



The Red Sea's largest coastal lagoon is a reproductive site for endangered whiprays and guitarfish

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ABSTRACT: Safeguarding reproductive habitats can be crucial to sustaining batoid populations, yet such areas remain poorly documented, particularly in the Red Sea. This study used ultrasonography to assess seasonal patterns of pregnancy in 2 threatened batoids, the halavi guitarfish *Glaucoptegus halavi* (Critically Endangered) and the reticulate whipray *Himantura uarnak* (Endangered), from the Red Sea's largest coastal lagoon (Al Wajh Lagoon, Saudi Arabia). In total, 15 *G. halavi* and 6 *H. uarnak* were confirmed pregnant in the lagoon, providing the first evidence of a gestational site for batoids in the Red Sea. These records refine minimum female size-at-maturity estimates for both species (82 cm disc width for *H. uarnak*; 91 cm total length for *G. halavi*), which until now have remained unresolved. Male reproductive assessments revealed that maturity is reached at least at 76.3 cm total length in *G. halavi* and 76.7 cm disc width in *H. uarnak*. Additional observations of neonates, smaller than previously reported size-at-birth for each species, and aborted fetuses from a fishery-landed *G. halavi* provide suggestive evidence that parturition may also occur within the lagoon. These findings advance our understanding of reproductive biology in threatened batoids, highlight the Al Wajh Lagoon as a multi-species reproductive site of regional conservation importance, and underscore the need for expanded sampling.

KEY WORDS: Gestation · Life history · Nursery habitat · Maturity · Ultrasound · Elasmobranch · Important Shark and Ray Area · Stingray

1. INTRODUCTION

Reproductive habitats, including sites used for gestation and parturition, serve a critical role in the persistence of batoid (i.e. ray) populations by facilitating the development of new generations. Protecting gestational and parturition habitats is a widely recognised priority for conservation (Hyde et al. 2022), as reproductive females and neonates represent demographically sensitive life stages that are highly sus-

ceptible to disturbance, fishing pressure, and habitat loss (Martins et al. 2018, Dulvy et al. 2021). The identification and protection of reproductive habitats has become increasingly important for batoids, as many species face sustained global population declines (Dulvy et al. 2021). An estimated 36% of ray species are currently threatened with extinction (Dulvy et al. 2021), and threats are particularly pronounced in tropical coral reef ecosystems (Sherman et al. 2023, Simpfendorfer et al. 2023). Despite the

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importance of reproductive sites for conserving batoid populations, the spatial, temporal, and ecological characteristics of these habitats remain poorly documented for most species (Martins et al. 2018).

The Red Sea, an ecologically distinct peripheral basin of the Indian Ocean, is a region where there is very limited information available on the reproductive biology of elasmobranchs (Spaet 2019). Within the north-eastern Red Sea off the coast of Saudi Arabia lies the Al Wajh Lagoon (2081 km²), the basin's largest coastal lagoon, comprising 92 islands, shallow seagrass beds, expansive sandy coastal shelves, mangrove forests, and fringing coral reef ecosystems (Chalastani et al. 2020). The lagoon is designated as an Important Shark and Ray Area (ISRA) by the International Union for the Conservation of Nature (IUCN) under sub-criterion C1 (reproductive areas) based on observations of juvenile halavi guitarfish *Glaucostegus halavi*, with the reticulate whipray *Himantura uarnak* listed as a supporting species due to the occurrence of unspecified life stages (IUCN SSC 2023). However, the ISRA designation is a non-regulatory framework that identifies ecological importance without conferring legal protection (Hyde et al. 2022), and there remains a need for empirical confirmation of reproductive use (e.g. pregnancy and parturition) to justify targeted management measures.

G. halavi and *H. uarnak* are among the most threatened batoid species that occur in the Red Sea (Borsa et al. 2021, Garzon et al. 2022, McIvor et al. 2022, Frappi et al. 2024). Very limited data exists on the reproductive biology of this Critically Endangered guitarfish (Kyne & Jabado 2019), and there is no contemporary confirmation of reproductive sites used by the species (Gohar & Mazhar 1964). Similarly, female reproductive characteristics (e.g. timing of parturition and size at maturity) of the Endangered *H. uarnak* (Sherman et al. 2021) remain largely undocumented, leaving significant gaps in life-history knowledge for the species.

Here, we address critical knowledge gaps for *G. halavi* and *H. uarnak* by using ultrasonography and maturity assessments alongside records of pre- and postnatal life stages to investigate reproduction of these species in Al Wajh Lagoon, Red Sea. The results of this study are intended to provide novel insights into the reproductive biology of these species and identify critical life history sites to facilitate protection.

