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CONVERSATION

In the field: an interview with Katsufumi Sato

Katsufumi Sato is a Professor at The University of Tokyo, Japan, where he investigates the behaviour of top marine predators. He completed his undergraduate degree in Fisheries, and his Master's degree and PhD at Kyoto University, Japan. After a postdoctoral fellowship at the National Institute of Polar Research, Japan, Sato was appointed as an Assistant Professor in the same institute, before moving to the Atmosphere and Ocean Research Institute at the University of Tokyo, Japan, in 2004. Sato was awarded a National Geographic Emerging Explorer grant in 2009 and promoted to Professor in 2014. Telling us about his research experiences around Japan and in Antarctica, Sato describes how his data logging devices have led to collaborations with scientists across the globe.

Which animals most fascinated you as a child?

When I was 10 years old, I went fishing for the first time in a small river with my father in his home region, Niigata Prefecture in northern Japan. I caught a bigger fish than him and after that I was fascinated. That beginner's luck decided my future. I also kept freshwater fish as a hobby; I had many species and I enjoyed feeding them.

How did your first field trip come about?

At the end of my undergraduate degree, I went to Tokushima Prefecture to study loggerhead turtles. We captured two turtles when they landed on the beach to nest and we deployed devices on their carapaces to measure depth, water temperature, light intensity and whether they were in water or on land. We also deployed a temperature sensor in their stomachs. Usually, sea turtles nest three or four times every summer on the same beach, returning after about 2 weeks, but for some reason the tagged turtles did not come back. Then I changed my field site to Wakayama Prefecture during the first year of my Master's course and tagged two more turtles using the same strategy, but they did not come back either. However, in 1991 we developed a new method to attach the devices using epoxy glue and this time the turtles did return. Once the methodology was established, I collected a lot of data from the loggerheads and I received my PhD for my study of their body temperature regulation in May 1995.

How did you catch the turtles?

It was very easy. When they arrived at the nesting beach, they started digging a hole and then they started laying eggs. During this period they didn't move, so I measured the carapace length and deployed the external device. After a turtle had finished egg laying, four people held the animal and we placed a temperature logger in the turtle's stomach, attached to a thread, so that we could retrieve it when the turtle returned. Then we released the turtle. The most important moment of the project was when I recaptured the first individual that came back to the beach. We deployed devices on four animals during the second year of my Master's degree and they all returned. However, data loggers were not so reliable then. Sometimes they didn't work and we used microfilm to record the data, so it took 3 months to digitise the film and extract the temperature data to find out whether the data loggers had recorded anything.

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What logistical challenges did you have to overcome during your loggerhead study and what did you learn from the experience?

I discovered that communication is very important. Many tourists visit the nesting site, so we had to share the turtles with them. Sometimes we behaved as tour guides for the tourists, explaining the ecology of the turtles and answering their questions. However, some of the tourists were unhappy because we were catching the animals and deploying devices on them; they just wanted to enjoy turtle watching. So we surveyed the nesting beach and when we found a nesting turtle, we escorted tourists there, because they could not find nesting turtles at night.

What biological questions were you investigating?

Initially, I was interested in the turtles' foraging ecology. However, the adult females did not forage during the inter-nesting period. Then, we decided to understand how water temperature variation affects the body temperature of the turtles. In 1993, the summer was very cold and the nesting cycle was more than 20 days. We almost gave up trying to retrieve the devices, but finally, 20 or 21 days after leaving, the animals came back. We realised that the temperature experienced by the turtles affects the length of the inter-nesting period.

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Katsufmi Sato returning a green turtle to the Pacific Ocean in 2013. Photo credit Takuya Fukuoka.

How many animals have you worked with during your career?

I have dealt with 32 species, but in total I have published papers on 66 species, through comparative collaborations. In 1996, after I got my PhD, I went to Alfred Faure Station, the French sub-Antarctic station on Île de la Possession in the Crozet Islands, to deploy prototype accelerometers on the king penguins with Yvon Le Maho from CNRS Strasbourg. We travelled there on the *Marion Dufresne* research vessel, departing from Réunion Island in the Indian Ocean. It took about 1 week to reach the island, which is tiny. There are no trees and most of the beach was covered by king penguins. It was an amazing experience for me. I spent 2 months at the research station. It was a French Research Station, so the food was very nice and it was very comfortable. When we were working we spoke in English, but at the table during dinner and lunch, I used important French phrases that I had learned, such as, 'Please give me the wine!'.

