Sexual Reproduction of Millepora intricata and Millepora tenella (Hydrozoa : Milleporidae)

1. INTRODUCTION

1 - 1 Taxonomy of *Millepora*

The coral *Millepora* (Hydrozoa: Milleporidae) is more commonly known as "fire coral". It often causes minor stings and inflammation to human tissue when touched. Previous authors have had problems identifying each *Millepora* species. Boschma (1948, 1949, 1950) made a major contribution to the systematics of millepores, however, some taxonomic problems remain (de Weerdt 1981). The difficulty is that there are variable phenotypic forms of each species but no morphological characteristics of taxonomic value, other than growth forms of the coralla (de Weerdt 1984; Lewis 1989).

Species specific growth forms were classified for *Millepora* by Boschma (1948). Until now 15 species of *Millepora* have been described (Moschenko 1990). In the Ryukyu islands six species are recognized: *M. platyphylla*, *M. tenella*, *M. exaesa*, *M. intricata*, *M. murrayi*, and *M. dichotoma* (Nishihira & Veron 1995). For this study, I chose two branching species; *Millepora intricata* Edwards (Figure 1) and *Millepora tenella* Ortmann (Figure 2) because these species were commonly found in this study area, and their branches were easy to sample.

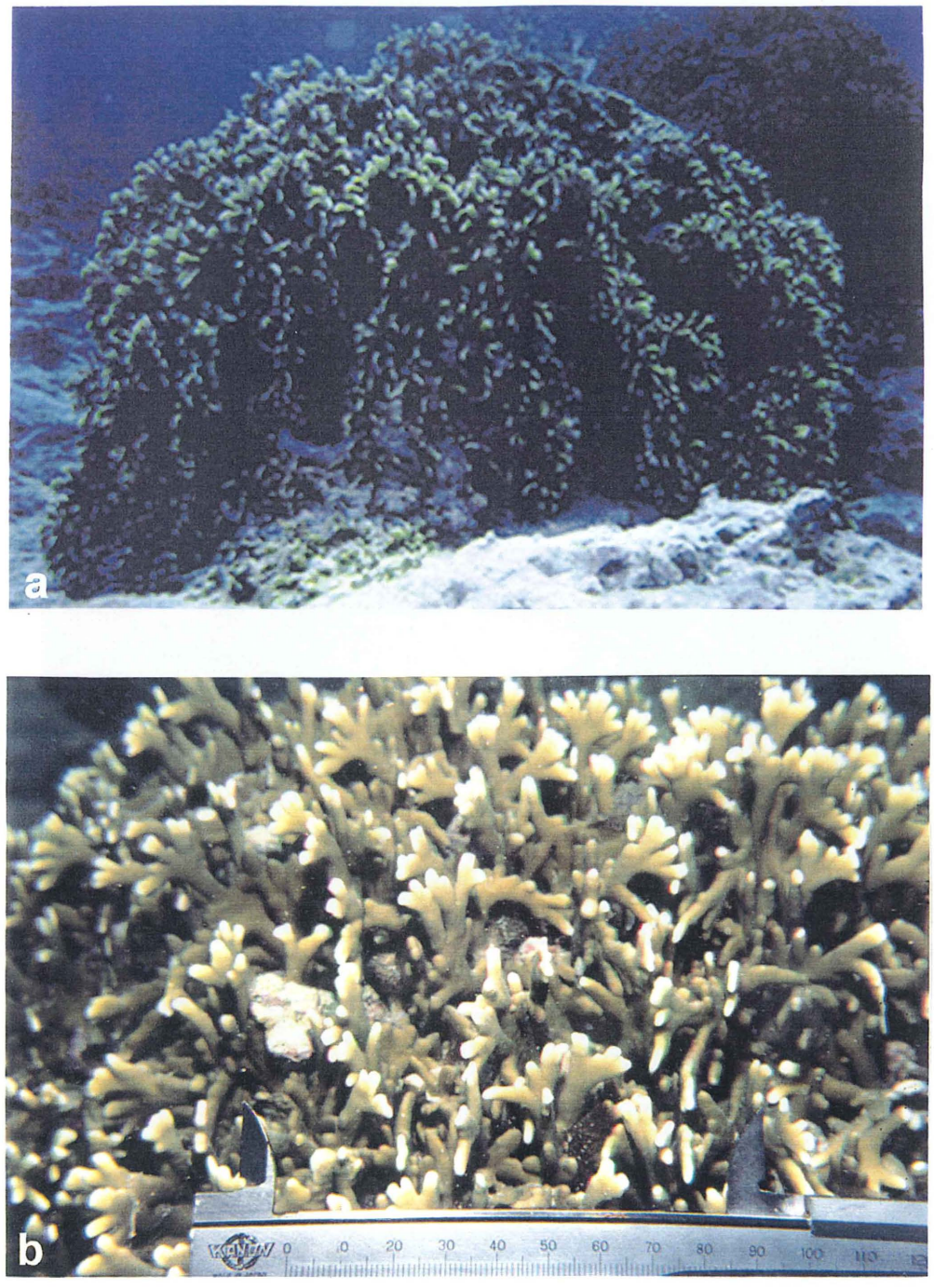

Figure 1. Underwater photographs of *M. intricata* showing the **a**) dome-shaped coralla and **b**) fine branches.