2. MATERIALS AND METHODS

Targeted collections of large rays (>75 cm disc width [DW], total length [TL]) were conducted using

bottom-set longline gear in the Al Wajh Lagoon at depths ranging from 1.5 to 4.5 m (Fig. 1). Longlines consisted of 500 m sinking 4 mm diameter cord (i.e. mainline) weighted centrally and at each end. Each longline set consisted of 30 hooks at an interval of approximately 15 m. Branch lines consisted of an 11/0 Mustad 2X circle hook, 1 m of 200 lb monofilament, a 500 lb barrel swivel, 2 m of 250 lb monofilament, and a stainless-steel longline clip affixed to the mainline between 2 small overhand knots. Lines were baited with both sardine (Clupeidae) and squid (*Sepioteuthis* sp.) on each hook and checked at intervals of 1–1.5 h.

Captured rays were placed in a rubber-coated dip net, detached from the mainline, and transferred into a shaded onboard holding pool. Hooks were removed by cutting exposed barbs, allowing the remaining portion of the hook to be easily extracted with minimal additional injury. DW (cm), measured between the apices of the pectoral fins, was recorded for both *Glaucostegus halavi* and *Himantura uarnak*. TL (cm) was measured only for *G. halavi* due to the high prevalence of tail injuries in *H. uarnak*, which compromised measurement accuracy. To enable individual identification and track potential recaptures, passive integrated transponder (PIT; Biomark) tags were implanted subcutaneously below the first dorsal fin on the right side in *G. halavi*, and in the right posterior disc musculature near the tail base in *H. uarnak*. All individuals were released at their capture site within 15 min of being brought onboard.

For both species, the sex of each captured individual was determined by the presence of claspers for males and the absence of claspers for females. Male maturity was assessed based on full clasper calcification (Stehmann 2002). Female *G. halavi* were previously suspected to mature at 83 cm TL (Last et al. 2016). Accordingly, female *G. halavi* individuals near 83 cm TL and larger were considered potentially mature and selected as candidates for further reproductive assessment. Female size-at-maturity of *H. uarnak* remains uncertain (Sherman et al. 2021). The only available reproductive reference point for *H. uarnak* was the smallest documented mature male, which measured 74.8 cm DW (Borsa et al. 2021). Since male batoids mature at smaller sizes than females (Gayford et al. 2025), this size (~74 cm DW) was considered a conservative lower-end value of potential female maturity, and females above this size were subsequently selected as candidates for pregnancy assessments.

Female reproductive assessments were performed using a high-resolution portable ultrasound unit (EVO3; E.I. Medical Imaging) equipped with an eCL3 curved

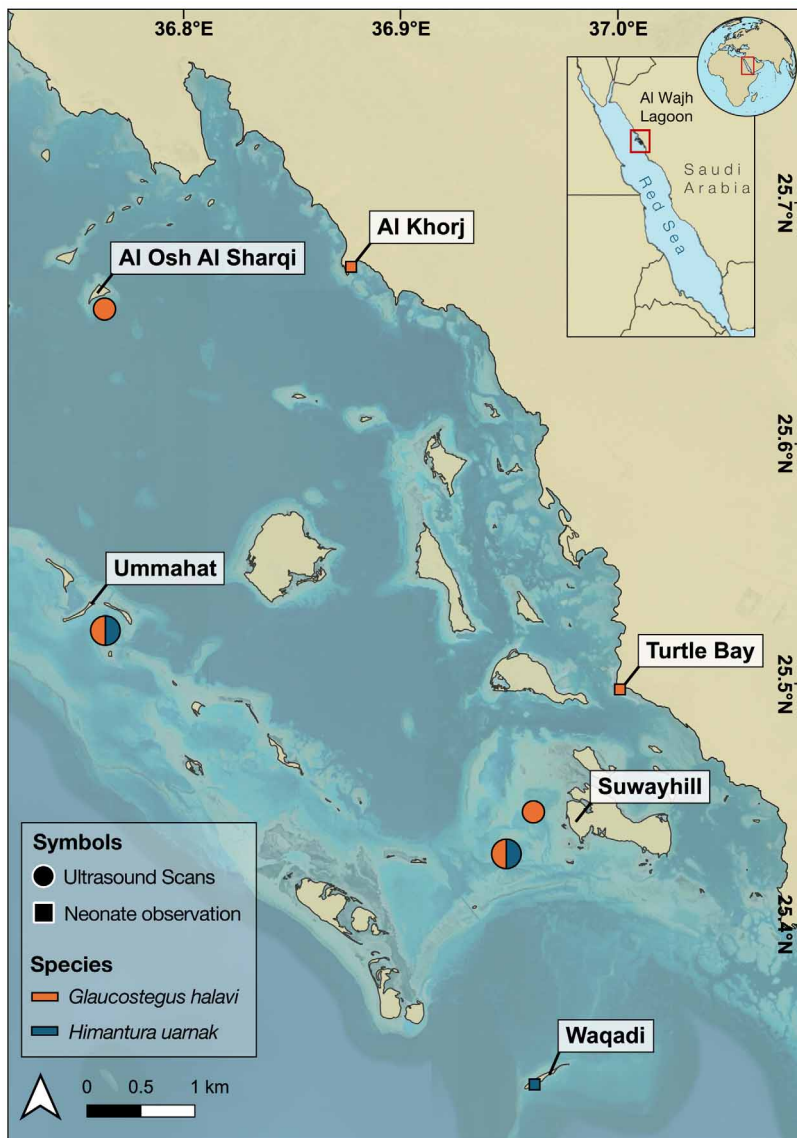


Fig. 1. Spatial distribution of ultrasound scans and neonate observations of *Glaucostegus halavi* and *Himantura uarnak* from Al Wajh Lagoon, Saudi Arabia

