PSEUDOCEROTID POLYCLADS OF LAKSHADWEEP ISLANDS

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FOREWORD

India is one of the biodiversity hotspots of the world and we are blessed with very diverse seascapes encompassing very rich marine flora and fauna. However there are many invertebrate groups for which lack of taxonomic experts is still a significant problem. Thus, it is of utmost importance to take systematic research on the least studied marine faunal groups to understand their taxonomy and ecology.The present photographic catalogue "Pseudocerotid polyclads of Lakshadweep Islands" prepared by Centre for Marine Living Resources and Ecology (CMLRE) is an attempt to address one such understudied group of marine flatworms also known as polyclads. This catalogue contains compilation of polyclads reported from Lakshadweep Islands collected/observed during recent surveys by CMLRE with up to date taxonomic information. I am delighted to present this catalogue to the readers. I laud the efforts of authors for bringing out structured and well researched information regarding polyclads of Lakshadweep which will serve as a valuable source of information on Indian marine flatworms. This catalogue would also serve as photographic guide to help identification of Lakshadweep pseudocerotid polyclads and would help the scientific community, naturalists, and marine biology students. I wish the authors best luck for their future expeditions and showcasing such beautiful and diverse marine and coastal biodiversity to the knowledge of the general public.

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PREFACE

Polyclads, commonly called as marine flatworms are some of the most colourful animals one can find underwater. Though available from intertidal to deep sea habitats, these animals are still meagrely studied all over the world taxonomically and ecologically. The present catalogue is an attempt to cumulate the research done by Centre for Marine Living resources and Ecology (CMLRE), on these worms from Lakshadweep waters from April 2018 to February 2020 and to bring out a photographic guide for tentative identification of these worms. With sections about collection, preservation, up to date nomenclature and species information, this catalogue will act as a reference guide for students, researchers, underwater photographers and any marine biologist with an interest in these colourful underwater beauties.

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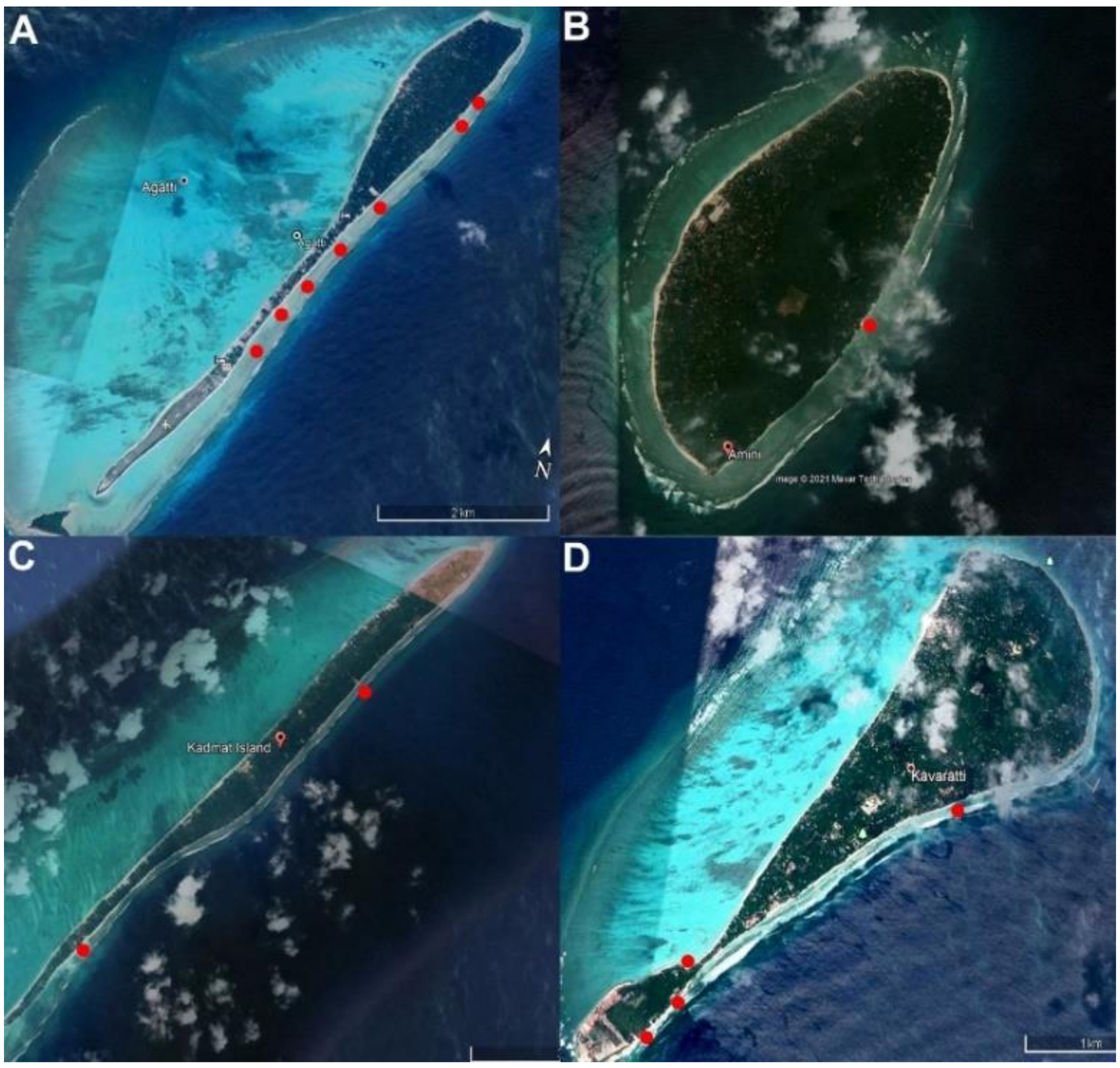
INTRODUCTION

