caps: *Sprostonia longiphallus****	+	
Mono: Dipl: *Diplectanum maa*		+
Mono: Dipl: *Pseudorhabdosynochus* cf. *shenzhenensis*		+
Mono: Dipl: *Pseudorhabdosynochus maaensis*		+
Mono: Dipl: *Pseudorhabdosynochus malabaricus*		+
Mono: Dipl: *Pseudorhabdosynochus manifestus*		+
Mono: Dipl: *Pseudorhabdosynochus manipulus*		+
Mono: Dipl: *Pseudorhabdosynochus marcellus*		+
Mono: Dipl: *Pseudorhabdosynochus maternus*		+
Mono: Dipl: Unidentified 6 species**	+	
Dige: Buce: *Prosorhynchus maternus*		+
Dige: Opec: *Cainocreadium* sp.		+
Tryp: Laci: *Pseudogilquinia pillersi*		+
Tryp: Pseu: *Pseudotobothrium dipsacum*		+
Nema: Anis: *Terranova* sp.	+	
Nema: Unidentified species		+
Total: 25; 0 in common, but possibly several ancyrocephalids* and diplectanids** in common but not specifically identified in HI; *** dubious record because the type-species of *Sprostonia* occurs on an elasmobranch (Whittington 2004). In addition, both capsalids in the list from HI are not mentioned from this host in the original publication cited.	5	20

or with a very low level of parasite identification (Lafferty et al. 2008). Apparently no study has compared significant lists of parasites from several groups with a sufficient level of parasite taxonomic accuracy in several locations.

Table 8 lists general surveys of fish parasites available for the Indo-Pacific. Only helminths and parasitic crustaceans are included. Most studies have only a very small number of serranid species and parasites in common with our study. The study by Rigby et al. (1999) apparently has more potentially comparable data, but the lack of precision of the parasite identifications makes it of little value. Finally, significant and reliable data are available only in the general list of Lester and Sewell (1989) for Heron Island (Queensland), on the Great Barrier Reef. This study has the additional interest of being limited to a small geographical area, as is our study.

Five species of groupers were shared by the Heron Island (HI) list and our work in New Caledonia (NC). Tables 9–13 summarise the parasite species found on HI and in NC for these five fish species. An interesting case is *Ep. merra*. Of 16 parasite records, including 7 on HI and 9 in NC, none was found in common (Table 13). 'Detective work' on Museum slides deposited by P. C. Young in collections (Justine et al. 2009a) lead to the conclusion that the fish designated as *Ep. merra* in parasitological works by Young was probably *Ep. quoyanus*. It is therefore not surprising that no parasite was found in common between two different fish species; this work exemplifies the need for deposition of parasite, and even fish, specimens, tissue samples and digital images. Finally, after excluding *Ep. merra*, only four species of fish could be compared for their parasitic fauna between HI and NC (Table 14). In total these fish had 91 parasite records (37 on HI and 65 in NC). Including imprecise identifications only nine records were shared. Shared records with identifications at the species level were only six (7% of all records). These include one isopod, the corallanid *Argathona macronema* in *Pl. leopardus*; one copepod, the hatschekiid *Hatschekia*

Table 12. *Plectropomus leopardus*: comparison of its parasitic fauna in Heron Island (HI) (Lester and Sewell 1989) and New Caledonia (NC) (present study).

Plectropomus leopardus	HI	NC
Isop: Aegi: *Aega lethrina*	+	
Isop: Cora: *Argathona macronema*	+	+
Isop: Cora: *Argathona rhinoceros*		+
Cope: Cali: *Dentigryps* sp.	+	
Cope: Cali: *Lepeophtheirus* sp.		+
Cope: Diss: *Dissonus manteri*		+
Cope: Diss: Unidentified species	+	
Cope: Hats: *Hatschekia plectropomi*	+	+
Cope: Lern: *Sagum epinepheli*		+
Cope: Penn: Larvae		+
Mono: Ancy: Unidentified species	+	
Mono: Caps: *Trochopus* sp.	+	
Mono: Caps: Trochopodinae sp. 2 of Perkins et al. (2009)		+
Mono: Dipl: *Echinoplectanum leopardi*		+
Mono: Dipl: *Echinoplectanum pudicum*		+
Mono: Dipl: *Echinoplectanum rarum*		+
Mono: Dipl: Unidentified species	+	
Dige: Bive: Unidentified species	+	
Dige: Buce: *Prosorhynchus* sp.	+	+
Dige: Buce: *Neidhartia* sp. 1		+
Dige: Buce: *Neidhartia* sp. 2		+
Dige: Didy: Unidentified species	+	
Dige: Hemi: Unidentified	+	
Dige: Opec: *Pacificreadium serrani*	+	+
Dige: Apor: *Pearsonellum corventum*	+	
Tetra: Unid: Unidentified species	+	+
Tryp: Laci: *Pseudogilquinia pillersi*		+
Tryp: Laci: *Floriceps minacanthus*	+	+
Tryp: Pseu: *Pseudotobothrium dipsacum*		+
Tryp: Unid: Unidentified species	+	
Nema: Anis: *Hysterothylacium* sp.	+	
Nema: Anis: *Terranova* sp.	+	
Nema: Capi: Unidentified species		+
Comments: Total: 33; 5 in common, including 4 identified at the species level	19	20

Table 13. *Epinephelus merra*: comparison of its parasitic fauna in Heron Island (HI) (Lester and Sewell 1989) and New Caledonia (NC) (present study). Discrepancies suggest that the host was misidentified in Heron Island (see text).

Epinephelus merra	HI	NC
Cope: Cali: *Caligus epinepheli*	+	
Cope: Cali: *Lepeophtheirus* sp.		+
Cope: Lern: *Sagum epinepheli*		+
Cope: Lerp: *Alella pterobrachiata*	+	
Cope: Lerp: *Anaclavella sillaginoides*	+	
Cope: Lerp: *Thysanote gymnobrachiata*	+	
Cope: Penn: Larvae		+
Cope: Siph: Larvae		+
Mono: Dipl: *Pseudorhabdosynochus melanesiensis*		+
Mono: Dipl: *Pseudorhabdosynochus* cf. *coioidesis*		+
Mono: Caps: Unidentified Benedeniinae		+
Dige: Opec: *Allopodocotyle epinepheli*		+
Dige: Opec: *Cainocreadium epinepheli*	+	
Dige: Opec: *Helicometra epinepheli*		+
Dige: Opec: *Helicometra fasciata*	+	
Dige: Apor: *Pearsonellum corventum*	+	
Comments: Total: 16, 0 in common	7	9

Table 14. Summary of all comparisons in Tables 9–13 between serranids of Heron Island (HI) and New Caledonia (NC). *Epinephelus merra* is excluded because of fish misidentification in HI (Justine et al. 2009a).

Fish	HI	NC	Total of records	Records in common (including imprecise identifications)	Records in common (with identification at species level)
Cromileptes altivelis	6	3	8	1	1
Epinephelus fasciatus	7	21	25	3	1
Plectropomus leopardus	19	20	33	5	4
Epinephelus malabaricus	5	20	25	0	0
Total	37	65	91	9 (10% of all records)	6 (7% of all records)

plectropomi in *Pl. leopardus*; two monogeneans, the ancyrocephalid *Haliotrema cromileptis* in *Cromileptes altivelis* and the diplectanid *Pseudorhabdosynochus youngi* in *Ep. fasciatus*; one digenean, the opecoelid *Pacificreadium serrani* in *Pl. leopardus*; and one larval trypanorhynch cestode, *Floriceps minacanthus*.

Only limited comparisons can be made between the trypanorhynch species found in New Caledonia and those reported from Heron Island by Lester and Sewell (1989) and Palm (2004). All five species occur around Heron Island and all except *C. gracilis* and *P. pillersi* have been found in serranids (*Ep. ongus*, *Ep. quoyanus*, *Pl. leopardus*, *Pl. maculatus*). There are numerous records of *C. gracilis* from teleosts from the north-east coast of Australia (Palm 2004), though none is from serranids, while *P. pillersi* has been reported from lethrinids off Heron Island (Beveridge et al. 2007). More extensive collecting of serranids at Heron Island is likely to confirm the presence of all of these trypanorhynch species in this host group.

From the prediction of the parasite fauna attempted above, we would expect 10 parasite species per fish, i.e. a total of 40 species for the four fish involved. Table 14 includes 91 records, but this does not indicate that biodiversity has been sampled accurately; indeed, many records are duplicated in both locations because of insufficient precision in species identification. As an example, for *Pl. leopardus*, we do not know if the 'unidentified Dissonidae' found on HI is the same as *Dissonus manteri* found in NC, and currently we are forced to regard these two records as separate taxa.

Reliable comparisons should be made only on parasites identified at the species level, and there are only six of these from the four species of fish (Table 14). It is difficult to interpret these results from a biogeographical perspective. We consider that the very small number of species in common does not reflect differences in the parasite fauna but rather shows that sampling was inadequate at both locations. The taxonomic impediment strikes again here,

making it practically impossible to compare the parasite faunas of the serranids in these two locations. Again, the limitation of 'scientist-hours' for small-bodied organisms (Lawton et al. 1998) is obvious.

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Appendix 1: Host-parasite list (28 fish species)

For brevity, all references are numbered according to this list:
[0] This paper; [1] Beveridge et al. 2007; [2] Boxshall et al. 2008; [3] Bray and Justine 2006a; [4] Bray and Justine 2006b; [5] Bray and Justine 2007; [6] Hinsinger and Justine 2006a; [7] Hinsinger and Justine 2006b; [8] Journo and Justine 2006; [9] Justine 2005a; [10] Justine 2005b; [11] Justine 2007b; [12] Justine 2007c; [13] Justine 2008a; [14] Justine 2008c; [15] Justine 2008b; [16] Justine 2009; [17] Justine et al. 2009a; [18] Justine and Euzet 2006; [19] Justine et al. 2009b; [20] Justine and Sigura 2007; [21] Kuchta et al. 2009a; [22] Moravec and Justine 2005; [23] Moravec and Justine 2008; [24] Moravec and Justine 2009; [25] Moravec et al. 2006; [26] Sigura et al. 2007; [27] Sigura and Justine 2008.