linear transducer. Ultrasound scanning was performed with the animal's spiracles and gills fully submerged in seawater. Scans were conducted in both transverse and longitudinal planes, primarily along the ventral surface of the body cavity, with secondary dorsal scans taken when feasible (Fig. 2A,B). Scanning depth was set to 6–10 cm, depending on body size and image resolution. Foetuses and embryos were identified based on structures visualized by ultrasound (see Murakumo et al. 2020). Females were classified as pregnant if a foetus or embryo was observed *in utero*. Gestational development was categorised into 4 stages, adapted from Lara-Mendoza & Márquez-Farías (2021): (0) no embryos present *in utero*; (1) large uterine yolk sacs with limited

embryonic structures; (2) weakly defined vertebral column in close association with a similarly sized yolk-sac; and (3) strong echogenic vertebral column with faint to no visualisation of yolk-sac. Stage 0 represents non-pregnant individuals, whereas Stages 1–3 indicate pregnancy. Pregnant females were considered mature, but non-pregnant females were not assumed to be immature.

To supplement reproductive assessments and confirm parturition timing, neonates were opportunistically collected from the Al Khorj fish landing site, Turtle Bay beach, and Waqadi Island (Fig. 1). Free-swimming neonates were captured using hand-seine nets (1.5 × 15 m) or small dip nets in shallow water (<50 cm depth; see McIvor et al. 2024). Morphometric measurements (DW and TL) were taken with the animals submerged, and all individuals were released at the site of capture within 2–3 min.

This study complied with relevant animal welfare laws, guidelines, and policies and was authorized by the Saudi Arabian National Center for Wildlife (permit RS-25-000024) as well as the Department of Environmental Protection and Regeneration at Red Sea Global (DES-ER-FRM-015-020). Longline capture of live animals was secondarily approved by the Institutional Animal Care and Use Committee at King Abdullah University of Science and Technology (23IACUC010).

3. RESULTS

A total of 106 *Glaucostegus halavi* (68 male, 38 female) and 18 *Himantura uarnak* (5 male, 13 female) individuals were captured in the Al Wajh Lagoon from October 2024 to June 2025. Male and female individuals were captured at all longline survey areas, apart from the northeastern Suwayhill site, where only female *G. halavi* were encountered (Fig. 1). Sex ratios (M:F) were skewed towards males in *G. halavi* (1.8:1) and towards females in *H. uarnak* (1:2.6). Within both species, females were generally larger than males (Fig. 3).

