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Oct 2000

nudibranchNEWS

in this issue

Editorial

It was great not to have my email blocked for four days with bouncing newsletters. The technical problems of the last few months seem to be solved.

Neville Coleman and I had the opportunity go to the Fairy Pools at Noosa National Park recently. Nev's trusty golf buggy came in handy for carrying all our snorkel and camera gear. I had forgotten about how far we had to hike. We turned up about 13 species, 12 in one pool thus a flatworm and ended up hiking out of the park in the dark. A report on our finds will appear in an upcoming issue.

Thanks to Darryl Potter and others for offering articles for the newsletter. Darryl's article appears in this issue.

Feedback

Thanks to those who sent feedback after the last issue. The comments below sums up what many of you wrote. To those that offered articles, thank you and I look forward to publishing them.

Hello Wayne,

In your editorial you mentioned the limited feedback which you are getting. Well, we enjoy your monthly newsletter very much. For us Europeans Miquel Pontes' articles are especially interesting. And we like that you extended beyond nudibranchs and added the flatworm article.

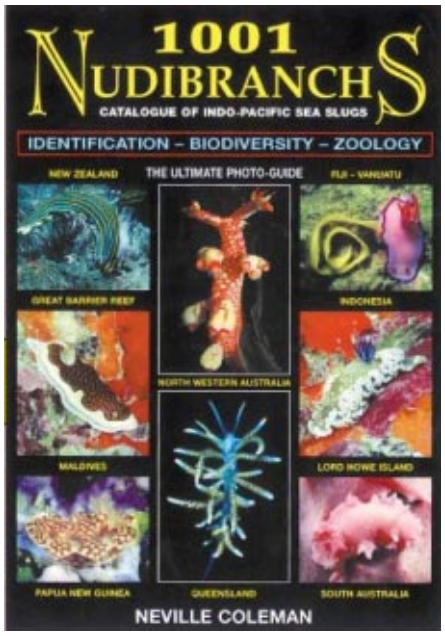
Greetings from Germany,

Hans Rothauscher

http://home.t-online.de/home/rothauscher/dugong.htm

Limited Edition Offer

Neville Coleman's upcoming book, "1001Nudibranchs – Catalogue of Indo–Pacific Sea Slugs" is due for release in the coming month's. This will be the most comprehsive Identification Book of it's kind in the world.



The book contains:

- 1100 colour pictures
- Over 28,000 easy to read words
- Indo–Pacific Locality Guide
- Colour coded Habitat symbols
- Natural History information for each photo
- Tropical & temperate species
- Photo guide to food species
- Hundreds of remarkable colour variations
- Fully indexed Common & Scientific names, Authors/dates.
- Reproductive strategies and egg ribbons
- Photo guide to habitats and locations
- How and where to find them
- Nudibranch photography
- 30 years of information

The introductory price in Australia is $45 (includes GST) + postage $5.50 (includes GST).

For overseas readers $45 + $10 postage and package. All prices are in Australian dollars.

The offer is only available for a short time. For information on how to order your copy please email glaskin@ozemail.com.au (Wayne Ellis).

nuts & bolts of nomenclature

richard willan

Specific names as adjectives

Austraeolis ornata is a nudibranch familiar to anyone who has ever investigated life in tidepools in southeastern Australia. At a maximum length of 58 mm (though most adults are 24 to 30 mm long), it is quite large for an aeolid and this large size is matched by a voracious appetite and pugnacious behaviour. In an aquarium *A. ornata* eats almost any meat and this makes it one of the few nudibranchs that can be kept in captivity. It is in an aquarium where one can observe the magnificent colours and intricate pattern of this nudibranch – the body and foot are apricot-orange, sprinkled with white and flecked with blue. The oral tentacles have an orange median section and white tips. The cerata are chocolate brown with a multitude of white dots. George Angas created the specific name *ornata* in 1864 (in the combination *Flabellina ornata*) to signify the rich and colourful adornment of this nudibranch.

