

Insights into cleaner-client specialization in coral reefs of Guanahacabibes National Park, Cuba

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INTRODUCTION

- Cleaner species play a key ecological role in coral reefs, affecting fish health and community structure. Their coexistence may involve functional segregation, behavioral or in their interaction patterns with clients, which influences network stability and resilience.
- Guanahacabibes National Park (GNP) harbors ecologically well-preserved reefs with multiple cleaner species, yet cleaning mutualisms remain scarcely studied in the area.
- This setting thus provides an ideal natural framework to test whether redundancy or specialization underpins the dynamics of cleaning interaction networks.

OBJECTIVE

To assess the degree of functional differentiation among coexisting cleaner species in Guanahacabibes National Park (GNP) coral reefs by analyzing their interaction patterns, cleaning behavior, and client selectivity.

RESULTS

1 | We recorded a diverse cleaning network across 76 stations, involving 4 cleaner species and 32 client species. The network included 65 cleaner - client pairs and 1,823 interactions, showing overall homogeneous activity across sites.

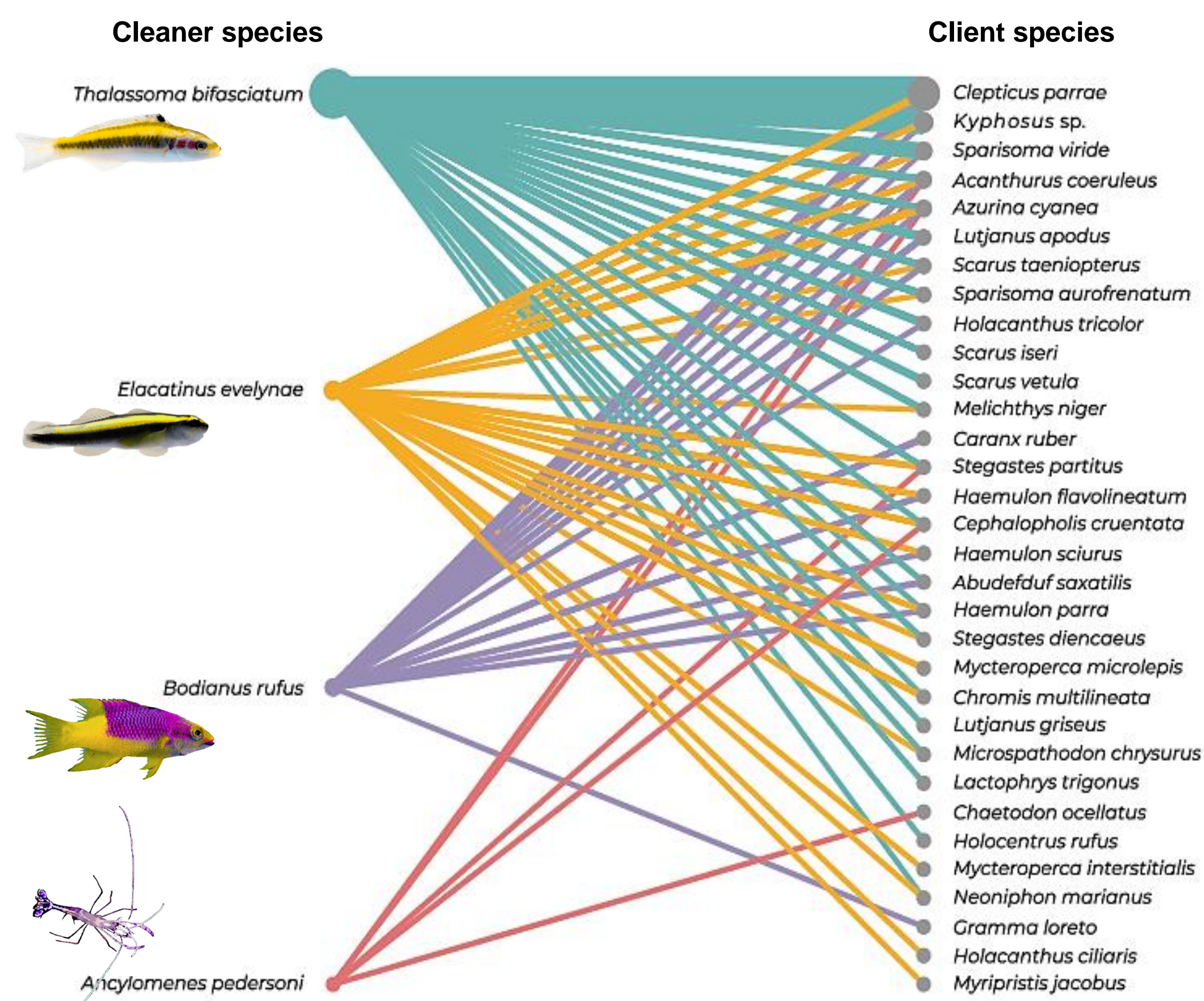


Figure 2. Bipartite cleaning network in Guanahacabibes National Park, Cuba. Line width = interaction frequency; node size = total interactions per species.

3 | Interaction strategies differed among species: facultative cleaners (*T. bifasciatum* and *B. rufus*) engaged in more frequent but shorter interactions, while dedicated cleaner species (*E. evelynae* and *A. pedersoni*) had fewer but longer interactions.

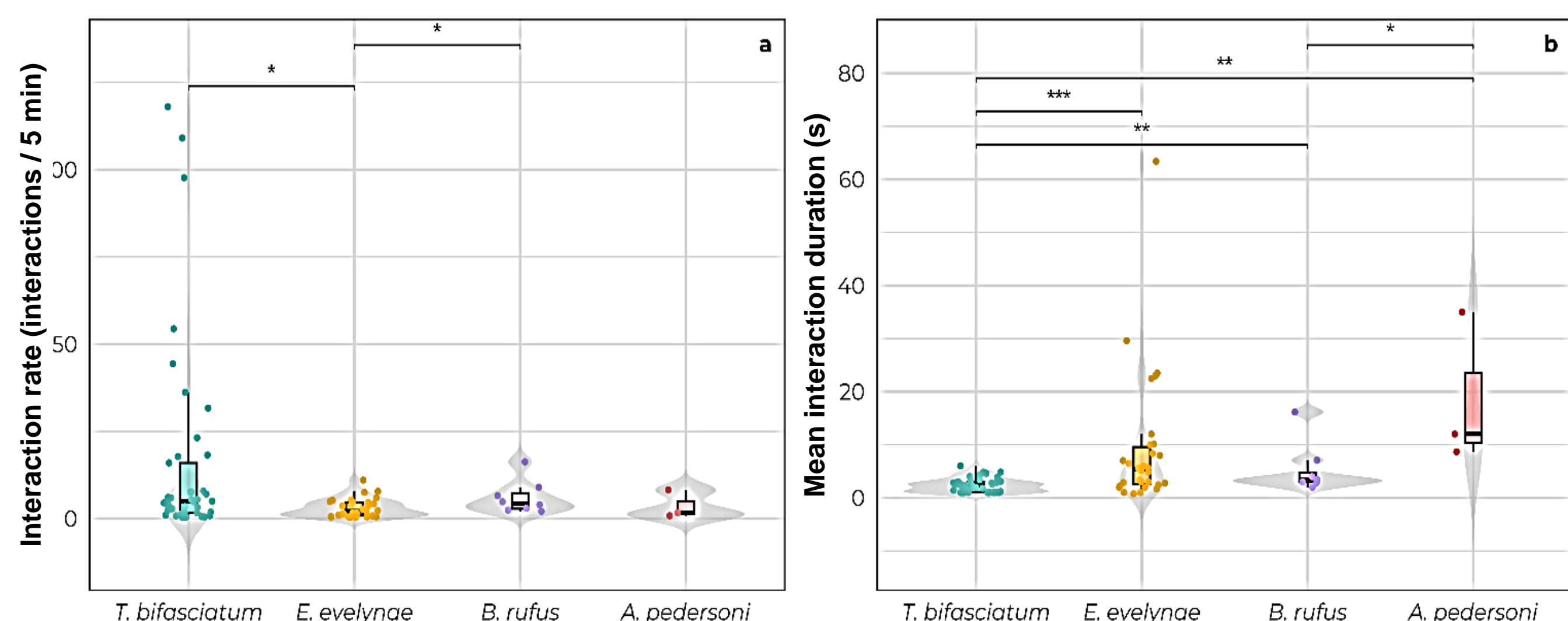


Figure 4. Cleaner species behavior in Guanahacabibes National Park: (a) interaction rate (per 5 min), (b) mean interaction duration (s).

