

The MUSORSTOM-TDSB deep-sea benthos exploration programme (1976-2012): An overview of crustacean discoveries and new perspectives on deep-sea zoology and biogeography

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INTRODUCTION

In 1976, the French research vessel “Vauban” was scheduled to travel from France to New Caledonia. Through the efforts of Alain Crosnier (Director of the Oceanography, ORSTOM), it was decided that the craft take a detour through the Philippines —this became the first MUSORSTOM cruise. The principal objective of this cruise was to find new

specimens of the living fossil glypheid *Neoglyphea inopinata* described one year earlier by Jacques Forest and Michèle de Saint Laurent from a single specimen collected by the U.S. Fish Commission Steamer research vessel “Albatross” in the beginning of the 20th century (Forest 1981, 2006; Richer de Forges & Justine 2006; Bouchet *et al.* 2008). This first French deep-sea cruise in the Indo-West Pacific was a great success for two reasons. Firstly, nine fresh specimens of *Neoglyphea inopinata* were collected near Lubang island in a very small area (Figure 1A). The detailed description of this only extant species of glypheid contributed significantly to our knowledge on the evolution of decapod crustaceans (Schram & Ah Yong 2002). Secondly, the trawls in the Philippine archipelago also collected a very rich benthic fauna including many rare and new species, demonstrating that the exploration of the deep-sea fauna was far from complete.

In the last quarter of the 20th century, our knowledge of the deep-sea fauna was mainly based on the results of the so-called “Great Expeditions” of preceding decades. These expeditions, which took place in the era between the CHALLENGER in 1873 and the GALATHEA in 1952, sampled the oceans on a world-wide scale. They studied and mapped the geography and bathymetry of the sea, and brought up a totally new fauna, resulting in the re-writing of marine zoology (Thomson 1878; Bruun 1953). However, despite their many significant discoveries, these expeditions only sampled about 1000 deep-sea stations across the planet. Considering the size of Earth’s oceans, huge areas remained totally unexplored.

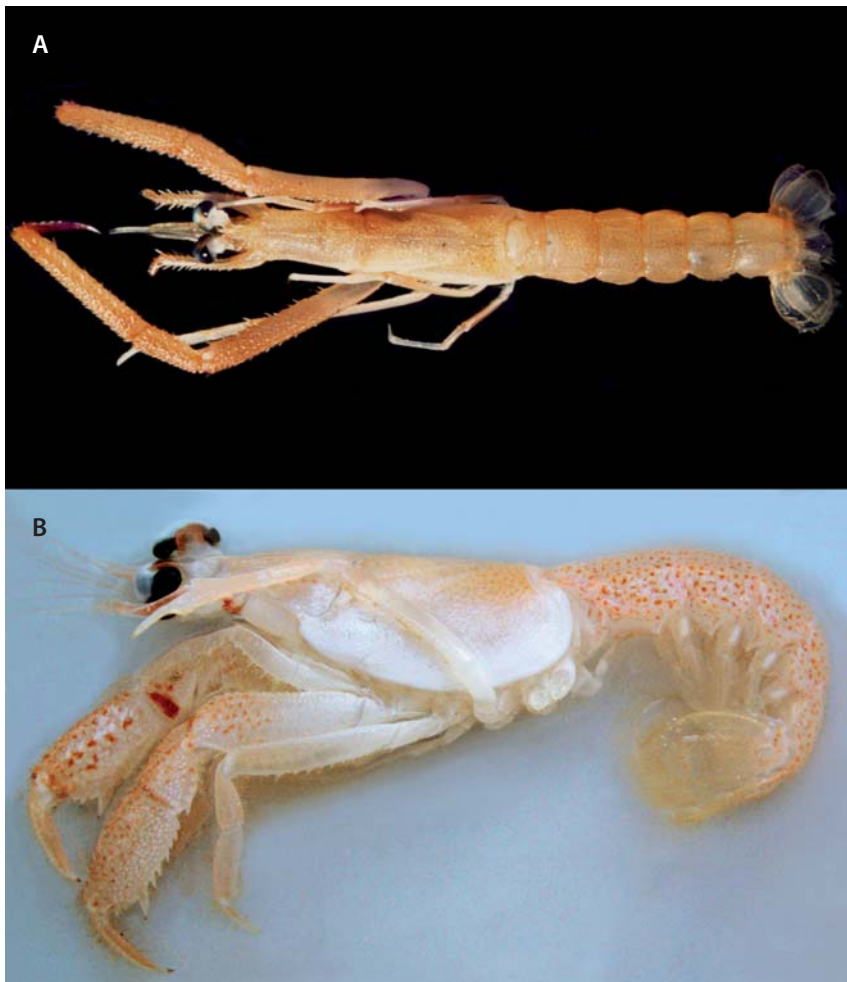


FIGURE 1

The species of extant glypheids were considered as “living fossils” supposedly extinct 50 million years ago. **A**, *Neoglyphea inopinata*, male, cl 120 mm, Philippines (photograph J. Forest). **B**, *Laurentaeglyphea neocaledonica*, female, cl 60.0 mm, Chesterfield Island (photograph J. Lai).

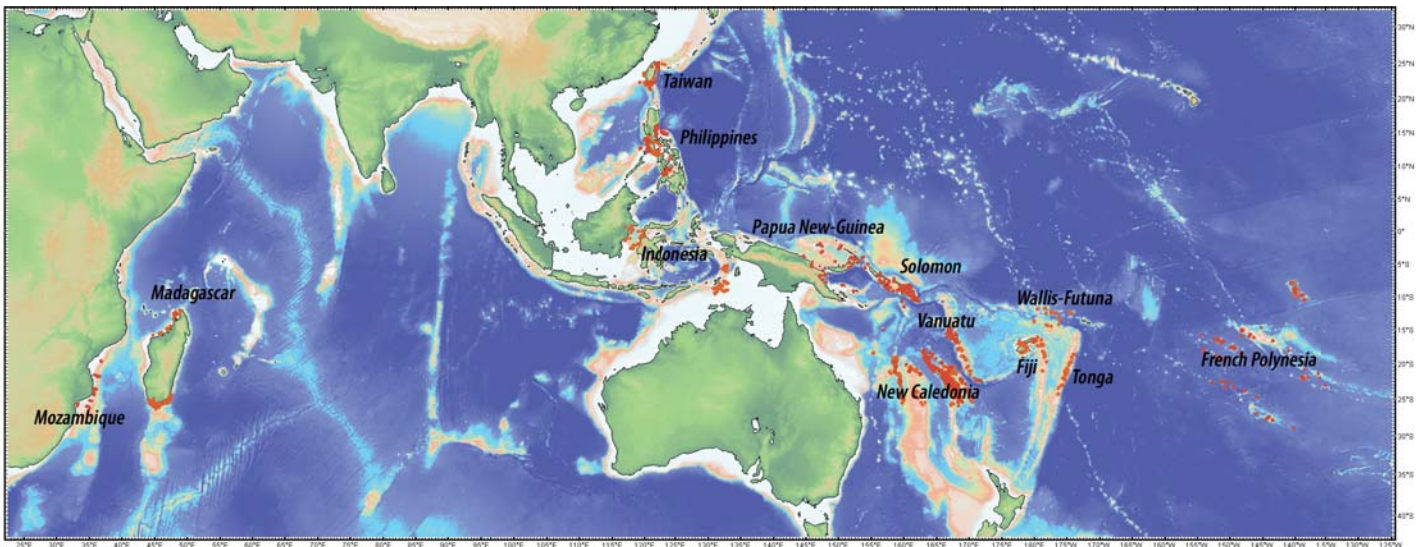


FIGURE 2

Updated map of the MUSORSTOM-TDSB cruises.

This first MUSORSTOM cruise in 1976 was to be the starting point of a long series of deep-sea cruises in the Indo-Pacific (Figure 2). Under the leadership of Alain Crosnier, a modern pioneer in deep-sea biodiversity research, these cruises rewrote the annals of deep-sea biodiversity. The saga of the MUSORSTOM cruises is also intricately linked to the late Jacques Forest and Michèle de Saint Laurent. Their discovery of, and search for, *Neoglyphea* was the catalyst that started the whole exploration process. To appreciate the significance of these cruises and explorations, one must remember that they took place 10 years before the invention of the word “biodiversity” and 30 years before the “CENSUS OF MARINE LIFE” (CoML) began. With the publication of the 27th volume of scientific results of the MUSORSTOM-TDSB cruises in 2013, after 37 years of exploration across the Indo-West Pacific, it is timely for a preliminary assessment of its impact. As noted above, the cruises first started in 1976. As these were guided and inspired by carcinologists like Crosnier, Forest and de Saint Laurent, it is not surprising that a “carcinological slant” continued over the years. Of all the animals collected by these cruises, the best studied and best reported on were the crustaceans. Some 33% of all papers resulting from these cruises were on these crustaceans (Figure 3). It is thus appropriate to summarize how our increased knowledge of crustaceans resulting from the MUSORSTOM-TDSB program contributed to knowledge of deep-sea biology.

CONTRIBUTIONS OF THE TDSB PROGRAMME TO ZOOLOGY

The programme of Tropical Deep-Sea Benthos (TDSB), formerly MUSORSTOM, is ongoing and very ambitious: to describe the deep-sea fauna of the tropical Indo-Pacific. The first three cruises in the Philippines (1976, 1980, 1985) mainly devoted to the catch of *Neoglyphea* showed that even the deep-sea fauna from the area sampled by the U.S. Fish Commission Steamer research vessel “Albatross”, was still poorly known. The question then was: what about the other archipelagoes never sampled because they stayed outside of the cruise track of the “Great Expeditions”? What started in 1976 with the research vessel “Vauban” was soon expanded to other parts of the western Pacific (Richer de Forges 1990). Between 1984 to 1994, 12 cruises totally devoted to the zoological exploration (after 1988 using the R.V. “Alis”), 7 cruises targeting chemical products in the deep-sea animals and 3 cruises focused on resources were realized in the New Caledonia EEZ (Exclusive Economic Zone). These cruises captured a huge amount of deep-sea material. From this

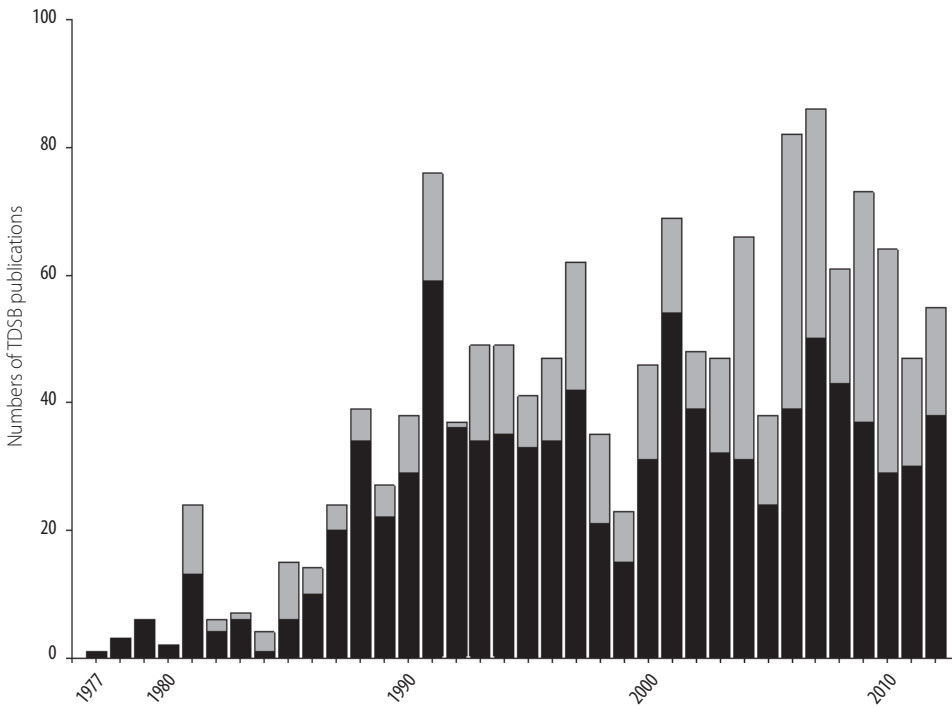


FIGURE 3
Publications from the MUSORSTOM-TDSB programme between 1977 and 2012: total number 1411 of which 468 (33 %) concern Crustacea (grey bars).

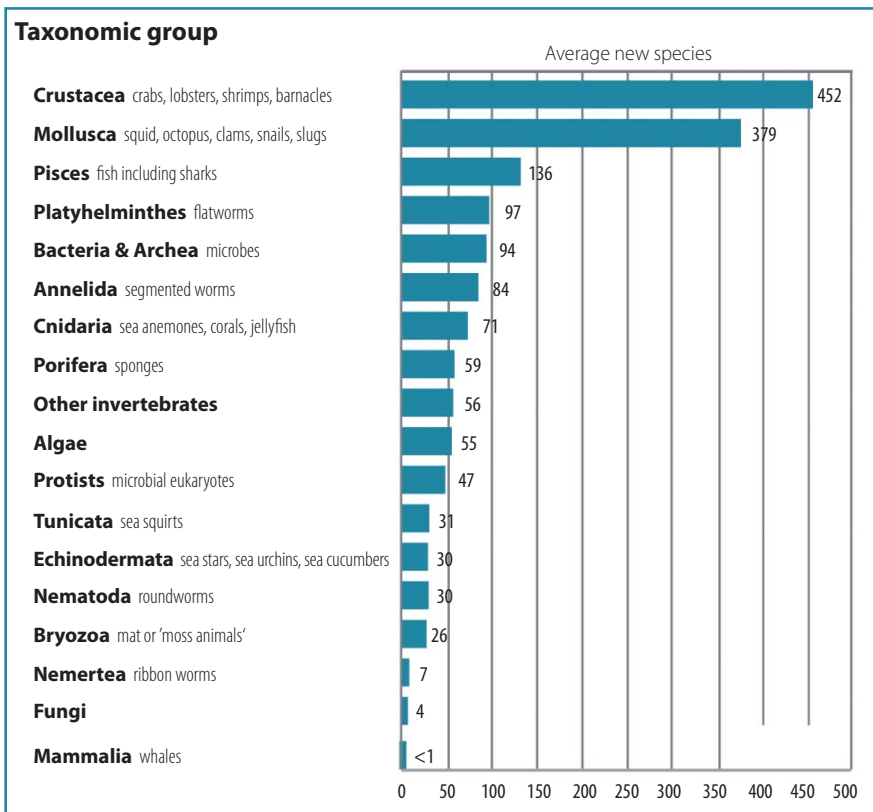


FIGURE 4
Histogram from CoML showing the species discovered during the 10 years of the program. Crustaceans dominate (after Ausubel *et al.* 2010: fig. 12).

material, deposited primarily in Muséum national d'Histoire naturelle, actively managed by Alain Crosnier for many years, and later by Philippe Bouchet, more than 1400 scientific articles were published, totally renewing knowledge of the Tropical Deep-Sea Benthos (Figure 3). For New Caledonia alone, of the 1619 species reported in 2000, 60.7 % were new to science (Richer de Forges *et al.* 2000, 2005). Since 1994 other areas have been extensively sampled: Wallis & Futuna, Fiji, Tonga, Marquesas, Australes, Vanuatu, Solomons, Indonesia, Papua New Guinea, Taiwan, Philippines, Mozambique and Madagascar. The collections have covered the Central Pacific, the Melanesian Arc in the Southern Hemisphere, part of the Southeast Asia in the Northern Hemisphere targeting the “Coral Triangle” and in the Indian Ocean. It has made possible broad geographical taxonomic and systematic revisions, and for the first time, resulted in well grounded hypothesis about the origin and evolution of the deep-sea fauna.

Among the deep-sea fauna, crustaceans are dominant across all depths, sometimes with high diversity. The TDSB programme overlapped and contributed significantly to the CoML initiative. Ausubel *et al.* (2010) observed that crustaceans dominated the number of new species found during the decade of the CoML, with 452 species named (Figure 4) — some 20% of all discovered species. Molluscs and fish came out as second and third in diversity. Much of this crustacean diversity was reported by the carcinologists working on the TDSB collections. Below, we provide a summary of some of the accomplishments of the TDSB programme.

DISCOVERY SUMMARY AND HIGHLIGHTS OF KEY CRUSTACEAN GROUPS

TRUE CRABS (BRACHYURA) — The brachyuran crabs are the most diverse of all decapods, with half the known taxa (Ng *et al.* 2008; De Grave *et al.* 2009) and over 7000 species. The MUSORSTOM-TDSB collections have been invaluable in the discovery of hundreds of species, not just in obtaining specimens of new species but also providing valuable comparative material to resolve the taxonomy of many others. The collections from the first few expeditions were first reported on by Serène & Vadon (1981) but the few new species described belies this paper's significance as it was just a preliminary study. A series of papers by Guinot and others demonstrated that the deep-sea brachyuran fauna was not just rich, but extremely rich (*e.g.*, see Guinot & Richer de Forges 1981a, b). This was not restricted to the Philippines but in waters off New Caledonia (see Richer de Forges & Ng 2006) and even Taiwan (*e.g.*, see Ho *et al.* 2004). The expedition material has been the basis of a large number of studies in the following families: Atelecyclidae (Guinot 1989b); Cancridae (Davie 1991), Calappidae and Leucosiidae (Chen 1989, 1990; Tan & Ng 1993, 1995; Galil 1997, 2003; Galil & Ng 2007, 2009, 2010; Ng & Richer de Forges 2007), Dorippidae (Chen 1986, 1993), Dromiidae (McLay 1993, 2001; McLay & Ng 2005, 2007), Ethusidae (Chen 1997, 2000; Ng & Ho 2003; Castro 2005; Naruse *et al.* 2009), Euryplacidae (Ng & Castro 2007; Castro & Ng 2010a), Goneplacidae (Guinot 1989a, 1990; Castro 2007, 2009, 2013; Castro & Ng 2010b), Latreilliidae (Castro *et al.* 2003), various families in the Majoidea (Guinot & Richer de Forges, 1982a, b, 1986; Tavares 1991a; Poupin 1995; Ahyong & Ng 2007; Richer de Forges & Ng 2007b, 2008a, 2009a, b, 2012, 2013; Richer de Forges 2010; Richer de Forges & Corbari 2012; Ng & Richer de Forges 2013), Mathildellidae (Crosnier & Ng 2004), Parthenopidae (Tan & Ng 2007a, b; McLay & Tan 2009), Pilumnidae (Chia & Ng 1995, 2000; Komai & Motoh 2012), Plagusiidae (Crosnier 2001), Pinnotheridae (Ahyong & Ng 2008), Portunidae (Moosa 1996; Crosnier 2002; Davie & Crosnier 2006; Nguyen & Ng 2010), Progeryonidae (Castro & Ng 2008), Trapeziidae (Castro *et al.* 2004), Trichopeltarionidae (Tavares & Cleva 2010), and Xanthidae (Davie 1993, 1997; Ng & Chia 1994; Ng & Naruse 2007b; Manuel-Santos & Ng 2007; Mendoza & Ng 2008a, b, 2010; Mendoza 2012; Mendoza & Manuel-Santos 2012).

