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PNEOPHYLLUM CONICUM KILLING REEF-CORALS IN MAURITIUS: A NEW INDO-PACIFIC SYNDROME?

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Coral reef health-condition around the island of Mauritius (Mascarene Islands, Indian Ocean) was surveyed in 1990 (Antonius, 1993) and again in 1998, yielding some surprising results (Antonius, in prep.). In these surveys, all incidences of coral diseases and other syndromes degrading coral-health (Antonius, 1985, 1995; Antonius and Riegl, 1997; Antonius and Ballesteros, 1998) were recorded. Besides quite a number of other syndromes (Antonius, 1993, 1999a), a coralline red alga was observed that overgrows and kills living coral. Examination of preserved material (4% formalin-seawater) in the laboratory revealed the species to be *Pneophyllum conicum* (Dawson) Keats, Chamberlain and Baba 1997, a non-geniculate Corallinacea. The extremely severe form of epizoism by *P. conicum* found in Mauritius was considered a novel syndrome. It was assigned the symbol PNE and listed as such in transect protocols. PNE was not encountered in Mauritius in the 1990 survey (Antonius, 1993).

Non-geniculate (i.e., entirely calcified) coralline algae are essential for growth, structure, and ecology of coral reefs (Adey et al., 1982; Littler, 1972; Littler and Doty, 1975; Littler and Littler, 1984; Matsuda, 1989; Womersley and Baily, 1969). Among these, *P. conicum* is the only species capable of regularly and commonly overgrowing and killing live coral (Keats et al., 1997), a characteristic not even reported from other species of the same genus (Penrose and Woelkering, 1991; Penrose, 1996). Usually, however, the percentage amount of corals being killed by *P. conicum* is negligible per reef-site, the alga occupying coral surfaces in the order of magnitude of square centimeters. In this rather inconspicuous form, *P. conicum* is widespread throughout the tropical and subtropical Indo-Pacific and has been observed in the Red Sea (Antonius, pers. observ.), subtropical South Africa (Keats et al., 1997), Mauritius (this study), Philippines, Papua New Guinea, Australia (Antonius, pers. observ.), Guam (Gordon et al., 1976), French Polynesia (Antonius, pers. observ.; Keats et al. 1997), Xisha Islands, China (Zhang and Zhou, 1980), Ryukyu Islands (Matsuda, 1989), Japan (Tsuda, 1991), fiji (Keats et al., 1997), Hawaii (Adey et al., 1982) and Pacific Mexico (Dawson, 1960).

P. conicum occurs from intertidal reef-crest areas down to over 30 m depth. and from sun-drenched upper reef surfaces deep into poorly illuminated caves (Keats et al., 1997). The color of the alga tends to correspond to the exposure to light, showing a dark purple-red inside deep caves, a deep purple in shaded parts of the reef, gradually becoming lighter at better illuminated sites, all the way to a purplish light-gray (Figs. 1–4) in shallow reef-crest environments.

Thalli may grow to over 1 m in diameter (Fig. 4), and usually do not overgrow each other where they meet, but rather fuse and form a ‘seam’ (Fig. 3). The alga is strongly adherent, growing over live coral (Fig. 1) much more frequently than over bare skeletons or coral rock. Semi-quantitative counts showed at least three quarters of all *P. conicum* encountered in reefs to grow over living corals. The margin of the alga is adherent to slightly free, entire to slightly lobed or undulate and lacks orbital ridges, while the surface has a granular texture (Fig. 2), as a result of trichocyte fields (Keats et al., 1997).