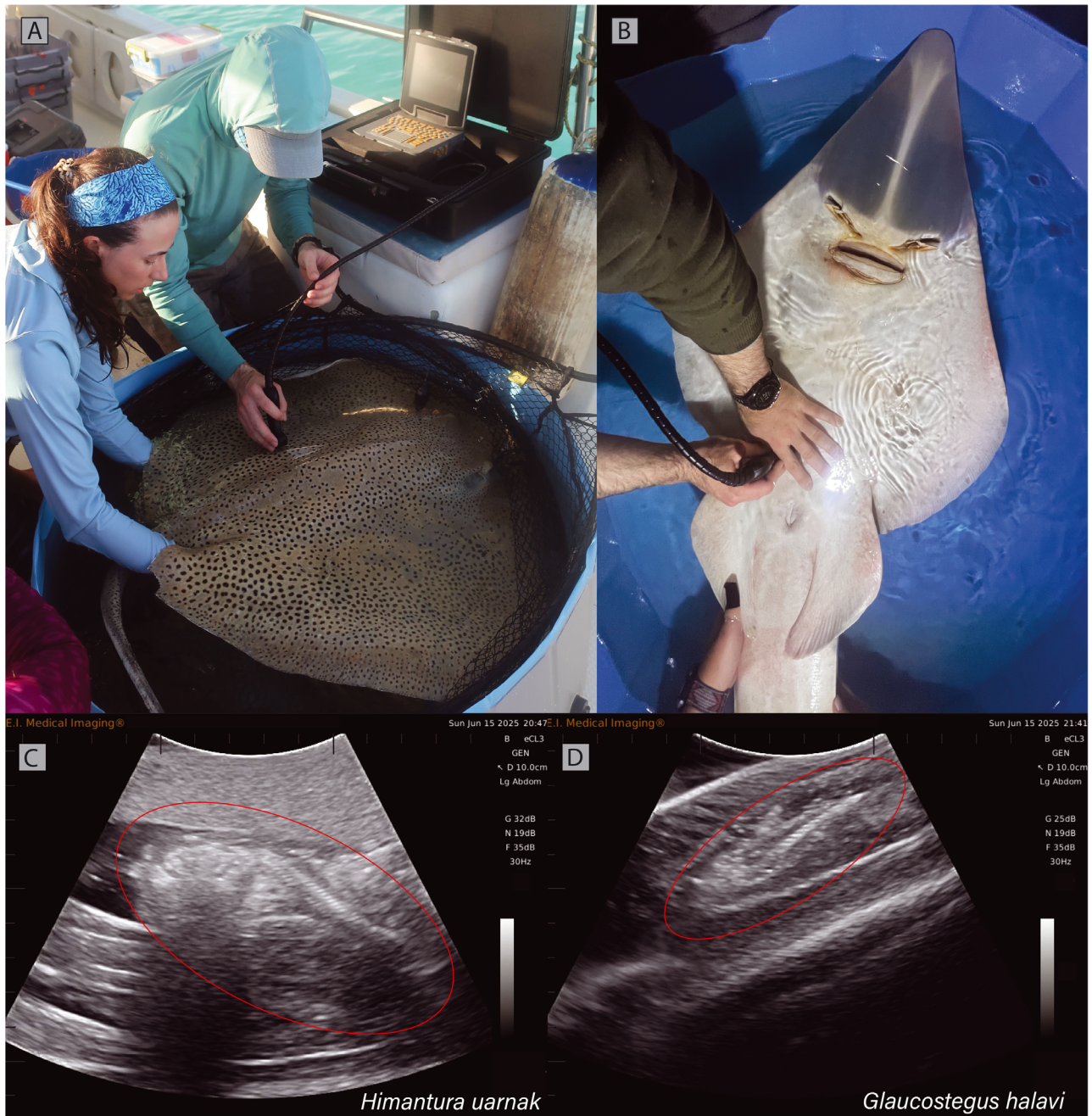


Fig. 2. Ultrasound scans of pregnant (A,C) reticulate whipray *Himantura uarnak* and (B,D) halavi guitarfish *Glaucostegus halavi* captured in the Al Wajh Lagoon. Red circles: extent of each foetus

Ultrasound scans were conducted on 23 mature or near-mature female batoids across 3 islands in the Al Wajh Lagoon ($n = 17$ *G. halavi*; $n = 6$ *H. uarnak*; Table 1). Pregnancy was confirmed for 15 of the 17 *G. halavi* (88%; 91–154 cm TL; 33–61 cm DW) and all 6 *H. uarnak* (100%; 82–104 cm DW). Many pregnant females exhibited conspicuous dorsal bulging of the body cavity (i.e. a convex body cavity), and no pregnant females were documented with a concave body cavity.

However, this characteristic was an unreliable determinant of pregnancy, as several pregnant females of both species did not exhibit abdominal bulging and males were also found to have extended body cavities on occasion. Of the males captured using benthic long-lines, 67 *G. halavi* (99%; 76–104 cm TL; 25–36 cm DW) and 5 *H. uarnak* (100%; 77–89 cm DW) exhibited fully calcified claspers, indicating sexual maturity (Fig. 3, Table 2).