Among the Brachyura, members of the family Homolidae are interesting, with some deep-sea taxa even displaying what seems like “a human face” on the dorsal shell (*e.g.*, *Lamoha personata*, Figure 5A). Almost all are deep-water genera, with only the genus *Latreillopsis* having some representatives in waters shallower than 100 m. It took five years just to gather the few specimens collected by the “Great Expeditions” before they could be compared with the MUSORSTOM-TDSB collections. Some new taxa from the study were written up (Guinot & Richer de Forges 1981c) but a world-wide revision of the family was eventually published in the MUSORSTOM series (Guinot & Richer de Forges 1995). Before 1995, the family contained 14 genera and some 40 species. Their 1995 revision added four new genera and 17 new species! This group shows a very special shape of



the 5th ambulatory legs, forming a forceps-like structure to carry other animals like sponge for camouflage. The morphological diversity of this supplementary structure was commented in relation with the behavior of these animals (Guinot & Richer de Forges 1995). The mysterious pigmented spot situated on the chelae of some species of *Lamoha* (formerly *Hypsophrys*, see Ng 1998a) and interpreted as a luminescent organ were also documented. Since this key revision, many more species were described from new cruises in the Philippines, Salomon and Vanuatu archipelago. The family now has 68 species (Ng 1998b; Ng & Chen 1999; Ng & Wang 2002; Richer de Forges & Ng 2007a, 2008b; Naruse & Richer de Forges 2010; Ng & Eldredge 2012).

Associated with the homolids were several essentially deep-water families that many carcinologists regard as “primitive crabs”. The Homolodromiidae was revised by Guinot (1993, 1995), and although no new genera were established, the affinities of this enigmatic family were substantially clarified. Even so, eight new species were described. In subsequent years, expeditions have obtained two more species from TDSB cruises (Ng & McLay 2005; Ng & Naruse 2007a). The small family Dynomenidae was revised by McLay (1999), and in the process, he named 13 species in five genera, two of which were newly described. Using new collections from the subsequent expeditions, seven more species have since been added by McLay & Ng (2004, 2005) and Ng & McLay (2010). Recently, in a major reappraisal of the systematics of the family, Guinot (2008) recognised three new subfamilies in the Dynomenidae. Perhaps one of the most exciting discoveries to French Polynesia was a new family, Poupiniidae, described by Guinot (1991). A revision of Cyclodorippidae and Cymonomidae from the Indo-West Pacific conducted by Tavares (1991b, 1992, 1993), which had previously only nine genera and 48 species, resulted in eight new genera and 21 new species described! In a follow-up study (Tavares 1998), several genera were removed into their own family, the Phyllotymolinidae Tavares, 1998. Since then, using these studies as the basis, seven other species have been described from the Indo-West Pacific as a result of new MUSORSTOM-TDSB collections (Ahyong & Ng 2009, 2011; Naruse 2013)!

From the crabs collected in the Philippines, a new superfamily was described by de Saint Laurent (1989): Retroplumoidea. Retroplumid crabs live in very muddy habitats of the deep-sea. They have a very flat carapace and with the fifth ambulatory legs greatly modified and sometimes feather-like. There are only two genera, *Retropluma* and *Bathylpluma*, in the Indo-West Pacific. Description on the newly collected MUSORSTOM-TDSB material allowed detailed comparisons with the crab fossils of this group. Based on morphological characters, de Saint Laurent (1989) proposed a phylogeny of this group of crabs as separated from the Eubranchyura since the upper Cretaceous. Using a larger collection of Retroplumidae, McLay (2006) was able to provide full descriptions on these animals and added more paleogeographical comments. There are now seven species of *Retropluma* and three species of *Bathylpluma*. Another poorly known group are the palicids. Studying the large Indo-Pacific collection, Castro (2000) completed a revision of the family Palicidae. There are now two subfamilies, 10 genera and 43 species, with four genera and 17 species newly described. More species were treated by Castro (2010) from additional collections. A strange crab, presumably associated with deep-water wood and debris, collected from recent expeditions to the Philippines, *Vultocinus anfractus*, proved to belong to a new family, Vultocinidae (Ng & Manuel-Santo 2007). Surprisingly, it was later also discovered in New Caledonia from among the older MUSORSTOM collections (Ng & Richer de Forges 2009).

SHRIMPS AND LOBSTERS — The MUSORSTOM-TDSB collection has contributed significant knowledge that has often led to a world-wide or Indo-West Pacific revision of many shrimp and lobster groups (Figures 1, 5E, 6). These include Solenoceridae (Crosnier 1978, 1985a, 1988a, 1989, 1994c; Crosnier & Dall 2004; Chan 2012), Sicyoniidae (Crosnier 2003), *Parapenaeus* (Crosnier 1985b, 2005), *Metapenaepsis* (Crosnier 1987, 1991, 1994a, b), *Trachypenaepsis* (Crosnier 2007), Stenopodidae (de Saint Laurent & Cleva 1981; Saito *et al.* 2009), Spongicolidae (de Saint Laurent & Cleva 1981; Komai & Saito 2006; Saito & Komai 2008), Stylodactylidae (Cleva 1990, 1997, 2004), Processidae (Noël 1985), Pasiphaeidae (Crosnier

FIGURE 5

Remarkable crustaceans collected by the MUSORSTOM-TDSB programme. **A**, *Lamoha personata*, New Caledonia (photograph B. Richer de Forges, carapace size about 40 x 50 mm). **B**, *Lithodes richeri*, Vanuatu (photograph B. Richer de Forges, carapace size about 70 x 100 mm). **C**, Giant ostracod *Azygocypridina brynmawria*, measuring 17 mm across, Coral Sea (photograph B. Richer de Forges). **D**, The living fossil barnacle *Waikalasma boucheti*, New Caledonia (photograph B. Richer de Forges, size about 20 mm). **E**, *Glyphocrangon panglao*, Philippines (photograph T.-Y. Chan, cl 15.0 mm). **F**, *Sympagurus brevipes*, Philippines (photograph T.-Y. Chan, size about 10 mm). **G**, *Babamunida callista*, New Caledonia (photograph B. Richer de Forges, cl 12.0 mm). **H**, *Eurysquilloides sibogae*, Philippines (photograph T.-Y. Chan, size about 50 mm).



FIGURE 6

Dinochelus ausubeli, male, cl 31.1 mm, Philippines (photograph T.-Y. Chan). An icon of the Census of Marine Life.

1988b; Hayashi 1999, 2004, 2006), Bathypalaemonellidae (Cleva 2001, 2004), deep-sea Pontoniinae (Bruce 1981, 1990, 1991, 1996; Li *et al.* 2008; Mitsuhashi & Chan 2006, 2009; Mitsuhashi *et al.* 2010, 2012), *Heterocarpus* (Crosnier 1988c, 1999b; Cleva & Crosnier 2006; Li 2006; Yang *et al.* 2010; Li & Chan 2013), *Plesionika* (Crosnier 1986; Chan & Crosnier 1991, 1997; Chan & Yu 1991c; Chan 2004; Komai & Chan 2010; Li & Chan 2013), *Eugonatonotus* (Chan & Yu 1991b), Nematocarcinidae (Burukovsky 2013), *Glyphocrangon* (Komai 2004, 2006b, 2007, 2011; Komai & Chan 2008, 2013), many Crangonidae genera (*Aegaeon*, *Pontocaris*, *Parapontocaris* (Chan 1996), *Parapontophilus* (Komai 2008), *Prionocrangon* (Kim & Chan 2005), *Lissosabinea* (Komai 2006a), *Metacrangon* (Komai 1997, 2012)), Glypheidae (Forest & de Saint Laurent 1981, 1989; Richer de Forges 2006; Forest 2006a, b; Boisselier-Dubayle *et al.* 2010), *Enoplometopus* (de Saint Laurent 1988; Chan & Yu 1998; Chan & Ng 2008), *Nephropsis* (Macpherson 1990b; Chan 1997), *Metanephrops* (Macpherson 1990b; Chan & Yu 1991a; Chan 1997), Thaumastochelidae (Chan & de Saint Laurent 1999; Ah Yong *et al.* 2010), *Justitia* (Poupin 1994), *Palinustus* (Chan & Yu 1995), *Puerulus* (Chan *et al.* 2013), Scyllarinae (Holthuis 2002; Yang *et al.* 2008, 2011; Yang & Chan 2010, 2012) and Polychelidae (Galil 2000; Ah Yong & Galil 2006; Ah Yong & Chan 2008). Altogether, 29 genera and 263 species were described from these works, and many of these reports have become the essential taxonomic references for deep-sea shrimps and lobsters. The high diversity for several classical deep-sea caridean groups such as Pasiphaeidae, *Glyphocrangon* and *Plesionika* has certainly exceeded all expectations.

Of the numerous crustacean species collected during the MUSORSTOM-TDSB programme, the most famous are certainly the glypheids. The discovery of extant species by Forest of this group, previously known only as fossils and supposedly extinct at the end of the Cenozoic era, was a major event in the taxonomy of crustaceans. The glypheids, well known from the Mesozoic, was considered to be extinct in the Eocene, 50 million years ago. They were originally placed under the infraorder Palinura and considered as probable ancestors of part of the remaining Decapoda Reptantia. However, detailed studies on the first extant species *N. inopinata* showed that the glypheids are closer to the Astacidae (Forest 2006). In 2005, the cruise EBISCO discovered a second species of glypheid (Figure 1B) living in a very different habitat in the Coral Sea (Richer de Forges 2006). This new species was so different from *Neoglyphea inopinata* that Forest decided to establish a new genus *Laurentaeglyphea* for it. This lobster-like animal, *Laurentaeglyphea neocaledonica* soon became famous under the nickname “Jurassic shrimp” (the first species discovered was called the “Phoenix lobster”, Trew Crist *et al.* 2009). The second species, *L. neocaledonica*, is even closer to those glypheids known from the Mesozoic and Eocene (Forest 2006).

Another bizarre lobster *Dinochelus ausubeli* (Figure 6), recently collected from the Philippines AURORA expedition (Ahyong *et al.* 2010) shows all the ‘monster-like’ features associated with deep-sea animals. This species was chosen as an icon of CoML and has been used by popular media to promote deep-sea biodiversity and conservation (*e.g.*, Trew Crist *et al.* 2009; Snelgrove 2010).

ANOMURANS — Perhaps no other group of decapods has been as substantially impacted by the MUSORSTOM-TDSB expeditions than the Paguroidea (*sensu* McLaughlin *et al.* 2007). Prior to 1976 when collecting efforts began on cruises of the VAUBAN, the extent of deep-water paguroid specimens from the Indo-West and Central Pacific available in museums, was minimal and insufficient for scientists to decipher the morphological boundaries and distributions of many species. Taxonomic research was confined mostly to studying type material, with only scant additional preserved or fresh specimens accessible. The first major work on paguroids that was produced with MUSORSTOM-TDSB material was that by Forest (1987), who expanded exponentially our knowledge of the intriguing and mysterious “symmetrical” hermit crabs of the family Pylochelidae, a presumably ancient group considered key to understanding hermit crab evolution (Tsang *et al.* 2011). Before Forest’s work, only 19 species were known, based on 60 specimens obtained at 30 stations from around the world. He added 24 new species and subspecies using 400 specimens from about 200 sites, primarily from MUSORSTOM-TDSB cruises, and complemented by specimens from earlier deep-sea expeditions on the ALBATROSS. Subsequent MUSORSTOM-TDSB and other French cruises obtained considerably more material which was used to further increase our knowledge of the diversity of pylochelids, resulting in revisions of their classification and phylogeny (McLaughlin & Lemaitre 2008; Lemaitre *et al.* 2009; McLaughlin *et al.* 2009).

Among the hermit crabs of the family Diogenidae, the genus *Trizopagurus* benefitted greatly from a major revision by Forest (1995) of their taxonomy and morphology, largely based on specimens obtained during MUSORSTOM-TDSB. This genus contained only 10 species before the study by Forest, who expanded it to contain (in addition to *Trizopagurus*) two new genera (*Ciliopagurus* Forest, 1995, *Strigopagurus* Forest, 1995) and 24 species, 14 of them new. Particularly fascinating are the stridulatory structures in these three genera, the morphology of which Forest (1995) described for the first time in great detail. He also discussed their anatomy in an evolutionary context. From the extraordinary collections in Polynesia, another new *Ciliopagurus* was described by Poupin (2001), as well as new species and colour data of *Calcinus* species (Poupin & McLaughlin 1998; Poupin & Lemaitre 2003). The taxonomy, diversity and morphology of what is probably the most speciose and complex diogenid (indeed paguroid) genus, *Paguristes*, and other taxonomically difficult diogenid genera, were significantly improved with a number of important taxonomic and morphological studies by Rahayu (2005, 2006, 2007, 2008, 2010) and Rahayu & Forest (2009). Even a new species of burrowing barnacle of the genus *Tomlinsonia* that is a parasite on three species of *Calcinus* was documented by Williams & Boyko (2006).

A seminal paper on the Paguridae from Indonesian waters was published by McLaughlin (1997). That paper was based on specimens obtained during the KARUBAR expedition, and revealed an unexpected wealth of hermit crabs of this family in the Indo-West Pacific. Seven new genera and 26 new species were discovered. Previous to McLaughlin’s paper, most hermit crabs inhabiting the tropical environs of the Indo-West Pacific were thought to be species of Diogenidae. In fact, McLaughlin’s paper showed that the Paguridae are as rich or even richer in this region of the world oceans than the Diogenidae, and opened the door to a complete re-evaluation of the Paguroidea in general from the Indian and Pacific Oceans or indeed the world over. Whereas brachyurans are certainly the most diverse in number of species among the Decapoda, the anomurans, and in particular the Paguroidea, are the most diverse in body shape and morphology. Additional discoveries based on MUSORSTOM-TDSB include: a new species of *Xylopagurus* A. Milne-Edwards, 1880, a genus previously known only from the western Atlantic and eastern Pacific (Forest 1997); several more new genera and new species (Lemaitre & McLaughlin 1995; McLaughlin & Forest 1997); new species of *Porcellanopagurus* and *Solitariopagurus*, two genera that include remarkably carcinized forms (McLaughlin 2000); a remarkable new genus and species with reduced corneas (Lemaitre 2003); two astounding and minute new species of a new genus, *Pteropagurus* McLaughlin & Rahayu, 2006, found living in empty planktonic pteropod shells accumulated on the seafloor in a very unusual hermit crab-mollusc association; new species or records, and taxonomic clarifications of species of *Cestopagurus*,

Pagurixus, *Pseudopagurus* (Rahayu & Komai 2013) and *Pagurus* (Komai & Chan 2006; Komai 2010; Komai & Poupin 2012); and a new monotypic genus with a dwarf new species, *Pumilopagurus tuberculomanus* McLaughlin & Rahayu, 2008b. In addition, a major taxonomic and morphological review of *Nematopagurus*, a genus with 26 species distributed primarily in the Indo-West Pacific, was published by McLaughlin (2004b).

Within the paguroids, no other family has been impacted as much by the rich collections from the MUSORSTOM-TDSB projects, than the deep-water hermit crabs of the family Parapaguridae. In the last 40 years, primarily because of the wealth of deep-water material collected by French expeditions, the number of species has increased from 31 to 86, and the number of genera from 4 to 10, an increase of 277% and 250%, respectively (Figure 5F). Numerous parapagurid specimens were collected from many deep-water habitats and regions that had never been sampled before. Before 1986, when French expeditions using the S.M.C.B. "Marara" began to collect in French Polynesia including the Marquesas, there were no specimens or records of parapagurids from that immense region of the central South Pacific. Works on those collections resulted in the description of several remarkable new species, and more importantly a better picture of the anomurans from that region emerged. The Polynesian parapagurids as well as other paguroids and decapods, were summarized in a number of catalogues or atlases, including fisheries data and many color photographs (Poupin *et al.* 1990; Poupin, 1996a, b). Furthermore, a database of the species of decapods (shrimps, lobsters, crabs, hermit crabs) and stomatopods (mantis shrimps), recorded from the French Polynesian Islands (Marquesas, Society, Tuamotu, Austral, and Gambier), Pitcairn, Easter Island and Clipperton, is available through a free database in the internet (<http://decapoda.free.fr/>). The numerous studies on the taxonomy and systematics of parapagurids based on specimens from all these French-sponsored faunistic studies, greatly expanded and clarified the world-wide picture of diversity and biogeography of the parapagurids, an evolutionary key group of hermit crabs. Taxonomic and systematic information of this family can be found in a number of convenient, broad generic reviews or revisions (Lemaitre 1999, 2004a, b, 2013), as well as in a number of papers reporting on parapagurids from particular regions and describing new species, or discussing morphological and biological aspects (Lemaitre 1993, 1994, 1997, 1998, 2004a, b, 2006; Lemaitre & Poupin 2003).

The specialized burrowing crabs of the superfamily Hippoidea from the tropical Indo-West Pacific region had been the subject of few systematic studies until many specimens of this poorly known group of crabs became available from collections obtained by MUSORSTOM-TDSB. As result, three landmark and detailed studies on the systematics of the families Albuneidae and Hippidae, including descriptions of several new species, have been published (Boyko & Harvey 1999; Boyko 2000, 2002). In those papers, the diagnostic morphology of the group was radically redefined and deciphered to the benefit of future studies on their biology and evolution.

Squat lobsters are a major component of the deep-sea crustacean fauna (Baba *et al.* 2008). They are divided into two main groups. The Galatheoidea (with four families Galatheididae, Munididae, Munidopsidae and Porcellanidae) has a large number of free-living species living on the ocean bottom, and generally have numerous eggs with planktonic larvae. The Chirostyloidea (with three families Chirostylidae, Eumunididae and Kiwaidae) are often associated with other benthic invertebrates like sponges, antipatharians or gorgonians, and produce few eggs with advanced larvae and limited dispersion. The abundant galatheid material obtained in the MUSORSTOM-TDSB collection has resulted in intensive taxonomic studies on these animals that have revolutionised our understanding of their diversity. After the TDSB studies initiated in 1976, these families have been enriched by 13 new genera (Baba 1991, 2004; Baba & de Saint Laurent 1996; Macpherson 1998, 2006; Macpherson & Machordom 2000; Cabezas *et al.* 2008). The total number of known species has increased nearly 2.5 fold since 1976, with 937 taxa today (Baba *et al.* 2008; Appeltans *et al.* 2012). Most of the newly described species have been based on the MUSORSTOM-TDSB material. Some of them living in the upper part of the bathyal zone (200-600 m) can be surprisingly colourful, although some live colours and patterns have to be seen to be believed (Figure 5G).