Ornata is an adjective, from Latin orno, meaning something that is ornamented or embellished. Being an adjective means, in Latin grammar, it has to "agree" with its subject noun and this **principle of co-ordination** has been incorporated in scientific nomenclature from the outset of formal regulations. All adjectives exist in three forms depending on the gender of their subject noun and these forms differ by different endings: the ending –a, as in ornata, is the ending for feminine subjects; the ending –us is for masculine subjects; the ending –um is for neuter subjects. Adjectives are shown in Latin dictionaries in all three forms (i.e., ornatus, a, um), the first being the male form So one finds the same adjective spelt *ornatus* in the combination *Dermatobranchus ornatus* (*Dermatobranchus* is masculine) and *ornatum* in the combination *Sagaminopteron ornatum* (*Sagaminopteron* is neuter). Not only do adjectives have to agree with the gender of the genus, they must also change their termination if a species gets transferred into a genus of a different gender. In other words, such names derived from adjectives **do change** when the gender of the genus changes. So, if this aeolid which is the subject of this months column, was – hypothetically – transferred into the genus *Jason* (which is obviously a masculine genus), the specific name would automatically change to *ornatus* and we would have the combination *Jason ornatus*, or if it were transferred into *Phyllodesmium* (a neuter genus), the combination would automatically become *Phyllodesmium ornatum*.

Another Latin adjective is speciosus, a, um, meaning unsurpassed. When used in combination with the female genus *Thorunna*, the specific name has to be spelt *speciosa*. So the correct scientific name of the chromodorid that appeared on the cover of *Nudibranch News* in February this year (Ellis 2000) is ***Thorunna speciosa***.

Scientific names derived from adjectives are actually the best kind of specific name because they describe the organism itself or some particular attribute of the organism. For example, the specific name *rubrolineata*, (which is a compound adjective) in the combination *Flabellina rubrolineata* indicates that the species possesses red lines and this is a very distinctive and characteristic feature of this species of aeolid. In the sense of being descriptive, adjectives are more preferable as specific names than nouns or patronyms or names of places.

Periodically I hear complaints about mandatory changes of specific names resulting from the principle of co-ordination. Opponents of this principle are concerned that mandatory name changes create instability and, in practical terms, make computer searching for specific names more difficult. The first point is quite true, but all name changes create instability and if introduced into the widely available scientific literature with adequate justification they quickly become accepted and used by everyone. For instance there were no problems when Robert Burn created the new genus *Austraeolis* to accommodate *Flabellina ornata* (and two other species) in 1962, and the change-over was as immediate and complete as with the decimalisation of our currency.

The second point is more correctly turned into a criticism of the requirement for exactness of present-day computers than a complaint about the rules of nomenclature. As I have explained above, the rules of agreement are simple, in fact they are far more simple than the operating

instructions for a home computer. I am sure future customised databases or search engines will be capable of automatic checking for different terminations just as built-in spell checks presently do for permutations of correct spelling of words.

