

Supplementary Material

Rapid physiological colouration change is a challenge - but not a hindrance - to successful photo identification of giant sunfish (*Mola alexandrini*, Molidae)

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1 Supplementary Tables

Supplementary Table 1 Photo Event metadata of re-sighted *Mola alexandrini* individuals in the Nusa Penida Marine Protected Area, Bali, Indonesia, logged with Match My Mola (MMM). See Figure 1 in the main text for dive site locations. Dates are given as dd/mm/yyyy.

Fish name and MMM Catalogue number	Photo Event number (fish side)	Photo Event date and dive site	Photographer	Photo Event submission and verification details	Date of earliest digital footprint of image(s) and/or video(s).
"Phili" MMM-0018	PhE-00131 (right)	28/04/2013, Buyuk	Anonymous guest at Lembongan Dive Center, Nusa Lembongan	Submitted and verified by Peter Bassett and Helen Mitchell from Aquatic Alliance (now part of the Marine Megafauna Foundation) who collected the image personally from the photographer. Metadata considered reliable as 1) both submitters are experienced in manta ray photo identification, cataloguing and verification of metadata, and 2) the date stamp of the original image file provided (29/04/2013) is largely* in accord with the stated sightings date.	Submitted to MMM on 20/08/2013
	PhE-01025 (right)	01/08/2020, Blue Corner	Keith Mesh, Guest at World Diving Lembongan, Nusa Lembongan	Mined from World Diving Lembongan Facebook page by MMM, verified by the photographer. Metadata considered reliable as the photographer reported that 1) the image was taken during an overseas trip described as "...we did arrive in Lembongan on 31 July 2020 for a few days diving...", 2) the image was posted on social media shortly after the purported sightings date, 3) the date stamp of the original image file (communicated to us by the photographer as 01/08/2020) is in accord with the stated sightings date and the timing of the photographer's overseas trip, and 4) the photographer is personally known to a close contact of ours, who facilitated the contact.	Posted on Facebook on 03/08/2020
"Tiga" MMM-0014	PhE-00456 (left)	03/09/2012, Crystal Bay	Tomoki Ueda, Papas Dive Center, Bali	Submitted and verified by the photographer. Metadata considered reliable as: 1) the photographer provided metadata as part of the original 2015 submission, then re-verified the data in 2022, and 2) the date stamp of the original image file provided by the photographer (03/09/2012) is in accord with the stated sightings date.	Submitted to MMM on 09/08/2015

	PhE-01074 (left)	Between 01/01/2018 and 24/03/2018**, Crystal Bay	Benny Gunawan, Bali Stingray Divers, Bali	Mined from Bali Stingray Diver Instagram by MMM, verified by the photographer. Metadata considered reliable as the photographer was asked “ <i>Are you 100% sure it is from 2018?</i> ” and answered “ <i>Yes, 100% sure</i> ”.	Posted on Instagram on 24/03/2018
“Concept” MMM-0022	PhE-00009 (left)	--/08/2013, Crystal Bay	Sabrina Si Sadi, Guest at Dive Concept Lembongan, Nusa Lembongan	Mined from Dive Concept Lembongan Facebook, verified by staff (Freddy Mira) at Dive Concept Lembongan, who partook in the dive. Metadata considered reliable based on extensive communication with the staff member who commented “ <i>...I remember this dive as it was my first mola...</i> ” and “ <i>...I’m sure that was in August as I left after the 31 of august...</i> ”.	Posted on Facebook on 01/09/2013
	PhE-00747 (left, right)	01/09/2013, Crystal Bay	Michael Shark	Mined from the photographer’s YouTube channel by MMM (YouTube profile is no longer available) and verified by the photographer. Metadata considered reliable as: 1) the video was uploaded to YouTube shortly after the stated sighting date, and 2) the same fish had been sighted in the area just prior (i.e., PhE-00009 – see above).	Uploaded to YouTube on 14/09/2013
	PhE-00801 (left, right)	13/07/2018, Crystal Bay	Niamh Lynch, Guest at Blue Corner Dive, Nusa Lembongan	Submitted and verified by the photographer. Metadata considered reliable as: 1) the images were submitted by the photographer shortly after the observation, 2) the photographer communicated extensively with us and provided additional files, and 3) the date stamp of the original file provided (13/07/2018) is in accord with the stated sightings date.	Submitted to MMM on 28/07/2018
“Fosforito” MMM-0007	PhE-00382 (right)	Between: --/06/2011, --/07/2011, Blue Corner	Guest at Lembongan Dive Adventure, Nusa Lembongan	Submitted and verified by staff member (Katya Belykh) from Lembongan Dive Adventure, who partook in the dive. Metadata is considered reliable as: 1) the submitter is personally known to us, and 2) the submitter remembered the dive vividly due to the unusually high number of molas seen (also evident on the submitted video).	Submitted to MMM on 10/07/2014
	PhE-00383 (right)	19/09/2014, Blue Corner	Jonathan Andersen,	Video taken by a volunteer during a research dive by the first author for other research purposes (Nyegaard, 2018).	Submitted to MMM on 19/09/2014