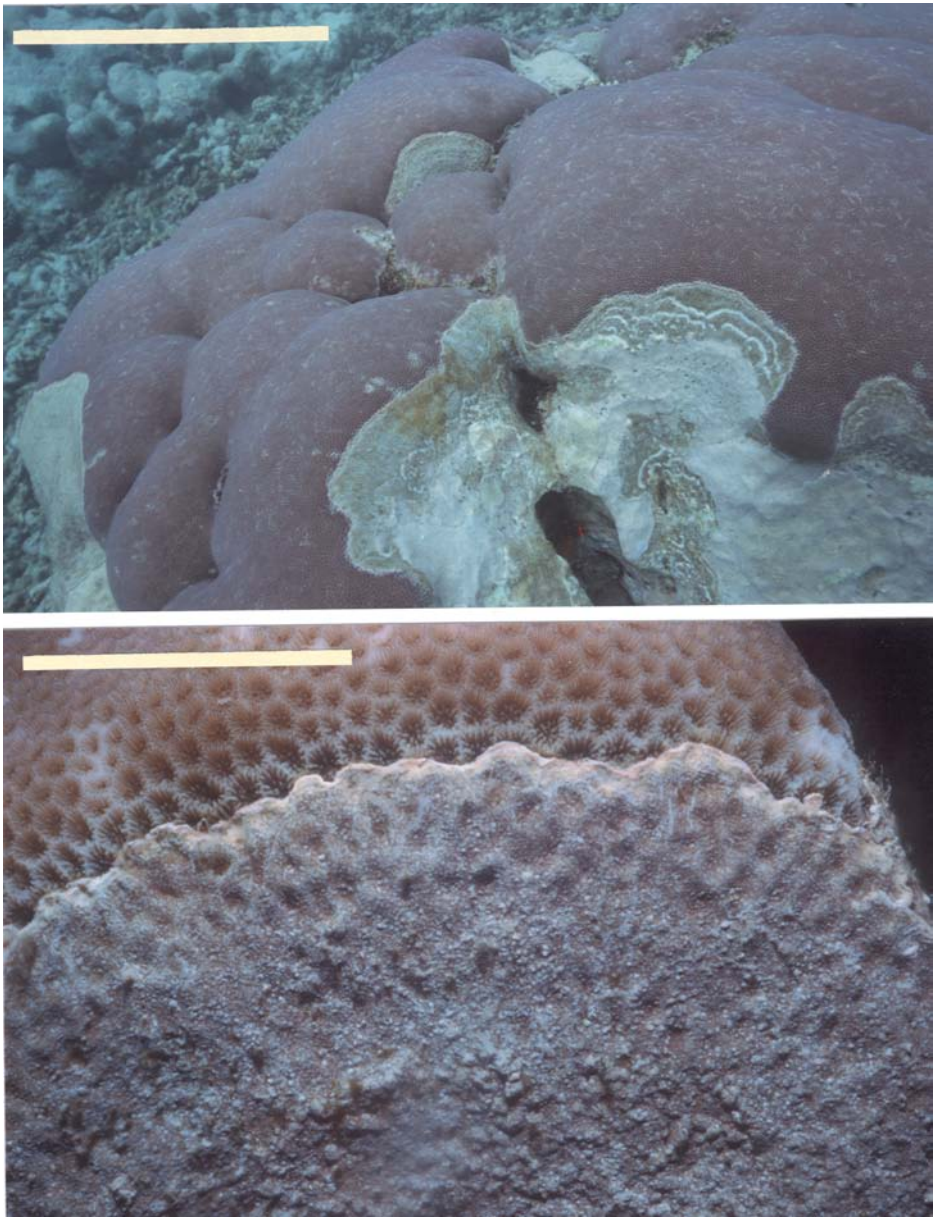
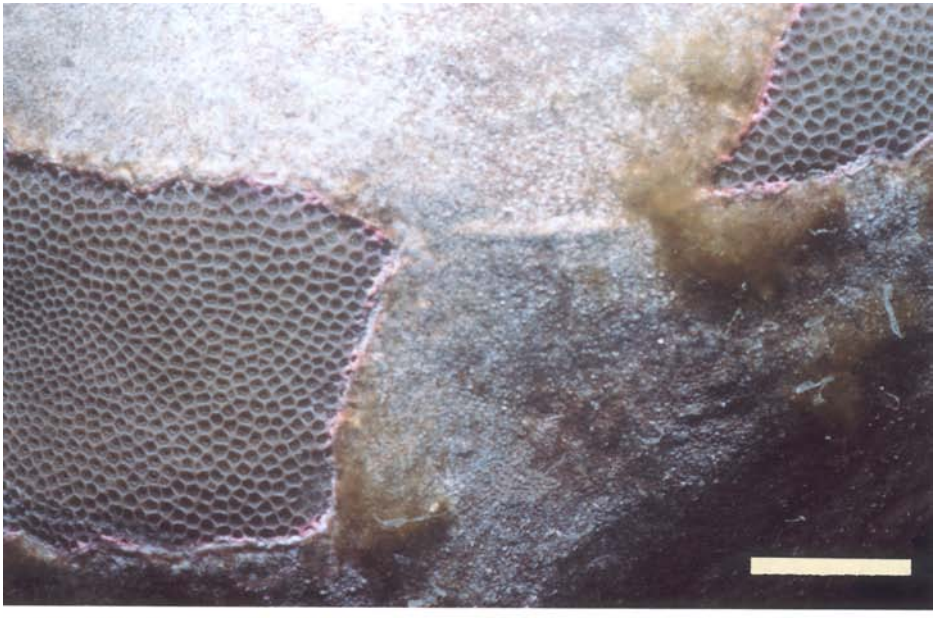


