diversity

MDPI

Interesting Images

Variation in Fluorescence in Some Northeast Atlantic Malacostraca (Pancrustacea)

Thomas I. Baxter *, David M. Paterson and Andrew J. Blight

Sediment Ecology Research Group, Scottish Oceans Institute, School of Biology, University of St Andrews, St Andrews KY16 8LB, UK

* Correspondence: tib1@st-andrews.ac.uk

Abstract

Fluorescence is known to occur on varying surfaces across crustacea but is only cited in sporadic reports, despite being a potentially important visual signal and changing with development and within moult cycles. Here, we present the occurrence of fluorescence in some common Northeast Atlantic crustaceans and highlight differences by age and sex, to bring attention to this potentially important facet of their biology. Fluorescence was present on dactyli tips across most species, and setae on the ventral side of edible crabs and lobsters (with greater occurrence in females) and over the whole body in spider and hermit crabs.

Keywords: crustacea; decapoda; visual ecology

Fluorescence is present in various forms across Arthropoda [1,2], with occurrence in some groups (particularly scorpions) widely known. Occurrence of fluorescence in crustacea is less well studied than other groups (however, see [3–6]), potentially due to the more easily detected bioluminescence across many terrestrial taxa in more accessible habitats [7]. Inducement of fluorescence depends on ambient light levels (particularly blue and UV, tied to depth in the sea [5]), while detection depends on the visual capacity of both the fluorescing species (for conspecific interaction) and potential predators or prey [8].

Knowledge of fluorescence and its drivers in crustaceans is limited, but studies on stomatopods (which are known to be sensitive to UV light) have indicated fluorescence as a potential enhancer for visual signalling in the more light-limited underwater environment [5], with the potential for patterns to aid in identification of conspecifics, though it is noted visual systems in this group are particularly sensitive. Fluorescence in Portunid crabs has been found to typically increase with growth stage (juveniles typically displaying lower levels or incomplete patterns compared to those found in adults) [6]. Simulated stress was shown to decrease fluorescence in some areas of Lithoid king crabs over short time scales [4]. The use of fluorescence to aid in crustacean identification has been noted [6], and increasing knowledge of decapod fluorescence has been garnered by underwater photography awards, such as the Underwater Photographer of the Year award for a photo of a fluorescing squat lobster *Galathea strigosa* (Linnaeus, 1761) [9], as well as other examples for other species and groups exhibiting fluorescence not covered here [10].

Here, we document the occurrence of this property among common species found in the Northeast Atlantic. Observations were made sporadically during rockpooling trips from 2025 to 2026, but all photos (excluding those for edible crabs and European lobsters) were taken on 3/3/26 with individuals found in the intertidal of East Sands, St Andrews, Scotland. Photos for edible crabs and European lobsters were taken when the species were present in the Scottish Oceans Institute for study on 11/9/25. A commercially available

Check for updates

Academic Editor: Bert W. Hoeksema

Received: 30 March 2026
Revised: 9 April 2026
Accepted: 9 April 2026
Published: 11 April 2026

Copyright: © 2026 by the authors. Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license.

UV torch (Lepro, Las Vegas, NV, USA) was used to induce fluorescence (at 395 nm), and photographs were taken using an OM TG-7 camera (OM Digital Solutions, Tokyo, Japan). Photos were taken in standard or macro mode, with automatic focus used at varying distances. A Zeikos 40.5 mm UV filter (Zeikos, NJ, USA) was used to block reflected UV light.

Fluorescence was generally localised in the setae and dactyli tips of pereiopods, the most visible found in the great spider crab *Hyas araneus* (Linnaeus, 1758; Brachyura: Oregoniidae; Figure 1) and the common hermit crab *Pagurus bernhardus* (Linnaeus, 1758; Anomura: Paguridae; Figure 2). All encountered *H. araneus* and *P. bernhardus* displayed fluorescence in the same areas and to the same degree.

