MedCrave
Step into the World of Research

Journal of Aquaculture & Marine Biology

Manned Submersibles, the Efficient Tools for Exploring Deep-Sea Creatures

Abstract

In this paper, the significant meaning for conducting deep sea creature research and the current study status will be introduced and the great value for using manned submersibles to support such research will be researched, especially the applications carried out in hydrothermal vents, cold seep, mid-ocean ridge areas. Then, some results for China's JIAOLONG manned submersible on implementing deep-sea creature investigation will be presented. To better support the future underwater explorations, at the conclusion part, some suggestions will be brought forward to promote the development of China's JIAOLONG manned submersible and its related technologies.

Keywords: Manned submersible; Deep-sea creature; Hydrothermal vent; Research; Efficient tools; Exploring; Deep sea; Earth's environment; Underwater gliders; Vehicles; JIAOLONG manned

Research Article

Volume 3 Issue 2 - 2015

Xianpeng Shi*

Department of National Deep Sea Center, China

***Corresponding author:** Xianpeng Shi, Department of National Deep Sea Center, 1# Weiyang Road, Aoshanwei Street, Jimo, Qingdao, 266237, China, Tel: +86-532-67722125; Email: shxp_007@163.com

Received: October 20, 2015 | **Published:** December 04, 2015

Abbreviations: FAMOUS: French American Mid-Ocean Undersea Study; HADES: Hadal Ecosystem Studies; CoML: Census of Marine Life; ROVs: Remote Operated Vehicles; AUVs: Autonomous Underwater Vehicles; HOVs: Human Occupied Vehicles

Introduction

The global oceans cover 70% of our Earth's environment, consist of 95% of the living space and are the core momentum of our planet's physical, chemical and biological cycles, resulting in a great potential source of economic, social and political importance that directly or indirectly affects human's daily living. For today's land resources are depleting, it is necessary account for the Earth's oceans, especially the deep sea [1]. The deep sea is the lowest layer in the ocean, existing below the thermocline and above the seabed, at a depth of 1000 fathoms (1800 m) or more. Little or no light penetrates this part of the ocean and most of the organisms that live there rely for subsistence on falling organic matter produced in the photic zone [2]. In addition, the pressure is very huge which make people hard to explore via normal technologies.

For this reason scientists once assumed that life would be sparse in the deep ocean but virtually every probe has revealed that, on the contrary, life is abundant with about 85% of the species living in the oceans. The deep-sea creatures and deep-sea biological gene as a new biological resources, has attracted wide international community's attention for its wide applications in industry, medicine, environmental protection, national defense and other fields [3]. Marine biological research and related technology development is currently undergoing all over the world, but the secrets of our oceans have remained largely undiscovered. The main reason for the delay of this work is lack of capable technologies [4].

Materials and Methods

Deep-sea biology research and the status

It is a dark place throughout the years in the deep-sea area, the sun hardly penetrating into it. Many species are living in harsh environments with high salinity, huge pressure and extreme hypoxia. This kind of species has a unique biological structure, metabolism and the body producing a special biologically active substance, such as basophils, thermophilic, psychrophilic, pressure resisting, extreme anti-drug enzymes and the biologically active substance is the most valuable part o the application in deep-sea biological resources [5-7].

In recent years, some investigation research shows that the deep-sea biological resources in extreme environments, often present in the form of community existing in different forms depending on the distribution of the living environment, forming a unique food chain. According to the geographical division for deep-sea creature's living, the most currently studied biological communities include deep-sea hydrothermal communities, cold seep communities, middle-ocean ridge communities, deep-sea seamounts, trenches and mud volcanoes and other communities [8-12].

The hidden biological resources in deep-sea extreme environments and special biological communities have aroused great concern of the international community. There are a variety of research contents for deep-sea creatures and the current research priorities focus on the following aspects:

Seabed ecological balance: Research on the relationship between the biological communities lived in the seabed extreme environment and the seabed environment. Research on linkages between fluid existing in seabed extreme environment, minerals and deep-sea biological communities, explore the particularity of marine life living environment.

