October 17, 2008
Japan Agency for Marine-Earth Science and Technology

Deep-sea Jellyfish's Biology and Ecological Role Unraveled by High-resolution Images ~Species interactions will cause a chain reaction~

Outline

Dhugal Lindsay, Research Scientist, Marine Biology and Ecology Research Program, Extremobiosphere Research Center(XBR) of the Japan Agency for Marine-Earth Science and Technology (JAMSTEC: Mr. Yasuhiro Kato, President) and his colleagues have been carrying out studies on deep water jellyfishes in collaboration with other Japaneseand overseas-based researchers (National Research Institute of Fisheries Research, Instituto de Ciencias del Mar, East Stroudsburg University, etc.).

Analysis of high-resolution video images and collected samples obtained through surveys in the sea off Japan revealed that rather than being a rare species as previously thought, large numbers of the red paper lantern jelly, Pandea rubra(*1), occur at depths between 500 and 1000m depth above the Japan Trench off the Sanriku Coast.

Pycnogonids or sea spiders (*2) had been known to inhabit the body surface of this jellyfish and the present research verified for the first time that Pandea rubra is also used as a habitat for amphipod crustaceans (*3) and other jellyfish also.

The polyp stage of Pandea rubra, from which the adult jellyfish are released, attaches to pelagic snails (Pteropoda) in a species-specific manner. Recent research has shown that the shells of pteropod snails dissolve in the low pH seawater that will accompany acidification of the ocean through global warming, much as coral skeletons of calcium carbonate will also dissolve. Extinction of these pteropod snails will lead to extinction of Pandea rubra and cause a chain reaction in the animals reported here to associate with this jellyfish, and the animals associated with them in turn.

This finding suggests that the number of species threatened by ocean acidification is beyond our present expectations, considering that these midwater creatures are strongly associated with each other. The effects of ocean acidification will not stop at the surface waters or with animals with calcium carbonate shells or skeletons but will spread from the surface to the depths of the oceans faster than was expected. Such verification of inter-species associations by in situ surveys is necessary for projecting how climate change will affect the marine ecosystem and the biodiversity of other marine organisms.

These results will appear in the "Journal of the Marine Biological Association of the United Kingdom" in the December, 2008 special issue devoted to hydrozoans and their jellyfish.

Title: The anthomedusan fauna of the Japan Trench: preliminary results from in situ surveys with manned and unmanned vehicles

Authors: Dhugal Lindsay, Francesc Pages, Jordi Corbera, Hiroshi Miyake, James C. Hunt, Tadafumi Ichikawa, Kyohei Segawa, and Hiroshi Yoshida

Background

Because of their fragile gelatinous bodies, it is difficult to collect jellyfish by nets, so that much about their life history and ecology remains unknown.

Many kinds of jellyfish have been observed in large numbers in deep-sea surveys in the ocean's midwater zone. This indicates that jellyfish may play a significant role in marine food webs, matter transfer and transformation. However, there were many question marks as to their distributions, numbers, habitats and relationships with other creatures.

Pandea rubra was described in 1913 and less than 20 animals had been reported previously in the literature, although they had been captured in several areas around the world. However, the survey data and observations were not enough to study their habitat distribution and ecology.

Species such as corals, calcareous algae and shellfish with calcareous shells or skeletons will be negatively impacted by the ocean acidification associated with CO2 accumulation in the atmosphere and it subsequent dissociation into carbonic acid as it is absorbed by seawater. It has been reported that the floating pteropod snails that inhabit waters near the ocean surface are in danger since their shells dissolve in acidic, low pH seawater. (reference: Press Release on September 27, 2005)

Methods and results

Analyses were carried out on ten years worth of in situ images, video images of collected specimens and direct observation of samples taken by the Remotely Operated Vehicle HYPER DOLPHIN, Manned Research Submersibles SHINKAI 2000 / SHINKAI 6500, visual plankton recorder (VPR) and a multi-sampling layer plankton net system equipped with high definition cameras.