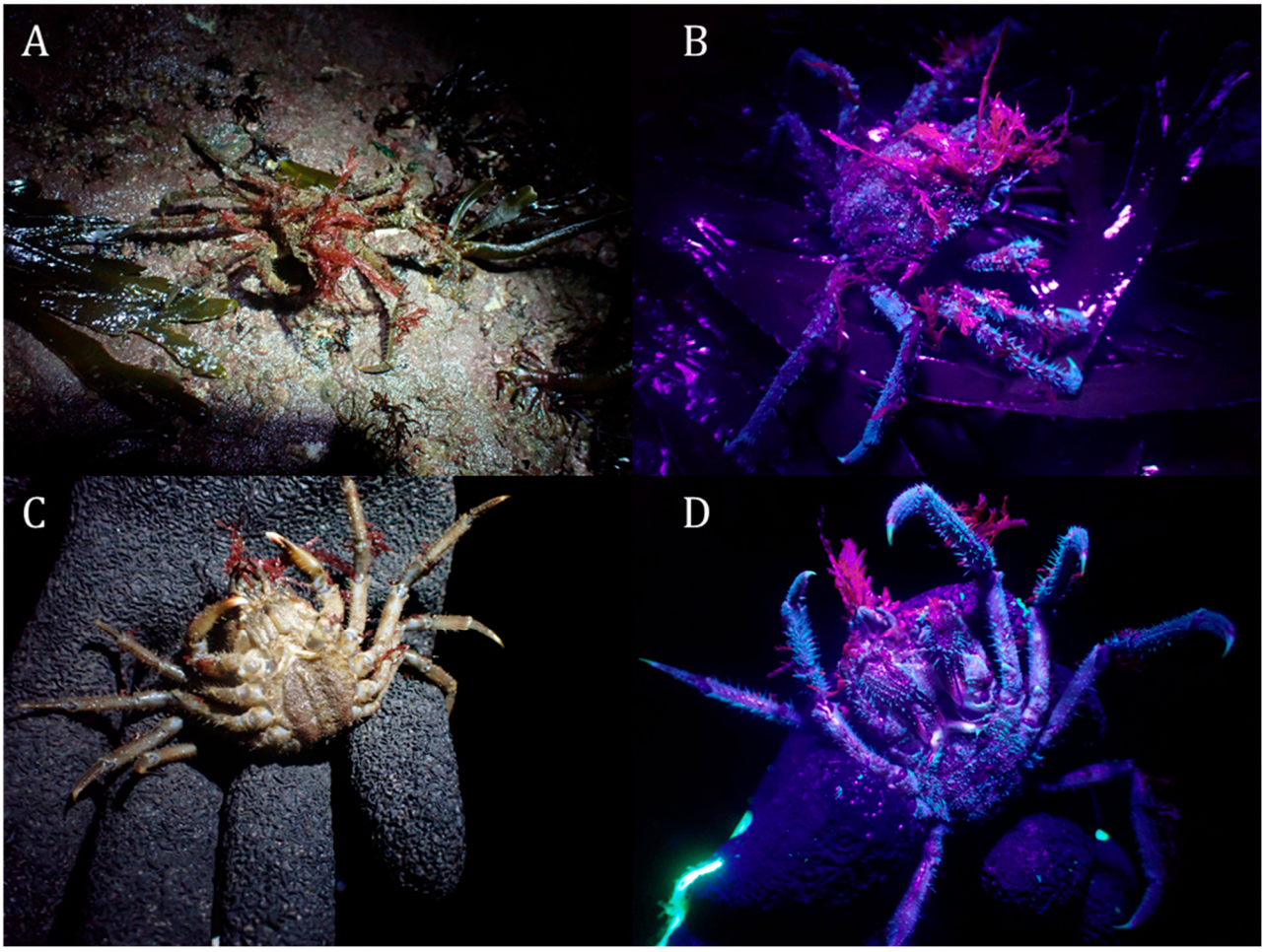


Figure 1. Dorsal (**A**,**B**) and ventral (**C**,**D**) views under normal (**A**,**C**) and UV (**B**,**D**) light of the great spider crab *Hyas araneus*. Setae fluorescence occurs across the body and limbs, with dactyli tips also fluorescing. Red fluorescing tufts are attached algae (largely *Plocamium* spp). The carapace width of the individual photographed was ~5 cm.

