A Regional Survey of Clypeasteroid and Spatangoid Echinoids of the Central Florida Keys

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Grun, T.B. and Kowalewski, M., 2022. Spatial distribution, diversity, and taphonomy of clypeasteroid and spatangoid echinoids of the central Florida Keys. PeerJ, 10, p.e14245. https://peerj.com/articles/14245/

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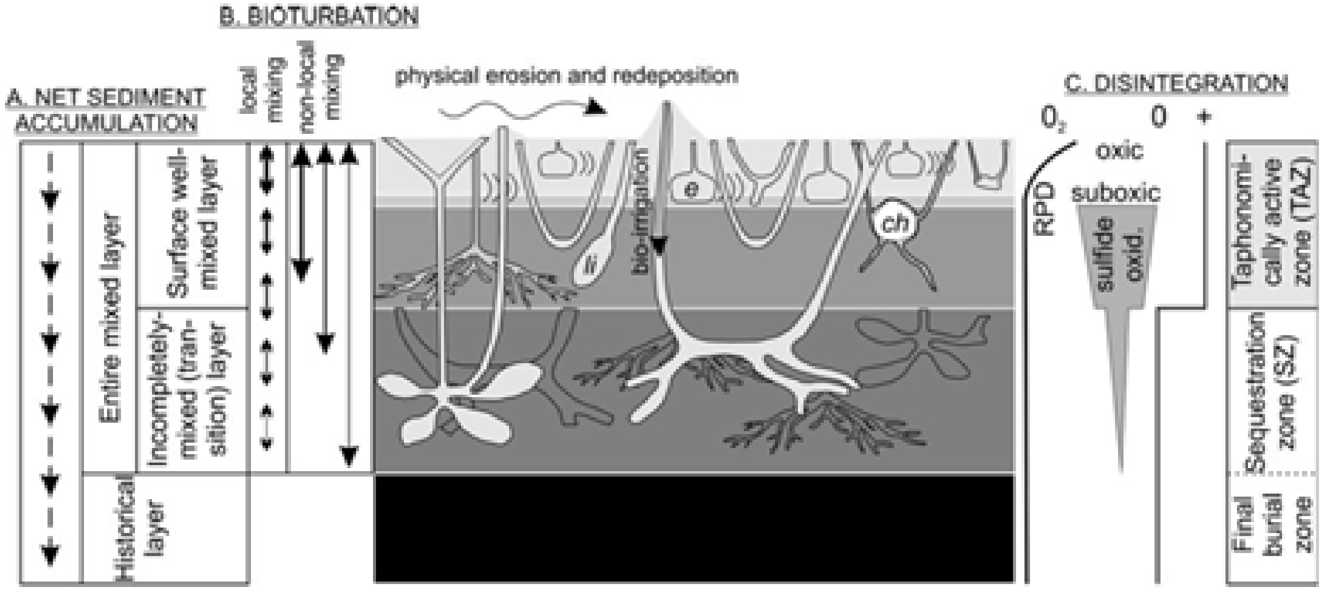
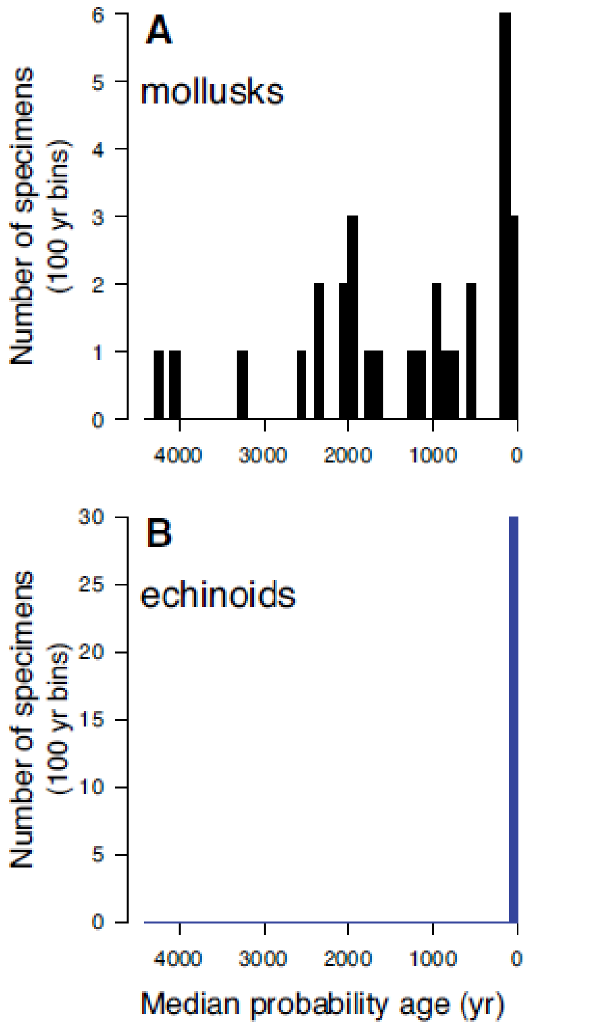
Why Do Paleontologists Study Modern Marine Ecosystems?

Reason 1 – Quality and Resolution of the fossil record

To understand how the fossil record forms and what type of information is preserved in the fossil record