The first contribution towards galatheid systematics using these collections was published by Baba (1990) on specimens collected by Alain Crosnier on board of the R.V. "Vauban", in Madagascar. Subsequently, Baba (1991a, b), using material from some expeditions carried out around New Caledonia, described new genera and species of chirostylids and galatheids of the genera *Alainius*, *Leiogalatea*, *Phylladiorhynchus*, *Gastroptychus* and *Chirostylus*. These papers,

together with the review of the genus *Eumunida* (de Saint Laurent & Macpherson 1990a) along the Indian and Pacific Oceans, were the starting point of the many subsequent studies of the group. The genus *Eumunida* was revised again by de Saint Laurent & Poupin (1996), adding numerous specimens from the MUSORSTOM expeditions, and describing six new species from the Indian and Pacific Oceans. Baba & de Saint Laurent (1996) described some new genera of small galatheids (*Anoplionida*, *Neonida*, *Plesionida*, among others), closely related to the genus *Bathymunida*. Furthermore, they divide the galatheids in two large groups (*i.e.* having one or two pairs of male gonopods) and reorganizing the taxonomy of the family. The phylogenetic value of this division was later validated by molecular tools (Machordom & Macpherson 2004).

Baba (2004) erected the genus *Uroptychodes* from *Uroptychus*, using material collected in New Caledonia, Indonesia and adjacent waters. An additional study on the genus *Uroptychus* from Taiwan was published by Baba & Lin (2008), Cabezas *et al.* (2012), and a large and complete revision of the genus including more than 100 species will be published soon (Baba in preparation). This major taxonomic revision of the Chirostylidae (Baba in preparation) will also form the basis for new hypotheses on seamount endemism.

Macpherson (1993a, b) and Macpherson & Baba (1993) studied the material collected in the early MUSORSTOM-TDSB cruises carried out in the Philippines and Indonesia, adding numerous new species belonging to the genera *Agononida*, *Munida* and *Paramunida*. In addition, they solved the confusing status of *Munida japonica* and their relatives. In 1994, a study on the collections obtained mostly in New Caledonia, Chesterfield, Matthew and Hunter Islands, demonstrated the existence of 56 new species of *Agononida* and *Munida* (Macpherson 1994). The existence of a very rich fauna in the western Pacific was also supported by the results obtained in MUSORSTOM-TDSB expeditions from Wallis and Futuna (Macpherson 1996), Kei Islands (Indonesia) (Macpherson 1997), Vanuatu (Macpherson 1999a), Marquesas Islands (Macpherson 2000), Fiji and Tonga (Macpherson 2004), Austral Islands (Macpherson 2006a), Solomon Islands (Cabezas *et al.* 2009) and Taiwan (Lin *et al.* 2004, 2005; Cabezas *et al.* 2011b). Other studies using specimens from recent expeditions are completing our knowledge of the group along the continental shelf and slope of the western and central Pacific, and eastern Indian Ocean (Macpherson 1999b, 2006b, 2009; Macpherson & Baba 2006).

The deep-sea fauna, mostly belonging to the genera *Munidopsis* and *Galacantha*, was also studied using numerous specimens collected in all MUSORSTOM-TDSB cruises, from Madagascar to French Polynesia (Baba & de Saint Laurent 1992, Macpherson 2007, 2012), adding more than 25 new species. Furthermore, numerous new species have been collected in recent expeditions along the coasts of Taiwan and the Philippines (Lin *et al.* 2007, 2011; Osawa *et al.* 2006a, b, 2007, 2008, 2013).

The shallow-water genera (*e.g.*, *Allogalatea*, *Galathea*, *Lauriea*, *Sadayoshia*) have also been enriched by the MUSORSTOM-TDSB expeditions confirming the existence of a highly diverse fauna with similar patterns than in the continental shelf, slope and abyssal basins (Macpherson & Baba 2010; Macpherson & Cleva 2010; Cabezas *et al.* 2011), and a major revision of the diverse genus *Galathea* is in preparation (Macpherson in preparation).

The results obtained from MUSORSTOM-TDSB programme have demonstrated that squat lobsters are abundant, speciose and widely distributed. They occur in all marine habitats at depths ranging from the surface of the sea to more than 5000 m (Baba *et al.* 2008). Squat lobsters are most diverse in the western Pacific area and, at present, the most speciose genera are *Munida* and *Munidopsis*. The highest numbers of squat lobsters are found in the Coral Sea (Solomon-Vanuatu-New Caledonia), and Indo-Malay-Philippines Archipelago (Macpherson *et al.* 2010; Osawa *et al.* 2013). Most species of *Munida* are from shelf and slope depths, whereas those of *Munidopsis* and *Galacantha* are found mainly on continental slopes and the continental rise zones. The distribution of endemism along the Pacific Ocean indicates that there are several major centers of diversity, for example in the Coral Sea, Indo-Malay-Philippines Archipelago and French Polynesia.

The squat lobsters are becoming one of the best-known groups of deep-sea crustaceans. As a summary of the work that started in 1976, the different authors have produced many important papers that have formed the basis for other major, synthetic works. For instance, studies on the fauna of some basins, *e.g.*, Taiwan (Baba *et al.* 2009), the checklist of squat lobsters of the world (Baba *et al.* 2008), and a book on the biology of squat lobsters (Poore *et al.* 2011).

The king crabs (family Lithodidae) are also well represented in MUSORSTOM-TDSB collections (Figure 5B). The first contribution using specimens collected by Alain Crosnier in Madagascar was published by Macpherson (1988). Other studies covering the area of New Caledonia and French Polynesia were published by Macpherson (1990) and (1991), respectively. The hydrothermal vents also provide some interesting new species (de Saint Laurent & Macpherson 1997), and the most recent MUSORSTOM-TDSB expeditions collected additional material, including interesting new occurrences and species from New Caledonia, Vanuatu, Solomon, Fiji and Tonga areas (Macpherson 2001, 2003). More recently, some interesting species have been described in expeditions carried out in Taiwan (Macpherson & Chan 2008; Ah Yong & Chan 2010).

OTHER REMARKABLE CRUSTACEANS — Not all the work done on crustaceans during the MUSORSTOM-TDSB exercise was on decapods. From the crustaceans collected in the deep-sea some were remarkable by their giant size such as the isopods *Bathynomus* and ostracod *Azygocypridina*. Other than “living fossils” like the glypheids *Neoglyphea inopinata* and *Laurentaeglyphea neocaledonica*, the ancient cirriped *Waikalasma boucheti* also merits mention. These have since been used as “icons” for deep-sea biodiversity research.

Bathynomus is an isopod genus containing the largest known isopod species, its members living between 100 and 1000 m deep. Based mainly on the MUSORSTOM-TDSB collection, Lowry & Dempsey (2006) published a revision of this group of giant scavengers from the Indo-West Pacific. Six species are redescribed and six new species were added. The authors separated the genus into two groups, the giants and the super-giants having an adult size between 150 and 500 mm long (Figure 7).



FIGURE 7

A supergiant of the isopod genus *Bathynomus* — *B. kensleyi*, Philippines (photograph P. K. L. Ng). A saga of the MUSORSTOM-TDSB deep-sea expeditions.

Another giant described from the MUSORSTOM-TDSB material was the ostracod *Myodocopa* in the family Cyprinidae, *Azygocypridina brynmawria*. It was collected in the Coral Sea at about 400 m deep (Diamond, Richer de Forges & Kornicker 2008). The majority of ostracods have adult sizes of only a few millimetres, but this species has a diameter of 17 mm (Figure 5C). *Azygocypridina* ostracods possess iridescence on the first antennae. The description of this phenomenon by Andrew Parker on a species of the same genus was the starting point of the fascinating speculations on the color vision in fossil crustaceans and its role in the so called “Cambrian Explosion” of life (Parker 1998, 2003; Nielsen & Parker 2010).

Cirripeds of the genus *Waikalasma* was known only from fossils in the Miocene of New Zealand. However, during the cruise MUSORSTOM 8 in Vanuatu a living species was collected: *Waikalasma boucheti*. In 2011, the cruise EXBODI discovered another specimen of this species from New Caledonia. This genus is characterised by an extra layer of plates around the body (Figure 5D).

Although a much smaller group than the decapods, the mantis shrimps (Order Stomatopoda) are generally best known from shallow waters. Knowledge of their deep-water diversity, however, has been significantly increased through MUSORSTOM-TDSB sampling programmes, with discovery of many new species, genera and even a new family, Alainosquillidae, from New Caledonia (Moosa 1991). Further discoveries are ongoing with many more new species under study. Many uncommon species were often collected by the MUSORSTOM-TDSB cruises, such as *Bathysquilla microps*, *B. crassispinosa* and *Gonodactyloideus cracens*, and others that were until that time thought particularly rare, such as the enigmatic, *Eurysquilloides sibogae* (Figure 5H), which is now known to be common in the Philippines. Studies dealing with Stomatopoda include major studies from the Philippines (Moosa 1986; Ah Yong 2010, 2013), New Caledonia (Moosa 1991; Ah Yong 2007), Indonesia and the Marquesas (Ah Yong 2002a, b).

OTHER CONTRIBUTIONS OF THE MUSORSTOM-TDSB PROGRAMME

BIOGEOGRAPHY

The science of biogeography synthesises knowledge from taxonomy, phylogeny and genetics, and helps us understand how the marine environment has evolved, the impacts of sea level variations and plate tectonics on biodiversity. All these different aspects of science contribute to reconstructing the spatio-temporal scenario explaining the origin and current distribution of species (Heads 2005, 2008; Hoeksema 2007). The sparseness of deep-sea samplings often impairs a meaningful interpretation of the deep-sea biogeography. Hypotheses of deep-sea biogeography, inferred primarily from shallow-water patterns are far from accurate. One exception is among the squat lobsters (Galatheoidea and Chirostyloidea) because they have been extensively sampled by the MUSORSTOM-TDSB programme from a wide range of depths (littoral to 1500 m deep), having a large number of species supported by solid taxonomy.

Using the taxonomic results of squat lobsters coming largely from the MUSORSTOM-TDSB collections, two papers were published in 2010 marking the end of the first phase of the Census of Marine Life operations (Macpherson *et al.* 2010; Rowden *et al.* 2010). The first paper was trying to define through statistical analysis the characteristics of each biogeographical province in the Pacific Ocean. The data set composed of 54 deep-sea cruises and 3200 stations with 402 species. The multivariate analyses clearly showed a gradient of decreasing specific richness from Western to Central Pacific. This fundamental concept, well known for the littoral marine fauna, was demonstrated for the first time in the bathyal zone. The richest areas are the Coral triangle (Indo-Malayan-Philippines) and the Coral Sea.

The second work focused on the seamounts of the southwest Pacific and was trying to determine if the faunistic composition is different between seamounts and the slopes at comparable depths. They used a data set from a total of 502 species (Rowden *et al.* 2010) and concluded that the different assemblages of squat lobsters between seamounts and non-seamounts are mainly a consequence of hydrological conditions and especially the availability of food.

Both studies have clearly demonstrated that good taxonomic work at species level is a prerequisite for any meaningful analysis on ecology or biogeography.

SPECIAL ECOSYSTEMS

During the MUSORSTOM-TDSB explorations two unusual habitats were discovered, representing rich oasis in the deep-sea desert: the summit of seamounts and sunken woods. Both have a special assemblage of life with remarkable crustaceans.

SUNKEN WOOD FAUNA — The presence of animals on plant remains at the deep-sea floor was first documented by the CHALLENGER expedition (1872-1876). The GALATHEA expedition (1950-1952) also recorded the abundant presence of plant remains on the deep-sea floor (Bruun 1959). The importance of plant material in the deep sea was first emphasized by Wolf (1979). Associated with these remains is a unique fauna, which has mainly been examined by the taxonomists. The ecological aspects are less well studied until recently. Apart from sporadic taxonomic considerations, plant-associated organisms were seen as zoological and/or ecological curiosities and thus only anecdotally studied. Sunken wood and plant material has long been considered a mere curiosity, but this habitat was recently emphasized as deep-sea environment of major evolutionary importance. Many of the species living on sunken wood are phylogenetically related to those living on hydrothermal vents, cold seeps and other organic substrates (*e.g.*, whale falls).

Distel *et al.* (2000) underlined the evolutionary affinities of the giant hydrothermal vent mussels with those found on sunken wood or whale bones (so-called whale falls). This result was then confirmed by several studies (Samadi *et al.* 2007; Lorion *et al.* 2009; Fujita *et al.* 2009; Kyuno *et al.* 2009). The zoological affinities of organisms associated with sunken woods and whale falls with those from hydrothermal vent or cold seep ecosystems suggests that these ecosystems, developing on organic substrata in the deep-sea, could be an evolutionary step toward the colonization of hydrothermal vents (the so-called “wooden steps” hypothesis of Distel *et al.* (2000)). However, few data are available for sunken wood organisms. Recent results suggest that the evolutionary history of deep-sea mussels associated with organic falls is completely mixed up with that of vent and seep mussels, with evolutionary scenarios probably more complex than the “wooden steps” hypothesis (Lorion *et al.* 2010; Thubaut 2012). Moreover, geography, rather than habitat specificity or chemosymbiotic requirements, seems to significantly structure diversification patterns in sunken wood-associated mytilids (Lorion *et al.* 2009, 2010).

In 2004, the TDSB programme started specific series of cruises particularly devoted to the exploration of sunken-wood environments (Biodiversité des Organismes Associés aux bois coulés — BOA). Since the first MUSORSTOM cruises in the Philippines (see Forest 1981) and Indonesia (see Moosa 1984), it became clear that the slopes of oceanic islands within these regions accumulate large amounts of decomposing vegetation. Subsequent cruises in the Solomon Islands, Vanuatu Archipelago, and Papua New Guinea specifically targeted sunken vegetation to further characterize its fauna. Several cruises provided specimens associated with sunken wood in the depth range between 100-1500 m from different locations corresponding to the most important bathyal area where sunken woods accumulate in the Indo-Pacific region: (i) Philippines (PANGLAO, 2005; AURORA, 2007; LUMIWAN, 2008), (ii) Solomon Islands (SALOMON 2, 2004; SALOMONBOA 3, 2007), (iii) Vanuatu Archipelago (BOA 0, 2004; BOA 1, 2005 and SANTOBOA, 2006) and Papua New Guinea (BIOPAPUA, 2010). Additional samples from other cruises, far from these basins, also provided specimens associated with organic remains. Indeed, for example, on seamounts, small pieces of wood and seeds (*e.g.*, coconuts) are variously pulled up by the trawls or the dredges and these erratic substrates, are usually also colonized by the organisms typically found on pieces of wood in accumulation areas.

This sampling is, however, focussed on substrates that are easy to locate on the deep-sea floor (such as large pieces of wood off the mouth of the rivers). Therefore, to more accurately catch the diversity of the organisms associated with a larger diversity of organic substrates that can be found on the deep-sea floor, pots covered by netting with mesh of 3 mm were deployed (Samadi *et al.* 2010). The “bait” placed in the pots were seeds and pieces of wood of various tree species, sugar cane stems, whale bones, green turtle shell, stag horn, feathers, cephalopod beaks and cuttlefish-bones. These lines of pots were deployed in 2003 off the barrier of New Caledonia and off Santo island in Vanuatu and left for periods ranging from 10 to 30 months.

These studies demonstrated that such organic substrates were associated with a rich and unique fauna (Samadi *et al.* 2007) and its confirmation catalyzed new research interests for the TDSB team (reviewed in Samadi *et al.* 2010). With the large scale sampling conducted by TDSB cruises, new recent taxonomic and phylogenetic studies have been

launched, mainly focused on different key-groups like molluscs such as Mytilidae (Lorion *et al.* 2010, 2011; Thubaut 2012) and polyplacophoran chitons (Duperron *et al.* 2012). Several studies have also been done on the feeding behaviour of echinoderms (Becker *et al.* 2009) and molluscs (Zbinden *et al.* 2010), botanical identification of the plant-remains (Pailleret *et al.* 2007), prokaryotic diversity (Palacios *et al.* 2009), fungal diversity (Dupont *et al.* 2009) and the association of mytilids with chemosynthetic bacteria (reviewed in Duperron *et al.* 2009).

For crustaceans, isopods, amphipods and decapods as well as barnacles have been found among plants debris in the trawls or dredges. It is, however, difficult to know to what extent they depend on the decaying plant substrates, in particular for the vagrant fauna. Among the decapods, the main groups repeatedly caught with such substrata include squat lobsters (*e.g.*, *Munidopsis andamanica*, *M. nitida*, *M. bispinosculata*, *M. similior*), two different families of symmetrical hermit crabs (all the species of the genus *Xylopagurus* and several species of *Pylocheles* inhabit centimetre-sized pieces of wood), ghost shrimp (*e.g.*, *Rayllianassa amboinensis*), some Axiidae and a number of snapping shrimps (Alpheidae) (Figure 8A-E).



FIGURE 8

A-D, Wood-associated crustaceans. **A**, *Galacantha* sp. (photograph B. Richer de Forges). **B**, *Parapylocheles scorpio* (photograph T.-Y. Chan). **C**, *Bathyceradocus* sp. **D**, *Onesimoides* sp. **E-H**, *Bathyceradocus* sp. **E**, General view, total length 18 mm. **F**, SEM picture (magnification x 40) of the mouthparts illustrating the dense bacterial colonisation. **G, H**, SEM pictures (respectively x 800 and x 6000) of the diversity of bacterial morphotypes (rod-shaped and filamentous bacteria) fixed on the mouthpart setae (photographs C-H, L. Corbari).

With regard to peracarid crustaceans, the most recurrent specimens collected in association with wood were: Isopoda (Sphaeromatidae, *Cassidias*; Limnoriidae, *Limnoria* sp.; Gnathiidae, *Elaphognathia* sp.), Amphipoda (Lysianassidae, *Onesimoides* sp.; Maeridae, *Bathyceradocus* sp.). The same organisms were also collected in the pots that were submerged off New Caledonia or Vanuatu.

The main challenge is now to understand the interactions between crustaceans and organic substrates (e.g., habitat, feeding relationship or even dependence in relation to reduced compounds produced by the wood-degradation via microorganisms such as fungi). Preliminary studies on the diet of wood-associated decapods have been conducted on squat lobsters, ghost shrimp and pylochelid hermit crabs (TDSB samples from Vanuatu, New Caledonia, Solomon Archipelago, Philippines). A multidisciplinary approach based on electron microscopy (SEM, TEM); fluorescence in situ hybridization (FISH) and stable isotopic analyses revealed their affiliation to different diets and emphasizes their trophic relationships by the presence (or absence) of bacterial symbioses (Hoyoux 2010). The results revealed that two main diet-groups can be identified for the studied wood-associated decapods: (i) predators such as *Xylocheles macrops*, *Bathycheles incisus*, *B. integer* and *Xylopagurus caledonicus*; and (ii) detritivorous species such as *Munidopsis bispinoculata*, *M. pilosa*, *M. nitida*, *M. andamanica* and the thalassinid *Rayllianassa amboinensis*. The most striking results deal with the detritivorous groups, especially *M. andamanica* and *M. nitida*. Both species have detritivorous and xylophagous diets and harbour symbiotic digestive microflora, indicating their close trophic interactions with wood and organic substrates. Indeed, a careful examination of the feeding appendages, gut contents and gut lining of *M. andamanica* caught with wood falls revealed this species to be a truly detritivorous species which uses wood and the biofilm-covering as its two main food sources (Hoyoux *et al.* 2009). *Munidopsis andamanica* also possesses a resident gut microflora consisting of bacteria and fungi possibly involved in the digestion of the wood fragments. This species can therefore be regarded as a xylophagous specialist. In this work (Hoyoux *et al.* 2012), authors also examined the feeding appendages, gut contents and gut lining of *M. nitida*, *M. bispinoculata* and *M. pilosa* from natural sunken woods and compared them with specimens of the same species having survived and grown on different hard to-digest substrates (*i.e.*, woods, turtle shells and whale bones) experimentally submerged in the deep South Pacific. In both cases, all three species directly ingest large wood fragments that have been substantially degraded by micro-organisms. However, *M. nitida* also feeds on experimentally submerged whale bone and turtle shell fragments. *Munidopsis nitida* is also the only species known to host a resident gut microflora, although the bacterial morphotypes vary according to the ingested substrate. The results suggest that the three species are most probably opportunistic, bacterivorous detritivores and *M. nitida* could be at the beginning of an evolutionary process leading towards xylophagy within the genus *Munidopsis*.