Figure 1. (top). *Pneophyllum conicum* beginning to overgrow a large boulder of *Goniastrea retiformis* from at least three different spots: upper center, left margin, and foreground center, where the alga grew out of a deep crack in the corallum. Scale bar = 50 cm.

Figure 2. (bottom). Close-up of *Pneophyllum conicum* overgrowing a *Goniastrea retiformis*. The alga is extremely tightly attached to the coral surface, with no trace of coral tissue left at the entire area of contact. Scale bar = 5 cm.



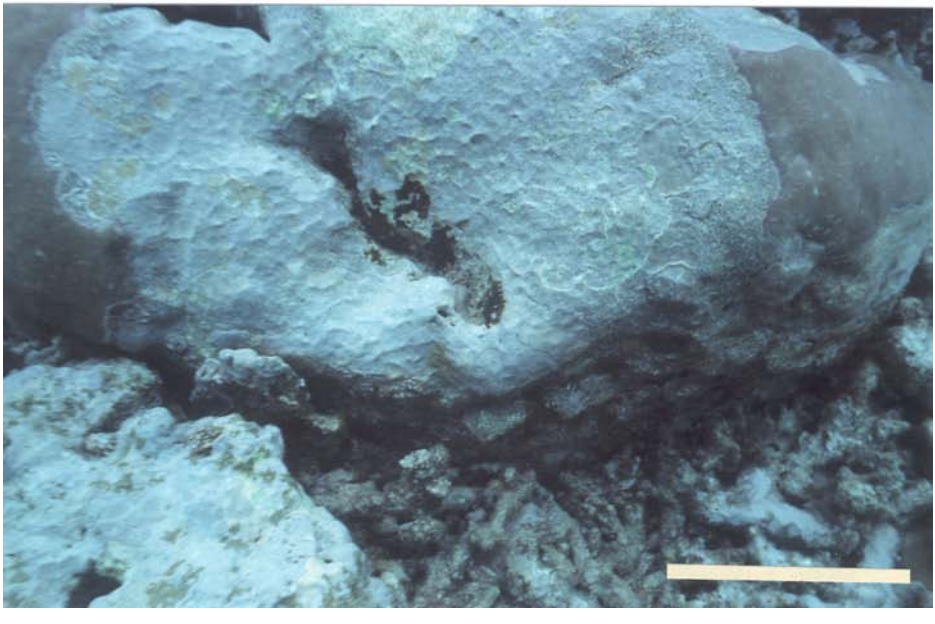


Figure 3. (top). Wherever different thalli of *Pneophyllum conicum* meet, such as here on a *Goniastrea retiformis* surface, they usually do not overgrow each other, but rather fuse and form a 'seam'. Note beginning green algal overgrowth. Scale bar = 5 cm.

