

Western Indian Ocean JOURNAL OF Marine Science

Volume 18 | Issue 1 | Jan – Jun 2019 | ISSN: 0856-860X

Chief Editor José Paula



Western Indian Ocean JOURNAL OF Marine Science

Chief Editor **José Paula** | Faculty of Sciences of University of Lisbon, Portugal

Copy Editor **Timothy Andrew**

Editorial Board

Serge ANDREFOUËT

France

Ranjeet BHAGOOLI

Mauritius

Salomão BANDEIRA

Mozambique

Betsy Anne BEYMER-FARRIS

USA/Norway

Jared BOSIRE

Kenya

Atanásio BRITO

Mozambique

Louis CELLIERS

South Africa

Pascale CHABANET

France

Lena GIPPERTH

Sweden

Johan GROENEVELD

South Africa

Issufo HALO

South Africa/Mozambique

Christina HICKS

Australia/UK

Johnson KITHEKA

Kenya

Kassim KULINDWA

Tanzania

Thierry LAVITRA

Madagascar

Blandina LUGENDO

Tanzania

Joseph MAINA

Australia

Aviti MMOCHI

Tanzania

Cosmas MUNGA

Kenya

Nyawira MUTHIGA

Kenya

Brent NEWMAN

South Africa

Jan ROBINSON

Seycheles

Sérgio ROSENDO

Portugal

Melita SAMOILYS

Kenya

Max TROELL

Sweden

Published biannually

Aims and scope: The *Western Indian Ocean Journal of Marine Science* provides an avenue for the wide dissemination of high quality research generated in the Western Indian Ocean (WIO) region, in particular on the sustainable use of coastal and marine resources. This is central to the goal of supporting and promoting sustainable coastal development in the region, as well as contributing to the global base of marine science. The journal publishes original research articles dealing with all aspects of marine science and coastal management. Topics include, but are not limited to: theoretical studies, oceanography, marine biology and ecology, fisheries, recovery and restoration processes, legal and institutional frameworks, and interactions/relationships between humans and the coastal and marine environment. In addition, *Western Indian Ocean Journal of Marine Science* features state-of-the-art review articles and short communications. The journal will, from time to time, consist of special issues on major events or important thematic issues. Submitted articles are subjected to standard peer-review prior to publication.

Manuscript submissions should be preferably made via the African Journals Online (AJOL) submission platform (<http://www.ajol.info/index.php/wiojms/about/submissions>). Any queries and further editorial correspondence should be sent by e-mail to the Chief Editor, wiojms@fc.ul.pt. Details concerning the preparation and submission of articles can be found in each issue and at <http://www.wiomsa.org/wio-journal-of-marine-science/> and AJOL site.

Disclaimer: Statements in the Journal reflect the views of the authors, and not necessarily those of WIOMSA, the editors or publisher.

Copyright © 2019 – Western Indian Ocean Marine Science Association (WIOMSA)

No part of this publication may be reproduced, stored in a retrieval system or transmitted in any form or by any means without permission in writing from the copyright holder.

ISSN 0856-860X



A review of nudibranch (Mollusca: Euthyneura) diversity from the Republic of Mauritius: Status and Future Work

Lisa Ah-Shee-Tee^{1,*}, Daneshwar Puchoo¹, Vishwakalyan Bhoyroo¹, Chandani Appadoo²

¹ Department of Agricultural & Food Science, Faculty of Agriculture, University of Mauritius, Réduit, Mauritius

² Department of Biosciences & Ocean Studies, Faculty of Science, University of Mauritius, Réduit, Mauritius

* Corresponding author: chin.29.ah@gmail.com

Abstract

Nudibranchs are considered one of the most diverse groups of opisthobranchs. Their history in Mauritius dates from 1832, with first records appeared in expedition reports and systematic works. Recent review of their biodiversity in Mauritius identified 23 species. The present study provides a list of nudibranch species using data from both systematic works and internet records as a means of maintaining an inventory from Mauritius. Some 105 species belonging to 20 families (excluding undescribed taxa and those recorded as cf.) have been identified in Mauritius. Most species have been collected in the north-west part of the island which is dominated by hotels and not subjected to easterlies which could be one reason explaining their abundance. Providing a list of nudibranchs species is important, to be able to design better ways of conserving them in the future, if the need arises. With a wide maritime zone and considered as a striking biodiversity hotspot, further species might be discovered from both Mauritius and Rodrigues.

Keywords: biodiversity, inventory, nudibranchs, opisthobranchs, Republic of Mauritius

Introduction

Mauritius and Rodrigues islands form the Republic of Mauritius in the South Western Indian Ocean. Mauritius lies 20°S and 57°E and Rodrigues is located 19°S and 63°E, 574 km east of Mauritius (Thébaud *et al.*, 2009). The islands are both of volcanic origin, arising from an oceanic hotspot and known to be topographically distinct units (Louchart *et al.*, 2018; McDougall & Chamalaun, 1969). The study of McDougall & Chamalaun (1969) demonstrates Mauritius island as the oldest of the Mascarenes (7.8 million years old) and Rodrigues as the youngest and most isolated (1.8 million years old). Having always shared a close association with several of its islets but secluded from large land masses, the Republic of Mauritius is known to have a reservoir of intact communities. The Mascarenes have thus, been listed among the world's top biodiversity hotspot (Thébaud *et al.*, 2009). A total of 284 marine molluscs species including 175 marine gastropods and 109 bivalve species have been reported in Rodrigues by the