Tomašových et al., 2024, *Paleobiology*



Kowalewski et al., 2018, *Geology*

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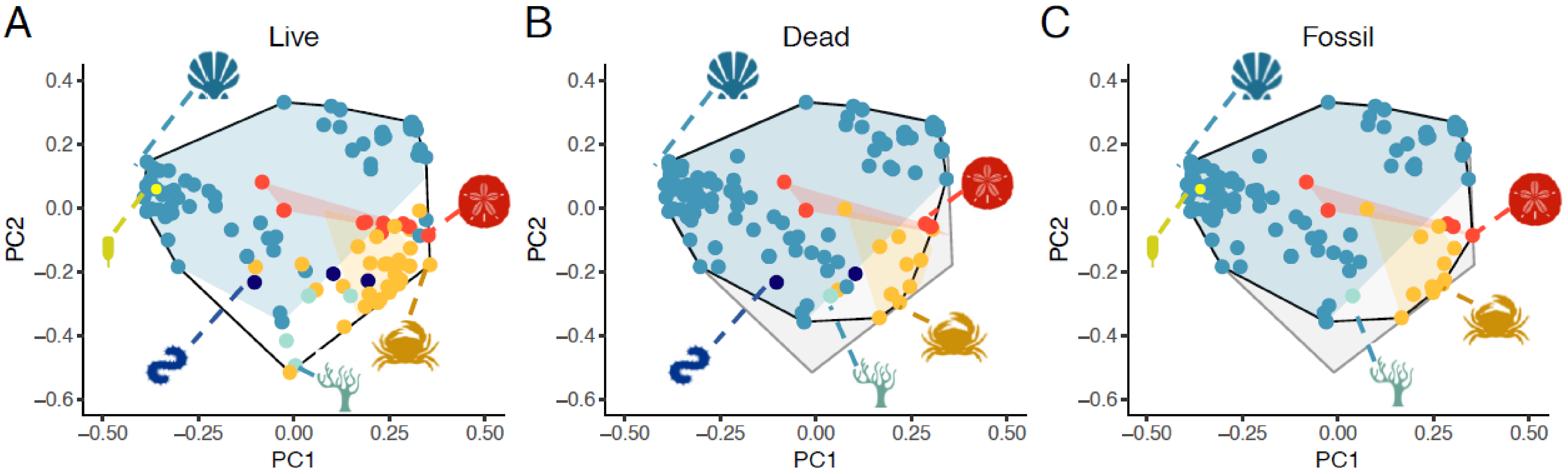
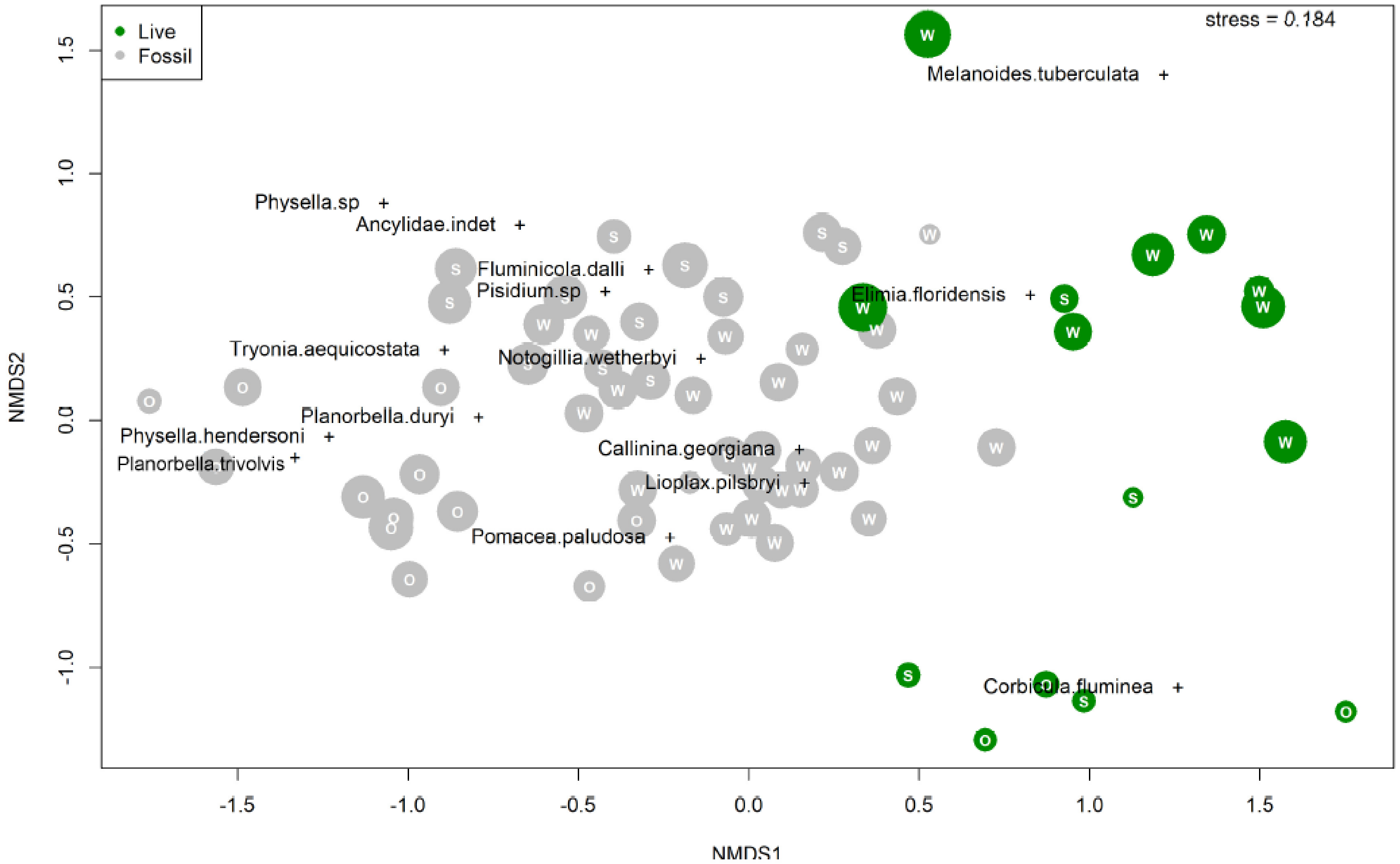


Tyler and Kowalewski, 2025, *PNAS*

Why Do Paleontologists Study Modern Marine Ecosystems?

Reason 2 – Conservation Paleobiology

The youngest fossil record archives last millennia of ecosystem history
(transition from pristine to human-impacted ecosystems)



Kusnerik et al., 2022, *Frontiers in Ecology and Evolution*

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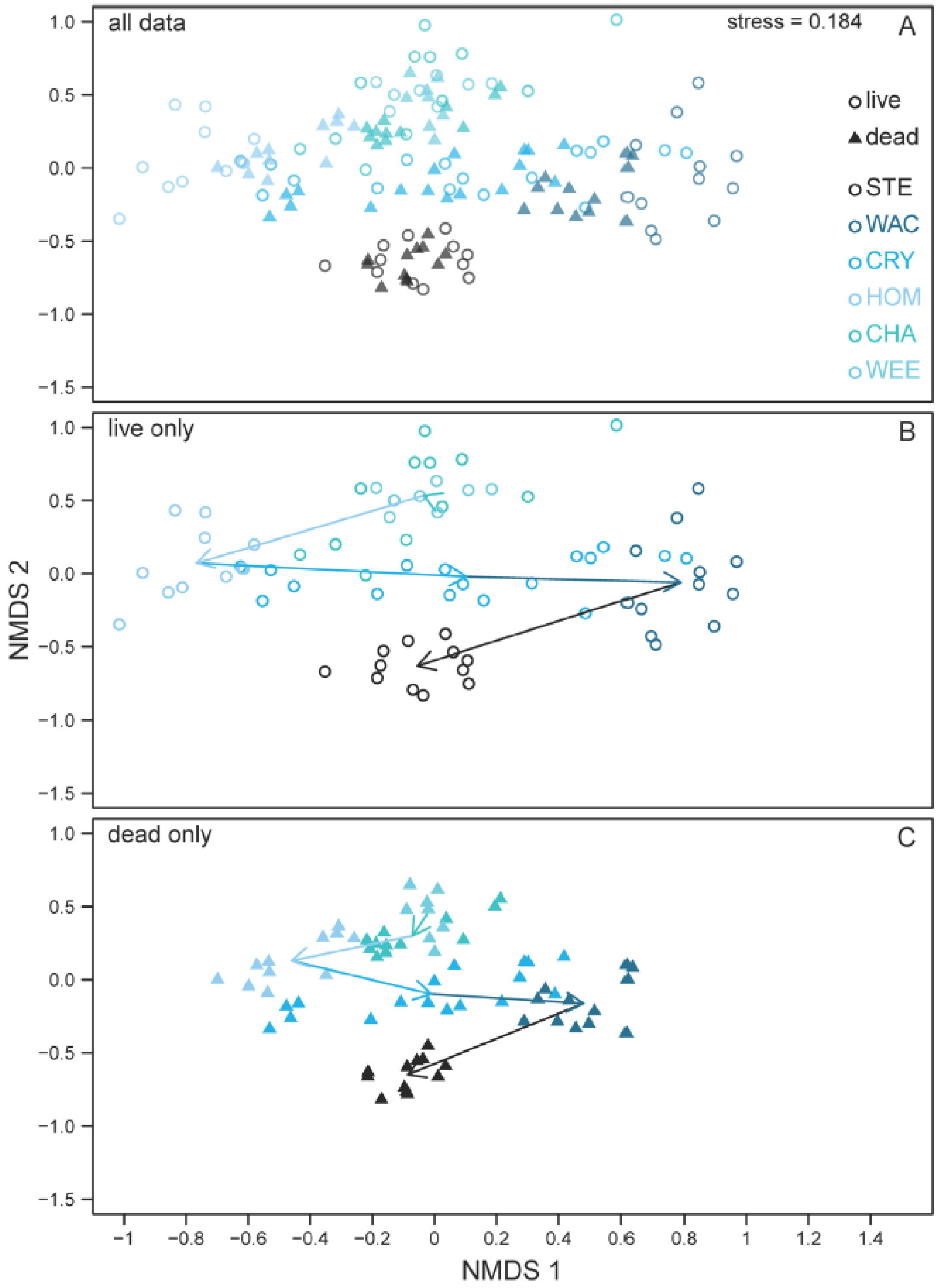

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Grimmelbein et al., 2025, *Marine Ecology Progress Series*

Why Echinoids of Florida Keys?

