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Occurrence and relative abundance of the warm-water indicator Euphylax dovii (Crustacea: Portunidae) in Northern Peru waters during the developing 2026/2027 El Niño

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Research Article

Keywords: Portunid Swimming Crabs, Mesoscale Hydrographic Boundaries, Neustonic Aggregations, Biological Indicators, Thermal Habitat Window

Posted Date: November 26th, 2026

DOI: https://doi.org/10.21203/rs.3.rs-11723110/v1

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Additional Declarations: No competing interests reported.

Abstract

Early detection and spatial characterization of pelagic marine species responding to climatic anomalies provide critical insights into the biological connectivity and progressive changes in eastern boundary upwelling systems. This study evaluates the neustonic incursion and relative abundance of the portunid crab *Euphylax dovii* across cross-shelf transects off northern Peru (Chicama and Paita) during the initial development of the 2026/2027 El Niño event. Standardized vessel-based visual censuses combined with hydrographic profiling revealed that species occurrences were strictly restricted to a middle-to-outer shelf corridor spanning 40 to 80 nautical miles offshore, effectively isolated from cooler inshore upwelling zones and extreme oceanic warm cores. Non-parametric comparisons, multivariate principal component analysis, and generalized linear mixed models confirmed that the swarms were anchored to a constrained environmental window characterized by sea surface temperatures between 23.52°C and 24.90°C, supporting the hypothesis that localized hydrographic convergence and shelf-edge dynamics drive biological transport during warm events. Spatial symmetry between port and starboard observation counts validated the reliability of standardized vessel-based monitoring protocols. Overall, integrating quantitative visual sighting rates into routine oceanographic surveys enhances real-time early-warning capabilities and ecological monitoring of tropical marine species incursions. Our data indicate a more southerly distribution for *E. dovii* than previously reported.

1. Introduction

During warm El Niño (EN) events, the relaxation of upwelling-favorable winds and the deepening of the thermocline reduce the vertical supply of nutrients to surface waters. This process drives a progressive shift from the typically eutrophic conditions of the Northern Humboldt Current System (NHCS, with a dynamic northern border ~ 5° C) toward almost oligotrophy during extreme conditions, accompanied by a decline in the organic loading that sustains a shallow oxygen minimum zone (OMZ) (Tarazona and Arntz 2001; Graco et al. 2019). Concurrently, the poleward intrusion of warm, well-oxygenated Equatorial Surface Waters (ESW) onto the continental shelf alters the vertical structure of temperature, salinity, and dissolved oxygen (DO) (Huyer et al. 1987; Racault et al. 2017). Unlike the persistent, oxygen-deficient subsurface waters characteristic of the Peruvian coast under non-El Niño conditions, these incoming equatorial water masses transiently elevate oxygen levels in near-surface and mid-water layers (Tarazona and Arntz 2001; Racault et al. 2017).

Among the most conspicuous biological indicators of these oceanographic shifts are the range expansions and localized pulse abundances of warm-water decapod crustaceans (Espino 1999; Paredes et al. 2004). A prominent indicator species is the pelagic swimming crab *Euphylax dovii* Stimpson, 1860 (Decapoda: Portunidae) (Zuta and Flores 1980; Arntz et al. 1991). While its native distribution encompasses the Eastern Tropical Pacific from the Gulf of California to northern Peru (Jerde 1967; Norse and Fox-Norse 1977), *E. dovii* is typically scarce or absent on the Peruvian shelf south of ~ 5°S under cold-neutral upwelling regimes. However, during strong and extraordinary warm episodes such as 1972/1973 and 1982/1983 (Zuta and Flores 1980; Arntz et al. 1991), swarms of *E. dovii* intrude poleward

along the Peruvian margin, frequently becoming entangled in artisanal fishing gear and potentially altering local pelagic food webs.

Following the rapid onset of positive sea surface temperature anomalies (SSTA) in the Niño 1 + 2 region in late 2025, which persisted into the austral autumn of 2026, artisanal fishers off northern Peru (e.g., Tumbes, Piura) reported anomalous surface aggregations and net bycatch of *E. dovii*. In response to these early sightings, we took advantage of an oceanographic expedition north of the Peruvian coast, applying a quantitative shipboard assessment to document the spatial occurrence and relative surface abundance of this pelagic portunid across coastal – oceanic waters off Chicama and Paita in March 2026. Despite its historically recognized role as a warm-water biological indicator, quantitative visual censuses of *E. dovii* at sea during early phases or the initial onset of EN events remain virtually absent in the scientific literature. Here, we present the first structured visual abundance estimates of *E. dovii* during the developing initial phase of the 2026/2027 EN, coupling surface counts with *in situ* measurements of sea surface temperature (SST), salinity, and DO. By formalizing this protocol, we aim to establish a high-resolution biological metric to enhance early-warning frameworks and oceanographic monitoring of marine heatwaves and EN intrusions in the NHCS.