Ministry of Agro Industry and Food Security (2015). The Republic of Mauritius has an overall of 13 marine protected areas (MPA) with Mauritius holding eight and Rodrigues owning five, of which the South East Marine Protected Area (SEMPA) is gazetted as the biggest MPA of the Republic of Mauritius (Pasnin *et al.*, 2016). Rodrigues Island is also known to have the best developed reef in the Mascarenes (Naim *et al.*, 2000; McDougall *et al.*, 1965), providing home for innumerable species, hence, a unique biodiversity of both marine fauna and flora (Beedessee *et al.*, 2015). The fifth national report under the convention on biological diversity for the Republic of Mauritius provided no information concerning the distribution and diversity of nudibranchs from these two islands (Ministry of Agro Industry and Food Security, 2015). However, report concerning the status of the marine reserves of Rodrigues indicated the presence of nudibranchs (Desiré *et al.*, 2011). Unfortunately, no elaboration pertaining to the different species contained in each of the four marine protected areas was

given. Nudibranchs, poetically known as *butterflies of the sea*, constitute a diverse group of marine gastropod, representing roughly over 4700 known species (Dean & Prinsep, 2017; Anderson, 1995). Nudibranch (Mollusca: Euthyneura) is classified under the subclass Heterobranchia proposed by Haszprunar (1985) (Bouchet *et al.*, 2017). Formerly, they were known to belong to the infraclass Opisthobranchia. However, recent research by Wägele *et al.* (2014) denoted the peculiar infraclass as paraphyletic or even polyphyletic. Hence, Opisthobranchia was rejected as part of traditional taxa by Wägele *et al.* (2014) and considered as outdated by Schrödl *et al.* (2011) and Yonow (2015). Instead, Euthyneura has been recognised as the new infraclass with Nudipleura as its first offshoot (Bouchet *et al.*, 2017; Schrödl *et al.*, 2011). Nudibranchs have lost their shells through evolution which made them rely mostly on chemical defence to protect themselves from predators (Yonow, 2015). However, they are also known to sequester important metabolites from their prey and produce *de novo* defences (Dean & Prinsep, 2017). The sea slugs can be found in a wide range of habitat ranging from polar regions to the tropics and have been continuously assessed for their chemistry over the years (Dean & Prinsep, 2017; Chavanich *et al.*, 2013). In addition of being highly attractive, nudibranchs are also of high economic value, providing new leads to drug discovery (Dean & Prinsep, 2017; Jensen, 2013).

The current paper aims at giving an overview of nudibranch species collected in both Mauritius and Rodrigues (data obtained from both systematics works and internet records). Cataloguing a list of species is also an element of biodiversity. Biodiversity itself describes the number and variety of living organism and can be defined in terms of species, genes and ecosystems (Vitorino & Bessa, 2018; Magurran, 2004). The first component describes the methodology employed to construct the list of nudibranch species from the Republic of Mauritius. The second part confers to the results. The result section outlines the physical geography of the Republic of Mauritius, reports the history of nudibranchs in Mauritius and reviews the occurrence of nudibranchs. Finally, conclusion and further works are reported in the third constituent.

Materials and methods

The list of species compiled is restricted to sea slug of the order Nudibranchia only. Data were screened from both regional checklist, systematic works as well as online data sources including photo-sharing

website such as South-west Indian Ocean Seaslug site (http://seaslugs.free.fr/nudibranche/a_intro.htm). Systematic works includes, Tibiriçá *et al.* (2018), Tibiriçá *et al.* (2017), Yonow (2012), Yonow & Hayward (1991), Bergh (1888). Species were compiled with peculiar interest towards the site collection. Scientific names were confirmed using the World Register of Marine Species (WoRMS). Only taxa which could be identified following WoRMS were included in the species list. Undescribed taxa and those recorded as cf. on website or systematics were not included in the list.

Results

In total, systematics works have identified 60 species. Together with internet records, the number of nudibranchs species found in the Republic of Mauritius would amount to 105 belonging to 20 families (Table 1).

Physical geography of the Republic of Mauritius

Along with Mauritius and Rodrigues, the Republic of Mauritius also consists of many outer islands including St Brandon, Agalega, Tromelin and Chagos Archipelago including Diego Garcia. Mauritius is surrounded by a total of 49 offshore islets while 18 islets lie in the lagoon of Rodrigues. Mauritius Island has an Exclusive Economic Zone (EEZ) of over 2.3 million km², of which 99% is still unexplored (Ministry of Agro Industry and Food Security, 2015; Kauppaymuthoo, 2010). Further, Mauritius is made up of ten districts out of which seven are known as coastal, two as inland with Rodrigues making up the tenth districts. Mauritius is surrounded by 150 km of protective corals which are unfortunately being degraded. Around 50 to 60% of the coral cover which make up the reef of the Mauritian lagoon has already been lost. Such a loss in coral reefs habitats indicate serious threat to the biological diversity of the Republic of Mauritius (Ministry of Agro Industry and Food Security, 2015; Kauppaymuthoo, 2010). Mauritius covers a surface area of 1865 km², bordered by coral reefs of both fringing and barrier type which are interrupted by major river mouths, enclosing a lagoon area of 300 km² of varying widths (0 to 8 km) (Naim *et al.*, 2000; Fagoonee, 1990). Rodrigues is the smallest island with an area of 104 km², is 18.3 km long by 6.5 km wide with the entire coast bordered by fringing reef (90 km), covering an area of 200 km². The presence of patch reefs, atolls and reef flats are significant around Rodrigues (Ministry of Agro Industry and Food Security, 2015). Figure 1 shows the location of the Republic of Mauritius in the South Western Indian Ocean.

History of nudibranchs in Mauritius

The history of nudibranchs in Mauritius dates back from 1832. The first records of opisthobranchs in Mauritius arose from expedition reports and systematic works (Yonow & Hayward, 1991; Claude, 1985; Bergh, 1888; Quoy & Gaimard, 1832). In 1888, Bergh first collected and described species from Mauritius Island belonging to both lineages; Cladobranchia and Anthobranchia (Bergh, 1888). Bergh introduced the genus *Baeolidia* in 1888, based on the description of a single specimen, *Baeolidia moebii* which eventually contained contradictory information and thus, led to morphological confusion (Carmona *et al.*, 2014a).