The serranid hosts of digenean species described by Manter were often very vaguely designated as 'leche' (Justine 2007a). New Host Records for these species are indicated as NHR*.

Anyperodon leucogrammicus (Valenciennes, 1828)

Cope: Siph: larvae (gills) [0]

Mono: Dipl: *Pseudorhabdosynochus* n. sp. 1 (gills) [0]
Mono: Dipl: *Pseudorhabdosynochus* n. sp. 2 (gills) [0]

Remarks: Based on examination of 3 specimens (2 for gills, 1 for abdominal organs).
Host-parasite combinations: 3; with species-level identification: 0.

Cephalopholis* hybrid: *aurantia* × *spiloparaea

Cope: Siph: larvae (gills) [0]

Both: Both: *Bothriocephalus celineae* Kuchta, Scholz et Justine, 2009 (digestive tract) [21]

Remarks: Based on examination of single specimen (1 for gills, 1 for abdominal organs)
Host-parasite combinations: 2; with species-level identification: 1.
Reference for hybrid fish: Randall and Justine 2008.

Cephalopholis argus Bloch et Schneider, 1801

Isop: Gnat: Praniza larvae (gills) [0]

Mono: Dipl: *Pseudorhabdosynochus argus* Justine, 2007 (gills) [12]
Mono: Caps: unidentified (gills) [0]

Dige: Buce: *Prosorhynchus robertsthomsoni* Bott et Cribb, 2009 (digestive tract) [0] (NGR)

Nema: Anis: unidentified larvae (digestive tract) [0]

Remarks: Based on examination of 5 specimens (4 for gills, 3 for abdominal organs).
Host-parasite combinations: 5; with species-level identification: 2.

Cephalopholis boenak (Bloch, 1790)

Isop: Gnat: Praniza larvae (gills) [0]
Isop: Cora: *Lanocira zeylanica* Stebbing, 1905 (body) [0] (NHR)

Dige: Bive: *Bivesicula claviformis* Yamaguti, 1934 (digestive tract) [0] (NHR)

Tetr: Unid: larvae (digestive tract) [0]
Tryp: Laci: *Callitetrarhynchus gracilis* (Rudolphi, 1819) larvae (body cavity) [0] (NHR)
Tryp: Laci: *Pseudolacistorhynchus heroniensis* (Sakanari, 1989) larvae (body cavity) [0] (NHR)

Nema: Anis: unidentified larvae (digestive tract) [0]

Remarks: Based on examination of 59 specimens (42 for gills, 18 for abdominal organs); absence of gill monogeneans confirmed on 42 specimens.
Host-parasite combinations: 7; with species-level identification: 4.

Cephalopholis miniata (Forsskål, 1775)

Mono: Caps: unidentified Benedeniinae 1 (branchiostegal membranes) [0]
Mono: Caps: unidentified Benedeniinae 2 (gills) [0]
Mono: Caps: unidentified Benedeniinae 3 (gills) [0]
Mono: Dipl: *Diplectanum* sp. (gills) [0]

Dige: Didy: unidentified adult (gills) [0]
Dige: Opec: *Cainocreadium epinepheli* (Yamaguti, 1934) (digestive tract) [0]

Tetr: Unid: larvae (digestive tract) [0]
Tryp: Laci: *Floriceps minacanthus* Campbell et Beveridge, 1987 larvae (body cavity) [0] (NHR)

Tryp: Pseu: *Pseudotobothrium dipsacum* (Linton, 1897) larvae (body cavity) [0] (NHR)

Nema: Anis: unidentified larvae (digestive tract) [0]

Remarks: Based on examination of 3 specimens (3 for gills, 3 for abdominal organs).
Host-parasite combinations: 10; with species-level identification: 3.

Cephalopholis sonnerati (Valenciennes, 1828)

Cope: Penn: larvae (gills) [0]

Mono: Ancy: *Haliotrema* sp. of Justine 2007 (gills) [12]
Mono: Caps: unidentified Benedeniinae (gills) [0]
Mono: Dipl: *Diplectanum nanus* Justine, 2007 (gills) [12]
Mono: Dipl: *Pseudorhabdosynochus minutus* Justine, 2007 (gills) [12]

Tetr: Unid: larvae (digestive tract) [0]
Tryp: Pseu: *Pseudotobothrium dipsacum* larvae (body cavity) [0] (NGR)

Nema: Anis: unidentified larvae (digestive tract) [0]

Remarks: Based on examination of 8 specimens (7 for gills, 5 for abdominal organs).
Host-parasite combinations: 8; with species-level identification: 3.

Cephalopholis spiloparaea (Valenciennes, 1828)

Cope: Siph: larvae (gills) [0]

Tetr: Unid: larvae (digestive tract) [0]
Tryp: Unid: larvae (body cavity) [0]

Remarks: Based on examination of 2 specimens (1 for gills, 2 for abdominal organs).
Host-parasite combinations: 3; with species-level identification: 0.

Cephalopholis urodeta (Schneider, 1801)

Isop: Gnat: Praniza larvae (gills) [0]

Cope: Penn: larvae (gills) [0]

Mono: Caps: unidentified species (body) [0]
Mono: Dipl: *Diplectanum parvus* Justine, 2008 (gills) [13]

Dige: Acan: *Stephanostomum japonocasum* Durio et Manter, 1969 (digestive tract) [0]
Dige: Buce: *Prosorhynchus* sp. (digestive tract) [0]
Dige: Opec: *Helicometra* sp. (digestive tract) [0]
Dige: Opec: *Cainocreadium epinepheli* (digestive tract) [0]

Tetr: Unid: larvae (digestive tract) [0]

Tryp: Laci: *Floriceps minacanthus* larvae (body cavity) [0] (NHR)
Tryp: Pseu: *Pseudotobothrium dipsacum* larvae (body cavity) [0] (NHR)

Nema: Anis: unidentified larvae (digestive tract) [0]

Remarks: Based on examination of 38 specimens (32 for gills, 19 for abdominal organs).
Host-parasite combinations: 12; with species-level identification: 5.

Cromileptes altivelis (Valenciennes, 1828)

Cope: Siph: larvae (gills) [0]

Mono: Ancy: *Haliotrema* cf. *cromileptis* (gills) [0]

Nema: Anis: unidentified larvae (digestive tract) [0]

Remarks: Based on the examination of 4 specimens (4 for gills, 2 for abdominal organs).
Host-parasite combinations: 3; with species-level identification: 0.

Epinephelus areolatus (Forsskål, 1775)

Isop: Gnat: Praniza larvae (gills) [0]

Mono: Caps: unidentified immature (gills) [0]
Mono: Dipl: *Pseudorhabdosynochus* sp. (gills) [0]
Mono: Dipl: *Diplectanum* sp. (gills) [0]

Dige: Buce: *Prosorhynchus longisaccatus* Durio et Manter, 1968 (digestive tract) [0] (NHR*)
Dige: Acan: *Stephanostomum japonocasum* (digestive tract) [0]
Dige: Opec: *Allopodocotyle* sp. (digestive tract) [0]

Tetr: Unid: larvae (digestive tract) [0]

Nema: Anis: *Terranova* sp. larvae
Nema: Anis: *Anisakis* sp. larvae
Nema: Philo: *Philometra ocularis* Moravec, Ogawa, Suzuki, Miyazaki et Donai, 2002 (orbits) [23][24]

Remarks: Based on examination of 14 specimens (9 for gills, 12 for abdominal organs).
Host-parasite combinations: 11; with species-level identification: 3.

Epinephelus chlorostigma (Valenciennes, 1828)

Cope: Hats: *Hatschekia* n. sp. 2 (gills) [0]
Cope: Lern: *Sagum epinepheli* (Yamaguti et Yamasu, 1960) (gills) [0] (NHR)

Mono: Caps: *Allobenedenia* cf. e*pinepheli* (Bychowsky et Nagibina, 1967) (gills) [0]
Mono: Dipl: *Pseudorhabdosynochus epinepheli* (Yamaguti, 1938) (gills) [16]
Mono: Dipl: *Pseudorhabdosynochus* n. sp. 1 (gills) [0]
Mono: Dipl: *Diplectanum* n. sp. (gills) [0]
Mono: Ancy: *Haliotrema* sp. (gills) [0]

Dige: Didy: unidentified adult (fins) [0]
Dige: Hemi: *Lecithochirium* sp. (digestive tract) [0]
Dige: Buce: *Prosorhynchus* sp. (digestive tract) [0]
Dige: Acan: *Stephanostomum japonocasum* (digestive tract) [0]
Dige: Bive: *Bivesicula* sp. (digestive tract) [0]

Tetr: Unid: larvae (digestive tract) [0]
Tryp: Laci: *Pseudolacistorhynchus heroniensis* larvae (body cavity) [0] (NHR)
Tryp: Laci: *Callitetrarhynchus gracilis* (Rudolphi, 1819) larvae (body cavity) [0] (NHR)

Nema: Anis: unidentified larvae (digestive tract) [0]

Remarks: Based on examination of single specimen (1 for gills, 1 for abdominal organs).
Host-parasite combinations: 16; with species-level identification: 5.