The brown crab *Cancer pagurus* (Linnaeus, 1758; Brachyura: Cancridae) exhibited no visible fluorescence as a juvenile but did so as an adult, with this generally limited to setae on the mouthparts, the underside of the body, and pereiopods except the chelae, in addition to the dactyli tips (Figure 3). Mature females had more and longer setae, resulting in greater levels of fluorescence than males of similar sizes. Juveniles only exhibited fluorescence at dactyli tips. Adult European lobsters *Homarus gammarus* (Linnaeus, 1758; Astacidea: Nephropidae) also fluoresced, largely from setae on the mouthparts, swimmerets, distal pereiopod segments (except for the chelae), pleon, and telson fringes (Figure 4). Higher setae density was also present on females of this species, but this divergence was to a lesser

degree than *C. pagurus* and unclear in photos (TIB pers. obvs.). Preserved early benthic-phase lobsters (with a carapace length of < 2 cm) were also investigated for fluorescence and did not display it, though it has been noted that preservation can lessen levels [6].

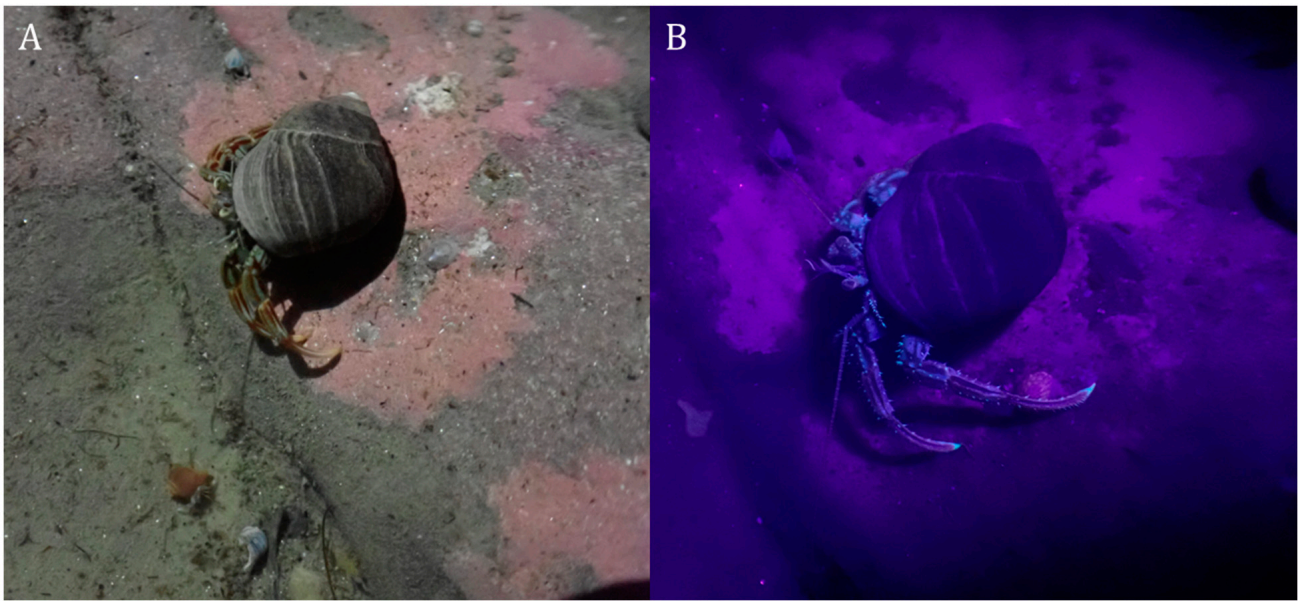


Figure 2. Common hermit crab *Pagurus bernhardus* under normal (**A**) and UV light (**B**) with fluorescence on setae across the body and dactyli tips. The *Littorina littorea* shell occupied was ~3 cm at the coiling axis.

The green crab *Carcinus maenas* (Linnaeus, 1758; Brachyura: Carcinidae) generally only fluoresced at the dactyli tips (Figure 5). Large individuals sometimes fluoresced on the carapace, possibly due to longer time in moult, driving degradation of the cuticle and exposure of fluorescent layers, especially at the edges and white points on the carapace (Figure 5A,B) or facilitating greater growth of encrusting species which may themselves fluoresce (Figure 5C,D).

No fluorescence was noted in the long claw porcelain crab *Pisidia longicornis* (Linnaeus, 1767; Anomura: Porcellanidae), broad claw porcelain crab *Porcellana platycheles* (Pennant, 1777; Anomura: Porcellanidae), isopods *Idotea* spp. (Isopoda: Idoteidae), and some amphipods (likely *Gammarus* spp., Figure 6).