50 species of nudibranchs were recorded in Mauritius belonging to 9 families by Michel Claude (Claude, 1985). Yonow and Hayward reviewed the biodiversity of opisthobranchs in 1991. In October and November 1985 also in February and March 1990, Yonow and Hayward described thirty-five opisthobranchs species from the coral reefs habitats in Mauritius. Of the thirty-five species, twenty-three belonged to the order Nudibranchia (Yonow & Hayward, 1991). Recent review of the opisthobranchs from the western Indian Ocean localities which include Mauritius, described the occurrence of seventy opisthobranchs species in details (Yonow, 2012). Over the years, species described

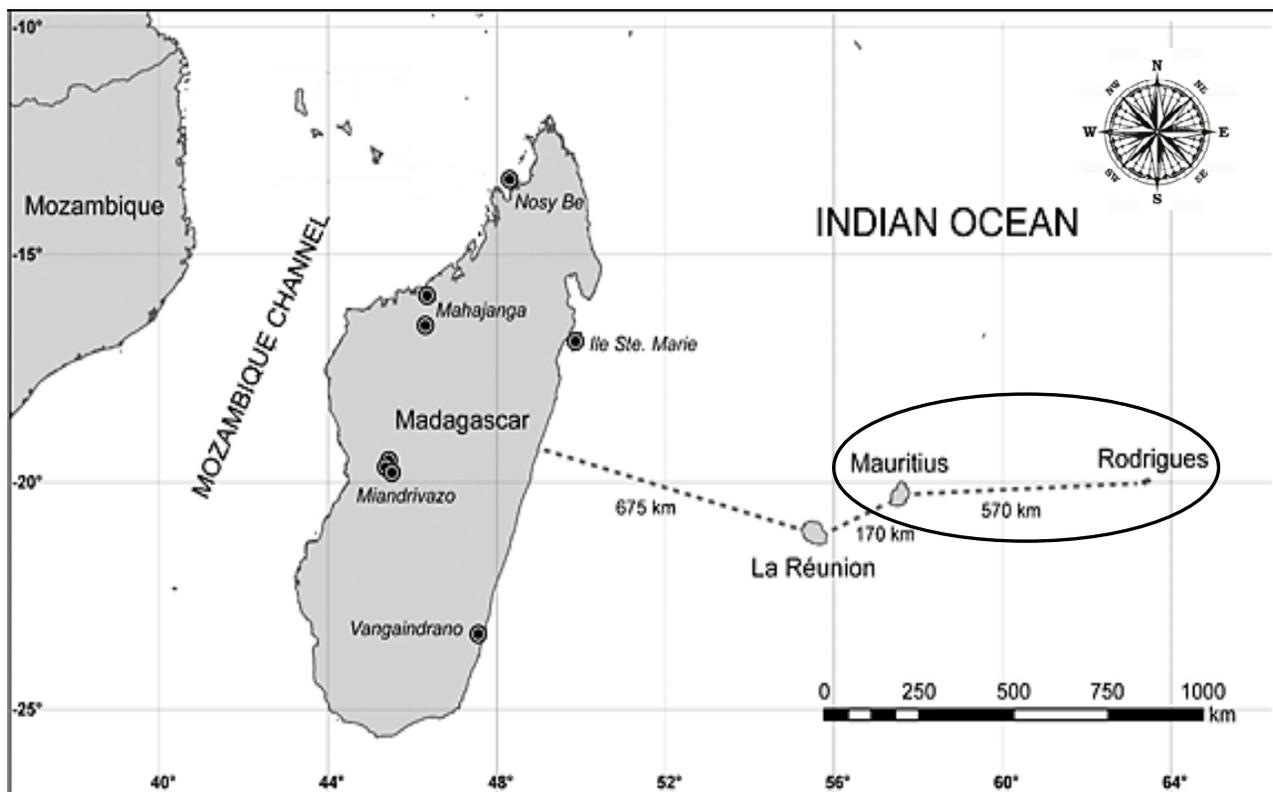


Figure 1: Map showing the Republic of Mauritius (black circle) in the South Western Indian Ocean, redrawn and adapted from (Chan *et al.*, 2011)

Limenandra fusiformis (Baba, 1949) reported from Mauritius, has initially been reported as *Baeolidia* species. However, recent study validated the genus *Limenandra* and *Limenandra fusiformis* was attributed to this genus only (Carmona *et al.*, 2014b). Among the cladobranchs described included *Anteaeolidiella indica* (Bergh, 1888) which is based on the drawing and notes of Moebius. No additional materials were obtained to outline the morphological characteristic of the species (Carmona *et al.*, 2014c). Apart from expedition reports and systematic works, accounts of nudibranchs have been given in publications by Michel Claude. In 1985,

from Mauritius relied mostly on morphology and anatomical studies. Morphological description has frequently been challenged by modern identification techniques such as molecular data, in addition to the parallel evolution of numerous organ systems (Wägele *et al.*, 2014). Taxonomy is a dynamic field, experiencing regular revision in both nomenclature and classification. As a result, many of the names proposed by previous works appear as synonyms. New species are still being recorded in the South Western Indian Ocean (Tibiriçá *et al.*, 2019, 2018, 2017; Yonow, 2012). Inventories carried out by the Ministry of Agro Industry and