Figure 4. (bottom). A large boulder of *Goniastrea retiformis* in the process of being totally enveloped by *Pneophyllum conicum*. On the coral in the left foreground this process is finished, with 100% of the surface occupied by the alga. Scale bar = 50 cm.

Older parts of thalli are often overgrown by other coralline algae, such as *Hydrolithon onkodes* (Heydrich) Penrose et Woelkering, *Lithophyllum insipidum* Adey, Townsend et Boykins, other species of *Lithophyllum*, as well as by other algae (Fig. 3). But besides that, *P. conicum* surfaces also provide good substrates for the settlement of larvae, and young coral colonies or other sedentary organisms are commonly found attached to these older parts of thalli (Keats et al., 1997). In the reef-crest environments investigated in Mauritius, *Millepora* species appeared to be the most successful competitors among secondary settlers, sometimes converting the entire original scleractinian into fire-coral. This means that in such a case the primary scleractinian surface is covered by a secondary layer of *P. conicum*, which in turn is covered by a tertiary layer of *Millepora sp*.

Like most other organisms epizoic on stony corals, *P. conicum* starts from the dead base of a coral colony (Antonius and Ballesteros, 1998), or from some deep crack or crevice (Fig. 1), and from there proceeds upward (Antonius, 1999b), overgrowing living coral tissue (Fig. 2). As mentioned, this phenomenon is widespread throughout the Indo-Pacific, but very rarely amounts to a major threat to the wellbeing of reef corals.

The greater the surprise in 1998 to find a spot in Mauritius where *P. conicum* proved to be absolutely deadly to the local coral population. In one reef-barrier surrounding a lagoon, approximately 1 km west of the peninsula l'Harmonie (SW Mauritius), over a distance of several hundred meters, and from 0 to about 8 m depth, nearly the entire living coral population was found to be overgrown to some degree by *P. conicum*. Roughly one third of all corals, massive as well as branching forms, was registered as 10 to 40% overgrown, one third as 40 to 80% overgrown, and one third as 80 to 100% overgrown. The most impressive cases were large coralla being overgrown from all sides by two, three, or more contiguous algal thalli, with only small patches of live coral surface left (Fig. 4).

Once corals are totally covered by *P. conicum* (Fig. 4), only the growth-form gives a clue as to the original species. Although in this study, only overgrown *Goniastrea* is shown (Figs. 1–4), many other species were found afflicted. They include: *Pocillopora damicornis*, *P. verrucosa*, *Stylophora pistillata*, *Acropora sp.*, *Favia stelligera*, *Favites complanata*, *F. abdita*, *F. flexuosa*, *Goniastrea retiformis*, *Platygyra daedalea*, *P. lamellina*, *Leptoria phrygia*, *Porites solida*, *P. lutea*, and other shallow-water species. Contrary to the findings of Keats et al. (1997), larger-sized corallites did not seem to pose an obstacle for epizoism by *P. conicum*.

Although a special effort was made at finding a clue, it could not be determined why *P. conicum* had become that predominant at this one particular reef-site. Only a few hundred meters along the same reef-crest, the occurrance of *P. conicum* shrank to insignificance, while at the investigated site several 5×5 m squares showed nothing but *P. conicum* surface cover.

P. conicum attacking reef corals in such an extreme, concentrated manner, certainly amounts to another one of the emerging syndromes of epizoism (Antonius, 1999b; Antonius and Ballesteros, 1998). Thus representing a new coral disease, it was given the designation PNE (Antonius, 2001). So far, in all reef-surveys in Indo-Pacific waters, We have observed PNE only this one time in Mauritius. No case of PNE was found during the 1990 Mauritius reef survey (Antonius, 1993), suggesting that the syndrome may be of relatively recent origin and that its frequency of occurrence may be on the rise. Thus, it will be little surprise to find cases of PNE more often in the future, just as other novel syndromes of coral diseases, such as SEB (Antonius, 1999a) and PEY (Antonius, 1999b) have emerged recently. In any survey detailing the health-condition of coral reefs in Indo-

Pacific waters, PNE should be recognized and registered as a novel, coral-killing syndrome, and it should be considered in the diagnosis.

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