The phylum Platyhelminthes represents group of unsegmented worms with a head, tail end and are considered as most primitive bilaterally symmetrical animals. It is obvious to think about parasitic worms reading the term Platyhelminthes (as mostly all parasites infecting animals and humans belong to this phylum) but, there is an order named as Polycladida which comprises of beautiful and intriguing coloured free living marine flatworms, are an ace predators with a very complex body systems despite of being primitive and one of the oldest living creatures on earth. The word polyclad consists of two words *i.e. poly* - many and *clade* - branches, and these worms are named so because of their highly branched gut.

The order Polycladida is divided into two sub orders based on presence or absence of sucker on ventral side. The suborder Cotylea comprises of polyclads with ventral sucker while absence of ventral sucker classify them under the suborder Acotylea. Polyclads are cosmopolitan being most colourful and populous in tropical waters yet studies regarding these worm are meagre and awaits serious attention. These worms are found from intertidal to deep waters and are an important members of coral reef ecosystem. They feed mostly on sponges and ascidians. However, serious ecological and behavioral studies are still needed to prove their roles in coral health. Prior to studies done on polyclads by CMLRE in Lakshadweep, only two works were published (Laidlaw, 1902) and (Apte and Pitale, 2011) from these islands. Recently, description of five polyclads as new to science (Dixit et al. 2019, 2020, 2021) is a result of research initiated by CMLRE on these worms after a gap of many years.

STUDY AREA

Lakshadweep Islands, the only atoll islands of our country are among major coral reefs present in Indian EEZ. These islands harbor some of finest and highly biodiverse coral reefs in our country. The present work on polyclads is result of biodiversity surveys undertaken from April 2018 – February 2020 to record marine biodiversity in Lakshadweep Islands. Four Islands namely Agatti, Amini, Kadmat and Kavaratti were surveyed. The survey sites were surveyed by scuba diving in subtidal region and hand picking method in intertidal regions.



Four islands namely (A) Agatti, (B) Amini, (C) Kadmat, (D) Kavaratti surveyed during the study period. Red dots are the sampling sites

COLLECTION

Polyclads indeed are very attractive but collecting them is certainly a challenge. They can be collected in intertidal areas beneath rocks or boulders; while diving in sub tidal areas, they can be spotted either crawling on substratum or beneath any hard structures like dead corals, rocks, boulders, wooden logs and even discarded plastic pieces. Due to their small size, cryptic nature and ability to fit in small spaces, it is always very difficult to spot a flatworm and it is even more difficult to lift and get them into a container. They are too fragile to be picked up by hands, thus must be collected by using paint brush and kept in separate containers as they secrete mucous when touched or stressed which can be toxic for other flatworms in same container. The process of being autolyse under stress conditions is another major challenge that a biologist have to tackle between the time of collection and preservation. The role of good quality photography is of utmost importance in polyclad taxonomy, thus photographs were taken *in-situ* and *ex-situ* to record the actual colours and patterns while the specimens were alive. Most of the colours during the course of fixation and preservation faded away leaving behind a cream coloured or transparent worm, thus the importance of good quality photograph cannot be neglected for identification of a polyclad.

