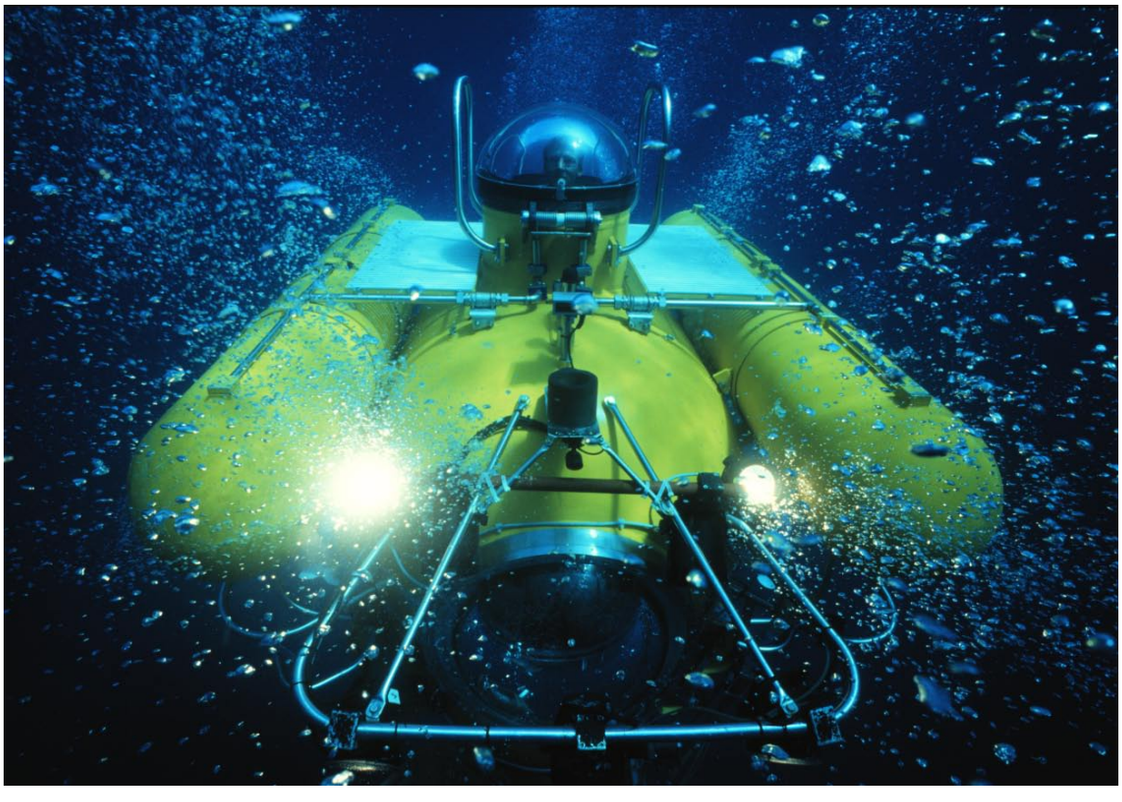
IFM-GEOMAR

Leibniz-Institut für Meereswissenschaften
an der Universität Kiel

# IFM-GEOMAR Report 2006

## From the Seafloor to the Atmosphere

## - Marine Sciences at IFM-GEOMAR Kiel -



**IFM-GEOMAR Report 2006**

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Cover photo: Submersible JAGO diving in the Indian Ocean (Jürgen Schauer, IFM-GEOMAR).
Inner cover: s.a.

# Preface

Three years after the merger of IfM and GEOMAR, the decision to merge the two institutes has proven to be a strategic and scientific success. The reputation and profile of IFM-GEOMAR has increased tremendously and has established Kiel as a major centre of marine sciences in Germany and Europe. One indicator of the success of the new institute is the so-called "DFG-ranking", published by the German Research Foundation (DFG). For the period 2002-2004, IFM-GEOMAR was by far the most successful non-university research institute in terms of DFG-project funding. An important milestone for the strategic development of the institute is represented by the positive funding decision for the excellence cluster "The Future Ocean". In this project, IFM-GEOMAR cooperates with six different faculties of the University of Kiel, the Kiel Institute for the World Economy and the Muthesius College of Fine Arts. The cluster, which has a budget of 36 Mio. Euros for a 5-year period, will cover a wide range of topics including chances and risks of the future ocean such as ocean acidification, marine resources and the consequences of climate change. Four of the 14 new junior research groups will be located at IFM-GEOMAR. The generous funding of "Future Ocean" will enable the creation of about 100 new high-profile jobs in Kiel.