			Research volunteer	Metadata is considered reliable as 1) it was filed along with the imagery according to robust quality assurance and quality control protocols for the wider research project, and 2) it was lodged with MMM on the same day as the observation by the first author.	
“Melissa” MMM-0020	PhE-00010 (left)	24/07/2013, Sentel	Emmanuel Groult, Manager of Dive Concept Lembongan, Nusa Lembongan	Submitted and verified by the photographer. Metadata is considered reliable as: 1) the photographer is personally known to us and has been a regular contributor to MMM, and 2) the imagery was submitted shortly after the dive.	Submitted to MMM on 02/08/2013
	PhE-00636 (left)	29/03/2015, Blue Corner	Ben Coffey, Blue Corner Dive, Nusa Lembongan.	Submitted and verified by the photographer, also verified by the owner of Blue Corner Dive, Nusa Lembongan. Metadata considered reliable as: 1) the photographer and the dive operator owner are both personally known to us, 2) both have been regular contributors to MMM, and 3) the imagery was submitted shortly after the dive.	Submitted to MMM on 01/04/2015
“Jaho” MMM-0051	PhE-00283 (left)	24/09/2014, Crysal Bay	Choocart Treetavekul, Guest at Dune Bali Atlantis, Bali	Submitted and verified by staff (Camille Ménard) at Dune Bali Atlantis. Metadata considered reliable as: 1) the submitter is personally known to us and is a regular contributor to MMM, and 2) the files were provided personally to us shortly after the sightings date.	Submitted to MMM on 29/09/2014
	PhE-01264 (left)	24/09/2014, Crystal Bay	Guest from Big Fish Diving	Submitted and verified by a staff member (Lillian Ellevog) of Aquatic Alliance (now part of the Marine Megafauna Foundation). Metadata considered reliable as 1) the staff member is experienced in manta ray photo identification, cataloguing and metadata verification, and 2) the date stamp of original image file provided (24/09/2014) is in accordance with the stated sightings date.	Submitted to MMM on 14/10/2014
	PhE-00236 (left)	24/09/2014, Crystal Bay	David Abbott, Guest at Blue Corner Dive, Lembongan	Submitted and verified by the photographer. Metadata considered reliable as: 1) the photographer is personally known to us, 2) the photographer obtained the imagery during a trip to Nusa Lembongan where he joined the first author on a number of research dives, and 3) the lag time between the stated sighting date	Submitted to MMM on 04/11/2014

and the submission date was anticipated from personal communication with the photographer.

