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Chapter 1. Introduction to the Isopoda

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Identification of species, the most fundamental unit in taxonomy, is the essential first step of any biological study. This introduction to a guidebook to families and genera of marine isopods of the world outlines the significance of isopods in marine environments, summarises taxonomical research, explains how the guidebook provides access to what has been written before, and lays out the conventions and information contained in subsequent chapters.

Keywords Isopoda, history, resources

Introduction

Identification of species, the most fundamental unit in taxonomy, is the essential first step of any biological study. Confidence in any report on a species' ecology, physiology or behaviour, and trust in a species list in multispecies research, depend on the study organism, or organisms, being reliably labelled with their current scientifically accepted name. Knowing that one's target organism is several species rather than one, or vice versa, has considerable impact on the conclusions that can be drawn (Schram and Ng, 2012).

Naming of species is managed by taxonomists and is governed by rules and conventions (International Commission on Zoological Nomenclature, 1999). Using the taxonomic literature to ensure that the subject of a researcher's study is identified correctly can be difficult for a non-taxonomist, and troublesome for anyone not familiar with all families in a particular group. Names and the classificatory hierarchy may change with time in the light of research on taxonomic affinities and relationships, but such changes are traceable. The problem is exacerbated in multispecies projects. This guidebook aims to enable biologists to identify any marine isopod to the level of family and genus. The dichotomous keys lead to diagnoses of 86 families, nine subfamilies (of Bopyridae) and 891 genera. A guidebook of over 400 pages cannot be a resource for identification to the species level, but references to key literature are included that should facilitate more precise identification.

Isopods, order Isopoda, are members of Crustacea, a group that includes crayfish, crabs, shrimps and lobsters. Not being large or otherwise easily noticed, marine isopods have few common names, although pill bug (for those that can roll up), sand louse or sea louse (for those that scavenge), fish louse (for those that parasitise fishes), sea centipede (for thin species associated with plants), gribble (for those bore into wood or algae) and sponge mite (for those associated with sponges) are some names adopted by an Australian authority in the 1920s (Hale, 1929). Terrestrial isopods, not covered in this work, are known as slaters or woodlice.

Crustaceans play critical roles in the ecology of the oceans, acting as important trophic links, including as scavengers, predators, parasites and food for many of their cohabitants. Crustaceans range in size from 0.1 mm in maximum diameter (a tantulocarid parasite) to 4 m across (a Japanese spider crab). One species of oceanic copepod, *Oithona similis* Claus, 1866 may be the most common animal on earth (Gallienne and Robins, 2001). Additionally, crustaceans have been found almost as far back in the fossil record as any group of complex animals.

Crustacea generally are most diverse in the marine environment (77% of species occur in the sea) (Poore and Ahyong, 2023) but are represented in fresh water and on land. Isopods are similarly wide-ranging. The global number of marine animals for which we have accepted names is almost 300,000 (as of 21 March 2025), of which 23% (almost 67,000) are crustaceans (Appeltans et al., 2012; Poore and Ahyong, 2023; Vandepitte et al., 2024). On 21 March 2025 the *World Marine, Freshwater and Terrestrial Isopod Crustaceans Database* (Boyko et al., 2025), a subregister of the World Register of Marine Species (WoRMS) listed 10,838 accepted species of Isopoda (13% of Crustacea from all environments), of which 6253 (58%) are marine or brackish (Ahyong et al., 2011; Appeltans et al., 2012; Hartebrodt et al., 2023, updated in 2025 from WoRMS). About a third (36%) of the non-marine species belong to the terrestrial superfamily Oniscoidea. Isopods therefore represent about 17% of all known marine crustacean species, many more than the number of known brachyuran crabs (WoRMS Editorial Board, 2025).

It is widely accepted that the number of described species (those with Linnaean names) is just a small fraction of the true number of species, which has been estimated at 0.3–2+ million for the world's oceans (Appeltans et al., 2012). The reason for this underestimate, for most of Crustacea, is typically not because they are hard to recognise. We know from childhood what a crayfish, crab, shrimp or lobster looks like, and have a general concept of crustaceans. In a catch of animals from a marine habitat it is simple to separate larger crustaceans from fish, snails, worms and seastars. However, crustaceans can be extremely abundant and diverse. Densities may be in thousands of individuals per square metre of sea floor or cubic metre of ocean water, and many different kinds live side by side. Many surveys reveal numerous unnamed crustaceans, particularly in groups such as the isopods that are composed mostly of smaller (<1 cm) species, can be quite cryptic and comprise mostly undescribed species (Brandt et al., 2004; Poore et al., 2014). Based on current rates of species descriptions, over 600 species of isopod are projected to be described by 2100, mostly from marine environments (Hartebrodt et al., 2023). It is predicted that ultimately there remain several times this many undescribed isopod species, especially considering the cryptic species and parasitic groups that have been sampled poorly (Williams and Boyko, 2012).