Progress has also been made in the area of research infrastructure. The new Technology and Logistics Centre (TLC) of IFM-GEOMAR opened as the new central basis for the development and maintenance of instrumentation, as well as for the technical preparation of seagoing expeditions. The first large device that found its new home in the TLC is the submersible "Jago" the only manned research submersible in Germany. "Jago" was acquired by IFM-GEOMAR in January and provides an attractive platform for multidisciplinary marine research. In addition, the construction of a Remotely Operated Vehicle (ROV) with a diving capability of 6000m started recently. The ROV will be available for the marine research community in late 2007. Other large-scale facilities such as offshore mesokosms and an Autonomous

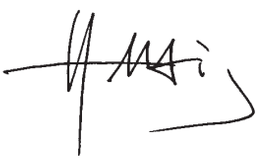
Underwater Vehicle (AUV) are also being developed.

On the scientific side, plans for a new collaborative research centre (SFB) on "Climate-Biogeochemistry Interactions in the Tropical Oceans" are well developed. The review of the pre-proposal was very encouraging and the on-site review and the funding decision are expected for 2007.

Overall, the developments in marine sciences in Kiel and particularly at IFM-GEOMAR have been extremely positive during the past year. Due to successful proposals and generous additional support by the State of Schleswig-Holstein, the institute now enjoys a solid foundation with which it can strive for continued excellence in marine research. We are confident that we can further strengthen our leadership position over the next few years in order to establish IFM-GEOMAR as a "National Centre for Marine Sciences" with high international visibility.

This report provides a short overview of the major developments and scientific highlights during the past year Detailed statistical information can be found in the appendices. I hope that you will enjoy reading the "IFM-GEOMAR Highlights 2006".

Kiel, October 2007



***Prof. Peter M. Herzig***
***Director***

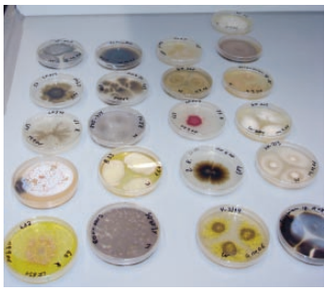
# New natural products from marine microorganisms

Investigations on marine natural products have gained much interest during the past years, mainly because of two reasons: i) It is increasingly obvious that interaction between marine microorganisms and also between microorganisms and macroorganisms are governed by chemical interactions and that cell-cell communication systems play an important role in establishing ecological niches. Often signalling molecules induce the synthesis of substances with antibiotic or other biological activities. ii) A number of secondary metabolites and inhibitors of signalling molecules of marine microorganisms have great potential in pharmaceutical and medicinal applications and are attractive candidates for development of new drugs.

Biological active substances have been known from many marine invertebrates and algae, but only in recent years the role of associated microorganisms came into the focus. Because of their production of biological active substances, in particular marine sponges and their associated microorganisms gained much interest. Sponges, like other sessile marine organisms depend on chemical defence mechanisms against predators, but also against attacks of pathogenic microorganisms. A large fraction of microorganisms living in association with marine sponges have been shown to produce biological active substances. They may contribute to their host´s integrity and defence by the excretion of antibiotic and other biologically active substances. One of the substances, which we have identified chemically and also on the basis of genetic sequence information of its biosynthetic pathway, is known as a potent inhibitor also of multiresistent bacteria. Interestingly, the substance is produced by a bacterium isolated from a sponge and the biosynthesis of this substance is stimulated by signalling molecules released by other microorganisms. Therefore, this substance may well play a role in species-species interactions in the natural habitat.

In the Marine Microbiology group, the specific association of microorganisms with sponges was investigated in selected sponge species which were studied by microscopic and genetic analysis. The microscopic studies revealed large differences in the association of bacteria with different sponges. *Suberites domuncula* e.g. showed only a small number of bacteria on its interior surfaces, while the sponges *Halichondria panicea* and *Ircinia fasciculata* revealed abundant and highly diverse bacterial assemblages. Sponge-species specific association of bacteria was demonstrated by comparison of the bacterial community associated to the Mediterranean sponges *Chondrilla nucula* and *Tethya aurantium.* The latter species even had two clearly distinct bacterial communities associated with exterior and interior cells, which could be differentiated by microscopic studies and genetic analyses (Fig. 1). These findings support the assumption that certain bacteria found in sponges are specifically associated with these animals and may have adapted during evolutionary processes to the sponge environment.

