

Diamondback squid and egg mass record in Vanuatu

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Diamondback squid (*Thysanoteuthis rhombus*) is relatively unknown in the tropical Pacific Islands region. An assessment of potential fishable stocks in the region has identified potential stocks of diamondback squid in New Caledonia, Cook Islands and recently in Fiji (Blanc and Ducrocq 2012; Sokimi 2013, 2014). One other method of indentifying potential stocks of diamondback squid is by tracing egg masses (Aiken et al. 2007) and sighting stranded or dead diamondback squid. A first catch of diamondback squid was made at Aneityum Island in southern Vanuatu and an egg mass was sighted at Efate in 2013 as part of the activities of the Japan International Cooperation Agency-funded “Grace of the Sea Project”. The findings could indicate the presence of a breeding population of diamondback squid in Vanuatu waters.

Diamondback squid fishing

The large oceanic diamondback squid (DBS), *Thysanoteuthis rhombus*, is a deep-sea resource that has yet to be exploited in the Pacific Islands region (Blanc and Ducrocq 2012). DBS is present in tropical and subtropical seas around the world. In Japan, occasional sightings of dead and stranded DBS have been recorded since before the 1960s, probably in connection with the seasonal migration of this species along the warm Tsushima Current in the Sea of Japan (Nishimura 1966). The commercial fishery for this species began in the early 1960s (Bower and Miyahara 2005). DBS annual catches in Japan increased from 339 tonnes (t) in 1989 to almost 6,000 t in 2001, averaging close to 4,900 t during the period 1998–2003 (Bower and Miyahara 2005). About 90% of DBS catches are made in the Sea of Japan and around Okinawa. In the Sea of Japan, annual catches ranged from 1,600–3,700 t during the period 1998–2003, while at Okinawa, annual catches increased from 15 t in 1989 to 2,300 t in 2003 (Bower and Miyahara 2005). These increases may have been related to an increase in biomass due to unusually warm temperatures in the Sea of Japan (Miyahara et al. 2006).

In the summer, DBS move to shallower waters along Japan’s western coast as they migrate north, following the Tsushima Current (Nishimura 1966). The real expansion of the fishery in Japan began with the introduction of an innovative fishing gear known as *taru-nagashi* (Fig. 1) (Bower and Miyahara 2005).

DBS fishery development in other parts of the world has been slow for two reasons: the lack of proper gear and the abundance of other resources to be exploited (e.g. the Canary Islands; Perez et al. 2012). In the

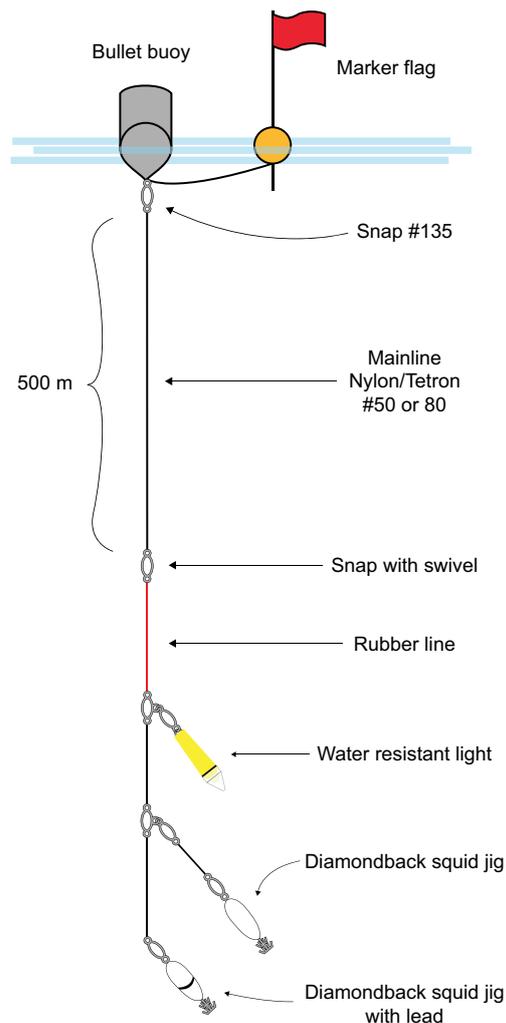


Figure 1. The taru-nagashi (free floating dropline) gear.