Some crustaceans can detect UV [11], and fluorescence in such species can be used for visual signalling [5]. Development of fluorescent structures at maturity and differentially between sexes could function to aid in mate detection, or may simply be a product of differential setae investment between sexes. Consistent localization at the dactyli tips may also be a consequence of cuticle structure at this point, but may aid in increasing the visibility of threat displays, as in stomatopods [5]. Potential predators, such as fish [12], birds [13], and other crustaceans, can also detect UV, and this may constrain fluorescence in small species or juvenile stages which do not have the size-based escape (large decapods) or defences (hermit crab shell, spider crab camouflage) of the other fluorescing species; fluorescence is often lower in juveniles than adults of crustaceans [6] and other arthropods [2]. Species investigated here were predominantly intertidal, where light is present across the spectrum; colour and fluorescence may be more important in these species than crustaceans that inhabit deeper water or pelagic environments, which have more blue-biassed vision due to the reduced spectrum experienced [14].

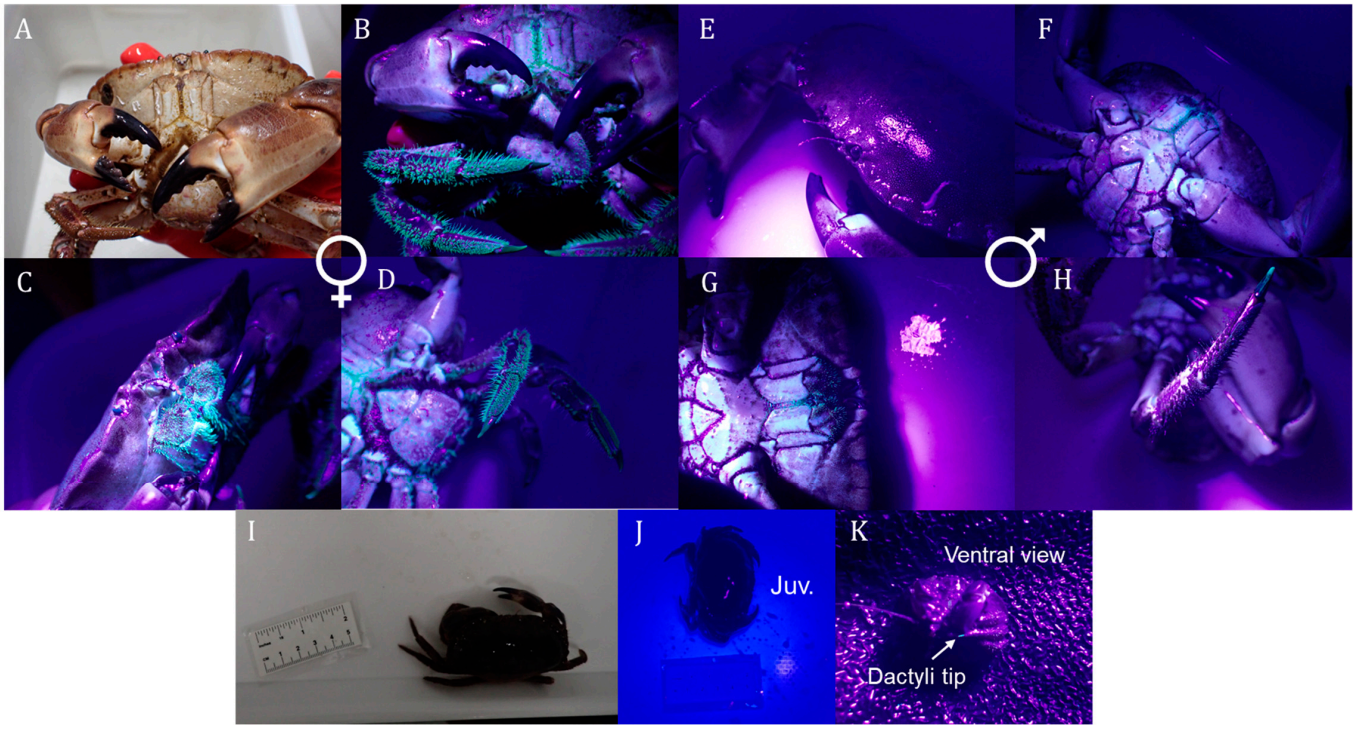


Figure 3. Views of edible crab *Cancer pagurus* under normal (**A**,**I**) and UV light (**B**–**H**,**I**,**K**). Panels (**A**–**D**) display a female crab (carapace width, CW, ~12 cm) with focus on overall ventral surface (**B**), mouthparts (**C**), and pereiopod tips (**D**). (**E**–**H**) display a male (~13 cm CW) with reduced setal cover and fluorescence compared to the female in the ventral surface (**F**), mouthparts (**G**), and pereiopods (**H**). (**I**–**K**) displays juveniles (**I**,**J** ~6 cm CW, **K** ~2 cm CW), the colour in ambient light (**I**) and lack of fluorescence under UV on the dorsal (**J**,**K**) and ventral side, excluding dactyli tips (**K**).

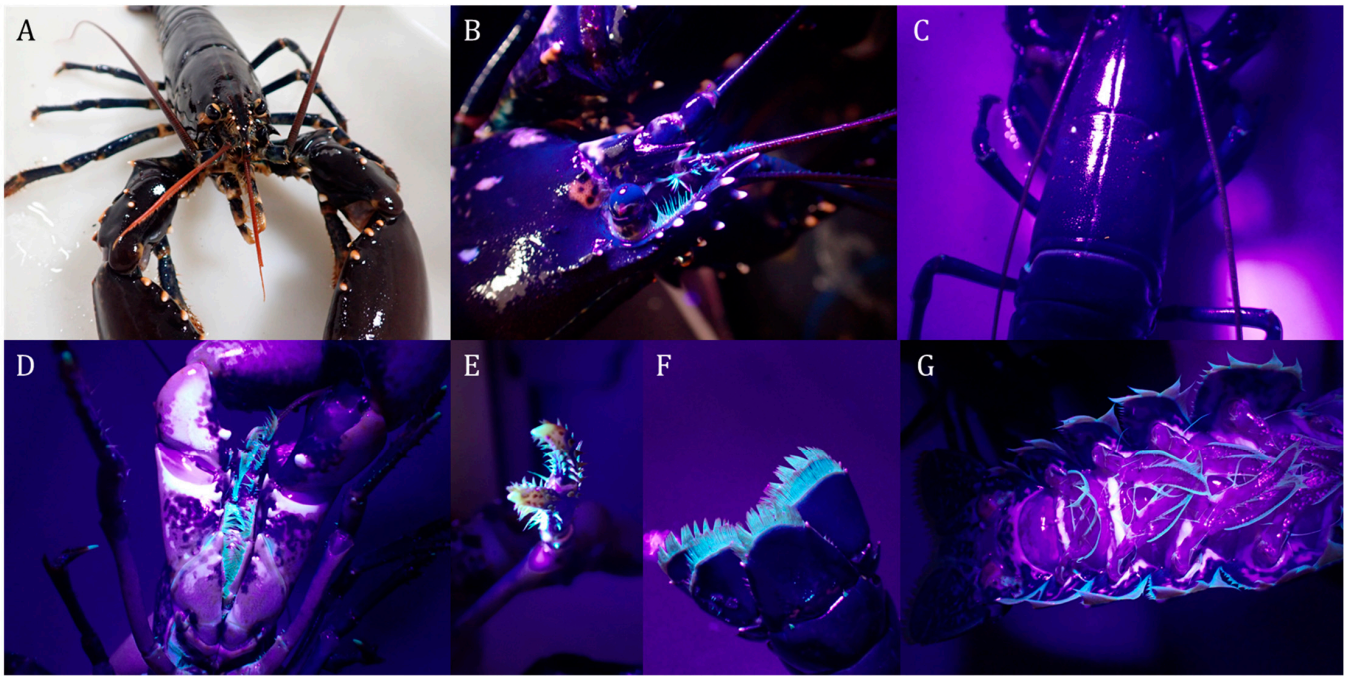


Figure 4. European lobster *Homarus gammarus* viewed in normal (**A**) and UV (**B**–**G**) light. Fluorescence was typically limited to setae at the rostrum (**B**) on the dorsal side but not the rest of the carapace (**C**). Ventral setal fluorescence was present across the mouthparts (**D**), pereiopods (**E**; excluding chelae), telson (**F**), and pleopods (**G**). The lobster pictures here had a carapace length of ~9 cm.

