Marine Flatworms of the Tropical Indo-Pacific

Reef ID Books

Andrey Ryanskiy

Marine Flatworms of the Tropical Indo-Pacific

Photographic guide on marine polyclads with 580+ species

Andrey Ryanskiy

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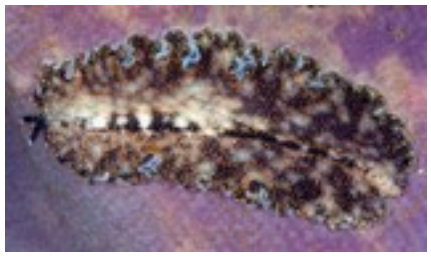

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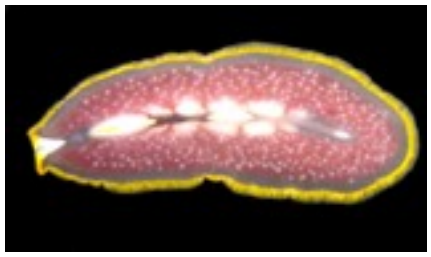

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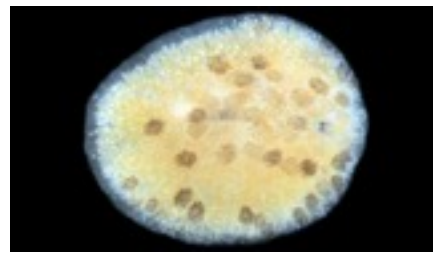

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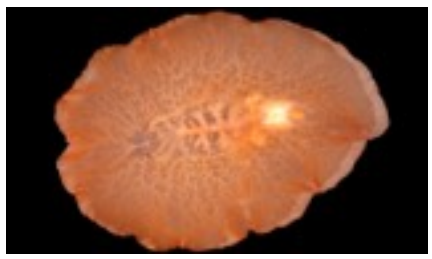

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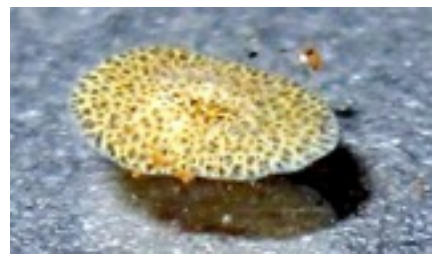

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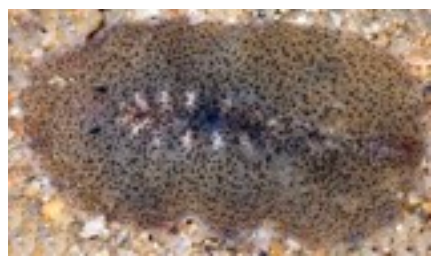

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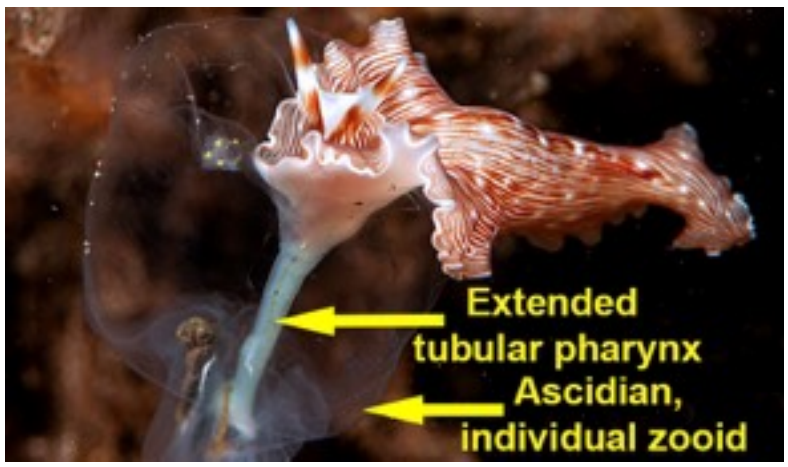
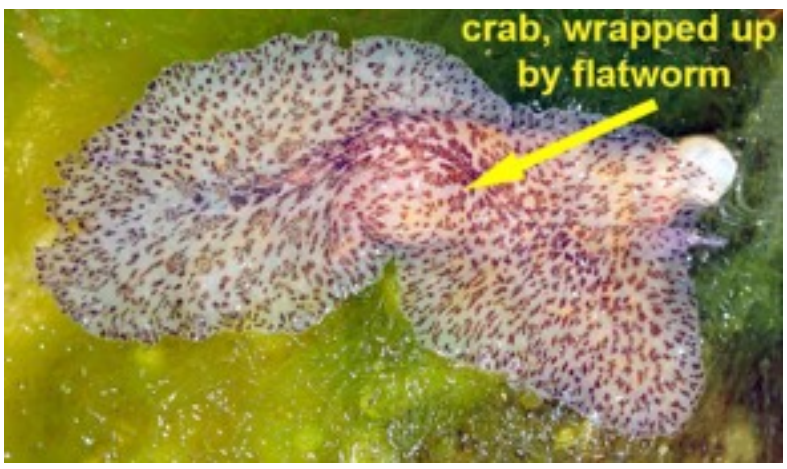
FLATWORMS: BASIC KNOWLEDGE

Why are they flat?

Polyclads are considered the most primitive bilaterally symmetrical animals (left side mirrors the right). They evolved from hydra-like animals about 550 million years ago. Flatworms have no body cavity other than the gut. Respiratory and blood vessel systems are completely missing and diffusion is used for transport of oxygen inside the body. This constrains flatworms to be flat as possible for maintaining metabolism, since no cell can be too far from the outside, making a flattened body shape necessary.





How do they eat?

Flatworms/Polyclads have a mouth with pharynx inside: a muscular tube through which the flatworm can suck food. Pharynx may be tubular or ruffled with numerous folds (more details on External Morphology Basics pages)

Flatworms are carnivorous, feeding on small invertebrates, suctioning entirely their prey or digesting a part of it.

Many species of the Pseudocerotidae family prefer ascidians, sponges, and bryozoans. For feeding, the pharynx protrudes and can be expanded into the individual zooids of colonial ascidians.

But not all flatworms limit themselves to preying upon sessile invertebrates. You can see in the photo on the left how the polyclad *Ilyella gigas* wraps up its prey with the rear half of its body after capturing a crab with its membranous pharynx. Its pharynx digests the crustacean externally. All kinds of crustacean prey - crabs, shrimps are consumed by *Ilyella gigas* without visual resistance, implying that flatworm may release some tranquilizer secretions during prey capture.

Most species of flatworms have no anus and they spit out indigestible bits through the mouth. This means that their digestive process cannot be continuous.

Upper photo: ©Deb Aston, bottom photo: ©Wei-Ban Jie

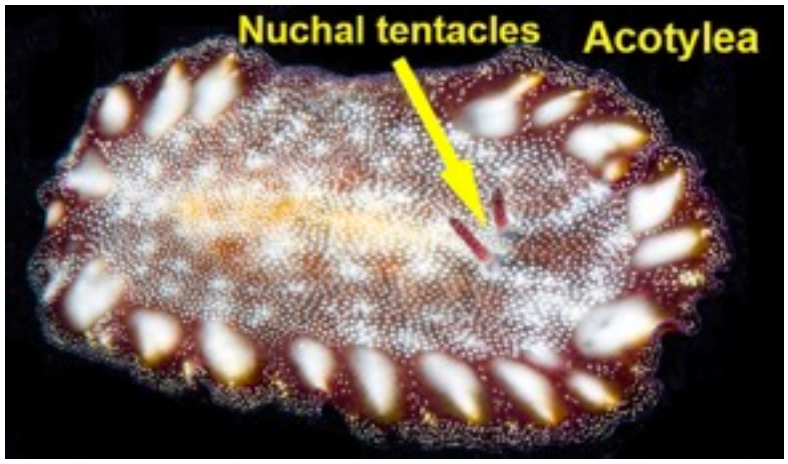
How do flatworms reproduce?