CONCLUSIONS

- Coexisting cleaner species in GNP show moderate functional differentiation: they vary in interaction frequency, duration, and client selectivity, yet maintain overlapping roles that reduce competition.
- Functional overlap combined with moderate differences likely stabilizes the cleaning network, allowing multiple species to coexist while contributing complementary ecological roles.

MATERIALS & METHODS

Date and location: March 2025. 10 sites surveyed in Cabo Corrientes (Cuba).

Methods: SCUBA dives (60 min, 5–18 m depth) → identification of cleaning stations → GoPro recordings (~10 min).

Video processing: Identification of individuals, species pairs, interaction frequency/duration.

Data analysis: Network structure multivariate interactions patterns, and behavioral data were evaluated and visualized in R environment.



Figure 1. Study area: sampling sites in Guanahacabibes National Park, Cuba.

2 | Cleaner identity shaped network structure. Despite functional overlap, species interacted with partially distinct client sets, showing broad sharing but preferential trends linked to client traits.

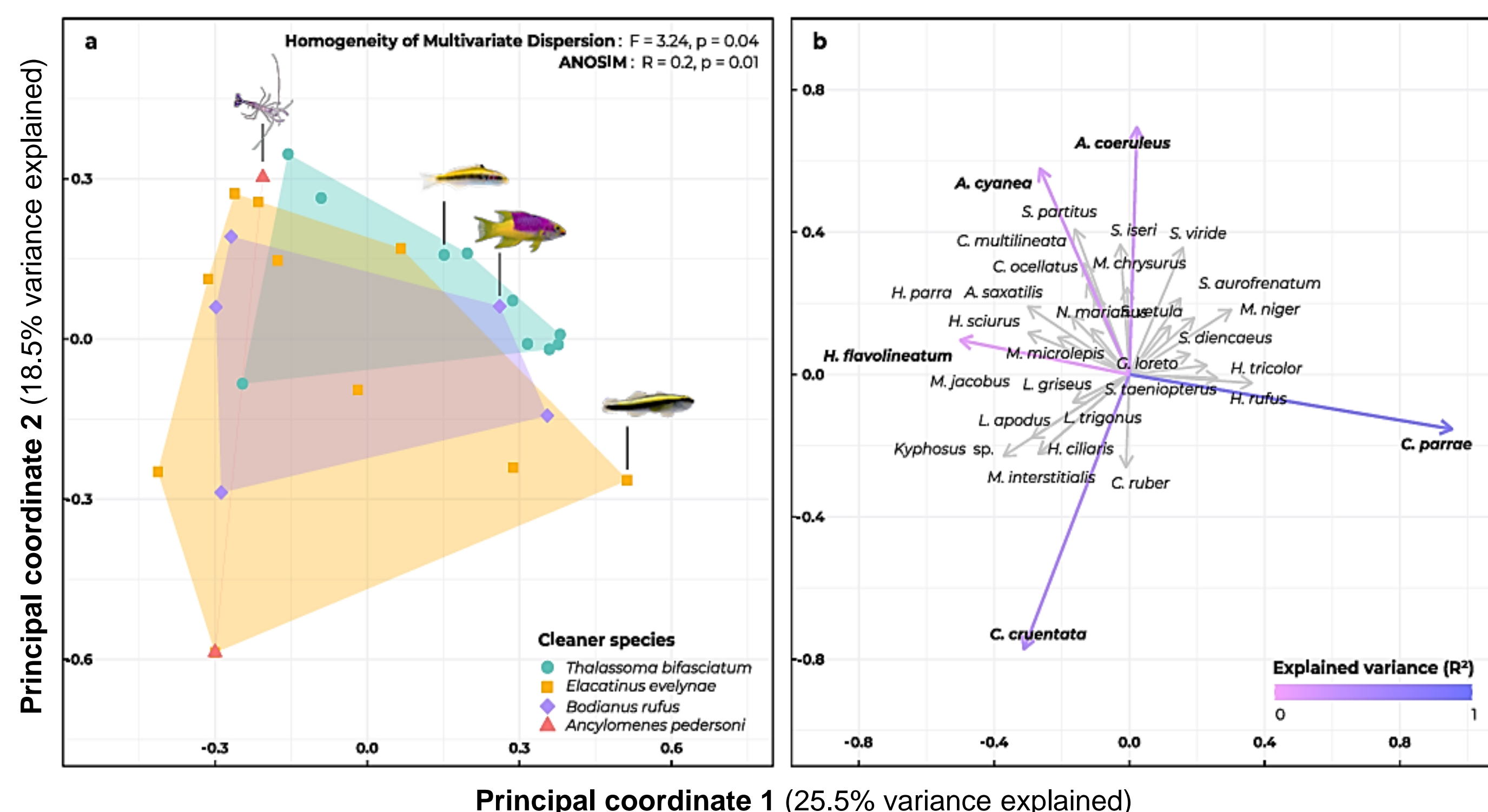


Figure 3. Interaction patterns between cleaner species and clients in Guanahacabibes National Park, Cuba. (a) PCoA showing client composition. (b) Vector projection indicating client species contributions.

4 | Cleaner species differed in network roles. *T. bifasciatum* was the most generalist and central, with highest species strength and normalized degree. *B. rufus* and *E. evelynae* played more restricted but relevant roles. No significant differences in *d'* specialization index, but species aligned along a gradient of partially overlapping functions.

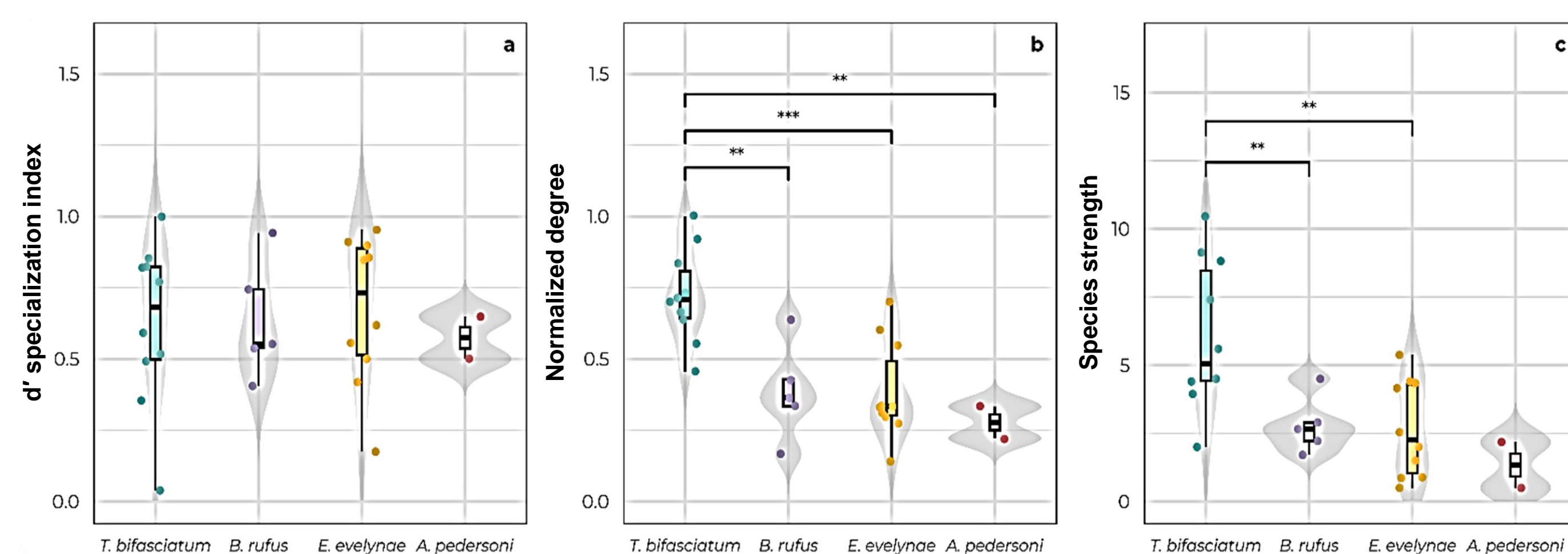


Figure 5. Bipartite network species-level indices for cleaners in Guanahacabibes National Park, Cuba: (a) *d'* specialization, (b) normalized degree, (c) species strength.

REFERENCES

Côté, I. M., & Brandl, S. J. (2021). Functional niches of cleanerfish species are mediated by habitat use, cleaning intensity and client selectivity. *Journal of Animal Ecology*, 90(12), 2834–2847. <https://doi.org/10.1111/1365-2656.13585>