Deep-sea biological diversity: Through a comparative study of biological resources in deep-sea extreme environment communities and the biodiversity, systematically reveal the origins of human life, as well as the study of biological evolution cause adaptability to special circumstances.

Deep-sea biomedical research: The unique chemical structure of deep-sea creatures provides a good source for today's scientists to screen for new drugs and the chance for explore new drugs in the sea is much larger than the land. Therefore, the new research areas including deep-sea enzymes, natural medicine and medicinal research began to draw a national research attention.

The United States, France, Japan and other developed countries have been at the leading place in deep-sea creature research areas and a number of research programs on this area has been or being conducted, such as project French-American Mid-Ocean Undersea Study (FAMOUS) [13,14] the hadal ecosystem studies (HADES) project, Census of Marine Life (CoML).

Manned submersibles used for deep-sea creature research

In order to gain a better understanding of the deep-sea creatures, until now, large numbers of facilities including research vessels, satellites, buoys and various kinds of underwater submersibles have been applied for deep-sea creature investigations. Especially, underwater submersible technologies have made substantial strides over the past two decades, such as Remote Operated Vehicles (ROVs), Autonomous Underwater Vehicles (AUVs), Underwater Gliders and Human Occupied Vehicles (HOVs) and other new type ones. Starting from nascent navigation and control algorithm research in laboratories, applied underwater technology has developed considerably and at present the manned submersibles are able to dive thousands of meters to take scientists directly to the depths of the Oceans to conduct underwater observations and sampling operations [15-17].

Compared with other underwater vehicles, the manned submersible can take marine biologists to the deep sea and the biologists will get a direct view to the deep-sea creatures. Some photos can be taken and some samples can also be captured and stored in bio-box. It is well known to a number of marine biologists that the American manned submersible Alvin traveled through the Panama Canal for the first time. Geology work in the Galapagos Rift was completed during February and March, 1977 [18]. The major discovery of an abundance of exotic animal life on and in the immediate proximity of warm water vents prompted theories about the generation of life. Since no light can penetrate through the deep waters, scientists concluded that the animal chemistry here is based on chemosynthesis, not photosynthesis. This has opened a new century for world's marine scientists to exploring the deep-sea creatures, especially the creatures in deep-sea extreme environment, such as the hydrothermal vents, cold seep and mid-ocean ridge areas. Marine biology exploration and research has been the main work field of manned submersibles. It was counted that from 1966 to the end of 2010, the Alvin manned submersible had dived around 5,000 times with a variety kind of applications and the use for deep-sea creatures took up 38%, which can be shown in Figure 1.

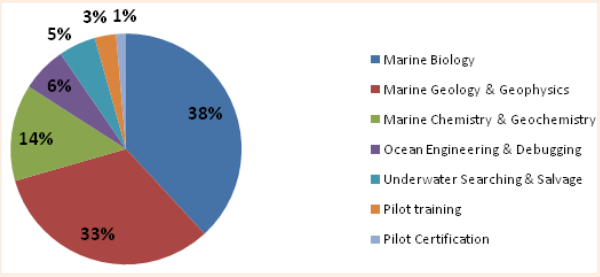

Figure 1: The application areas of Alvin manned submersible.

Applications of chinese JIAOLONG manned submersible

The R&D program of JIAOLONG manned submersible was approved in late 2002 (Figure 2) and after six-year R&D with joint research by related agencies of China, from 2009 to 2012, the 1,000m, 3,000m, 5,000m and 7,000m class sea trial was conducted in South China Sea, South China Sea, Northeast Pacific Ocean and Mariana Trench respectively, with a maximum dive depth of 7,062m, which has made China to be the fifth country grasping manned deep submergence technology over 4,500m ability after the United States, Japan, France and Russia [19-21]. During the 4-year sea trials, some deep-sea creatures have been sampled and a lot of high definition pictures and videos on deep-sea creatures have been taken (Figure 3-5).