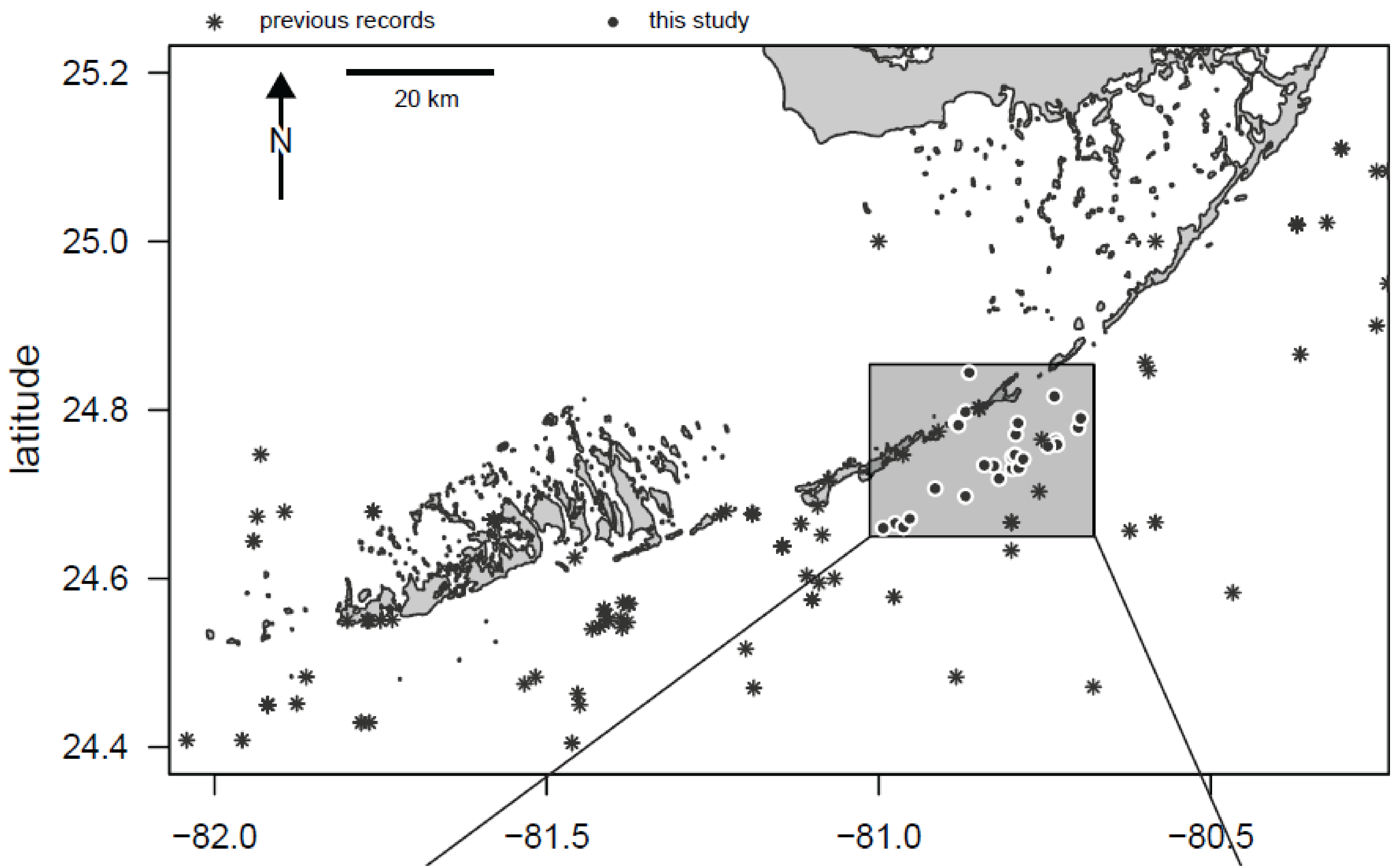
Echinoids are important ecosystem engineers with a long evolutionary history

Many irregular echinoid species form dense populations in open sand habitats

Sand dollars, sea biscuits and heart urchins were surveyed by researchers in 1960s (opportunity to examine changes in populations)

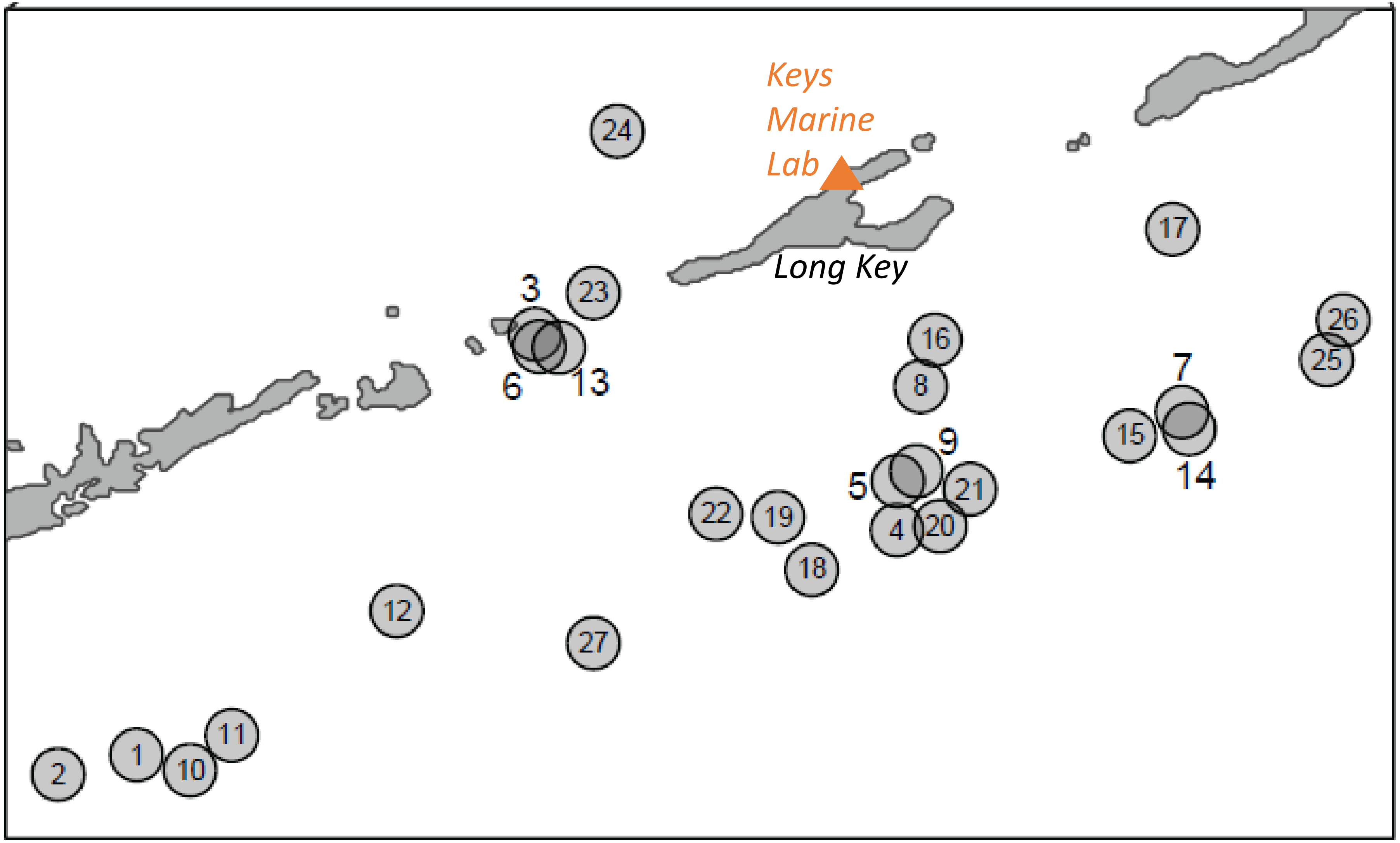
Tests of echinoids are distinct and unlike mollusk shells are quickly destroyed (potential non-invasive bio-inventorying tool)

Study Area



previous records
this study
20 km
N
latitude
25.2
25.0
24.8
24.6
24.4
−82.0
−81.5
−81.0
−80.5

Study Area



Keys
Marine
Lab
Long Key
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Methods