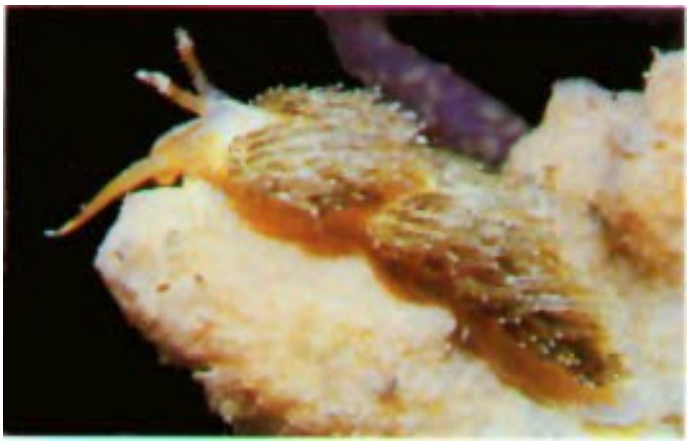
Those who dislike name changes resulting from agreement would prefer one single spelling of a name to be fixed and unalterable no matter what gender of genus it is in combination with. But there is no agreed way for "fixing the spelling" of names so that they would not change. Reverting to the spelling employed by the original author would necessitate many new changes because the original species were often described in all-inclusive genera (like *Doris* and *Flabellina*), which are generically different to the gender of today's much more finely divided genera. [Some common masculine genera are *Siraius, Plocamopherus, Aegires, Hexabranchus, Eubranchus, Favorinus* and *Glaucus*.] Alternatively, we could arbitrarily deem all generic names in Zoology are feminine or we could decide to retain the spellings that were generally accepted on January 1, 2000. Or perhaps those who have problems with changing names would not use genera at all like those who are currently advocating the "Least-Inclusive Taxonomic Unit" concept (Pleijel & Rouse 2000), wherein groups of organisms have single names only. I certainly prefer the devil I know!

References

Ellis, W. 2000. Creature feature: Thorunna speciosus *Rudman, 1990.* Nudibranch News ***2(6)****; 21.*

International Commission on Zoological Nomenclature 1999. International Code of Zoological Nomenclature Fourth Edition*. Published by the International Trust for Zoological Nomenclature, London, xxix + 306 pp.*

Pleijel, F. & G.W. Rouse 2000. A new taxon, capricornia *(Hesionidae, Polychaeta), illustrating the LITU ('Least-Inclusive Taxonomic Unit') concept.* Zoologica Scripta ***29****: 157-168.*



Austraeolis ornata (Angas, 1864)
Photo: Richard Willan

New Paper

Heike Wagele and Richard Willan have published a new paper: Phylogeny of the Nudibranchia. Zoological Journal of the Linnean Society vol 130, no. 1, pp.83-181, September 2000.

mimicry in nudibranchs and flatworms

darryl potter

Warning Colours - predator avoidance

Aposematic or warning colouration serves to alert predators to the potential dangerousness or unpleasantness of the prey [1]. The warning colours, to be effective, are usually bright and conspicuous. This type of colour pattern has been shown to be more effective than cryptic ones in terms of generating a learned response in predators [2]. Aposematically coloured species, in order to avoid predation, must warn predators about some form of punishment that will be inflicted on them if they are attacked. This punishment may be in the form of dangerousness or unpalatability.

Other species that have evolved signals resembling those of the aposematic species are known as mimics. Mimicry is the resemblance of one species (the mimic) to another (the model) whereby a third species (the receiver) confuses the two [3]. The mimic gains a defensive advantage by possession of warning patterns that predators have learned to avoid through encounters with the aposematic species [4].

Batesian Mimicry - patterns of deception

In Batesian mimicry, it is thought that a palatable or harmless species evolves to mimic the warning colour pattern of an unpalatable or dangerous model [5, 6]. Predators avoid the aposematically coloured mimic because of past experience with the model. Batesian mimicry has most likely evolved more frequently in the presence of common and highly unprofitable (unpalatable/dangerous) models [7]. However it has been shown that perfect Batesian mimics can gain some degree of protection even when only ten percent of the prey are models [8].

Müllerian Mimicry - a distasteful alliance

In Müllerian mimicry, unpalatable or dangerous species are believed to have evolved to share the same or very similar aposematic colour pattern. An inedible or dangerous species may achieve a survival advantage by having a predator learn from sampling another inedible or dangerous species similar in appearance [9]. Once a predator has associated unpalatability or danger with a particular warning colouration, it is likely to avoid all similarly patterned species whether harmful or not. Predators need only learn one pattern and fewer prey will be attacked. A group of sympatric species sharing a common aposematic pattern is referred to as a mimicry ring [3] or mimicry guild [10]. A mimicry ring may also include Batesian mimics.

Batesian or Müllerian - where to draw the line?