PRESERVATION

Polyclads have always been notorious and difficult to preserve for taxonomic study. Therefore many biologists ignored this group. They are very sensitive organisms and can shrink or disintegrate even on a slightest change in water quality, thus simply placing a worm in formalin will not serve the purpose of taxonomic studies. A shrunken specimen can be of no use for a taxonomic study and

identification. Ten percent frozen formalin buffered with seawater is used which ensures that animals do not disintegrate or shrink and preserved flat for microscopic, histological studies and museum storage, though the colours are always lost during preservation (Newman & Cannon, 2003). The animal is first floated on a piece of paper and placed on the frozen formalin surface where after coming in contact with cold surface, animals tend to flatten. Further with a help of paint brush, animal is pressed gently in order to keep it flat during the course of fixation. 70% ethanol can be used for long term storage.

IDENTIFICATION

Identification of a polyclad is based on external as well as internal characters. External characters like shape and size of pharynx, number and position of eyes, number of gonopores, presence or absence of sucker and most importantly colour patterns are studied for identification. For generic and species level identification and especially for similarly coloured species, histological studies of male and female reproductive structures and molecular studies have to be carried out to confirm the identity as well to describe an undescribed species. The shape and arrangement of structures like seminal vesicle and prostatic vesicle are very important in determination of the family and genus as well.

SYSTEMATICS

Phylum	:	Platyhelminthes Miniot, 1876
Class	:	Rhabditophora Ehlers, 1895
Order	:	Polycladida Lang, 1884
Suborder	:	Cotylea Lang, 1884
Superfamily	:	Pseudocerotoidea Faubel, 1984
Family	:	Pseudocerotidae, Lang, 1884

There are 10 genera under the Family Pseudocerotidae present in the world's ocean. However, the present catalogue includes only the species under the genus viz, *Acanthozoon* Collingwood, 1876; *Pseudobiceros* Faubel, 1983 ;*Pseudoceros* Lang, 1884; *Bulaceros* Newman & Cannon, 1996 ; which are collected and documented during our survey at Lakshadweep waters.

Acanthozoon fuscobulbosum Dixit, Sivaperuman & Raghunathan, 2018

Type Locality: Great Nicobar Island, India

Description: Background body colour cream. Margin darker with pinkish tinge and rim of small transverse and crisscrossed white lines. Dorsal surface covered with numerous brown and bulbous papillae of variable sizes. Median area elevated with less papillae. Cerebral eye cluster horseshoe shaped and tentacular eyes present only on lower half of pseudotentacles which are erect and black with white tips. Cerebral eye cluster with about 35 eyes and about 7 eyes on each tentacles within the black coloured region. Size – 1 to 3 cm.

Distribution: Lakshadweep Islands (Agatti, Kavratti) and Andaman and Nicobar Islands

Pseudobiceros apricus Newman & Cannon, 1994

Type Locality: Heron Island, Australia.

Description: Background colour light brown to black and translucent on the edges. Dorsum is speckled with numerous white dots and with clusters of white dots. Median area elevated and darker. Margins slightly ruffled, pseudotentacles square like with white tips. Eye cluster horseshoe shaped present in clear area (devoid of pigment) between pseudotentacles. Size – 1 to 4 cm

Distribution: Lakshadweep Islands (Agatti), Andaman and Nicobar Islands, India; Heron Island and Queensland, Australia; Eilat, Red Sea

Pseudobiceros damawan Newman & Cannon, 1994

Type Locality: Laing Island, Papua New Guinea

Description: Body semi-transparent, mottled opaque white and grey with widely spreaded out black spots all over the dorsum. Median region slightly elevated with cream colour. Marginal band is thick made up of reddish orange colour with white transverse streaks. A very thin black rim is present on the periphery of the body. Pseudotentacles ear like and erect. Size – 2 to 4 cm.