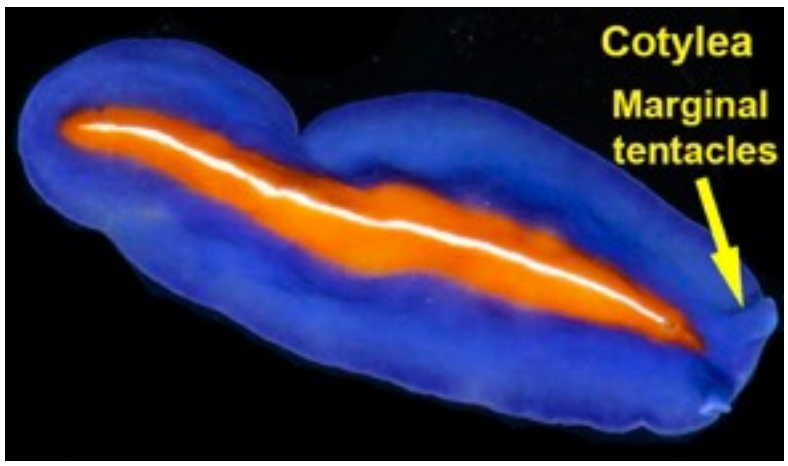
Marine flatworms are hermaphrodites, possessing both male and female reproductive organs. When two flatworms engage in a mating session, they exchange sperm. Some species simply inject their male copulatory parts (called stylets) through the body wall of the partner. Unsurprisingly, this is called “hypodermic impregnation.”

In yet other species, two individuals will fight in strangely beautiful combat, “penis fencing” until one is able to plunge his sperm-delivering organ into the other's body, leaving the loser with the burden of bearing the flatworm’s young. It is believed that there is a strong advantage to being the male; that is why each flatworm tries to impregnate the other without itself being impregnated. In one study, penis fencing was observed to be just a mating ritual and not necessary for insemination, not always aggressive, and could also result in eventual reciprocal insemination.

Upper photo: *Pseudobiceros uniarborensis*, engaged in penis fencing, ©Brian Mayes.

Bottom photo: *Pseudoceros liparus*, with white sperm bundles, gradually absorbed in the body after insemination, ©C. Harris.





Cotylea and Acotylea

The order Polycladida is divided into the two suborders Cotylea and Acotylea. Acotylea is clearly distinguishable from Cotylea by the presence of nuchal tentacles (in most of them) and the absence of ventral sucker (cotyl). Acotyleans are major predators of sessile marine invertebrates such as all bivalves, oysters, mussels, scallops and giant clams. Many acotyleans are nocturnal, dull in coloration, and cryptic in their behavior, hiding in crevices and under rocks during the day.

Cotyleans are better known to divers, snorkelers and underwater photographers due to bright colors, variety of patterns and less cryptic way of life. This conspicuous colouration is known as aposematic colouration, a warning strategy associated with the presence of toxic or distasteful defense substances.

They have marginal tentacles, either as simple folds of anterior margin (pseudotentacles), or “true” ones. The ventral sucker (cotyl) is often very difficult to see even for professional marine biologists.

Pseudocerotidae and Euryleptidae, how to tell them apart.

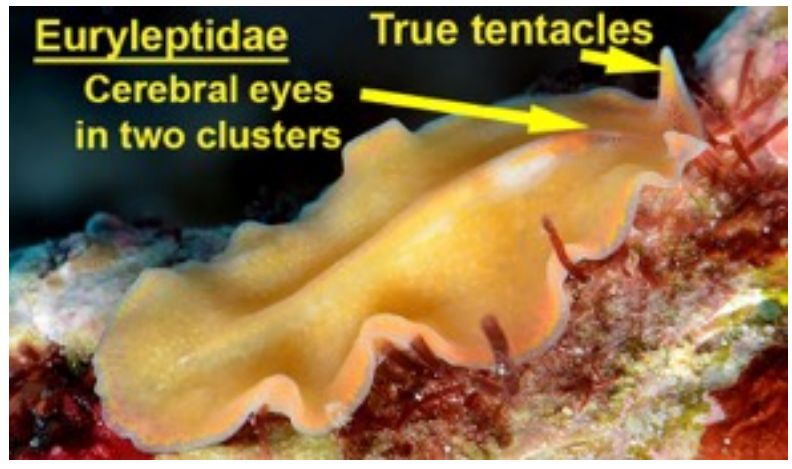
The world of marine flatworms (order Polycladida) is infinitely rich. Majority of species are still undescribed, >800 species are recognized now. They are divided into >40 families. At the same time, the vast majority of flatworms found underwater by divers and underwater photographers are from just a few families. These are, first of all, Pseudocerotidae. Much less common finds are Euryleptidae, followed by Planoceridae. Representatives of other families are a rare find. Therefore, in this book, special attention is paid to the representatives of the first two families.

Pseudocerotidae

- distinct pseudotentacles
- ruffled pharynx with simple or complex (branching) folds anterior to midline of the body
- cerebral, usually horseshoe-shaped eyespot, but maybe a single round cluster in species of *Phricoceros* or two clusters (*Bulaceros*)

Euryleptidae

- true tentacles or small bumps in some species
- cerebral eyes usually in two elongate clusters
- tubular pharynx in anterior part of the body
- easily confused with species of *Pseudoceros* (Pseudocerotidae)



Pseudoceros* or *Pseudobiceros

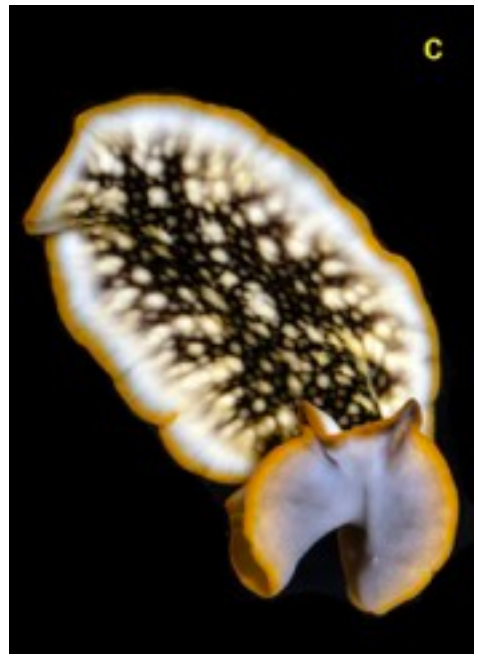
The most important difference between the two genera is a number of male reproductive systems: one in Pseudoceros and two in Pseudobiceros. However, this count is not easy even in the laboratory. But we can rely on some external features for preliminary identification:

Pseudobiceros

- pseudotentacles ear-like and pointed (A) or square with ruffles (B)
- deep marginal ruffles
- easy swims
- pharynx with simple folds, cannot feed on several ascidians at the same time