Batesian and Müllerian mimicry are not mutually exclusive [11]. For any two species with similar aposematic patterns to be identically unpalatable or venomous would be extremely unlikely. If both are highly unpalatable, they may be regarded as Müllerian co-mimics, however if one is slightly more palatable, it might be considered a Batesian mimic. It can be difficult to decide at which point along the palatability gradient (from highly distasteful to edible) a species is termed a Batesian mimic rather than a Müllerian mimic.

Extensive studies of aposematism and Batesian-Müllerian mimicry have been carried out on terrestrial insects such as butterflies and on the American coral snakes. It is no doubt easier to design experiments and make observations on terrestrial groups than it is on creatures in aquatic environments. However, these phenomena have also been observed in marine invertebrates such as nudibranchs and flatworms.

Warning Colouration in Nudibranchs

Sea slugs of the family Phyllidiidae are known for their bright contrasting colouration and the fact that they are commonly observed on reefs during the day [12], when predators such as fish are active. In addition, phyllidiids possess noxious distasteful compounds sequestered from sponge food and appear to be avoided by predators [13]. Other nudibranchs such as some members of the family Chromodoridae are also brightly coloured and feed on sponges, however less is known about their palatability to predators.

Extensive field observations of phyllidiids were carried out subtidally over a five-year period by Brunckhorst [13]. These were supplemented by additional collecting records and information held by the Australian Museum, Sydney, and the Western Australian Museum, Perth. A total of 774 records relating to

19 species provided strong evidence that phyllidiids advertise their presence during daylight hours and are most likely aposematically coloured. Only one species, *Phyllidiopsis cardinalis*, was always hidden on the underside of coral rubble. However, this species has a colour pattern of low contrast and is probably cryptic in both colour and habit .

Most phyllidiids possess a tough pustulose body with a 'rubbery' texture that offers further defence from predators in terms of increased unpalatability and mechanical protection [13]. However, actual predation experiments involving taste, rejection, and predator learning have not been carried out on phyllidiids.

Warning Colouration in Flatworms

Like nudibranchs, many polyclad flatworms are noted for their bright colour patterns. Some species such as *Pseudoceros verecundus*, closely resemble organisms on which they feed and are thus thought to be cryptic, however others may be aposematically coloured [14]. In addition, flatworms are also commonly encountered on reefs during daylight hours and several are known to contain toxins that render them unpalatable to predators. However, there has been very little investigation to test aposematism in marine flatworms.

Hing and Newman [14] presented three species of live flatworms (*Pseudoceros paralaticlavus*, *Pseudobiceros stellae*, and *Phrikoceros baibaiye*) to a group of reef fish predators (moon wrasse, *Thalassoma lunare*). Brine shrimp-flavoured agar models designed to resemble the flatworms in size, shape, and colour pattern along with flavoured uncoloured models (for controls), were used to test if the fish would learn to avoid live flatworms in addition to their colour models. Different 'attack' values were assigned to subjects based on time taken for flatworms and models to be either damaged or consumed over each nine-hour trial.

Uncoloured control models had significantly higher attack values, however fish that initially swallowed live flatworms rejected these immediately and thereafter avoided both the flatworms and colour models of the flatworms [14]. The flatworms were clearly unpalatable to the fish. This experiment demonstrated that these flatworms possess distasteful substances and a recognisable aposematic pattern that the fish would avoid. In addition, the trials showed that mimicry could take place because the coloured models were essentially Batesian mimics of the live flatworms.

Flatworm/Nudibranch Mimicry Rings

As previously discussed, there is strong evidence that brightly coloured phyllidiid nudibranchs possessing noxious bioactive compounds are aposematically coloured. Brunckhorst [15] reported that an undescribed polyclad flatworm was a mimic of one of these phyllidiids. This flatworm was later described and named *Pseudoceros imitatus*, and was recorded from Papua New Guinea and the Great Barrier Reef [16].