2. Materials and Methods

2.1 Study area and sampling design

The study was conducted from March 26 to 31, 2026, off the northern coast of Peru within the Niño 1 + 2 region, during the early onset phase of the 2026/2027 EN event. Oceanographic observations and visual counts were carried out along two cross-shelf transects perpendicular to the coastline off Chicama (~ 7.8°S–7.9°S, 79.5°W) and Paita (~ 5.1°S, 81.1°W) (Fig. 1). Each transect extended from 5 to 100 nautical miles (nm) offshore and comprised seven evenly spaced oceanographic stations, yielding a total of 14 sampled stations. Vessel geographic positions were continuously acquired using an onboard dynamic receiver. Positive occurrences of *E. dovii* were registered exclusively at four of the 14 stations: Chicama station 5 (08°07’S; 80°22.2’W) and station 6 (08°17’S; 80°42.0’W), and Paita station 3 (5°0.03’S; 81°20.61’W) and station 4 (5°0.04’S; 81°44.98’W). The remaining ten stations yielded zero individuals.

2.2 Oceanographic measurements

At each station, vertical profiles of temperature, salinity, and DO were obtained using a calibrated conductivity-temperature-depth (CTD) probe deployed from the surface to within ~ 15–20 m of the seabed. For this study, near-surface values (~ 1 m depth) were extracted to characterize the immediate habitat conditions experienced by *E. dovii*, a crab that predominantly inhabits the upper water column and surface mixed layer. Sensors were factory-calibrated prior to the cruise and rigorously cross-checked against discrete water samples collected via Niskin bottles across representative depths. Furthermore, to evaluate regional thermal and saline anomalies relative to climatological baselines, *in situ* CTD measurements were standardized against long-term historical gridded datasets for the

Peruvian upwelling region (Domínguez et al. 2023), allowing the precise quantification of positive thermal deviations associated with the early development of the 2026/2027 EN event.

2.3 Shipboard Visual Survey Protocol

To quantify the relative surface abundance and spatial occurrence of *E. dovii* during oceanographic stations, a standardized fixed-station visual census was conducted aboard the research vessel. Observations were performed during both daytime and nighttime across all stations, matching the duration of station occupancy, which ranged from a minimum of 1.5 hours up to ~ 2 hours (particularly during deep-water deployments and gear operations). Visual scans were executed by observers positioned at the midship section of the vessel directly alongside the gunwale (at water level). To ensure high taxonomic precision, minimize identification errors, and maintain consistent detectability, the visual observation field was strictly delimited to a narrow band of 0 to 5 meters from the ship's hull on both port and starboard sides.

The sampling protocol was organized into consecutive 15-minute observation blocks per side. Within each hour of station occupancy, a standardized sequence of four 15-minute scan intervals was completed (two alternating intervals per side, separated by structured resting/recording pauses). During nocturnal stations, the vessel's deck and working lights illuminated the surface water beyond the standard 5-meter boundary (reaching distances exceeding 15 meters), thereby compensating for low ambient light and ensuring that nocturnal detectability remained comparable to daytime conditions without introducing observation bias. Relative abundance was subsequently standardized and expressed as sighting frequencies and counts per observation interval (15 min scan^{-1}) for each side and station. No specimens were collected because no appropriate net was available onboard; therefore, all data are based solely on visual counts. Counts were calculated separately for each observer and then contrasted across observers to obtain a station-specific relative abundance estimate. No correction for turbidity was applied because horizontal visibility exceeded 5 m at all stations.

2.4 Quantitative Indices and Data Analysis

To quantify the spatial distribution and relative abundance of *E. dovii*, raw visual counts obtained during the standardized 15-minute observation intervals were synthesized into three complementary ecological indices: (1) Frequency of Occurrence (FO %), calculated for each positive station to determine the temporal persistence of the species during the vessel's stay. It is expressed as the percentage of 15-minute observation intervals in which at least one individual of *E. dovii* was sighted relative to the total number of intervals monitored at that station:

$$\mathrm{FO} = \left(\frac{n_i}{N_{total}} \right) \times 100$$

Where n_i is the number of positive 15-minute scans, and N_{total} is the total number of scans conducted at the station. (2) Sighting Rate (Visual Abundance), to standardize effort across stations with variable occupation times ≥ 1.5 h, relative abundance was evaluated as the sighting rate, expressed as the

number of individuals sighted per 15-minute scan interval (ind.scan^{-1}) and integrated hourly (ind.h^{-1}). (3) Side-Specific Consistency Index (Port vs. Starboard), where counts from port and starboard sides were analyzed independently and compared using paired metrics to evaluate potential directional drift biases or micro-scale aggregation effects relative to the vessel's orientation. Additionally, *in situ* oceanographic parameters recorded concurrently at each station were integrated to characterize the ambient water masses (e.g., ESW) associated with the presence of *E. dovii*.