Accumulated data and improved performance of cameras and image recording equipment made it possible to obtain a wide variety of data, including information on their delicate morphology, behavior, in situ associations between crustaceans and this jellyfish species, and information on the polyps of this jellyfish on the shells of pteropod snails.

Close interdependence of creatures and use of jellyfishes as attachment substrates for rearing young in the deep sea environment as was observed during this study is significant as a survival strategy and for maintenance of biodiversity in the deep ocean ocean. Extinction of one species can lead to the extinction of other dependent species, and consequences or other species as part of a chain reaction or detrimental cascade. At present, obvious impacts of ocean acidification on midwater organisms have yet to be verified, but this study indicates that once acidification becomes prominent, not only surface-dwelling calcareous shelled creatures but also a number of other species will suffer due to a chain reaction effect.

Future prospects

Recent research has suggested that the impact of climate change on marine organisms will become more pronounced. Accurate evaluation of this impact requires verification by in situ surveys as well as model projections. Many

marine organisms have different forms and habitats in their larval stage and adult stages. The present results which provides a concrete example of a probable detrimental chain reaction would never have been attained if surveys were only conducted for adult forms.

There are so many organisms, including jellyfish, in the midwater zone of the ocean, many of which are still undescribed. By improving survey vehicles, development of new vehicles such as the PICASSO system, and development of in situ observation devices such as the VPR, further investigations and observations are expected to shed further light on the diversity of marine organisms and impacts on them associated with climate change.

It is expected that continued collection of data to clarify the diversity of marine organisms and verify the assessment of impacts associated with climate change will contribute to more reliable predictions of marine ecosystem changes.

*1 Pandea rubra

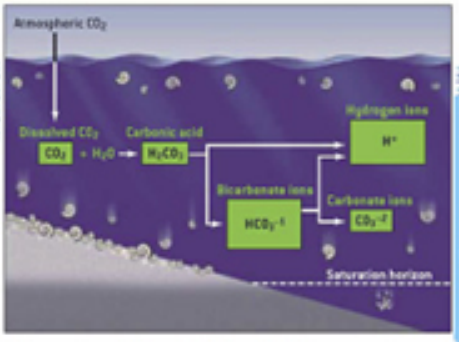
A kind of Hydromedusae, the polyp stage of which attaches to the winged pteropod snail Clio recurva in a species-specific manner. Its umbrella is bell-shaped and tall, maximum umbrella height is 17cm. 14 ~ 30 tentacles are very long, about 6 times as long as its umbrella height. It usually appears at depths of 450 ~900 m and has been reported throughout the world’s oceans, including the Antarctic , but there is as yet no evidence of its existence in the Arctic Ocean.

*2 Pycnogonids

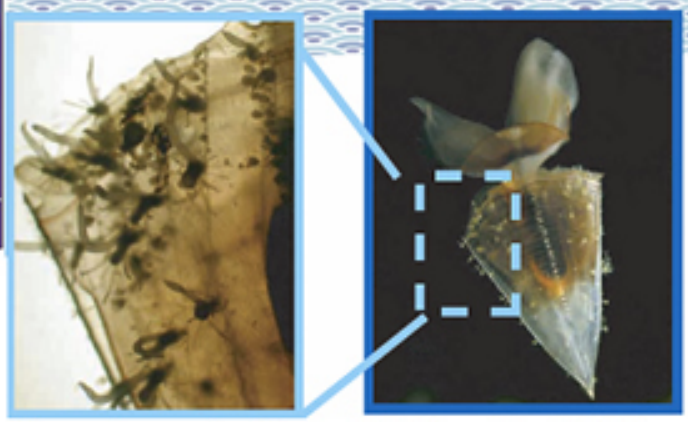
Sea spiders. Arthropods belonging to the Chelicerata, which includes animals such as horseshoe crabs and spiders. They have 4 pairs of thin, long legs with claws and their digestive tracts extend into their legs. They are known to stick their proboscis into Mollusks or Cnidaria and absorb their body fluids. Currently 1300 species of pycnogonid are known to Science.