Distribution: Andaman and Nicobar Islands, India; Australia; Indonesia; Micronesia; Marshall Islands; Papua New Guinea and South Africa

Pseudobiceros hancockanus (Collingwood, 1876)

Type Locality: Singapore (exact locality unknown)

Description: Background colour dark grey to black. Marginal bands three: inner bright orange, middle transparent grey followed by a thin white rim. Ventral surface light brown with same three marginal bands as seen from dorsal surface. Pseudotentacles black, ear-like and pointed, bordered by white rim and noticeable white tips. A small white triangular area present between the pseudotentacles. Cerebral eyespot in a clear uncoloured area with a thin white line starting from white triangle transecting the eyespot cluster. Median area can be darker. Size – 2 to 6 cm.

Distribution: Lakshadweep Islands (Agatti, Kavratti, Kadmat) and Andaman and Nicobar Islands, India; Australia; Hawaii; Indonesia; Mauritius; Micronesia; Papua New Guinea; Red Sea and Singapore.

Pseudobiceros hymanae Newman & Cannon, 1997

Type Locality: Madang, Papua New Guinea

Description: Background colour black with velvety appearance, opaque; margin made up of two distinct bands, first orange followed by a narrow black rim. Pseudotentacles square, black with the same marginal bands. Ventrally black in colour with same marginal bands. Cerebral eyespot cluster present but not clearly visible due to black background. Size – 1 to 4 cm.

Distribution: Lakshadweep Islands (Agatti) and Andaman and Nicobar Islands, India; Australia; Indonesia; Maldives; Papua New Guinea; Solomon Islands and South Africa.

Pseudobiceros stellae Newman & Cannon, 1994

Type Locality: Heron Island, Australia.

Description: Background colour grey to black and translucent on the edges. Dorsum is speckled with numerous white dots and clusters of dots are arranged in flower like pattern Median area elevated. Margins slightly ruffled, Pseudotentacles squared. Eye cluster horseshoe shaped present in clear area (devoid of pigment) between pseudotentacles. Size – 2 to 6 cm.

Distribution: Lakshadweep Islands (Agatti & Kavratti), India; Heron Island and Queensland, Australia; Eilat, Red Sea

Pseudoceros agattiensis Dixit, 2019

Type Locality: Agatti Island, Lakshadweep, India.

Description: Background body colour is brown in centre and fading to black towards the margin, covered with numerous white spots, densely arranged in the centre and sparse towards the margin. Three longitudinal stripes runs throughout the dorsal surface. Median stripe is thin without any branches while lateral stripes are branches towards the margin. These stripes are white in centre and light brown at most extremities with bulging ends. Pseudotentacles are simple folding of the anterior margin and black in colour. Cerebral eye cluster horseshoe shaped. Size – 2 to 4 cm.

Distribution: Lakshadweep Islands, (Agatti and Kavratti)

Pseudoceros bicolor Verrill, 1901

Type Locality: Birds Island, Bermuda.

Description : Background colour yellow to light brown, numerous minute white spots present all over body except margins; marginal band white with greyish transversal stripes; dorsal longitudinal band speckled with interrupted brown and white blotches; pseudotentacles developed and square like, shaded with white and brown. Size – 2 to 4 cm.

Distribution: Lakshadweep Islands (Agatti); Bermuda; Colombia; Jamaica; Belize; Hounduras; Panama; Brazil

Pseudoceros bipurpurea Dixit, 2021

Type Locality: Agatti Island, Lakshadweep.

Description: Background body colour cream with an orange median band surrounded by dense patches of purple spots without touching the margin (Figure 2A). These dense purple spots tend to disperse and broaden toward posterior end. Marginal rim blue.

Distribution: Lakshadweep Islands (Agatti), Andaman and Nicobar Islands, India.

Pseudoceros bolool Newman & Cannon, 1994

Type Locality: Heron Island, Australia.

Description: Background colour black with no markings or patterns on the body. Ventrally lighter black to grey. Pseudotentacles small and black; cerebral eyespot difficult to spot due to black body colour. Size – 4 to 8 cm.