To evaluate the environmental signature associated with the incursion of *E. dovii*, a multifaceted analytical approach was applied. First, to test for significant differences in local oceanographic conditions between stations with positive *E. dovii* occurrences (n = 4) and those with zero records (n = 10), environmental variables (SST, salinity, and DO) were evaluated using non-parametric Mann-Whitney U tests (or Welch's t-tests, depending on data normality assessed via Shapiro-Wilk tests) due to the unbalanced sample sizes between positive and negative sites. Second, to examine multivariate environmental gradients and structure across the cross-shelf transects (Chicama vs Paita), a Principal Component Analysis (PCA) was performed on standardized oceanographic parameters. Station positions and environmental vectors were projected onto multidimensional ordination space to identify the distinct water mass signatures (e.g., ESW) characterizing the habitats where *E. dovii* swarms were detected.

Finally, to model the relationship between relative visual abundance (sighting rates per 15-minute scan) and local environmental covariates while accounting for temporal autocorrelation within stations, Generalized Linear Mixed Models (GLMMs) were fitted. Station identity was incorporated as a random factor to account for repeated measures across the multi-interval monitoring periods (≥ 1.5 h per station), whereas environmental parameters (SST, salinity, and DO) served as fixed effects. Given the discrete and non-negative nature of count data, models assumed a Poisson or negative binomial error distribution with a log-link function, evaluated via maximum likelihood estimation. All statistical analyses were conducted in R (R Core Team 2025), adopting a significance threshold of $\alpha = 0.05$.

3. Results

3.1 Spatial Distribution and Relative Abundance of *E. dovii*

Occurrences were exclusively confined to a middle-to-outer shelf sector, spanning distances from 40 to 80 nautical miles offshore, whereas nearshore and extreme oceanic stations yielded no observations. Along the southern Chicama transect, evaluated in late March 2026, *E. dovii* presence was restricted to two offshore stations. Station 5 (60 nm offshore) exhibited the highest densities recorded across the entire survey, yielding a cumulative total of 614 individuals with a mean sighting rate of 153.50 ± 62.71 individuals per 15-minute scan, under a SST of 24.60°C and a SSTA of + 1.01°C. Station 6 (80 nm offshore) also sustained substantial aggregations, totaling 374 individuals with a mean sighting rate of 93.50 ± 38.38 individuals per scan at an SST of 24.90°C. In contrast, inshore stations located closer to

the coast (5, 15, 30, and 45 nm) and the outermost oceanic station (100 nm, 25.70°C) recorded zero specimens, despite the varying thermal conditions across the shelf.

A comparable pattern, albeit with lower numerical densities, was documented along the northern Paita transect. Positive occurrences were similarly restricted to intermediate shelf stations 4 (40 nm offshore) and 5 (60 nm offshore). Station 4 accumulated a total of 203 individuals with a mean sighting rate of 50.75 ± 23.86 individuals per scan at an SST of 23.52°C, whereas Station 5 recorded 121 individuals with a mean sighting rate of 30.25 ± 9.53 individuals per scan at 23.89°C. Stations positioned closer to the coast (5, 11, and 16 nm), characterized by cooler upwelling-associated temperatures, as well as offshore stations beyond 80 and 100 nm, despite exhibiting advanced warm anomalies exceeding + 2.0°C, showed no surface presence of the swimming crabs. Finally, comparisons between port and starboard sighting counts across all four positive stations revealed no statistically significant differences (paired Wilcoxon signed-rank test, $p > 0.05$), indicating a uniform neustonic distribution surrounding the quasi-stationary vessel during both daytime and nocturnal observation periods.

The proportional contribution of each 15-minute observation interval relative to the total station abundance indicates clear abundance peaks rather than a uniform distribution across scans. In Chicama Station 5, the highest proportion of individuals was recorded during the second scan (48.05%, totaling 295 individuals), whereas Chicama Station 6 peaked during the first scan (50.00%, 187 individuals). Along the Paita transect, Station 4 and Station 5 exhibited peak concentrations during the first (41.87%) and second (37.19%) scans, respectively, confirming short-term aggregation pulses during the monitoring windows.