Because marine sponges are considered as one of the most important sources of substances with antibiotic, antitumoral or antiviral activities and a major portion of these substances may be produced by associated microorganisms, the associated microorganisms are a potentially important source of new products for pharmaceutical and medicinal applications. During the past years, we have isolated a large numbers of bacteria and fungi with antibiotic activities against other microorganisms. Several hundred biologically active marine bacteria and fungi are currently treated in detailed biological and chemical analyses. Some are active against tumor cell propagation and have antiviral activities. New biologically active chemical compounds have been identified. Several compounds were patented and one of these, sorbicillacton A, is in an advanced preclinical stage of the development for antileukemic treatment. Sorbicillacton A is produced by a fungus isolated from a marine sponge and is promoted within the national research project "Center of Excellence BIOTEC*marin*". Experiments



*Some test probes of marine sponges in the Centre for Marine Substances.*

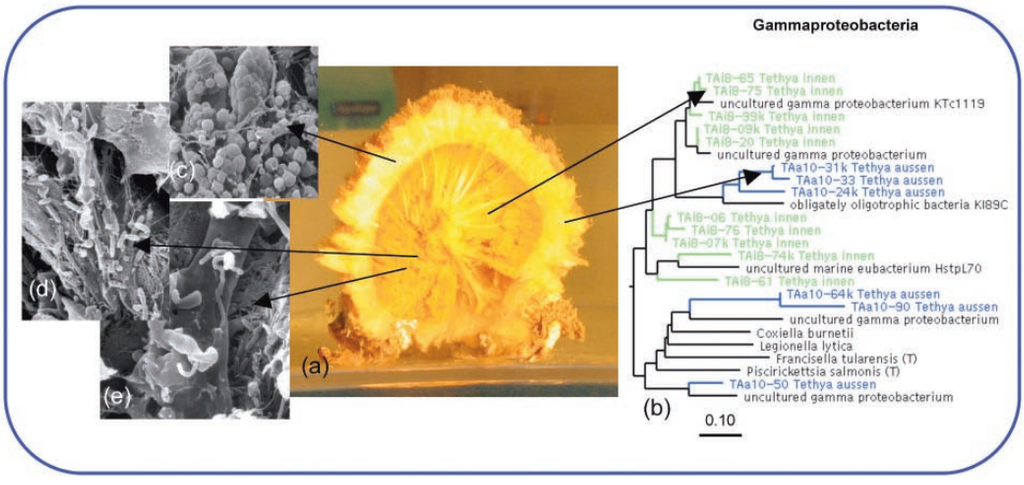



*Fig. 1: Specific differences in the association of bacteria with cortex and interior of the marine sponge Tethya aurantium (Sea-orange) (a) Cross section of the sponge (b) phylogenetic positions of Gammaproteobacteria sequences found in different cell structures and (c)(d)(e) corresponding electron microscopic (REM) exposure*

towards optimization of biosynthetic production of this compound were performed. The chemical structure was elucidated by chemical partners at the University of Würzburg. The biosynthetic pathway was established in joint experiments of the Marine Microbiology at IFM-GEOMAR and the chemical partners, and important biological activities against viruses and cancer cells were established by partners at the University of Mainz.

In 2006 major progress was made in further strengthening the research on bioactive natural products from marine microorganisms and to establish it as a central topic in the Marine Microbiology group at IFM-GEOMAR. Research was extended to bacteria from other marine sources including algae, bryozoa and also extreme habitats from the deep sea and hypersaline brines. The "Zentrum für Marine Wirkstoffe", funded by the Schleswig-Holstein Ministry of Science, Economy and Traffic, has taken major investments into laboratory facilities and instrumentation to establish research facilities and a network of local collaborating partners in science and industry. Both, marine bacteria and marine fungi are principal sources of biotechnological research and development in this "Zentrum". Application of marine natural products is envisaged in infective diseases (bacteria, fungi and viruses), anti-inflammatory processes and tumor treatments. Partners are institutions and groups at the medical clinics and the natural science faculty of the CAU, other research institutions and commercial companies. Together with local, national and international partnerships the "Zentrum für Marine Wirkstoffe" will promote the development of new pharmaceuticals from marine organisms and establishes a center of marine biotechnological research in Kiel. In the centre all instrumentation and know how is available to identify and produce natural products from marine natural resources: We isolate, grow, identify and maintain bacterial and fungal cultures. Large culture collections are available and will be maintained. New isolates will be included into these collections. Cultivation and fermentation of the microorganisms, including process development, extraction of secondary metabolites, chemical analysis of the extracts, identification of the chemical structures as well as studies on biosynthesis and genetic studies belong to the basic research work. Most important a large panel of biological assays is used to establish a broad spectrum of biological activities and to identify substances useful for medical treatments, for plant diseases and other applications. Because the increase of antibiotic-resistant bacteria causes severe problems in medical treatment, special emphasis is given the search for substances active against multiresistant pathogenic bacteria.

***Johannes F. Imhoff***