Distribution: Lakshadweep Islands (Agatti), Andaman and Nicobar Islands, India; Australia; Indonesia; Papua New Guinea; Philippines.

Pseudoceros galatheensis Dixit, Raghunathan & Chandra, 2017

Type Locality: Galathea Wildlife Sanctuary, Great Nicobar Island, India.

Description. Small, smooth, light blue in colour and terminally rounded. Margin dark blue without any ruffles. Thin, bright yellowish-orange median line starting from behind cerebral eyespot cluster and ending before posterior margin without touching it. Pseudotentacles small, formed by simple folds of the anterior margin and dark blue with presence of 12-14 scattered eyespots on each pseudotentacle on either side. Cerebral eyespots cluster with 25-28 eyes. Size – 1 to 3 cm.

Distribution: Lakshadweep (Agatti, Kavratti & Amini), Great Nicobar Island, India; Micronesia and Indonesia.

Pseudoceros galaxea Dixit, 2021

Type Locality: Agatti Island, Lakshadweep.

Description: Background body colour chocolate brown with numerous small white to cream dots on the entire dorsal surface. These minute dots are very densely distributed giving a spray-like appearance. Some white dots are too close forming clusters appearing like bigger dots. A black marginal band studded with white microdots runs around the whole body including pseudotentacles.

Distribution: Lakshadweep Islands (Agatti).

Pseudoceros indicus Newman & Schupp, 2002

Type Locality: Moreton Bay, Queensland, Australia.

Description: Background body colour mottled cream and opaque. A characteristic and conspicuous blue margin made up of numerous medium sized blue coloured spots. Ventrally cream with tinge of purple or pink (possibly due to presence of prey in the gut). Cerebral eyespot with about 30- 40 eyes in a horseshoe shaped cluster. Size – 2 to 6 cm.

Distribution: Lakshadweep (Agatti, Kadmat), Andaman and Nicobar Islands, India; Australia; Indonesia; Maldives; Micronesia and South Africa.

Pseudoceros paralaticlavus Newman & Cannon, 1994

Type Locality: Heron Island, Australia.

Description: Background body colour black with a broad grey median band with light shade in middle and darker at margin giving the appearance of white median line. Marginal band thin white followed by a thick bright yellow/fluorescent rim on both dorsal and ventral side. Pseudotentacles small, black and with yellow rim. Horseshoe shaped eye cluster with around 30 eyes. Size – 2 to 6 cm.

Distribution: Lakshadweep (Agatti, Kadmat, Kavratti), Andaman and Nicobar Islands, India; Australia; Indonesia; Japan; Marshall Islands; Micronesia; Papua New Guinea; Reunion Islands; South Africa; Thailand and Hawaii.

Pseudoceros duplicinctus Prudhoe, 1989

Type Locality: Heron Island, Australia.

Description: Background body colour light to dark bwown. Marginal band thin light blue to cream followed by a thick yellow rim on both dorsal and ventral side. In some species thin light blue band is very light and difficult to observe. Pseudotentacles very simple and small with yellow rim. Horseshoe shaped eye cluster with around 30 eyes and very difficult to observe due to dark background. Size – 2 to 6 cm.

