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# Checklist of polyclad flatworms (Platyhelminthes) from Micronesian coral reefs

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**Abstract**—We record 68 species of polyclad flatworms from new material (all photo-documented) and 28 species from literature records, for a total diversity of 88 species for Micronesia. Up to 60% of the encountered species may be undescribed. Guam has the largest recorded fauna with 59 species, followed by 28 species known from Palau. Pseudocerotidae comprise 58% of documented species, and more than 3 times as many cotyleans than acotyleans are documented. This study shows that the polyclad fauna of Micronesia is diverse yet poorly known, and highlights the need for further work.

## Introduction

Polyclad flatworms are conspicuous inhabitants of coral reefs especially throughout the Indo-West Pacific, yet their diversity within Micronesia remains poorly documented. Only five papers have dealt with the polyclad fauna of this large and diverse area (Kato 1943, Hyman 1955, 1959; Newman & Cannon 1997, Newman & Schupp 2002). This checklist represents the first comprehensive account of polyclad flatworms from Micronesian waters.

Although many tropical polyclads are brightly colored and attract attention, they remain understudied partly for methodological reasons. Accurate taxonomic determinations involve examination of both the morphology of living animals and the anatomy of the reproductive structures (Newman & Cannon 1994a). Diagnostic color characters tend to disappear rapidly after fixation and need to be documented photographically from living animals. Polyclads are also extremely

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delicate and notoriously difficult to fix. Comparisons with the previous literature are difficult, because many species were described from immature or damaged specimens or because their color patterns were not accurately documented. Species records and museum types are often scarce or lacking.

## Methods

Most of the new material on which this study is based was collected on Guam during the past 10 years by staff of the University of Guam Marine Laboratory. A smaller collection from the Coral Reef Research Foundation, Palau, was also studied, as were a few photographic records from other islands. Specimens were taken during structured biodiversity surveys as well as during routine taxonomic collecting, by snorkeling and SCUBA, generally at night or from under rubble. Specimens were photographed whenever possible either *in situ* or in the laboratory. Cited photographs (Appendix 1) are on the WWW at: http://www.flmnh.ufl.edu/reefs; they are also available on the Marine Biodiversity of Guam CD-ROM co-publication. All specimens were fixed on frozen 10% seawater formalin, a fixation method modified from Newman & Cannon (1995a). Specimens were then preserved in 70% ethanol for histological preparation and long term storage. The importance of both photodocumentation and proper fixation for tropical polyclads cannot be overemphasized. Taxonomic determinations were made by L.J. Newman. All specimens have been deposited in the Queensland Museum worm collections (QM). Records of Micronesian polyclads from the literature were reevaluated and their nomenclature updated after Faubel (1983, 1984) and Cannon (1996).

## Results

We documented 88 species of polyclads from Micronesia: 68 species based on new material and 28 species from literature records (Appendix 1). Only 8 species are common between new and historical records. An additional 5 species are recorded in the literature, but are insufficiently described to be identifiable. The documented fauna consists of 14 families, with cotylean flatworms (67 spp.) much better represented than acotyleans (21 spp). The Pseudocerotidae is the most diverse family with 51 species.

Guam has the greatest recorded polyclad diversity in Micronesia with 59 species, all but one representing new records for the island. One additional species is known from Saipan making the Mariana total 60 species. Other islands from Micronesia are poorly sampled in comparison, with Palau having the next highest diversity with 28 species (+5 species of uncertain status; see Appendix 1), while only 8 species are known from the next best known area, the Federated States of Micronesia.

About 60% of the collected species (N=68) remain unidentified; the majority of these appear to be undescribed. Further histological examination of the

morphological characters and reproductive structures are needed to verify their status and describe those species that are new. Among the taxa encountered only the genera *Pseudoceros* and *Pseudobiceros* have been taxonomically revised in the Indo-West Pacific (Newman & Cannon 1994a). Of the 33 species recorded in this well-known group, 8 (24%) are undescribed, an additional 4 (12%) differ slightly from nominal species, designated in Appendix 1 by a 'cf.'. Of the 26 species of *Pseudoceros* and *Pseudobiceros* we encountered in Micronesia, 81% are new records for the region.