Pseudoceros

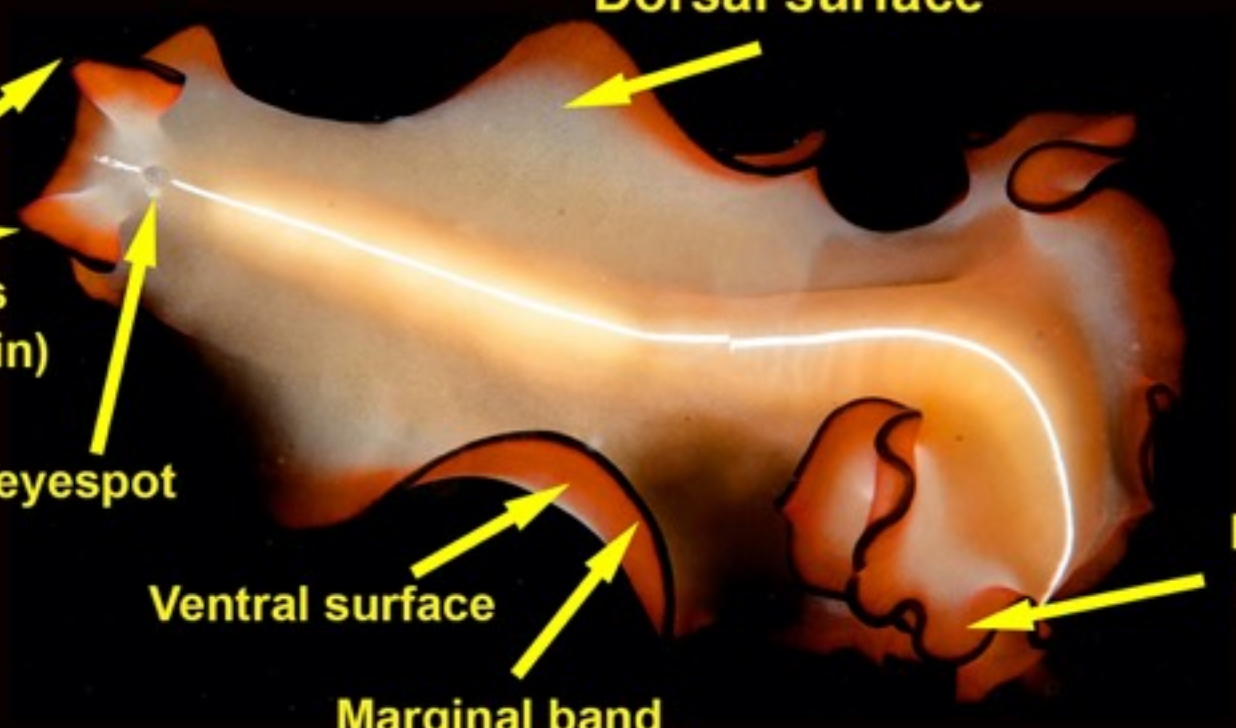
- pseudotentacles as simple folds (C)
- shallow marginal ruffles
- does not swim
- pharynx with complex, branching folds, allows to feed on several ascidians at the same time