Epinephelus coeruleopunctatus (Bloch, 1790)

Cope: Lern: *Sagum epinepheli* (gills) [0] (NHR)
Cope: Hats: *Hatschekia* n. sp. 1 (gills) [0]
Cope: Cali: *Lepeophtheirus epinepheli* Ho et Dojiri, 1977 (Skin) [0] (NHR)

Mono: Dipl: *Pseudorhabdosynochus bacchus* Sigura, Chauvet et Justine, 2007 (gills) [26]
Mono: Dipl: *Pseudorhabdosynochus* n. sp. 1 (gills) [26]
Mono: Dipl: *Pseudorhabdosynochus* n. sp. 2 (gills) [26]
Mono: Ancy: *Haliotrema* sp. (gills) [26]

Dige: Buce: *Prosorhynchus* sp. immature (digestive tract) [0]
Dige: Dero: *Derogenes*-like sp. (digestive tract) [0]
Dige: Opec: *Cainocreadium epinepheli* (digestive tract) [5]

Remarks: Based on examination of 7 specimens (5 for gills, 5 for abdominal organs).
Host-parasite combinations: 10; with species-level identification: 4.

Epinephelus coioides (Hamilton, 1822)

Isop: Cora: *Argathona rhinoceros* (Bleeker, 1857) (nasal cavities) [0] (NHR)

Mono: Caps: *Allobenedenia* cf. *epinepheli* (gills) [0]
Mono: Dipl: *Pseudorhabdosynochus* sp. 1 (gills) [0]
Mono: Dipl: *Pseudorhabdosynochus* sp. 2 (gills) [0]
Mono: Dipl: *Pseudorhabdosynochus* sp. 3 (gills) [0]
Mono: Dipl: *Pseudorhabdosynochus* sp. 4 (gills) [0]
Mono: Ancy: *Haliotrema* sp. (gills) [0]

Tryp: Laci: *Pseudogilquinia pillersi* (Southwell, 1929) larvae (body cavity) [1]
Tryp: Pseu: *Pseudotobothrium dipsacum* larvae (body cavity) [0] (NGR)

Nema: Anis: unidentified larvae (digestive tract) [0]
Nema: Phil: *Philometra ocularis* Moravec, Ogawa, Suzuki, Miyazaki et Donai, 2002 (orbits) [22]

Remarks: Based on examination of 1 specimen (1 for gills, 1 for abdominal organs).
Host-parasite combinations: 11; with species-level identification: 4.

Epinephelus cyanopodus (Richardson, 1846)

Isop: Gnat: Praniza larvae (gills) [27]
Isop: Cora: *Argathona rhinoceros* (gills) [27] (NHR)

Cope: Cali: *Caligus asymmetricus* Kabata, 1965 (gills) [0] (NHR)
Cope: Cali: *Lepeophtheirus plectropomi* Nunes-Ruivo et Fourmanoir, 1956 (gills) [0] (NHR)
Cope: Hats: *Hatschekia* n. sp. 1 (gills) [0]
Cope: Hats: *Hatschekia* n. sp. 11 (gills) [0]
Cope: Diss: *Dissonus manteri* Kabata, 1966 (gills) [2][27]
Cope: Lern: *Sagum epinepheli* (gills) [27] (NHR)
Cope: Penn: larvae (gills) [27]

Mono: Ancy: *Haliotrema* sp. (gills) [27]
Mono: Caps: *Allobenedenia* sp. (gills) [27]
Mono: Dipl: *Pseudorhabdosynochus cyanopodus* Sigura et Justine, 2008 (gills) [27]
Mono: Dipl: *Pseudorhabdosynochus podocyanus* Sigura et Justine, 2008 (gills) [27]
Mono: Dipl: *Pseudorhabdosynochus chauveti* Sigura et Justine, 2008 (gills) [27]
Mono: Dipl: *Pseudorhabdosynochus exoticus* Sigura et Justine, 2008 (gills) [27]
Mono: Dipl: *Pseudorhabdosynochus duitoe* Justine, 2007 (gills) [27]
Mono: Dipl: *Pseudorhabdosynochus huitoe* Justine, 2007 (gills) [27]
Mono: Dipl: *Laticola cyanus* Sigura et Justine, 2008 (gills) [27]

Dige: Buce: *Prosorhynchus longisaccatus* (digestive tract) [3]
Dige: Didy: unidentified adults (gills) [27]
Dige: Didy: unidentified adults (fins) [27]
Dige: Fell: *Tergestia* sp. immature (digestive tract) [27]
Dige: Hemi: *Erilepturus hamati* (Yamaguti, 1934) (digestive tract) [27]
Dige: Opec: *Allopodocotyle epinepheli* (Yamaguti, 1942) (digestive tract) [5]
Dige: Opec: *Cainocreadium epinepheli* (digestive tract) [27]

Tetr: Unid: larvae (digestive tract) [0]
Tryp: Laci: *Pseudolacistorhynchus heroniensis* larvae (body cavity) [27]
Tryp: Laci: *Floriceps minacanthus* larvae (body cavity) [27]

Nema: Phil: *Philometra ocularis* (orbits) [22]
Nema: Phil: *Philometra cyanopodi* Moravec et Justine, 2008 (ovaries) [23]
Nema: Anis: *Terranova* sp. larvae (digestive tract) [27]

Remarks: Based on examination of 25 specimens (21 for gills, 14 for abdominal organs).
Host-parasite combinations: 31; with species-level identification: 20.
The hemiurid *Erilepturus tiegsi* Woolcock, 1935 was recorded from “loche bleue” off New Caledonia (Manter 1969), which most prob-

ably corresponds to this host (Justine 2007a). Our findings did not confirm this record.
An exhaustive comparison of the parasitic fauna of this species in various locations was performed (Sigura and Justine 2008).

Epinephelus fasciatus (Forsskål, 1775)

Cope: Cali: *Caligus* n. sp. (gills) [0]
Cope: Hats: *Hatschekia* n. sp. 1 (gills) [0]

Mono: Caps: *Benedenia* cf. *epinepheli* (gills) [0]
Mono: Dipl: *Pseudorhabdosynochus caledonicus* Justine, 2005 (gills) [9]
Mono: Dipl: *Pseudorhabdosynochus youngi* Justine, Dupoux et Cribb, 2009 (gills) [17]

Dige: Bive: *Bivesicula* sp. (digestive tract) [0]
Dige: Didy: unidentified adults (opercula) [0]
Dige: Didy: unidentified larvae (digestive tract) [0]
Dige: Gorg: *Phyllodistomum* sp. (digestive tract) [0]
Dige: Hemi: *Lecithochirium* sp. (digestive tract) [0]
Dige: Lepo: *Lepidapedoides angustus* Bray, Cribb et Barker, 1996 (digestive tract) [3]
Dige: Opec: *Allopodocotyle epinepheli* (digestive tract) [5]
Dige: Opec: *Cainocreadium epinepheli* (digestive tract) [5]
Dige: Opec: *Helicometra epinepheli* (Yamaguti, 1934) (digestive tract) [5]

Tetr: Unid: larvae (digestive tract) [0]
Tryp: Laci: *Pseudolacistorhynchus heroniensis* larvae (body cavity) [0] (NHR)
Tryp: Pseu: *Pseudotobothrium dipsacum* larvae (body cavity) [0] (NHR)

Nema: Anis: unidentified larvae (digestive tract) [0]
Nema: Cama: *Procamallanus variolae* Moravec, Justine et Rigby, 2006 (digestive tract) [25]
Nema: Phil: *Philometra fasciati* Moravec et Justine, 2008 (ovaries) [23][25]

Turbellaria: Unid: unidentified species (skin) [19]

Remarks: Based on examination of 92 specimens (45 for gills, 61 for abdominal organs).
Host-parasite combinations: 21; with species-level identification: 10.

Epinephelus fuscoguttatus (Forsskål, 1775)

Isop: Gnat: Praniza larvae (gills) [0]

Cope: Cali: *Lepeophtheirus* sp. (gills) [0]
Cope: Hats: *Hatschekia* n. sp. 5 (gills) [0]
Cope: Siph: larvae (gills) [0]

Mono: Caps: Trochopodinae sp. 4 of Perkins et al. (2009) (gills) [0]
Mono: Dipl: *Pseudorhabdosynochus* sp. 1 (gills) [0]
Mono: Dipl: *Pseudorhabdosynochus* sp. 2 (gills) [0]

Nema: Anis: unidentified larvae (digestive tract) [0]

Remarks: Based on examination of 2 specimens (2 for gills, 1 for abdominal organs).
Host-parasite combinations: 8; with species-level identification: 0.

Epinephelus howlandi (Günther, 1873)

Isop: Cymo: *Elthusa* sp. (gills) [0]

Mono: Dipl: *Pseudorhabdosynochus venus* Hinsinger et Justine, 2006 (gills) [6]
Mono: Dipl: *Pseudorhabdosynochus cyathus* Hinsinger et Justine, 2006 (gills) [7]

Tryp: Laci: *Pseudolacistorhynchus heroniensis* larvae (body cavity) [0] (NHR)

Nema: Anis: unidentified larvae (digestive tract) [0]

Remarks: Based on examination of 24 specimens (23 for gills, 3 for abdominal organs).
Host-parasite combinations: 5; with species-level identification: 3.