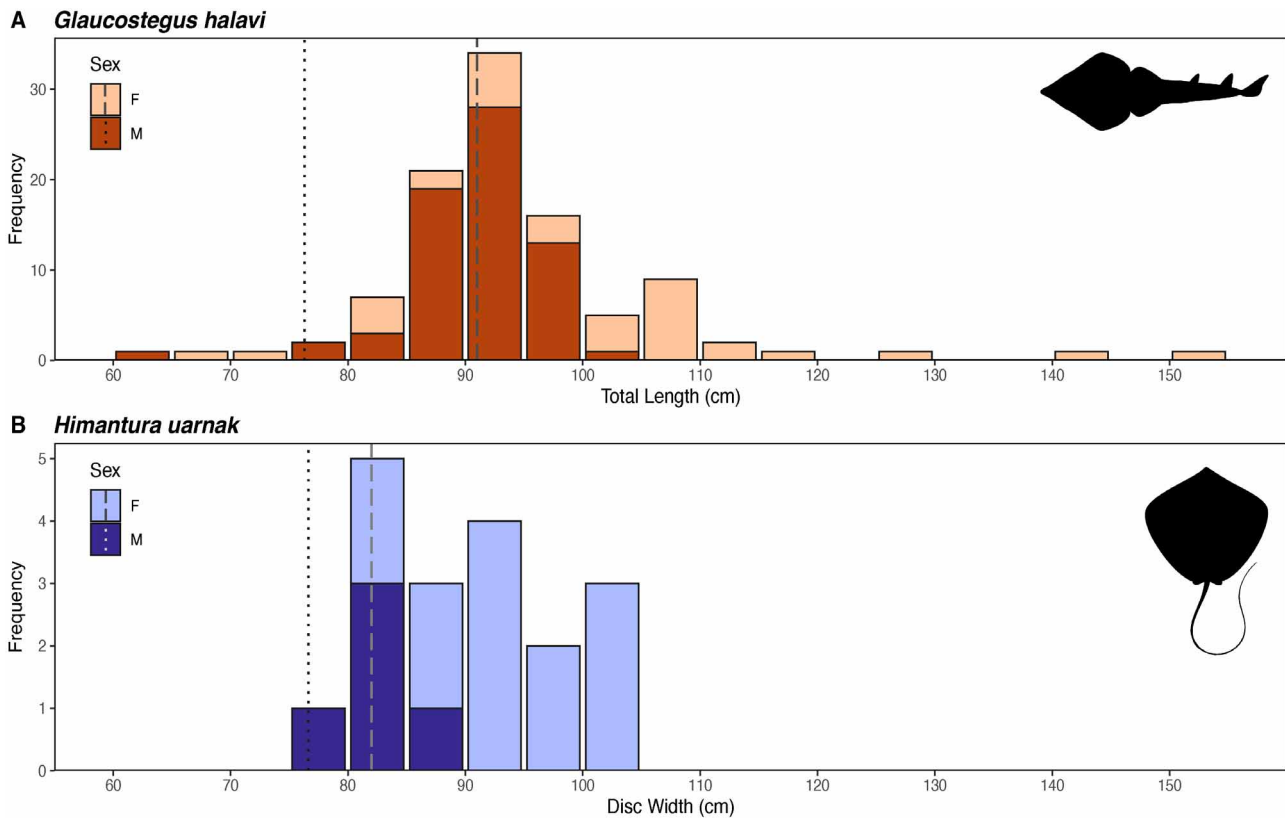


Fig. 3. Size-frequency by sex of (A) halavi guitarfish *Glaucostegus halavi* and (B) reticulate whipray *Himantura uarnak* collected via longline in the Al Wajh Lagoon. Dashed lines: size of the smallest pregnant female; dotted lines: size of the smallest mature male

Pregnancy was documented in *G. halavi* from April to November with a general trend of increasingly developed gestational stages throughout this period (Fig. 4, Table 1). Most female *G. halavi* individuals scanned in April–June were of Stage 2, indicative of mid-gestation in spring and early summer (Fig. 4). Late-stage gestation (Stage 3) was observed in *G. halavi* from June to November (i.e. summer to autumn), corresponding to a potential seasonal partition period (Fig. 4). Relatively smaller females (106 cm TL) carried late-stage pregnancies earlier in the year (June) than the largest scanned female (154 cm TL), which exhibited a late-stage pregnancy in early November (Table 1). Additionally, the 2 smallest *G. halavi* females scanned in this study were of the same size (81 cm TL), and were the only scanned individuals found not to be pregnant. The absence of pregnancy by itself is not indicative of immaturity, and as such, no reference to female reproductive maturity could be assumed for these 2 females.

In *H. uarnak*, female reproductive classifications ranged from early to late-term pregnancies (Stages 1–3) with an increasing trend of gestational develop-

ment between April and February (Fig. 4, Table 1). Pregnant individuals collected in April–May were at Stage 1, those in June–October were at Stage 2, and the February individual at Stage 3, corresponding to a potential seasonal partition period across autumn and winter in the Red Sea (Fig. 4). One *H. uarnak* individual (104 cm DW), originally captured on 29 October 2024, exhibited a convex dorsal body cavity and was confirmed by ultrasound to be pregnant. Upon recapture on 13 June 2025 (within 500 m of its initial collection location), the same individual had a distinctly concave dorsal surface above the body cavity, suggesting parturition had potentially occurred between capture events. This was the only confirmed recapture of a pregnant female in this study.

Collections of pre- and postnatal life stages (i.e. aborted fetuses and free-swimming neonates) further support local reproduction of *G. halavi* and *H. uarnak* in the Al Wajh Lagoon (Fig. 5). On 22 May 2024, 4 *G. halavi* fetuses aborted by a pregnant female were discarded by local fishers at the Al Khorj fish landing site (25.673280° N, 36.876905° E). These exhibited yolk sacs proportional to body size (Stage 2), undeveloped

Table 1. Total length (TL; cm), disc width (DW; cm), pregnancy status (Y: pregnant; N: not pregnant), gestational stage (0–3), date of ultrasound scan, and collection location (island name and coordinates) of female *Glaucostegus halavi* and *Himantura uarnak* from the Al Wajh Lagoon (Red Sea, Saudi Arabia). Total length measurements are not provided for *H. uarnak*, given the prevalence of tail damage within the species