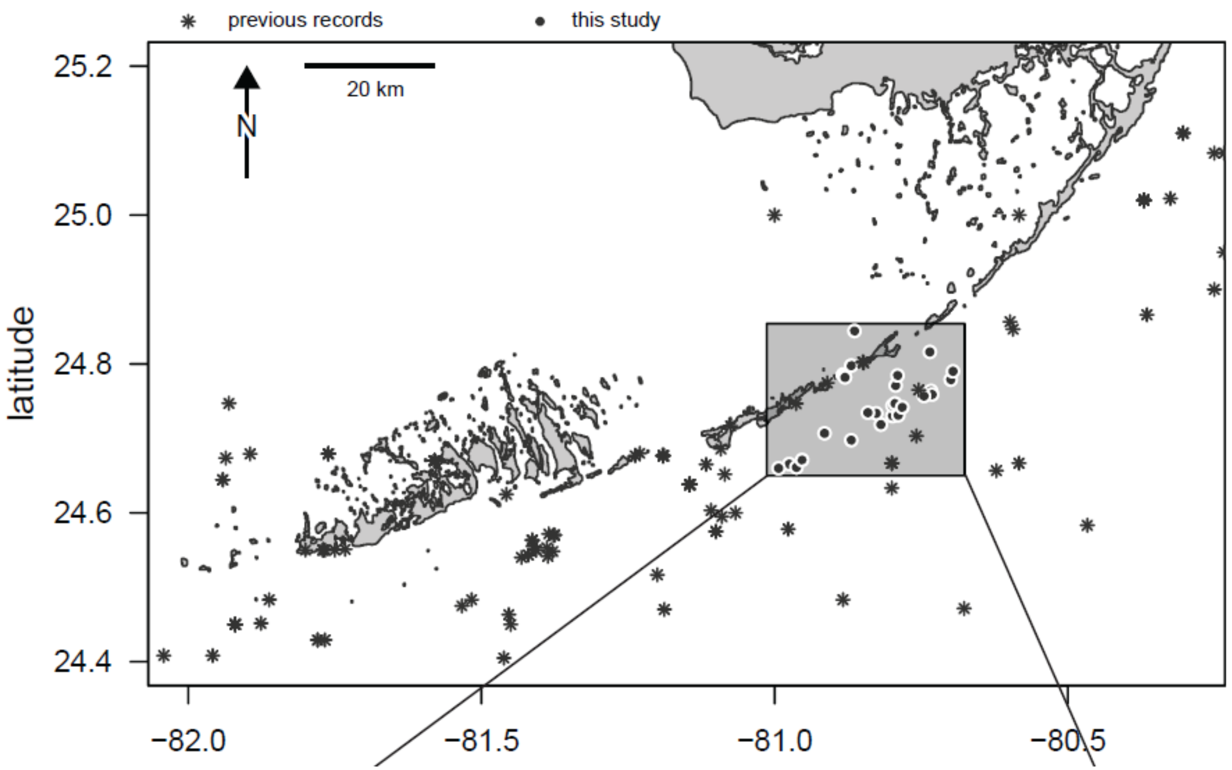
Three SCUBA daytime surveys by a team of two divers: August 2020, January 2021, and April 2021

Survey scope: 27 sites from nearshore seagrass to forereef (water depth from 1.8m to 37.5m)

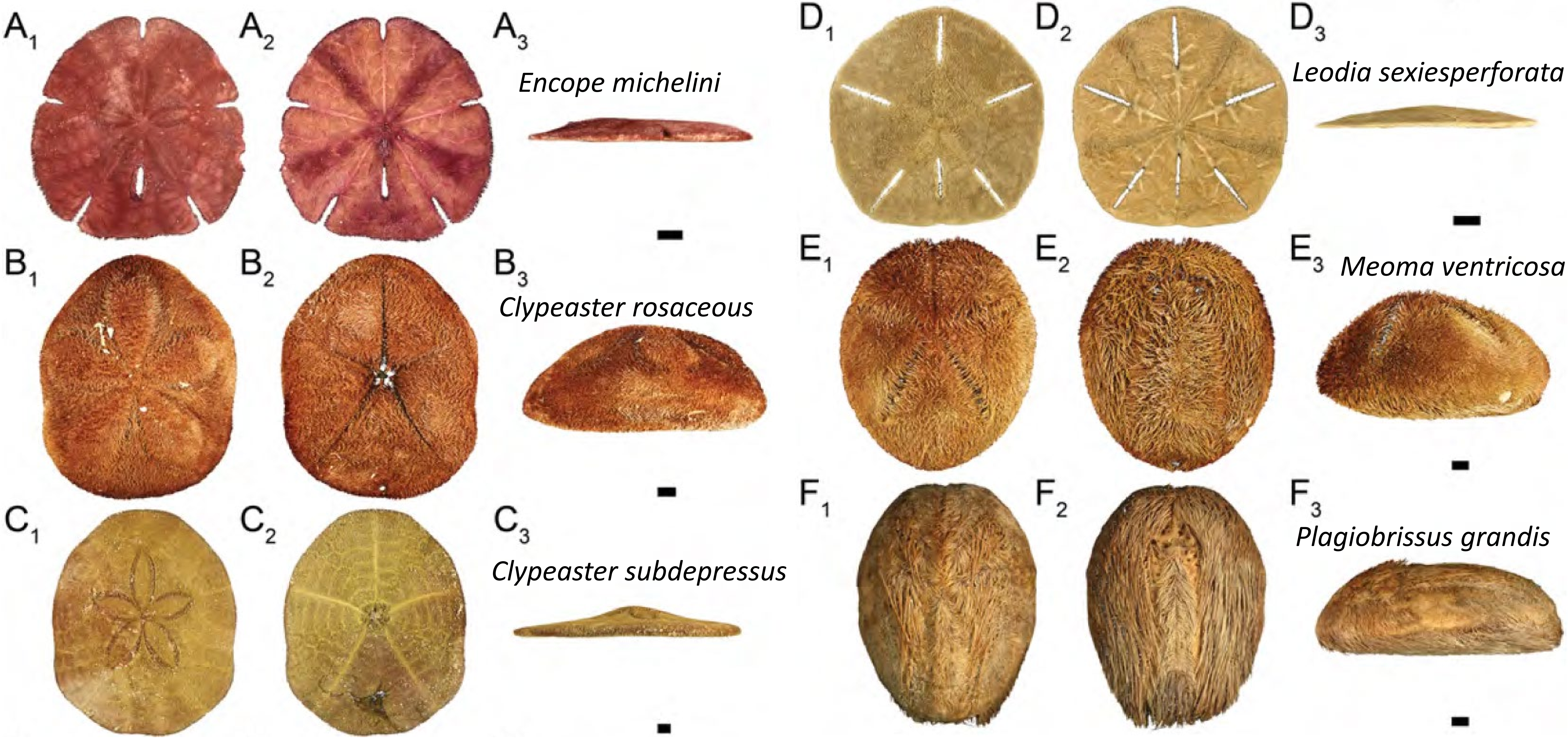
Each dive (15 ± 3 min) was a survey for live echinoids, echinoid tests (denuded skeletons), test fragments, and echinoid-produced trails. Sediment was hand-raked to a depth of ~15 cm (whenever soft sediment was present)

The abundance was estimated using three ordinal ranks: present (< 3 specimens per square meter), common (3 to 10 specimens), and abundant (>10 specimens)