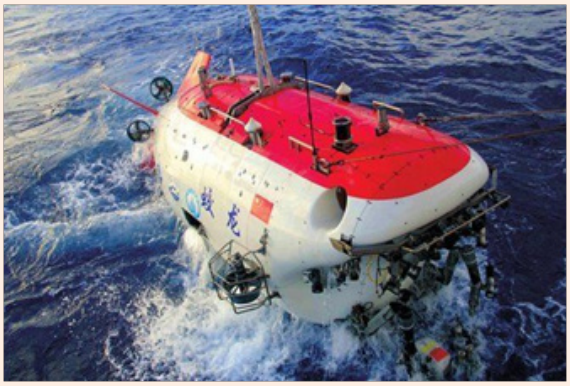

Figure 2: Jiaolong Manned Submersible.

After the four-year sea trials, JIAOLONG manned submersible came to a new phase named Test Operational Phase. In 2013, a cruise comprised of three legs was carried out in South China Sea, Northeast Pacific Ocean and Northwest Pacific Ocean respectively. The investigation areas including cold-seep, sea mount, China's polymetallic nodule contract area and cobalt-rich crust contract area. Besides conducting some marine resource related surveys, some biological research has been carried out and even more deep-sea creatures were sampled and shoot during this cruise.

Then, from 2014 to early 2015, JIAOLONG has implemented a cruise comprising of three legs in Northwest Pacific Ocean and Northwest Indian Ocean. Specially, the last two voyages were carried out in hydrothermal vents area of Northwest Indian Ocean and great achievements have achieved for biological study. It's the

first time for JIAOLONG to conduct a more systematic investigation to creature composition, abundance and distribution of three different hydrothermal vents area. 635 creature samples were captured which will lay a basis to implement species identification, characteristics measuring, diversity study, molecular system research, genetics, microbiology and so on.

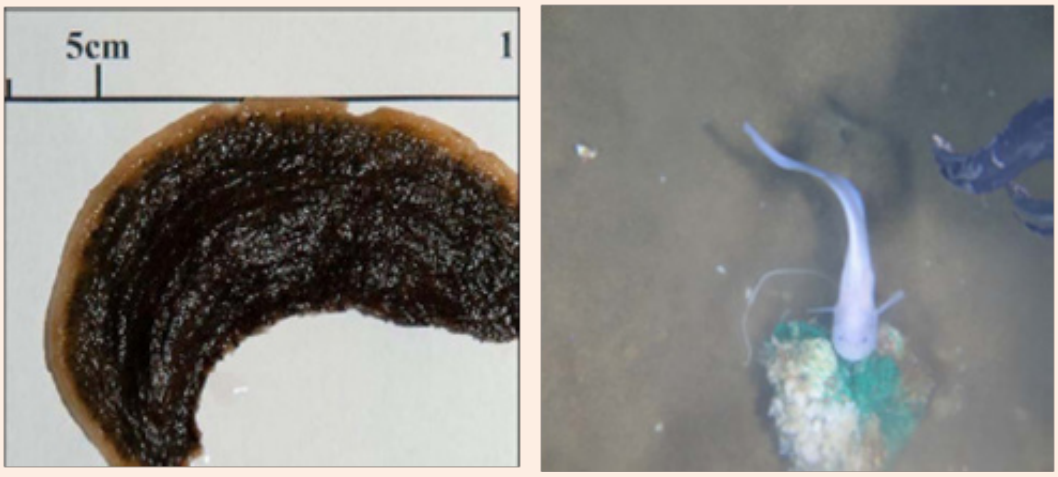

Figure 3: (Left) Unicellular protozoan; (Right) Snail fishes attracted by fish meat [20].