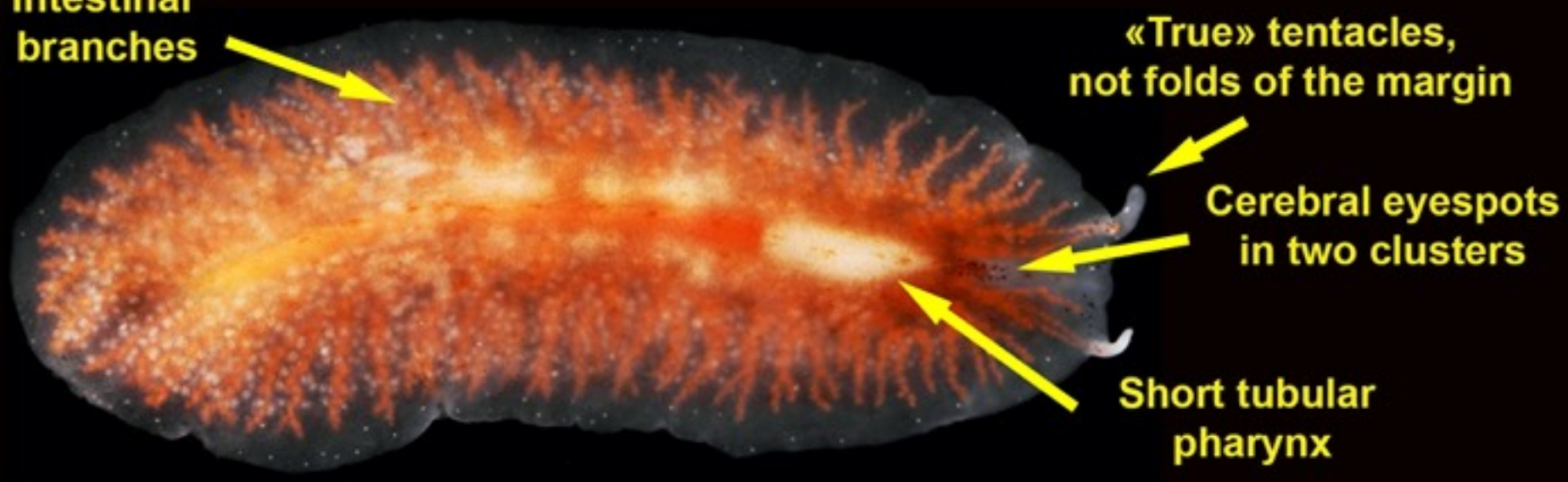
BASIC EXTERNAL MORPHOLOGY

COTYLEA

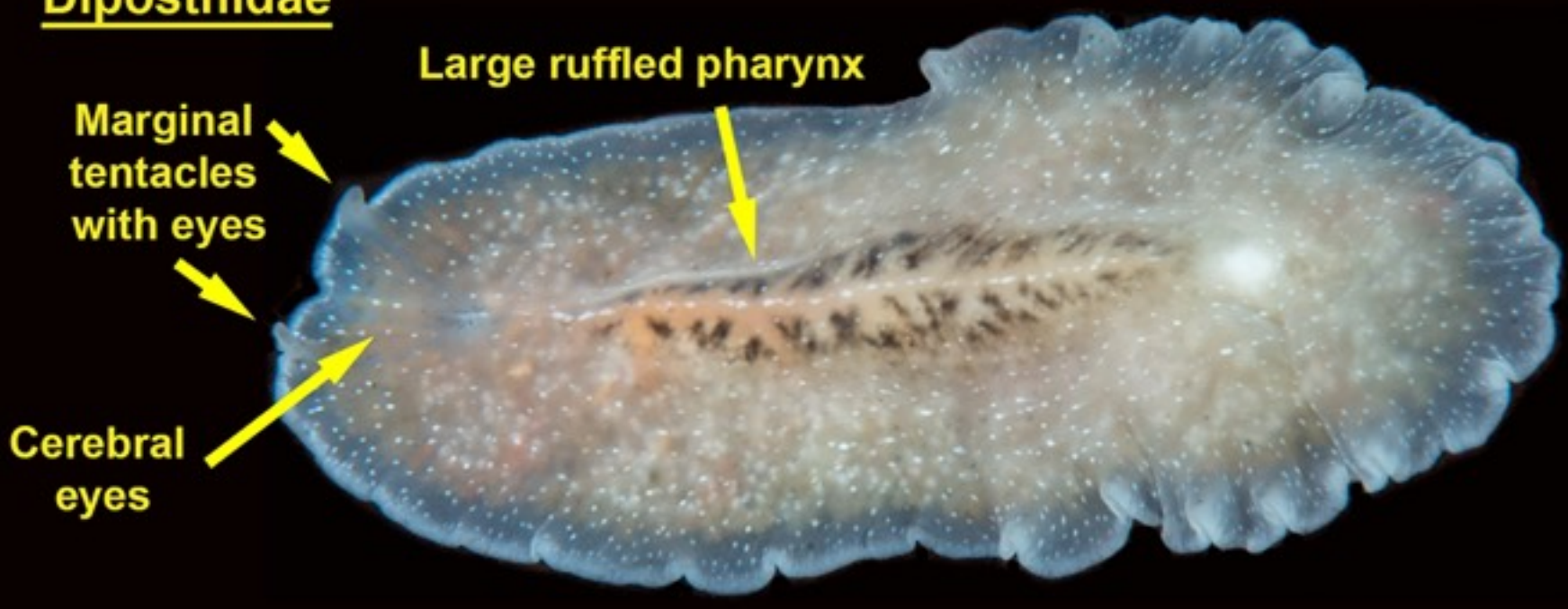
Pseudocerotidae



Euryleptidae



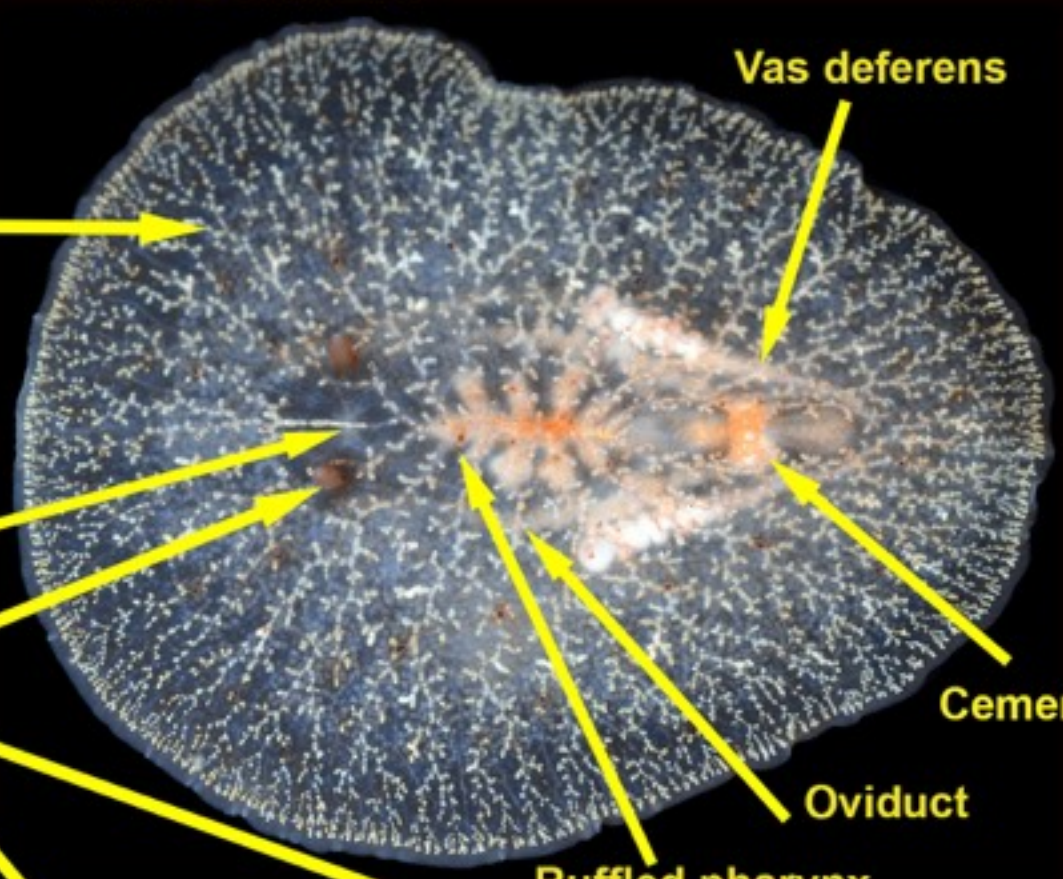
Diposthidae

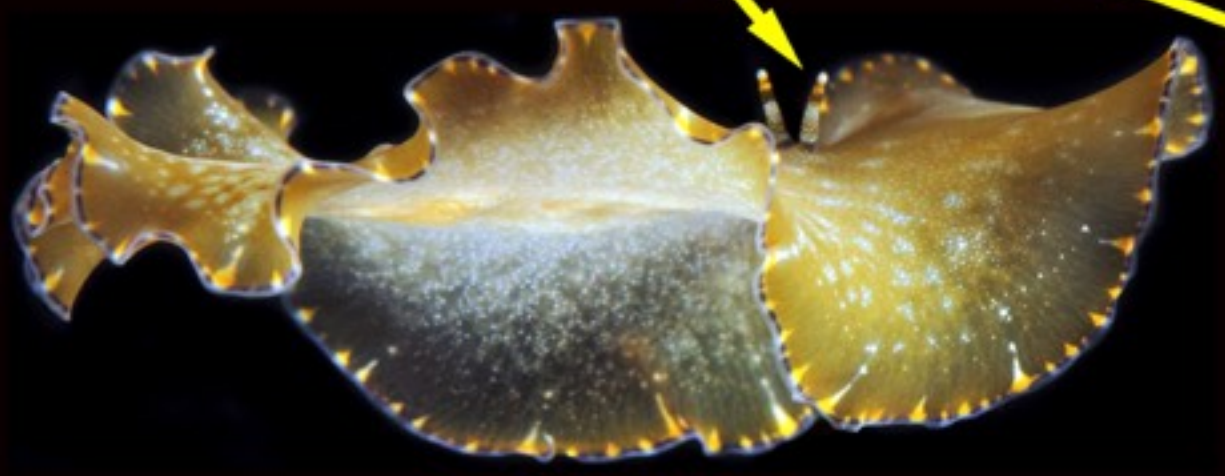


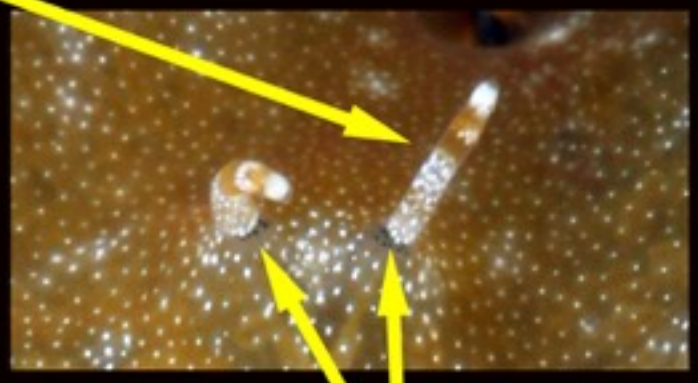
BASIC EXTERNAL MORPHOLOGY

ACOTYLEA

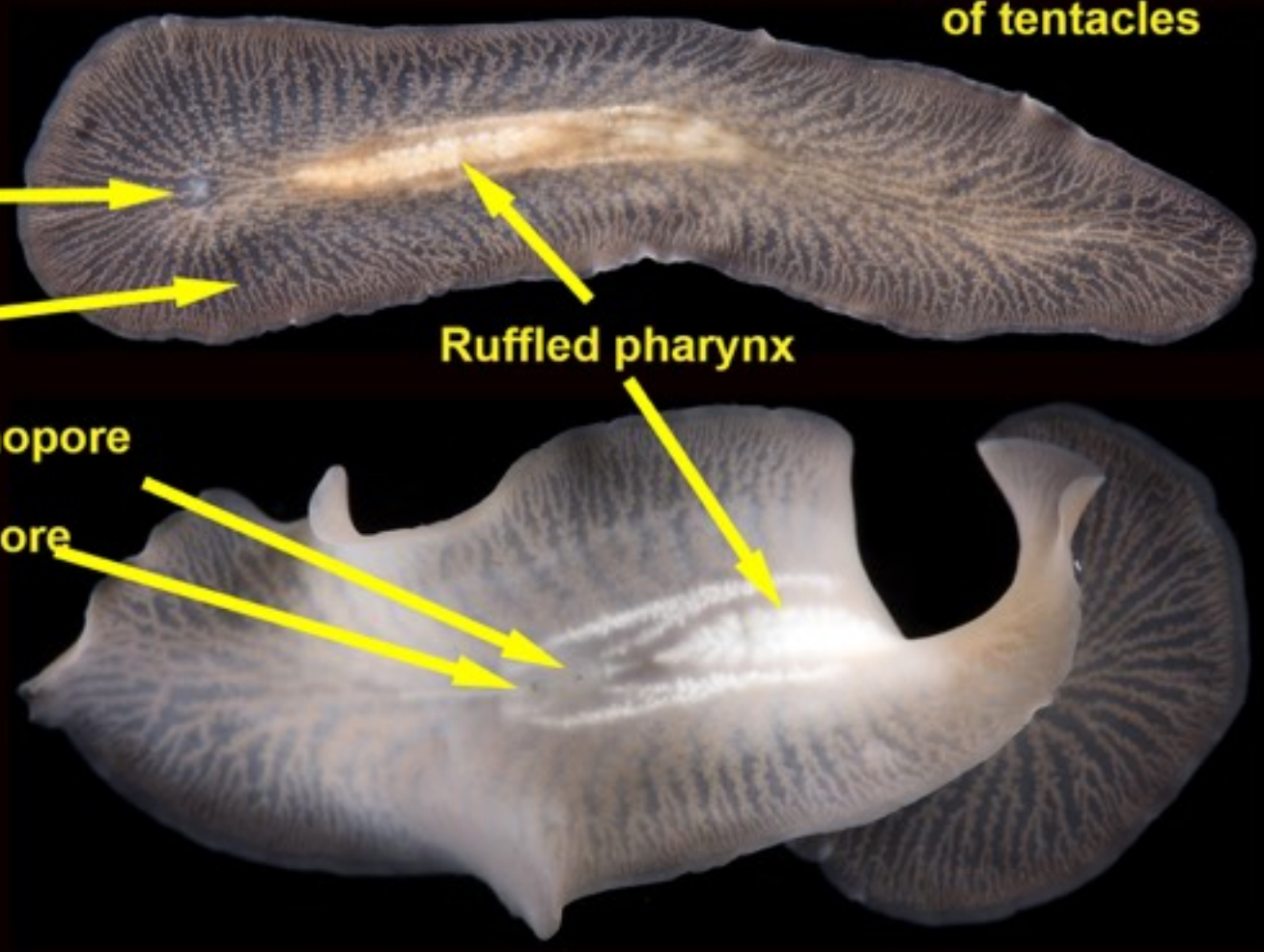
Planoceridae







Leptoplanidae




Pseudobiceros apricus Red Sea, Madagascar, India, Australia, 6 cm. Light brown to orange-brown or black, with numerous white dots and clusters of white dots. ©Alain Rassat, Nosy Be, left. ©Denis Riek, NSW, right.


Pseudobiceros apricus (cont-d) White-tipped, square-like pseudotentacles, elevated median area. @Vishal Bhave, India, left, ©Brian Mayes, Australia, right.


Pseudobiceros bajae Gulf of California, Mexico, Philippines, Singapore, 5.5 cm. Black with evenly spaced white dots, not forming clusters. Ruffled, square pseudotentacles, cerebral eyespots in a clear area. ©AR, Philippines.


Pseudobiceros bedfordi Red Sea, E. Africa to Maldives, Indonesia, Australia, Vietnam, Philippines, Japan, Papua New Guinea and Marshall Islands. Easily swims with margin undulations (photo on the left) ©AR.