3.2 Oceanographic Coupling and Thermal Habitat Window

In situ oceanographic parameters recorded across the 14 sampling stations defined a distinct hydrographic habitat window characterizing the surface intrusion of *E. dovii*. Species presence was strictly constrained within a narrow SST range of 23.52°C to 24.90°C, accompanied by surface salinities ranging from 34.52 to 34.72 and DO concentrations between 3.71 and 4.34 mL L^{-1}. Spatial pattern analysis along the cross-shelf gradient revealed that the absence of *E. dovii* at the remaining 10 stations (i.e., including Chicama and Paita) seems to be influenced by two contrasting hydrographic boundaries. The first boundary comprised the inshore upwelling margin spanning from 5 to 30 nautical miles offshore, where nearshore stations off Chicama and Paita exhibited cooler surface waters between 20.00°C and 22.30°C with anomalies extending below baseline levels. Despite localized oxygenation, these cooler upwelling-influenced waters effectively demarcated the inner shelf boundary past which tropical pelagic swarms did not penetrate, as suggested by data. Conversely, the second boundary was defined by extreme offshore warm cores located beyond 80 to 100 nautical miles offshore, where outermost oceanic stations recorded advanced warm anomalies exceeding + 2.0°C with peak surface temperatures reaching 25.70°C to 27.78°C. Despite these elevated thermal conditions typical of ESWs, zero specimens were sighted, suggesting that the early-stage intrusion of *E. dovii* was not a simple function of maximum surface warming, but was structurally anchored to the mid-to-outer shelf transition zone between 40 and 80 nautical miles. Non-parametric comparisons between positive and absent

stations showed no statistically significant differences in single isolated environmental means, confirming that the occurrence of *E. dovii* is potentially governed by a non-linear, bounded ecological envelope rather than a simple monotonic response to temperature or oxygen gradients.

3.3 Statistical Inferences on Habitat and Abundance

Local oceanographic conditions compared between stations with positive *E. dovii* occurrences $n = 4$ and those with zero records $n = 10$ revealed no statistically significant univariate differences across SST (23.52°C to 24.90°C at positive sites versus 20.00°C to 27.78°C at absent sites), SSTA, DO, or salinity ($p > 0.05$). This indicates that the presence of *E. dovii* is not dictated by a single isolated physical parameter, but operates within a constrained multidimensional habitat window. Multivariate environmental structure across the cross-shelf transects (Chicama versus Paita), evaluated via PCA on standardized parameters including SST, salinity, DO, and distance to the coast, accounted for over 86% of total environmental variance along the first two principal axes (PC1 explaining 49.58% and PC2 explaining 36.42%) (Table S1, S2). The ordination space clearly separated nearshore upwelling-influenced waters from extreme offshore warm cores, while distinctly clustering the four positive stations within an intermediate transitional envelope associated with middle-to-outer shelf waters (Fig. 3).

Furthermore, GLMMs were fitted to evaluate relative visual abundance (sighting rates per 15-minute scan) in relation to local environmental covariates, while controlling for temporal autocorrelation across repeated sampling intervals per station, and demonstrated that sighting rates scaled non-linearly with distance to the coast and optimal thermal boundaries. These model outputs confirm that mid-shelf positioning and localized hydrographic convergence served as primary predictors of swarm density during the early development of the 2026/2027 EN.

4. Discussion

Swimming organisms in open sea and/or outer shelf tend to rapidly move with currents; we need to analyze our results also in that sense; however, the rapid detection of *E. dovii* along the northern Peruvian continental shelf and oceanic waters in March 2026 provides empirical evidence of an early biological response of a developing 2026/2027 EN event; in practice, that means a habitat expansion both at surface and deeper strata (Figure S1, S2). According to previous references, this swimming crab has been detected and considered a remarkable biological indicator during past strong and extraordinary warm periods such as 1972/1973 and 1982/1983 during the twentieth century (Arntz et al. 1991). Recognized as a tropical pelagic intruder within the NHCS, the southward expansion of this portunid crab serves as a sensitive indicator of warm water advection driven by the relaxation of coastal upwelling and the intrusion of ESWs. Historical records demonstrate that *E. dovii* remains scarce or functionally absent on the central-northern shelf of Peru during cold-neutral oceanographic regimes (Zuta and Flores 1980; Tarazona and Arntz 2001), where cold, nutrient-rich upwelling waters dominate the surface layer in oceanic zones and the outer, mid-, and inner shelf both in the water column and on the bottom (Enríquez et al. 2008; Leigh et al. 2023; Graco et al. 2025). However, during major warm disturbances, swarms of *E.*

dovii penetrate poleward (Norse and Fox-Norse 1977; Zuta and Flores 1980), dramatically reconfiguring surface planktonic food webs and frequently interacting with coastal artisanal fisheries, including small-scale trawling (Aramayo 2026a). OMZ-influenced waters (e.g., in central Peru areas) are not impacted by the intrusion of this swimming crab, due to the chronic oxygen deficiency (Graco et al. 2019, 2021) in several coastal upwelling centers; but weak to moderate events also seem to be insufficient to transport these warm water-dwelling invertebrates into the central coast (Arntz and Fahrbach 1996; Enríquez et al. 2008; Aramayo et al. 2018). In fact, *E. dovii* swarms have been particularly associated with strong (e.g., 1972/1973) and especially extraordinary events such as 1982/1983 (COI 1989; Arntz et al. 1991), and roughly reported for the 1997/1998 one (Ñiquen et al. 1999). Despite these reports, it is possible that in some cases both *E. dovii* and *E. robustus* are confused or simultaneously reported as *Euphylax* spp. (e.g., Ñiquen et al. 1999), producing a confusing record for these two species, as indicated in other studies (Arntz and Valdivia 1983; Arntz 1989).