Food Security in 2015 reported incomplete information pertaining to the malacofauna status in Mauritius (Ministry of Agro Industry and Food Security, 2015). Nudibranchs are slow moving organisms, casting spectacular coloration making them highly photogenic among underwater photographers and scuba divers. Concerned about the environment, most divers collect only pictures of sea slugs however, it becomes difficult to identify species from pictures such that sometimes, it is suspected that the latter is an undescribed species (Jensen, 2013). Other than articles and books, databases such as the Sea Slug Forum and South-west Indian Ocean Seaslug site also provide considerable information on the proper morphological identification of nudibranchs, species distributions as well as a complete set of species list. The website South-west Indian Ocean Seaslug site provides a specific list of nudibranchs species recorded in Mauritius, Reunion Island, Mayotte, Madagascar and Seychelles. In addition to a specific list, the website also furnishes information about the specific location the picture was taken, date, name of the diver, maximum size of the organism, abundance, taxonomy information and pictures of the organism. To date, internet record contains more nudibranchs species than systematic works in Mauritius. The website South-west Indian Ocean Seaslug contains 410 nudibranchs species belonging to 35 families out of which 100 species belonged to Mauritius and 239 species belonged to Reunion Island. The website also contains undescribed species of the superfamily Doridoidea, one of which was observed on Mauritius Island (Summers, 2014), unassigned Cladobranchia, two species belonging to the family Janolidae (Pola *et al.*, 2019) were also found on Mauritius Island; *Janolus* sp. 1 (Arnim, 2010a) and *Janolus* sp. 2 (Arnim, 2010b). Additionally, the website hold species with uncertain identification (species with abbreviation cf.); three belonging to the Chromodorididae, two from Polyceridae, one from Tritoniidae, Fionidae and Facelinidae, a total of eight species. Nudibranch is known to exhibit notable polymorphism in their colour pattern which can mask diversity (Matsuda & Gosliner, 2018). The genus *Glossodoris* is recognised to contain multiple cryptic and pseudocryptic species. Among the species of uncertain identification on the South-west Indian Ocean Seaslug website include *Glossodoris* cf. *cincta* found in Mauritius which is highly similar to Bergh's description of *Glossodoris cincta* (type locality: Mauritius). As a result, to be able to resolve species complexity, further studies which include collection of *Glossodoris cincta* in Mauritius is required (Matsuda & Gosliner, 2018). Other databases include the Mauritius Oceanography

Institute (MOI) which consists of four types of online databases. The first type provides both taxonomic and geographic information of marine organism of Mauritius. The second type is the genetic databank which furnishes morphometric as well as genetic data. Both of these databases provide limited information pertaining to the nudibranchs species in Mauritius. Other types include oceanographic data mapping and characterisation of aquaculture site in the Republic of Mauritius. The project started by the MOI in 2010 which consisted of assessing the marine living resources in the Mauritian waters using both traditional taxonomic and molecular identification techniques furnishes complete set of information only for fish and sea cucumbers (Mauritius Oceanography Institute, 2017). Even though limited ecological and biodiversity information relating to nudibranchs species in Mauritius were available, pharmaceutical research involving the latter had already begun. In 2015, while attempting to discover novel metabolites from Mauritian marine organisms, Beedessee *et al.* noticed the outstanding proportion of dorid nudibranchs among other mollusc species. The authors studied the cytotoxicity activities of 20 different nudibranchs collected around the island at both different location and depth. Promising cytotoxic activities were obtained for *Notodoris citrina* (Bergh, 1875) (Aegiridae) when tested on both epidermoid carcinoma and acute promyelocytic leukemia cells ($100 \pm 1\%$ at $10 \mu\text{g/ml}$) (Beedessee *et al.*, 2015).

Nudibranchs occurrence in the Republic of Mauritius

Based on their general morphology and digestive glands, nudibranchs can be classified into two distinct groups; the dorids and aeolids (Dean & Prinsep, 2017). Additionally, depending on their prey association, nudibranchs can be further divided into; sponge grazers, bryozoan grazers, hydroid grazers and a miscellaneous category. Nudibranchs belonging to either groups are best suited to their prey. Aeolids are less bulky and more buoyant to prey upon delicate and erect hydroids. In contrast, dorids are bulky, flattened and consist of an invariably broad radula with multiple rows of simple hook-shaped teeth to be able to graze encrusting sponges (Todd, 1983). It is usually believed that nudibranchs are a group of highly specialised predators (Megina *et al.*, 2002) feeding on few related prey species. Penney (2013) showed that diets for some species are broader than expected. The coastal habitats from east to west and from north to south of Mauritius are quite diverse (Fagoonee, 1990). Mauritius is known to contain 163 species of corals,

of which 132 species are also found in Rodrigues (Moothien-Pillay *et al.*, 2002). The study conducted by Fenner *et al.* in 2004 identified 130 named species of hard corals in Rodrigues, out of which eight were unidentified species. According to Fenner *et al.* (2004), thirty-seven species are new records for the southern Mascarene archipelago. Nudibranchs are also associated with corals for instance, the aeolid nudibranch *Phestilla lugubris* (Bergh, 1870) which is found in Mauritius (Summers, 2015). The latter is known to feed on the coral *Porites* (Rudman, 1999). However, the coral reef habitats around the Republic of Mauritius are being degraded (Ministry of Agro Industry and Food Security, 2015). Oceanographic survey report has been carried out both in Mauritius and Rodrigues which revealed that 40.26% of corals within peculiar marine park are heavily damaged (Kauppamuthoo, 2010). On the contrary, marine protected areas (MPA) in Rodrigues are being strictly monitored. Of the four marine reserves in Rodrigues, nudibranchs have been spotted in three of them; Riviere Banane, Grand Bassin and Passe Demi marine reserves. However, the report pertaining to the status of marine reserves in Rodrigues provide no elaboration of the different species of nudibranchs spotted in the reserves (Desiré *et al.*, 2011). Opisthobranchs documented by Yonow & Hayward (1991) were taken from four coastal districts; Pamplemousses, Riviere du Rempart, Flacq and Black River. Out of the 23 nudibranchs species described by Yonow & Hayward (1991), most species came from the Chromodorididae (21.7%) and Phyllidiidae (30.4%) families. The Phyllidiidae are known to display themselves during daylight (Su *et al.*, 2009). In their study, Yonow and Hayward provided no