Pseudobiceros bedfordi (cont-d) Dark grey or brown with numerous yellow dots and curved pink streaks. Black margin with white spots. ©Jeanette Johnson, photo on the left - juvenile.


Pseudobiceros bedfordi (cont-d) Pointed, ear-like pseudotentacles. Background color is highly variable, but pattern is very persistent. ©Jeanette Johnson, photo on the right - subadult.

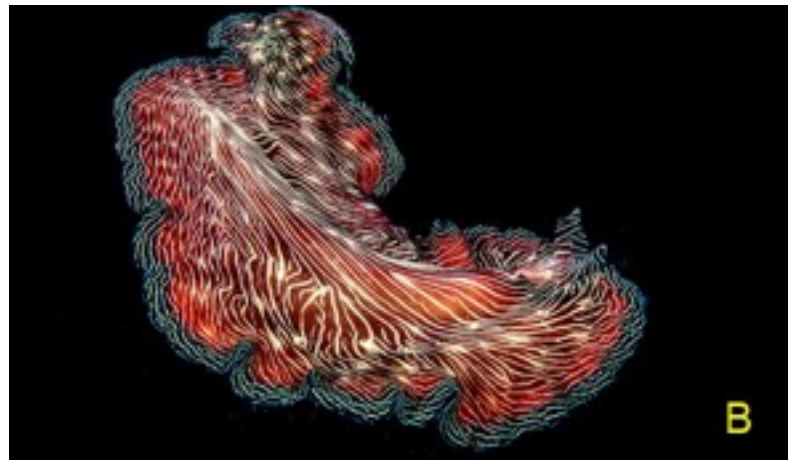

Pseudobiceros damawan South Africa, India, Australia, Indonesia, Philippines, Singapore, Marshall Islands, 3 cm. Mottled grey and cream with widely scattered black spots. ©AR.


Pseudobiceros damawan (cont-d) Narrow black marginal band followed by wide orange band, interrupted by white transverse streaks. Square, ruffled pseudotentacles. ©Toh Chay Hoon (left), ©Valda Fraser (right).


Pseudobiceros flavocanthus PNG, Indonesia, 5 cm. Black with white marginal line and yellow rim. ©SJ.

Pseudobiceros flowersi Oman, Australia, Indonesia, Philippines, 6 cm. Coloration variable. ©AR.

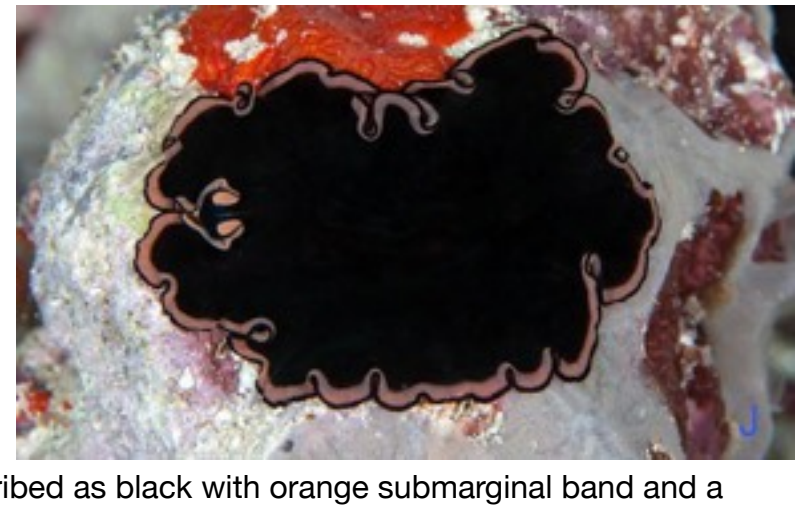

Pseudobiceros flowersi (cont-d) Olive green to dark brown, with 2 or 3 marginal bands: inner band wide and dark, outer band narrow white and often olive green between them (right). Square ruffled pseudotentacles. ©AR.