https://doi.org/10.3390/d18040224

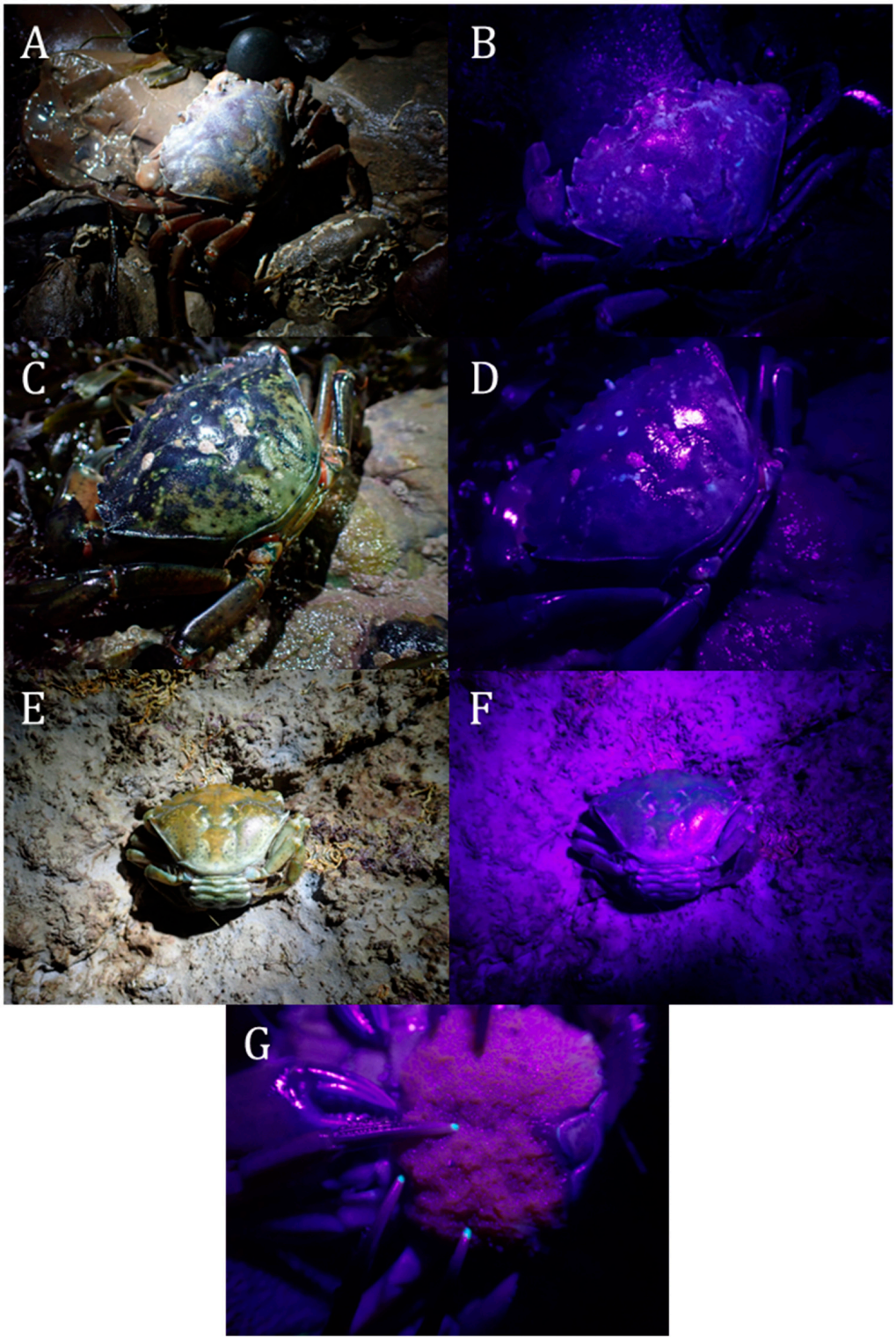


Figure 5. Views of three green crabs *Carcinus maenas* (**A**,**B** ~9 cm CW, **C**,**D** ~6 cm CW, **E**–**G** ~5 cm CW) under ambient (**A**,**C**,**E**) and UV light (**B**,**D**,**F**,**G**). Fluorescence was seen most clearly on the largest (and oldest) crab, matching carapace patterning (**B**), though it was also seen on dactyli tips (**G**). White growth on the carapace also fluoresced (**C**,**D**).