Caribbean Islands, potential fishing grounds were identified near Grenada and Tobago in 2001 but local fishers were more interested in catching tuna, which was abundant. In the Neves Islands, a small-scale DBS fishery and FAD fishery were developed in 2001 with the support of the Japan International Cooperation Agency, with catches sold to hotels (CRFM 2010). DBS meat in Japan is eaten raw as sashimi and sushi and can also be cooked in several ways.

Test fishing from relatively large (16–37 m) vessels in New Caledonia, Cook Islands and recently Fiji by the Secretariat of the Pacific Community has recorded the presence of DBS and neon flying squid resources (Blanc and Ducrocq 2012; Sokimi 2013, 2014), and more tests are planned for other Pacific Island countries and territories. But test fishing using vessels of these sizes is an expensive exercise. Another way of identifying the presence of DBS stocks is to interview local fishers about possible sightings of egg mass (showing them pictures of DBS egg masses) or dead DBS. The method based on local knowledge about egg masses is known as “the egg trace method”. Use of this method in Jamaica led to the location of a DBS fishing ground, which was confirmed by successful test fishing (Aiken et al. 2007). Test fishing can be done from small artisanal fishing craft, which means that it can be done in any Pacific Island country or territory where egg masses or dead DBS are sighted. Here, we report on the first recorded catch of diamondback squid from small boats in Vanuatu, as well as the sighting of an egg mass.

Biology and vertical distribution of DBS

The vertical distribution of DBS varies. During the day it stays deep (at around 400–650 m) but moves to shallower waters (50–100 m) to feed at night, and can be found in depths of 100 m off of islands and down to 500 m in open ocean (Miyahara et al. 2006). DBS grow to a maximum of 100 cm in mantle length and up to 20 kg in total weight. Sexual maturity for both males and females is reached at around six to eight months, and their life span is approximately one year (Guerra et al. 2002; Nigmatullin et al. 1995;).

Sexually mature DBS move to shallow waters to breed (Miyahara et al. 2006; Yano et al 2000). Mating and spawning season in the Northern Hemisphere occurs from November to May and female squid move to shallow waters to lay eggs. DBS egg masses (see Fig. 6): are cylindrical in shape; large, gelatinous and planktonic; vary in length from 0.6–1.8 m and their diameter from 110–300 mm (Nigmatullin et al 1995); changes colour, going from redish-pink before hatching to white after hatching (Perez et al. 2012). Each egg mass contain between 35,000 and 75,000 eggs that

are arranged in two rows of spirals over a sausage-shaped gelatinous structure that can be close to two meters in length (Nigmatullin et al 1995).

The redish-pink colour indicates an advanced embryonic stage before hatching; after hatching, the egg mass turns white, indicating the remains of egg shells (Perez et al 2012). Sightings and recordings of DBS egg masses are uncommon worldwide, with only 29 records in total from the Atlantic, Mediterranean and Pacific (Perez et al. 2012). Sightings of DBS egg masses in the Pacific have been recorded in five sites around Japan (Miyahara et al. 2006) and in several sites in Indonesia (Billings et al 2000).

DBS is known to spawn in waters associated with strong currents and throughout the year in tropical regions, and during the warm season in temperate regions (Nigmatullin et al. 1995). The high capture of DBS in shallow waters has been linked to strandings during migration (Nishimura 1966), but it could also be linked to spawning aggregation events. Another indication of the presence of DBS is from sightings of dead DBS in coastal waters due to stranding or natural mortality. But, sightings of dead carcasses of DBS in the Pacific Islands region are rare.

Trial fishing for DBS

In November 2013, trial fishing for DBS was conducted in Aneityum Island as part of the coastal fisheries diversification activity of the “Grace of the Sea project, Phase II”, which was funded by the Japan International Cooperation Agency. The Japanese free-floating dropline gear *taru-nagashi* — a 500-m-long line with two large squid jigs attached at the bottom end and a pressure float with a flagpole at the top end (Fig. 1) — was used for the trial fishing. Squid are attracted to the gear by a pressure-resistant light snapped onto the mainline and above the squid jigs (Perez et al 2012). Fishing technology training for local fishers was led by fishing technology expert Motoki Fujii and local counterpart George Amos.