mention of the time of collection (Yonow & Hayward, 1991). Nudibranchs are known to be nocturnal, cryptic (Su *et al.*, 2009), consist of flexible colour pattern and bathymetric range limits (Layton *et al.*, 2018). Recent study showed that external morphology can be unreliable in taxonomic identification of nudibranch, as a result of mimicry between species (Layton *et al.*, 2018). Hence, more nudibranchs species are yet to get discovered or identified as colour variant of the same species. On the other hand, internet record revealed nudibranch species from five districts particularly Pamplemousses, Riviere du Rempart, Flacq, Grand Port and Black River. Out of the 117 proclaimed beaches in Mauritius, only 22 have been investigated in the past years including both systematics (Yonow & Hayward, 1991) and internet record (South-west Indian Ocean Seaslug site). Nudibranchs from four islets have also been recorded; Ile aux Cerfs, Ile aux Benitiers, Ile aux Aigrettes and Ile Sancho. Most species (including both systematics and internet record) have been collected in the north-west part of the island (Trou aux Biches and Pereybere containing 20 species while Grand Baie contained 15 species) where waves are known to be less strong (Fagoonee, 1990) followed by Pointe d'Esny which is found in the southeast part of the island (19 species). The north part of the island is dominated by several hotels, surprisingly it contained the most species. Likely, the northern sides of the island are not subjected to easterlies (south east trade winds) which could be among the many reasons why most nudibranch species were found there (Fagoonee, 1990). A list of species found in the Republic of Mauritius is provided in Table 1 below.

Table 1. Species recorded from both Mauritius (MAU) and Rodrigues (*), a compilation of data obtained from website South-west Indian Ocean (SWIO) Seaslug site and systematics work with solid circle indicating proper classification of species and non-solid circle showing improper classification or species is still recognised by its synonymised name on website/systematics.

Family	Species	Systematics					Website	Distribution
		Bergh (1888)	Yonow & Hayward (1991)	Yonow (2012)	Tibiriçá <i>et al.</i> (2017)	Tibiriçá <i>et al.</i> (2018)	SWIO Seaslug Site	Mauritius (MAU)
Cadlinidae	<i>Aldisa fragaria</i> (Tibiriçá, Pola & Cervera, 2017)						●	MAU
	<i>Ardeadoris angustolutea</i> (Rudman, 1990)				●		●	MAU
	<i>Cadlinella ornatissima</i> (Risbec, 1928)						●	MAU
Chromodorididae	<i>Chromodoris aspersa</i> (Gould, 1852)		●				●	MAU
	<i>Chromodoris porcata</i> (Bergh, 1889)	●						MAU
	<i>Doriprismatica atromarginata</i> (Cuvier, 1804)	○	○				●	MAU

Family	Species	Systematics					Website	Distribution
		Bergh (1888)	Yonow & Hayward (1991)	Yonow (2012)	Tibiriçá <i>et al.</i> (2017)	Tibiriçá <i>et al.</i> (2018)	SWIO Seaslug Site	Mauritius (MAU)
	<i>Goniobranchus albopunctatus</i> (Garrett, 1879)						•	MAU
	<i>Goniobranchus conchyliaius</i> (Yonow, 1984)						•	MAU
	<i>Goniobranchus fidelis</i> (Kelaart, 1858)						•	MAU
	<i>Goniobranchus geminus</i> (Rudman, 1987)		○				•	MAU
	<i>Goniobranchus lekker</i> (Gosliner, 1994)						•	MAU
	<i>Goniobranchus tennentanus</i> (Kelaart, 1859)						•	MAU
	<i>Goniobranchus tinctorius</i> (Rüppell & Leuckart, 1830)						•	MAU
	<i>Glossodoris cincta</i> (Bergh, 1888)	•						MAU
	<i>Glossodoris hikuensis</i> (Pruvot-Fol, 1954)						•	MAU
	<i>Glossodoris pallida</i> (Rüppell & Leuckart, 1830)						•	MAU
Chromodorididae (continuation)	<i>Hypselodoris bullockii</i> (Collingwood, 1881)			○			•	MAU
	<i>Hypselodoris carnea</i> (Bergh, 1889)				•			MAU
	<i>Hypselodoris whitei</i> (A. Adams & Reeve, 1850)						○	MAU
	<i>Hypselodoris maculosa</i> (Pease, 1871)			•	•		•	MAU
	<i>Hypselodoris maridadilus</i> (Rudman, 1977)		•				•	MAU
	<i>Hypselodoris nigrolineata</i> (Eliot, 1904)						•	MAU
	<i>Hypselodoris nigrostriata</i> (Eliot, 1904)						•	MAU
	<i>Hypselodoris pulchella</i> (Rüppell & Leuckart, 1830)			○			•	MAU
	<i>Mexichromis katalexis</i> (Yonow, 2001)						•	MAU
	<i>Mexichromis lemniscata</i> (Quoy & Gaimard, 1832)	○	○				•	MAU
	<i>Verconia varians</i> (Pease, 1871)						•	MAU
	<i>Asteronotus cespitosus</i> (Van Hasselt, 1824)	•			•		•	MAU
	<i>Carminodoris grandiflora</i> (Pease, 1860)	○						MAU
	<i>Carminodoris mauritiana</i> (Bergh, 1891)	•						MAU
Discodorididae	<i>Discodoris cebuensis</i> (Bergh, 1877)						•	MAU
	<i>Halgerda formosa</i> (Bergh, 1880)	•	•	•		•	•	MAU
	<i>Jorunna funebris</i> (Kelaart, 1859)				•		•	MAU