Pseudoceros imitatus very closely resembles the nudibranch *Phyllidiella pustulosa* (see Figure 1). Both are generally black and light pink in colour and are similarly patterned and textured. *Phyllidiella pustulosa* is one of the most common phyllidiids on Indo-Pacific reefs, whereas *Pseudoceros imitatus* is a much rarer species within its range [17]. Newman and Cannon [16] postulate that the flatworm mimics the more common phyllidiid to avoid predation by reef fish, that learn to associate these warning patterns with unpalatability. However, it is not known whether *Pseudoceros imitatus* is also unpalatable. Therefore, whether it is a palatable Batesian mimic or an unpalatable Müllerian mimic of *Phyllidiella pustulosa* is yet to be ascertained [14].

There are other possible examples of flatworms mimicking nudibranchs. A number of flatworms are thought to mimic chromodorids [17]. Like phyllidiids, many of these brightly coloured sea slugs also feed on sponges. However, little is known about their palatability to predators and whether they are in fact aposematically coloured.

Our Current Understanding of Mimicry

The purpose of mimicry is to deceive the signal receiver [3]. In Batesian and Müllerian mimicry, the mimic by achieving this deception greatly lowers its chances of attack by predators. The association is clearest in Batesian mimicry whereby a palatable or harmless mimic has evolved a colouration identical or very similar to the aposematic pattern of the distasteful or dangerous model [5]. The mimic thus successfully hides behind its own false replication of the model's warning signal.

The association is less clear in Müllerian mimicry whereby the distinction between model and mimic is difficult to define, because both are distasteful or dangerous and share an identical or very similar aposematic pattern [3]. In fact, it is not really mimicry at all and perhaps a more correct (but cumbersome) term for this association would be Müllerian co-aposematism.

Assigning mimics to either the Müllerian or Batesian end of the mimicry gradient is not always easy, and may not just relate to factors such as palatability. Predator discrimination error may also be important [18]. In addition, in cases where there are many predators, individual predator species taste tolerances and foraging behaviour may lead to conflicting evaluations of palatability or dangerousness of the mimic.

Some aspects of mimicry are still not fully understood and evoke strong disagreement in the literature. Quasi Batesian, quasi-Müllerian, and various intergrades of imperfect mimicry are described and analysed in efforts to shed more light on these amazing phenomena [18, 19]. Knowledge of the subject would benefit from further studies involving predator discrimination error, innate avoidance of aposematically coloured prey, and predation/palatability experiments on marine invertebrates such as nudibranchs and flatworms. Like mimicry itself, our understanding of the dynamic and complex nature of Batesian and Müllerian relationships is a process of evolution.

References

1 *Getty, T. and Krebs, J.R. 1985 Lagging partial preferences for cryptic prey: A signal detection analysis of great tit foraging.* American Naturalist, *125: 39-60.*

2 *Gittleman, J.L. and Harvey, P.H. 1980 Why are distasteful prey not cryptic?* Nature, *286: 149- 150.*

3 *Wickler, W. 1968* Mimicry in plants and animals. *Weidenfeld and Nicholson, London.*

4 *Edmunds, M.E. 1974* Defense in Animals: A Survey of Antipredator Defenses. *Longman, Burnt Mill, England.*

5 *Bates, H.W. 1862 Contributions to an insect fauna of the Amazon valley. Lepidoptera: Heliconiidae.* Transactions of the Linnean Society of London, *23: 495-566.*

6 *Malcolm, S.B. 1990 Mimicry: Status of a classical evolutionary paradigm.* Trends in Ecology and Evolution, *5(2): 57-62.*

7 *Endler, J.A. 1991 Interactions between predators and prey. In Krebs, J.R. and Davies, N.B. (eds),* Behavioural Ecology, *pp.169-201. Blackwell Scientific Publications,*

8 *Brower, J.V.Z. 1960 Experimental studies of mimicry. IV. The reactions of starlings to different proportions of models and mimics.* American Naturalist, *94: 271-282.*

