

# Species Boundaries Dilemma in Diatoms: Distinguishing Separate Species from the Ends of a Continuum

Maya Flores, Christopher Lobban, Ph.D.  
University of Guam

## Introduction

Diatoms are one of the most important groups of eukaryotic microalgae, playing a vital role in global oxygen production. Among the many diatom genera, *Mastogloia* (primarily a marine group) stands out for its distinctive morphology. This genus contains a large number of morphologically similar species, many of which differ only in subtle features. Such overlap often makes accurate identification challenging, especially when relying on light microscopy alone. As a result, species may be misidentified or entirely overlooked. It appears that this was the case for two diatom researchers: Paddock and Kemp. In 1988, Paddock and Kemp published a paper identifying *M. mediterranea* in a sample collected from Belize. *M. indonesiana* was also present in the same sample, though it was overlooked entirely. This was likely due to the subtle morphological differences between the two species, including variation in the number of partecta and peduncles, as well as valve shape and size. At the time, the microscopy technology available to them was less advanced (as seen in their LM images in Fig. 1.), which likely contributed to the oversight. In contrast, the SEM used in our lab allows for the observation of minute morphological details, making it much easier to distinguish between closely related species.

Additionally, given that *M. mediterranea* and *M. indonesiana* are geographically disjunct and have never again been found together in a single sample, the presence of both species raises more questions. Kemp and Paddock reportedly received the material from divers, suggesting the possibility of potential contamination from residual sediment in the collection container, resulting in a “dustbin” sample.

## Methods

The samples observed in this study originate from Guam and Indonesia. In preparation to be examined, samples were cleaned with nitric acid and rinsed with distilled water. If any calcium carbonate was still present, they were then put through a hydrochloric treatment. The processed samples were then placed onto stubs and coated in preparation to be loaded into a scanning electron microscope (SEM) (Phenom World desktop XL G2, running at 10 kv with low emission). Light microscopy with a Nikon i80 (with differential interference contrast) was also used in the viewing of specimens.

## Results

Results revealed consistent differences between the two groups across several morphological traits, with no intermediate forms observed. *M. indonesiana* specimens were generally larger, with more chambers and peduncles, and a rhombic-lanceolate valve shape. In contrast, *M. mediterranea* was smaller, with fewer chambers and peduncles, and a more elliptical-lanceolate valve shape. These distinguishing features remained stable across all observed specimens.