How did you deploy the data loggers on the penguins and how did you retrieve them?

In the case of the penguins, we used waterproof tape to fix the data loggers on the back feathers of breeding adults, because they repeatedly return to the beach after foraging trips. Once we had deployed the device and released the penguin, it would depart for a foraging trip of between 5 days and 2 weeks. We put yellow marks on the chests of the birds fitted with data loggers, so it was easy to recognise them when they returned. But, the penguins would try to escape when we recaptured them, so we had to hold them by the chest and then catch the beak, because they tried to peck our eyes, which can be dangerous. After that it was easy to hold them because we placed a hood on the head, which calms them down. Then it takes about 10–20 min to deploy the data logger. It's easy to recapture animals in Antarctica, because there are no dangerous predators on the land or ice, so penguins and seals do not pay attention to land animals, including humans. But, in the case of fish, the successful deployment ratio is very different. For example, recently I tried to deploy a camera and behaviour recorder on marlin. When the fishermen caught a fish, we positioned the device on its beak with cable ties, but sometimes the device fell off. Year by year, we're improving the methodology, but we still haven't succeeded completely.

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How do you track the devices to retrieve them from the sea?

Each device is attached with a timer that triggers the cable ties to break 3 to 5 days after deployment. Then, the tag floats to the surface and we rely on satellite and VHF transmitters attached to the float to find it. Retrieving data loggers needs training and several of my graduate students now know how to find detached tags. The satellite transmitter shows each tag's live position through the internet. After that, we charter a boat and go to the location. When we get close to the tag, we use a VHF transmitter to find it, which is quite difficult. Before we used satellite transmitters, we sometimes climbed mountains to detect the VHF transmitters, because the detection range increases in high places. For example, one of the graduate students, Kagari Aoki, from Nobuyuki Miyazaki's lab at the University of Tokyo, had deployed a device on a sperm whale, but we couldn't detect the signal after the device detached, so she climbed Mount Fuji and used a small antenna to search for the signal. Tourists on the volcano asked what she was doing and she answered, 'I'm looking for a buoy from a sperm whale'. They thought she was crazy, so they ran away, but she finally detected the signal. When she knew the direction of the signal, she went to the port and asked some fishermen to take her in that direction. The boat took several hours, but finally, she retrieved the device. It's a great moment when you get the data logger back.

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How important is collaboration in your field work and how do you build successful collaborations?

Collaboration is very important, because Japan is far from Europe and the US and we have less communication with scientists in other countries. Therefore, we develop new devices and then build international collaborations with scientists who wish to use the equipment. We also participate in expeditions with scientists from other countries to improve our international communication. In the 1990s, Yasuhiko Naito – a pioneer of bio-logging – built a new acceleration logger and I published my first paper with the data in 2002 in JEB. Immediately, Paul Ponganis at Scripps Institution of Oceanography, USA, sent an email to me about collaborating; this is a typical pattern. That paper also led to collaborations with Patrick Miller at the University of St Andrews, UK. When I build a new device now, new collaborators contact me by email. After that, we discuss what projects we will focus on, how to implement the study and then go to the field together.

In 2020, you published a paper in JEB investigating the body temperature of whale sharks in the wild; how did you get involved in that experiment?

I am always in contact with people from aquaria, so one day my co-author Rui Matsumoto at Okinawa Churaumi Aquarium told me we had a chance to deploy a device on a whale shark because they

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were going to release the bigger individuals into the sea. The aquaria try to keep whale sharks as long as they can, but the size of the tank is a limiting factor, so they have to release the animals. According to some previous anecdotal information, whale sharks sometimes dive to depths greater than 1000 m. Itsumi Nakamura, the first author of the paper, from Nagasaki University, and I wondered how they control their body temperature in such cold conditions. Both of us realised that we had a great chance to study the body temperature of the largest fish when these whale sharks were released, so we did not hesitate to deploy devices to them.