9 *Müller, F. 1879 Ituna and Thyridia; a remarkable case of mimicry in butterflies.* Transactions of the Entomological Society of London, *1879: xx-xxix.*

10 *Pough, F.H. 1988 Mimicry and related phenomena**.** In Gans, C. and Huey, R.B. (eds),* Biology of the Reptilia, Volume 16, Ecology B: Defense and Life History. *Alan R. Liss, Inc., New York.*

11 *Darlington, P.J. 1938 Experiments on mimicry in Cuba, with suggestions for future study.* Transactions of the Royal Entomological Society of London, *87: 681-695.*

12 *Johnson, S. 1989 Temporal patterns of nudibranch mollusk activity on a subtidal Hawaiian reef.* The Veliger, *32: 1-7.*

13 *Brunckhorst, D.J. 1991 Do phyllidiid nudibranchs demonstrate behaviour consistent with their apparent warning colouration?- some field observations.* Journal of Molluscan Studies, *57: 481-483.*

14 *Hing, P.A. and Newman, L.J. 1998 Warning colouration in peudocerotid flatworms (Platyhelminthes, Polycladida). A preliminary study.* Hydrobiologia, *383: 29-33.*

15 *Brunckhorst, D.J. 1989 Fabulous finds of phyllidiids.* Hawaiian Shell News, *37: 7.*

16 *Newman, L.J. and Cannon, L.R.G. 1994 A new flatworm (Platyhelminthes: Polycladida) which mimics a phyllidiid nudibranch (Mollusca, Nudibranchia).* Zoological Journal of the Linnean Society, *110: 19-25.*

17 *Gosliner, T.M., Behrens, D.W. and Williams, G.C. 1996* Coral Reef Animals of the Indo-Pacific: Animal life from Africa to Hawai'i exclusive of the vertebrates. *Sea Challengers, Monterey, California.*

18 *MacDougall, A. and Dawkins, M.S. 1998 Predator discrimination error and the benefits of Müllerian mimicry.* Animal Behaviour, *55: 1281-1288.*

19 *Speed, M.P. 1993 Muellerian mimicry and the psychology of predation.* Animal Behaviour, *45: 571-580.*

20 *Allen, G.R. and Steene, R. 1999* Indo-Pacific Coral Reef Field Guide. *Tropical Reef Research, Singapore.*

21. *Newman, L. and Flowers, A.*

fig.1a

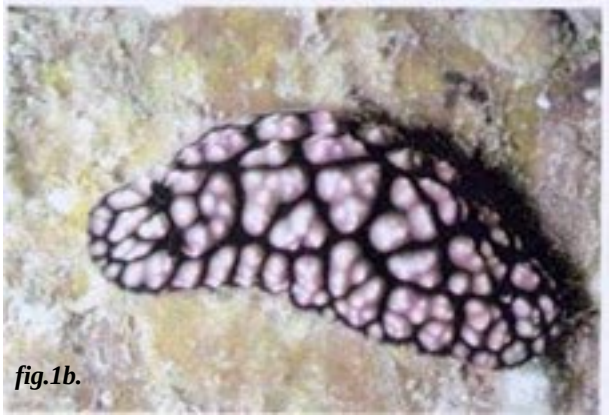


fig.1b.

fig.2.

Figure 1: *The polyclad flatworm,* Pseudoceros imitatus, *(fig.1a.) which mimics the unpalatable phyllidiid nudibranch,* Phyllidiella pustulosa, *(fig.1b.) in colour pattern and texture.*
Sources: Pseudoceros imitatus [20], *photo, © L. Newman and A. Flowers;* Phyllidiella pustulosa [17], *photo, T. Gosliner.*
Figure2:Phyllidiella pustulosa[21], (left) with Pseudoceros imitatus (right).
Source*: © L. Newman and A. Flowers. Used with permission.*

miquel pontes

Tritonia nilsodhneri

This dendronotacean nudibranch was described by Marcus Ev. in 1983. The etymology of the gender name *Tritonia* suggests one of the names of Minerva while the species name *Nilsodhneri* is dedicated to Nils Odhner, (1884-1973), a molluscs specialist at the Swedish Museum of Natural History.