## Discussion

Polyclads are diverse, often strikingly colorful, yet rarely studied components of Pacific coral reef faunas. Previous to our study the greatest diversity of polyclads documented for any Pacific island group was 34 species recorded with various levels of identification from Hawaii (Poulter 1987), and 23 species recorded from Palau (Appendix 1). The 59 species here documented from Guam demonstrates a considerably greater local species richness in the region. Yet even Guam's flatworm diversity is greatly understudied. Several additional species are known to us from Guam but were not included in this paper because they are insufficiently documented, and new flatworms are regularly encountered during fieldwork. Our efforts have disproportionately focused on large and colorful species, notably the Pseudocerotidae. More than a quarter of the species are known from single specimens, further indicating that considerable diversity remains to be discovered. We estimate that Guam's polyclad diversity is well over a 100 species. Finally, the general reef fauna of Guam is not particularly species rich in the western Pacific: even within Micronesia, Palau and the Federated States of Micronesia (Caroline Islands) have been found to harbor much higher diversity in all groups for which comparisons are available (e.g. Myers 1999, Randall 1995).

As few faunistic studies have been done on polyclad flatworms, it is difficult to put Micronesian polyclad diversity in a regional perspective. The most thorough study of an Indo-West Pacific polyclad fauna was done on the Great Barrier Reef, where >5 years of focused collecting effort resulted in 11 described and 123 undescribed polyclads (Newman & Cannon 1994b). The preponderance of undescribed species on the GBR (>90%) compares well with Micronesia (up to 60%) and indicates how poorly known even colorful tropical polyclads are. The somewhat lower proportion of undescribed species encountered in Micronesia reflects taxonomic activity in the past 7 years during which approximately 60 species of Pseudocerotidae have been named (Newman & Cannon 1994a, 1995b, 1996a, 1996b, 1997, 1998, Newman & Schupp 2002). In fact 64% (18 of 28) of the previously described species that we recorded for Micronesia have been named since 1994.

The taxonomic composition of recent collections differs noticeably from that of older collections documented in the literature. Acotyleans are better

represented among literature than among recent records (13 vs. 9 species, 9 vs. 3+ families), so that while 39% of literature records are composed of acotyleans, only 13% of recent collections are. This discrepancy likely has multiple causes, most important being our focus on colorful pseudocerotids, which can usually be identified from color pattern alone (Newman & Cannon 1995a), a claim confirmed by molecular data (Litvaitis & Newman 2001). In contrast, pseudocerotids are poorly represented in older collections, in part because they are the most delicate of the polyclads. They often autolyse during collection and dissolve on fixation. With no reliable means of preserving specimens prior to Newman and Cannon (1995a), these beautiful animals were just too difficult to study. In contrast, acotyleans were generally ignored in recent efforts and remain to be studied, as identification of most species requires histological study, and no specialists were actively working on the Indo-West Pacific fauna. Our focus on habitats was also different, with historical studies carried out more at intertidal and shallow subtidal habitats, especially on reef flats and shallow lagoons, while we focused on deeper, fore reef habitats accessible by SCUBA.

Our results illustrate the need for further studies to document tropical polyclad biodiversity. At present we barely have an appreciation of even the magnitude of the species richness of tropical Pacific polyclads, and the majority of species encountered at even well sampled locations are undescribed. Yet polyclads are not only conspicuous components of the coral reef biota, but also important predators of benthic invertebrates such as ascidians, crustaceans and molluscs, including all commercial bivalve species (Newman et al. 1993, O'Connor & Newman 2001, in press). The group will also provide a wealth of material for ecological, evolutionary, behavioral, and biogeographic studies as studies progress.

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## Appendix 1. Polyclads of Micronesia

Voucher: most vouchers were photographed and the photo reference number corresponds to the specimen voucher listed. Exceptions, where photographed and vouchered specimen are not the same are marked with '*'.

