First spawning observations in sandfish farmed in sea pens, and evidence of wild juveniles growing

Loïc Gaumez[1]* and Igor Eeckhaut[1,2,3]

Introduction

Numerous observations of *Holothuria s*cabra spawning in the wild have been made throughout the distribution area of this species (Conand 1993; Mercier et al. 2000; Rahantoknam 2017; Lee et al. 2018; Shelley 1981; James and James 1993; Hamel et al. submitted for review). Observations of natural spawning in farmed sea pens, however, has not yet been reported in the literature.

We report here, for the first time, on the natural spawning of sandfish in farmed sea pens and give evidence that the larvae settled and grew in the sea pens. This occurred in farmed sea pens of Indian Ocean Trepang (IOT), a company in southwestern Madagascar that specialises in the aquaculture of *Holothuria scabra* (Eeckhaut et al. 2008; Eeckhaut 2021). IOT carries out the entire rearing cycle and utilises two grow-out models: the "company farm" model where salaried workers take care of the fattening of sea cucumbers in sea pens, and the "village farming" model where villagers take care of the fattening and are paid according to the total weight of sea cucumbers produced at the end of the rearing process (Eeckhaut 2021).

Observations of Holothuria scabra *spawning*

Spawning of *H. scabra* was observed during a monthly observation of stock in the IOT rearing pens. The sea ranching site is located south of Tulear lagoon (23°29'S and 43°45'E) in southwestern Madagascar in an area protected by the Great Reef of Tulear. The spawning observation was made on 25 March 2020. The tide had a coefficient of 86 and the high tide was at 18:23.

Spawning was observed in a single pen that was 10 ha in size. Individuals in that sea pen were five months old when they were transferred from the nursery on 12 December 2019. They spawned at around 9.5 months after their birth (fertilisation time). The average weight of the animals in mid-February 2020 was 263.85 g. The water temperature on 25 March 2020 was 26°C. We observed the spawning of about 50 individuals in an estimated area of 100 m^2 about one hour before high tide. Figure 1 shows one individual in breeding position, and three individuals that are not spawning. In the 100 m^2 area, there were either isolated individuals in the spawning position, or several gregarious individuals were close together (less than 1 m^2 apart). Aggregation prior to spawning has been reported from Solomon Islands, where spawning is correlated with the lunar cycle (Hamel et al. submitted; Mercier et al. 2000). The aggregation behaviour of *H. scabra* suggests that chemical communication may occur during period. Their position, with the anterior end bent upright, allows them to expel their gametes over the leaves of the phanerogams (seed-producing plants) that cover the floor of the sea pens. This position favours the dispersal of gametes towards other partners and prevents gametes from falling on the sediments (Hartley et al. 2020). Contrary to the observations of Moosleitner (2006) and Hartley et al. (2020), there were no fish in the spawning area.

In nature, *H. scabra* exhibits two main reproductive patterns: seasonally predictable spawning at high latitudes, and aseasonal spawning at low latitudes (Hamel et al. submitted). In Tulear, an annual reproduction cycle occurs, with most individuals becoming fully mature between November and April. Spawning is thus considered to occur in this period, between November and April (Rasolofonirina et al. 2005). Observations regarding the influence of the moon on the spawning period of *H. scabra* vary significantly from author to author (see Hamel et al submitted). Spawning, when forced, can be obtained at any time of the lunar cycle (see Hamel et al submitted, Lin and Nan in this issue). Here, spawning was observed one day after the new moon.

Observations of natural juveniles in farmed sea pens

Part of IOT sea ranching is done by village farmers. In southern Tulear Bay, there is one village enclosure site where 40 farmers work. The farmers started finding juveniles of *H. scabra* around 100 g or less in their sea pens in July 2020. These juveniles obviously come from natural reproduction because no juveniles of this size were introduced into those sea pens since the seeding in December 2019. In order to avoid disrupting the monitoring of production in sea pens, IOT decided to create a special enclosure dedicated to these juveniles and to carry out a monthly count of these juveniles.

In total, 1717 juveniles were collected in the farmed sea pens by village farmers. The smallest harvest was in August with 205 individuals and the largest harvest was in September with 848 individuals. Figure 2 shows the monthly number of juveniles that were <100 g and harvested by village farmers. Since the end of the 20th century, natural stocks of *H.*

[1] Madagascar Holothurie (R&D of Indian Ocean Trepang), Toliara, Route du Port Mahavatse II, PO Box 141, 601 Toliara, Madagascar
[2] Biology of Marine Organisms and Biomimetics, Research Institute for Biosciences, University of Mons – UMons, Place du Parc, 6, 7000, Mons, Belgium. Email: igor.eeckhaut@umons.ac.be
[3] Marine Station of Belaza, Institut Halieutique et des Sciences Marines (IH.SM), University of Toliara, 601 Toliara, Madagascar
* Author for correspondence: loic.gaumez@iotrepang.com

Figure 1. Spawning *Holothuria scabra*.