This is a thin and elongated nudibranch that reaches lengths of 20 to 35mm. The colour of the body is variable as it tends to imitate the colour of the gorgonians on which it lives It feeds on the gorgonian polyps.

In the Western Mediterranean it is commonly found over the white gorgonian *Eunicella singularis*, where it wraps itself like a ring around the gorgonian branch and is coloured white or light grey.

The front veil has 6 digitiform processes, the outer ones longer than the rest. The white rhinophores grow from their high, cylindrical sheaths. There are 5 to 7 pairs of ramified dorsal appendixes mimicing the polyps of the gorgonian

The egg masses, are the same colour as the nudibranch and are laid in a very characteristic spiral surrounding the gorgonian branch. In fact, finding an egg mass is the easiest way to find the animal.

Because of its relatively small size and cryptic colouration, it can be a difficult to find. It shares its range with that of the gorgonians, usually at depths ranging from 5 to 25 meters.

Readers can find more interesting information and pictures of this nudibranch at Erwin Köhler's MedSlugs **(http://www.medslugs.de/E/Mediterranean/Tritonia_nilsodhneri.htm), at**

Bernard Picton's "Nudibranchs of the British Isles**" (http://www.pictonb.freeserve.co.uk/nudibranchs/trinil.html) and at**

Bill Rudman's Seaslug Forum at the Australian Museum Online **(http://www.seaslugforum.net/tritnils.htm)**

book review

dave behrens

Indo-Pacific Coral Reef Field Guide
1994. Gerald R. Allen and Roger Steene

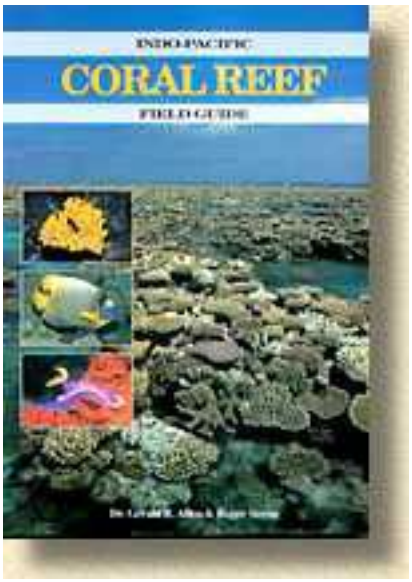
This compact field guide has been available since 1994, and is still considered one the most useful, comprehensive and accurate Indo-Pacific field guides available today. Generically referred to as either just "Allen & Steene" or "the field guide", this great little book provides an excellent introduction to over 1,800 marine plants, invertebrates, fishes, reptiles, birds and mammals from the Central and Western Pacific and Indian Ocean.

Gerry and Roger put the book together by selecting just over 1800 photographs from their collective files of over 40,000 underwater shots. The caption for each photograph provides the common name, if there is one, scientific name and the size.

The excellent nudibranch and sea slug chapter includes 53 species, including several species described since its publication in '94. These include: Notodoris serenae, Chromodoris dianae and Reticulidia fungia.

I can't say enough about the excellent color photos, which make each chapter not only informative and useful, but enjoyable. This softcover guide is both a coffee table book, and field guide rolled into one. Personally, my favorites chapters are the Cephalopods, and the Crustceans, but I know the aquarium enthusiasts will really appreciate the fish section, which is roughly 1/3 of the book.

This guide is a real value, selling for $42.95 USD, and a must for every dive bag.



Images

1. (left)Chromodoris dianae. 2. (right) Notodoris serenae. 3. (bottom left) Reticulidia fungia

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