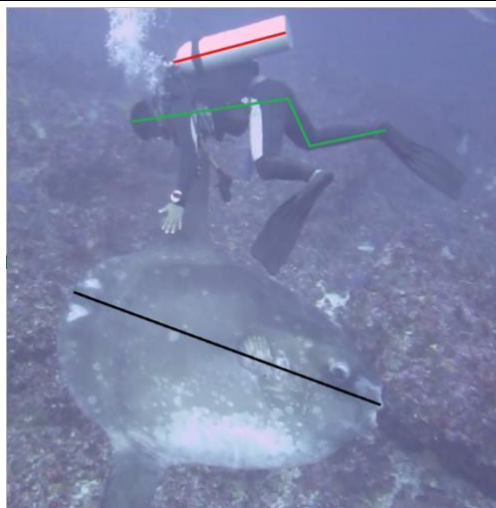
	PhE-00519 (left)	26/09/2015, Blue Corner	Researcher	Imagery was obtained during a research dive by the first author for other research purposes (Nyegaard, 2018). Metadata considered reliable as: 1) dive log and imagery were filed according to robust quality assurance and quality control protocols for the wider research project, 2) the Photo Event was lodged with MMM on the same day as the observation by the first author, and 3) the date stamp of original image file (26/09/2015) is in accordance with the recorded sightings date.	Submitted to MMM on 26/09/2015
"Issara" MMM-0043	PhE-00484 (left)	22/08/2015, Blue Corner	Researcher	Imagery was obtained during a research dive by the first author for other research purposes (Nyegaard, 2018). Metadata considered reliable as: 1) dive log and imagery were filed according to robust quality assurance and quality control protocols for the wider research project, 2) the Photo Event was lodged with MMM on the same day as the observation by the first author, and 3) the date stamp of original image file (22/08/2015) is in accordance with the recorded sightings date.	Submitted to MMM on 06/09/2015
	PhE-00650 (left)	12/09/2015, Crystal Bay	Lionel Issara, Guest at Dune Bali Atlantis, Bali	Mined from Dune Bali Atlantis' Facebook, verified by the photographer and a staff member (Camille Ménard) at Dune Bali Atlantis. Metadata considered reliable as: 1) the staff member is known to us personally and is a regular contributor to MMM, 2) the detail of the metadata provided upon request was highly detailed and indicative of robust record keeping, 3) the photographer confirmed that the image was posted on Facebook the same day as the sighting took place.	Posted on Facebook on 12/09/2015
"Johnaz" MMM-0067	PhE-00797 (right)	27/10/2018, Buyuk	John Erik Eidesgaard, PADI dive instructor	Submitted and verified by the photographer. Metadata considered reliable as the detail of the provided metadata suggests excellent record keeping.	Submitted to MMM on 22/11/2018

	PhE-00970 (right)	28/10/2018, Crystal Bay	Jason Fondis, Blue Corner Dive Penida, Nusa Penida	Submitted and verified by the photographer. Despite the long lag between sighting and submission (nearly two years) the metadata is considered reliable as 1) the submitter is a regular contributor to MMM, 2) the detail of the provided metadata suggests excellent record keeping, and 3) the date stamp of the original file provided (28/10/2018) is in accord with the stated sightings date.	Submitted to MMM on 28/07/2020
"Erin" MMM-0071	PhE-00830 (right)	29/08/2019, Crystal Bay	Christian Loader, Guest at Scuba Junkie Penida, Nusa Penida	Submitted and verified by staff (Danielle Drury) at Scuba Junkie Penida. Despite the long lag-time between the sighting and the submission (nearly two years) the metadata is considered reliable as the detail of the provided metadata suggests excellent record keeping.	Submitted to MMM on 07/08/2020
	PhE-00944 (right)	30/08/2019, Crystal Bay	Petter Thorden	Mined from Flickr by MMM, verified by the photographer. Metadata considered reliable as the Flickr profile and the photographer's response suggests excellent record keeping.	Uploaded to Flickr on 12/11/2020

*The file date differs from the stated observation date by ~1 day. This sometimes happens where travelers arrive from overseas with cameras set for local time zones (e.g., Europe, USA etc.).

**Photo Event date is early 2018, prior to the date of the Facebook post.

2 Supplementary Figures

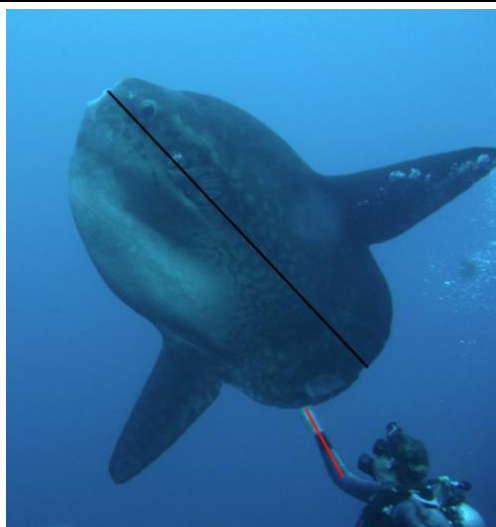


***Mola alexandrini*, c. 191 cm TL**
Nusa Penida, Bali (2011)

Molid size estimated relative to SCUBA tank:

Still image from video of a SCUBA diver touching the base of the dorsal fin of a *M. alexandrini*. The diver and fish are approximately in the same plane. The diver is wearing a Luxfer 11.1 80 cf cylinder (length: 66.2 cm, sans first stage). Using the tank as a relative measure, the total length of the molid is estimated at c. 191 cm (black line), and the height of the diver (green lines) c. 166 cm.

Image by guest at Lembongan Dive Adventure, printed with permission.



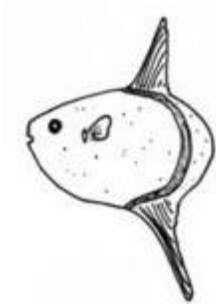
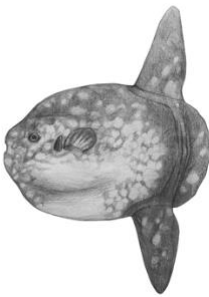
***Mola alexandrini*, c. 174 cm TL**
Nusa Penida, Bali (2015)

Molid size estimated relative to SCUBA diver's arm:

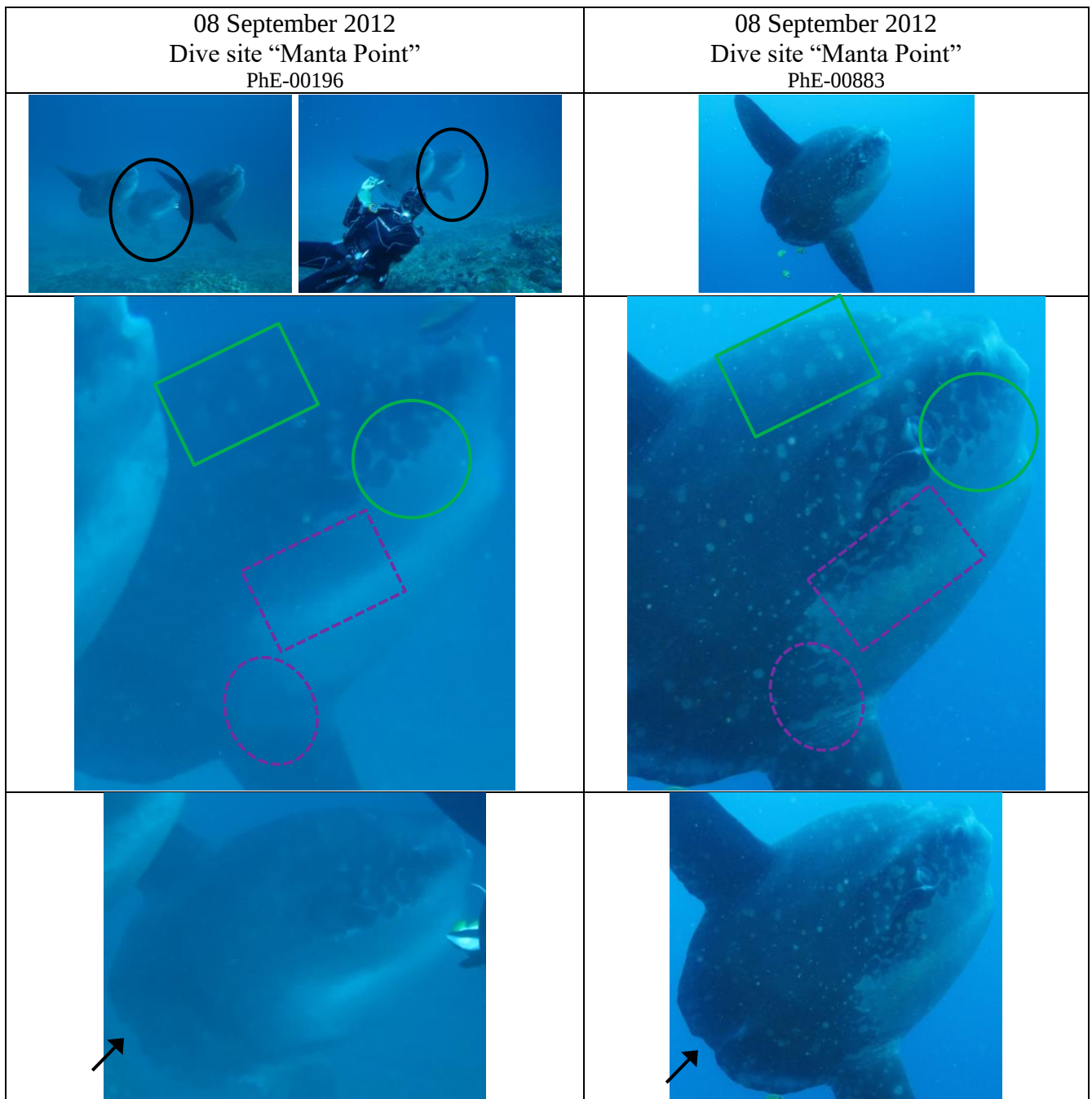
Photo of a research SCUBA diver collecting a skin sample from a *M. alexandrini*. The diver and fish are approximately in the same plane. The diver's lower arm is c. 35 cm long, including part of the hand (red line). Using the arm as a relative measure, the total length of the molid is estimated at c. 174 cm (black line).