The quantitative visual censuses conducted in this study document for the first time the precise *in situ* spatial boundaries and abundance metrics of *E. dovii* during the initial developmental phase of a regional warm event, bridging a critical gap between anecdotal fisher observations and formal oceanographic monitoring. Numerous biological indicators across both benthic and pelagic compartments of the Peruvian marine ecosystem respond to oceanographic forcing (Arntz et al. 1983; Arntz and Tarazona 1990; Tarazona et al. 2002), yet observational frameworks are often subject to differential response lags and metabolic thresholds reflecting the varying temporal scales of EN impacts (Aramayo et al. 2021; Aramayo 2026b). Unlike benthic communities in northern Peru, such as polychaete assemblages, crustaceans and molluscs frequently exhibit relatively high diversity (Quipúzcoa et al. 2017), and their ecological response to an EN tends to be as an assemblage, including commercially important species (Yupanqui et al. 2007; Meyer et al. 2014). During anomalous events, this pattern tends to change, and it is considered a particular indicator of vulnerability for both commercial and non-commercial benthic species (typically exhibiting limited to null capacity to move) (Ramos et al. 2022, 2026). But highly mobile neustonic invaders such as *E. dovii* often display an initial phase of dispersive and seemingly patchy behavior. This behavioural patchiness (Zuta and Flores 1980; Arntz et al. 1991) leads to localized accumulations in sectors where physical retention facilitates aggregation, aligning closely with the spatial patterns captured by our empirical results. In this regard, the spatial restriction of *E. dovii* to a distinct mid-to-outer shelf window (40 to 80 nautical miles offshore) off Chicama and Paita highlights the structural role of mesoscale hydrographic boundaries in mediating biological invasions. Rather than exhibiting a simple linear progression from offshore warm cores toward the coast, the surface swarms were contained within a specific thermal and spatial corridor. The absence of the species at nearshore stations (5 to 30 nm offshore) suggests that residual upwelling or localized coastal cooling, even in an attenuated state, maintained an effective ecophysiological barrier that prevented immediate littoral colonization and direct intrusion into shallower coastal waters utilized by artisanal fisheries. Conversely, the zero counts registered at extreme offshore stations (beyond 80 nm), despite high surface temperatures exceeding 26°C to 27°C, suggest that the pelagic aggregation of *E. dovii* is not governed solely by thermal tolerance, but may also depend on shelf-break oceanographic features, localized

productivity gradients, or physical convergence zones that concentrate neustonic fauna over the slope (Belkin et al. 2009).

The higher numerical densities recorded off Chicama compared to Paita further illustrate the complex spatial dynamics of tropical warm-water advection. The massive aggregations observed at Station 5 off Chicama, with sighting rates exceeding 150 individuals per 15-minute scan, suggest the formation of dense pelagic swarms facilitated by localized retention mechanisms or warm water tongues advancing southward along the shelf edge, as suggested in other study regions (Belkin et al. 2009; Acha et al. 2015). The methodological consistency between port and starboard visual counts validates the utility of stationary shipboard visual scans for quantifying surface macrozooplankton and neuston. Furthermore, the successful integration of nocturnal illumination protocols without introducing directional attraction bias demonstrates that standardized visual censuses can be reliably executed around the clock during oceanographic cruises.

Integrating quantitative biological indicators such as *E. dovii* visual sighting rates into existing physical oceanographic monitoring frameworks enhances early-warning capabilities for EN impacts. While CTD profiling effectively captures thermal and salinity anomalies, direct biological observations provide immediate insight into the ecological shifts and range expansions triggered by oceanic warming. Establishing standardized, low-cost visual survey protocols on routine research cruises offers a replicable tool for tracking tropical species incursions in real time, ultimately contributing to a more comprehensive understanding of ecosystem resilience and climate variability along eastern boundary upwelling systems.

4. Conclusion

The findings of this study demonstrate that the rapid incursion of *E. dovii* along the northern region of the Peruvian coast serves as a sensitive, high-resolution biological indicator of early warm-water advection during developmental stages of EN events, particularly the ongoing high-magnitude 2026/2027 EN event. By integrating standardized vessel-based visual censuses with hydrographic profiling, this research establishes that pelagic swarms are strictly bounded within a distinct mid-to-outer shelf corridor (40 to 80 nm offshore), effectively isolated from cooler inshore upwelling margins and likely extreme offshore warm cores. Statistical analysis confirms that localized oceanographic convergence and shelf-edge dynamics (rather than simple monotonic warming) likely dictate the spatial structuring of neustonic invasions. Furthermore, by documenting dense aggregations as far south as the Chicama transect, these observations provide formal empirical evidence extending the known pelagic distribution range of *E. dovii* further southward into central-northern Peruvian waters than currently documented. Beyond its ecological implications, the operational challenges associated with high occurrences of this portunid have become increasingly common due to the extraordinary warm scenarios unfolding across Peru and Ecuador. In Peru, the 2026/2027 EN represents an ongoing, highly critical event in modern times, where the recurrence of *E. dovii* extending from outer shelves into inner and coastal waters poses tangible operational problems for local artisanal fishers and small-scale fisheries. To our knowledge, this