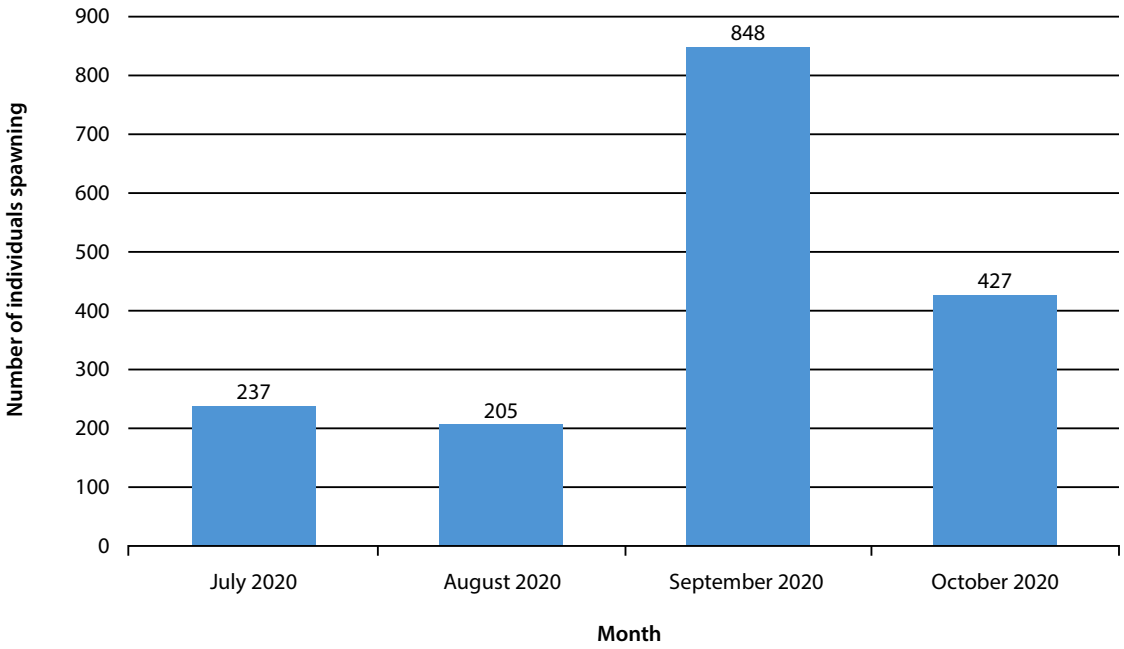

Figure 2. Number of *Holothuria scabra* individuals of 100 g or less sampled in farmed sea pens in Tulear lagoon from July to October 2020.

scabra have been drastically reduced in Madagascar (Conand and Byrne 1993) to the point that none can be found in Tulear lagoon. This allows us to correlate the observation of spawning in March 2020 with the fact that villagers found animals weighing around 100 g in the sea pens. With a modelled projection, a growth curve suggests that a weight of 100 g requires 100 days of growth for *H. scabra*, or about three months (see Hamel et al. submitted). In addition, in the present work, spawning was observed on 25 March and the juveniles that were observed between July and October would be between four to seven months old if they came from this spawning event.

References

Conand C. 1993. Reproductive biology of the holothurians from the major communities of the New Caledonian Lagoon. Marine Biology 116(3):439–450.

Conand C. and Byrne M. 1993. A review of recent developments in the world sea cucumber fisheries. Marine Fisheries Review 55(4):1–13.

Eeckhaut I. 2021. From fundamental to applied research: The history of the Indian Ocean Trepang company. SPC Beche-de-mer Information Bulletin 41:40–47. https://purl.org/spc/digilib/doc/zmk8h

Eeckhaut I., Lavitra T., Rasoforinina R., Rabenevanana M.W., Gildas P. and Jangoux M. 2008. Madagascar Holothurie SA: The first trade company based on sea cucumber aquaculture in Madagascar. SPC Beche-de-Mer Information Bulletin 28:22–23. https://purl.org/spc/digilib/doc/8crw5

Hamel J.F., Eeckhaut I., Conand C., Sun J., Caulier G. and Mercier A. (submitted). Global knowledge on the commercial sea cucumber *Holothuria scabra*. Advances in Marine Biology.

Hartley S.L., Purcell S.W. and Rowe F.W.E. 2020. Spawning of *Australostichopus mollis* at its northernmost subtropical locality. SPC Beche-de-mer Information Bulletin 40:56–58. https://purl.org/spc/digilib/doc/86sfd

James P.S.B.R. and James D.B. 1993. Ecology, breeding, seed production and prospects for farming of sea cucumbers from the seas around India. Fishing Chimes 13(3):24–34.

Lee S., Ford A., Mangubhai S., Wild C. and Ferse S. 2018. Length-weight relationship, movement rates, and in situ spawning observations of *Holothuria scabra* (sandfish) in Fiji. SPC Beche-de-Mer Information Bulletin 38:11–14. https://purl.org/spc/digilib/doc/zjivr

Lin T.H. and Nan F.H. 2022. First trials in inducing spawning and larviculture of *Holothuria scabra* in Palau. SPC Beche-de-mer Information Bulletin 42:58–64.

Mercier A., Battaglene S.C. and Hamel J.-F. 2000. Periodic movement, recruitment and size-related distribution of the sea cucumber *Holothuria scabra* in Solomon Islands. Hydrobiologia 440:81–100.

Moosleitner H. 2006. Observation of natural spawning of *Holothuria tubulosa*. SPC Beche-de-mer Information Bulletin 24:53. https://purl.org/spc/digilib/doc/q8sb4

Rahantoknam S.P.T. 2017. Maturity gonad sea cucumber *Holothuria scabra* under the month cycle. In: IOP Conference Series: Earth and Environmental Science Vol. 89. IOP Publishing, p. 012015.

Rasolofonirina R., Vaïtilingon D., Eeckhaut I. and Jangoux M. 2005. Reproductive cycle of edible echinoderms from the southwestern Indian Ocean. II The sandfish *Holothuria scabra* (Jaeger, 1833). Western Indian Ocean Journal of Marine Science 4:61–75.

Shelley C.C. 1981. Aspects of the distribution, reproduction, growth and fishery potential of holothurians (beche de mer) in the Papuan costal lagoon. University of Papua New Guinea (Papua New Guinea). Ocean and Coastal Management 51(8–9):589–593.