The lack of observation of fluorescence in some species at any particular stage does not rule it out: the relevant moult stage, age, or sex may not have been observed, or the signal strength of fluorescence in some areas may not have been detected by the observers. If fluorescence development is seasonal, it also may have been missed. UV examination in

other wavelengths may also yield results not found here. This is also the reverse in the case of fluorescing species: stages or sexes not examined may not fluoresce in the same manner as adults, and no pelagic (larval) stages were assessed of any species.

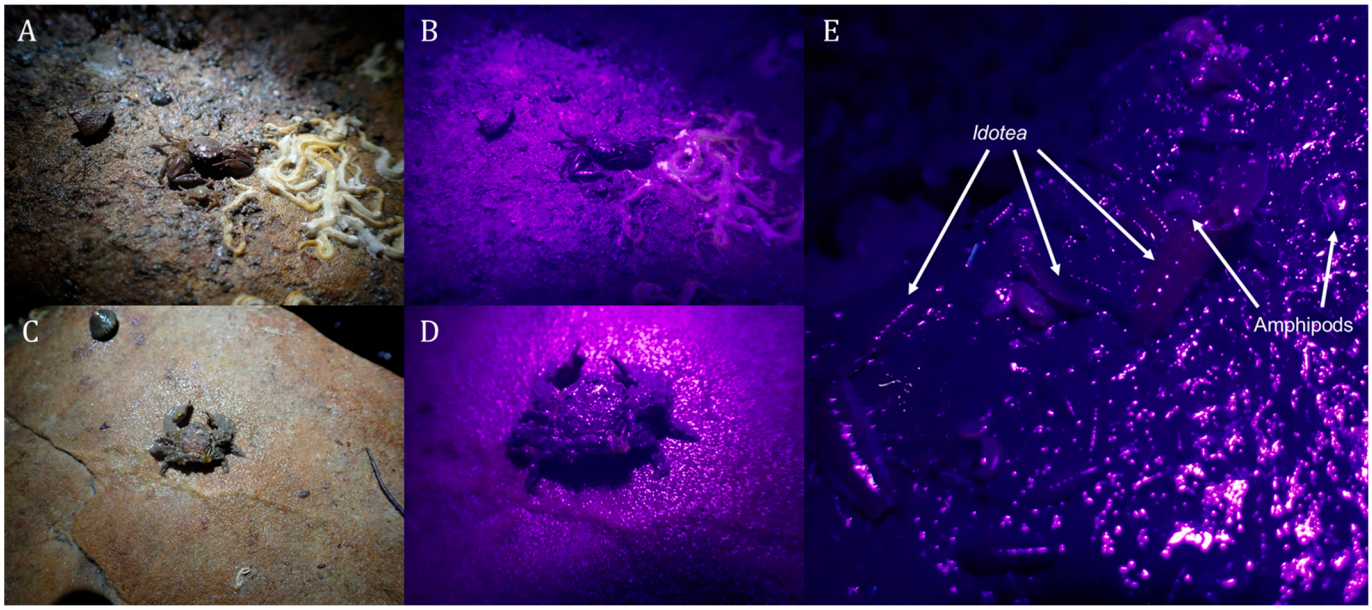


Figure 6. Views of the long claw porcelain crab *Pisidia longicornis* (**A**,**B**, <1 cm CW) and broad claw porcelain crab *Porcellana platycheles* (**C**,**D**, ~1 cm CW) under normal (**A**,**C**) and UV (**B**,**D**) light, displaying no fluorescence. *Idotea* isopods and amphipods under UV (**E**) also displaying no fluorescence (individual sizes ~1 cm).

Overall, we highlight the variability of fluorescence within and between species to bring attention to its potential impact in ecology. Fluorescence is helpful in locating camouflaged species such as *H. araneus* (TIB pers. obvs.) and has the capacity to aid identification of similar species [6]. More widespread knowledge of this phenomenon could aid in guiding future experimentation and surveys of species with fluorescent properties.

Author Contributions: Concept, investigation, writing—original draft: T.I.B. Supervision, writing—review and editing: D.M.P. and A.J.B. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Institutional Review Board Statement: Crustaceans, while recognised as sentient in the UK, are afforded no protection under the law, and ethical assessments do not need to be undertaken for them. All animals photographed for this paper were handled with care and returned to the wild once photographed (except in the cases of adult *Cancer pagurus* and *Homarus gammarus*, which were in use for a different experiment).