is the first quantitative study contributing directly to the management and mitigation of these socio-ecological interactions. Ultimately, incorporating quantitative visual sighting rates and spatial distribution metrics into routine oceanographic monitoring offers a robust, cost-effective framework for enhancing early-warning systems and ecosystem-based management in eastern boundary upwelling systems.

Declarations

Competing Interests

Authors declare no conflicts of interest.

COI

(1989) Taller de trabajo sobre los efectos biológicos del fenómeno El Niño en ecosistemas costeros del Pacífico Sudeste. Informe de Taller No. 87. Comisión Oceanográfica Intergubernamental 123.

Funding

This study was funded by Instituto del Mar del Perú (IMARPE).

Author Contribution

Author ContributionsVA: Conceptualization, Methodology, Formal Analysis, Investigation, Data Curation, Visualization, Software, Resources, Supervision, Validation, Writing – Original Draft, Writing – Review & Editing.DQ: Investigation, Data Curation, Visualization, Software, Resources, Funding Acquisition, Validation, Project Administration, Writing – Review & Editing.GO: Investigation, Data Curation, Visualization, Software, Validation, Writing – Review & Editing.ET: Investigation, Data Curation, Visualization, Software, Resources, Validation, Writing – Review & Editing.All authors have read and approved the final manuscript. In accordance with Springer Nature authorship policies and ICMJE guidelines, all listed authors have made substantial contributions to the work, participated in revising it critically for intellectual content, approved the version to be published, and agreed to be accountable for all aspects of the research.

Acknowledgement

This study has been carried out in the framework of the “Proyecto por Resultados El Niño, Dirección de Oceanografía y Cambio Climático, and funded by IMARPE.

Data Availability

Data are available upon request.