Image by Jonathan Anderson, printed with permission.

Supplementary Figure 1 Size estimates of two *Mola alexandrini* individuals from the Bali area. Estimates are approximations as they are based on objects in the images that are not perfectly aligned in the same plane as the fish. All image lines were measured with ImageJ.

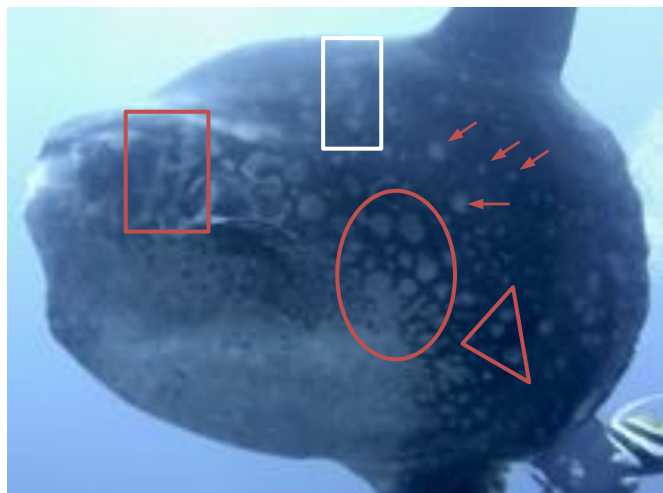
100 cm  Generalised body morphology based on the images to the right	92 cm Oman  OMMSFC 1085 in Sawai, (2016), drawing by Emma based on Jawad et al. (2012), from Nyegaard (2018)	116 cm Taiwan  Unpublished image and measurement by Ching-Tsun Chang	138 cm Australia  WAM P.33481-001 in Nyegaard & Sawai (2018). Image by Gilbert Stockman
200 cm  Generalised body morphology based on the images to the right	197 cm Australia  ‘Second animal’ in Vogelnest (2003). Unpublished image by Larry Vogelnest	200 cm Australia  QM I10163 in Sawai and Nyegaard (2022). Image by Jeff Johnson	210 cm Taiwan  Unpublished image and measurement by Ching-Tsun Chang
300 cm  Generalised body morphology based on the images to the right	c. 270 cm Australia  Unpublished image by George Appleby, measurement by Mark Rodrigue	300 cm Japan  OIMo-1 in Sawai et al., (2015). Image by Etsuro Sawai	310 cm Australia  M3 in Sawai and Nyegaard (2022). Unknown photographer

Supplementary Figure 2 Generalised body morphology (line drawings to the left) of giant sunfish (*Mola alexandrini*) of 100 cm (upper panel), 200 cm (middle panel) and 300 cm total length (lower panel). Drawings by Robin Ljungfeldt Bryhni. Images printed with permission or in accordance with the Australian Copyright Act 1968.