Refs.: 1: Kato 1943, 2: Hyman 1955, 3: Hyman 1959, 4: Newman & Cannon 1997, 5: Newman & Schupp 2002

Photos: CRPLA: Coral Reef Research Foundation, Palau, GP: G. Paulay, RRW: R. Ritson-Williams, RFM: F. Myers, SWTH: S. W.T. Hughes, PS: P. Schupp

Is: Islands: G = Guam, S = Saipan, P = Palau, Po = Pohnpei, K = Kapingamarangi, O = Onotoa, E = Enewetak, I = Ifaluk, Kw = Kwajalein, M = Majuro, Y = Yap, C = Chuuk.

Notes: numbered notes follow at end of Appendix.

| Taxon | Voucher | Ref | Photo | Notes | Is |
|---|---|---|---|---|---|
| ACOTYLEA: CALLIOPLANIDAE | | | | | |
| *Asolenia deilogyna* Hyman 1959 | | 3 | | | P |
| *Callioplana marginata* Stimpson, 1857 | QMG211140 | | RRW7-01-PC-H | | G |
| *Kaburakia oceanica* (Hyman 1955) | | 2 | | | S |
| ACOTYLEA: CESTOPLANIDAE | | | | | |
| Cestoplanidae sp. 1 | QMG211126 | | GP403-20 | | G |
| ACOTYLEA**:** EUPLANIDAE | | | | | |
| *Aprostatum longipenis* (Kato 1943) | | 1 | | | P |
| ACOTYLEA**:** ILYPLANIDAE | | | | | |
| *Ilyella gigas* (Schmarda 1859) | | 2(O),3(G,K) | | | O,G,K |
| ACOTYLEA: LATOCESTIDAE | | | | | |
| *Eulatocestus pacificus* (Laidlaw 1903) | | 3 | | | P |
| ACOTYLEA: NOTOPLANIDAE | | | | | |
| *Notoplana micronesiana* Hyman 1959 | | 3 | | | I |
| *Notocomplana palaoensis* (Kato 1943) | | 1 | | | P |
| ACOTYLEA**:** PALAUIDAE | | | | | |
| *Palaua tropica* (Hyman 1959) | | 3 | | | P |
| ACOTYLEA: PLANOCERIDAE | | | | | |
| *Aquaplana pacifica* Hyman 1959 | | 3 | | | P |
| *Paraplanocera fritillata* Hyman 1959 | | 3 | | | E |
| *Paraplanocera oligoglena* (Schmarda 1859) | QMG211116(G)* | 2(Kw) | GP461-11(G)* | 1 | Kw, G |
| Planoceridae sp. 1 | QMG211128 | | GP781-34 | | G |

Appendix 1. Polyclads of Micronesia / *(continued)*

| Taxon | Voucher | Ref | Photo | Notes | Is |
|---|---|---|---|---|---|
| Planoceridae sp. 2 | QMG211201 | | RRW4-7-PP-H | | G |
| Planoceridae sp. 3 | | | GP402-16 | | G |
| Planoceridae sp. 4 | QMG211121 | | GP403-26 | | G |
| ACOTYLEA**:** STYLOCHIDAE | | | | | |
| *Leptostylochus pacificus* (Kato 1943) | | 1 | | | P |
| ACOTYLEA**:** STYLOCHOPLANIDAE | | | | | |
| *Stylochoplana minuta* Hyman 1959 | | 3 | | | E,I |
| ACOTYLEA: UNIDENTIFIED | | | | | |
| Acotylea sp. 1 | | | GP399-25 | | G |
| Acotylea sp. 2 | | | GP862-18 | | G |
| COTYLEA: EURYLEPTIDAE | | | | | |
| *Eurylepta rugosa* (Hyman 1959) | | 3 | | | P |
| *Maritigrella stellata* Newman & Cannon, 2000 | QMG211118 | | GP290-1 | | G |
| Euryleptidae sp. 1 | QMG211176* | | GP389-24* | | G |
| Euryleptidae sp. 2 | QMG211190 | | RRW1-44-DR-H | | G |
| COTYLEA: PERICELIDAE | | | | | |
| *Pericelis beyerleyana* (Collingwood 1876) | | 1 | | | P |
| *Pericelis* sp. 1 | QMG211101 | | GP403-31 | | G |
| *Pericelis* sp. 2 | QMG211129 | | GP543-16 | | G |
| *Pericelis* sp. 3 | | | GP448-23 | | M |
| Pericelidae sp. 1 | | | GP582-10 | | G |
| COTYLEA: PROSTHIOSTOMIDAE | | | | | |
| *Euprosthiostomum exiguum* (Hyman 1959) | | 3 | | | E |
| *Prosthiostomum griseum* Hyman 1959 | | 3 | | | E |
| *Prosthiostomum trilineatum* Yeri & Kaburaki 1920 | QMG211108(G) | 1(P) | GP590-18(G) | 2 | P,G |
| *Prosthiostomum* sp. 1 | QMG211147 | | RRW2-03-HA-H | | G |
| *Prosthiostomum* sp. 2 | QMG211124 | | GP366-15 | | G |
| *Prosthiostomum* sp. 3 | QMG211191 | | RRW2-9-PB-H | | G |
| COTYLEA: PSEUDOCEROTIDAE | | | | | |
| *Acanthozoon / Thysanozoon* sp. 1 | | | GP818-25 | | G |
| *Acanthozoon* sp. 1 (n. sp.) | | | RFM-B-95 | | P |
| *Acanthozoon* sp. 2 | QMG211114 | | GP814-33 | | G |