New investigations are in progress on wood-associated amphipods. Taxonomic and phylogenetic studies have been conducted on several groups. Identified as a key-group is the genus *Bathyceradocus* (family Maeridae; Figure 8E-H) that revealed an unsuspected diversity. *Bathyceradocus* has only three species: *B. iberiensis*, described from Mediterranean Sea; *B. stephensi* described from three specimens collected during cruises of the SIBOGA in the Celebes sea (Pirlot 1934) and *B. wuzzae* recently described by Larsen & Krapp-Schickel (2007) from the vicinity of hydrothermal vents (Juan de Fuca). In all these descriptions, the specimens were collected from dropped wood or plant remains but without more ecological information. About 80 specimens of *Bathyceradocus* sp. have been collected during MUSORSTOM-TDSB cruises from Madagascar to Fiji islands through Philippines and Papua New Guinea. The first morphological hypothesis suggests that these specimens are representative of *B. stephensi*. Phylogenetic analyses (COI and 18S) have revealed that this group is much more diversified than expected: 12 species (based on morphological and molecular data) have been differentiated, revealing the cryptic diversity in this genus (L. Corbari unpublished data). Moreover, microscopic and ultra-structural investigations on the digestive tract have revealed the presence of wood-fragments in the digestive content and the occurrence of micro-organisms (bacteria and fungi) in the posterior part of the intestine. These results confirm that the diet of the *Bathyceradocus* group as strictly wood-feeders (L. Corbari unpublished data). More interesting is the recurrent presence of bacterial ectosymbiosis on the mouthparts of these specimens that suggests an original pathway of nutrition that could involve bacteria in wood degradation (L. Corbari unpublished data). The same approach

of integrative taxonomy (combining morphological and molecular characters) is also being conducted for amphipods in the *Onesimoides* group.

SEAMOUNTS — Seamounts are mountains under the sea level and elevated above the sea bottoms more than 1000 m. Seamounts are major features of the oceans. Recent mapping estimated that their number is at least to 14,000 but less than 400 of them had been biologically sampled (Richer de Forges *et al.* 2000; Samadi *et al.* 2007; McClain 2007; Koslow 2007; Richer de Forges & Tessier 2012). They form a benthic habitat of exceptional richness, both in diversity and abundance, and they became a theme of a special section in the CoML called CenSeam, Census of Seamounts (2005-2010). Several MUSORSTOM-TDSB cruises were devoted to this rich habitat in the Pacific (CHALCAL 2, AZTEQUE, NORFOLK 1 & 2, EBISCO, TERRASSE, TARASOC). A preliminary hypothesis on the endemism of the seamount fauna was proposed after the first Norfolk cruises (Richer de Forges *et al.* 2000). More recent studies of population genetics on several animal groups such as molluscs and crustaceans have shown that seamounts are functioning as oases in the deep-sea (Samadi *et al.* 2006; Castelin *et al.* 2012). On the other hand, some species generally considered to be very “rare” were also caught on the Norfolk Ridge seamounts like *Palinustus unicornutus*; *Homola ranunculus*; *Sphaerodromia lamellata*, and *Takedromia longispina*. But the notion of rarity in ecology is a complex issue because sampling in the sea is generally not representative and with some habitats largely neglected, particularly at steep slopes of islands and seamounts (see Mendoza *et al.* 2009).

EVOLUTION — Traditional phylogenetic studies based on morphology have been complicated by the identification of homologies, which is often difficult. Many modern techniques have been recently developed to overcome these difficulties. However, all these modern techniques require fresh specimens or specimens preserved in a particularly way when fresh. Most museum specimens are or have been preserved in formalin and unsuitable for these modern techniques. Taxa from the deep-sea are generally not easy to collect because of the access of ship-time and very high running cost of research vessels. Unfortunately, many species and even the whole genus or family in various animal groups are entirely from the deep-sea. Thus, phylogenetic studies using modern techniques often encounter difficulties in sourcing enough taxa to be included in the analysis.

The abundant and diverse specimens collected during the MUSORSTOM-TDSB programme from a very broad geographical area are almost all preserved in ethanol or with the specimens specially treated immediately after collection for later molecular or histological work. For example, a fruitful collaboration was established amongst Bertrand Richer de Forges of the IRD, Danièle Guinot of the Muséum national d’Histoire naturelle and Barrie Jamieson of the University of Queensland on the ultrastructure of spermatozoa in decapod crustaceans. Morphology of reproductive cells is very conservative and can be used to reconstruct phylogeny. Before the MUSORSTOM programme very little was known on the morphology of sperm in decapod crustaceans. Having large access to fresh material from the deep-sea new data were rapidly obtained for the following families: Brachyura (Homolidae, Homolodromiidae, Dromiidae, Dynomeniidae, Latreilliidae, Cyclodorippidae, Dorippidae, Calappidae, Atelecyclidae, Raninidae, Palicidae, Retroplumidae, Leucosiidae, Geryonidae, Goneplacidae, Cancridae, Grapsidae, Xanthidae, Portunidae, Majidae, Hymenosomatidae), Anomura (Paguridae, Pylochelidae, Parapaguridae, Chirostylidae, Galatheidae, Lithodidae, Hippidae, Porcellanidae), and Macrura (Palinuridae, Polychelidae, Nephropidae). A large part of these results has been published (Guinot *et al.* 1994; Richer de Forges *et al.* 1997; Tudge *et al.* 2012). Using the sperm characters a new phylogeny of Brachyura was proposed (Jamieson *et al.* 1995). The phylogeny trees obtained are coherent with the classification of Guinot (1977) and distinguishing the three groups Podotremata, Heterotremata and Thoracotremata.

During the last decade, the fast development of molecular biology has provided supplementary information that can strengthen the outcomes of traditional morphology-based studies. The vast and diverse samples collected by the MUSORSTOM-TDSB programme are now a major focus of the international BarCode of Life programme on crustaceans. On the other hand, the availability of many deep-sea taxa that can be used for molecular sequencing has allowed comprehensive studies on the higher classification and evolution of decapod crustaceans (*e.g.*, Tong *et al.* 2000;

Ahyong *et al.* 2007; Chan *et al.* 2008, 2009, 2010; Tsang, Lin *et al.* 2008; Tsang, Ma *et al.* 2008; Ahyong *et al.* 2009; ; Chu *et al.* 2009; Lai *et al.* 2009; Ma *et al.* 2009; Sin *et al.* 2009; Tshudy *et al.* 2009; Tsang *et al.* 2009, 2011; De Grave *et al.* 2010; Boisselier-Dubayle *et al.* 2010; Lai *et al.* 2011; Li *et al.* 2011; Schnabel *et al.* 2011; Tsoi *et al.* 2011; Yang *et al.* 2012). Some studies have shown the importance of the southwest Pacific area, specifically the island arc of Fiji, Tonga, Vanuatu, Wallis and Futuna, for diversification of squat lobsters, probably associated with a global warming, high tectonic activity, and changes in oceanic currents that took place in this region during the Oligocene-Miocene period (Cabezas *et al.* 2012).

The results of these molecular studies have revolutionized the classification scheme of decapod crustaceans; such as the hermit crabs, squat lobsters, the mud shrimps Thalassinidea, the subfamilies in Nephropidae and many caridean superfamilies are not likely to be monophyletic groups, while the family or generic status of Sicyoniidae, Thaumastochelidae, and Synaxidae may not be valid. On the other hand, the status of Enoplometopidae is settled and considered as a superfamily in Astacidea. Moreover, the molecular data provide insights into the evolution within some of the infraorders, such as parallel carcinization within the Anomura (Tsang *et al.* 2011).

Phylogenetics and molecular studies of paguroids in particular, and anomurans or decapods in general, have taken advantage of the new availability of specimens as well as the greatly expanded morphological and distributional knowledge generated during nearly 40 years of publications based on sampling programs in the deep-seas of the Indo-West Pacific. Discoveries of remarkable new forms of what may be considered primitive or advanced taxa, have provided improved insight into the evolution of paguroids. Cladistic and genetic studies have incorporated the data or molecular information extracted from the vast MUSORSTOM-TDSB collections. Significantly improved evolutionary scenarios have been produced, and although theories are still controversial and hotly debated, we are much closer than before to the understanding of the true relationships and origins of paguroids in particular, and anomurans in general (*e.g.*, McLaughlin *et al.* 2007; Tsang *et al.* 2008, 2011; Ahyong *et al.* 2009; Lemaitre & McLaughlin 2009; Lemaitre *et al.* 2009).

The molecular techniques have been providing new findings on the taxonomy, phylogeny and classification of squat lobsters, *e.g.*, Machordom & Macpherson (2001, 2004), Chu *et al.* (2009), Ahyong *et al.* (2009), Cabezas *et al.* (2008, 2010), Puillandre *et al.* (2011). The most recent and complete studies have proposed a new classification of the squat lobsters (Ahyong *et al.* 2010; Schnabel & Ahyong 2010), with two superfamilies (Galattheoidea and Chirostyloidea). The material obtained along the Indian and Pacific Oceans has allowed some studies on the phylogeny and origin of this rich fauna. These studies suggest that the galatheid diversification in the southwestern Pacific may have begun some 7-14 million years ago, during the Middle or Late Miocene (Machordom & Macpherson 2004), and the Coral Sea area seems to be the origin of several genera of squat lobsters like *Paramunida* and *Plesionida* (Cabezas *et al.* 2009, 2012).

All in all, the MUSORSTOM-TDSB collection now forms an important part in specimen sourcing for the molecular component in the international Assembling the Tree of Life project on decapod crustaceans.

THE ALAIN CROSNIER EFFECT

All crustacean researchers who have worked on the MUSORSTOM-TDSB collections were invariably influenced by the "Alain Crosnier effect". His energy, passion and dedication were legendary. In the years between the first cruise (1976) to 2008 (when he decided to fully retire), he was instrumental in arranging expeditions, having the material centralized in the Muséum national d'Histoire naturelle where he sorted it out, then invited specialists from around the world to work on them (or occasionally sending it to them for study) and then assiduously arranging to have them published. The series of MUSORSTOM volumes for which he personally edited and readied for press exceeds 10,000 printed pages, and with hundreds of new genera and species described within.

More significantly, many of the papers published as a result of Crosnier's efforts were not just straightforward new genera and new species descriptions. A good number were major revisions or reviews of genera, subfamilies and families that are extremely important and useful for biologists. Crosnier used the extensive MUSORSTOM-TDSB collections as a nexus and a catalyst for such revisions that brought together types and material from all over the world. Crosnier was directly or indirectly responsible for more such major revisions than any other period in carcinological science.

Overall, the efforts he put in to secure the collections and the funds to have the experts work in Paris, and then to have them published were nothing short of phenomenal. And he was a tough taskmaster, driving the researchers hard to have the job done and done well. He was a “one-man army”, almost single-handedly pushing carcinological and deep-sea research to heights it has never seen before. It was a Herculean effort that has never been exceeded and may never be equaled.

Through all these years, Alain also created a special community of carcinologists devoted to the MUSORSTOM enterprise and the advancement of crustacean systematic knowledge (see Macpherson *et al.* 1998). This included the many researchers he invited to the museum to work on his material (the first was the late Chen Hui-Lian from Qingdao, China, who worked on Leucosiidae and Dorippidae; the last being Tomoyuki Komai from Chiba, Japan, a specialist of crangonids and glyphocrangonids) as well as those he generously sent material to. Affectionately known as “Crosnier’s cronies”, this community continues their works to this day across almost all continents and over a dozen countries. He was even honoured by his peers and “cronies” in a special volume of *Zoosystema* in 1998 (Volume 20 number 2). Alain was an influential carcinologist himself, specialising in penaeoid shrimps, but also publishing on a wide variety of other decapods. Even today, several years after his retirement from science, many researchers of this “fellowship of the MUSORSTOM” still correspond with him. For us, he is a classic demonstration of the French proverb “la foi soulève des montagnes” (faith that moves mountains). And he did move “many large mountains” in advancing carcinology and deep-sea research. The Alain Crosnier effect is now deeply entrenched in carcinological history.

THE INDISPENSABLE ROLE OF TAXONOMY

The endeavours of the MUSORSTOM-TDSB rammed home the importance of taxonomy as a science. Nowadays, with the rapid development of powerful new molecular tools, there is a tendency for many people, including respected colleagues and scientific leaders, to decry morphological taxonomy as “old fashioned” and obsolete, dated, unimportant and irrelevant. They think new techniques like DNA barcoding and fingerprinting will replace morphologists. They are wrong.

The MUSORSTOM-TDSB programme is a clear demonstration that taxonomy is at the heart of good biological science. Exploration and surveys can collect extensive material for study, but for this material to be useful for science, the right questions must be asked and hypotheses tested. To have a solid knowledge of zoology, the species in this material have to be formally described and named. Detractors who argue that a COI gene sequence alone is enough to characterise a species are fooling themselves. A genetic barcode is not unlike a person’s identification number — it indicates your position in a list, but not who you are (see also Kwong *et al.* 2012; Taylor & Harris 2012).

It is often forgotten (or ignored) that taxonomic classifications and species names, represent hypotheses of biological relationship. The population to which a species name has been applied has unique biological properties, shared within the group, and different from the next species. The information embodied in the species’ classification tells us about its diagnostic and distinctive features, and provides indications as to what the animals may do in life.

There can be no denying that molecular methods are powerful aids to the work of taxonomists, but they cannot be used in isolation. Moreover, genetic tools are also limited in their ability to distinguish species, without reference to morphology, as recently demonstrated for deep-sea corals (Baco & Cairns 2012). Ultimately, knowledge of the morphology is integral to the human understanding of what animals are and do. Far from being “old-fashioned”, morphological taxonomy remains a timeless and very essential discipline.

The strong taxonomic foundation deriving from the MUSORSTOM-TDSB programme has led to numerous advances in our knowledge of deep-sea biology. The many named taxa (families, genera and species) have been used for dozens of important phylogenetic, biogeographic and ecological questions, many of which have been reviewed above.

NEW PARADIGMS

In the middle of the 19th century, our deep-sea knowledge was very limited and the dominant idea at this time was that the bathyal world is an extremely harsh environment that was primarily azoic. In the second half of the 19th century,

especially after the brilliant success of the deep-sea dredgings by Charles Wyville Thomson, the scientific community began to realise that there is a high diversity of animals in the deep-sea. England started the race to discover and sample the world oceans with the CHALLENGER expedition (1872-1876) funded by the Royal Society. Other countries quickly followed suit: The Netherlands (SIBOGA 1899-1900), Germany (VALDIVIA 1898-1899), British India (INVESTIGATOR 1884-1897), United States (ALBATROSS 1891-1905) and Denmark (GALATHEA 1950-1952). As a result of these surveys, by the middle of the 20th century, the revised thinking was that there is life in the deep-sea at all depths, but the diversity is relatively poor with the animals widely distributed.

From 1970 onwards, ORSTOM, under the leadership of Alain Crosnier, started sampling the deep-sea fauna in Madagascar, originally aimed at exploring fish and crustacean resources. But these explorations were boosted by the discovery of *Neoglyphæa* in 1975 and its rediscovery in 1976 in the Philippines; the same year the American submersible "Alvin" discovered the astonishing fauna living in and around hydrothermal vents. This extraordinary discovery completely changed our concept of life in the deep-sea. Several decades of deep-sea studies mainly using "high technology" submersibles have since focused on this remarkable fauna that is dependent on chemosynthetic ecosystems along the oceanic ridges (Desbruyères & Segonzac 1997; Laubier 2008; www.noc.soton.ac.uk/chess).

At the same time, the MUSORSTOM-TDSB programme used "low technology" efforts to sample the bathyal zone around tropical Islands and started to document the "more ordinary fauna". These studies have opened several new paradigms in our understanding of the deep-sea environment: (i) the deep-sea benthos in tropical areas is very diverse in the upper part of the bathyal zone; (ii) some ecosystems like steep hard cliffs are neglected and very hard to sample but nevertheless very species rich; (iii) even if some species have a wide distribution, each archipelago generally has its own unique faunal assemblage; (iv) for the deep-sea epi-benthos in the Pacific, there is a decreasing gradient of diversity from West to East; with a similar pattern from the West Pacific to West Indian Ocean; (v) organic substrates such as sunken wood provides a key food resource in the deep-sea, and acts as stepping stones for the dispersion of chemosynthetic species; and (vi) the thousands of seamounts in the world oceans are generally oases that are concentrate with deep-sea species and play an important role in the global dispersion of species.

CONCLUSIONS

With the rapid changes of environment, the huge MUSORSTOM-TDSB collection of deep-sea fauna that spans the last 40 years constitutes a very valuable archive to understand deep-sea evolution on our planet. Climate change is a hot topic nowadays. With the Arctic ice disappearing rapidly, sea level rise may increase faster than expected. The increasing erosion of the coast and discharge of anthropogenically impacted rivers bringing huge amounts of sediments and organic material into the oceans. The changing hydrological conditions on the surface modify the plankton productivity and may also modify oceanic currents and deep-sea habitats. All this will ultimately influence the deep-sea fauna significantly.

In only 160 years, our scientific knowledge of the deep-sea has transitioned from a trickle to a flood, giving scientists an almost "panoramic vision" of the great diversity of life existing on the sea floor of our planet. Not surprisingly, this diversity is mostly localized at ridges, seamounts and continental slopes. The richest deep-sea areas appear to be situated in the western tropical Pacific Ocean. However, we have to remain very humble about our knowledge of the deep-sea, remembering that a large part of it remains unexplored (Observatory Biodiversity Information System: www.iobis.org). For example, less than 3% of large seamounts have been sampled, and a large part of the zoological collections already obtained from seamounts and deep-water systems are still unstudied because of an acute lack of taxonomic specialists. Even for studied species very little is known about the reproduction, growth and behavior of these deep-sea animals. Deep-sea explorations now mainly focus on the role of chemosynthesis, methane seeps, hydrothermal vents and the origin of chemosynthetic fauna. To understand, conserve and manage the deep-sea environment, deep-sea biodiversity survey programs such as TDSB are more important than ever.