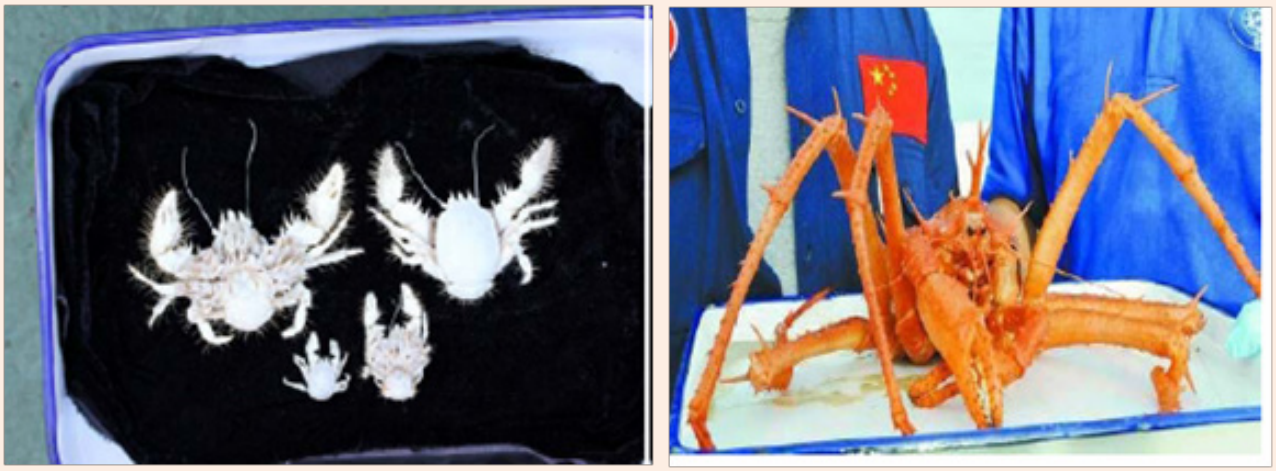

Figure 4: (Left) Bythograea thermydron; (Right) King crab.

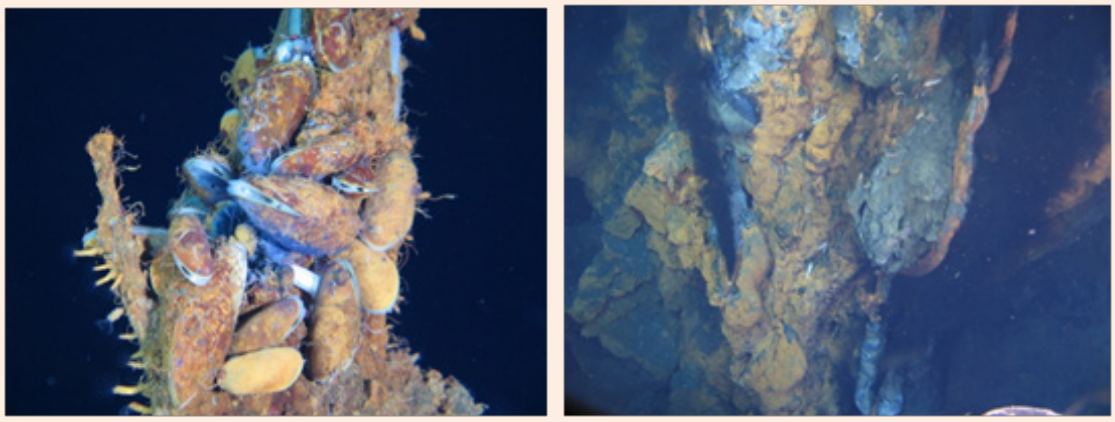

Figure 5: (Left) mussels (Right) Shrimps on hydrothermal vent.

Citation: Shi X (2015) Manned Submersibles, the Efficient Tools for Exploring Deep-Sea Creatures. J Aquac Mar Biol 3(2): 00067. DOI: 10.15406/jamb.2015.03.00067

Conclusion

In this paper, the research status of deep-sea creatures has been introduced. To support this research, the manned submersible technology has been introduced and finally some results for China's JIAOLONG manned submersible has been listed from sea trials to Test Operational Phase which has been conducted in South China Sea, Northeast Pacific Ocean, Northwest Pacific Ocean and Southwest Indian Ocean. To call the interest of conducting deep-sea creature and to exploit the deep-sea biological resources, it is necessary to use manned submersibles and related underwater technologies to make further investigations and conduct related researches. In addition, based on current platforms to develop in-situ deep-sea samplers and other tools used for deep-sea creature sampling and research will be very meaningful and it is also very necessary. In the future, JIAOLONG will dive more and more to bring more support to the world's marine scientists for conducting deep-sea creature research.