A-H: ***Pseudobiceros fulgor*** Red Sea, East Africa, Australia, Indonesia, Philippines, Marshall Islands, 7 cm. Orange to brown with fine white broken lines. Black margin with white interrupted streaks.
Photo D - brown color morph, Red Sea. A-D, H: ©AR, E-G: ©Jeanette Johnson.
I-J ***Pseudobiceros* cf.1 *fulgor*** New Caledonia, Marshall Islands, P. N. G., 5 cm. Orange to orange-brown with reticulate white pattern. DNA studies may confirm (or not) the validity of this species. I: ©Y. Thévenet, J: ©SJ.

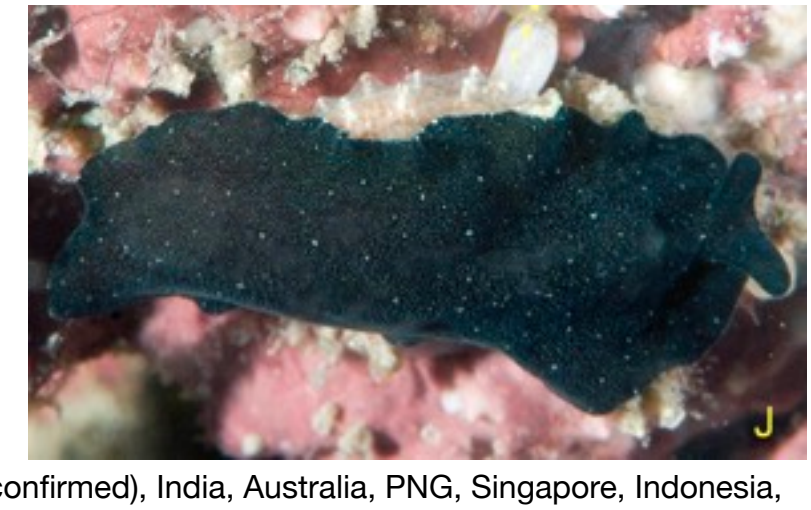
Pseudobiceros* cf.2 *fulgor S. Africa to Hawaii, 5 cm. Probably a form of *P. fulgor,* that was described as having "Margin black with numerous white streaks, parallel to the rim". White streaks are transverse here. ©V. Fraser.

Pseudobiceros gloriosus Red Sea and South Africa to Maldives, Japan, Philippines, Indonesia, Papua New Guinea, Australia, New Caledonia, Marshall Islands and Hawaii, 9 cm. Black with 3 marginal bands: inner orange, outer dark burgundy and pink band between them. Square ruffled pseudotentacles. Photo H: unusual sequence of marginal bands, probably a separate species (Brian Sellick, ©South Africa)
A,B: ©AR, Indonesia, C: ©Y. Thévenet, D: ©C. Pittman, E: ©B. Mayes, F: ©Tsu Soo Tan, G: ©S. Johnson.



Pseudobiceros splendidus Circumtropical, 7 cm. Described as black with orange submarginal band and a black rim. After molecular research several similar species were synonymized with *Pseudobiceros splendidus* : *Pseudobiceros periculosus* (E, F, H), *Pseudobiceros evelinae* (C-D) and *Pseudobiceros hymanae* (A, B, G, I, J). Differences in marginal stripes have been explained by different nutritional status and photography conditions. A,C,D: ©AR, B,G: ©SJ, E: ©D. Burdick, F: ©C. Pittman, H: ©A. Patchimsiri, I: ©Y. Thévenet, J: ©S. Ruxton.

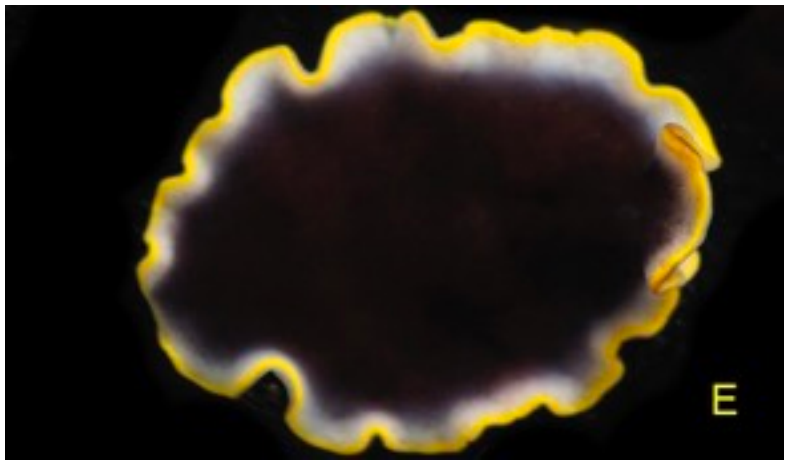
PSEUDOCEROTIDAE



Pseudobiceros stellae E. Mediterranean, Red Sea (unconfirmed), India, Australia, PNG, Singapore, Indonesia, Marshall Islands, Hawaii, 6 cm. Brown to dark grey or black with white dots. Similar to *Pseudobiceros bajae* and *Pseudobiceros apricus*, but distinguished by dots, arranged in flower-like pattern and pseudotentacles, highly ruffled laterally. At the same time ID, based only on photographic records is often only tentative.
A, B, F, H: ©Jeanette Johnson, C, D, E: ©Scott Johnson, G: ©Ria Tan, I: ©A. Patchimsiri, J: ©AR.

Pseudobiceros uniarborensis Red Sea, Mauritius to India, Indonesia, Australia, PNG, Philippines, Guam, 6 cm. Grey to brown or black, with 3 marginal bands: inner orange, middle transparent grey, followed by a narrow white rim. Pointed pseudotentacles are black with white tips.

Photo J (©Brian Mayes): penis fencing (a mating behavior). A-D: ©AR, E, G, H, I: ©Jeanette Johnson, F: ©David Burdick.



Pseudoceros duplicinctus Mozambique, Kenia, Red Sea, Iran, India, Maldives, Australia, Papua New Guinea, Indonesia, Japan, Micronesia, Philippines, Marshal Islands, Eastern Mediterranean Sea, 3 cm. Light brown to velvety black body, orange, yellow or cream outer marginal band (narrow), white or bluish inner band (wide). *P. prudhoei*, *P.* cf. *prudhoei*, P. *depiliktabub*, have been identified as junior synonyms of *P. duplicinctus.*
A: ©SJ, B, F, G: ©AR, C,D: ©J. Johnson, E (Spratli Isl): ©Y. Deart, H: ©L. Warren, I, J (Red Sea): @I. Sverdlova.

PSEUDOCEROTIDAE


Pseudoceros ferrugineus Indonesia, Philippines, Sri Lanka, Indonesia, Papua New Guinea, Micronesia, Australia, Hawaii, 6 cm. Red with evenly spaced white dots, red margin without dots with orange rim. ©AR, Bali.


Pseudoceros ferrugineus (continued) Color pattern variable, pseudotentacles are simple folds. ©AR, Philippines, left, ©Scott Johnson, Hawaii, right.


Pseudoceros ferrugineus (continued) Feeds on colonial ascidians, found under rocks and rubble. ©Yury Deart, Spratli Isl, left, ©Carole Harris, Philippines, right.


Pseudoceros* cf. *ferrugineus South Africa, 5 cm. Similar to *Pseudoceros ferrugineus*, but marginal bands are different: inner wide cream yellow band, then dark red and orange rim. ©Brian Sellick, left, ©Valda Fraser, right.


Pseudoceros fuscomaculatus Comoro Is., Indonesia, Philippines. Whitish with irregular patches of greenish-brown. Two symmetrically-disposed areas of dark green anteriorly. Not registered in WoRMS. ©Lindsay Warren.