Epinephelus maculatus (Bloch, 1790)

Isop: Gnat: Praniza larvae (gills) [0]

Cope: Cali: *Lepeophtheirus epinepheli* (gills) [0] (NHR)
Cope: Diss: *Dissonus manteri* (gills) [2]
Cope: Hats: *Hatschekia* n. sp. 1 (gills) [0]
Cope: Hats: *Hatschekia* n. sp. 10 (gills) [0]
Cope: Penn: larvae (gills) [0]

Mono: Ancy: *Haliotrema* cf. *epinepheli* (gills) [11]
Mono: Ancy: *Haliotrema* sp. of Justine, 2007 (gills) [11]
Mono: Caps: unidentified (gills) [0]
Mono: Dipl: *Diplectanum uitoe* Justine, 2007
Mono: Dipl: *Laticola dae* Journo et Justine, 2006 (gills) [8]
Mono: Dipl: *Pseudorhabdosynochus auitoe* Justine, 2007 (gills) [11]
Mono: Dipl: *Pseudorhabdosynochus buitoe* Justine, 2007 (gills) [11]
Mono: Dipl: *Pseudorhabdosynochus cuitoe* Justine, 2007 (gills) [11]
Mono: Dipl: *Pseudorhabdosynochus duitoe* Justine, 2007 (gills) [11]
Mono: Dipl: *Pseudorhabdosynochus euitoe* Justine, 2007 (gills) [11]
Mono: Dipl: *Pseudorhabdosynochus fuitoe* Justine, 2007 (gills) [11]
Mono: Dipl: *Pseudorhabdosynochus guitoe* Justine, 2007 (gills) [11]
Mono: Dipl: *Pseudorhabdosynochus huitoe* Justine, 2007 (gills) [11]

Dige: Acan: *Stephanostomum japonocasum* (digestive tract) [0] (NHR*)
Dige: Buce: *Prosorhynchus longisaccatus* (digestive tract) [0] (NHR*)
Dige: Didy: unidentified adults (gills, orbit, branchiostegal membranes) [0]
Dige: Didy: unidentified larvae (digestive tract, swim bladder) [0]
Dige: Hemi: *Erilepturus hamati* (digestive tract) [0]
Dige: Hemi: *Lecithochirium* sp. 1 (digestive tract) [0]
Dige: Hemi: *Lecithochirium* sp. 2 (digestive tract) [0]
Dige: Hemi: *Aphanurus* sp. (digestive tract) [0]
Dige: Hemi: *Tubulovesicula angusticauda* (Nicoll, 1915) (digestive tract) [0] (NHR) (NGR)
Dige: Lepo: *Lepidapedoides angustus* (gall bladder) [0] (NHR)
Dige: Opec: *Cainocreadium epinepheli* (digestive tract) [0] (NHR)
Dige: Opec: *Helicometra epinepheli* (digestive tract) [0] (NHR)

Both: Unid: larvae (flesh) [0]
Tetr: Unid: larvae (digestive tract) [0]
Tryp: Otob: *Otobothrium* sp. larvae (body cavity) [0]

Nema: Cama: unidentified species (digestive tract) [0]
Nema: Anis: unidentified larvae (digestive tract) [0]

Remarks: Based on examination of 62 specimens (38 for gills, 38 for abdominal organs).
Host-parasite combinations: 36; with species-level identification: 19.

Epinephelus malabaricus (Bloch et Schneider, 1801)

Isop: Cora: *Argathona rhinoceros* (gills) [0]

Cope: Hats: *Hatschekia* n. sp. 6 (gills) [0]
Cope: Cali: *Lepeophtheirus plectropomi* (gills) [0] (NHR)
Cope: Siph: chalimus larvae (gills) [0]

Mono: Ancy: *Haliotrema* sp. 1 (gills) [20]
Mono: Ancy: *Haliotrema* sp. 2 (gills) [20]
Mono: Caps: *Allobenedenia* sp. (gills) [0]
Mono: Dipl: *Diplectanum maa* Justine et Sigura, 2007 (gills) [20]
Mono: Dipl: *Pseudorhabdosynochus* cf. *shenzhenensis* (gills) [20]
Mono: Dipl: *Pseudorhabdosynochus maaensis* Justine et Sigura, 2007 (gills) [20]
Mono: Dipl: *Pseudorhabdosynochus malabaricus* Justine et Sigura, 2007 (gills) [20]
Mono: Dipl: *Pseudorhabdosynochus manifestus* Justine et Sigura, 2007 (gills) [20]
Mono: Dipl: *Pseudorhabdosynochus manipulus* Justine et Sigura, 2007 (gills) [20]
Mono: Dipl: *Pseudorhabdosynochus marcellus* Justine et Sigura, 2007 (gills) [20]
Mono: Dipl: *Pseudorhabdosynochus maternus* Justine et Sigura, 2007 (gills) [20]

Dige: Buce: *Prosorhynchus maternus* Bray et Justine, 2006 (digestive tract) [3]
Dige: Opec: *Cainocreadium* sp. (digestive tract) [0]

Tryp: Laci: *Pseudogilquinia pillersi* larvae (body cavity) [1]
Tryp: Pseu: *Pseudotobothrium dipsacum* larvae (body cavity) [20]

Nema: Unid: (digestive tract)

Remarks: Based on examination of 2 specimens (2 for gills, 2 for abdominal organs).
Host-parasite combinations: 20; with species-level identification: 12.
An exhaustive comparison of the parasitic fauna of this species in various locations was performed (Justine and Sigura 2007).

Epinephelus merra Bloch, 1793

Cope: Cali: *Lepeophtheirus* sp. (gills) [0]
Cope: Lern: *Sagum epinepheli* (gills) [0] (NHR)
Cope: Penn: larvae (gills) [0]
Cope: Siph: larvae (gills) [0]

Mono: Dipl: *Pseudorhabdosynochus melanesiensis* Laird, 1958 (gills) [9]
Mono: Dipl: *Pseudorhabdosynochus* cf. *coioidesis* (gills) [7]
Mono: Caps: unidentified Benedeniinae (gills) [0]

Dige: Opec: *Helicometra epinepheli* Yamaguti, 1934 (digestive tract) [5]
Dige: Opec: *Allopodocotyle epinepheli* (Yamaguti, 1942) (digestive tract) [5]

Remarks: Based on examination of 64 specimens (58 for gills, 18 for abdominal organs).
Host-parasite combinations: 9; with species-level identification: 4.
Additional records: The digeneans *Helicometra fasciata* (Opecoelidae) and *Lepidapedoides angustus* (Lepocreadiidae; as *L. 'kerapu'*, see note on species name in Justine 2007a), the unidentified cestode '*Scolex polymorphus*' and unidentified trypanorhynch larvae were recorded off New Caledonia (Rigby et al. 1997). Curiously, our findings did not confirm any of these records, although '*S. polymorphus*' probably indicated the presence of tetraphyllidean cestode larvae.

Epinephelus morrhua (Valenciennes, 1833)

Isop: Gnat: Praniza larvae (gills) [0]

Cope: Hats: *Hatschekia cernae* Goggio, 1905 (gills) [0] (NHR)
Cope: Hats: *Hatschekia* n. sp. 4 (gills) [0]
Cope: Lern: *Sagum epinepheli* (gills) [0] (NHR)

Mono: Ancy: *Haliotrema* sp. of Justine 2008b (gills) [14]
Mono: Dipl: *Pseudorhabdosynochus morrhua* Justine, 2008 (gills) [14]
Mono: Dipl: *Pseudorhabdosynochus variabilis* Justine, 2008 (gills) [14]

Dige: Bive: *Bivesicula* sp. (digestive tract) [0]
Dige: Buce: *Prosorhynchus* sp. (digestive tract) [0]
Dige: Didy: unidentified larvae (gills)
Dige: Opec: *Cainocreadium epinepheli* (digestive tract) [0]

Tetr: unidentified larvae (digestive tract) [0]
Tryp: unidentified larvae (body cavity) [0]

Nema: Anis: unidentified larvae (digestive tract) [0]

Acantho: unidentified acanthocephalan species (digestive tract) [0]

Remarks: Based on examination of 5 specimens (5 for gills, 4 for abdominal organs).
Host-parasite combinations: 15; with species-level identification: 5.

Epinephelus polyphekadion (Bleeker, 1849)

Isop: Gnat: Praniza larvae (gills) [0]

Cope: Hats: *Hatschekia* n. sp. 1 (gills) [0]

Mono: Caps: *Benedenia* cf. *epinepheli* (gills) [0]
Mono: Dipl: *Pseudorhabdosynochus* sp. 1 (gills) [0]
Mono: Dipl: *Pseudorhabdosynochus* sp. 2 (gills) [0]
Mono: Dipl: *Pseudorhabdosynochus* sp. 3 (gills) [0]

Dige: Didy: unidentified adults (muscles) [0]
Dige: Hemi: *Lecithochirium* sp. (digestive tract) [0]

Both: Unid: larvae (flesh) [0]

Tryp: Laci: *Pseudolacistorhynchus heroniensis* larvae (body cavity) [0] (NHR)

Remarks: Based on examination of 8 specimens (6 for gills, 3 for abdominal organs).
Host-parasite combinations: 10; with species-level identification: 1.

Epinephelus retouti (Bleeker, 1868)

Mono: Dipl: *Pseudorhabdosynochus* cupatus-group n. sp.

Dige: Acan: *Stephanostomum japonocasum* (digestive tract) [0]
Dige: Didy: unidentified larvae (digestive tract) [0]
Dige: Hemi: *Lecithochirium* sp. (digestive tract) [0]

Tryp: Pseu: *Pseudotobothrium dipsacum* larvae (body cavity) [0] (NHR)

Nema: Anis: unidentified larvae (digestive tract) [0]
Nema: Cama: unidentified (digestive tract) [0]

Remarks: Based on examination of 2 specimens (1 for gills, 2 for abdominal organs).
Host-parasite combinations: 7; with species-level identification: 2.