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APPENDIX 1

Cruises in the *Tropical Deep-Sea Benthos* programme and satellite programmes that have yielded deep-sea zoological material, and relevant published cruise narratives or station lists (updated list since Bouchet *et al.* (2008).

CRUISE NAME OR ACRONYM	YEAR	SHIP	AREA	NO. OF STATIONS	STATION NUMBERS (CONSECUTIVE NUMBERING)	CRUISE REPORT IF ANY
ATIMO VATAE	2010	<i>Nosy bé 11</i>	South Madagascar	119	3508-3627	
AURORA 2007	2007	<i>DA-BFAR</i>	Philippines	117	2653-2764	
AZTEQUE	1990	<i>Alis</i>	New Caledonia	11		Grandperrin <i>et al.</i> 1990
BATHUS 1	1993	<i>Alis</i>	New Caledonia	75	639-713	Richer de Forges & Chevillon 1996
BATHUS 2	1993	<i>Alis</i>	New Caledonia	58	714-771	Richer de Forges & Chevillon 1996
BATHUS 3	1993	<i>Alis</i>	New Caledonia	78	773-849	Richer de Forges & Chevillon 1996
BATHUS 4	1994	<i>Alis</i>	New Caledonia	74	882-955	Richer de Forges & Chevillon 1996
BENTHAUS	2002	<i>Alis</i>	Austral Islands	161	1861-2021	
BERYX 11	1992	<i>Alis</i>	New Caledonia	60		Lehodey <i>et al.</i> 1992
BERYX 2	1991	<i>Alis</i>	New Caledonia	19		Grandperrin & Lehodey 1992
BIOCAL	1985	<i>Jean-Charcot</i>	New Caledonia	68		Lévi, 2006
BIOGEOCAL	1987	<i>Coriolis</i>	New Caledonia	152		Cotillon P. & Monniot C. 1987
BIOPAPUA	2010	<i>Alis</i>	Papua New-Guinea	156	3628-3783	
BOAO	2004	<i>Alis</i>	Vanuatu	27	2304-2330	
BOA1	2005	<i>Alis</i>	Vanuatu	71	2411-2480	
BORDAU 1	1999	<i>Alis</i>	Fiji	117	1391-1507	Richer de Forges 2000
BORDAU 2	2000	<i>Alis</i>	Tonga	138	1508-1645	
CALSUB	1989	<i>Cyana</i>	New Caledonia	22		Grandperrin & Richer de Forges 1989; Roux 1994
CHALCAL 1	1984	<i>Coriolis</i>	Coral Sea	27		Richer de Forges & Pianet 1984
CHALCAL 2	1986	<i>Coriolis</i>	New Caledonia	38		Richer de Forges <i>et al.</i> 1987
CONCALIS	2008	<i>Alis</i>	New Caledonia	102	2929-3030	
CORAIL 2	1988	<i>Coriolis</i>	Coral Sea	19		Richer de Forges <i>et al.</i> 1988
CORINDON 2	1980	<i>Coriolis</i>	Indonesia	70		Moosa 1985
EBISCO	2005	<i>Alis</i>	Coral Sea	187	1-14 and 2492-2652	
EXBODI	2011	<i>Alis</i>	New Caledonia	162	3784-3945	
GEMINI	1989	<i>Alis</i>	New Hebrides Arc	15		Bargibant <i>et al.</i> 1989
HALICAL 1	1994	<i>Alis</i>	New Caledonia	4		Grandperrin <i>et al.</i> 1995a
HALIPRO 1	1994	<i>Alis</i>	New Caledonia	32	850-881	Grandperrin <i>et al.</i> , 1995b
HALIPRO 2	1996	<i>Tangaroa</i>	New Caledonia	106		Grandperrin <i>et al.</i> 1997
KARUBAR	1991	<i>Baruna Jaya 1</i>	Indonesia	91		Crosnier <i>et al.</i> 1997
LAGON	1984-89	<i>Vauban, then Alis</i>	New Caledonia	62		Richer de Forges 1991
LITHIST	1999	<i>Alis</i>	New Caledonia	18		
MADANG	2012	<i>Alis</i>	Papua New-Guinea	137	3946-4082	
MAINBAZA	2009	<i>Vizconde de Eza</i>	Mozambique Channel	46	3130-3175	
MIRIKY	2009	<i>Miriky</i>	Madagascar	119	3176-3294	
MUSORSTOM 1	1976	<i>Vauban</i>	Philippines	75	1-73	Forest 1981
MUSORSTOM 2	1980	<i>Coriolis</i>	Philippines	82	1-83	Forest 1986
MUSORSTOM 3	1985	<i>Coriolis</i>	Philippines	59	86-145	Forest 1989
MUSORSTOM 4	1985	<i>Vauban</i>	New Caledonia	148	146-249	Richer de Forges 1986
MUSORSTOM 5	1986	<i>Coriolis</i>	Coral Sea	137	250-390	Richer de Forges <i>et al.</i> 1986
MUSORSTOM 6	1989	<i>Alis</i>	New Caledonia	103	391-493	Richer de Forges & Laboute 1989
MUSORSTOM 7	1992	<i>Alis</i>	Wallis & Futuna	147	494-638	Richer de Forges & Menou 1993
MUSORSTOM 8	1994	<i>Alis</i>	Vanuatu	186	956-1141	Richer de Forges <i>et al.</i> 1996
MUSORSTOM 9	1997	<i>Alis</i>	Marquesas	166	1142-1307	Richer de Forges <i>et al.</i> 1999
MUSORSTOM 10	1998	<i>Alis</i>	Fiji	83	1308-1390	Richer de Forges <i>et al.</i> 2000
NORFOLK 1	2001	<i>Alis</i>	New Caledonia	88	1651-1739	
NORFOLK 2	2003	<i>Alis</i>	New Caledonia	142	2022-2161	

CRUISE NAME OR ACRONYM	YEAR	SHIP	AREA	NO. OF STATIONS	STATION NUMBERS (CONSECUTIVE NUMBERING)	CRUISE REPORT IF ANY
PALEO-SURPRISE	1999	<i>Alis</i>	New Caledonia	29		Garrigue <i>et al.</i> 2000
PANGLAO 2005	2005	<i>DA-BFAR</i>	Philippines	80	2331-2409	Richer de Forges <i>et al.</i> 2009
SALOMON 1	2001	<i>Alis</i>	Solomon Islands	121	1740-1860	
SALOMON 2	2004	<i>Alis</i>	Solomon Islands	142	2164-2303	
SALOMONBOA 3	2007	<i>Alis</i>	Solomon Islands	97	2765-2860	
SANTO 2006	2006	<i>Alis</i>	Vanuatu	112		
SMCB	1990-91	<i>Marara</i>	French Polynesia	80		Poupin 1991
SMIB 1	1986	<i>Vauban</i>	New Caledonia	15		Richer de Forges 1990
SMIB 2	1986	<i>Vauban</i>	New Caledonia	31		Richer de Forges 1990
SMIB 3	1987	<i>Vauban</i>	New Caledonia	32		Richer de Forges 1990
SMIB 4	1989	<i>Alis</i>	New Caledonia	36		Richer de Forges 1990
SMIB 5	1989	<i>Alis</i>	New Caledonia	36		Richer de Forges 1993
SMIB 6	1990	<i>Alis</i>	New Caledonia	32		Richer de Forges 1993
SMIB 8	1993	<i>Alis</i>	New Caledonia	55		Richer de Forges & Chevillon 1996
SMIB 9	1993	<i>Alis</i>	New Caledonia	1		
SMIB 10	1995	<i>Alis</i>	New Caledonia	17		Richer de Forges 1990
TAIWAN 2000	2000	<i>Fisheries Researcher 1</i>	Taiwan	62		
TAIWAN 2001	2001	<i>Chung Tung Long 26</i>	Taiwan	80		
TAIWAN 2002	2002	<i>Cheng-Ming Fa and Ocean Researcher 1</i>	Taiwan	35		
TAIWAN 2004	2004	<i>Rih-Jheng 101 and Ocean Researcher 2</i>	Taiwan	23		
TARASOC	2009	<i>Alis</i>	French Polynesia	213	3295-3507	
TERRASSES	2008	<i>Alis</i>	New Caledonia	99	3031-3129	
Vauban 1978-79	1978-79	<i>Vauban</i>	New Caledonia	47		
VOLSMAR	1989	<i>Alis</i>	New Hebrides Arc	25		Laboute <i>et al.</i> 1989

APPENDIX 2

Check-list of deep-sea decapod crustaceans (recorded below 100 m depth) from New Caledonia. An asterisk * indicates that the species was originally described from New Caledonia. References to the original descriptions are listed in Appendix 4. The classification and the succession of the families follow De Grave et al. (2009).

PENAEOIDEA

ARISTEIDAE

Aristaeomorpha foliacea (Risso, 1827)
Aristaeopsis edwardsiana (Johnson, 1868)
Aristeus mabahissae Ramadan, 1938
Aristeus semidentatus Bate, 1881
Aristeus virilis (Bate, 1881)
Austropenaeus nitidus (Barnard, 1947)
Hemipenaeus carpenteri Wood-Mason & Alcock, 1891
Plesiopenaeus armatus (Bate, 1881)

BENTHESICYMIDAE

Benthescymus howensis Dall, 2001
Benthescymus investigatoris Alcock & Anderson, 1899
Benthescymus urinator Burkenroad, 1936
Gennadas bouvieri Kemp, 1909
Gennadas capensis Calman, 1925
Gennadas clavicornis de Man, 1907
Gennadas crassus Tirmizi, 1960
Gennadas gilchristi Calman, 1925
Gennadas incertus (Bals, 1927)

PENAEIDAE

Funchalia villosa (Bouvier, 1905)
Metapenaeopsis difficilis Crosnier, 1991
Metapenaeopsis evermanni (Rathbun, 1906)
Metapenaeopsis provocatoria Racek & Dall, 1965
Metapenaeopsis sibogae (De Man, 1907)
Metapenaeopsis velutina (Dana, 1852)
Parapenaeus cayrei Crosnier, 2005
Parapenaeus fissurus (Bate, 1881)
Parapenaeus investigatoris Alcock & Anderson, 1899
Parapenaeus kensleyi Crosnier, 2005 *
Parapenaeus murrayi Ramadan, 1938
Parapenaeus perezfarfanta Crosnier, 1986
Parapenaeus sextuberculatus Kubo, 1949
Penaeopsis balsi Ivanov & Hassan, 1976
Penaeopsis challengerii De Man, 1911
Penaeopsis eduardoi Pérez Farfante, 1977
Penaeopsis jerryi Pérez Farfante, 1979
Penaeopsis mclaughlinae Crosnier, 2006 *
Penaeopsis reducta (Bate, 1881)

SICYONIIDAE

Sicyonia adunca Crosnier, 2003 *
Sicyonia altirostrum Crosnier, 2003 *
Sicyonia australiensis Hanamura & Wadley, 1998
Sicyonia benthophila De Man, 1907
Sicyonia curvirostris Bals, 1913
Sicyonia dejuanetti Crosnier, 2003 *
Sicyonia fallax De Man, 1907
Sicyonia inflexa (Kubo, 1949)
Sicyonia laevis Bate, 1881
Sicyonia lancifer (Olivier, 1811)

Sicyonia rotunda Crosnier, 2003 *
Sicyonia trispinosa De Man, 1907
Sicyonia truncata (Kubo, 1949)
Sicyonia vitulans (Kubo, 1949)

SOLENOCERIDAE

Cryptopenaeus clevei Crosnier, 1985
Cryptopenaeus crosnieri Pérez Farfante & Kensley, 1985
Gordonella kensleyi Crosnier, 1988a *
Gordonella paravillosa Crosnier, 1988a *
Hadropenaeus lucasii (Bate, 1881)
Hadropenaeus spinicaudatus Liu & Zhong, 1983
Haliporoides cristatus Kensley, Tranter & Griffin, 1987
Haliporoides sibogae sibogae (De Man, 1907)
Haliporus thetis Faxon, 1893
Hymenopenaeus debilis Smith, 1882
Hymenopenaeus equalis (Bate, 1888)
Hymenopenaeus halli Bruce, 1966
Hymenopenaeus methalli Crosnier & Dall, 2004 *
Hymenopenaeus neptunus (Bate, 1881)
Hymenopenaeus obliquirostris (Bate, 1881)
Hymenopenaeus propinquus (De Man, 1907)
Mesopenaeus brucei Crosnier, 1986
Solenocera comata Stebbing, 1915

SERGESTOIDEA

SERGESTIDAE

Sergia talismani (Barnard, 1947)

STENOPODIDAE

SPONGICOLIDAE

Globospongicola spinulatus Komai & Saito, 2006
Paraspongicola inflatus (de Saint Laurent & Cleve, 1981)
Spongicola andamanicus Alcock, 1901
Spongicola depressus Saito & Komai, 2008 *
Spongicola goyi Saito & Komai, 2008 *
Spongicola levigatus Hayashi & Ogawa, 1987

CARIDEA

ACANTHEPHYRIDAE

Acanthephyra armata A. Milne-Edwards, 1881
Acanthephyra curtirostris Wood-Mason & Alcock, 1891
Acanthephyra eximia Smith, 1884
Acanthephyra quadrispinosa Kemp, 1939
Acanthephyra sanguinea Wood-Mason [in Wood-Mason & Alcock, 1892]
Acanthephyra smithi Kemp, 1939
Acanthephyra tenuipes (Bate, 1888)
Heterogenys micropthalma (Smith, 1885)
Meningodora vesca (Smith, 1886)

ALPHEIDAE

Batella praecipua De Grave, 2004 *

ANCHISTIOIDIDAE

Anchistioides willeyi (Borradaile, 1900)

BATHYPALAEONELLIDAE

Bathypalaemonella hayashii Komai, 1995
Bathypalaemonella serratipalma Pequegnat, 1970
Bathypalaemonetes brevirostris (Bruce, 1986)
Bathypalaemonetes pilosipes (Bruce, 1986)

BRESILIIDAE

Bresilia antipodarum Bruce, 1990

CRANGONIDAE

Aegaeon lacazei (Gourret, 1887)
Aegaeon rathbuni De Man, 1918
Lissosabinea armata Komai, 2006 *
Lissosabinea indica (De Man, 1918)
Lissosabinea unispinosa Komai, 2006 *
Parapontocaris aspera Chace, 1984
Parapontophilus caledonicus Komai, 2008 *
Parapontophilus cyrtus Komai, 2008 *
Parapontophilus demani (Chace, 1984)
Parapontophilus difficilis Komai, 2008
Parapontophilus junceus (Bate, 1888)
Parapontophilus longirostris Komai, 2008
Parapontocaris levigata Chace, 1984
Pontocaris propensalata Bate, 1888
Pontocaris sibogae (De Man, 1918)
Pseudopontophilus serratus Komai, 2004a *

EUGONATONOTIDAE

Eugonatonotus chacei Chan & Yu, 1991 *

GLYPHOCRANGONIDAE

Glyphocrangon armata Komai, 2004b *
Glyphocrangon conodactylus Komai, 2004b *
Glyphocrangon cornuta Komai, 2004b *
Glyphocrangon dimorpha Komai, 2004b *
Glyphocrangon musorstomia Komai, 2006
Glyphocrangon parviocellus Komai, 2006 *
Glyphocrangon punctata Komai, 2004 *
Glyphocrangon regalis Bate, 1888
Glyphocrangon richeri Komai, 2004b
Glyphocrangon similior Komai, 2004
Glyphocrangon speciosa Komai, 2004b *

HIPPOLYTIDAE

Gelastreutes crosnieri Bruce, 1990b *

NEMATOCARCINIDAE

Nematocarcinus combensis Burukovsky, 2000
Nematocarcinus crosnieri Burukovsky, 2000 *
Nematocarcinus gracilis Bate, 1888
Nematocarcinus parvus Burukovsky, 2000

Nematocarcinus paucidentatus Bate, 1888
Nematocarcinus productus Bate, 1888
Nematocarcinus richeri Burukovsky, 2000
Nematocarcinus tenuipes Bate, 1888
Nematocarcinus tenuirostris Bate, 1888
Nigmatullinus acanthitelsonis (Pequegnat, 1970)

OPLOPHORIDAE

Janicella spinicauda (A. Milne-Edwards, 1883)
Oplophorus gracilirostris A. Milne-Edwards, 1881
Oplophorus spinosus (Brullé, 1839)
Systellaspis debilis (A. Milne-Edwards, 1881)
Systellaspis lanceocaudata Bate, 1888
Systellaspis pellucida (Filhol, 1884)

PALAEMONIDAE

Altopontonia disparostris Bruce, 1990a *
Amphipontonia kanak Bruce, 1991 *
Anchistus pectinis Kemp, 1925
Ancylomenes tenuirostris (Bruce, 1991) *
Cuapetes tenuipes (Borradaile, 1898)
Dactylonia monnioti (Bruce, 1990a) *
Mesopontonia gorgoniophila Bruce, 1967
Mesopontonia gracilicarpus Bruce, 1990a *
Mesopontonia monodactylus Bruce, 1991 *
Palaemonella dolichodactylus Bruce, 1991 *
Palaemonella rotumana (Borradaile, 1898)
Paraclimenes franklini (Bruce, 1990a) *
Paraclimenes setirostris (Bruce, 1991) *
Periclimenaeus jeancharcoti Bruce, 1991 *
Periclimenes acanthimerus Bruce, 2006 *
Periclimenes albatrossae Chace & Bruce, 1993
Periclimenes alcocki Kemp, 1922
Periclimenes aleator Bruce, 1991 *
Periclimenes brevisrostris Bruce, 1991 *
Periclimenes forcipulatus Bruce, 1991 *
Periclimenes forgesi Li & Bruce, 2006 *
Periclimenes foveolatus Bruce, 1981
Periclimenes fujinoi Bruce, 1990a *
Periclimenes hertwigi Balss, 1913
Periclimenes laccadivensis (Alcock & Anderson, 1894)
Periclimenes latipollex Kemp, 1922
Periclimenes leptodactylus Bruce, 1991 *
Periclimenes loyautensis Li & Bruce, 2006 *
Periclimenes ordinarius Bruce, 1991 *
Periclimenes paraleator Li & Bruce, 2006 *
Periclimenes parvispinatus Bruce, 1990a *
Periclimenes pectinipes Bruce, 1991 *
Periclimenes platyrhynchus Bruce, 1991 *
Periclimenes rectirostris Bruce, 1981
Periclimenes richeri Bruce, 1990a *
Periclimenes uniunguiculatus Bruce, 1990a *
Periclimenes vaubani Bruce, 1990a *
Urocaridella urocaridella (Holthuis, 1950)

PANDALIDAE

Bitias brevis (Rathbun, 1906)
Calipandalus elachys Komai & Chan, 2003
Chelonika macrochela Fransen, 1997 *
Heterocarpus amacula Crosnier, 1988b