Acknowledgement

The author is grateful for the anonymous reviewers for their valuable suggestions. This work was supported by Science and Technology Development Plan of Shandong Province (grant no.2014GGF01046).

References

1. Aharon P, Fu B S (2003) Sulfur and oxygen isotopes of coeval sulfate-sulfide in pore fluids of cold seep sediments with sharp redox gradients. Chem Geol 195(1-4): 201-218.
2. https://en.wikipedia.org/wiki/Deep_sea
3. Weisberg RH (2011) Coastal ocean pollution, water quality, and ecology. Mar Technol Soc J 45(2): 35-42.
4. Shi XP, Lembke C (2015) Characteristic function–based trial and-error control of underwater profilers for vertical-column observation. J Engineering for the Maritime Environment: 1-8.
5. Kildow JT, Mcllgorm A (2010) The importance of estimating the contribution of the oceans to national economies. Mar Policy 34(3): 367-374.
6. He RY, Weisberg RH (2003) West Florida shelf circulation and temperature budget for the 1998 fall transition. Cont Shelf Res 23(8): 777-800.
7. Daniel T, Manley J, Trenaman N (2011) The Wave Glider: enabling a new approach to persistent ocean observation and research. Ocean Dynam 61(10): 1509-1520.
8. Von Damm K L, Edmond J M, Grant B, Measures C I (1985) Chemistry of submarine hydrothermal solutions at 21°N, East Pacific Rise. Geochim Cosmochim Acta 49(11): 2197-2220.
9. Metz S, Treey JH (2000) Chemical and mineralogical influences on concentrations of trace metals in hydrothermal fluids. Geochimica et Cosmochimica Acta 64(13): 2267-2279.
10. Bayon G, Loncke L, Dupre S, Capraisd JC, Ducassoue E, et al. (2009) Multi-disciplinary investigation of fluid seepage on an unstable margin: The case of the Central Nile deep sea fan. Marine Geology 261(1-4): 92-104.
11. Ritt B, Sarrazin J, Caprais JC, Philippe N, Olivier G, et al. (2010) First insights into the structure and environmental setting of cold-seep communities in the Marmara Sea. Deep Sea Research I: Oceanographic, 57(9): 1120-1136.
12. Debenham NJ, John PLD, Ferrero TJ, Smith CR (2004) The impact of whale falls on nematode abundance in the deep sea. Deep-Sea Research I 51(5): 701-706.
13. Choukroune P, Francheteau J, Le Pichon X (1978) In situ structural observations along transform fault A in the FAMOUS area. Mid-Atlantic Ridge. Geol Soc Am Bull 89(7): 1013-1029.
14. Luyendyk BP, Macdoald KC (1977) Physiographic and structure of the inner floor of the FAMOUS rift valley: Observations with a deep-towed instrument package. Geol Soc Am Bull 88(5): 648-663.
15. Antonelli G, Fossen TI, Yoerger DR (2008) Underwater robotics. Spr Hdb Robot 987-1008.
16. Bowen A, Walden BB (1992) Manned versus unmanned systems: A complimentary approach Mar Technol Soc J 26(4): 79-80.
17. (2004) Future needs in deep submergence science. Occupied and unoccupied vehicles in basic ocean research. The National Academies Press, Washington DC, USA.
18. Ballard R D, Vanandel T H (1977) Morphology and tectonics of the inner rift valley at Lat 36°50'PN on the Mid-Atlantic Ridge. Geol Soc Am Bull 88(4): 507-530.
19. Liu F, Cui WC, Li XY (2010) China's first deep manned submersible, Jiaolong. Sci China Ser D 53(10): 1407-1410.
20. Liu F (2014) Jiaolong Manned Submersible: A decades' retrospect from 2002 to 2012. Mar Technol Soc J 48(1): 7-16.
21. Cui WC, Liu F, Hu Z, Zhu M, Guo W, et al. (2012) 5000 m sea trials test of the deep manned submersible JIAOLONG. J Ship Mechanics 16(10): 1131-1143.