Epinephelus rivulatus (Valenciennes, 1830)

Isop: Gnat: Praniza larvae (gills) [0]

Cope: Hats: *Hatschekia* n. sp. 1 (gills) [0]

Mono: Caps: unidentified immature (gills) [0]
Mono: Dipl: *Pseudorhabdosynochus calathus* Hinsinger et Justine, 2006 (gills) [7]
Mono: Dipl: *Pseudorhabdosynochus inversus* Justine, 2008 (gills) [15]

Dige: Didy: unidentified larvae (digestive tract) [0]
Dige: Hemi: *Lecithochirium* sp (digestive tract) [0]

Tetr: Unid: larvae (digestive tract) [0]
Tryp: Laci: *Pseudolacistorhynchus heroniensis* larvae (body cavity) [0] (NHR)
Tryp: Laci: *Callitetrarhynchus gracilis* larvae (body cavity) [0] (NHR)

Nema: Phil: *Philometra ocularis* (orbit) [22]

Remarks: Based on examination of 14 specimens (14 for gills, 8 for abdominal organs).
Host-parasite combinations: 11; with species-level identification: 5.

Plectropomus laevis (Lacépède, 1801)

Isop: Cora: *Argathona macronema* (Bleeker, 1857) (gills) [0] (NHR)

Cope: Diss: *Dissonus manteri* (gills) [2]
Cope: Hats: *Hatschekia plectropomi* Ho et Dojiri, 1978 (gills) [0] (NHR)
Cope: Penn: larvae (gills) [0]

Mono: Dipl: *Echinoplectanum chauvetorum* Justine et Euzet, 2006 (gills) [18]
Mono: Dipl: *Echinoplectanum laeve* Justine et Euzet, 2006 (gills) [18]

Dige: Buce: *Prosorhynchus* sp. (digestive tract) [0]
Dige: Buce: *Neidhartia* sp. 2 (digestive tract) [0]
Dige: Opec: unidentified immature (digestive tract) [0]

Both: Unid: larvae (digestive tract) [0]
Tryp: Laci: *Floriceps minacanthus* larvae (body cavity) [0] (NHR)
Tryp: Laci: *Pseudogilquinia pillersi* larvae (body cavity) [1]
Tryp: Pseu: *Pseudotobothrium dipsacum* larvae (body cavity) [0] (NHR)

Nema: Capi: unidentified species (digestive tract) [0]
Nema: Anis: *Hysterothylacium* sp. larvae (digestive tract) [0]

Remarks: Based on examination of 14 specimens (14 for gills, 6 for abdominal organs).
Host-parasite combinations: 15; with species-level identification: 8.

Plectropomus leopardus (Lacépède, 1802)

Isop: Cora: *Argathona macronema* (gills) [0]
Isop: Cora: *Argathona rhinoceros* (gills) [0]

Cope: Cali: *Lepeophtheirus* sp. (gills) [0]
Cope: Diss: *Dissonus manteri* (gills) [2]
Cope: Lern: *Sagum epinepheli* (gills) [0] (NHR)
Cope: Hats: *Hatschekia plectropomi* (gills) [0]
Cope: Penn: larvae (gills) [0]

Mono: Dipl: *Echinoplectanum leopardi* Justine et Euzet, 2006 (gills) [18]
Mono: Dipl: *Echinoplectanum pudicum* Justine et Euzet, 2006 (gills) [18]
Mono: Dipl: *Echinoplectanum rarum* Justine et Euzet, 2006 (gills) [18]
Mono: Caps: Trochopodinae sp. 2 of Perkins et al. (2009) (gills) [0]

Dige: Buce: *Prosorhynchus* sp. (digestive tract) [0]
Dige: Buce: *Neidhartia* sp. 1 (digestive tract) [0]
Dige: Buce: *Neidhartia* sp. 2 (digestive tract) [0]
Dige: Opec: *Pacificreadium serrani* (Nagaty et Abdel-Aal, 1962) (digestive tract) [5]

Tetr: Unid: larvae (digestive tract) [0]
Tryp: Laci: *Floriceps minacanthus* larvae (body cavity) [0] (NGR)
Tryp: Laci: *Pseudogilquinia pillersi* larvae (body cavity) [0] (NHR)
Tryp: Pseu: *Pseudotobothrium dipsacum* larvae (body cavity) [0] (NGR)

Nema: Capi: unidentified adult (digestive tract) [0]

Remarks: Based on examination of 42 specimens (21 for gills, 24 for abdominal organs).
Host-parasite combinations: 20; with species-level identification: 12.

Variola albimarginata Baissac, 1952

Isop: Gnat: Praniza larvae (gills) [0]

Cope: Hats: *Hatschekia* n. sp. 1 (gills) [0]
Cope: Hats: *Hatschekia* n. sp. 8 (gills) [0]

Mono: Ancy: *Haliotrema* cf. *epinepheli* (gills) [0]

Dige: Buce: *Prosorhynchus serrani* Durio et Manter, 1968 (digestive tract) [0]

Nema: Anis: *Terranova* sp. larvae (digestive tract) [0]
Nema: Cama: *Procamallanus variolae* (digestive tract) [25]
Nema: Cucu: *Cucullanus* sp. (digestive tract) [0]

Remarks: Based on examination of 4 specimens (4 for gills, 2 for abdominal organs).
Host-parasite combinations: 8; with species-level identification: 2.

Variola louti (Forsskål, 1775)

Isop: Gnat: Praniza larvae (gills) [0]

Cope: Hats: *Hatschekia* n. sp. 1 (gills) [0]
Cope: Hats: *Hatschekia* n. sp. 8 (gills) [0]
Cope: Siph: larvae (gills) [0]

Mono: Dipl: *Pseudorhabdosynochus hirundineus* Justine, 2005 (gills) [10]
Mono: Ancy: *Haliotrema* cf. *epinepheli* (gills) [10]

Dige: Acan: *Stephanostomum japonocasum* (digestive tract) [0]
Dige: Buce: *Prosorhynchus serrani* (digestive tract) [3]
Dige: Didy: unidentified adults (body) [0]
Dige: Didy: unidentified larvae (digestive tract) [0]
Dige: Opec: *Cainocreadium epinepheli* (digestive tract) [5]
Dige: Opec: *Pacificreadium serrani* (digestive tract) [0]

Tryp: Laci: *Callitetrarhynchus gracilis* larvae (body cavity) [0] (NHR)
Tryp: Laci: *Floriceps minacanthus* larvae (body cavity) [0] (NGR)
Tryp: Laci: *Diesingium* cf. *lomentaceum* (Diesing, 1850) larvae (body cavity) [0]
Tryp: Pseu: *Pseudotobothrium dipsacum* larvae (body cavity) [0] (NGR)

Nema: Phil: *Philometra ocularis* (orbit) [25]
Nema: Cama: *Procamallanus* sp. (digestive tract) [0]
Nema: Cucu: *Cucullanus* sp. (digestive tract) [0]
Nema: Anis: *Terranova* sp. larvae (digestive tract) [0]

Remarks: Based on examination of 34 specimens (28 for gills, 18 for abdominal organs).
Host-parasite combinations: 20; with species-level identification: 9.
Additional records: *Prosorhynchus serrani* was described from the same host in New Caledonia (Durio and Manter 1968a); this is confirmed by our findings.

Appendix 2: Parasite-host list

Isopoda
(5 'species'; 3 identified species)

Cora: *Argathona macronema* (NGR)
Plectropomus laevis (NHR)
Plectropomus leopardus

Cora: *Argathona rhinoceros* (NGR)
Epinephelus coioides (NHR)
Epinephelus cyanopodus (NHR)
Epinephelus malabaricus
Plectropomus leopardus

Cora: *Lanocira zeylanica* (NGR)
Cephalopholis boenak (NHR)

Cymo: *Elthusa* sp.
Epinephelus howlandi

Gnat: Praniza larvae
Cephalopholis argus
Cephalopholis boenak
Cephalopholis urodeta
Epinephelus areolatus
Epinephelus cyanopodus
Epinephelus fuscoguttatus
Epinephelus maculatus
Epinephelus morrhua
Epinephelus polyphekadion
Epinephelus rivulatus
Variola albimarginata
Variola louti

Copepoda
(19 'species'; 7 identified species)

Cali: *Caligus asymmetricus*
Epinephelus cyanopodus (NHR)

Cali: *Caligus* n. sp.
Epinephelus fasciatus

Cali: *Lepeophtheirus epinepheli*
Epinephelus coeruleopunctatus (NHR)
Epinephelus maculatus (NHR)

Cali: *Lepeophtheirus plectropomi*
Epinephelus cyanopodus (NHR)
Epinephelus malabaricus (NHR)

Cali: *Lepeophtheirus* sp.
Epinephelus fuscoguttatus
Epinephelus merra
Plectropomus leopardus

Diss: *Dissonus manteri*
Epinephelus cyanopodus
Epinephelus maculatus
Plectropomus laevis
Plectropomus leopardus

Hats: *Hatschekia cernae*
Epinephelus morrhua (NHR)

Hats: *Hatschekia plectropomi*
Plectropomus laevis (NHR)
Plectropomus leopardus

Hats: *Hatschekia* n. sp. 1
Epinephelus coeruleopunctatus
Epinephelus cyanopodus
Epinephelus fasciatus
Epinephelus maculatus
Epinephelus polyphekadion
Epinephelus rivulatus
Variola albimarginata
Variola louti

Hats: *Hatschekia* n. sp. 2
Epinephelus chlorostigma

Hats: *Hatschekia* n. sp. 4
Epinephelus morrhua

Hats: *Hatschekia* n. sp. 5
Epinephelus fuscoguttatus

Hats: *Hatschekia* n. sp. 6
Epinephelus malabaricus

Hats: *Hatschekia* n. sp. 8
Variola albimarginata
Variola louti

Hats: *Hatschekia* n. sp. 10
Epinephelus maculatus

Hats: *Hatschekia* n. sp. 11
Epinephelus cyanopodus

Lern: *Sagum epinepheli*
Epinephelus chlorostigma (NHR)
Epinephelus coeruleopunctatus (NHR)
Epinephelus cyanopodus (NHR)
Epinephelus merra (NHR)
Epinephelus morrhua (NHR)
Plectropomus leopardus (NHR)