Environmental awareness exploded in the 1970s, and this was accompanied, particularly in Australia, South Africa, the USSR and the USA, by surveys of marine invertebrates and descriptions of many newly discovered species of marine Isopoda (see species described by G.C.B. Poore, N.L. Bruce, B. Kensley, O.G. Kussakin, T.E. Bowman, J.C. Markham and R.C. Brusca). Until recently, deep ocean basins were little explored (Hessler and Sanders, 1967; Kussakin, 1967) but are now showing that Isopoda are a significant fraction of the benthic fauna. The only survey of a bathyal fauna along the southeastern Australian coast discovered 359 species of isopods (90% new) (Poore et al., 1994), with some subsequently described in the 30-year period since. Isopods accounted for 35% of all peracarid species encountered on the Antarctic shelf (Brandt, 1999; Brökeland et al., 2007), many being undescribed. A study of Gulf of Mexico isopods found 62 of 135 species (46%) to be undescribed (Wilson, 2008). A continent-wide survey of marine invertebrates discovered 118 undescribed species among 127 isopods (93% new) (Poore et al., 2014). A similar percentage (96.8%) of new isopods was found in the Clarion–Clipperton Zone in the deep Pacific Ocean (Rabone et al., 2023). These and exploratory surveys of other marine environments such as coral and rocky reefs have revealed that isopods are a significant but poorly understood component of the fauna. All have and will continue to provide ample material for taxonomic studies.

Among the many reasons for so many species remaining undescribed are that it is difficult to know where to start and naming and description takes some effort. This guidebook is designed to address these issues, although many other taxonomic hurdles remain (Engel et al., 2021; Favret, 2024; Löbl et al., 2023). After the naturalist goes into the field with a dredge or hand-net and collects an isopod, this book should enable identification of the specimen to suborder, family and genus level, even if it is an undescribed species (unless it belongs to an undescribed genus, of course). The citations following each family and genus can be explored to discover whether the species is described.

This introductory chapter explains to the reader how the book has been planned and what to expect from each section. Chapter 2 deals with the higher systematics of Crustacea and explains what an isopod is, how isopods are related to other crustaceans, and clarifies their classification. It includes a glossary explaining novel terms. Chapters 3 to 10 cover the major isopod suborders.

Scope of this work

This guidebook tries to bridge the gap between taxonomists and other marine biologists. These non-taxonomists, such as ecologists, biogeographers and physiologists (to name a few), are the target audience for this volume. The gap exists in part because, while taxonomists are experts in identification, they often write in an arcane language. Additionally, new evidence sometimes causes taxonomists to change accepted Linnaean names, a necessary step but one that can cause considerable problems in both ecological studies and applied settings such as conservation (Sandall et al., 2023). Our aim is to write in a consistent language that is understandable to all and assist future studies relying on accurate identification of isopods.

This guidebook serves to document the state of play in isopod taxonomy in late-2025. Systematics and classification are dynamic disciplines, and the accepted family and generic names published today may not apply in the near or distant future. Nevertheless, these chapters are a point of access to the taxonomic literature. We do not describe new genera or species, or, with few exceptions, undertake any taxonomic revisions. We introduce, for convenience, one new family. However, we discovered errors and inconsistencies in past work and correct these with new interpretations. We rely on the most recent or most generally accepted classifications and lists of names, among which are a few we treat as new synonyms.

The work is confined to marine isopods (all genera of free-living and symbiotic species, including commensal and parasitic ones, are covered). Exclusively freshwater or terrestrial taxa, such as freshwater families and genera of Asellota, Microcerberidea, Cymothoida and Sphaeromatidea, are omitted. The terrestrial and freshwater suborders Calabozoidea, Oniscidea, Phreatoicidea and Tainisopidea are omitted completely. Families with marine, estuarine and freshwater representatives are diagnosed, but exclusively freshwater genera might be listed without appearing in keys. Although regional keys to marine isopods exist (see examples below), this is the first global key to marine isopod families and genera.