Species	TL (cm)	DW (cm)	Pregnant (Y/N)	Stage	Date	Location	Lat.	Long.
<i>Glaucostegus halavi</i>	81	27	N	0	2024-10-27	Al Sharqi	25.658	36.763
<i>Glaucostegus halavi</i>	81	29	N	0	2024-10-29	Suwayhill	25.431	36.949
<i>Glaucostegus halavi</i>	91	33	Y	2	2025-06-16	Suwayhill	25.445	36.962
<i>Glaucostegus halavi</i>	94	35	Y	2	2025-06-14	Ummahat	25.518	36.759
<i>Glaucostegus halavi</i>	96	34	Y	2	2025-06-16	Suwayhill	25.446	36.961
<i>Glaucostegus halavi</i>	99	36	Y	2	2025-06-16	Suwayhill	25.447	36.960
<i>Glaucostegus halavi</i>	101	37	Y	2	2025-04-26	Suwayhill	25.431	36.948
<i>Glaucostegus halavi</i>	103	38	Y	2	2025-06-15	Ummahat	25.520	36.759
<i>Glaucostegus halavi</i>	106	40	Y	3	2025-06-16	Suwayhill	25.447	36.959
<i>Glaucostegus halavi</i>	106	39	Y	3	2025-06-16	Suwayhill	25.447	36.959
<i>Glaucostegus halavi</i>	107	40	Y	2	2025-06-16	Suwayhill	25.446	36.961
<i>Glaucostegus halavi</i>	107	39	Y	2	2025-06-16	Suwayhill	25.447	36.960
<i>Glaucostegus halavi</i>	109	40	Y	2	2025-05-06	Suwayhill	25.443	36.958
<i>Glaucostegus halavi</i>	111	43	Y	2	2025-05-03	Suwayhill	25.431	36.949
<i>Glaucostegus halavi</i>	116	43	Y	2	2025-05-06	Suwayhill	25.446	36.960
<i>Glaucostegus halavi</i>	143	55	Y	2	2025-04-26	Suwayhill	25.431	36.951
<i>Glaucostegus halavi</i>	154	61	Y	3	2024-11-05	Al Sharqi	25.659	36.760
<i>Himantura uarnak</i>	—	82	Y	3	2025-02-18	Ummahat	25.521	36.763
<i>Himantura uarnak</i>	—	89	Y	2	2025-06-15	Ummahat	25.520	36.761
<i>Himantura uarnak</i>	—	91	Y	1	2025-05-01	Suwayhill	25.429	36.951
<i>Himantura uarnak</i>	—	96	Y	2	2024-10-29	Suwayhill	25.431	36.950
<i>Himantura uarnak</i>	—	98	Y	1	2025-04-26	Suwayhill	25.431	36.948
<i>Himantura uarnak</i>	—	104 ^a	Y	2	2024-10-29	Suwayhill	25.431	36.950

^aRecaptured individual that was later presumed not pregnant on 13 June 2025

Table 2. Previously reported body sizes of critical life history stages (size-at-birth and size-at-maturity) for *Glaucostegus halavi* (total length, TL) and *Himantura uarnak* (disc width, DW) in comparison to data obtained in the present study. Male size-at-maturity estimates from the literature represent the smallest documented mature individuals

	<i>Glaucostegus halavi</i> TL (cm)	<i>Himantura uarnak</i> DW (cm)
Size-at-birth [in-utero size]	29 ^a	21–28 ^{b,h} [23.5–33.6] ^{c,d}
Smallest specimen (present study)	25.1	23.2
Female size-at-maturity	83 ^{e,h}	Unknown ^f
Smallest pregnant female (present study)	91.1	82.0
Male size-at-maturity	95 ^a	74.8 ^g
Smallest mature male (present study)	76.3	76.7

^aGohar & Mazhar (1964); ^bLast & Stevens (1994);
^cBaşusta & Başusta (2023); ^dHenderson et al. (2024);
^eLast et al. (2016); ^fSherman et al. (2021);
^gBorsa et al. (2021); ^hunsubstantiated values listed in the literature

pigmentation, and fused pectoral fins, features consistent with mid-gestation (Lara-Mendoza & Márquez-Farías 2021) (Fig. 5). Additional observations of neonates included a female *G. halavi* (25.1 cm TL) collected at Turtle Bay beach on 20 August 2024 (25.498143° N, 36.000734° E), and a male *H. uarnak* (23.2 cm DW) collected at Waqadi Island on 6 November 2024 (25.333370° N, 36.961460° E) (Fig. 5).

4. DISCUSSION

Our study provides the first evidence of a gestational site for *Glaucostegus halavi* and *Himantura uarnak* in the Al Wajh Lagoon, with observations that are suggestive of local parturition. Within the lagoon, the presence of pregnant females and mature males of both species was confirmed across multiple seasons, signalling the potential for mating to occur locally, and records of small neonates indicate recent birth nearby. Our findings refine regional estimates of reproductive timing, size-at-maturity, and size-at-birth for *G. halavi* and *H. uarnak*, in addition to reinforcing the ecological importance of this lagoon within the Red Sea. Although the Al Wajh Lagoon is already des-