Pseudoceros galatheensis Seychelles, India, Indonesia, Singapore, Guam, New Caledonia, Wallis Island 1.5 cm. Light blue, dark blue rim, yellow-orange median stripe. ©D. Burdick, left, ©Y. Thévenet, right. (*P*. sp.6 FF).

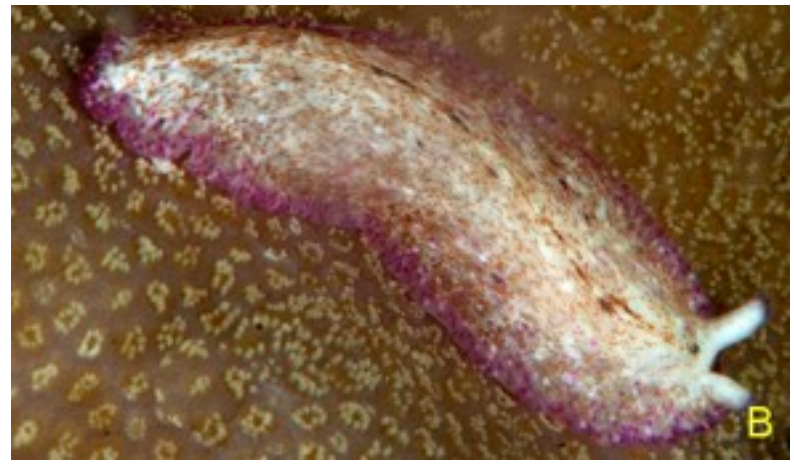

Pseudoceros* cf. *galatheensis Thailand, Singapore, 1.5 cm. Close to previous species. ©A. Patchimsiri

Pseudoceros gamblei India, Australia, 3 cm. Cream with a purple or blue marginal band. ©E. Hardaker.


Pseudoceros gamblei (continued) Similar to *Pseudoceros indicus*, but DNA studies confirmed it is a separate species. *P. gamblei* has continues marginal band while in *P. indicus* marginal band is dotted. ©E. Hardaker.


Pseudoceros gravieri East Africa to Gulf of Oman, Indonesia, Philippines, Micronesia, Australia, Papua New Guinea, 6 cm. Purple-blue with yellow longitudinal stripes. ©Philippe & Guido Poppe www.poppe-images.com

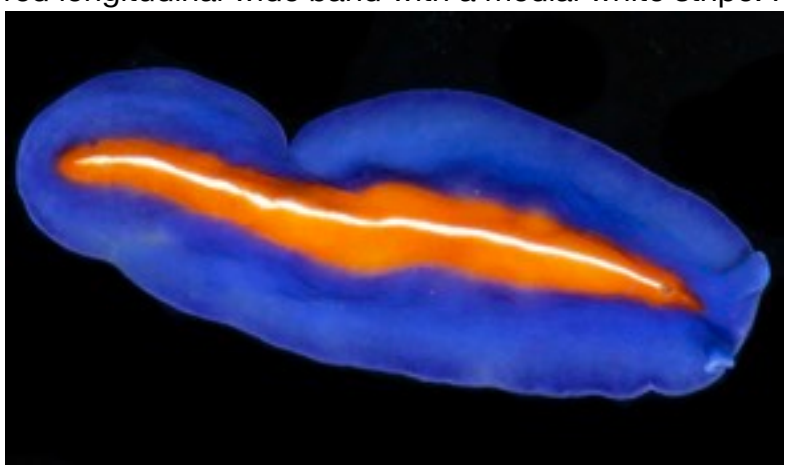

Pseudoceros gravieri (continued) Photo on the right: juvenile with fewer yellow lines, similar to *Pseudoceros tristriatus* (below). ©Bernd Hoppe, left, ©Brian Mayes, right.



Pseudoceros goslineri Red Sea, East Africa, Maldives, India, Thailand, Papua New Guinea, Indonesia, New Caledonia, Marshall Islands, 7 cm. Coloration variable. Cream mottled with orange, pink and brick-red, darker medially. Margin consists of pink or purple spots. Pseudotentacles as simple folds, pink ventral surface. Found under rubble and small rocks.

Pseudoceros scintillatus Red Sea, South Africa, Mayotte, Thailand, Indonesia, Papua New Guinea, Philippines, Japan, Australia, Marshall Islands, Hawaii, 1.5 cm. Coloration variable. Black with yellow-green spots encircled by white rim. Wide orange marginal band, often interrupted by yellow-green spots.
A,D: ©AR, E: ©Shaun Ruxton, F-H: ©Ashirawat Patchimsiri, I, J: ©Jeanette Johnson
A,E, I, J: Philippines, B: Papua New Guinea, C,D: Indonesia, F-H: Thailand.


Pseudoceros susanae Maldives, Indonesia, PNG, N. Caledonia, Micronesia, 3 cm. Blue background, orange or red longitudinal wide band with a medial white stripe. Red to burgundy or dark blue margin. ©AR, Maldives.

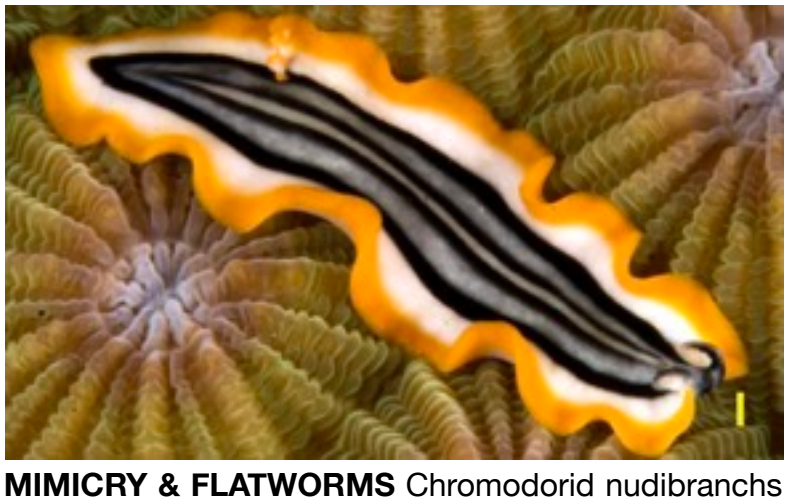



Pseudoceros susanae (continued) Pattern and coloration variable, marginal band can be present or absent, like on these animals from New Caledonia. ©AR, left, ©Yves Thévenet, right.


Pseudoceros* cf. *susanae India, 2 cm. Yellow-orange with white median band. Three marginal bands, inner white, then blue with purple rim. Undescribed species, remotely similar to *P. susanae*. ©Ravi Vadher, ©Vishal Bhave.


Pseudoceros tristriatus Mozambique, Indonesia, Philippines, Papua New Guinea, Australia, Singapore, 5 cm. Cream-bluish or blue-purple background, three yellow to orange longitudinal stripes. ©Ria Tan.