Data Availability Statement: The original contributions presented in this study are included in the article. Further inquiries can be directed to the corresponding author.

Acknowledgments: TIB would like to thank Ian Baxter, who gifted the UV torch, Boyd Dunster and William Lewis, for joining the rockpooling jaunt which resulted in the project, and Peter Crighton and Matthew Nicholson for aiding in the subsequent photography trip. Thanks to Vicki Balfour and Mark James for access to their crabs and lobsters.

Conflicts of Interest: The authors declare no conflicts of interest.

References

1. Berthier, S.; Schöllhorn, B. Fluorescence. In *Light-Arthropod Interactions*; Berthier, S., Schöllhorn, B., Eds.; Springer Nature: Cham, Switzerland, 2026; pp. 295–341, ISBN 978-3-031-76224-6.
2. Lawrence, R.F. Fluorescence in Arthropoda. *J. Entomol. Soc. South. Afr.* **1954**, *17*, 167–170.
3. Glenn, D.; Pakes, M.J.; Caldwell, R.L. Fluorescence in Arthropoda Informs Ecological Studies in Anchialine Crustaceans, Remipedia, and Atyidae. *J. Crustac. Biol.* **2013**, *33*, 620–626. [CrossRef]
4. Juhasz-Dora, T.; Thesslund, T.; Maguire, J.; Doyle, T.K.; Lindberg, S.-K. Investigation of Biofluorescence Produced by the Red King Crab Paralithodes Camtschaticus. *Aquac. Fish Fish.* **2024**, *4*, e159. [CrossRef]
5. Mazel, C.H.; Cronin, T.W.; Caldwell, R.L.; Marshall, N.J. Fluorescent Enhancement of Signaling in a Mantis Shrimp. *Science* **2004**, *303*, 51. [CrossRef] [PubMed]
6. Ze-Lin, W.; Ngan-Kee, N.; Teo, S.L.-M.; Parra-Velandia, F.J. Fluorescent Patterns in Some Portunus Species (Custacea: Brachyura: Portunidae). *Contrib. Mar. Sci.* **2012**, *35*, 135–143.
7. Herring, P.J. Bioluminescence in Decapod Crustacea. *J. Mar. Biol. Assoc. UK* **1976**, *56*, 1029–1047. [CrossRef]
8. Cronin, T.W. The Visual Ecology of Predator-Prey Interactions. In *Ecology of Predator-Prey Interactions*; Oxford University Press: New York, NY, USA, 2005; pp. 105–138.
9. Lynott, J. Behind the Shot: Fluoro Spiny Squat Lobster. Available online: https://www.divephotoguide.com/underwater-photography-special-features/article/behind-shot-fluoro-spiny-squat-lobster-scotland/ (accessed on 8 April 2026).
10. Lynott, J. FluoDiving Scotland—James Lynott Photography. Available online: https://jameslynott.smugmug.com/Underwater-Fluorescence/FluoDiving-Scotland (accessed on 13 March 2026).
11. Cronin, T.W.; Hariyama, T. Spectral Sensitivity in Crustacean Eyes. In *Proceedings of the The Crustacean Nervous System*; Wiese, K., Ed.; Springer: Berlin/Heidelberg, Germany, 2002; pp. 499–511.
12. Losey, G.S.; Cronin, T.W.; Goldsmith, T.H.; Hyde, D.; Marshall, N.J.; McFarland, W.N. The UV Visual World of Fishes: A Review. *J. Fish Biol.* **1999**, *54*, 921–943. [CrossRef]
13. Rajchard, J. Ultraviolet (UV) Light Perception by Birds: A Review. *Vet. Med.* **2009**, *54*, 351–359. [CrossRef]
14. Johnson, M.L.; Gaten, E.; Shelton, P.M.J. Spectral Sensitivities of Five Marine Decapod Crustaceans and a Review of Spectral Sensitivity Variation in Relation to Habitat. *J. Mar. Biol. Assoc. UK* **2002**, *82*, 835–842. [CrossRef]

Disclaimer/Publisher's Note: The statements, opinions and data contained in all publications are solely those of the individual author(s) and contributor(s) and not of MDPI and/or the editor(s). MDPI and/or the editor(s) disclaim responsibility for any injury to people or property resulting from any ideas, methods, instructions or products referred to in the content.