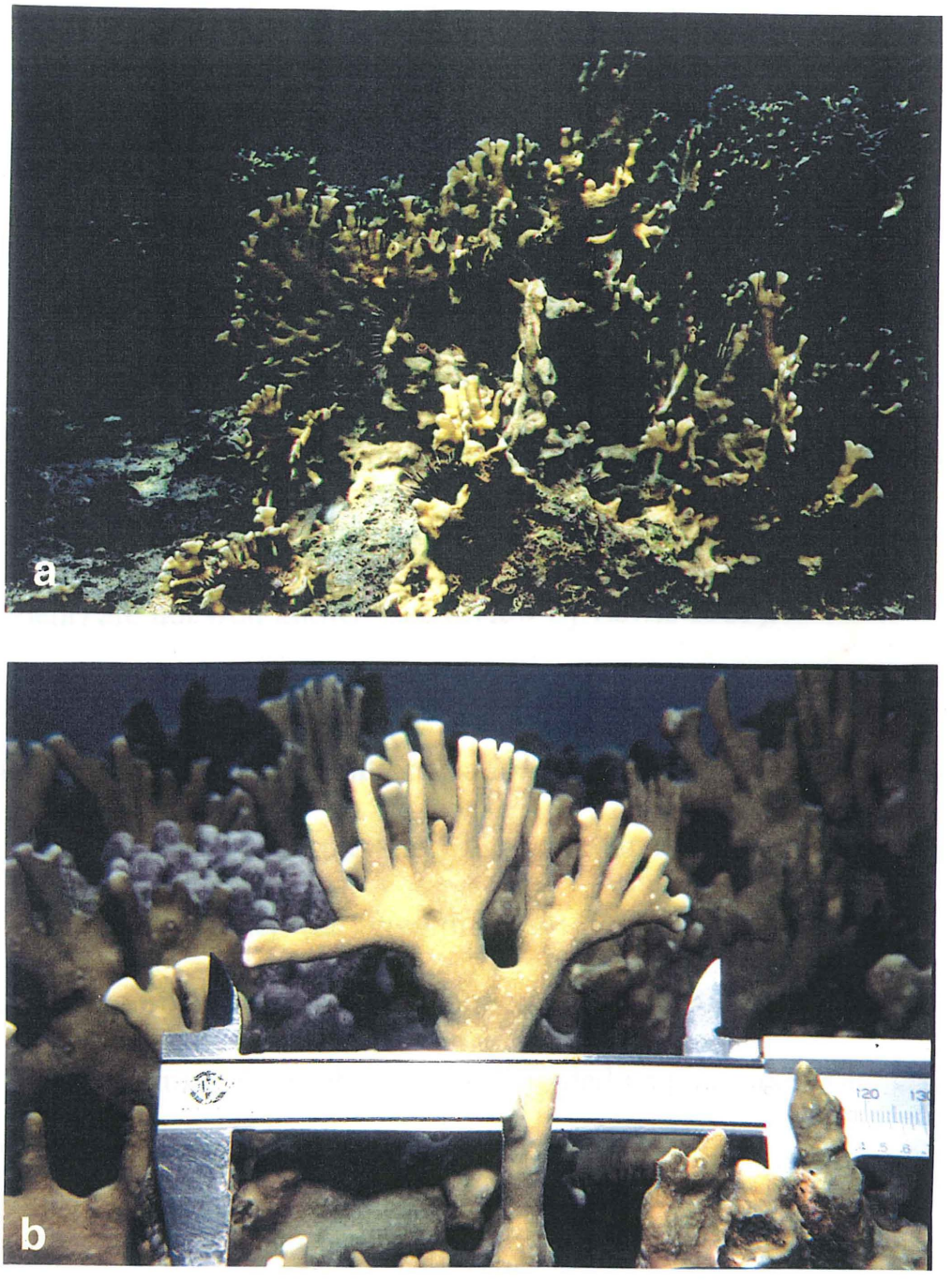

Figure 2. Underwater photographs of *M. tenella* showing **a)** both branching and encrusting colony morphologies, and **b)** hand-like branches.

1 - 2 Distribution and growth-form of *Millepora*

Millepora ranges widely over the tropical seas, occurring in the Red Sea, Indian Ocean, Atlantic region of America, Pacific Ocean, and in the West Indies (Hickson 1898, Boschma 1948). They are generally found in depths from 1 m to about 40 m (Lewis 1989). Although millepores are often reported as abundant, or even dominant on some reefs, quantitative data is scarce (Lewis 1989), and ecological processes that affect populations (e.g. recruitment) are not well known (see review by Lewis 1989).