*3 Amphipods

Arthropods belonging to the Paracarida, which includes Mysid shrimps. A big group having more than 10,000 species and distributed all over the world from tropical to polar regions.



Seawater is mildly alkaline at present. Increase of CO2 concentration in the atmosphere will increase the amount of CO2 dissolved in the ocean and acidifies seawater by the balance of carbonic acid – bicarbonic aced – hydrogen ion.

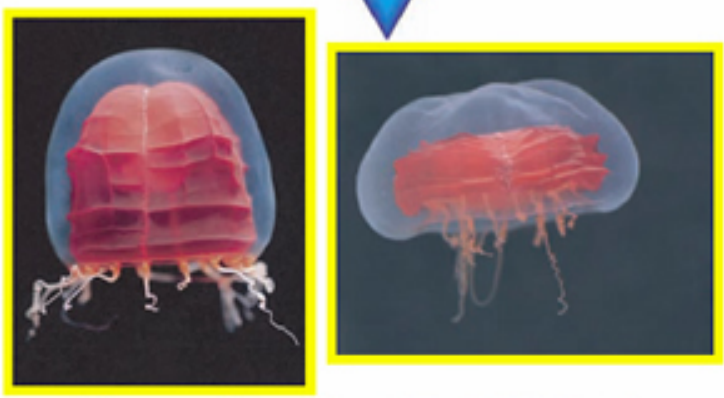


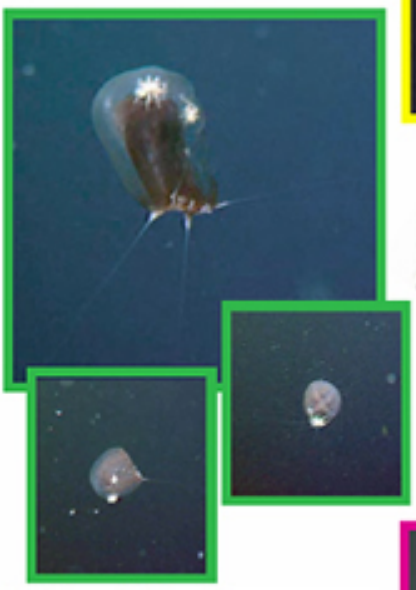
Pteropods are planktonic shellfish contained within an airplane-shaped shell made of calcium carbonate. Pandea rubra's polyp attaches to the shell of this species.

Deeper than 500m

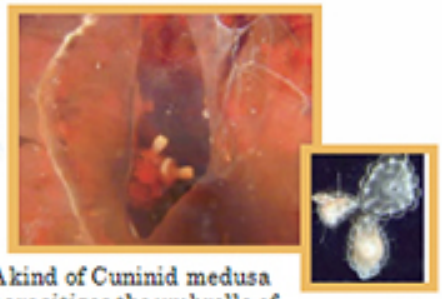
Adult Pandea rubra move to deeper water.

Like a paper lantern it can stretch and contract its body.





Only through in situ observations was it possible to identify pycnogonids in association with Pandea rubra(white color).



A kind of Cuninid medusa parasitizes the umbrella of Pandea rubra to grow its larvae into adults.

In situ observation image of Pandea rubra with amphipod attached. An amphipod.

In situ observation image of amphipod parasitizing the Cuninid medusa Solmissus incisa.

[PDF:902KB]

Contacts:
(For the study)
Dhugal Lindsay, e-mail: dhugal@jamstec.go.jp

Research Scientist
Marine Biology and Ecology Research Program,
Extremobiosphere Research Center(XBR)
Ken'ichi Takahashi,e-mail ; xbr@jamstec.go.jp
Manager, Research Promotion Office, XBR

(For publications)
Noriyuki Murata, e-mail: press@jamstec.go.jp
Manager, Planning Department Press Office