Aug 16, 2012
JAMSTEC

Unique ecology of a deep-sea amphipod from the world's deepest ocean area in the Marianas Trench and discovery of a novel cellulase

Senior Scientist Hideki Kobayashi and research team members from the Japan Agency for Marine-Earth Science and Technology (JAMSTEC: Asahiko Taira, President) Institute of Biogeosciences have been investigating the ecology of an amphipod (*Hirondellea gigas*) living in the Challenger Deep of the Marianas Trench (10,900 m depth).

The amphipod *Hirondellea gigas* is an amazing creature living in the deepest part of the Mariana Trench. The *H. gigas* thrives at low temperatures, extreme pressures, and very nutrient-poor environments at the bottom of deepest sea. The existence of the deepest sea lives was known from 1960s, however, their lifestyle as well as their foods was still unknown. What are they eating? We caught 185 amphipods using bait traps on the "ASHURA" (an 11,000-m class free-fall sediment sampler with a camera system), and analyzed the activities of digestive enzymes in *H. gigas*. As the result, we found that *H. gigas* survives, in part, by digesting plant materials that have sunk into the hadal sea. They accomplish this by producing enzymes of amylase, cellulase, mannanase, and xylanase (Fig. 1). The *H. gigas* contained much glucose, maltose, and cellobiose, which were products of their digestive enzymes in their body. We succeed in purifying *H. gigas* cellulase (HGcel) from 10 amphipods, and analyzed its enzymatic property. HGcel produced glucose and cellobiose from carboxymethyl cellulose at a molar ratio of 2:1 (Fig. 2). We found that HGcel can digest even sawdust, which is one of the possible substrates for bio-ethanol production. Furthermore, HGcel reacted on plain paper, and produced glucose at room temperature without water (Fig. 3). HGcel was a novel cellulase, and showed very different property from known cellulases of other organisms. This makes it an excellent candidate for industrial production of ethanol, an important biofuel.

The deepest sea was the extra high pressure, low temperature, and nutrient-poor environment, whose sediments contained organic carbon less than 6 ppm/g (dry-weight). *H. gigas* adapted to the deepest nutrient-poor environments by eating sunk plants. HGcel helps its getting nourishment by one-step production of glucose from cellulose.

Manuscript: The hadal amphipod *Hirondellea gigas* possessing a unique cellulase for digesting wooden debris buried in the deepest seafloor

Hideki Kobayashi[1], Yuji Hatada[1], Taishi Tsubouchi[1], Takahiko

Nagahama[1, 2] and Hideto Takami[1]
1. Institute of Biogeosciences, Japan Agency for Marine-Earth Science and Technology (JAMSTEC), 2-15 Natsushima, Yokosuka 237-0061, Japan;
2. Laboratory of Hygiene, Department of Food and Nutrition, Higashi-Chikushi Junior College, 5-1-1 Shimoitozu, Kokurakita-ku, Kitakyusyu, Fukuoka, 803-0846, Japan

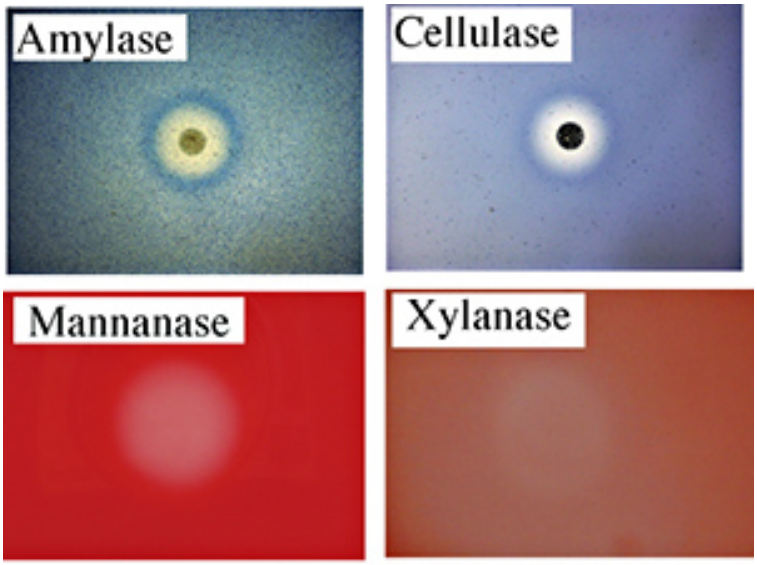

Figure 1 Digestive enzymes of *H. gigas*
Enzyme made halo on each substrate.