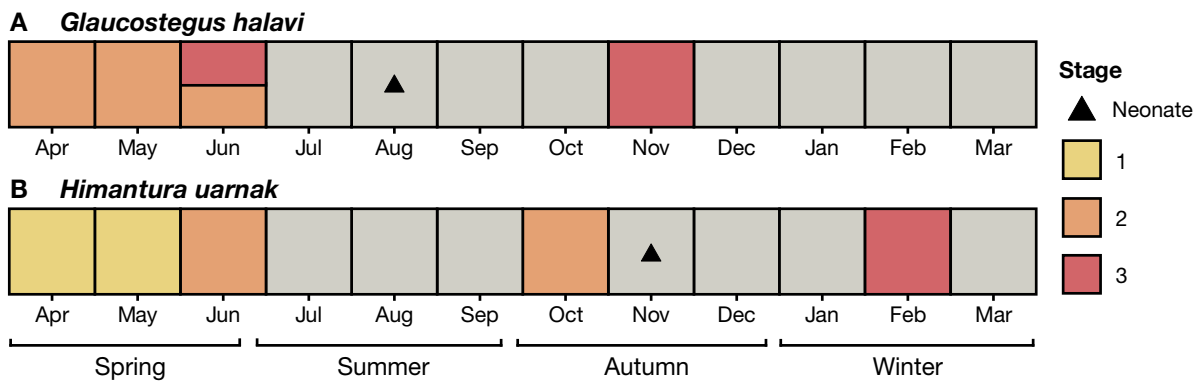


Fig. 4. Monthly distribution of female (A) halavi guitarfish *Glaucostegus halavi* and (B) reticulate whipray *Himantura uarnak* reproductive stages (1–3) classified through ultrasonography. Triangles denote the smallest documented neonate for each species

ignated as an ISRA based on earlier records of juvenile *G. halavi* (IUCN SSC 2023), our results expand the relevance of the ISRA to include pregnant females of both *G. halavi* and *H. uarnak* as well as neonate *H. uarnak*, providing further evidence to support the establishment of localized management measures (e.g. spatial protection).

The Al Wajh Lagoon may provide favourable conditions for batoid reproduction due in part to its relatively elevated temperatures, which could facili-

tate maternal thermophily (i.e. use of warm habitats by gravid females to elevate body temperature and accelerate embryonic development) (Schlaff et al. 2014). The lagoon's semi-enclosed, shallow geomorphology produces thermally distinct habitats that can remain 2–3°C warmer than adjacent Red Sea waters (Zhan et al. 2022). With pregnant batoids known to concentrate in relatively warm environments to accelerate gestation (e.g. *Urobatis halleri*; Jirik & Lowe 2012), the repeated observations of pregnant *G. halavi* and



Fig. 5. Images of (A) non-viable *Glaucostegus halavi* embryos (~12 cm TL) aborted from a fishery-landed female (photo: Mohammed Nami), (B) a *Glaucostegus halavi* neonate (25.1 cm TL), and (C) a *Himantura uarnak* neonate (23.2 cm DW) collected from the Al Wajh Lagoon

H. uarnak within the Al Wajh Lagoon could indicate similar utilization of warm habitat by these species to incur a thermal advantage for gestation. This hypothesis is potentially supported by longline captures in shallow, warmer sub-lagoons (e.g. the northeast Suwayhill site; Fig. 1) comprising entirely female *G. halavi*, which also corresponds to previously suggested sex-based spatial segregation within the species (Jabado 2018). Although our study did not directly evaluate temperature and space use by pregnant rays, these observations raise a hypothesis that warrants targeted investigation.

For *G. halavi*, integrated data sources point to a seasonal pattern of parturition (i.e. pupping) from approximately June to November. The observed timing of late-stage pregnancies in *G. halavi* derived from ultrasound scans (June–November) aligns with several independent observations, including historical reports of parturition between May and November in the northern Red Sea (Gohar & Mazhar 1964), the aborted mid-term fetuses found in May, and the capture of a notably small neonate in August (25.1 cm TL). Ultrasound scans also suggested that size-based differences in *G. halavi* parturition timing may occur during this period, with smaller females giving birth earlier than larger females (Tokunaga et al. 2022). However, these patterns should be interpreted cautiously, given the limited temporal coverage and small sample sizes. Further sampling remains necessary to refine the seasonal timing of *G. halavi* parturition and the factors influencing intraspecific variation in gestational development.

Similarly, our data indicated seasonal reproduction of *H. uarnak* in the Al Wajh Lagoon with gestation beginning in the spring (~April) and protracted parturition likely occurring from autumn into late winter (November–February). A seasonal reproductive pattern in *H. uarnak* was supported by increasing gestational development of pregnant females from April to February, with late-stage pregnancy occurring at the end of this period, inferred parturition by a recaptured female between October and June, as well as the occurrence of a very small neonate (23.2 cm DW) in early November, indicative of recent birth. In the central Red Sea (Thuwal, Saudi Arabia), *H. uarnak* neonates are found between September and May (A. J. McIvor unpubl. data), which suggests that this stingray species may give birth over a slightly longer duration than was detected in our study, possibly because of relatively limited sampling. Overall, our data for *H. uarnak* provides evidence of seasonal reproduction and the first documented reproductive site for this species in the Red Sea.