History and resources

Like any group of animals, crustaceans have long attracted the attention of biologists. In his *Systema Naturae* Linnaeus (1758) included a pre-Linnaean genus *Asellus* for one isopod species, and introduced *Oniscus* for eight species – an oniscid woodlouse, two valviferans, one aegid and three cymothoid fish lice, as well as one amphipod whale louse. The age of European biological ship-based exploring expeditions began in the late

eighteenth century and continued through to the mid-twentieth century. The series of scientific reports, many taxonomic, associated with ships such as HMS *Challenger*, RIMSS *Investigator*, the *Siboga*, or with the United States Exploring Expedition remain relevant today. Today, research vessels of several nations continue this tradition. Documentation of biodiversity in the Indo-West Pacific has benefitted from the MUSORSTOM, now *Tropical Deep-Sea Benthos*, series of volumes (Bruce, 1996; Lowry and Dempsey, 2006; Markham, 1990; Markham, 1994; Markham, 1999; Poore, 1991; Poore and Brandt, 1997).

General books on Crustacea are found only in speciality libraries. Old books have a fascination of their own because they established the classifications and terminology still used today. Many are now out of print but can be tracked down in the antiquarian market or online. The Reverend T.R.R. Stebbing's *A history of Crustacea: Recent Malacostraca* (1893) and William T. Calman's *The life of Crustacea* (1911) are classics. Patsy McLaughlin's *Comparative morphology of Recent Crustacea* (1980) is a useful practical guide to the definition of living taxa but is not a taxonomic guide and has no ecological information. Alfred Kaestner's (1980) *Crustacea* is a useful translation of a systematic German text. Frederick Schram's more detailed volume, also entitled *Crustacea* (1986), is packed with information and includes all the fossil taxa. Schram and Koenemann (2021) updated it as *Evolution and phylogeny of Pancrustacea: a story of scientific method*, an essential reference book on evolution, taxonomy and general biology for crustacean biologists. The recent and continuing series *The Natural History of the Crustacea* (Watling and Thiel, 2013; Derby and Thiel, 2014; Chang and Thiel, 2015; Thiel and Watling, 2015; Thiel and Wellborn, 2018; Anger et al., 2020; Cothran and Thiel, 2020; Lovrich and Thiel, 2020; Poore and Thiel, 2020; Thiel and Gutow, 2025) deals with all aspects of the biology of Crustacea. Smit et al.'s (2019) *Parasitic Crustacea* serves as a useful resource for background on the natural history and host associations for isopods and related groups.

None of these texts is useful for species identification, although some regional keys are dedicated to that task. While these keys are valuable references, some of the species names given are no longer accepted due to later synonymy or rearrangement of higher classifications. Nevertheless, former species names can usually be traced and updated using the World Marine, Freshwater and Terrestrial Isopod Crustaceans Database (https://www.marinespecies.org/isopoda/, a subregister of WoRMS). Table 1.1 lists the major regional studies geographically. Guides to individual families or genera can be found in the general text. Only works with keys or species diagnoses are listed.

We have referred to these books in the course of research for this volume. However, our task would not have been possible without the following three web-based resources.

(1) The World Marine, Freshwater and Terrestrial Isopod Crustaceans Database https://www.marinespecies.org/isopoda/, a subregister of WoRMS, http://www.marinespecies.org/) is an authoritative classification and catalogue of marine names (WoRMS Editorial Board, 2025). The WoRMS database is managed at the Flanders Marine Institute (VLIZ) and is updated by a team of volunteer taxonomic editors. All family and generic names were checked and downloaded from WoRMS in mid-2025 and these names became the foundation of our review. WoRMS also provides access to much of the relevant taxonomic literature, as citations and often as downloadable publications.

(2) The Biodiversity Heritage Library (https://www.biodiversitylibrary.org/) houses scanned pages of most of the non-copyrighted books and journals held in museums and other institutions, a rich source of old taxonomic literature.

(3) The Ocean Biodiversity Information System (OBIS, https://obis.org/) is a global open-access data and information clearing-house on marine biodiversity for science, conservation and sustainable development. OBIS provides distributional and depth-range data by species and higher taxa derived from museum, fisheries and other sources, and was one of our sources for distributional information.

Table 1.1 Major regional studies of isopod Crustaceans by location.

Southern Australia	Hale, 1929
Southern Africa	Kensley, 1978
Costa Rica	Brusca and Iverson, 1985
Caribbean	Kensley and Schotte, 1989
North America	Richardson, 1905; Schultz, 1969
Southern California, USA	Wetzer et al., 1997; Stebbins and Wetzer, 2023
Great Britain	Naylor, 1972
Norway	Sars, 1896–1899
Russia NW Pacific	Kussakin, 1979, 1982a, 1988
Antarctica	Kussakin, 1967, 1982b
Arctic	Kussakin, 1999, 2003
Indian Ocean	Kensley and Schotte, 2000, 2002; Schotte and Kensley, 2005; Kensley et al., 2007, 2009

The structure of this guidebook, and some advice!