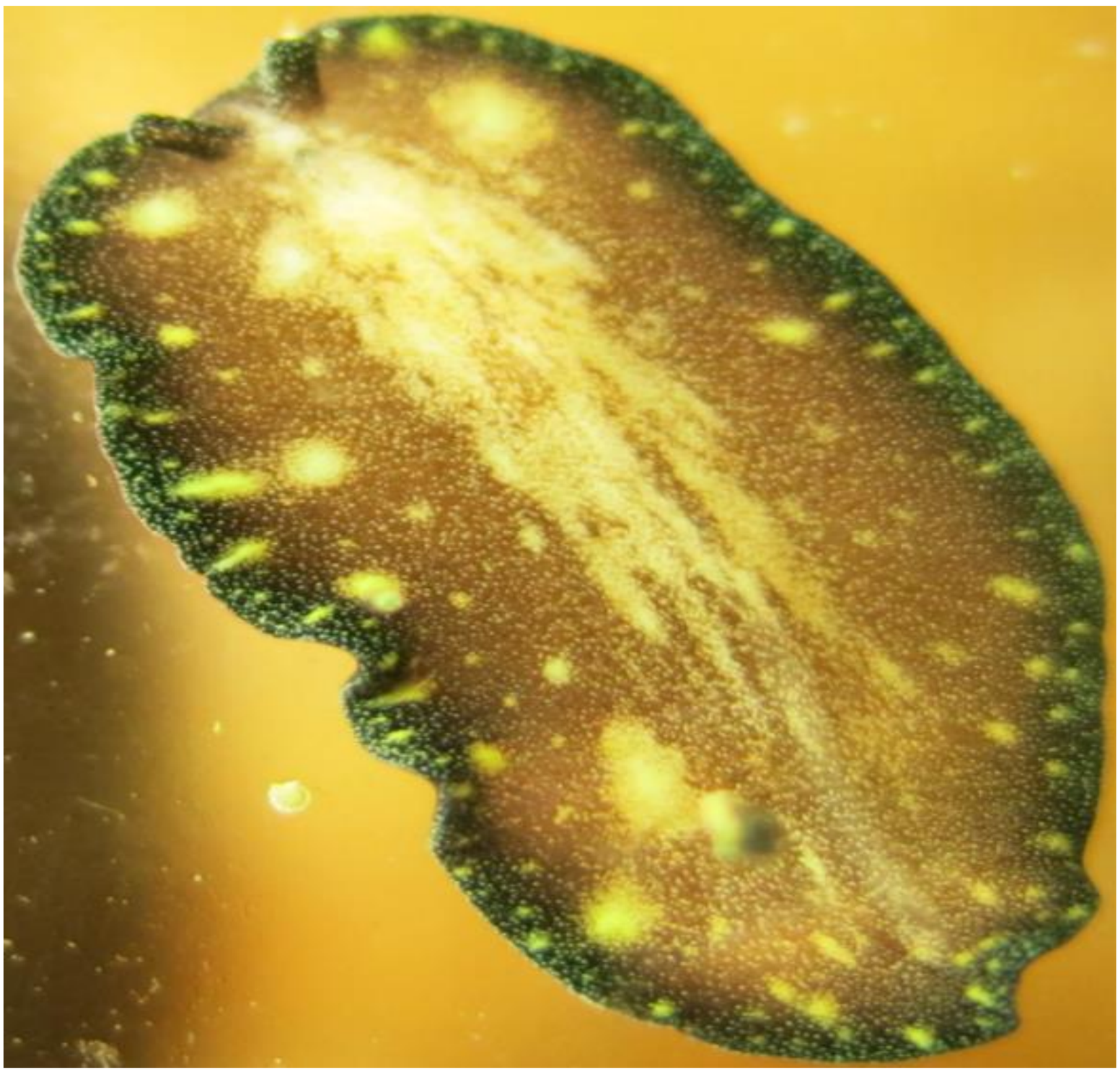
Distribution: Lakshadweep (Agatti, Kadmat, Kavratti), Andaman and Nicobar Islands, India; Australia; Kenya; Marshall Islands; Micronesia; Papua New Guinea.

Pseudoceros stellans Dixit, 2019

Type Locality: Agatti Island, Lakshadweep, India.

Description: Background body colour brown with numerous small white to yellow microdots on dorsum. Different sized yellow blotches present on dorsum but most of the small white blotches are present on marginal area. Half of the median area is marbled with irregular white shading, thus appearing as depigmented area. A thick black marginal band run around whole body including pseudotentacles. This marginal band is studded with microdots and small yellow blotches. Cerebral eye cluster horseshoe shaped. Size – 2 to 3 cm.

Distribution: Lakshadweep Islands (Agatti)



Bulaceros newcannorum Dixit, 2020

Type Locality: Agatti Island, Lakshadweep, India.

Description: Background body translucent grey. Yellow medially and white spots scattered on dorsum. Black mottling in median area. Marginal band translucent and clear with many white spots followed by broken orange and black bands. Pseudotentacles knobbed distally, small and ear like. Size – 3 to 6 cm.