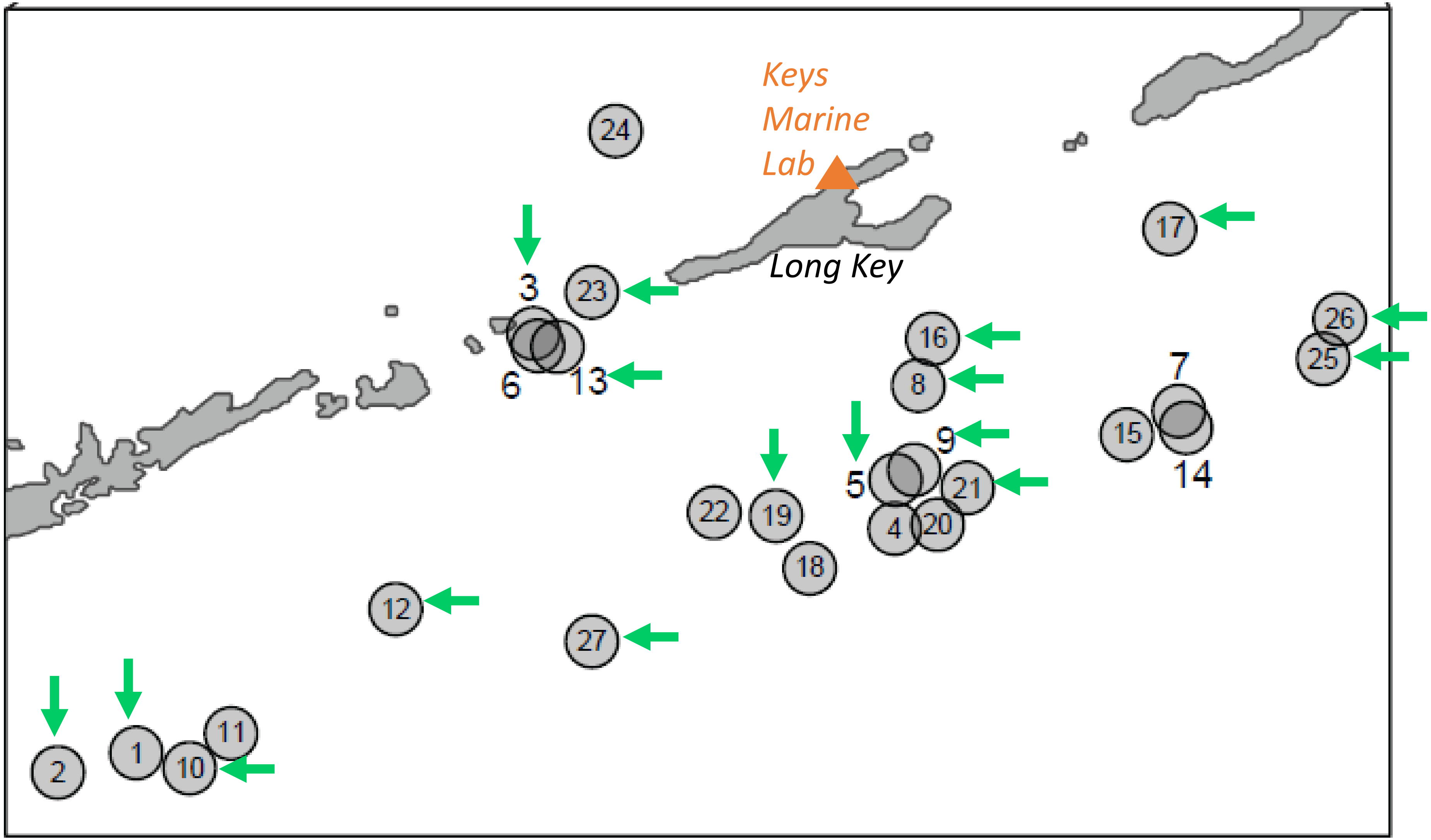
Past collection efforts were summarized using iDigBio database, FLMNH Specify portals, and the primary literature



Six species were identified



Out of the 27 surveyed sites, irregular echinoids were found at 17 sites (63%)



At all sites, at which echinoids were present, one species dominated, and in some cases only one species was observed.

At five sites three or more species occurred (5, 8, 9, 21, 26)