Millepora has a high adaptability to various environmental circumstances, often changing their morphology in accordance with depth, water movement, and turbidity (de Weerdt 1984). The growth form of the corallum is extremely variable including plates, blades, branches, rounded clumps, and encrusting morphs. Robust, bladed or plate-like colonies are most common on the surf-swept edge of reefs, where there is strong water movement. Delicately branching, upright colonies flourish in lagoons and in sheltered deeper waters. Encrusting forms may occur at all depths and appear to be the first stage of every growth form (Crossland 1928; de Weerdt 1981).

Millepora has two types of polyps 1) the short nutritive gastrozooids and 2)

the long elongate dactylozooids (Boschma 1956; Nemenzo 1986). Both types of polyps connect to the canal system at their bases (Boschma 1956). These will bud and build up a colony asexually.

Several measurements of growth were reported for *Millepora complanata* Lamarck by Strömgren (1975), de Weerdt (1981), Witman (1988), and Lewis (1991a), using different methods. There was considerable variation in growth rates in accordance with study areas, seasons, and methods used. Strömgren (1975) obtained mean growth rates of 15 and 55 μm per day (0.45 and 1.65 mm per month or 5.4 and 19.8 mm per year) by a laser diffraction method. The growing edge increments measured by de Weerdt (1981), from photographs of transplanted specimens, was 1.4 mm per month. Witman (1988) reported 8.0 mm per year (0.67 mm per month) from close-up photographs of the colonies under natural conditions. Lewis (1991a) obtained mean values of 1.6 mm per month (19.2 mm per year) from measurements using Vernier calipers in situ.

1 - 3 *Millepora* life cycle and reproduction

The hydrozoan coral *Millepora* has a life cycle in which both the polyp and the medusa stage exist. *Millepora* releases male and female medusae, that are about 1 mm in diameter, from separate colonies (Lewis 1991c), while

scleractinian corals shed eggs and sperm, and/or planulae (Harrison and Wallace 1990; Richmond and Hunter 1990). Each medusa grows inside a receptacle (Hickson 1891), which is called an 'ampulla' (Quelch 1884), while gametogenesis of scleractinian corals takes place in temporary gonads embedded in mesenteries (Fadlallah 1983; Veron 1995).

The earliest description of the ampullae appears to have been by Quelch (1884). Hickson (1891) was the first to describe the presence of medusae in *Millepora.* Hickson obtained some specimens with ampullae and found that each ampulla contained a curious medusiform gonophore in different stages of development. He tried to find specific differences in medusae among species of this genus, but concluded that no specific distinction could be drawn (Hickson 1897). Likewise, Boschma (1949, 1950) and Moschenko (1993) investigated ampullae to find taxonomic differences, but ampullae did not show valuable distinctions between species.

Hickson (1891, 1899) and Mangan (1909) identified several developmental stages of medusa, however, they did not try to follow gametogenesis in any single colony continuously. There does not appear to be any subsequent studies on ampulla and medusa of *Millepora* until Lewis's 1991c study. He investigated the development of ampullae in *M. complanata* using

Scanning Electron Microscope (SEM) techniques. He provided the first description on the seasonal appearance of *M. complanata* ampullae in Barbados and briefly showed the manner in which medusae were released.

Male and female medusae are released from separate colonies (Lewis 1991c), immediately fertilize and then die (Hickson 1899). There has not been any description or any subsequent metamorphosis reports of the fertilized eggs. However, Dr. M. Yamaguchi (personal communication) took photos of planulae and spat of *Millepora intricata* in 1982 (see p 46).

1 - 4 Purpose of this research

Scientific knowledge on the sexual reproduction of scleractinian corals has markedly increased in the last two decades (see reviews by Fadlallah 1983; Harrison and Wallace 1990; and Richmond and Hunter 1990). However, little attention has been paid to the sexual reproduction, and other ecological aspects, of the hydrozoan coral *Millepora*, a common reef builder in the Indo-Pacific.

Knowledge of reproductive coral biology and associated processes of dispersal and recruitment is essential for ecological studies on coral populations and communities. This study is aimed to further our

understanding of the sexual reproduction of *Millepora.* The difference between my approach and previous investigations on *Millepora* reproduction is that I continuously observed and examined marked colonies in their natural condition to reveal their reproductive season and traced the developmental processes of the medusae and ampullae. Whereas, other studies did not follow their reproduction through time. As descriptions of *Millepora* medusa has been limited to *Millepora murrayi* Quelch (Hickson 1891) and *M. complanata* (Lewis 1991c), I made a comparison of the reproductive traits between those species and *M. intricata* and *M. tenella*.