Family	Species	Systematics					Website	Distribution
		Bergh (1888)	Yonow & Hayward (1991)	Yonow (2012)	Tibiriçá et al. (2017)	Tibiriçá et al. (2018)	SWIO Seaslug Site	Mauritius (MAU)
Discodorididae (continuation)	<i>Jorunna rubescens</i> (Bergh, 1876)	○			●		●	MAU
	<i>Peltodoris murrea</i> (Abraham, 1877)	○	○				●	MAU
	<i>Platydoridiscus scabra</i> (Cuvier, 1804)	●					●	MAU
	<i>Discodoris coerulea</i> (Bergh, 1888)	●						MAU
	<i>Discodoris concinniformis</i> (Bergh, 1888)	○						MAU
	<i>Sebadoris fragilis</i> (Alder & Hancock, 1864)	○	○				●	MAU
	<i>Sebadoris nubilosa</i> (Pease, 1871)						●	MAU
Dorididae	<i>Doriopsis granulosa</i> (Pease, 1860)						○	MAU
	<i>Doris verrucosa</i> (Linnaeus, 1758)							MAU
	<i>Doris venosa</i> (Quoy & Gaimard, 1832)	○						MAU
Dotidae	<i>Doto indica</i> (Bergh, 1888)	●						MAU
Goniodorididae	<i>Trapania naeva</i> (Gosliner & Fahey, 2008)				●		●	MAU, *
Dendrodorididae	<i>Dendrodoris carbunculosa</i> (Kelaart, 1858)	●					●	MAU
	<i>Dendrodoris denisoni</i> (Angas, 1864)						●	MAU
	<i>Dendrodoris fumata</i> (Rüppell & Leuckart, 1830)	○	○	●	●			MAU
	<i>Dendrodoris krusensternii</i> (Gray, 1850)	○						MAU
	<i>Dendrodoris limbata</i> (Cuvier, 1804)	●						MAU
	<i>Dendrodoris nigra</i> (Stimpson, 1855)	●	●	●			●	MAU
	<i>Dendrodoris pustulosa</i> (Alder & Hancock, 1864)	●						MAU
	<i>Dendrodoris tuberculosa</i> (Quoy & Gaimard, 1832)	●						MAU
Phyllidiidae	<i>Phyllidia alyta</i> (Yonow, 1996)			●	●		●	MAU
	<i>Phyllidia coelestis</i> (Bergh, 1905)						●	MAU
	<i>Phyllidia ocellata</i> (Cuvier, 1804)	○			●		●	MAU
	<i>Phyllidia marindica</i> (Yonow & Hayward, 1991)		○	●	●		●	MAU
	<i>Phyllidia multituberculata</i> (C. R. Boettger, 1918)		●	●				MAU
	<i>Phyllidia varicosa</i> (Lamarck, 1801)	○	○	●			●	MAU, *
	<i>Phyllidia rueppelii</i> (Bergh, 1869)	○						MAU
<i>Phyllidiella meandrina</i> (Pruvot-Fol, 1957)		○	●	●		●	MAU	

Family	Species	Systematics				Website	Distribution
		Bergh (1888)	Yonow & Hayward (1991)	Yonow (2012)	Tibiriçá <i>et al.</i> (2017)	Tibiriçá <i>et al.</i> (2018)	SWIO Seaslug Site
Facelinidae	<i>Facalana pallida</i> (Bergh, 1888)	○					MAU
	<i>Facelina rhodopos</i> (Yonow, 2000)					●	*
	<i>Favorinus mirabilis</i> (Baba, 1955)					●	MAU
	<i>Herviella mietta</i> (Er. Marcus & J. B. Burch, 1965)					●	MAU
	<i>Pteraeolidia semperi</i> (Bergh, 1870)					●	*
Glaucidae	<i>Glaucus atlanticus</i> (Forster, 1777)	●				●	MAU
Trinchesiidae	<i>Phestilla lugubris</i> (Bergh, 1870)					●	MAU
	<i>Phestilla melanobranchia</i> (Bergh, 1874)					○	MAU
Samlidae	<i>Samla bicolor</i> (Kelaart, 1858)					●	MAU
Bornellidae	<i>Bornella anguilla</i> (S. Johnson, 1984)		●		●	●	MAU
Tethydidae	<i>Melibe engeli</i> (Risbec, 1937)					●	MAU
	<i>Melibe viridis</i> (Kelaart, 1858)	○				●	MAU
Tritoniidae	<i>Tritoniopsis elegans</i> (Audouin, 1826)					●	MAU
	<i>Marionia levis</i> (Eliot, 1904)				●		MAU
Arminidae	<i>Dermatobranchus rubidus</i> (Gould, 1852)					●	MAU

Conclusion and Future Works

This review summarises the existing nudibranchs species from the Republic of Mauritius (Table 1). Previous researches concerned the description of existing species however, no information of the time of collection was provided. In contrast to species belonging to the Phyllidiidae, many nudibranchs are nocturnal hence, further inventories need to be carried out to assess their biodiversity and distribution. To date, 60 species have been identified by systematic work. Together with internet records, the number of nudibranchs species found in the Republic of Mauritius would amount to 105 belonging to 20 families (excluding undescribed taxa and those recorded as cf., table 1). Further studies pertaining to resolve the issue of species complexity and clarifying morphological characteristic of *Anteaeolidiella indica* are required. Additionally, further works concerning the abundance of nudibranchs found in the Republic of

Mauritius should be carried out. Marine protected areas are designed for biodiversity conservation and detailed study on its biodiversity is essential. Rodrigues Island is strictly reinforcing the management of its marine reserves, comparison of the different species found in both marine reserves and non-marine reserves will bring out surplus information relating to the diversity of nudibranchs. With a wide maritime zone and considered as a striking biodiversity hotspot, further species might be discovered from both Mauritius and Rodrigues altogether with key molecules of medical importance.