In one case, 5 species were found within a single patch (9)

At 7 out of 17 sites at which echinoids were present, they were abundant (>10 per m^2)

Dense live populations were invariably dominated by one species: *Meoma ventricosa* (21), *Leodia sexiesperforata* (5), *Clypeaster rosaceous* (8 & 18).

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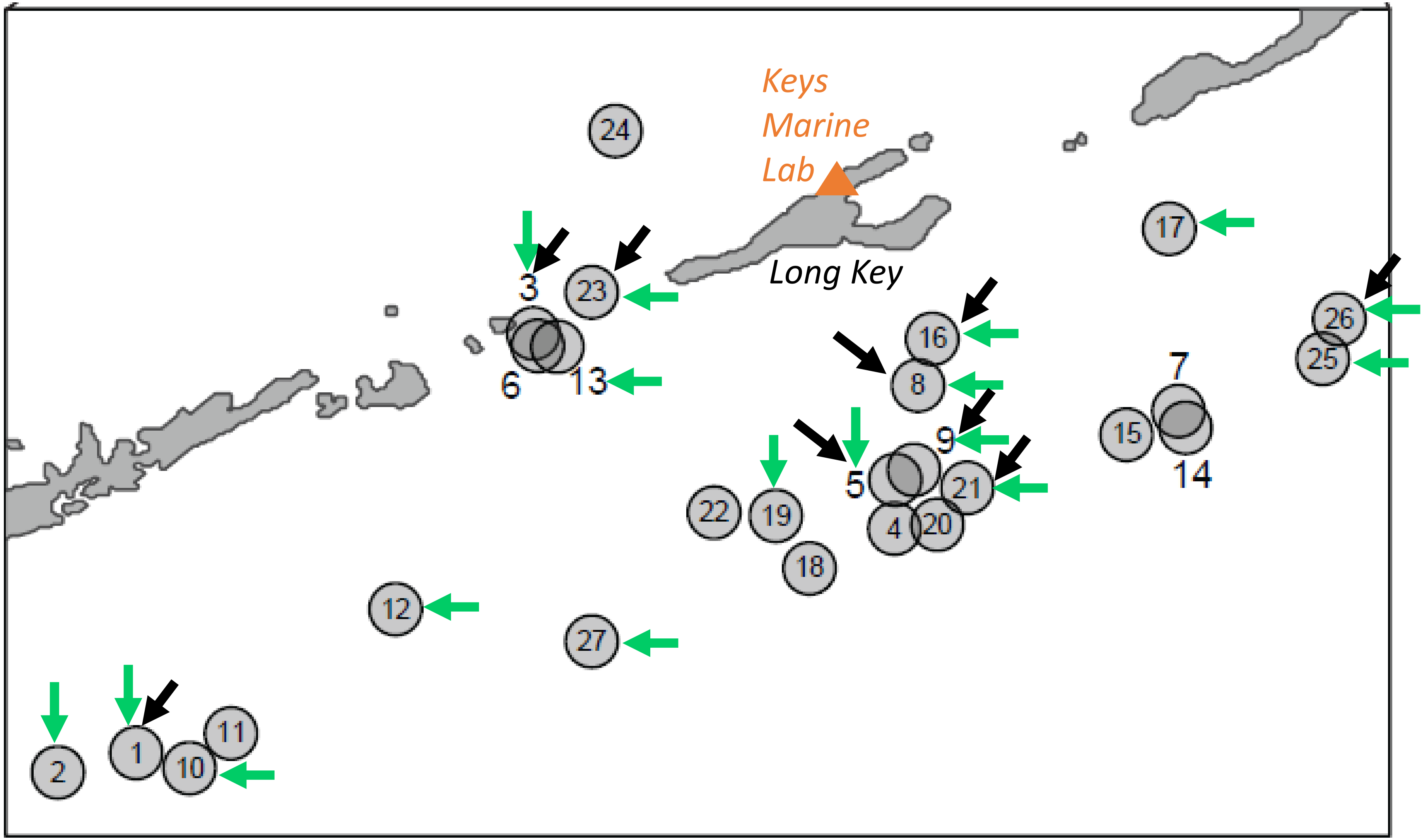
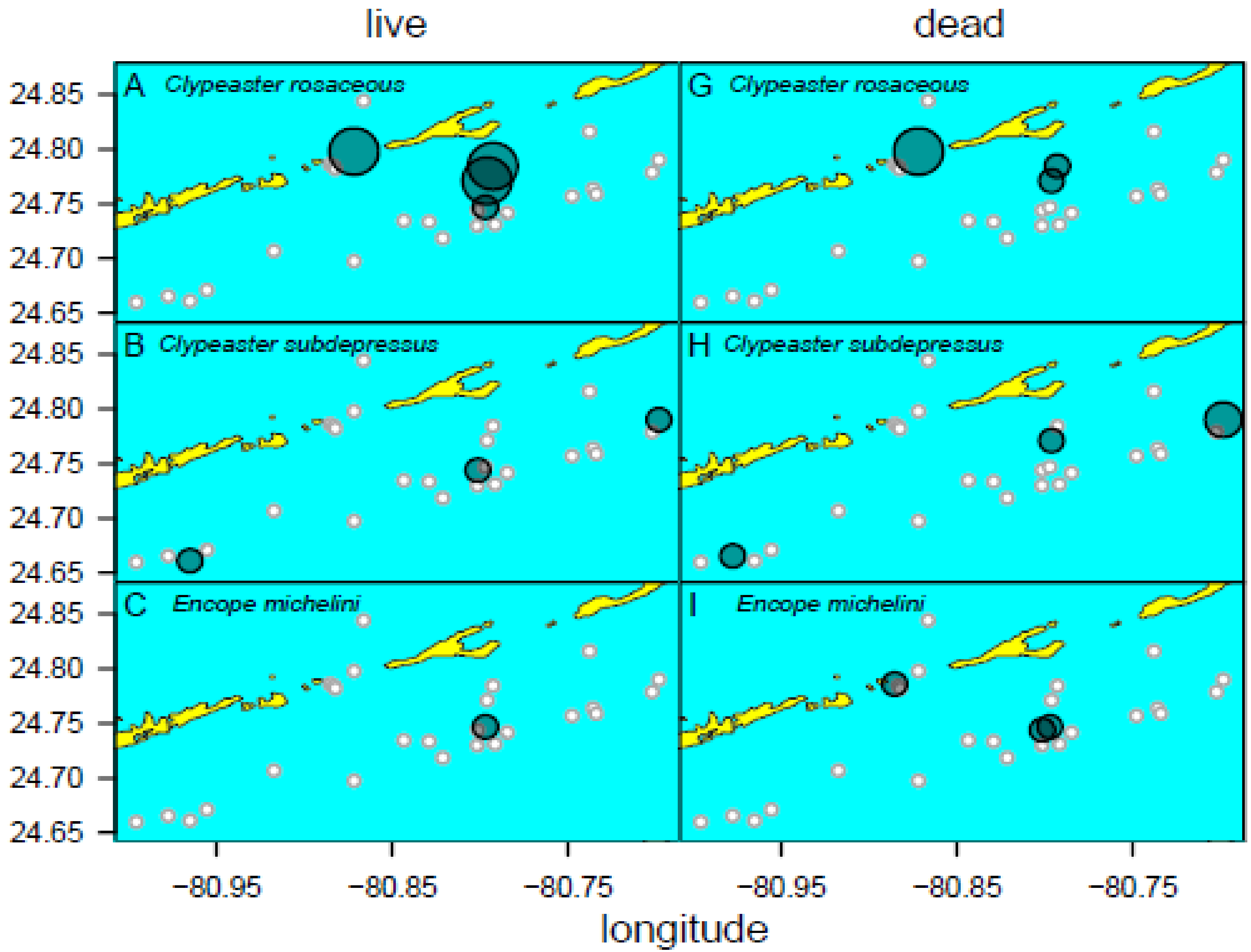