Penn: Larvae
Cephalopholis sonnerati
Cephalopholis urodeta
Epinephelus cyanopodus
Epinephelus maculatus
Epinephelus merra
Plectropomus laevis
Plectropomus leopardus

Siph: Larvae
Anyperodon leucogrammicus
Cephalopholis spiloparaea
Cromileptes altivelis
Epinephelus fuscoguttatus
Epinephelus malabaricus
Epinephelus merra
Variola louti

Monogenea
(56 'species'; 42 identified species)

Ancy: *Haliotrema* cf. *cromileptis*
Cromileptes altivelis

Ancy: *Haliotrema* cf. *epinepheli*
Epinephelus maculatus
Variola albimarginata
Variola louti

Ancy: *Haliotrema* spp.
Cephalopholis sonnerati
Epinephelus chlorostigma
Epinephelus coeruleopunctatus
Epinephelus coioides
Epinephelus cyanopodus
Epinephelus maculatus
Epinephelus malabaricus
Epinephelus morrhua

Caps: *Allobenedenia* cf. *epinepheli*
Epinephelus chlorostigma
Epinephelus coioides

Caps: *Allobenedenia* spp.
Epinephelus cyanopodus
Epinephelus malabaricus

Caps: *Benedenia* cf. *epinepheli*
Epinephelus fasciatus
Epinephelus polyphekadion

Caps: Unidentified Benedeniinae spp.
Cephalopholis miniata
Cephalopholis sonnerati
Epinephelus merra

Caps: Trochopodinae sp. 2 of Perkins et al. 2009
Plectropomus leopardus

Caps: Trochopodinae sp. 4 of Perkins et al. 2009
Epinephelus fuscoguttatus

Caps: Unidentified spp.
Cephalopholis argus
Cephalopholis urodeta
Epinephelus areolatus
Epinephelus maculatus
Epinephelus rivulatus

Dipl: *Diplectanum maa*
Epinephelus malabaricus

Dipl: *Diplectanum nanus*
Cephalopholis sonnerati

Dipl: *Diplectanum parvus*
Cephalopholis urodeta

Dipl: *Diplectanum uitoe*
Epinephelus maculatus

Dipl: *Diplectanum* spp.
Cephalopholis miniata
Epinephelus areolatus

Dipl: *Echinoplectanum chauvetorum*
Plectropomus laevis

Dipl: *Echinoplectanum laeve*
Plectropomus laevis

Dipl: *Echinoplectanum leopardi*
Plectropomus leopardus

Dipl: *Echinoplectanum pudicum*
Plectropomus leopardus

Dipl: *Echinoplectanum rarum*
Plectropomus leopardus

Dipl: *Laticola cyanus*
Epinephelus cyanopodus

Dipl: *Laticola dae*
Epinephelus maculatus

Dipl: *Pseudorhabdosynochus argus*
Cephalopholis argus

Dipl: *Pseudorhabdosynochus auitoe*
Epinephelus maculatus

Dipl: *Pseudorhabdosynochus bacchus*
Epinephelus coeruleopunctatus

Dipl: *Pseudorhabdosynochus buitoe*
Epinephelus maculatus

Dipl: *Pseudorhabdosynochus calathus*
Epinephelus rivulatus

Dipl: *Pseudorhabdosynochus caledonicus*
Epinephelus fasciatus

Dipl: *Pseudorhabdosynochus chauveti*
Epinephelus cyanopodus

Dipl: *Pseudorhabdosynochus cuitoe*
Epinephelus maculatus

Dipl: *Pseudorhabdosynochus cyanopodus*
Epinephelus cyanopodus

Dipl: *Pseudorhabdosynochus cyathus*
Epinephelus howlandi

Dipl: *Pseudorhabdosynochus duitoe*
Epinephelus cyanopodus
Epinephelus maculatus

Dipl: *Pseudorhabdosynochus epinepheli*
Epinephelus chlorostigma

Dipl: *Pseudorhabdosynochus exoticus*
Epinephelus cyanopodus

Dipl: *Pseudorhabdosynochus fuitoe*
Epinephelus maculatus

Dipl: *Pseudorhabdosynochus guitoe*
Epinephelus maculatus

Dipl: *Pseudorhabdosynochus hirundineus*
Variola louti

Dipl: *Pseudorhabdosynochus huitoe*
Epinephelus cyanopodus
Epinephelus maculatus

Dipl: *Pseudorhabdosynochus inversus*
Epinephelus rivulatus

Dipl: *Pseudorhabdosynochus maaensis*
Epinephelus malabaricus

Dipl: *Pseudorhabdosynochus malabaricus*
Epinephelus malabaricus

Dipl: *Pseudorhabdosynochus manifestus*
Epinephelus malabaricus

Dipl: *Pseudorhabdosynochus manipulus*
Epinephelus malabaricus

Dipl: *Pseudorhabdosynochus marcellus*
Epinephelus malabaricus

Dipl: *Pseudorhabdosynochus maternus*
Epinephelus malabaricus

Dipl: *Pseudorhabdosynochus melanesiensis*
Epinephelus merra

Dipl: *Pseudorhabdosynochus minutus*
Cephalopholis sonnerati

Dipl: *Pseudorhabdosynochus morrhua*
Epinephelus morrhua

Dipl: *Pseudorhabdosynochus podocyanus*
Epinephelus cyanopodus

Dipl: *Pseudorhabdosynochus variabilis*
Epinephelus morrhua

Dipl: *Pseudorhabdosynochus venus*
Epinephelus howlandi

Dipl: *Pseudorhabdosynochus youngi*
Epinephelus fasciatus

Dipl: *Pseudorhabdosynochus* cf. *coioidesis*
Epinephelus merra

Dipl: *Pseudorhabdosynochus* cf. *shenzhenensis*
Epinephelus malabaricus

Dipl: *Pseudorhabdosynochus* spp.
Anyperodon leucogrammicus
Epinephelus areolatus
Epinephelus chlorostigma
Epinephelus coeruleopunctatus
Epinephelus coioides
Epinephelus fuscoguttatus
Epinephelus polyphekadion
Epinephelus retouti

Digenea
(28 'species'; 13 identified species)

Acan: *Stephanostomum japonocasum*
Cephalopholis urodeta
Epinephelus areolatus
Epinephelus chlorostigma
Epinephelus maculatus (NHR*)
Epinephelus retouti
Variola louti

Bive: *Bivesicula claviformis*
Cephalopholis boenak

Bive: *Bivesicula* sp.
Epinephelus chlorostigma
Epinephelus fasciatus
Epinephelus morrhua

Buce: *Neidhartia* sp. 1
Plectropomus leopardus

Buce: *Neidhartia* sp. 2
Plectropomus laevis
Plectropomus leopardus

Buce: *Prosorhynchus longisaccatus*
Epinephelus areolatus (NHR*)
Epinephelus cyanopodus
Epinephelus maculatus (NHR*)

Buce: *Prosorhynchus maternus*
Epinephelus malabaricus

Buce: *Prosorhynchus robertsthomsoni*
Cephalopholis argus

Buce: *Prosorhynchus serrani*
Variola albimarginata
Variola louti

Buce: *Prosorhynchus* sp.
Cephalopholis urodeta
Epinephelus chlorostigma
Epinephelus coeruleopunctatus
Epinephelus morrhua
Plectropomus laevis
Plectropomus leopardus

Dero: *Derogenes*-like sp.
Epinephelus coeruleopunctatus

Didy: Unidentified adult
Cephalopholis miniata
Epinephelus chlorostigma
Epinephelus cyanopodus
Epinephelus fasciatus
Epinephelus maculatus
Epinephelus polyphekadion
Variola louti

Didy: Unidentified larvae
Epinephelus fasciatus
Epinephelus maculatus
Epinephelus morrhua
Epinephelus retouti
Epinephelus rivulatus
Variola louti

Fell: *Tergestia* sp.
Epinephelus cyanopodus

Gorg: *Phyllodistomum* sp.
Epinephelus fasciatus

Hemi: *Erilepturus hamati*
Epinephelus cyanopodus
Epinephelus maculatus

Hemi: *Lecithochirium* sp.
Epinephelus chlorostigma
Epinephelus fasciatus
Epinephelus maculatus
Epinephelus polyphekadion
Epinephelus retouti
Epinephelus rivulatus

Hemi: *Aphanurus* sp.
Epinephelus maculatus

Hemi: *Tubulovesicula angusticauda*
Epinephelus maculatus

Hemi: Unidentified species
Epinephelus morrhua

Lepo: *Lepidapedoides angustus*
Epinephelus fasciatus
Epinephelus maculatus

Opec: *Allopodocotyle epinepheli*
Epinephelus cyanopodus
Epinephelus fasciatus
Epinephelus merra

Opec: *Allopodocotyle* sp.
Epinephelus areolatus

Opec: *Cainocreadium epinepheli*
Cephalopholis miniata
Cephalopholis urodeta
Epinephelus coeruleopunctatus
Epinephelus cyanopodus
Epinephelus fasciatus
Epinephelus maculatus
Epinephelus morrhua
Variola louti

Opec: *Helicometra epinepheli*
Epinephelus fasciatus
Epinephelus maculatus
Epinephelus merra

Opec: *Helicometra* sp.
Cephalopholis urodeta

Opec: *Pacificreadium serrani*
Plectropomus leopardus
Variola louti

Opec: Unidentified species
Epinephelus malabaricus
Plectropomus laevis

Cestoda Bothriocephalidea
(3 'species'; 1 identified species)

Both: *Bothriocephalus celineae*
Cephalopholis hybrid: *aurantia* × *spiloparaea*

Unid: Larvae (muscles, flesh)
Epinephelus polyphekadion
Epinephelus maculatus

Unid: Larvae (digestive tract)
Plectropomus laevis

Cestoda Tetraphyllidea
(1 'species'; 0 identified species)