Distribution: Lakshadweep Islands (Agatti and Kavratti)

Bulaceros porcellanus Newman & Cannon, 1996

Type Locality: Australia.
Description: Background translucent white with opaque white mottling and white microdots on dorsal surface. Some evenly spaced black spots of different sizes are present on dorsum but absent near margin. Marginal orange brown surrounded by translucent rim with white spots.
Distribution: Lakshadweep Islands (Agatti)

Summary

The present catalogue illustrates 18 species of polyclads collected from various Islands of Lakshadweep archipelago namely Agatti, Amini, Kadmat and Kavaratti Islands. Out of these, five species are described as new to science, *Bulaceros newcannorum Dixit, 2020, Pseudoceros agattiensis* Dixit 2019*, Pseudoceros bipurpurea* Dixit, 2021*, Pseudoceros galaxea* Dixit, 2021 and *Pseudoceros stellans* Dixit, 2019. Two species, *Pseudoceros bicolor* Verrill, 1901 and *Bulaceros porcellanus* Newman & Cannon, 1996 are new geographical records to Indian waters.

The present work is the first attempt to publish acquired knowledge of polyclad biodiversity from few surveyed islands in the form of a photographic catalogue. Continuous systematic surveying and documenting are required to explore and reveal the hidden and undescribed diversity of this ecologically important group of organisms.

References

Apte, D. and Pitale, R.D., 2011. New records of polyclad flatworms (Platyhelminthes: Turbellaria) from coral reefs of Lakshadweep Island, India. *Journal of the Bombay Natural History Society*, *108*(2), pp.109-113

Dixit, S., Raghunathan, C. and Chandra, K., 2017. Two new marine flatworms (Polycladida: Pseudocerotidae) from Andaman & Nicobar Islands, India. *Zootaxa*, *4221*(1), pp.111-122. https://doi.org/10.11646/zootaxa.4221.1.5

Dixit, S., Sivaperuman, C. and Raghunathan, C., 2018. Description of two new pseudocerotids (Rahabditophora: Rhabditophora; Polycladida) from Andaman & Nicobar Islands, India. *Zootaxa, 4403*(2), pp.365-377. https://doi.org/ 10.11646/ zootaxa.4403.2.8

Dixit, S., Bayyana, S., Manjebrayakat, H., Saravanane, N & Sudhakar, M., 2019. Polyclad fauna of Agatti Island, Lakshadweep, India: new records and description of two new species. *Zootaxa* 4657 (2): 246–260

Dixit, S., Manjebrayakat, H. & Saravanane, N. 2020. A rare polyclad genus Bulaceros (Platyhelminthes: Polycladida: Pseudocerotidae): new species and new record from Indian coral atolls. Marine Biology Research, 16:8-9, 632-642. 10.1080/17451000.2020.1870044

Dixit, S., Manjebrayakat, H. & Saravanane, N. 2021. Two new Pseudoceros (Platyhelminthes: Polycladida: Pseudocerotidae) from Agatti Island, India and a species

checklist from Indian waters. Journal of the Marine Biological Association of the United Kingdom 1–11. https://doi.org/10.1017/S0025315421000151

Laidlaw, F.F., 1902. The marine Turbellaria with an account of the anatomy of some species. In: Gardiner, J.S. (Ed.), *The Fauna and Geography of the Maldive and Laccadive Archipelagoes: Being the Account of the Work carried on and of the Collections made by an Expedition during the years 1899 and 1900.* Vol. 1. The University Press, Cambridge, pp.282-312.

Newman, L.J. and Cannon, L.R.G., 1994. *Pseudoceros* and *Pseudobiceros* (Platyhelminthes, Polycladida, Pseudocertotidae) from eastern Australia and Papua New Guinea. *Memoirs of the Queensland Museum, 37*(1), pp.205-266.

Newman, L.J. and Cannon, L.R.G., 1996. New genera of pseudocerotid flatworms (Platyhelminthes; Polycladida) from Australian and Papua New Guinean coral reefs. Journal of Natural History, 30(10), pp.1425-1441. https://doi.org/10.1080/00222939600770811

Newman, L.J. and Cannon, L.R.G., 2003. Marine Flatworms. The World of Polyclads. CSIRO Publishing, Collingwood, pp 97.

Newman, L.J. and Cannon, L.R.G., 2005. Fabulous Flatworms: a guide to marine polyclads. Version 1. ABRS & CSIRO Publishing, Canberra. [CD-ROM]

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