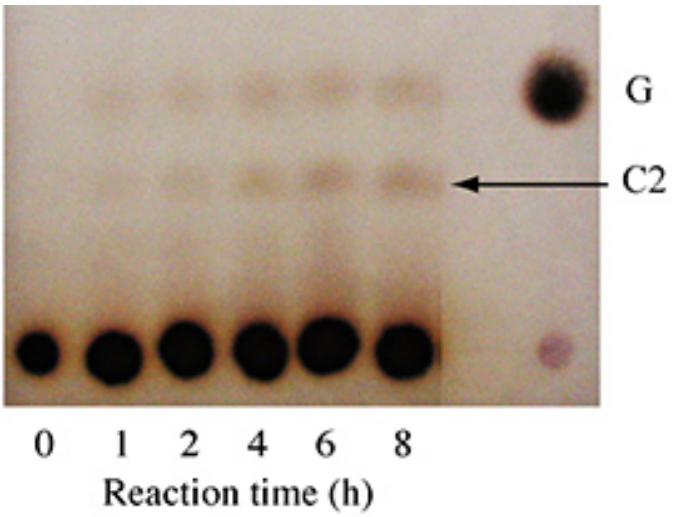

Figure 2 Products of cellulase reaction on CMC
Products were determined by TLC.
G: Glucose, C2: Cellobiose

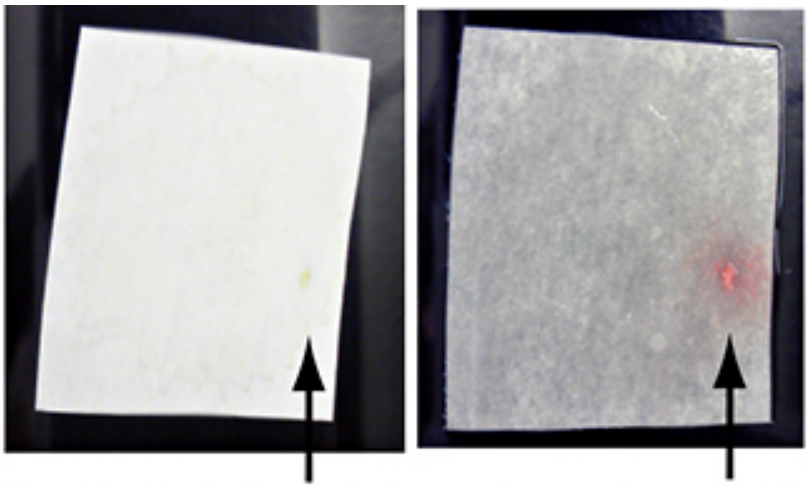

Figure 3 Production of glucose from a piece of plain paper by HGcel HGcel was spotted on a piece of plain paper (arrow indicated, left). Glucose was detected as pink colored spot by Glucose CII kit after 15 h incubation at room temperature (arrow indicated, right).

Contacts:
Japan Agency for Marine-Earth Science and Technology
(For the study)
Hideki Kobayashi,
Institute of Biogeosciences (BioGeos) Extremobiosphere Research Program
Environmental MetaGenome Research Team
E-mail: hidekik@jamstec.go.jp

PLoS ONE 7(8): e42727. doi:10.1371/journal.pone.0042727

(For publication)
Kazushige Kikuchi, Director
Planning Department, Press Office
Email: press@jamstec.go.jp