Unid: Larvae (digestive tract)
Cephalopholis boenak
Cephalopholis miniata
Cephalopholis sonnerati
Cephalopholis spiloparaea
Cephalopholis urodeta
Epinephelus chlorostigma
Epinephelus areolatus
Epinephelus cyanopodus
Epinephelus fasciatus
Epinephelus maculatus
Epinephelus morrhua
Epinephelus rivulatus
Plectropomus laevis

Cestoda Trypanorhyncha
(8 'species'; 5 identified species)

Laci: *Callitetrarhynchus gracilis* (NGR)
Cephalopholis boenak (NHR)
Epinephelus chlorostigma (NHR)
Epinephelus rivulatus (NHR)
Variola louti (NHR)

Laci: *Diesingium* cf. *lomentaceum*
Variola louti

Laci: *Floriceps minacanthus* (NGR)
Cephalopholis miniata (NHR)
Cephalopholis urodeta (NHR)
Epinephelus cyanopodus
Plectropomus laevis (NHR)
Plectropomus leopardus (NGR)
Variola louti (NGR)

Laci: *Pseudogilquinia pillersi*
Epinephelus coioides
Epinephelus malabaricus
Plectropomus laevis
Plectropomus leopardus (NHR)

Laci: *Pseudolacistorhynchus heroniensis*
Cephalopholis boenak (NHR)
Epinephelus chlorostigma (NHR)
Epinephelus cyanopodus
Epinephelus fasciatus (NHR)
Epinephelus howlandi (NHR)
Epinephelus polyphekadion (NHR)
Epinephelus rivulatus (NHR)

Otob: *Otobothrium* sp.
Epinephelus maculatus

Pseu: *Pseudotobothrium dipsacum* (NGR)
Cephalopholis miniata (NHR)
Cephalopholis sonnerati (NGR)
Cephalopholis urodeta (NHR)
Epinephelus coioides (NGR)
Epinephelus fasciatus (NHR)
Epinephelus malabaricus (NGR)
Epinephelus retouti (NHR)
Plectropomus laevis (NHR)
Plectropomus leopardus (NGR)
Variola louti (NGR)

Unid: Larvae
Cephalopholis spiloparaea
Epinephelus morrhua

Nematoda
(12 'species'; 4 identified species)

Anis: *Anisakis* sp. larvae
Epinephelus areolatus

Anis: *Hysterothylacium* sp.
Plectropomus laevis

Anis: *Terranova* sp. larvae
Epinephelus areolatus
Epinephelus cyanopodus
Variola albimarginata
Variola louti

Anis: Unidentified larvae
Cephalopholis argus
Cephalopholis boenak
Cephalopholis miniata
Cephalopholis sonnerati
Cephalopholis urodeta
Cromileptes altivelis
Epinephelus chlorostigma
Epinephelus coioides
Epinephelus fasciatus
Epinephelus fuscoguttatus
Epinephelus howlandi
Epinephelus maculatus
Epinephelus morrhua
Epinephelus retouti

Cama: *Procamallanus variolae*
Epinephelus fasciatus
Variola albimarginata

Cama: Unidentified species
Epinephelus maculatus
Epinephelus retouti
Variola louti

Capi: Unidentified species
Plectropomus laevis
Plectropomus leopardus

Cucu: *Cucullanus* sp.
Variola albimarginata
Variola louti

Phil: *Philometra cyanopodi*
Epinephelus cyanopodus

Phil: *Philometra fasciati*
Epinephelus fasciatus

Phil: *Philometra ocularis*
Epinephelus areolatus
Epinephelus cyanopodus
Epinephelus rivulatus
Variola louti

Unid: (digestive tract)
Epinephelus malabaricus

Turbellaria
(1 'species'; 0 identified species)

Unid: Unidentified species
Epinephelus fasciatus

Acanthocephala
(1 'species'; 0 identified species)

Unid: Unidentified species
Epinephelus morrhua

Appendix 3: Material deposited

*: type material

Isopoda
Cora: *Argathona rhinoceros* ex *Pl. leopardus*, MNHN Is6246; ex *Ep. malabaricus*, MNHN Is 6247; ex *Ep. coioides*, MNHN Is6249; ex *Ep. cyanopodus*, MNHN Is6252.
Cora: *Argathona macronema* ex *Pl. leopardus*, MNHN Is6248; ex *Pl. laevis*, MNHN Is6250, 6251.
Cora: *Lanocira zeylanica* ex *Ce. boenak*, MNHN Is6253, 6255, 6256.

Copepoda
Diss: *Dissonus manteri*, MNHN Cp2427–Cp2431; BMNH 2007.349–358.

Monogenea
Ancy: *Haliotrema epinepheli* ex *Ep. maculatus*, MNHN JNC1131, 1170.
Ancy: *Haliotrema* spp. ex *Ce. sonnerati*, MNHN JNC 1614–5, 1636; ex *Ep. maculatus*, MNHN JNC1101, 1150, 1170, 1190, 1522, 1547.
Caps: Trochopodinae sp. 2 of Perkins et al. (2009) ex *Pl. leopardus*, MNHN JNC 1391B1.
Caps: Trochopodinae sp. 4 of Perkins et al. (2009) ex *Ep. fuscoguttatus*, MNHN JNC 1379B2.
Dipl: *Diplectanum maa* ex *Ep. malabaricus*, MNHN JNC2130*; BMNH 2007.6.1.6*; USNPC 99871*; HCIP M-441*.
Dipl: *Diplectanum nanus* ex *Ce. sonnerati*, MNHN JNC1615*.
Dipl: *Diplectanum parvus* ex *Ce. urodeta*, MNHN JNC1212*, 1856*; USNPC 100490*; BMNH 2008.1.4.1*; SAMA AHC 29463*.
Dipl: *Diplectanum uitoe* ex *Ep. maculatus*, MNHN JNC1061*, 1131*, 1150*, 1190*, 1547*; BMNH 2006.4.4.18*; USNPC 97725*; ZRC PAR.10*.
Dipl: *Echinoplectanum chauvetorum* ex *Pl. laevis*, MNHN JNC963*, 1037*; BMNH 2005.7.20.6*; USNPC 97112*.
Dipl: *Echinoplectanum laeve* ex *Pl. laevis*, MNHN JNC963*, 1037*; BMNH 2005.7.20.7*; USNPC 97111*.
Dipl: *Echinoplectanum leopardi* ex *Pl. leopardus*, MNHN JNC 1012*, 1191*, 1392–4*; BMNH 2005.7.20.4*; USNPC 97113*.
Dipl: *Echinoplectanum pudicum* ex *Pl. leopardus*, MNHN JNC1012*, 1392–4*; BMNH 2005.7.20.5*; USNPC 97114*.
Dipl: *Echinoplectanum rarum* ex *Pl. leopardus*, MNHN JNC1392–94*.
Dipl: *Laticola cyanus* ex *Ep. cyanopodus*, MNHN JNC1546*, 1625–6*; BMNH 2007.11.23.12–14*; USNPC 100406–7*; SAMA AHC 29303–5*; HCIP M-461*; SLZU 2007112105-1–3*.
Dipl: *Laticola dae* ex *Ep. maculatus*, MNHN JNC1061*, 1150*, 1170*; BMNH