The guidebook follows what is now accepted as the new classification of Isopoda, each chapter devoted to a suborder. All chapters follow the same format: general introduction, diagnosis, a key to families and/or superfamilies, families treated in alphabetical order (each with an introduction, diagnosis and keys to genera), followed by all genera in alphabetical order (sometimes grouped in subfamilies). Each genus is diagnosed and maximum size, depth range, distribution and the number of described species are given.

Diagnoses. Diagnoses of families and genera are original, usually simplified from more detailed diagnoses in the cited literature. Most (Epicaridea excepted) were generated initially from data stored in DELTA databases (Dallwitz et al., 1993 onwards). Diagnoses attempt to characterise each taxon with the same suite of characters, but this was not always possible. DELTA facilitates use of implicit attributes (features that are common to most genera within a family). To save repetition, these features are listed separately following the family diagnosis and only exceptions are included with relevant generic diagnoses.

Ecology. The ecological range of each genus is summarised as depth ranges following widely accepted bathymetric classes. For benthic groups these are intertidal, subtidal (including inshore bays, 20 m or shallower), shelf (20–200 m), slope (200–2000 m), bathyal (2000–3500 m), abyssal (3500–6500 m), and hadal (> 6500 m). Special ecological affinities are also noted for estuarine genera or those living in marine anchialine caves. For the rare pelagic groups depth ranges are as follows: mesopelagic (200–1000 m) and bathypelagic (>1000 m). Actual recorded depth ranges are given when these data were readily available. Sometimes other ecological descriptors such as preferred sediment type or associated fauna are added, but often this detail can be found in the family introduction.

Distributions. Distributions of all benthic genera occurring down to slope depths are given in terms of the 12 realms used in the marine ecoregions of the world (MEOW; Spalding et al., 2006) as follows: Arctic, Temperate Northern Atlantic, Tropical Atlantic, Temperate Northern Pacific, Western Indo-Pacific, Central Indo-Pacific, Eastern Indo-Pacific, Tropical Eastern Pacific, Temperate South America, Temperate Southern Africa, Temperate Australasia, and Southern Ocean (Fig. 1.1). The realms are annotated when they do not adequately describe the distribution. For example, the annotations E and W are added when the known range is only within the eastern and western part of a realm, such as Temperate Northern Pacific or Tropical Atlantic. Further details are added or substituted where appropriate (e.g. Australia or New Zealand to Temperate Australasia). "Indo-West Pacific" is substituted when a genus ranges across the Western Indo-Pacific, Central Indo-Pacific and Eastern Indo-Pacific realms. Distributions of the few benthic genera occurring at bathyal or deeper depths are given in terms of the 14 bathyal provinces used in the Global Open Oceans and Deep Seabed classification (GOODS; UNESCO, 2009) as follows: Arctic, Northern Atlantic, Brazil Basin, Angola & Sierra Leone Basins, Argentine Basin, E Antarctic Basin, W Antarctic, Indian, E Pacific basins, S Pacific, Central Pacific, N Central Pacific, N Pacific, and W Pacific basins (Fig. 1.1).

References. The literature cited, almost 1100 papers, books and chapters, concentrates on the most relevant taxonomic references (i.e. those with more extensive diagnoses and keys to species and/or information on distributions). Single species descriptions are rarely cited unless they are accompanied by more information. Some key ecological works may be cited. References are listed after each family treatment.

Keys and illustrations. Identification is achieved using dichotomous keys adapted from many originally published in the primary literature or developed from scratch. The temptation when using keys is to assume when you reach the last couplet that your specimen belongs in that genus. It is worthwhile to check the diagnosis and the distribution given. The keys are supported by illustrations. Many of the illustrations are reworking of published figures, others are reproductions from the literature. References to elements in black and white figures are given in the key and some diagnoses.

Terminology. Keys written by expert taxonomists for other taxonomists use arcane language. To make matters worse, many specialise in a limited range of taxa using terms that only those specialists appreciate, or they may spell the same term differently. For example, those exploring the diversity of copepods rarely venture into the classification of larger crustaceans (including isopods). One consequence of this is that each group of taxonomists develops its own jargon, sometimes using different terms for the same (i.e. homologous) structure. Further, relative descriptors, such as "small" and "large" are treated as diagnostic terms but are not meaningful to outsiders. Inconsistent taxonomic names, variable terminology and indeterminate descriptors are confusing for the non-specialist. We prepared this guidebook using a consistent terminology that is hopefully understandable by our target audience. The terms used by crustacean taxonomists were compiled by Martin (2005) for the Assembling the Tree of Life (AToL) Decapod project. The illustrated glossary at the end of this volume should be helpful and is illustrated with special terms applicable to only some groups.