Heterocarpus dorsalis Bate, 1888
Heterocarpus ensifer A. Milne-Edwards, 1881
Heterocarpus hayashii Crosnier, 1988b *
Heterocarpus intermedius Crosnier, 1999 *
Heterocarpus laevigatus Bate, 1888
Heterocarpus lepidus De Man, 1917
Heterocarpus longirostris MacGilchrist, 1905
Heterocarpus parvispina De Man, 1917
Heterocarpus sibogae De Man, 1917
Heterocarpus tricarinatus Alcock & Anderson, 1894
Heterocarpus woodmasoni Alcock, 1901
Pandalus (Parapandalus) longirostris Borradaile, 1900
Plesionika alcocki (Anderson, 1896)
Plesionika bimaculata Chan, 2004
Plesionika echinicola Chan & Crosnier, 1991 *
Plesionika ensis (A. Milne-Edwards, 1881)
Plesionika erythrocyclus Chan & Crosnier, 1997
Plesionika flavicauda Chan & Crosnier, 1991
Plesionika hsehyui Chan, 2004
Plesionika laurentae Chan & Crosnier, 1991 *
Plesionika macropoda Chace, 1939
Plesionika reflexa Chace, 1985
Plesionika rufomaculata Chan, 2004 *
Plesionika scopifera Chan, 2004 *
Plesionika semilaevis Bate, 1888
Plesionika serratifrons (Borradaile, 1900)
Plesionika spinipes Bate, 1888
Plesionika suffusa Chan, 2004 *
Pseudopandalus curvirostris Crosnier, 1997a *

PASIPHAIDAE

Leptocheila (Leptocheila) japonica Hayashi & Miyake, 1969
Pasiphaea fragilis Hayashi, 1999 *
Pasiphaea gracilis Hayashi, 1999 *
Pasiphaea kapala Kensley, Tranter & Griffin, 1987
Pasiphaea major Hayashi, 2006 *
Pasiphaea mclaughlinae Hayashi, 2006 *
Pasiphaea planidorsalis Hayashi, 2004 *
Pasiphaea sirenkoi Burukovsky, 1987
Pasiphaea telacantha Hayashi, 2004 *

PSALIDOPODIDAE

Psalidopus huxleyi Wood-Mason [in Wood-Mason & Alcock, 1892]

STYLODACTYLIDAE

Neostyloactylus affinis Hayashi & Miyake, 1968
Parastyloactylus bimaxillaris Bate, 1888)
Parastyloactylus richeri Cleva, 1990 *
Parastyloactylus semblatae Cleva, 1990 *
Parastyloactylus tranterae Cleva, 1990 *
Styloactylus crosnieri Cleva, 1990 *
Styloactylus discissipes Bate, 1888
Styloactylus laurentae Cleva, 1990 *
Styloactylus libratu Chace, 1983
Styloactylus licinus Chace, 1983
Styloactylus macropus Chace, 1983
Styloactylus multidentatus multidentatus Kubo, 1942
Styloactylus profundus Cleva, 1990 *
Styloactylus tokarensis Zarenkov, 1968

ASTACIDEA

ENOPLOMETOPIIDAE

Enoplometopus gracilipes (Saint Laurent, 1988)

NEPHROPIDAE

Acanthacaris tenuimana Bate, 1888
Nephropsis acanthura Macpherson, 1990
Nephropsis suhmi Bate, 1888
Nephropsis sulcata Macpherson, 1990
Thaumastocheles japonicus Calman, 1913

GLYPHEIDAE

GLYPHEIDAE

Laurentaeglyphe neocaledonica (Richer de Forges, 2006) *

AXIIDAE

AXIIDAE

Acanthaxius miyazakiensis (Yokoya, 1933)
Ambiaxius alcocki (McArdle, 1900)
Bouvieraxius rudis (Rathbun, 1906)
Oxyrhynchaxius tricarinatus Lin, 2006 *
Spongiaxius holthuisi Poore & Collins, 2010 *

CALLIANASSIDAE

Callianassa jocularis de Man, 1905
Cheramus propinquus (De Man, 1905)

MICHELEIDAE

Meticonaxius dentatus Lin, 2006 *
Meticonaxius noumea Poore, 1997 *
Tethisea indica Poore, 1994

STRAHLAXIIDAE

Neaxius trondlei Ngoc-Ho, 2005

ACHELATA

PALINURIDAE

Linuparus meridionalis Tsoi, Chan & Chu, 2011 *
Linuparus sordidus Bruce, 1965
Nupalirus chani (Poupin, 1994) *
Nupalirus japonicus Kubo, 1955
Palinustus unicornatus Berry, 1979
Puerulus mesodontus, Chan, Ma & Chu, this volume
Puerulus quadridentis, Chan, Ma & Chu, this volume *
Puerulus richeri, Chan, Ma & Chu, this volume
Puerulus sericus, Chan, Ma & Chu this volume *

SCYLLARIDAE

Bathyarctus chani Holthuis, 2002 *
Bathyarctus rubens (Alcock & Anderson, 1894)
Eduarctus martensii (Pfeffer, 1881)
Galearctus aurora (Holthuis, 1982)
Galearctus avulsus Yang, Chen & Chan, 2011 *
Galearctus timidus (Holthuis, 1960)
Ibacus brevipes Bate, 1888
Ibacus brucei Holthuis, 1977
Petrarctus brevicornis (Holthuis, 1946)
Remiarctus bertholdii (Paulson, 1875)
Scammarctus batei (Holthuis, 1946)

POLYCHELIDA**POLYCHELIDAE**

Pentacheles laevis Bate, 1878
Pentacheles obscurus Bate, 1878
Pentacheles validus A. Milne-Edwards, 1880
Polycheles baccatus Bate, 1878
Polycheles coccifer Galil, 2000
Polycheles enthrix (Bate, 1878)
Polycheles typhlops Heller, 1862
Stereomastis aculeata (Galil, 2000) *
Stereomastis auriculata (Bate, 1878)
Stereomastis helleri (Bate, 1878)
Stereomastis nana (Smith, 1884)
Stereomastis phosphorus (Alcock, 1894)
Stereomastis surda (Galil, 2000)

ANOMURA**ALBUNEIDAE**

Austrolepidopa caledonia Boyko & Harvey, 1999 *
Paralbunea dayriti (Serène & Umali, 1965)
Zygopa nortoni Serène & Umali, 1965

CHIROSTYLIDAE

Chirostylus novaecaledoniae Baba, 1991a *
Gastrotychus breviproodus Baba, 1991a *
Gastrotychus hendersoni (Alcock & Anderson, 1899)
Gastrotychus paucispina Baba, 1991a *
Gastrotychus sternoonatus (Van Dam, 1933)
Urotychodes epigaster Baba, 2004 *
Urotychodes musorstomi Baba, 2004 *
Urotychodes spinimarginatus (Henderson, 1885)
Urotychus cavirostris Alcock & Anderson, 1899
Urotychus tridentatus (Henderson, 1885)

DIOGENIDAE

Areopaguristes micheleae (Rahayu, 2005)
Areopaguristes ngochoae (Rahayu, 2005)
Ciliopagurus alcocki Forest, 1995 *
Ciliopagurus krempfi (Forest, 1952)
Ciliopagurus pacificus Forest, 1995
Paguristes aciculus Grant, 1905
Paguristes alcocki McLaughlin & Rahayu, 2005
Paguristes ortmanni Miyake, 1978
Paguristes palythophilus Ortmann, 1892
Paguristes puniceus Henderson, 1896
Paguristes versus Komai, 2001
Pseudopaguristes laurentae (Morgan & Forest, 1991)
Pseudopaguristes monaporus (Morgan, 1987)
Strigopagurus boreonotus Forest, 1995 *

EUMUNIDIDAE

Eumunida annulosa de Saint Laurent & Macpherson, 1990 *
Eumunida capillata de Saint Laurent & Macpherson, 1990 *
Eumunida karubar de Saint Laurent & Poupin, 1996
Eumunida keijii de Saint Laurent & Macpherson, 1990 *
Eumunida marginata de Saint Laurent & Macpherson, 1990 *
Eumunida minor de Saint Laurent & Macpherson, 1990 *
Eumunida pacifica Gordon, 1930
Eumunida parva de Saint Laurent & Macpherson, 1990 *
Eumunida spinosa Macpherson, 2006b *

Eumunida sternomaculata de Saint Laurent & Macpherson, 1990 *
Pseudomunida fragilis Haig, 1979

GALATHEIDAE

Alainius crosnieri Baba, 1991b *
Allogalatea babai Cabezas, Macpherson & Machordom, 2011 *
Allogalatea elegans (Adams & White, 1848)
Allogalatea inermis Cabezas, Macpherson & Machordom, 2011 *
Galathea barbellata Macpherson, 2012 *
Galathea echinata Macpherson, 2012 *
Galathea profunda Macpherson, 2012
Galathea sanctae Macpherson, 2012
Leiogalatea laevirostris (Alcock, 1894)
Phylladorhynchus ikedai (Miyake & Baba, 1965)
Phylladorhynchus pusillus (Henderson, 1885)

LITHODIDAE

Lithodes richeri Macpherson, 1990 *
Neolithodes bronwynae Ah Yong, 2010
Paralomis dawsoni Macpherson, 2001 *
Paralomis haigae Eldredge, 1976

MUNIDIDAE

Agononida andrewi (Macpherson, 1994) *
Agononida callirrhoe (Macpherson, 1994) *
Agononida emimens (Baba, 1988)
Agononida incerta (Henderson, 1888)
Agononida laurentae (Macpherson, 1994) *
Agononida marini (Macpherson, 1994) *
Agononida norfocerta Poore & Andreakis, 2012
Agononida normani (Henderson, 1885)
Agononida ocyrhoe (Macpherson, 1994) *
Agononida rubrizonata Macpherson & Baba, 2009 *
Agononida sabatesae (Macpherson, 1994) *
Agononida soelae (Baba, 1986)
Agononida sphaecia (Macpherson, 1994) *
Agononida squamosa (Henderson, 1885)
Anoplomida inermis (Baba, 1994)
Babamunida callista (Macpherson, 1994) *
Babamunida javieri (Macpherson, 1994) *
Bathymunida balsi Van Dam, 1938
Bathymunida eurybregma Baba & de Saint Laurent, 1996 *
Bathymunida nebulosa Baba & de Saint Laurent, 1996 *
Bathymunida ocularis Baba & de Saint Laurent, 1996 *
Bathymunida rudis Baba & de Saint Laurent, 1996 *
Bathymunida sibogae Van Dam, 1938
Crosnierita dicata Macpherson, 1998 *
Crosnierita urizae (Macpherson, 1994) *
Crosnierita yante (Macpherson, 1994)
Enriquea levantennata (Baba, 1988)
Heteronida aspinirostris (Khodkina, 1981)
Munida acantha Macpherson, 1994 *
Munida alonsoi Macpherson, 1994 *
Munida amblytes Macpherson, 1994 *
Munida angusta Macpherson, 2004
Munida armilla Macpherson, 1994 *
Munida asprosoma Ah Yong & Poore, 2004
Munida aulakodes Macpherson, 2006b *
Munida barangei Macpherson, 1994 *
Munida brachytes Macpherson, 1994 *
Munida clinata Macpherson, 1994 *
Munida congesta Macpherson, 2000
Munida delicata Macpherson, 2004 *
Munida devestiva Macpherson, 2006b *
Munida distiza Macpherson, 1994 *
Munida eclepsis Macpherson, 1994 *
Munida elachia Macpherson, 1994 *
Munida erato Macpherson, 1994 *
Munida gilii Macpherson, 1993
Munida gordoae Macpherson, 1994 *
Munida guttata Macpherson, 1994 *
Munida hyalina Macpherson, 1994 *
Munida idyia Macpherson, 1994 *
Munida inornata Henderson, 1885
Munida japonica Stimpson, 1858
Munida leagora Macpherson, 1994 *
Munida leptitis Macpherson, 1994 *
Munida lineola Macpherson, 1994 *
Munida magniantennulata Baba & Türkay, 1992
Munida masi Macpherson, 1994 *
Munida microps Alcock, 1894
Munida moliae Macpherson, 1994 *
Munida notata Macpherson, 1994 *
Munida ommata Macpherson, 2004 *
Munida oritea Macpherson & Baba, 1993
Munida pagesi Macpherson, 1994 *
Munida parca Macpherson, 1996a *
Munida parile Macpherson & Machordom, 2005 *
Munida pectinata Macpherson & Machordom, 2005 *
Munida pontoporea Macpherson, 1994 *
Munida proto Macpherson, 1994 *
Munida psamathe Macpherson, 1994 *
Munida pseliophora Macpherson, 1994 *
Munida psylla Macpherson, 1994 *
Munida pygmaea Macpherson, 1996a *
Munida rhodonia Macpherson, 1994 *
Munida rogeri Macpherson, 1994 *
Munida rosula Macpherson, 1994 *
Munida rubridigitalis Baba, 1994
Munida rufiantennulata Baba, 1969
Munida runcinata Macpherson, 1994 *
Munida sacksi Macpherson, 1993
Munida sao Macpherson, 1994 *
Munida semoni Ortmann, 1894
Munida simulatrix Macpherson & Machordom, 2005 *
Munida spilota Macpherson, 1994 *
Munida stia Macpherson, 1994 *
Munida stigmatica Macpherson, 1994 *
Munida striola Macpherson & Baba, 1993
Munida taenia Macpherson, 1994 *
Munida thoe Macpherson, 1994 *
Munida tiresias Macpherson, 1994 *
Munida tuberculata Henderson, 1885
Munida tyche Macpherson, 1994 *
Munida typhle Macpherson, 1994 *
Munida zebra Macpherson, 1994 *
Onconida alaini Baba & de Saint Laurent, 1996 *
Onconida tropis Baba & de Saint Laurent, 1996
Paramunida amphitrita Macpherson, 1996b

Paramunida antares Cabezas, Macpherson & Machordom, 2010 *
Paramunida belone Macpherson, 1993 *
Paramunida granulata (Henderson, 1885)
Paramunida labis Macpherson, 1996b
Paramunida longior Baba, 1988
Paramunida microrhina Cabezas, Macpherson & Machordom, 2010 *
Paramunida parvispina Cabezas, Macpherson & Machordom, 2010 *
Paramunida pictura Macpherson, 1993 *
Paramunida pronoe Macpherson, 1993 *
Paramunida setigera Baba, 1988
Paramunida stichas Macpherson, 1993 *
Paramunida tenera Cabezas, Macpherson & Machordom, 2010 *
Paramunida thalie Macpherson, 1993 *
Plesionida aliena (Macpherson, 1996a) *
Plesionida psila Baba & de Saint Laurent, 1996 *
Raymunida bellior (Miyake & Baba, 1967)
Raymunida confundens Macpherson & Machordom, 2001 *
Raymunida dextralis Macpherson & Machordom, 2001 *
Torbenella calvata (Macpherson, 2006b) *
Torbenella insolita (Macpherson, 2004) *
Torbenella orbis (Baba, 2005)

MUNIDOPSISIDAE

Galacantha bellis Henderson, 1885
Galacantha quiqei Macpherson, 2007
Galacantha rostrata A. Milne Edwards, 1880
Leiogalatea laevirostris (Bals, 1913)
Munidopsis analoga Macpherson, 2007 *
Munidopsis andamanica MacGilchrist, 1905
Munidopsis arenula Macpherson, 2007 *
Munidopsis carinimarginata Baba, 1988
Munidopsis centrina Alcock & Anderson, 1894
Munidopsis ceres Macpherson, 2007 *
Munidopsis cornuata Macpherson, 2007 *
Munidopsis cylindrophthalma (Alcock, 1894)
Munidopsis debilis (Henderson, 1885)
Munidopsis kensleyi Ah Yong & Poore, 2004
Munidopsis latimana Miyake & Baba, 1966
Munidopsis nitida (A. Milne Edwards, 1880)
Munidopsis orcina McArdle, 1901
Munidopsis sinclairi McArdle, 1901
Munidopsis tafrii Osawa, Lin & Chan, 2006
Munidopsis ternaria Macpherson, 2007 *
Munidopsis treis Ah Yong & Poore, 2004
Munidopsis trifida Henderson, 1885

PAGURIDAE

Alainopaguroides megalophthalmus McLaughlin, 2006 *
Alainopagurus crosnieri Lemaître & McLaughlin, 1995 *
Anapagurus bonnierii Nobili, 1905
Catapagurus danida McLaughlin, 2002
Catapagurus franklinae McLaughlin, 2004a *
Catapagurus imperialis (Asakura, 2001)
Catapagurus spinicarpus de Saint Laurent & McLaughlin, 2000
Catapagurus tanimbarensis McLaughlin, 1997
Diacanthurus ecpHYMA McLaughlin & Forest, 1997 *
Diacanthurus richeri McLaughlin & Forest, 1997 *
Icelopagurus crosnieri McLaughlin, 1997

Icelopagurus undulatus McLaughlin, 2006 *
Michelopagurus limatulus (Henderson, 1888)
Micropagurus Polynesiansis (Nobili, 1906)
Micropagurus spinimanus Asakura, 2005 *
Nematopagurus alcocki McLaughlin, 1997
Nematopagurus australis (Henderson, 1888)
Nematopagurus diadema Lewinsohn, 1969
Nematopagurus gardineri Alcock, 1905
Nematopagurus indicus Alcock, 1905
Nematopagurus kosiensis McLaughlin, 1998
Nematopagurus lepidochirus (Doflein, 1902)
Nematopagurus lewinsohni Türkay, 1986
Nematopagurus meiringae McLaughlin, 1998
Nematopagurus ricei McLaughlin, 2004b *
Nematopagurus richeri McLaughlin, 2004b *
Nematopagurus scutelliformis McLaughlin, 1997
Nematopagurus spinulosensoris McLaughlin & Brock, 1974
Nematopagurus spongiparticeps McLaughlin, 2004b *
Nematopagurus vallatus (Melin, 1939)
Pagurojacquesia polymorpha (de Saint Laurent & McLaughlin, 1999)
Porcellanopagurus chiltoni de Saint Laurent & McLaughlin, 2000
Porcellanopagurus filholi de Saint Laurent & McLaughlin, 2000
Porcellanopagurus haptodactylus McLaughlin, 2000 *
Porcellanopagurus tridentatus Whitelegge, 1900
Propagurus haigae (McLaughlin, 1997)
Pteropagurus inermis McLaughlin & Rahayu, 2006 *
Pteropagurus spina McLaughlin & Rahayu, 2006 *
Pteropagurus spinulocarpus McLaughlin, 2007a *
Solitariopagurus triprobolus Poupin & McLaughlin, 1996
Solitariopagurus trullirostris McLaughlin, 2000 *
Solitariopagurus tuerkayi McLaughlin, 1997
Tomopaguroides valdividae (Bals, 1911)
Turleania boucheti McLaughlin, 2007b
Turleania multispina McLaughlin, 1997
Turleania senticosa (McLaughlin & Haig, 1996)
Xylopagurus caledonicus Forest, 1997 *