Pseudoceros tristriatus (continued) Stripes bordered by dark purple, margin with dark blue rim. ©Philippe & Guido Poppe www.poppe-images.com

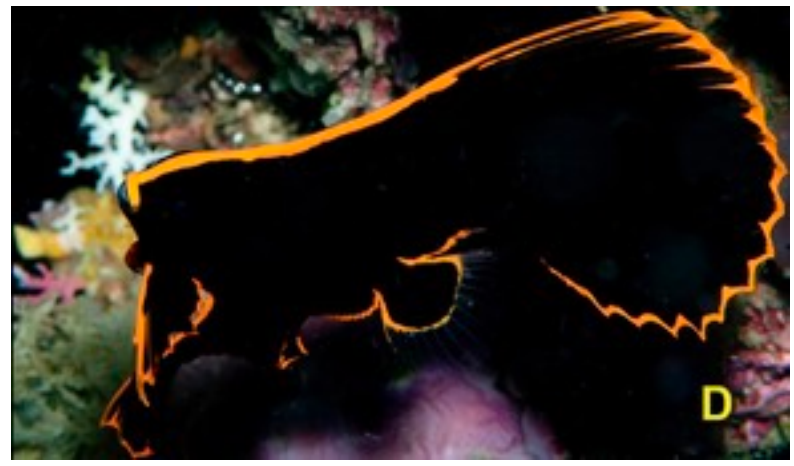


MIMICRY & FLATWORMS Chromodorid nudibranchs have mantle glands which contain chemicals, distasteful to fish. It explains the numerous cases of mimicry, where the model is chromodorid and the mimic is a flatworm.
A: *Pseudobiceros* sp.12 (flatworm), **B**: *Ardeadoris symmetrica* (nudibranch), both ©Valda Fraser.
C: *Pseudoceros* sp.91 (flatworm), ©Brian Sellick. **D**: *Ardeadoris averni* (nudibranch), ©AR.
E: *Pseudoceros* sp.41 (flatworm), ©AR, **F**: *Chromodoris magnifica* (nudibranch), ©AR.
G:*Pseudoceros* sp.29 (flatworm), ©AR, **H:** *Chromodoris* sp. (nudibranch), ©AR.
I: *Pseudobiceros* sp.28 (flatworm), ©AR, **J**: *Chromodoris quadricolor* (nudibranch), ©AR.

MIMICRY & FLATWORMS

MIMICRY & FLATWORMS Phyllidiid nudibranch *Phyllidiella pustulosa* exude toxic chemicals from the skin and appear to be avoided by most fish. It is imitated by flatworms, other nudibranchs and even a holothurian.
A: *Pseudoceros imitatus* (flatworm), **B**: *Phyllidiella pustulosa* (nudibranch), both ©AR
C: *Pseudoceros sapphirinus* (flatworm), ©Yves Thévenet. **D**: *Chelidonura varians* (sea slug), ©AR.
E: *Pseudoceros* sp.29 (flatworm), ©AR, **F**: *Chromodoris quagga* (nudibranch), ©AR.
G: Euryleptid 13 (flatworm), ©Irina Khlopunova, **H:** Chromodoris lochi (nudibranch), ©AR.
I: *Pseudoceros nigropunctatus* (flatworm), ©Wolfgang Kaufmann, J: *Chromodoris quadricolor* (nudibranch),

MIMICRY & FLATWORMS



MIMICRY & FLATWORMS Mimicry is an evolved resemblance between a mimic and a model that provides an advantage to the mimic. Sometimes it is not easy to determine who is the model and who is the mimic.
A: *Pseudoceros* sp.91 (flatworm) ©Valda Fraser, **B**: *Aseragoddes* sp. (juvenile flounder), ©AR
C: *Pseudoceros splendidus* (flatworm), ©David Burdick, **D**: *Platax pinnatus* (juvenile), ©AR.
E: Euryleptid 17 (flatworm), ©Denis Riek, **F**: *Coeloplana* sp. (comb jelly), ©AR.
G: Acotylean 12 (flatworm), ©Ashirawat Patchimsiri, **H:** *Coeloplana* sp. (comb jelly) ©AR.
I: *Cestoplana rubrocincta* (flatworm), ©Denis Riek, J: *Baseodiscus quinquelineatus* (ribbon worm), ©AR.

MIMICRY & FLATWORMS

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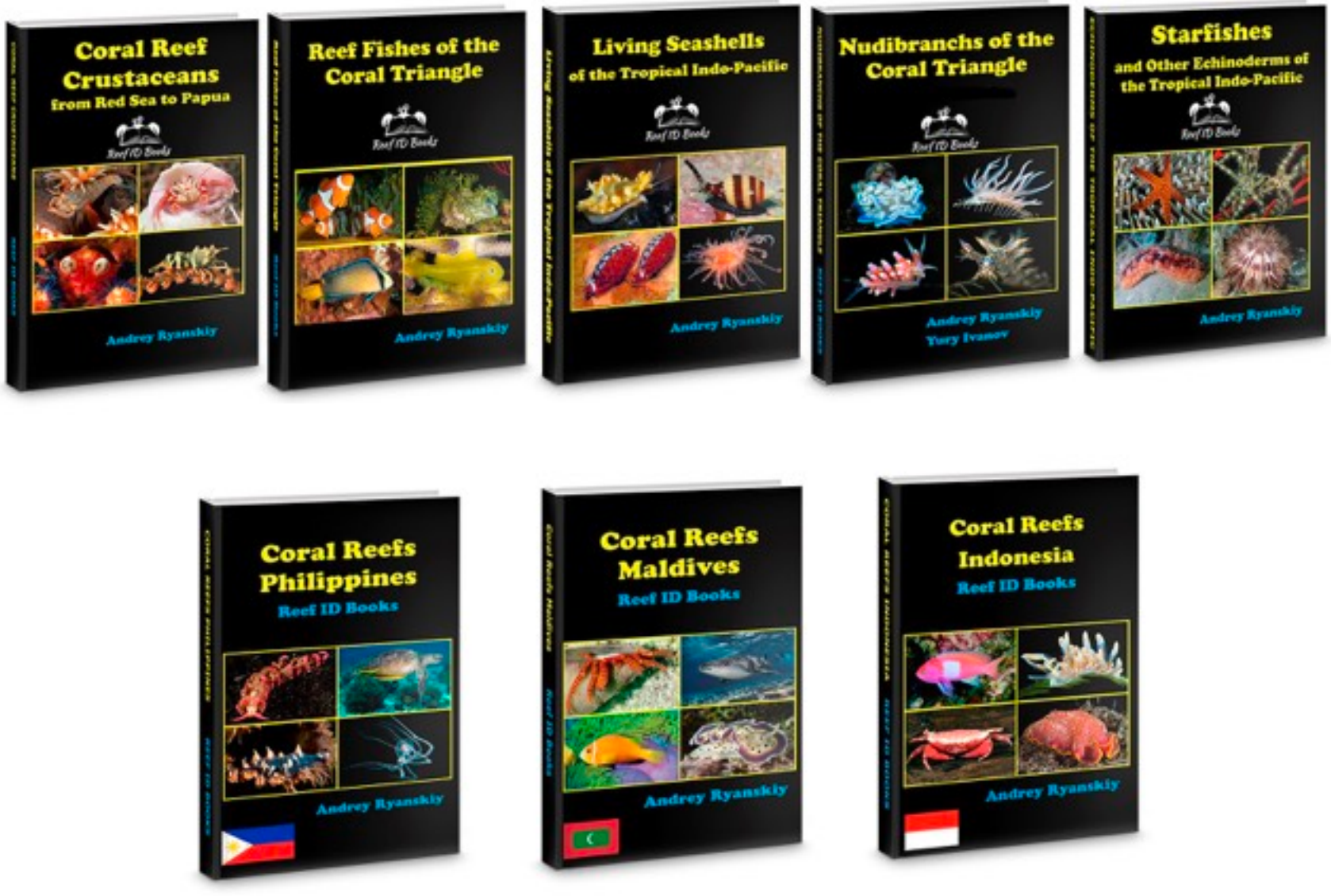

A project such as this would not be possible without significant input from numerous colleagues, photographers, marine biologists and citizen scientists for which author is most grateful (see Acknowledgment for details)

Thank you for taking time to read Marine Flatworms of the Tropical Indo-Pacific. If you enjoyed it, please consider telling your friends and posting a short review. Word of mouth is an author's best friend and much appreciated. Believe me, I read them all. Thank you!

Andrey Ryanskiy www.reefidbooks.com