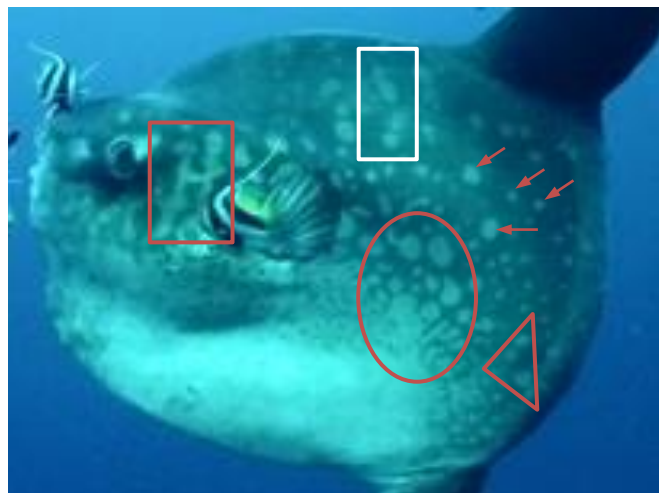


Supplementary Figure 3. Two Photo Events (PhE) of the same *Mola alexandrini* individual photographed on the same day at the same dive site by two different photographers, and submitted separately to Match My Mola. These two Photo Events were matched based on differing extents of body pattern: solid-line shape-pairs indicate areas of similar pattern extent, hashed-line shape-pairs indicate differing pattern extent. The match based on body patterns was verified from the indentation in the clavus edge (black arrows). Left panel images submitted by Paul Spratt on behalf of an anonymous guest at Lembongan Dive Center. Right panel images photographed and submitted by Jeffrey Low. Printed with permission.

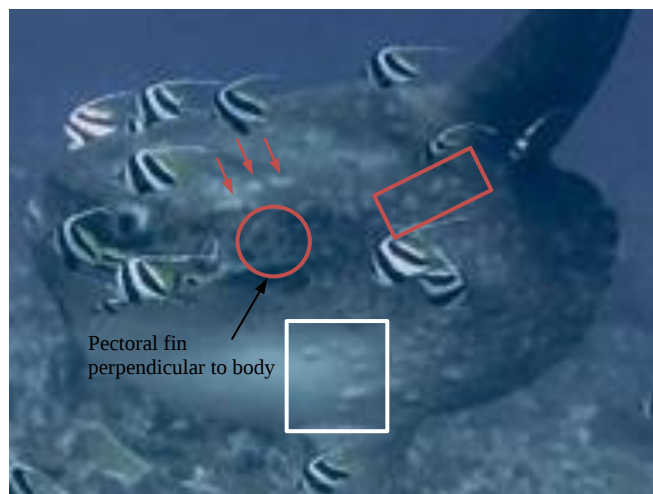
PhE-00283 (“Jaho”)



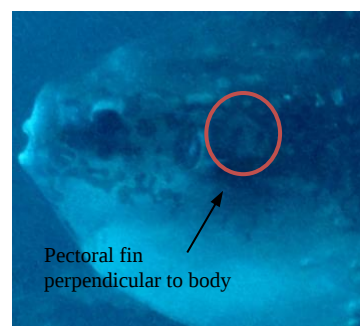
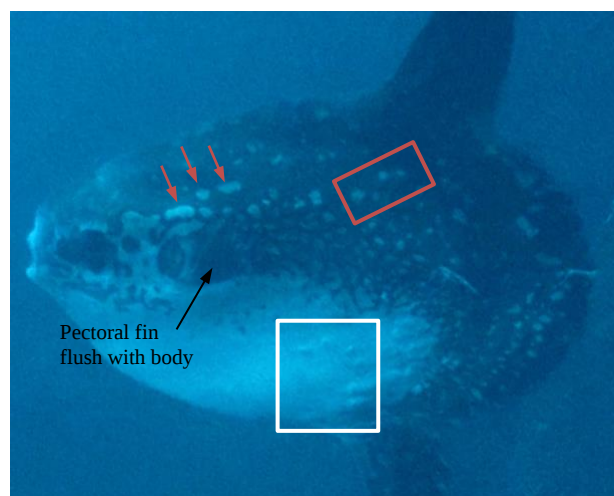
PhE-00519 (“Jaho”)