Acknowledgements

The first author would like to thank the University of Mauritius for a postgraduate scholarship and for logistics and support. The authors are also thankful to the anonymous reviewers for their critical comments and suggestions which improved the manuscript.

References

- Anderson RC (1995) Nudibranchs: butterflies of the sea. *International Zoo Yearbook* 34: 65-70
- Arnim YV (2010a) *Janolus* sp1. South-west Indian Ocean Seaslug site, Mauritius. Available from: http://seaslugs.free.fr/nudibranche/a_janolus_sp1.htm (accessed 2 July 2019)
- Arnim YV (2010b) *Janolus* sp2. South-west Indian Ocean Seaslug site, Mauritius. Available from: http://seaslugs.free.fr/nudibranche/a_janolus_sp2.htm (accessed 2 July 2019)
- Beedessee G, Ramanjooloo A, Marie DEP (2015) Marine natural products research in Mauritius: Progress and challenges. *Marine Chemistry* 170: 23-28.
- Bergh LSR. (1888) Malacologische Untersuchungen, Nudibranchien vom Meer der Insel Mauritius. In Semper C (eds) *Reisen im Archipel der Philippinen*, Vol. 3, pp. 755-872
- Bouchet P, Rocroi JP, Hausdorf B, Kaim A, Kano Y, Nützel A, Parkhaev P, Schrödl M, Strong EE (2017) Revised Classification, Nomenclator and Typification of Gastropod and Monoplacophoran Families. *Malacologia* 61:1-526.
- Carmona L, Pola M, Gosliner TM, Cervera JL (2014a) Review of *Baeolidia*, the largest genus of Aeolidiidae (Mollusca: Nudibranchia), with the description of five new species. *Zootaxa* 3802: 477-514.
- Carmona L, Pola M, Gosliner TM (2014b) The end of a long controversy: systematics of the genus *Limenandra* (Mollusca: Nudibranchia: Aeolidiidae). *Helgoland Marine Research* 68: 37-48.
- Carmona L, Bhave V, Salunkhe R, Pola M, Gosliner TM, Cervera JL (2014c) Systematic review of *Anteaeolidiella* (Mollusca, Nudibranchia, Aeolidiidae) based on morphological and molecular data, with a description of three new species. *Zoological Journal of the Linnean Society* 171: 108-132.
- Chan LM, Goodman SM, Nowak MD, Weisrock DW, Yoder AD (2011) Increased population sampling confirms low genetic divergence among *Pteropus* (Chiroptera: Pteropodidae) fruit bats of Madagascar and other western Indian Ocean islands. *PLoS Currents: Tree of Life* 3 [doi: 10.1371/currents.RRN1226]
- Chavanich S, Viyakarn V, Sanpanich K, Harris LG (2013) Diversity and occurrence of nudibranchs in Thailand. *Marine Biodiversity* 43: 31-36
- Claude M (1985) *Marine Molluscs of Mauritius* (1st ed.) Editions de l'Océan Indien, Rose-Hill, Mauritius. 91 pp.
- Dean LJ, Prinsep MR (2017) The chemistry and chemical ecology of nudibranchs. *Natural Product Reports* 34: 1359-1390
- Desiré S, Hardman E, Klaus R, Pasnin O (2011) Improving management effectiveness for the Marine Protected Areas of Rodrigues (Indian Ocean). 53 pp. <https://sgp.undp.org/publications-188/123-improving-management-effectiveness-for-the-marine-protected-areas-of-rodrigues-indian-ocean.html>
- Fagoonee I (1990) Coastal marine ecosystems of Mauritius. *Ecology* 208: 55-62.
- Fenner D, Clark TH, Turner JR, Chapman B (2004) A checklist of the corals of the island state of Rodrigues, Mauritius. *Journal of Natural History* 38: 3091-3102
- Haszprunar G (1985) The Heterobranchia—a new concept of the phylogeny of the higher Gastropoda. *Zeitschrift Für Zoologische Systematik Und Evolutionsforschung* 23: 15-37.
- Jensen KR (2013) Sea slugs – divers' favorites, taxonomists' problems. *Aquatic Science & Management* 1: 100-110.
- Kauppymuthoo V (2010) Oceanographic Survey Report - Blue Bay Area. 73 pp. <http://www.aknl.net/Eco-Sud%20-%20Blue%20Bay%20Survey%20Coral%20Study2.pdf>
- Layton KKS, Gosliner TM, Wilson NG (2018) Flexible colour patterns obscure identification and mimicry in Indo-Pacific *Chromodoris* nudibranchs (Gastropoda: Chromodorididae). *Molecular Phylogenetics and Evolution* 124: 27-36
- Louchart A, Bastian F, Baptista M, Guarino-Vignon P, Hume JP, Jacto-des-Combes C, Mourer-Chauvir C, Hanni C, Ollivier M (2018) Ancient DNA reveals the origins, colonization histories, and evolutionary pathways of two recently extinct species of giant scops owl from Mauritius and Rodrigues Islands (Mascarene Islands, south-western Indian Ocean). *Journal of Biogeography* 45: 2678-2689
- Magurran AE (2004) *Measuring Biological Diversity*. Blackwell, Oxford, United Kingdom. 287 pp.
- Matsuda SB, Gosliner TM (2018) Glossing over cryptic species: Descriptions of four new species of *Glossodoris* and three new species of *Doriprismatica* (Nudibranchia: Chromodorididae). *Zootaxa* 4444: 501-529.
- Mauritius Oceanography Institute (2017) Marine Diversity and Genetic Data Bank. Available from: <http://www.mdgdb.com/index.html> (accessed 7 January 2019)
- McDougall I, Upton BGJ, Wadsworth WJ (1965) A Geological reconnaissance of Rodriguez Island, Indian Ocean. *Nature* 206: 26-27
- McDougall I, Chamalaun F (1969) Isotopic Dating and Geomagnetic Polarity Studies on Volcanic Rocks