The gear was deployed during daytime from 7-m-long fibreglass skiffs, 9 miles southwest of Anelcouhat, Aneityum in the vicinity of the offshore FAD, which is moored in 1,000 m of water (20°18.918' S and 169°37.471' E). The weather during the fishing trial was fine, with gentle southeast winds and a moderate westerly current. The gear was hauled an hour after setting the gear, when the pressure float movement signalled a catch. The first DBS caught weighed 15 kg, had a total length of 146 cm, and a mantle that was 80 cm long by 66 cm wide (Fig. 2). The specimen was a fully mature male, identified by its fully developed gonad of 15 cm in diameter and 100 g in weight.



Figure 2. First diamondback squid catch at Aneityum Island, Vanuatu.

Preparation and tasting

In Japan, the meat of DBS is more valuable than that of other deep-sea squids. It is mostly consumed raw as sashimi and sushi rolls. In the Pacific Islands, it is a new food resource that is little known (Sokimi 2013). In

Aneityum, Motoki Fujii showed fishers how to gut DBS, identify the sex by the presence the gonads, peel off the outer skin layer and cut the meat into steak size pieces (Fig. 3). Steak pieces were wrapped in plastic for freezing and prepared into sashimi for tasting. Over 95% of the squid is edible, including the skin; the only parts that are thrown away are the teeth, intestinal waste, and a set of fin cartilages. Samples of the meat were brought to Port Vila for more tasting. It was a positive exercise, and people immediately appreciated the taste as sashimi. It was considered far tastier and softer than the meat of the familiar common octopus (*Octopus cyanea*).

Sighting of DBS egg mass

On 5 December 2013, one month after the squid fishing trial, an egg mass was discovered floating in shallow (~ 2 m) water near Havannah Resort at Havannah Harbour, at west Efate by Takuma Takayama. Photos of the egg mass were confirmed by Dr Kazutaka Miyahara, one of the leading Japanese experts on DBS. The colour of the egg mass was between red and pink (Fig. 4), indicating that the eggs were yet to hatch, a characteristic



Figure 3. a and b) Squid fishing expert Motoki Fujii showed community members how to prepare the diamondback squid mantle for local distribution; c) plastic-wrapped pieces; and d) immediate sashimi testing.

already recorded in the Canary Islands (Perez et al 2012). A search on the web allowed finding a similar picture of an egg mass sighting by an unnamed snorkeler in shallow waters of Madang in Papua New Guinea, in 2008 (Fig. 5). These are the only reported egg mass sightings in the Pacific Islands region. Because DBS is fairly unknown in the region, people will unlikely not know what an egg mass is if sighted. Dead DBS carcasses are commonly seen where DBS populations are present and have been used as an indication of existing stocks. However, sightings of dead carcasses are rarely recorded in the Pacific Islands region. Once such sighting of a DBS carcass was reported at Emae Island in central Vanuatu in 2013 (Moses Amos, Director of Fisheries, Aquaculture and Marine Ecosystems at the Secretariat of the Pacific Community, pers. comm.), pointing to another potential fishing ground.

Conclusion

Diamondback squid (*Thysanoteuthis rhombus*) has been fished for the first time in Vanuatu waters and could be a source for a potential new fishery. The sighting of an egg mass at Efate and of a dead carcass at Emae Island are an indication of the presence of DBS, and further test fishing could be done to locate new fishing grounds. Raising awareness about DBS, using photographs of adult DBS and egg masses, is needed to increase chances of locating other potential fishing grounds. Fishing trials indicate that small artisanal boats can be used to catch DBS and the Japanese free-floating dropline *taru-nagashi* could be the gear of choice for small-scale DBS fishing in the Pacific Islands. The fishing trial confirmed the successful results of similar experiments done in the Caribbean Islands (CRFM 2010). Further test fishing, following the “egg trace method”, or dead carcass sightings are recommended to locate potential fishing grounds.