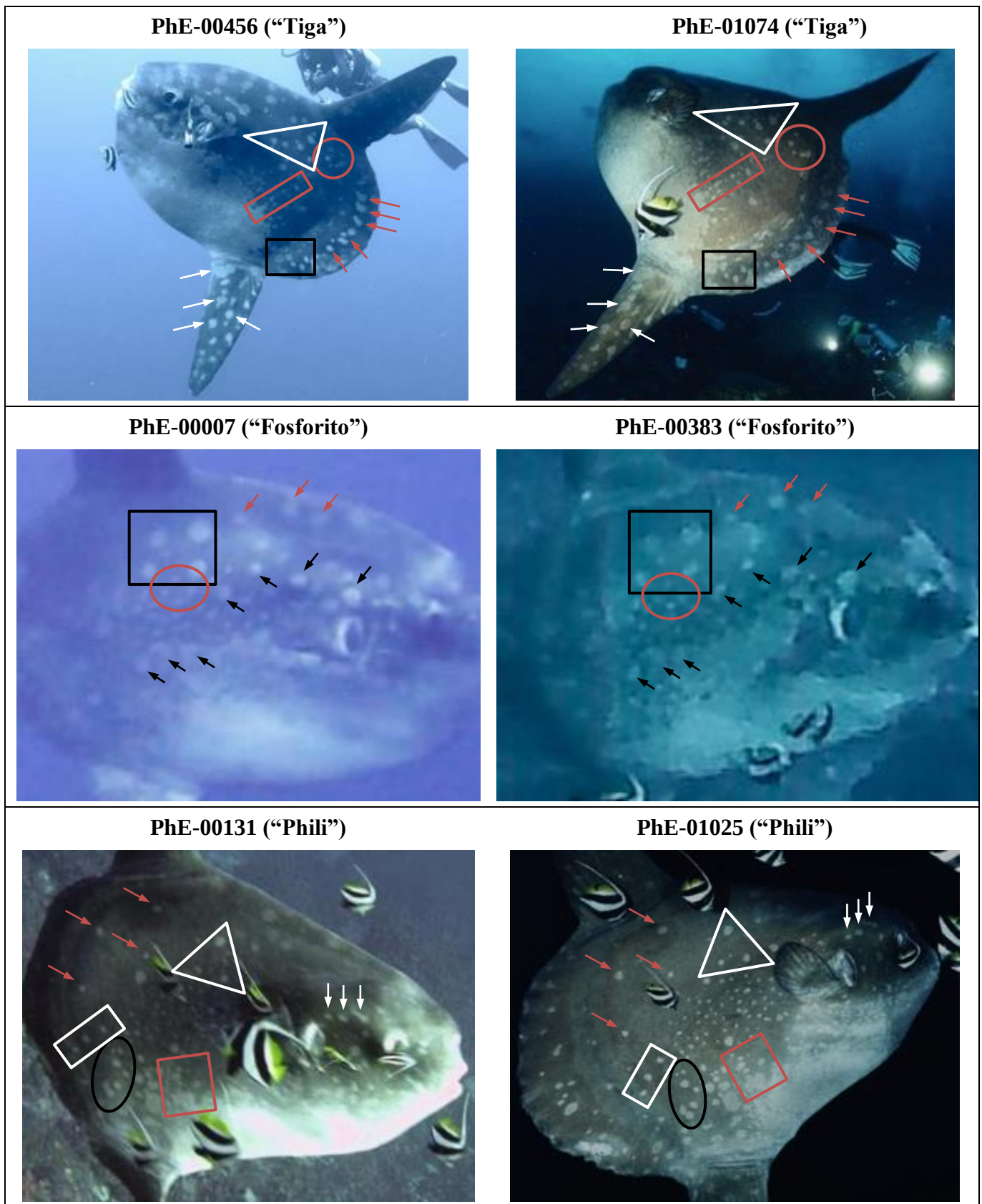
PhE-00020 (“Melissa”)



PhE-00636 (“Melissa”)