Dead remains were found at nine sites (33% of sites) and abundant tests were found at two sites

Dead remains were found at sites where live echinoids were observed.

In places where live echinoids were abundant, bare tests were typically found in higher numbers as well

Species vary in distribution across sites (dead track live)



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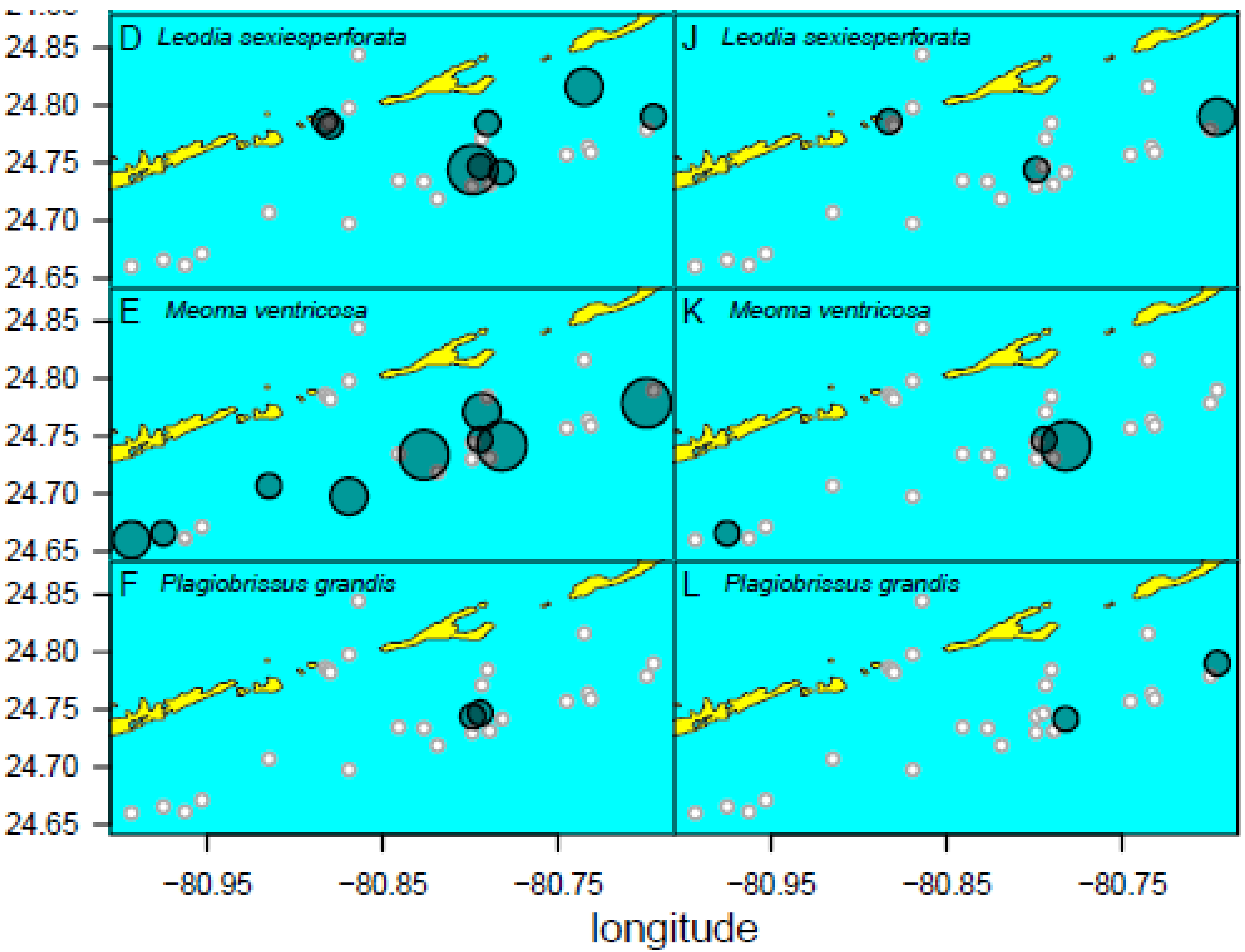
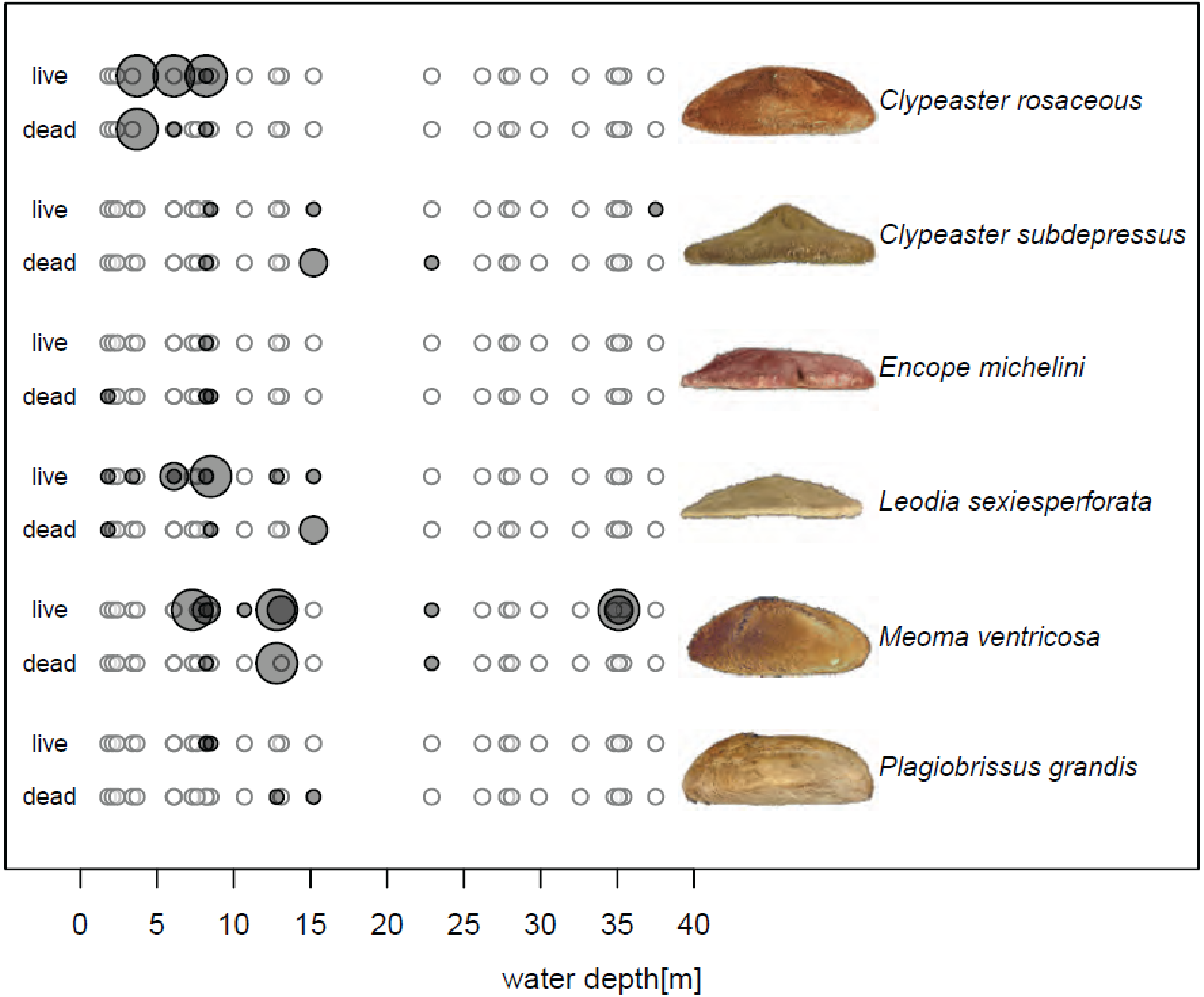
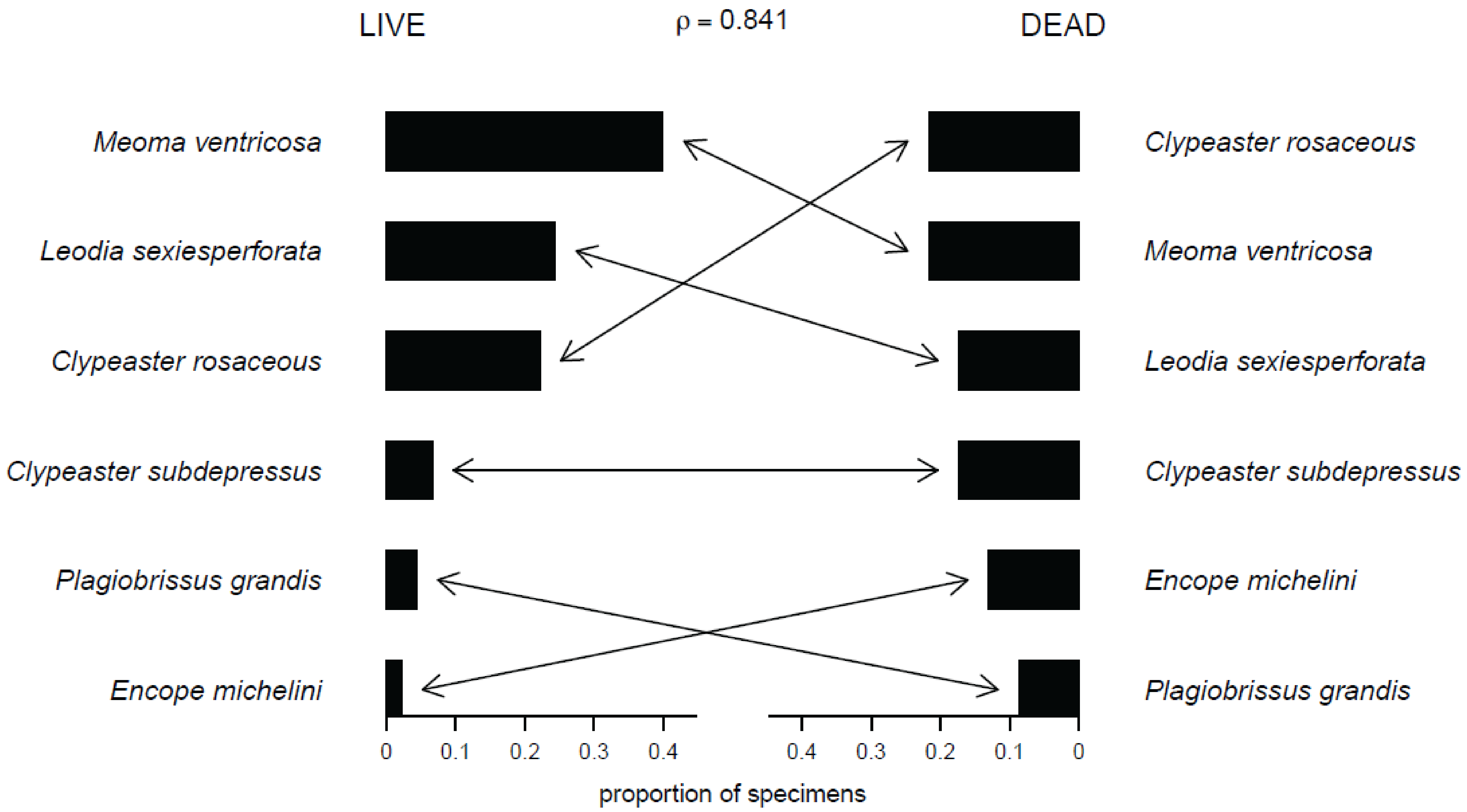


Bathymetric distribution (more abundant and widespread in shallow settings)