Abbreviations. AToL, Assembling the Tree of Life; BL, body length; GOODS, Global Open Oceans and Deep Seabed; MEOW, Marine Ecoregions of the World; mya, million years ago; OBIS, Ocean Biodiversity Information System; VLIZ, Flanders Marine Institute; WoRMS, World Register of Marine Species.

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Credits

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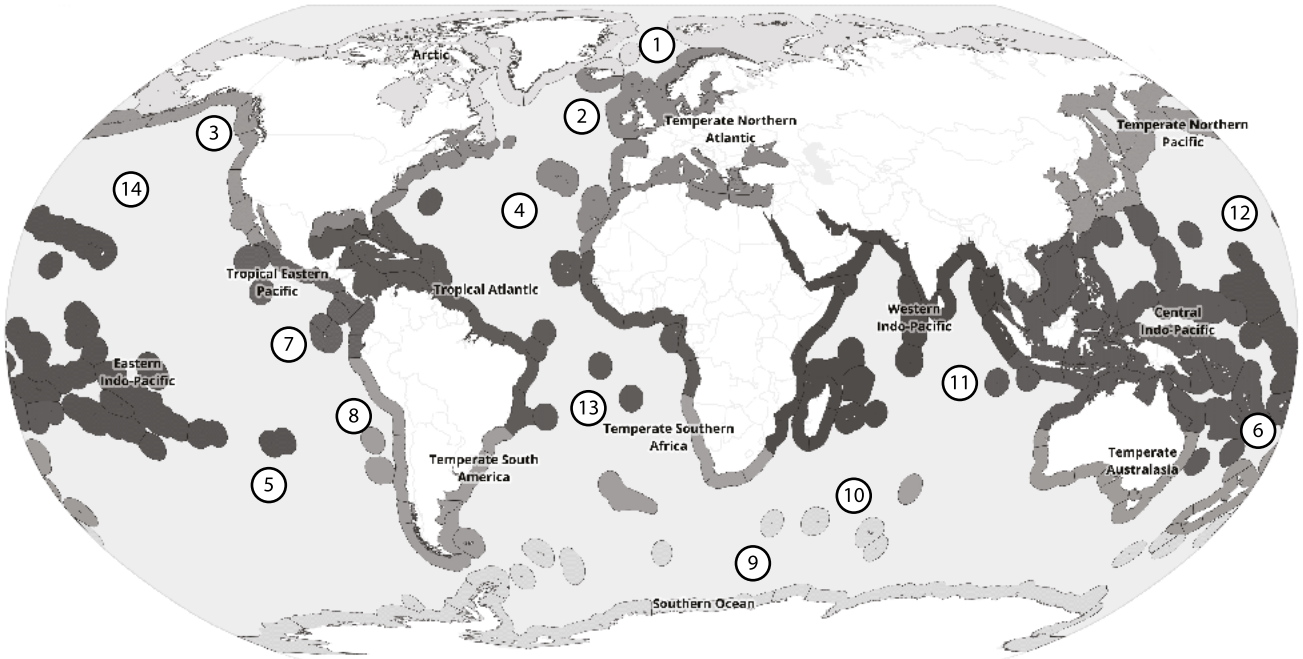

Figure 1.1. Twelve MEOW realms apply from intertidal to slope depths (0–2000 m depth) and are: Arctic, Temperate Northern Atlantic, Tropical Atlantic, Temperate Northern Pacific, Western Indo-Pacific, Central Indo-Pacific, Eastern Indo-Pacific, Tropical Eastern Pacific, Temperate South America, Temperate Southern Africa, Temperate Australasia, and Southern Ocean (Spalding et al., 2006 for detail). Numbers in circles refer to the 14 GOODS lower bathyal provinces (800–3000 m depth) as follows: 1, Arctic, 2, Northern N Atlantic, 3, Northern N Pacific, 4, N Atlantic, 5, SE Pacific ridges, 6, New Zealand/Kermadec, 7, Cocos Plate, 8, Nazca Plate, 9, Antarctic, 10, Subantarctic, 11, Indian, 12, W Pacific, 13, S Atlantic, 14, N Pacific (UNESCO, 2009 for detail). Map supplied by Marine Regions team, VLIZ, Oostende, Belgium.

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