- from Mauritius, Indian Ocean. *Geological Society of America Bulletin* 80: 1419-1442.
- Megina C, Carballo JL, Cervera JL, García-Gómez JC (2002) The diet of *Platydorid argo* (Gastropoda: Nudibranchia) and the dietary specialization of sponge eating dorids. *Journal of Molluscan Studies* 68: 173-179
- Ministry of Agro Industry and Food Security (2015) Fifth National Report on the Convention on Biological Diversity, Mauritius. 87 pp. <https://www.cbd.int/doc/world/mu/mu-nr-05-en.pdf>
- Moothien-Pillay R, Terashima H, Venkatasami A, Uchida H (2002) Field Guide to Corals of Mauritius. Albion Fisheries Research Centre, Albion, Petite Riviere, Mauritius. 334 pp.
- Naim O, Cuet P, Mangar V (2000) The Mascarene Islands. In McClanahan T, Sheppard CR, Obura D (eds) *Coral Reefs of the Indian Ocean; their ecology and conservation*. Oxford University Press, New York. pp 353-381
- Pasnin O, Attwood C, Klaus R (2016) Marine systematic conservation planning for Rodrigues Island, western Indian Ocean. *Ocean and Coastal Management* 130: 213–220
- Penney BK (2013) How specialized are the diets of North-eastern Pacific sponge-eating dorid nudibranchs? *Journal of Molluscan Studies* 79: 64-73.
- Pola M, Hallas JM, Gosliner TM (2019) Welcome back Janolidae and *Antiopella*: Improving the understanding of Janolidae and Madrellidae (Cladobranchia, Heterobranchia) with description of four new species. *Journal of Zoological Systematics and Evolutionary Research* 57: 345-367.
- Quoy JRC, Gaimard JP (1832) Mollusca. Voyage de découvertes de l'Astrolabe execute... sous le commandement de M. J. Dumont d'Urville. *Zoologie* 2: 1-320.
- Rudman B (1999) Coral feeding - utilising different parts of the coral tissue. Available from: <http://www.seaslugforum.net/corafeed2.htm> (accessed 9 January 2019)
- Schrödl M, Jörgen KM, Klussmann-Kolb A, & Wilson NG (2011) Bye bye "opisthobranchia"! a review on the contribution of mesopsammic sea slugs to euthyneuran systematics. *Thalassas* 27: 101-112.
- Su Y, Huang LJ, Chang YW, Mok HK (2009) Temporal changes in nudibranch composition at a coastal site off Penghu (the Pescadores) in the Taiwan Strait. *Zoological Studies* 48: 448-459.
- Summers G (2014) *Doridoidea* sp. 2. Available from: http://seaslugs.free.fr/nudibranche/a_doridoidea_sp2.htm (accessed 2 July 2019)
- Summers G (2015) *Phestilla lugubris* (Bergh, 1870). Available from: http://seaslugs.free.fr/nudibranche/a_intro.htm (accessed 2 July 2019)
- Thébaud C, Warren BH, Strasberg D, Cheke A (2009) Mascarene islands, biology. In Gillespie RG, Clague DA (eds) *Encyclopedia of islands*. University of California Press, Berkeley. pp 612-619
- Tibirică Y, Pola M, Cervera JL (2018) Systematics of the genus *Halgerda* Bergh, 1880 (Heterobranchia : Nudibranchia) of Mozambique with descriptions of six new species. *Invertebrate Systematics* 32: 1388-1421.
- Tibirică Y, Pola M, Cervera JL (2019) Two new species of the genus *Aldisa* Bergh, 1878 (Gastropoda, Heterobranchia, Nudibranchia) from southern Mozambique. *Marine Biodiversity* 49: 43-56.
- Tibirică Y, Pola M, Cervera JL (2017) Astonishing diversity revealed: An annotated and illustrated inventory of Nudipleura (Gastropoda: Heterobranchia) from Mozambique. *Zootaxa* 4359 [doi: <https://doi.org/10.11646/zootaxa.4359.1.1>]
- Todd CD (1983) Reproductive and Trophic Ecology of Nudibranch Molluscs. In Hunter WD (eds) *Ecology*. Academic Press, Vol. 6, pp 225-259
- Vitorino LC, Bessa LA (2018) Microbial Diversity: The Gap between the Estimated and the Known. *Diversity* 10 [doi: <https://doi.org/10.3390/d10020046>]
- Wägele H, Klussmann-Kolb A, Verbeek E, Schrödl M (2014) Flashback and foreshadowing - A review of the taxon Opisthobranchia. *Organisms Diversity and Evolution* 14: 133-149.
- Yonow N (2012) Opisthobranchs from the western Indian Ocean, with descriptions of two new species and ten new records (Mollusca, Gastropoda). *ZooKeys* 197 [doi: <https://doi.org/10.3897/zookeys.197.1728>]
- Yonow N (2015) Sea Slugs: Unexpected Biodiversity and Distribution. In Rasul N, Stewart ICF (eds) *The Red Sea*. Springer, Berlin. pp 531-550
- Yonow N, Hayward PJ (1991) Opisthobranch de l'île Maurice.pdf. *Revue Française d'aquariologie* 18: 1-31.