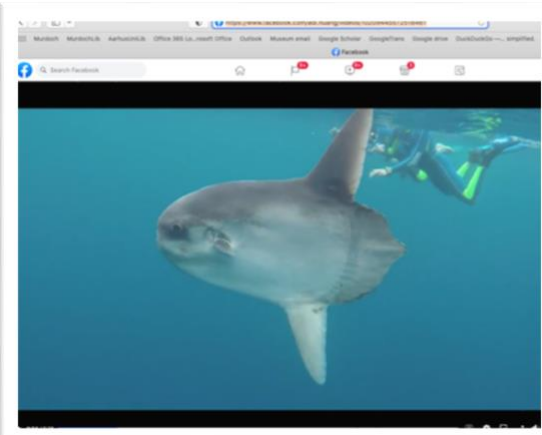
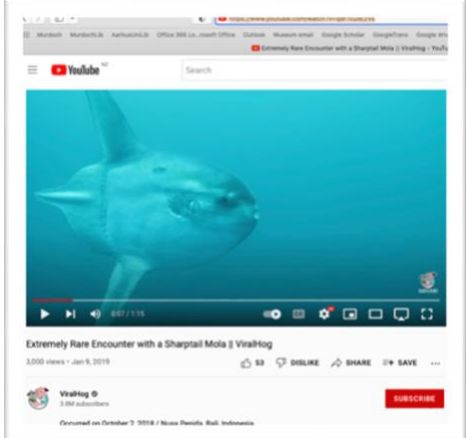
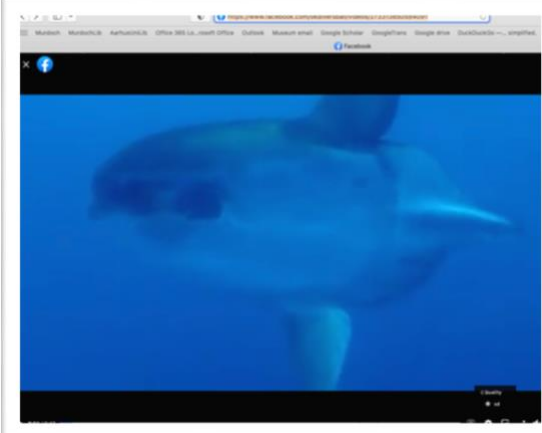
Supplementary Figure 4 Detailed comparison of *Mola alexandrini* individuals matched based on body patterns. PhE refers to Photo Event numbers in the Match My Mola database.



Supplementary Figure 5 Detailed comparison of individual *Mola alexandrini* matched based on body patterns. PhE refers to Photo Event numbers in the Match My Mola database.



Supplementary Figure 6 Morphology of the largest male *Mola alexandrini* known to us. Typical *Mola alexandrini* taxonomic traits (Sawai et al., 2018, 2020; Sawai, 2021) are apparent on the images: emerging chin bump (black solid arrow), emerging head bump (black hashed arrow), smooth body skin without raised, lateral skin wrinkles (white arrow), rounded clavus edge (black curved line), swollen dorso-lateral and ventro-lateral ridges (orange arrows). Unpublished images by Larry Vogelnest of the ‘second animal’ described in Vogelnest (2003) (197 cm TL, male). Stranded at Lady Robinson Beach in Botany Bay, New South Wales, Australia, on 18 September 2002. Images printed with permission.

	<i>Masturus lanceolatus</i>, 06 July 2017, Toyapakeh, Nusa Penida. Posted at: https://www.facebook.com/adi.huang/videos/10209445572518461 [accessed 01 March 2023] Metadata verified by Adi Huang
	<i>Masturus lanceolatus</i>, 31 October 2018, Nusa Penida. Posted at: https://www.youtube.com/watch?v=qdf7cuxEzVs [accessed 01 March 2023] Metadata verified by Stewart Childs.
	<i>Masuturs lanceolatus</i>, 03 October 2019, Padangbai, Bali. Posted at: https://www.facebook.com/okdiversbali/videos/273313850584091 (accessed 01 March 2023). Metadata verified by OK Divers.

Supplementary Figure 7 Sightings of sharptail sunfish (*Masturus lanceolatus*) off Bali, Indonesia, lodged with Match My Mola. Reprinted under YouTube fair use guidelines.

3 Bibliography

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