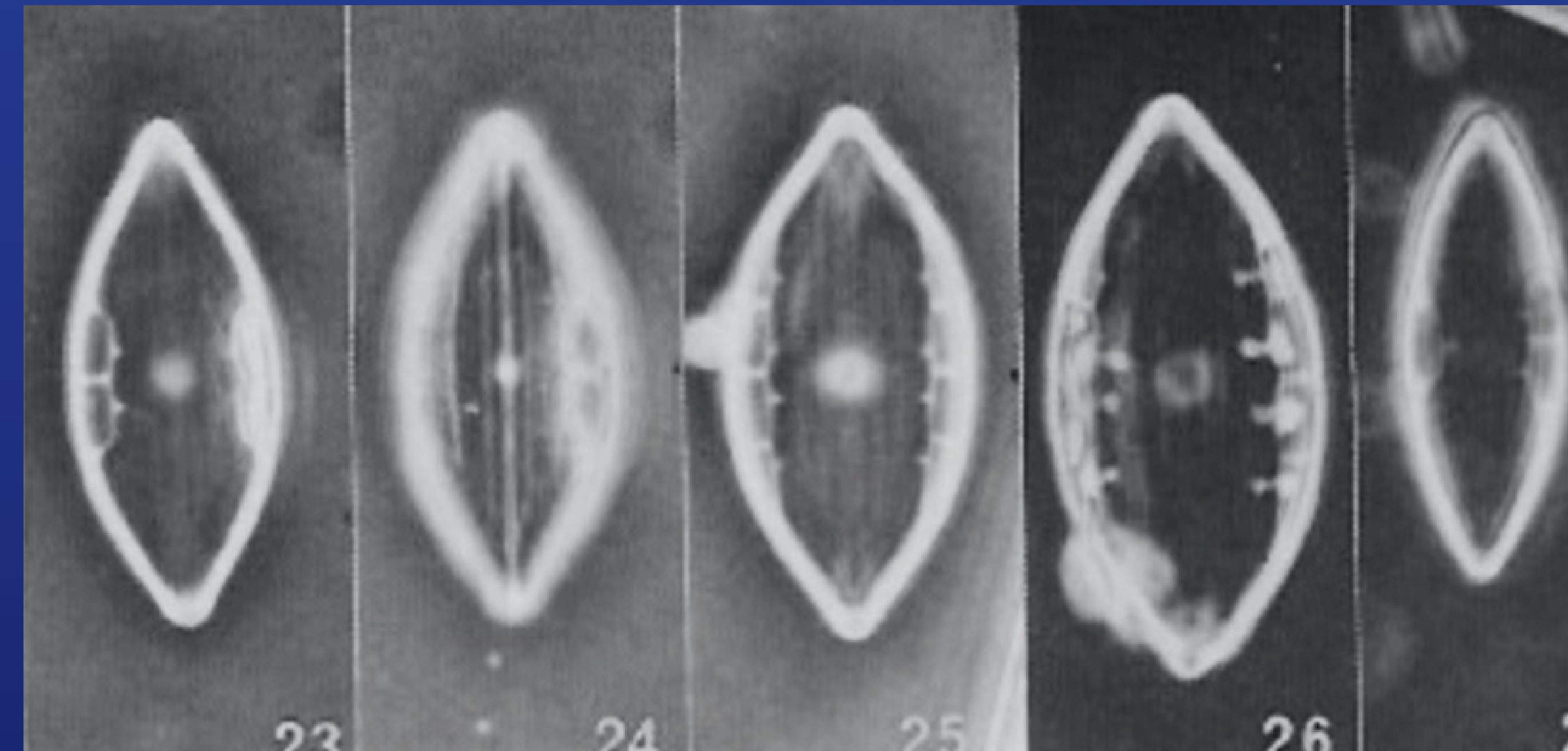


Fig 1. Paddock and Kemp's light microscopy images

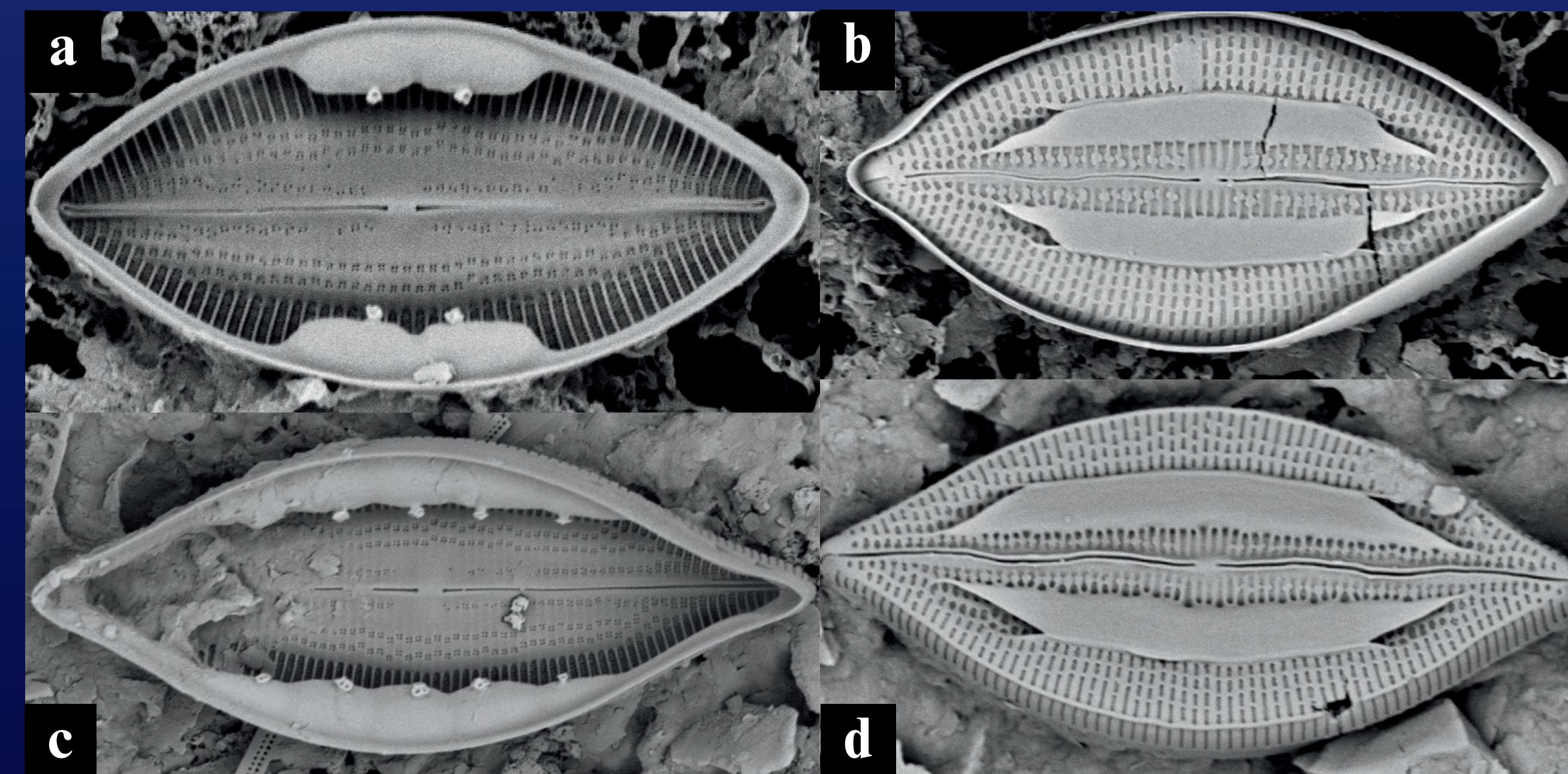


Fig 2. *M. mediterranea* interior (a) and exterior (b) and *M. indonesiana* interior (c) and exterior (d)