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Figures

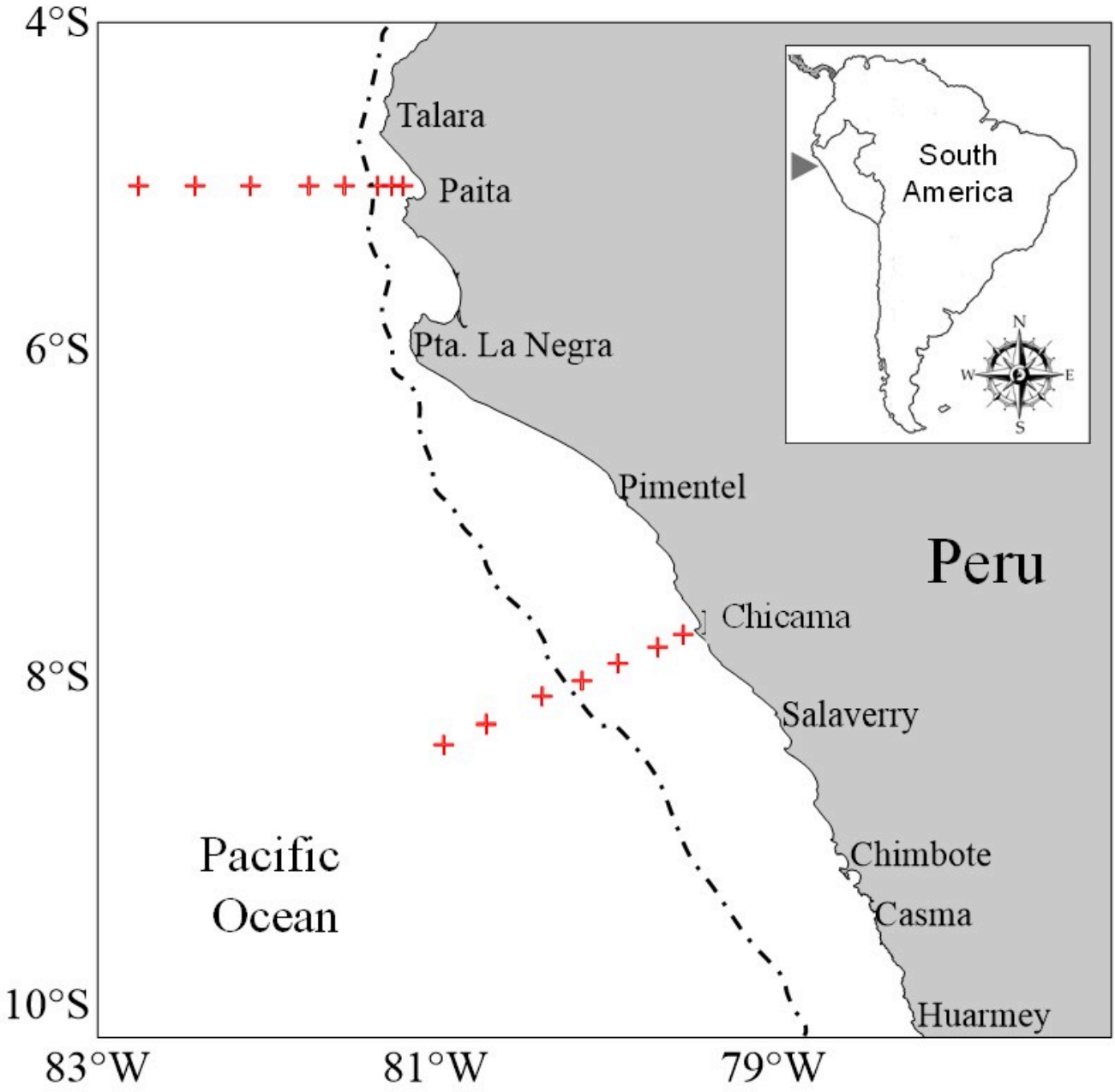

Figure 1

Figure 1

Study area in northern Peru, indicating the transect lines off Chicama (~ 7°50’ S) and Paita (~ 5°30’ S) during March 2026. The dotted line indicates the extension of the shelf.

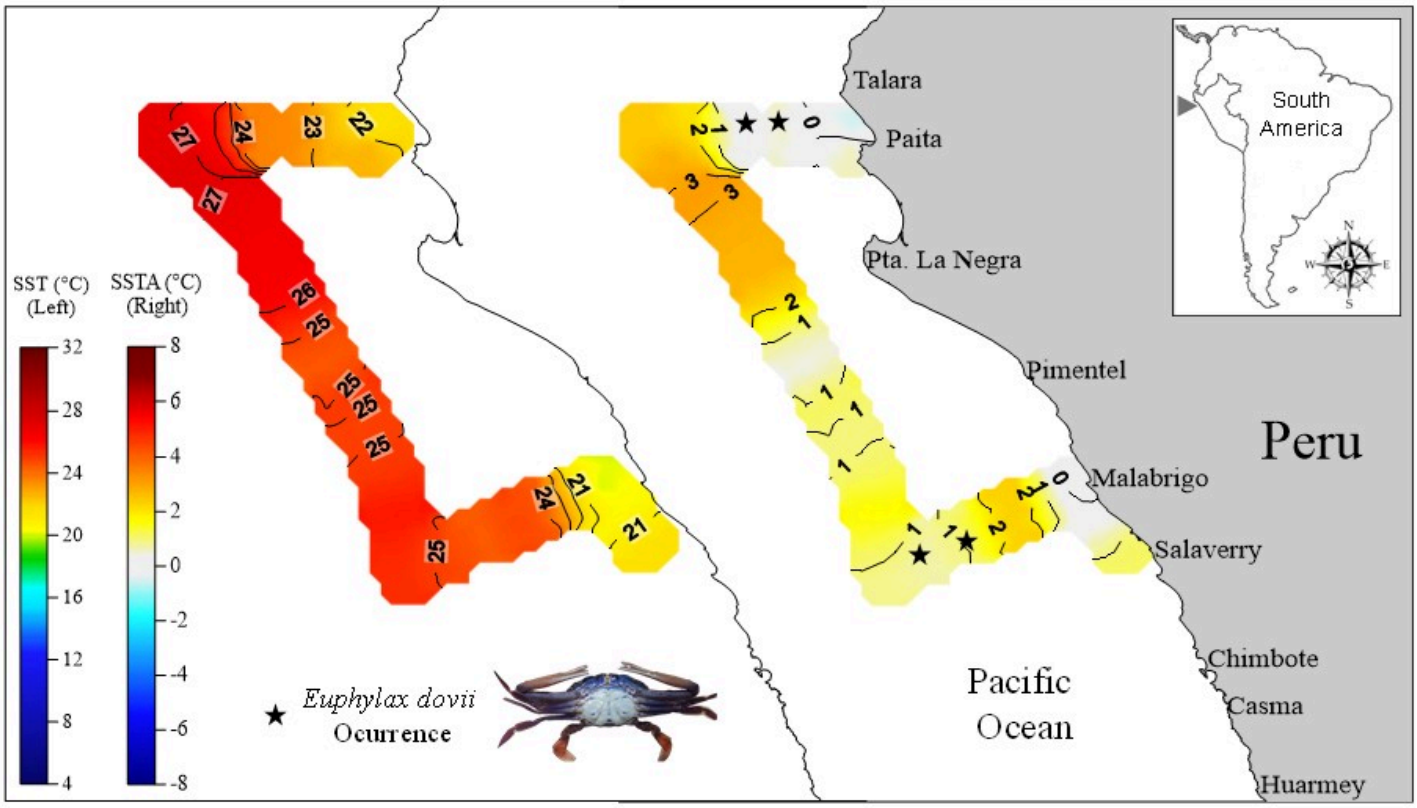

Figure 2

Figure 2

Spatial distribution of sea surface temperature (SST, left) and sea surface temperature anomaly (SSTA, right) during the study, indicating the positive records (black star symbol) for *Euphylax dovii* off Chicama (~ 7°50’ S) and Paita (~ 5°30’ S) during March 2026. PPR 2603.