Appendix 1. Polyclads of Micronesia / *(continued)*

| Taxon | Voucher | Ref | Photo | Notes | Is |
|---|---|---|---|---|---|
| *Acanthozoon* sp. 3 | QMG211184* | | GP862-16* | | G |
| *Acanthozoon* sp. 5 | QMG211185* | | RRW1-43-DR-H* | | G |
| *Bulaceros* sp. 1 (n. sp.) of Newman & Cannon, 1997 | QMG211168* | | GP862-9* | | G |
| *Pseudobiceros bedfordi* (Laidlaw, 1903) | QMG211142(G)* | 1(P),2(O,S), 3(I) | GP516-3(G)* | 3 | G,I,O,P,S |
| *Pseudobiceros* cf/aff. *gratus* (Kato, 1937) | QMG211149* | | GP855-25* | | G |
| *Pseudobiceros damawan* Newman & Cannon, 1994 | QMG211115 | | GP818-27 | | G |
| *Pseudobiceros flowersi* Newman & Cannon, 1997 | QMG211195 | | CRPLA 6 | | P |
| *Pseudobiceros fulvogriseus* (Hyman 1959) | | 3 | | | P |
| *Pseudobiceros gratus* (Kato, 1937) | QMG211125(G) | 1(P) | SWTH65-25(G) | | G,P |
| *Pseudobiceros izuensis* (Kato, 1944) | | 3 | | | P |
| *Pseudobiceros kryptos* Newman & Cannon, 1997 | QMG211141* | | GP540-30* | | G |
| *Pseudobiceros murinus* Newman & Cannon, 1997 | QMG211161(G)* | | GP783-32(G)*, GP794-17(Y) | | G,Y |
| *Pseudobiceros sharroni* Newman & Cannon 1997 | QMG210879 | 4 | | | P |
| *Pseudobiceros uniarborensis* Newman & Cannon, 1994 | QMG211148* | | GP772-13* | | G |
| *Pseudobiceros* sp. 1 (n. sp.) | QMG211105 | | GP811-34 | | G |
| *Pseudobiceros* sp. 2 (n. sp.) | QMG211127 | | GP570-26 | | G |
| *Pseudobiceros* sp. 3 (n. sp.) | QMG211194 | | CRPLA 14 | | P |
| *Pseudobiceros* sp. 4 (n. sp.) | QM G211187 | | RRW1-45-PA-H | | G |
| *Pseudobiceros* sp. 5 (n. sp.) | QM G211201 | | RRW1-72-TB-H | | G |
| *Pseudoceros bimarginatus* Meixner, 1907 | QMG211120 | | GP808-1 | | G |
| *Pseudoceros cruentus* Newman & Cannon, 1998 | QMG211167(G) | | RRW1-31-TC-H(G), GP375-35(Po) | | G,Po |
| *Pseudoceros* cf. *dimidiatus* (Graff, 1893) | | | GP356-29 | | G |
| *Pseudoceros ferrugineus* Hyman 1959 | QMG210915 | 3 | CRPLA 8 | | P |
| *Pseudoceros goslineri* Newman & Cannon, 1994 | | | GP586-23 | | G |
| *Pseudoceros indicus* Newman & Schupp, 2002 | QMG211137 (P) | 5(C) | PS | | C,P |
| *Pseudoceros josei* Newman & Cannon 1998 | QMG211112 | | GP389-1 | | G |
| *Pseudoceros paralaticlavus* Newman & Cannon, 1994 | QMG211103(G), QMG210961(P) | | GP540-4(G), CRPLA 7(P) | | G,P |