How do you balance your fieldwork with other responsibilities?

That's a good question. I'd prefer to focus on fieldwork only, but now I spend 50–80% of my time working as a faculty member at the university, teaching or applying for funding, I am required to contribute by sending young scientists to field studies. I also have to leave my family for long periods. When I first visited Antarctica, I sent emails to my girlfriend, who is now my wife, and sometimes I named animals after her. That kind of personal effort is important and I still do it. Fortunately, my family like my job, so when I'm away, I send emails home with pictures from the field. When my children were young, 3 or 4 years old, they asked my wife several times each day, 'When will my father come back from fieldwork?', but now they are in high school, they ask, 'When will you go?'.

Tell us about your experiences of working in Antarctica

My first trip to Antarctica was to visit the French Antarctic station (Dumont d'Urville) in 1997/98. The next was to the Japanese Syowa Station. I left Japan in November 1998 and returned in March 2000. Syowa Station is one of the most isolated stations in the world, so I had to travel down on an icebreaker, which goes from Japan to Antarctica and back once each year. That time, I went to study Weddell seals, which appear around the station in the Austral spring, October/November. I had to stay over winter because I can only study the seals during their lactation period from October to early December, when they return to feed their pups. The icebreaker arrives at the station around Christmas, which is too late. The biggest problem is that there is nothing for us to do in Antarctica during the winter, there are no animals around the station, so it was very difficult to pass the time. But, it was only 2 or 3 months. After that, it was a very exciting once-in-a-lifetime opportunity. We had developed an animal-borne camera with an artificial flashlight. When the seal dived deeper than 100 m, the camera took still pictures every 30 s. We deployed the camera on several adult females, so we could easily find them when they returned to their pups.

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Are there any other applications for your field-based research?

Around 7 years ago, one of my graduate students, Yoshinari Yonehara, developed a new method to analyse GPS data from shearwaters and he succeeded in estimating the ocean wind speed and direction. We talked through this result with a meteorologist, Akira Yoshida from the Japan Agency for Marine-Earth Science and Technology (JAMSTEC), and he was very interested in our dataset. After that, we started collaborating and we realised that animal-based data can provide very important contributions to weather forecasts. Last year, I went to West Papua to study olive ridley turtles. We were interested in the ecology of these turtles, but there was an important by-product of that study. We deployed a satellite relay data logger on nesting females that migrated into the Arafura Sea and transmitted the routes and depth temperature profiles almost every day. I provided these data to Takeshi Doi, a meteorologist also at JAMSTEC, who uses a dynamical seasonal prediction model in a super computer to predict water temperatures a few months ahead. He assimilated the turtle-based depth–temperature profiles with their locations into the model and the new information improved his seasonal forecasts.

What is the worst experience that you have had in the field?

I have a field site on an isolated island off the Sanriku Coast in the north of Japan, where I study streaked shearwaters. Three years ago, a black bear started visiting the island to eat the birds. I was afraid that it might injure my graduate students. Fortunately, the bear seems to have stopped coming to the island now, but it was very dangerous then. I asked a bear specialist, Koji Yamazaki from Tokyo University of Agriculture, to deploy a GPS collar on the bear for monitoring. We also asked him how to protect ourselves and he said that we should make noise. Fortunately, we never saw the bear – only footprints and sea bird carcasses.

How has the COVID-19 pandemic affected your 2020 fieldwork plans?

It is a very big problem for us. Every year I send graduate students to our turtle and streaked shearwater field sites in northern Japan. Fortunately, there are fewer cases of COVID-19 in Japan than other countries, especially around my field site in the north of Japan, where no one has been infected. However, the local residents are very hesitant to co-operate with us this year. Usually, local fishermen help us by collecting turtles and taking us to the streaked shearwater site, but this year the Fishermen's Cooperative Association decided not to work with scientists from around Tokyo, because many people from there were infected by the virus. Nobody near our field site wants to be the first to be infected. That meant that we could not continue our streaked shearwater study this year, but we were able to continue the sea turtle study on the Sanriku coast.

Katsufumi Sato was interviewed by Kathryn Knight. The interview has been edited and condensed with the interviewee's approval.