PARAPAGURIDAE

Oncopagurus conicus Lemaître, 2006 *
Paragiopagurus acutus (de Saint Laurent, 1972)
Paragiopagurus bicarinatus (de Saint Laurent, 1972)
Paragiopagurus boletifer (de Saint Laurent, 1972)
Paragiopagurus diogenes (Whitelegge, 1900)
Paragiopagurus hirsutus (de Saint Laurent, 1972)
Paragiopagurus orthotenes, Lemaître, this volume *
Paragiopagurus oxychelos, Lemaître, this volume *
Paragiopagurus ruticheles (A. Milne-Edwards, 1891)
Paragiopagurus schnauzer Lemaître, 2006 *
Paragiopagurus trilineatus, Lemaître, this volume *
Paragiopagurus umbonatus, Lemaître, this volume *
Parapagurus furici Lemaître, 1999 *
Parapagurus latimanus Henderson, 1888
Parapagurus richeri Lemaître, 1999 *
Strobopagurus breviacus Lemaître, 2004a *
Strobopagurus gracilipes (A. Milne-Edwards, 1891)
Strobopagurus sibogae (de Saint Laurent, 1972)
Sympagurus acinopus Lemaître, 1989 *
Sympagurus affinis (Henderson, 1888)
Sympagurus aurantium Lemaître, 2004b *

Sympagurus brevipes (de Saint Laurent, 1972)
Sympagurus burkenroadi Thompson, 1943
Sympagurus dofleini (Bals, 1912)
Sympagurus planimanus (de Saint Laurent, 1972)
Sympagurus poupini Lemaître, 1994
Sympagurus soela Lemaître, 1996 *
Sympagurus symmetricus Lemaître, 2004b *
Sympagurus trispinosus (Bals, 1911)
Sympagurus villosus Lemaître, 1996 *
Tylaspis anomala Henderson, 1885

PYLOCHELIDAE

Cheiroplatea pumicicola Forest, 1987
Trizocheles caledonicus Forest, 1987 *
Trizocheles pilgrimi Forest & McLaughlin, 2000
Trizocheles pulcher Forest, 1987 *
Trizocheles spinosus (Henderson, 1888)
Trizocheles vaubanae McLaughlin & Lemaître, 2008 *

BRACHYURA

AETHRIDAE

Aethra scruposa (Linnaeus, 1764)

CALAPPIDAE

Mursia armata De Haan, 1837
Mursia australiensis Campbell, 1971
Mursia longispina Crosnier, 1997b *
Mursia microspina Davie & Short, 1989
Mursia musorstomia Galil, 1993 *
Mursia trispinosa Parisi, 1914

CANCRIDAE

Platepistoma nanum Davie, 1991 *

CRYPTOCHIRIDAE

Cecidocarcinus zibrowii Manning, 1991 *

CYCLODORIPPIDAE

Ketamia depressa (Ihle, 1916)
Krangalangia orstom Tavares, 1993 *
Krangalangia spinosa (Zarenkov, 1970)
Tymalus daviei Tavares, 1997
Xeinostoma richeri Tavares, 1993 *

CYMONOMIDAE

Elassopodus stellatus Tavares, 1993 *

DROMIIDAE

Cryptodromia coronata Stimpson, 1858
Cryptodromia hilgendorfi de Man, 1888
Eodromia denticulata McLay, 1993 *
Epigodromia areolata (Ihle, 1913)
Epigodromia ebalioides (Alcock, 1899)
Epigodromia nodosa Sakai, 1936
Epigodromia rotunda McLay, 1993 *
Frodromia atypica (Sakai, 1936)
Lewindromia unidentata (Rüppell, 1830)
Metadromia wilsoni (Fulton & Grant, 1920)
Petalomera pulchra Miers, 1884
Sphaerodromia lamellata Crosnier, 1994 *

Stimdromia foresti (McLay, 1993) *
Takedromia cristatipes (Sakai, 1969)
Takedromia longispina McLay, 1993 *

DYNOMENIDAE

Dynomene hispida (Latreille, in Milbert, 1812)
Dynomene pilumnoides Alcock, 1900
Metadynomene tanensis (Yokoya, 1933)
Paradynomene deman McLay & Ng, 2004 *
Paradynomene diablo McLay & Ng, 2004 *
Paradynomene quasimodo McLay & Ng, 2004
Paradynomene tuberculata Sakai, 1963

EPIALTIIDAE

Guinotinia cordis Richer de Forges & Ng, 2009a *
Oxypleurodon alaini Richer de Forges & Ng, 2009b *
Oxypleurodon mammatum (Guinot & Richer de Forges, 1986b) *
Oxypleurodon orbiculatum (Guinot & Richer de Forges, 1986a) *
Oxypleurodon stuckiae (Guinot & Richer de Forges, 1986a) *
Stegopleurodon planirostrum Richer de Forges & Ng, 2009b *

ETHUSIDAE

Ethusa abbreviata Castro, 2005a
Ethusa crosnieri Chen, 1993 *
Ethusa curvipes Chen, 1993 *
Ethusa furca Chen, 1993 *
Ethusa granulosa Ihle, 1916
Ethusa indica Alcock, 1894
Ethusa izuensis Sakai, 1937
Ethusa magnipalmata Chen, 1993 *
Ethusa minuta Sakai, 1937
Ethusa obliquegens Chen, 1993 *
Ethusa orientalis Miers, 1886
Ethusa parapygmaea Chen, 1993 *
Ethusa pygmaea Alcock, 1894
Ethusa quadrata Sakai, 1937
Ethusina brevidentata Chen, 1993 *
Ethusina ciliacirrata Castro, 2005a
Ethusina coronata Castro, 2005a
Ethusina dilobotus Chen, 1993 *
Ethusina microspina Chen, 2000
Ethusina paralongipes Chen, 1993 *
Ethusina pubescens Chen, 1993 *
Ethusina robusta (Miers, 1886)
Ethusina stenommata Castro, 2005a
Ethusina vanuatuensis Chen, 2000

EURYPLACIDAE

Eucrate laevis (Borradaile, 1903)

GERYONIDAE

Chaceon bicolor Manning & Holthuis, 1989 *

GONEPLACIDAE

Carcinoplax cooki Rathbun 1906
Carcinoplax cracens Castro, 2007 *
Carcinoplax ischurodous (Stebbing, 1923)
Carcinoplax specularis Rathbun, 1914
Carcinoplax tenuidentata Castro, 2007
Carcinoplax tuberosa Castro, 2007 *

Carcinoplax uncinata Castro, 2009 *
Goneplacoides marivenae (Komatsu & Takeda, 2004)
Menoplax longispinosa (Chen, 1984)
Microgoneplax elegans (Chen, 1998)
Microgoneplax prion Castro, 2007 *
Neogoneplax renoculus (Rathbun, 1914)
Neogoneplax serratipes Castro, 2007 *
Paragoneplax serenei (Zarenkov, 1972)
Psopheticus stridulans Wood-Mason, 1892
Psopheticus vocans Guinot, 1985
Pycnoplax aspera Castro, 2009 *
Pycnoplax surugensis (Rathbun, 1932)
Thyraplax cooki (Rathbun, 1906)
Thyraplax crosnieri (Guinot & Richer de Forges, 1981a) *
Thyraplax truncata Castro, 2007

HEXAPODIDAE

Hexaplax megalops Doflein, 1904

HOMOLIDAE

Dagnaudus petterdi (Grant, 1905)
Homola coriolisi Guinot & Richer de Forges, 1995 *
Homola mieensis Sakai, 1979
Homola orientalis Henderson, 1888
Homola ranunculus Guinot & Richer de Forges, 1995 *
Homolochunia kullar Griffin & Brown, 1976
Homolochunia valdiviae Doflein, 1904
Homologenus levii Guinot & Richer de Forges, 1995 *
Homolomania sibogae Ihle, 1912
Ihlopsis tirardi Guinot & Richer de Forges, 1995 *
Lamoha inflata (Guinot & Richer de Forges, 1981b) *
Latreillopsis antennata Guinot & Richer de Forges, 1995 *
Latreillopsis bispinosa Henderson, 1888
Latreillopsis gracilipes Guinot & Richer de Forges, 1981b *
Moloha majora (Kubo, 1936)
Paromola bathyalis Guinot & Richer de Forges, 1995 *
Paromolopsis boasi Wood-Mason & Alcock, 1891

HOMOLODROMIIDAE

Dicranodromia foersteri Guinot, 1993 *
Dicranodromia spinulata Guinot, 1995 *
Homolodromia kai Guinot, 1993

HYPOTHALASSIIDAE

Hypothalassia armata (De Haan, 1835)

INACHIDAE

Cyrtomaia coriolisi Richer de Forges & Guinot, 1988 *
Cyrtomaia cornuta Richer de Forges & Guinot, 1988 *
Cyrtomaia ericina Guinot & Richer de Forges, 1982 *
Cyrtomaia furici Richer de Forges & Guinot, 1988 *
Cyrtomaia griffini Richer de Forges & Guinot, 1990
Cyrtomaia horrida Rathbun, 1916
Cyrtomaia ihlei Guinot & Richer de Forges, 1982 *
Cyrtomaia platypes Yokoya, 1933
Grypachaeus hyalinus Alcock & Anderson, 1894
Platymaia fimbriata Rathbun, 1916
Platymaia rebierei Guinot & Richer de Forges, 1986a
Platymaia wyvillethomsoni Miers, 1886
Pleistacantha cervicornis Ihle & Ihle-Landenberg, 1931

Pleistacantha exophthalmus Guinot & Richer de Forges, 1982 *
Pleistacantha cf japonica (Yokoya, 1933)

LATREILLIIDAE

Eplumula australiensis (Henderson, 1888)
Latreillia metanasa Williams, 1982
Latreillia pennifera Alcock, 1900
Latreillia valida De Haan, 1839

LEUCOSIIDAE

Alox ornatum (Ihle, 1918)
Ancylodactyla elata (Zarenkov, 1994)
Ancylodactyla elongata (Zarenkov, 1969)
Ancylodactyla nana (Zarenkov, 1990)
Arcania elongata Yokoya, 1933
Arcania tuberculata Bell, 1855
Galilia narusei Ng & Richer de Forges, 2007 *
Myra curtimana Galil, 2001a *
Myra eudactylus (Bell, 1855)
Myra fugax (Fabricius, 1798)
Tanaoa serenei (Richer de Forges, 1983) *
Toru septimus Galil, 2003 *
Umalana granulimera Galil, 2005

MATHILDELLIDAE

Intesius pilosus Guinot & Richer de Forges, 1981a *
Intesius richeri Crosnier & Ng, 2004 *
Mathildella maxima Guinot & Richer de Forges, 1981a *
Platypilumnus jamiesoni Richer de Forges, 1996 *

OZIIDAE

Eupilumnus laciniatus (Sakai, 1980)

PALICIDAE

Miropallicus vietnamensis (Zarenkov, 1968)
Palliculus kyusyuensis (Yokoya, 1933)
Parapallicus ambonensis Moosa & Serène, 1981
Parapallicus clinodentatus Castro, 2000
Parapallicus denticulatus Castro, 2000 *
Parapallicus inanis Castro, 2000 *
Parapallicus piruensis Moosa & Serène, 1981
Parapallicus trispinalis Castro, 2000
Pseudopallicus acanthodactylus Castro, 2000 *
Pseudopallicus amadaibai (Sakai, 1963)
Pseudopallicus declivis Castro, 2000 *
Pseudopallicus glaber Castro, 2000 *
Pseudopallicus investigatoris (Alcock, 1900)
Pseudopallicus oahuensis (Rathbun, 1906)
Rectopallicus amphiceros Castro, 2000 *
Rectopallicus ampullatus Castro, 2000 *
Rectopallicus woodmasoni (Alcock, 1900)

PARTHENOPIIDAE

Garthambrus pouppini (Garth, 1993)
Pseudolambrus guinotae Tan, 2010 *

PHYLLOTY MOLINIDAE

Genkaia keijii Tavares, 1993 *
Phyllopolinolum crosnieri Tavares, 1993 *

PILUMNIDAE

Eumedonus breviryhynchus Chia & Ng, 2000 *

PLAGUSIIDAE

Euchirograpsus timorensis Türkay, 1975

Miersiograpsus australiensis Türkay, 1978

POLYBIIDAE

Benthochascon hemingi Alcock & Anderson, 1899

Brusinia elongata (Sakai, 1969)

Brusinia profunda Moosa, 1996 *

Ovalipes iridescens (Miers, 1886)

Parathranites granosus Crosnier, 2002b

Parathranites intermedius Crosnier, 2002b *

Parathranites orientalis (Miers, 1886)

PORTUNIDAE

Charybdis (Charybdis) rufodactylus Stephenson & Rees, 1968

Cycloachelous orbitosinus (Rathburn, 1911)

Echinolatus caledonicus (Moosa, 1996) *

Liocarcinus vernalis (Risso, 1816)

Lissocarcinus polybiodes Adams & White, 1849

Lupocyclus philippinensis Semper, 1880

Lupocyclus tugelae Barnard, 1950

Nectocarcinus pubescens Moosa, 1996 *

Portunus (Monomia) gladiator Fabricius, 1798

Portunus (Monomia) lecromi Moosa, 1996 *

Portunus (Xiphonectes) hastatoides Fabricius, 1798

Portunus (Xiphonectes) stephensoni Moosa, 1981 *

Thalamita spinifera Borradaile, 1902

PROGERYONIDAE

Progeryon vaubani Guinot & Richer de Forges, 1981a *

Rhadinoplax microphthalmus (Guinot & Richer de Forges, 1981a) *

RANINIDAE

Cosmonotus mcLaughlinae Tavares, 2006

Lyreidus brevifrons Sakai, 1937

Ranina ranina (Linnaeus, 1758)

RETROPLUMIDAE

Retropluma serenei Saint Laurent, 1989

Retropluma solomonensis McLay, 2006

TRAPEZIIDAE

Calocarcinus africanus Calman, 1909

Calocarcinus crosnieri Galil & Clark, 1990 *

Quadrella maculosa Alcock, 1898

TRICHOPELTARIIDAE

Trichopeltarion vanuatuensis Tavares & Cleva, 2010

XANTHIDAE

Alainodaeus alis Davie, 1997 *

Alainodaeus rimatara Davie, 1993

Antrocarcinus petrosus Ng & Chia, 1994 *

Demiaia cultripes (Alcock, 1898)

Demiaia garthi Guinot & Richer de Forges, 1981a *

Demiaia intermedia Guinot, 1969

Demiaia mortenseni (Odhner, 1925)

Demiaia wardi Garth & Ng, 1985

Euryxanthops latifrons Davie, 1997 *

Gaillardiiellus bathus Davie, 1997 *

Glyptocarcinus politus Ng & Chia, 1994 *

Liomera nigrimanus Davie, 1997 *

Lophozozymus bertoncinae Guinot & Richer de Forges, 1981a *

Medaeops gemini Davie, 1997 *

Medaeops merodontos Davie, 1997 *

Medaeus aztec Davie, 1997 *

Meractaea multidentata Davie, 1997 *

Miersiella haswelli (Miers, 1886)

Palatigum trichostoma Davie, 1997 *

Paramedaeus globosus Serène & Vadon, 1981 *

Paraxanthodes cumatodes (MacGilchrist, 1905)

Rata chalcas Davie, 1997 *

Xanthias teres Davie, 1997 *

APPENDIX 3

New species of decapod crustaceans (recorded below 100 m depth) described from South Pacific island groups (other than New Caledonia) based on the *Tropical Deep-Sea Benthos* expeditions material. For references, see Appendix 4.

PENAEOIDEA		
PENAEIDAE		
<i>Parapenaeus cayrei</i> Crosnier, 2005	Tonga	<i>Plesionika flavicauda</i> Chan & Crosnier, 1991
SOLENOCERIDAE		<i>Plesionika payeni</i> Chan & Crosnier, 1997
<i>Maximiliaeus odoceros</i> Chan, 2012	PNG	<i>Plesionika picta</i> Chan & Crosnier, 1997
STENOPODIDEA		<i>Plesionika poupini</i> Chan & Crosnier, 1997
SPONGICOLIDAE		<i>Plesionika protati</i> Chan & Crosnier, 1997
<i>Globospongicola spinulatus</i> Komai & Saito, 2006	Vanuatu	<i>Plesionika rubrior</i> Chan & Crosnier, 1991
CARIDEA		STYLODACTYLIDAE
CRANGONIDAE		<i>Stylodactylus brucei</i> Cleve, 1994
<i>Metacrangon clevai</i> Komai, 2012	Solomon	
<i>Parapontophilus cornutus</i> Komai, 2008	French Polynesia	ASTACIDEA
<i>Parapontophilus difficilis</i> Komai, 2008	Vanuatu	ENOPLOMETOPIIDAE
<i>Parapontophilus longirostris</i> Komai, 2008	French Polynesia	<i>Enoplometopus gracilipes</i> (de Saint Laurent, 1988)
<i>Parapontophilus stenorhinus</i> Komai, 2008	Tonga	
GLYPHOCRANGONIDAE		AXIIDAE
<i>Glyphocrangon arduus</i> Komai, 2007	French Polynesia	<i>Acanthaxius clevai</i> Ngoc-Ho, 2006
<i>Glyphocrangon boa</i> Komai, 2011	Vanuatu	
<i>Glyphocrangon musorstomia</i> Komai, 2006	Wallis & Futuna	STRAHLAXIIDAE
<i>Glyphocrangon prostrata</i> Komai, 2011	Solomon	<i>Neaxius trondlei</i> Ngoc-Ho, 2005
<i>Glyphocrangon richeri</i> Komai, 2004b	Wallis & Futuna	
<i>Glyphocrangon rubricinctata</i> Komai, 2004b	Wallis & Futuna	THOMASSINIIDAE
<i>Glyphocrangon similior</i> Komai, 2004b	Vanuatu	<i>Crosniera dayrati</i> Ngoc-Ho, 2005
HYPPOLYTIDAE		
<i>Eumannigia pliarthron</i> Crosnier, 2000	Wallis & Futuna	ACHELATA
NEMATOCARCINIDAE		PALINURIDAE
<i>Nematocarcinus machaerophorus</i> Burukovsky, 2003	French Polynesia	<i>Nupalirus vericeli</i> (Poupin, 1994)
PALAEEMONIDAE		<i>Puerulus richeri</i> Chan, Ma & Chu, this volume
<i>Izucaris crosnieri</i> Li, 2008	French Polynesia	
<i>Palaemonella komaii</i> Li & Bruce, 2006	Tonga	SCYLLARIDAE
<i>Periclimenes paracocki</i> Li & Bruce, 2006	Wallis & Futuna	<i>Eduarctus marginatus</i> Holthuis, 2002
<i>Periclimenes poupini</i> Bruce, 1989	French Polynesia	<i>Galearctus rapanus</i> (Holthuis, 1993)
PANDALIDAE		<i>Chelarctus crosnieri</i> Holthuis, 2002
<i>Heterocarpus amacula</i> Crosnier, 1988b	French Polynesia	
<i>Heterocarpus corona</i> Yang, Chan & Chu, 2010	Vanuatu	POLYCHELIDA
<i>Heterocarpus tenuidentatus</i> Cleve & Crosnier, 2006	Solomon	POLYCHELIDAE
<i>Plesionika bimaculata</i> Chan, 2004	Vanuatu	<i>Stereomastis alis</i> (Ahyong & Galil, 2006)
<i>Plesionika carsini</i> Crosnier, 1986a	French Polynesia	
<i>Plesionika curvata</i> Chan & Crosnier, 1991	French Polynesia	ANOMURA
<i>Plesionika erythrocyclus</i> Chan & Crosnier, 1997	French Polynesia	ALBUNEIDAE
<i>Plesionika fenneri</i> Crosnier, 1986b	French Polynesia	<i>Albunea marquisiana</i> Boyko, 2000