Appendix 1. Polyclads of Micronesia / *(continued)*

| Taxon | Voucher | Ref | Photo | Notes | Is |
|---|---|---|---|---|---|
| *Pseudoceros perviolaceus* (Hyman, 1959) | | 3 | | | P |
| *Pseudoceros prudhoei* Newman & Cannon, 1994 | QMG211183* | | GP831-30* | | G |
| *Pseudoceros* cf. *rubronanus* Newman & Cannon, 1998 | QM211134 | | GP411-10 | | G |
| *Pseudoceros sapphirinus* Newman & Cannon, 1994 | | | GP323-37 | | P |
| *Pseudoceros* cf. *susanae* Newman & Anderson, 1997 | | | RFM-B-31 | | P |
| *Pseudoceros tristriatus* Hyman, 1959 | | 3(I,P) | GP776-27(G) | | G,I,P |
| *Pseudoceros* sp. 1 (n. sp.) | QMG211107 | | GP583-2 | | G |
| *Pseudoceros* sp. 2 (n. sp.) | QMG211104 (G)<br>QMG211197 (P) | | GP380-4 (G),<br>CRPLA 10(P) | | G,P |
| *Pseudoceros* sp. 3 (n. sp.) | QMG211122 | | GP807-33 | | G |
| *Thysanozoon nigropapillosus* (Hyman 1959) | | 3 | | | I |
| *Thysanozoon* sp. 1 (n. sp.) | | | GP592-32 | | G |
| *Thysanozoon* sp. 2 (n. sp.) | QMG211113(G) | | GP365-20(G),<br>GP639-23(P) | | G,P |
| *Thysanozoon* sp. 3 | QMG211157* | | GP781-29* | | G |
| *Thysanozoon* sp. 4 | | | GP382-36 | | G |
| *Thysanozoon* sp. 5 | QMG211192 | | RRW1-76-GB-H | | G |
| Pseudocerotidae sp. 1 | | | GP855-20 | | G |
| Pseudocerotidae sp. 2 | QMG211106 | | GP592-23 | | G |
| Pseudocerotidae sp. 3 | QMG211175 | | RRW1-19- PP-H | | G |
| Pseudocerotidae sp. 4 | QMG211123 | | GP811-33 | | G |
| Pseudocerotidae sp. 5 | QMG211200 | | RRW1-47-AI-H | | G |
| Pseudocerotidae sp. 6 | QMG211198(S) | | RRW-SI-6-H(S), RRW(G) | | G, S |
| COTYLEA: UNIDENTIFIED | | | | | |
| Pseudocerotidae/Eurylepidae sp. 1 | | | GP626-11 | | P |
| SPECIES OF UNCERTAIN STATUS | | | | | |
| *Pseudoceros ater* Hyman, 1959 | | 3 | | 4 | P |
| *Nymphozoon bayeri* Hyman 1959 | | 3 | | | P |
| *Pseudoceros caeruleocinctus* Hyman, 1959 | | 3 | | 4 | P |
| *Pseudoceros fuscogriseus* Hyman 1959 | | 3 | | | P |
| *Acanthozoon albopapillosus* Hyman, 1959 | | 3 | | 4 | P |

Notes:
1) Guam record is *Paraplanocera* cf. *oligoglena*
2) Guam record is *Prosthiostomum* cf. *trilineatum*
3) Onotoa and Saipan records as *Pseudoceros micronesianus* Hyman, 1955, a junior synonym (Newman & Cannon 1994)
4) These species appear not to be identifiable from their descriptions (Fauber 1983, 1984, Newman pers. obs. for *P. ater*) and were not included in diversity totals.