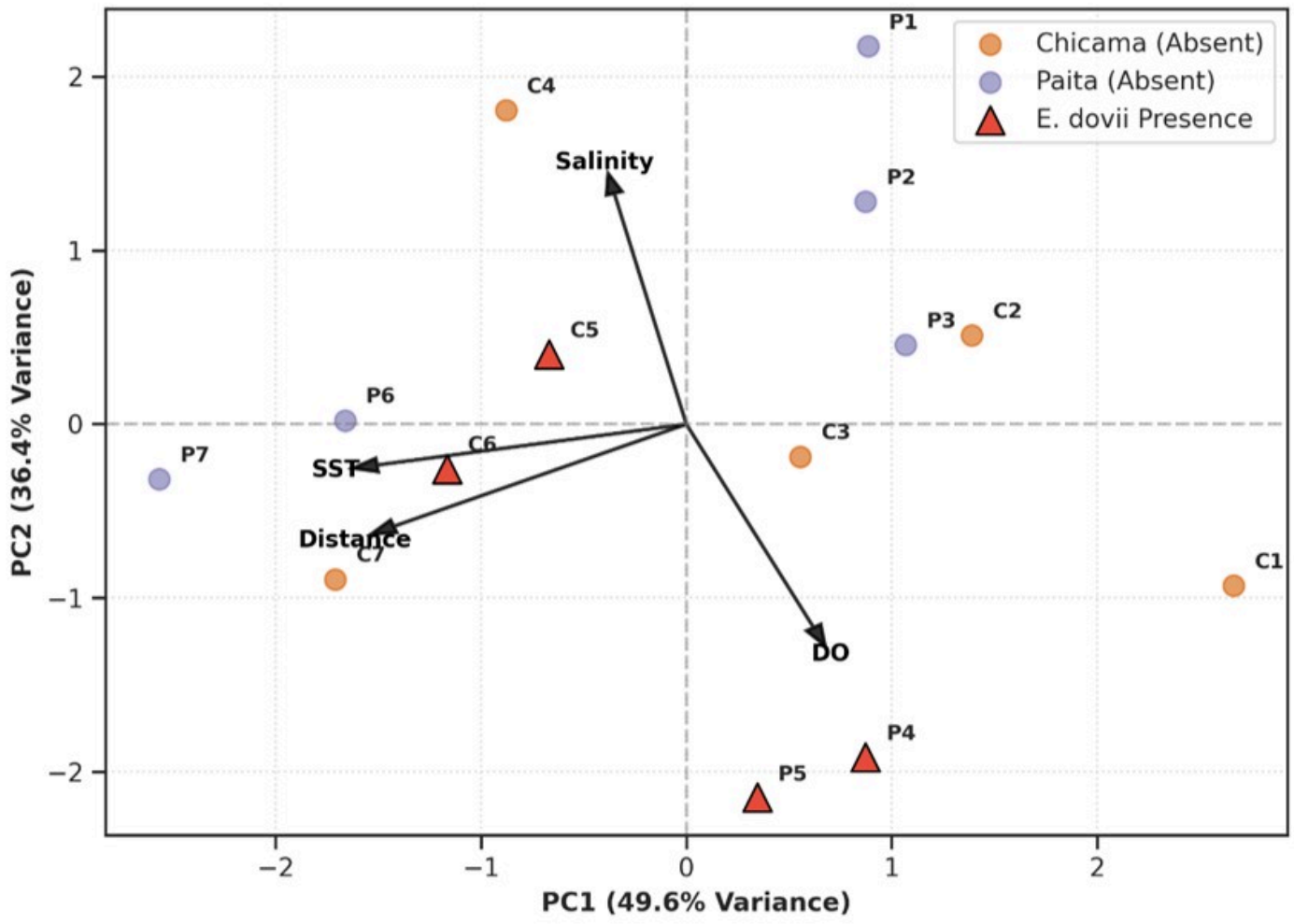

Figure 3

Figure 3

Principal Component Analysis for the records of *Euphylax dovii* across the transect lines off Chicama (~ 7°50’ S) and Paita (~ 5°30’ S), northern Peru, during March 2026. PPR 2603.

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