DIOGENIDAE

<i>Calcinus albengai</i> Poupin & Lemaître, 2003	French Polynesia
<i>Calcinus anani</i> Poupin & McLaughlin, 1998	French Polynesia
<i>Calcinus gouti</i> Poupin, 1997	French Polynesia
<i>Ciliopagurus major</i> Forest, 1995	French Polynesia
<i>Ciliopagurus pacificus</i> Forest, 1995	French Polynesia
<i>Ciliopagurus plessisi</i> Forest, 1995	French Polynesia
<i>Strigopagurus poupini</i> Forest, 1995	French Polynesia

EUMUNIDIDAE

<i>Eumunida treguierei</i> de Saint Laurent & Poupin, 1996	French Polynesia
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GALATHEIDAE

<i>Galathea profunda</i> Macpherson, 2012	Vanuatu
<i>Galathea raventosae</i> Macpherson, 2012	Vanuatu
<i>Galathea sanctae</i> Macpherson, 2012	Vanuatu

LITHODIDAE

<i>Lithodes megacantha</i> Macpherson, 1991	French Polynesia
<i>Paralomis arae</i> Macpherson, 2001	Fiji
<i>Paralomis mendagnai</i> Macpherson, 2003	Solomon

MUNIDIDAE

<i>Agononida aequabilis</i> Macpherson, 2006a	French Polynesia
<i>Agononida alisae</i> Macpherson, 1999	Vanuatu
<i>Agononida garciai</i> Macpherson, 2004	Fiji
<i>Agononida imitata</i> Macpherson, 2006a	French Polynesia
<i>Agononida isabelensis</i> Cabezas, Macpherson & Machordom, 2009	Solomon
<i>Agononida simillima</i> Macpherson, 2006a	French Polynesia
<i>Anoplionida patae</i> MacPherson & Baba, 2006	Tonga
<i>Babamunida corniculata</i> Macpherson, this volume	French Polynesia
<i>Babamunida hystrix</i> (Macpherson & de Saint Laurent, 1991)	French Polynesia
<i>Babamunida plexaura</i> (Macpherson & de Saint Laurent, 1991)	French Polynesia
<i>Bathymunida avatea</i> MacPherson & Baba, 2006	French Polynesia
<i>Bathymunida dissimilis</i> Baba & de Saint Laurent, 1996	Wallis & Futuna
<i>Bathymunida recta</i> Baba & de Saint Laurent, 1996	Wallis & Futuna
<i>Crosnierita tucanae</i> Macpherson, 2004	Fiji
<i>Crosnierita yante</i> (Macpherson, 1994)	French Polynesia
<i>Heteronida clivicola</i> MacPherson & Baba, 2006	French Polynesia
<i>Munida abelloi</i> Macpherson, 1994	Wallis & Futuna
<i>Munida amathea</i> Macpherson & de Saint Laurent, 1991	French Polynesia
<i>Munida angusta</i> Macpherson, 2004	Tonga
<i>Munida antliae</i> Macpherson, 2006a	French Polynesia
<i>Munida apheles</i> Macpherson, 2006a	French Polynesia
<i>Munida apodis</i> Macpherson, 2004	Tonga
<i>Munida arae</i> Macpherson, 2006a	French Polynesia
<i>Munida atarapa</i> Macpherson, this volume	French Polynesia
<i>Munida caeli</i> Cabezas, Macpherson & Machordom, 2009	Solomon
<i>Munida clevai</i> Macpherson, 2009	Vanuatu
<i>Munida columbae</i> Macpherson, 2006a	French Polynesia
<i>Munida congesta</i> Macpherson, 1999	Vanuatu
<i>Munida cornuta</i> Macpherson, 1994	Fiji
<i>Munida descensa</i> Macpherson, 2006a	French Polynesia
<i>Munida erugata</i> Macpherson, 2006a	French Polynesia
<i>Munida fasciata</i> Macpherson, 2006a	French Polynesia
<i>Munida fornacis</i> Macpherson, 2006a	French Polynesia

<i>Munida galaxaura</i> Macpherson, 1996b	Wallis & Futuna
<i>Munida glabella</i> Macpherson, 2000	French Polynesia
<i>Munida ignea</i> Macpherson, 2006a	French Polynesia
<i>Munida lailai</i> Cabezas, Macpherson & Machordom, 2009	Solomon
<i>Munida lenticularis</i> Macpherson & de Saint Laurent, 1991	French Polynesia
<i>Munida limatula</i> Macpherson, 2004	Tonga
<i>Munida llenasi</i> Macpherson, 2006a	French Polynesia
<i>Munida longicheles</i> Macpherson & de Saint Laurent, 1991	French Polynesia
<i>Munida masoae</i> Macpherson, 1996b	Wallis & Futuna
<i>Munida mendagnai</i> Cabezas, Macpherson & Machordom, 2009	Solomon
<i>Munida micula</i> Macpherson, 1996b	Wallis & Futuna
<i>Munida miniata</i> Macpherson, 1996b	Wallis & Futuna
<i>Munida oblonga</i> Macpherson, 2006a	French Polynesia
<i>Munida oblongata</i> Cabezas, Macpherson & Machordom, 2009	Solomon
<i>Munida ocellata</i> Macpherson & de Saint Laurent, 1991	French Polynesia
<i>Munida offella</i> Macpherson, 1996b	Wallis & Futuna
<i>Munida pasithea</i> Macpherson & de Saint Laurent, 1991	French Polynesia
<i>Munida pavonis</i> Macpherson, 2004	Tonga
<i>Munida polynoe</i> Macpherson & de Saint Laurent, 1991	French Polynesia
<i>Munida profunda</i> Macpherson & de Saint Laurent, 1991	French Polynesia
<i>Munida pumila</i> Macpherson, 2004	Tonga
<i>Munida rona</i> Macpherson, this volume	French Polynesia
<i>Munida rubella</i> Macpherson & de Saint Laurent, 1991	French Polynesia
<i>Munida rubrovata</i> Macpherson & de Saint Laurent, 1991	French Polynesia
<i>Munida spissa</i> Macpherson, 1996b	Wallis & Futuna
<i>Munida squarrosa</i> Macpherson, 2009	Vanuatu
<i>Munida volantis</i> Macpherson, 2004	Fiji
<i>Neonida grandis</i> Baba & de Saint Laurent, 1996	Vanuatu
<i>Onconida gemini</i> Baba & de Saint Laurent, 1996	Vanuatu
<i>Onconida modica</i> Baba & de Saint Laurent, 1996	Wallis & Futuna
<i>Onconida prostrata</i> Baba & de Saint Laurent, 1996	Wallis & Futuna
<i>Paramunida achernar</i> Cabezas, Macpherson & Machordom, 2010	Tonga
<i>Paramunida amphitrita</i> Macpherson, 1996b	Wallis & Futuna
<i>Paramunida ascella</i> Cabezas, Macpherson & Machordom, 2010	Vanuatu
<i>Paramunida cretata</i> Macpherson, 1996b	Wallis & Futuna
<i>Paramunida cristata</i> Macpherson, 2004	Fiji
<i>Paramunida curvata</i> Macpherson, 2004	Fiji
<i>Paramunida echinata</i> Macpherson, 2000	French Polynesia
<i>Paramunida labis</i> Macpherson, 1996b	Wallis & Futuna
<i>Paramunida lophia</i> Cabezas, Macpherson & Machordom, 2009	Solomon
<i>Paramunida luminata</i> Macpherson, 1996b	Wallis & Futuna
<i>Paramunida poorei</i> Cabezas, Macpherson & Machordom, 2010	French Polynesia
<i>Paramunida salai</i> Cabezas, Macpherson & Machordom, 2009	Solomon
<i>Paramunida spatula</i> Macpherson, 2006a	French Polynesia
<i>Paramunida spica</i> Cabezas, Macpherson & Machordom, 2010	Vanuatu
<i>Plesionida concava</i> Cabezas, Macpherson & Machordom, 2009	Solomon
<i>Raymunida cagnetei</i> Macpherson & Machordom, 2000	French Polynesia
<i>Raymunida erythrina</i> Macpherson & Machordom, 2001	Wallis & Futuna
<i>Raymunida limbata</i> Macpherson, 2006a	French Polynesia
<i>Setanida cristata</i> Macpherson, 2006a	French Polynesia

MUNIDOPSISIDAE

<i>Galacantha quiqei</i> Macpherson, 2007	Wallis & Futuna
<i>Munidopsis austellus</i> Macpherson, 2007	French Polynesia
<i>Munidopsis bruta</i> Macpherson, 2007	Solomon

<i>Munidopsis concava</i> Macpherson, 2007	Fiji
<i>Munidopsis demeter</i> Macpherson, 2007	Solomon
<i>Munidopsis denudata</i> Macpherson, 2007	Solomon
<i>Munidopsis keijii</i> Macpherson, 2007	Solomon
<i>Munidopsis pericalla</i> Macpherson, 2007	Solomon
<i>Munidopsis strigula</i> Macpherson, 2007	Solomon
<i>Munidopsis zarazagai</i> Macpherson, 2007	Vanuatu

PAGURIDAE

<i>Lithopagurus boucheti</i> McLaughlin & Lemaitre, 2004	Fiji
<i>Micropagurus bijdeleyi</i> Lemaitre, 2010	French Polynesia
<i>Pagurojaquesia polymorpha</i> (de Saint Laurent & McLaughlin, 1999)	Vanuatu
<i>Solitariopagurus triprobolus</i> Poupin & McLaughlin, 1996	French Polynesia
<i>Turleania boucheti</i> McLaughlin, 2007b	Wallis&Futuna

PARAPAGURIDAE

<i>Oncopagurus oimos</i> Lemaitre, 1998	French Polynesia
<i>Oncopagurus tuamotu</i> Lemaitre, 1994	French Polynesia
<i>Paragiopagurus bougainvillei</i> (Lemaitre, 1994)	French Polynesia
<i>Paragiopagurus fasciatus</i> Lemaitre & Poupin, 2003	French Polynesia
<i>Paragiopagurus trilineatus</i> Lemaitre, this volume	Tonga
<i>Paragiopagurus wallisi</i> (Lemaitre, 1994)	French Polynesia
<i>Sympagurus poupini</i> Lemaitre, 1994	French Polynesia

PYLOCHELIDAE

<i>Bathycheles phenax</i> McLaughlin & Lemaitre, 2009	Fiji
<i>Trizocheles mendanai</i> McLaughlin & Lemaitre, 2009	Solomon

BRACHYURA**CALAPPIDAE**

<i>Calappa sebastieni</i> Galil, 1997	French Polynesia
<i>Mursia diwata</i> Galil & Takeda, 2004	Vanuatu
<i>Mursia poupini</i> Galil, 2001	French Polynesia

CYCLODORIPPIDAE

<i>Ketamia limatula</i> Tavares, 1993	Vanuatu
<i>Tymolus daviei</i> Tavares, 1997	Vanuatu

DYNOMENIDAE

<i>Metadynomene tuamotu</i> Ng & McLay, 2010	French Polynesia
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DROMIIDAE

<i>Cryptodromia erioxylon</i> McLay, 2001	French Polynesia
<i>Cryptodromia marquesas</i> McLay, 2001	French Polynesia
<i>Sphaerodromia ducousoi</i> McLay, 1991	French Polynesia

EPIALTIIDAE

<i>Garthinia disica</i> Richer de Forges & Ng, 2009a	Solomon
<i>Guinotinia lehouarnoi</i> Richer de Forges & Ng, 2009a	Fiji
<i>Naxioides teatui</i> Poupin, 1995	French Polynesia
<i>Naxioides vaitahu</i> Poupin, 1995	French Polynesia
<i>Oxypleurodon barazeri</i> Richer de Forges & Ng, 2009b	Solomon
<i>Oxypleurodon christiani</i> Richer de Forges & Corbari, 2012	PNG
<i>Oxypleurodon parallelum</i> Richer de Forges & Ng, 2009b	Solomon
<i>Oxypleurodon tavaresi</i> Richer de Forges, 1995	Wallis & Futuna
<i>Rochinia boucheti</i> Richer de Forges & Ng, this volume	Solomon

ETHUSIDAE

<i>Ethusa abbreviata</i> Castro, 2005a	Vanuatu
<i>Ethusa barbata</i> Castro, 2005a	Solomon
<i>Ethusa crassipodia</i> Castro, 2005a	Solomon
<i>Ethusina ciliacirrata</i> Castro, 2005a	Vanuatu
<i>Ethusina coronata</i> Castro, 2005a	Solomon
<i>Ethusina crenulata</i> Castro, 2005a	French Polynesia
<i>Ethusina exophthalma</i> Castro, 2005a	Fiji
<i>Ethusina huiliana</i> Castro, 2005a	French Polynesia
<i>Ethusina microspina</i> Chen, 2000	Vanuatu
<i>Ethusina ocellata</i> Castro, 2005a	Solomon
<i>Ethusina stenommata</i> Castro, 2005a	Wallis & Futuna
<i>Ethusina vanuatuensis</i> Chen, 2000	Vanuatu
<i>Parethusia hylophora</i> Castro, 2005a	Solomon
<i>Serpenthusa brucei</i> Naruse, Castro & Ng, 2009	Vanuatu

GERYONIDAE

<i>Chaceon australis</i> Manning, 1993	French Polynesia
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GONEPLACIDAE

<i>Carcinoplax tenuidentata</i> Castro, 2007	Fiji
<i>Carcinoplax velutina</i> Castro, 2007	French Polynesia
<i>Guinoplax aphaeles</i> Castro & Ng, 2010	Fiji
<i>Microgoneplax cope</i> Castro, 2007	Wallis & Futuna
<i>Thyraplax cristata</i> Castro, 2007	French Polynesia
<i>Thyraplax digitodentata</i> Castro, 2007	French Polynesia
<i>Thyraplax truncata</i> Castro, 2007	Fiji

HOMOLIDAE

<i>Homola poupini</i> Richer de Forges & Ng, 2007	French Polynesia
<i>Homolochunia menezis</i> Richer de Forges & Ng, 2008b	Solomon
<i>Homologenus broussei</i> Guinot & Richer de Forges, 1981b	French Polynesia
<i>Homologenus wallis</i> Guinot & Richer de Forges, 1995	Wallis & Futuna
<i>Lamoha longirostris</i> (Chen, 1986)	Wallis & Futuna
<i>Lamoha personata</i> (Guinot & Richer de Forges, 1981b)	Vanuatu
<i>Yaldwynopsis guinotae</i> Richer de Forges & Ng, 2007	French Polynesia

INACHIDAE

<i>Cyrtomaia polynesica</i> Richer de Forges & Ng, 2008a	French Polynesia
<i>Platymaia rebierei</i> Guinot & Richer de Forges, 1986a	Vanuatu
<i>Pleisticanthoides piccardorum</i> Ng & Richer de Forges, 2012	PNG

LEUCOSIIDAE

<i>Euclosiana guinotae</i> Galil & Ng, 2010	Vanuatu
<i>Euclosiana vella</i> (Galil, 2007)	Solomon
<i>Tanaoa nanus</i> Galil, 2003	Vanuatu
<i>Tokoyo cirrata</i> Galil, 2003	Vanuatu
<i>Urnalana granulimera</i> Galil, 2005	Fiji

MATHILDELLIDAE

<i>Beuroisia manquenei</i> Guinot & Richer de Forges, 1981a	French Polynesia
<i>Intesius crosnieri</i> Davie, 1998	French Polynesia

PALICIDAE

<i>Neopalicus simulus</i> Castro, 2010	French Polynesia
<i>Parapalicus armatus</i> Castro, 2000	Vanuatu
<i>Parapalicus clinodentatus</i> Castro, 2000	Vanuatu
<i>Parapalicus inermis</i> Castro, 2000	Fiji

<i>Pseudopalicus pictus</i> Castro, 2000	Vanuatu	TRICHOPELTARIIDAE	
PLAGUSIIDAE		<i>Trichopeltarion dejouanneti</i> Tavares & Cleva, 2010	Solomon
<i>Euchirograpsus tuerkayi</i> Crosnier, 2001	French Polynesia	<i>Trichopeltarion parvum</i> Tavares & Cleva, 2010	Solomon
POLYBIIDAE		<i>Trichopeltarion vanuatuensis</i> Tavares & Cleva, 2010	Vanuatu
<i>Parathranites parahexagonus</i> Crosnier, 2002b	French Polynesia	<i>Sphaeropeltarion edentatum</i> Tavares & Cleva, 2010	Wallis & Futuna
<i>Parathranites tuberosus</i> Crosnier, 2002b	French Polynesia	XANTHIDAE	
PORTUNIDAE		<i>Alainodaeus akiaki</i> Davie, 1993	French Polynesia
<i>Echinolatus proximus</i> Davie & Crosnier, 2006	French Polynesia	<i>Alainodaeus nuku</i> Davie, 1997	French Polynesia
<i>Laleonectes stridens</i> Crosnier & Moosa, 2002	French Polynesia	<i>Alainodaeus rimatara</i> Davie, 1993	French Polynesia
<i>Thalamita difficilis</i> Crosnier, 2002a	French Polynesia	<i>Banareia fatuhiva</i> Davie, 1993	French Polynesia
PROGERYONIDAE		<i>Epistocavea mururoa</i> Davie, 1993	French Polynesia
<i>Progeryon mararae</i> Guinot & Richer de Forges, 1981a	French Polynesia	<i>Lipkembra rufomaculata</i> (Davie, 1993)	French Polynesia
PSEUDOZIIDAE		<i>Medaeus grandis</i> Davie, 1993	French Polynesia
<i>Euryozius danielae</i> Davie, 1993	French Polynesia	<i>Meractaea tafai</i> Davie, 1993	French Polynesia
RETROPLUMIDAE		<i>Paramedaeus megagomphios</i> Davie, 1997	Wallis & Futuna
<i>Retropluma solomonensis</i> McLay, 2006	Solomon	<i>Paraxanthodes polynesiensis</i> Davie, 1993	French Polynesia
TRAPEZIIDAE		<i>Rata tuamotense</i> Davie, 1993	French Polynesia
<i>Hexagonalia unidentata</i> Castro, 2005b	Salomon		

APPENDIX 4

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