2004.9.15.10–11*; USNPC 95080*; SLZU 2005080807–8*; HCIP M-449.
Dipl: *Pseudorhabdosynochus argus* ex *Ce. argus*, MNHN JNC1425*, 1828*; BMNH 2007.3.1.1*; USNPC 99680*; QM G227642*.
Dipl: *Pseudorhabdosynochus auitoe* ex *Ep. maculatus*, MNHN JNC1061*, 1101*, 1131*, 1150*, 1190*, 1522*, 1524*, 1547*; BMNH 2006.4.4.1–2*; USNPC 97707–8*; HCIP M-442.
Dipl: *Pseudorhabdosynochus bacchus* ex *Ep. coeruleopunctatus*, MNHN JNC1905*; BMNH 2006.12.13.1*; USNPC 99435*; HCIP M-429*.
Dipl: *Pseudorhabdosynochus buitoe* ex *Ep. maculatus*, MNHN JNC1101*, 1131*, 1150*, 1170*, 1190*, 1522–4*, 1547*; BMNH 2006.4.4.3–4*; USNPC 97709–10*; HCIP M-443.
Dipl: *Pseudorhabdosynochus calathus* ex *Ep. rivulatus*, MNHN JNC1203*, 1283*, 1351*, 1368*; BMNH 2005.7.20.3*; USNPC 97000; SLZU 2005080805*.
Dipl: *Pseudorhabdosynochus caledonicus* ex *Ep. fasciatus*, MNHN JNC1018*, 1082*, 1093*, 1094*; USNPC 095078*; BMNH 2004.8.11.3*.
Dipl: *Pseudorhabdosynochus chauveti* ex *Ep. cyanopodus*, MNHN JNC1625–6*, 1660–1*; BMNH 2007.11.23.5–7*; USNPC 100402–3*; SAMA AHC 29297–8*; HCIP M-459*; SLZU 2007112103-1–2*.
Dipl: *Pseudorhabdosynochus cuitoe* ex *Ep. maculatus*, MNHN JNC1061*, 1101*, 1131*, 1150*, 1170*, 1190*, 1522–4*, 1547*; BMNH 2006.4.4.5–6*; USNPC 97711–2*; HCIP M-444.
Pseudorhabdosynochus cyanopodus ex *Ep. cyanopodus*, MNHN JNC1546*, 1625–6*, 1660–1*; BMNH 2007.11.23.1–2*; USNPC 100398–9*; SAMA AHC 29294–5*; HCIP M-457*; SLZU 2007112101-1–2*.
Dipl: *Pseudorhabdosynochus cyathus* ex *Ep. howlandi*, MNHN JNC1195*, 1438*; BMNH 2005.7.20.2*; USNPC 96999*; SLZU 2005080804*.
Dipl: *Pseudorhabdosynochus duitoe* ex *Ep. maculatus*, MNHN JNC1061*, 1101*, 1131*, 1150*, 1170*, 1190*, 1522–4*, 1547*; BMNH 2006.4.4.7–8*; USNPC 97113–4*; HCIP M-445; ex *Ep. cyanopodus*, MNHN JNC1659, 1902.
Dipl: *Pseudorhabdosynochus epinepheli* ex *Ep. chlorostigma*, MNHN JNC2446; BMNH 2008.8-14.2–4; USNPC 101116; MPM 18877; SAMA AHC29538–9; HCIP M-470.
Dipl: *Pseudorhabdosynochus euitoe* ex *Ep. maculatus*, MNHN JNC1061*, 1101*, 1131*, 1150*, 1170*, 1190*, 1522–4*, 1547*; BMNH 2006.4.4.9*; USNPC 97715*; HCIP M-446.
Dipl: *Pseudorhabdosynochus exoticus* ex *Ep. cyanopodus*, MNHN JNC1546*, 1625–6*, 1660–1*; BMNH 2007.11.23.8–11*; USNPC 100404–5*; SAMA AHC 29299–300*; HCIP M-460*; SLZU 2007112104-1–4*.
Dipl: *Pseudorhabdosynochus fuitoe* ex *Ep. maculatus*, MNHN JNC1101*, 1131*, 1150*, 1170*, 1190*, 1522–4*, 1547*; BMNH 2006.4.4.10–12*; USNPC 97716–8*; HCIP M-447.
Dipl: *Pseudorhabdosynochus guitoe* ex *Ep. maculatus*, MNHN JNC1150*, 1170*, 1522–4*; BMNH 2006.4.4.13–14*; USNPC 97719–20*; HCIP M-448.
Dipl: *Pseudorhabdosynochus hirundineus* ex *Va. louti*, MNHN JNC994*, 1002*, 1026*; BMNH 2004.8.11.2*; USNPC 95079*.
Dipl: *Pseudorhabdosynochus huitoe* ex *Ep. maculatus*, MNHN JNC1061*, 1131*, 1150*, 1170*, 1190*, 1522–4*, 1547*; BMNH 2006.4.4.15–17*; USNPC 97723–4*; ex *Ep. cyanopodus*, MNHN JNC1530, 1901–2.
Dipl: *Pseudorhabdosynochus inversus* ex *Ep. rivulatus*, MNHN JNC2606*.
Dipl: *Pseudorhabdosynochus maaensis* ex *Ep. malabaricus*, MNHN JNC2130*.
Dipl: *Pseudorhabdosynochus malabaricus* ex *Ep. malabaricus*, MNHN JNC1536*; BMNH 2007.6.1.4*; USNPC 99869*.
Dipl: *Pseudorhabdosynochus manifestus* ex *Ep. malabaricus*, MNHN JNC1536*, 2130*; BMNH 2007.6.1.1–3*; USNPC 99867–8*; SAMA AHC 29213–4*; HCIP M-440*; SLZU 20070613-1-1–3*.
Dipl: *Pseudorhabdosynochus manipulus* ex *Ep. malabaricus*, MNHN JNC1536*.
Dipl: *Pseudorhabdosynochus marcellus* ex *Ep. malabaricus*, MNHN JNC1536*.
Dipl: *Pseudorhabdosynochus maternus* ex *Ep. malabaricus*, MNHN JNC1536*; BMNH 2007.6.1.5*; USNPC 99870*.
Dipl: *Pseudorhabdosynochus melanesiensis* ex *Ep. merra*, MNHN JNC986, 987, 1019, 1055, 1213, 1223, 1250; USNPC 095082.
Dipl: *Pseudorhabdosynochus minutus* ex *Ce. sonnerati*, MNHN JNC1614–5*, 1636*; BMNH 2007.3.1.2*; USNPC 99681*.
Dipl: *Pseudorhabdosynochus morrhua* ex *Ep. morrhua*, MNHN JNC2450*, 2453*, 2462; BMNH 2008.3.17.1*; USNPC 100953*; SAMA AHC 29477*; HCIP M-464*; MPM 18869*.
Dipl: *Pseudorhabdosynochus podocyanus* ex *Ep. cyanopodus*, MNHN JNC1546*, 1625–6*, 1660*; BMNH 2007.11.23.3–4*; USNPC 100400–1*; SAMA AHC 29296*; HCIP M-458*; SLZU 2007112102-1*.
Dipl: *Pseudorhabdosynochus variabilis* ex *Ep. morrhua*, MNHN JNC2450*, 2453*, JNC2462; BMNH 2008.3.17.2*; USNPC 100954*; SAMA AHC29478*; HCIP M-463*; MPM 18870*.
Dipl: *Pseudorhabdosynochus venus* ex *Ep. howlandi*, MNHN JNC1120*, 1451*, 1478*; BMNH 2005.7.20.1*; USNPC 97110*.
Dipl: *Pseudorhabdosynochus youngi* ex *Ep. fasciatus*, MNHN JNC985*, 1017*, 1017–8*, 1035–6*; QM G23161–2*; USNPC 95081*, 101565*; BMNH 2009.2.25.1*.
Dipl: *Pseudorhabdosynochus* cf. *coioidesis* ex *Ep. merra*, MNHN JNC 1440, 1492, 1494, 1499.
Dipl: *Pseudorhabdosynochus* cf. *shenzhenensis* ex *Ep. malabaricus*, MNHN JNC2130.

Digenea
Buce: *Prosorhynchus maternus* ex *Ep. malabaricus*, MNHN JNC1536D*; BMNH 2006.4.27.14–16*; HCIP D-596*.
Buce: *Prosorhynchus longisaccatus* ex *Ep. cyanopodus*, MNHN JNC1659; BMNH 2006.4.57.1–10.
Lepo: *Lepidapedoides angustus* ex *Ep. fasciatus*, MNHN JNC1666, 1667; BMNH 2006.8.23.6.
Opec: *Allopodocotyle epinepheli* ex *Ep. cyanopodus*, MNHN JNC1267; BMNH 2006.11.8.44–45; ex *Ep. fasciatus*, JNC1667; BMNH 2006.11.8.44–45; ex *Ep. merra*, MNHN JNC1434; BMNH 2006.11.8.4.
Opec: *Cainocreadium epinepheli* ex *Ep. coeruleopunctatus*, MNHN JNC1905; ex *Ep. fasciatus*, MNHN JNC1791, 1792; BMNH 2006.11.8.1–2; ex *Va. louti*, MNHN JNC1662; BMNH 2006.11.8.17–18.
Opec: *Helicometra epinepheli* ex *Ep. fasciatus*, MNHN JNC1023, 1636B, 1658A, 1664, 1787, BMNH 2006.11.8.19–29; ex *Ep. merra*, MNHN JNC1433, 1434, 1649, 1650, 1652, 1653, 1827; BMNH 2006.11.8.30–40.
Opec: *Pacificreadium serrani* ex *Pl. leopardus*, MNHN JNC1392E1–E11; BMNH 2006.11.8.3–10.

Cestoda Bothriocephalidea
Both: *Bothriocephalus celineae*, ex *Ce. aurantia* × *spiloparaea*, MNHN JNC1926*.

Cestoda Tetraphyllidea
none

Cestoda Trypanorhyncha
Laci: *Pseudogilquinia pillersi* ex *Ep. coioides*, MNHN JNC1535; ex *Ep. malabaricus*, JNC1536; ex *Pl. laevis*, JNC1865, 1887.
Laci: *Pseudolacistorhynchus heroniensis*, ex *Ep. fasciatus*, MNHN JNC1256, 1636, 1758, 1791, 1792; ex *Ep. polyphekadion*, JNC1915; ex *Ep. rivulatus*, JNC 1545.
Laci: *Floriceps minacanthus*, ex *Ep. cyanopodus*, MNHN JNC1998; ex *Pl. laevis*; ex *Va. louti*, JNC1859.
Pseu: *Pseudotobothrium dipsacum*, ex *Ce. sonnerati*, MNHN JNC1616; ex *Ep. coioides*, JNC1535; ex *Ep. fasciatus*, JNC1791; ex *Pl. laevis*, JNC1865, 1887; ex *Pl. leopardus*, JNC2126; ex *Va. louti*, JNC1629, 1662, 1756, 1757, 1859, 2116, 2117.
Unid: Larvae, ex *Ep. howlandi*, JNC1886

Nematoda
Cam: *Procamallanus variolae* ex *Va. albimarginata*, MNHN JNC1427*; HCIP N-864; ex *Ep. fasciatus*, JNC1253.
Phil: *Philometra cyanopodi*, ex *Ep. cyanopodus*, MHNH JNC546*, 1998–2000*; HCIP N-896*.
Phil: *Philometra fasciati*, ex *Ep. fasciatus*, MNHN JNC1251*, 1257–8*; HCIP N-898*.
Phil: *Philometra ocularis*, ex *Ep. coioides*, MNHN JNC1535; ex *Ep. areolatus*, JNC2017; ex *Ep. rivulatus*, JNC1368; ex *Va. louti*, JNC1406.

Fish
Ce. urodeta, MNHN 2004-2170; *Ep. coeruleopunctatus*, 2006-1706; *Ep. fasciatus*, 2004-2167; *Ep. howlandi*, 2004-2168–9, 2005-0778, 2005-1360–72, 2006-1333; *Ep. maculatus*, 2004-2166; *Ep. merra*, 2004-2171; *Va. albimarginata*, 2004-2163, 2005-0775, 2005-1014; *Va. louti*, 2004-2165, 2005-0774, 2005-1013.

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