Findings of the present study additionally refine several key life history parameters of *G. halavi* and *H. uarnak* that have long remained unresolved. For instance, the size-at-maturity for both sexes of *G. halavi* is commonly listed as ~83 cm TL (Kyne & Jabado 2019). This value was first reported in a species identification guide for a region outside the current range of *G. halavi*, stating that males of this species mature at 83 cm TL without any substantiating data (Compagno & Last 1999). Subsequent publications have reiterated this value (83 cm TL), expanding its attribution to females (Last et al. 2016, Kyne & Jabado 2019), and it is now frequently listed as an accepted size estimate of *G. halavi* maturity (Jabado 2018, Al Hameli et al. 2024). To our knowledge, the only published reproductive data set on *G. halavi* found that males matured at 95 cm TL and that all pregnant females were ≥ 170 cm TL (Gohar & Mazhar 1964). While these data, which also originate from the Red Sea, may represent overestimates related to sampling bias or size-selective fishing (Heino et al. 2015), they offer tangible benchmarks to attain more accurate size-at-maturity estimates. Our study now provides a contemporary data set to further refine the known minimum size-at-maturity of female and male *G. halavi* to at least 91 and 76 cm TL, respectively.

Even less data is available on reproductive demographics in *H. uarnak*. Prior dissections of pregnant *H. uarnak* females confirmed maturity in exceptionally large individuals (133–142 cm DW), but the size at which maturity is reached among *H. uarnak* females is often listed as entirely unknown (Sherman et al. 2021). Ultrasound scans from the current study reduce the known minimum female size-at-maturity for *H. uarnak* by documenting pregnancy in an 82 cm DW individual (Sherman et al. 2021). The size of this pregnant female corresponds to a commonly reported estimate for male size-at-maturity in this species (82 cm DW; Moore & Peirce 2013); however, there is evidence that *H. uarnak* males mature at even smaller sizes (74.8 cm DW; Borsa et al. 2021). Our study corroborates this smaller male size-at-maturity by identifying a mature male *H. uarnak* at 76.7 cm DW. Ultimately, these findings represent minimum estimates for size-at-maturity. More comprehensive studies are needed for both *G. halavi* and *H. uarnak* to establish robust maturity metrics (e.g. L_{50} : length at median maturity) that can better inform precise monitoring and management efforts.

Collections of *G. halavi* and *H. uarnak* from the Al Wajh Lagoon also aided in delineating the size-at-birth for both batoid species in this study. Historical collections of *G. halavi* in the northern Red Sea indi-

cated a size-at-birth for the species of ~29 cm TL (Gohar & Mazhar 1964), but this value has remained unverified for more than half a century. Our findings now provide the smallest ever documented *G. halavi* individual (25.1 cm TL), revealing that this species is likely born at smaller sizes than previously reported (Gohar & Mazhar 1964). The small size of this newly reported neonate is most likely indicative of variations in size-at-birth that were not previously represented in the limited data available for *G. halavi*.

Comparably, the *H. uarnak* neonate (23.2 cm DW) collected from the Al Wajh Lagoon was slightly smaller than previously reported sizes of unborn fetuses in the species from the Arabian region (23.5–33.6 cm DW; Basusta & Başusta 2023, Henderson et al. 2024). These *in utero* fetuses were collected from large *H. uarnak* individuals (133–142 cm DW; Basusta & Başusta 2023, Henderson et al. 2024), and it is expected that larger females would give birth to larger offspring (Cortés 2000, Hussey et al. 2010). Still, the widely recognized size-at-birth for *H. uarnak* is often listed as 21–28 cm DW, but this value appears to have been derived from Australia, where *H. uarnak* is no longer believed to occur following subsequent taxonomic revisions (Last & Stevens 1994, Last et al. 2016, Sherman et al. 2021). If the currently recognized size-at-birth for *H. uarnak* corresponds to a separate species within the *Himantura* species complex that occurs in Australia (e.g. *H. australis*; Last et al. 2016), there remains a need to establish size-at-birth estimates within the currently recognized distributional range of *H. uarnak*. Data from the current study provisionally suggests that *H. uarnak* may be born at slightly larger sizes than previously recognized (e.g. 23–34 cm DW), although further investigation into this topic remains necessary.

Overall, evidence of *G. halavi* and *H. uarnak* reproduction in the Al Wajh lagoon places added emphasis on mitigating localised threats to these species, highlighting the need for both targeted management measures and further research. The use of these shallow coastal habitats by both neonates and pregnant females could expose these vulnerable life stages to heightened risks of artisanal fishing, coastal development, and habitat degradation (Martins et al. 2018). Identifying and protecting reproductive habitats remains a key priority for elasmobranch conservation in the Red Sea (Spaet 2019), and the evidence presented here strengthens justification for spatial protections for batoids in the Al Wajh Lagoon. Although this study identifies the Al Wajh Lagoon as a reproductive site, future research that refines parturition timing, defines potential nursery areas (e.g. through the

abundance, distribution, and movements of neonates; Martins et al. 2018), and assesses residency patterns of reproductive females will facilitate more precise management actions to mitigate threats during these critical life stages.

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