Acknowledgements

We thank the Japan International Cooperation Agency “Grace of the Sea project, Phase I and Phase II”, and the Vanuatu Fisheries Department for funding support for this project. We thank William Naviti, Director of Vanuatu Fisheries, and Moses Amos (former Director of Vanuatu Fisheries) for their overall support of the project, and thank other officers who have contributed to the project’s implementation. We thank other experts of the Grace of the Sea Phase II for their technical support in the project’s design, and for providing technical assistance to the implementation phase. We also thank the chiefs, Aneityum Fishers Association, the various fisheries committees, the Aneityum Tourism Committee, and the people of Anelcouhat village on Aneityum for their support. Lastly, we thank the European Union-funded SciCOFish project for reviewing and supporting the production of this article.



Figure 4. First sighting of a diamondback squid egg mass at Havannah Harbour on Efate, Vanuatu (image: T. Takayama).



Figure 5. A diamondback squid egg mass at Madang in Papua New Guinea (source: <https://morealtitude.wordpress.com/2008/10/13/>, downloaded on Thursday 17 July 2014).

References

- Aiken K., Kumagai N., Yasuda T. and Jones I. 2007. The egg trace method of identifying diamondback squid fishing grounds in Jamaican waters. p. 267–272. In: Proceedings of the 59th Annual Meeting of the Gulf and Caribbean Fisheries Institute.
- Billings V.C., Sullivan M. and Vine H. 2000. Sighting of *Thysanoteuthis rhombus* egg mass in Indonesian waters and observations of embryonic development. Journal of the Marine Biological Association of the United Kingdom 80:1139–1140.
- Blanc M. and Ducrocq M. 2012. Exploratory squid fishing in New Caledonia: Nothing rough about these diamonds! SPC Fisheries Newsletter 138:2–3

- Bower J.R. and Miyahara K. 2005 The diamond squid (*Thysanoteuthis rhombus*): A review of the fishery and recent research in Japan. Fisheries Research 73: 1–11. DOI: 10.1016/j.fishres.2005.01.020ç
- CRFM (Caribbean Regional Fisheries Mechanism). 2010. Priliminary master plan. Study on formulation of master plan on sustainable use of fisheries Resources for coastal community development in the Caribbean. Japan International Cooperation Agency, CRFM and IC Net Ltd
- Guerra Á., González A.F., Rocha F.J., Sagarminaga R. and Cañadas A. 2002. Planktonic egg masses of the diamond-shaped squid *Thysanoteuthis rhombus* in the eastern Atlantic and the Mediterranean. Journal of Plankton Research 4: 333–338. DOI: 10.1093/plankt/24.4.333Perez et al 2012
- Miyahara K., Fukui K., Nagahama T. and Ohatani T. 2006. First record of planktonic egg masses of the diamond squid, *Thysanoteuthis rhombus* Troschel, in the Sea of Japan. Plankton and Benthos research Journal 1:59–63.
- Nigmatullin M.C., Arkhipkin A.I. and Sabirov M.R. 1995. Age, growth and reproductive biology of diamond-shaped squid *Thysanoteuthis rhombus* (Oegopsida: Thysanoteuthidae). Marine Ecology Progress Series 124:73–87.
- Nishimura S. 1966. Notes on the occurrences and biology of the oceanic squid *Thysanoteuthis rhombeus* Troschel in Japan. Publications from the Seto Marine Biological Laboratory 14:327–349.
- Pérez A. E., Elena R. R., González Á.F.G. and Sierra Á.G. 2012. On the occurrence of egg masses of the diamond-shaped squid *Thysanoteuthis rhombus* Troschel, 1857 in the subtropical eastern Atlantic (Canary Islands). A potential commercial species. ZooKeys 222:69–76.
- Sokimi W. 2013. Giant squid trials in the Cook Islands. SPC Fisheries Newsletter 141:9.
- Sokimi W. 2014. Successful diamondback squid fishing trials in Fiji. SPC Fisheries Newsletter 144:14–16.
- Yano K., Ochi Y., Shimizu H. and Kosuge T. 2000. Diurnal swimming patterns of the diamondback squid as observed by ultrasonic telemetry. p. 108–116. In: Elier J.H., Alcorn D.J. and Neuman M.E. (eds). Proceedings of the 15th International Symposium on Biotelemetry, Wageningen, The Netherlands.