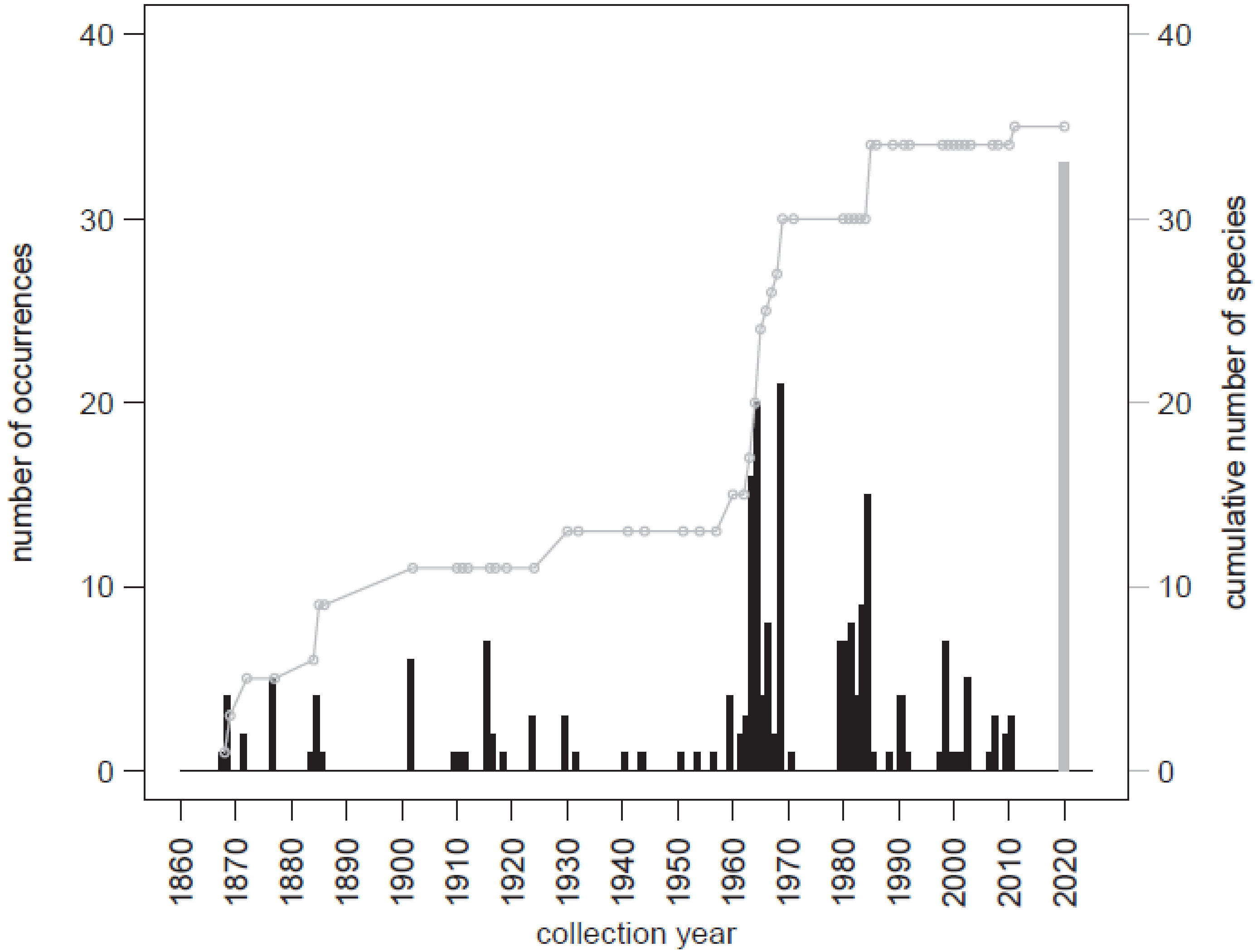


Echinoids were more widespread, abundant, and diverse in shallower waters (<20 m), including seagrass and algae meadows, open sand flats, and backreef settings, but less common in deeper forereef habitats.

Remains of dead echinoids provide reasonable estimates of living populations



Historical Review of Echinoid Surveys

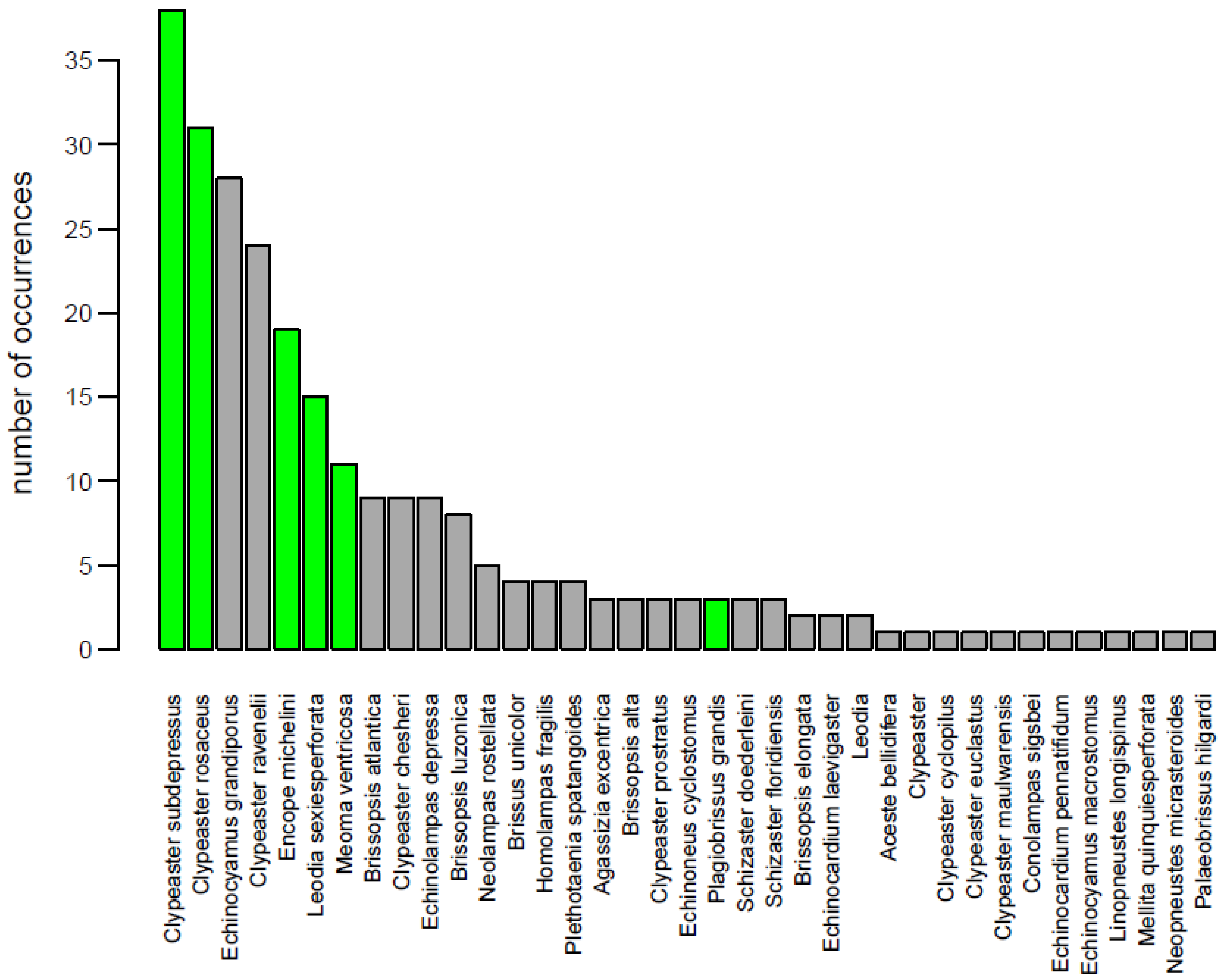


Most of the efforts focused on bio-inventorying echinoids around Florida Keys took place in the mid-to-late 20 century and declined dramatically over the most recent decades

The first cluster of sampling events in the 1960s reflects extensive sampling efforts by Kier and Grant (1965) and Chesher (1969)

The second cluster dates back to 1984 and 1985, a time interval that directly follows the die off of *Diadema antillarum* (Lessios et al., 1984; Lessios, Robertson & Cubit, 1984). This massive mortality event, which likely started in January 1983 (Lessios, 2016), may have triggered a spike in echinoid surveys.

Historical Review of Echinoid Surveys



All six species reported here were previously documented in the region

Five of those taxa were among the seven species most frequently encountered in the past

The present-day faunal assemblages resemble closely faunal assemblages reported by Kier and Grant in 1965 (60 years ago) from a comparable array of habitats in the Key Largo area

They found total of eight clypeasteroid and spatangoid species, including the same six species identified in our survey.

The two additional species reported from Key Largo (*Brissus unicolor* and *Schizaster floridiensis*) were rare or represented by dead tests only.

Echinoids have remained the same

Consistent with Kier and Grant (1965) and Chesher (1969):

1. Echinoid species occurred in spatially constrained patches dominated by single species

2. Common biotic interactions include predation by cassid snails and infestation by symbiotic pea crabs

3. Tiering, mobility, and other characteristics are in line with the ecological knowledge for the six observed species

4. Most species were observed in back reef and coastal habitat, whereas the only irregular echinoid relatively common in the deeper, forereef habitat was *Meoma ventricosa*

The similarities between this and past surveys suggest that spatial distribution and faunal composition of dominant echinoids have NOT undergone any substantial changes over the last 60 years

Are dead remains useful?

The high fidelity indicated by live-dead comparisons suggests that dead remains may archive spatial distribution and taxonomic composition of local echinoid populations.

The high live-dead agreement could either mean that echinoid patches persist through time and/or dead remains disappear quickly.

Regardless, the observed spatial and compositional fidelity indicates that dead remains track closely living populations.

Echinoid remains provide valuable, minimally invasive bio-inventorying data.

Echinoid bio-inventorying

Most of the efforts focused on bio-inventorying echinoids around Florida Keys took place in the mid-to-late 20 century and declined dramatically over the most recent decades

Our survey allows for comparative assessment with past surveys and should serve as an important reference point for future reassessment and monitoring efforts