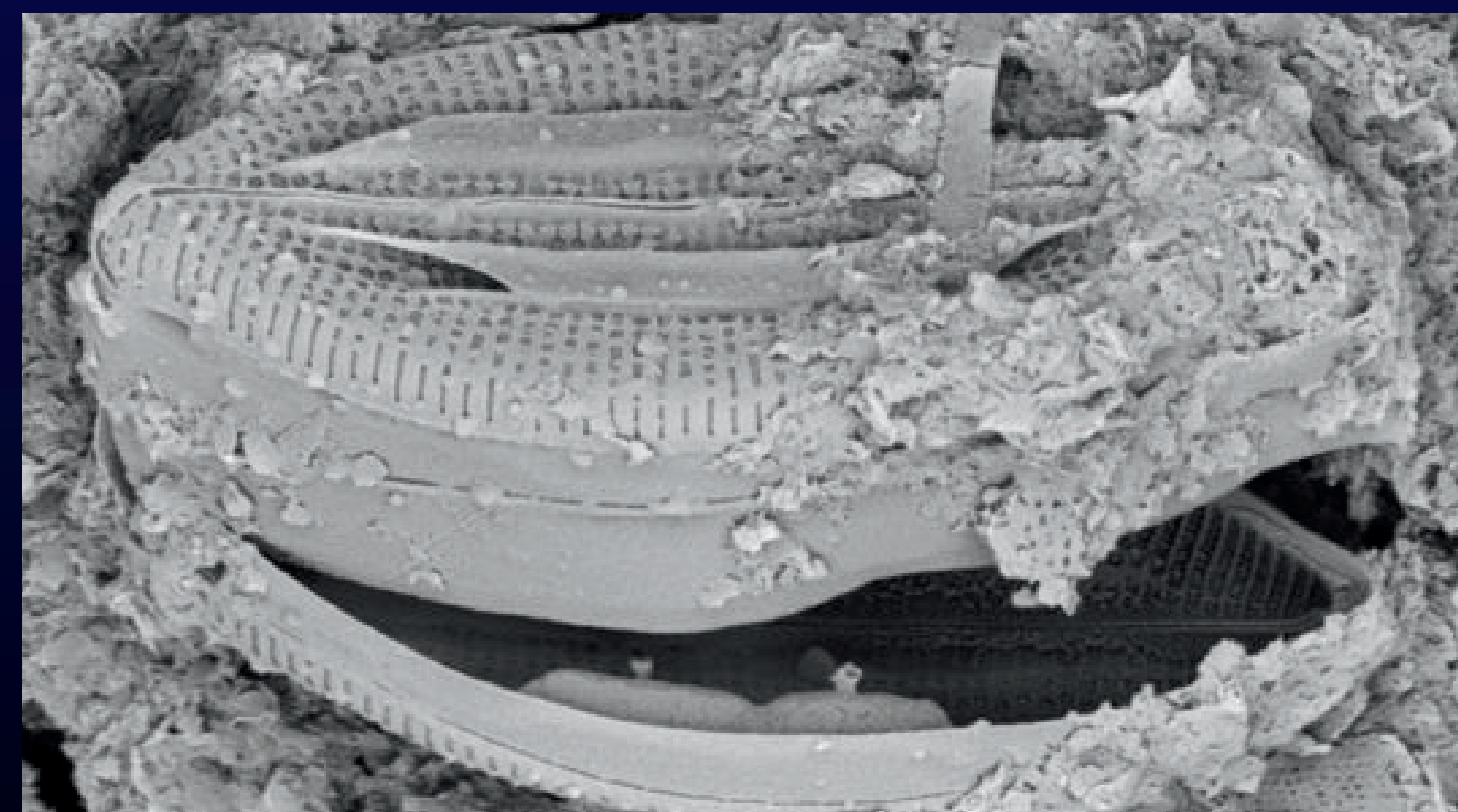


Fig 3. *M. mediterranea* Rosetta Stone

## Discussion

The use of scanning electron microscopy (SEM) was critical in enabling detailed examination of these morphological traits, particularly in distinguishing the subtle differences between the two species. One of the major challenges in diatom taxonomy is matching exterior valve views with interior ones, as the two halves of a frustule are often separated after the samples are properly prepared for viewing. Without direct evidence, it is impossible to be completely certain that a particular exterior and interior belong to the same individual. This uncertainty can only be resolved by finding a “Rosetta Stone” image; an SEM image where the valve is slightly open, allowing both interior and exterior features to be observed simultaneously (as seen in Fig. 3). In the case of *M. mediterranea*, we now have a Rosetta Stone image, which allows us to confidently identify the species even when only an exterior or interior valve is present. The evidence collected and careful observations, in the absence of population genetic data, support the interpretation that *M. mediterranea* and *M. indonesiana* are indeed separate species.

## Conclusion

In summary, detailed morphological analysis supported by SEM imaging has revealed consistent and reliable differences between *M. mediterranea* and *M. indonesiana*, with no evidence of intermediate forms. The discovery of a Rosetta Stone image for *M. mediterranea* has further strengthened our ability to distinguish between the species with more confidence. While these findings support the interpretation that the two are distinct species, future work could include the search for a Rosetta Stone image of *M. indonesiana*, which would allow for definitive matching of its interior and exterior features. Additionally, the integration of population genetic data would help confirm species boundaries with greater certainty.

## Acknowledgements

I'd like to acknowledge my mentor, Christopher Lobban, Ph.D., for his shared knowledge and support that made the completion of this study possible. I'd also like to acknowledge Cheryl Sanguenza, Ph.D., Franki Guerrero, and Axel Defngin for their amazing and undying support and upliftment throughout my time in this program.

## References

1. PADDOCK, T. B. B. & KEMP, K.-D. (1988). A description of some new species of the genus *Mastogloia* with further observations on *M. elegans* and *M. goessii*. *Diatom Research*, 3, 109-121
2. PADDOCK, T. B. B. & KEMP, K.-D. (1990). An illustrated survey of the morphological features of the Diatom genus *Mastogloia* Thwaites ex Wm Smith. *Didom Research*, 5, 73-103
3. LOBBAN, CHRISTOPHER. (2025). Towards a biogeography of *Mastogloia* (Diatomeae: Bacillariophyceae): a preliminary checklist for Yap, Micronesia, with new ultrastructure images and a review of problems. *Nova Hedwigia*. 120. 10.1127/nova\_hedwigia/2025/0977.