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IMPACTS OF OCEAN WARMING AND OCEAN ACIDIFICATION IN PREDATOR-PREY INTERACTION IN INTERTIDAL ZONE: WHAT IS KNOWN IN THE LAST DECADE

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Dissertação apresentada ao Programa de Pós-Graduação em Ciências Biológicas – Zoologia do Instituto de Biociências, Câmpus de Botucatu da Universidade Estadual Paulista "Júlio de Mesquita Filho"- Unesp, para obtenção do título de Mestre.

Orientação: Prof.ª Dr.ª Tânia Marcia Costa

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Palavras-chave: Alterações climáticas; Bibliometria; Interações ecológicas; Revisão; Tecelagem de pesquisa.

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"Ô filho! Tem pescado muito caranguejo?"

Oswaldo "Boca Rica" Guarizo

(1937 – 2020)

Resumo

Os efeitos do aquecimento e acidificação dos oceanos na interação presa-predador na zona do entremarés é um tópico de crescente preocupação para a comunidade científica na última década. Nesta revisão, nós visamos entender como a comunidade cientifica explorou este problema via "*research weaving*". Esta técnica é uma combinação de uma coleção sistemática de artigos em um conjunto de dados e uma revisão bibliométrica e literária de dados geográficos, institucionais, sobre periódicos e conteúdo bibliográfico de cada estudo. Nós coletamos artigos publicados entre 2010 e 2021 sobre como ambos estressores impactaram a predação na zona do entremarés, via métodos experimentais ou de observação. O Conjunto de dados (composto por 224 artigos) revelou uma forte rede de coautoria entre instituições e países do norte global. Esta revisão também revelou a gama de métodos usados para investigar como o estresse induzido pelas mudanças climáticas afetou a predação no entremarés, favorecendo designs baseados em um único estressor. Os pesquisadores também preferiram certos organismos modelo, como moluscos, equinodermos e crustáceos, com poucos dados publicados sobre outros taxa de invertebrados, vertebrados e de algas. Também fornecemos uma breve revisão de literatura sobre vários impactos da acidificação, aquecimento, ou sua interação em variáveis relacionadas à predação, afetando organismos desde o âmbito genético até um cenário ecológico maior. Esta revisão pode ajudar a orientar estudos futuros, avaliando o que já foi estudado e as lacunas em temas emergentes que podem ser preenchidas. Isso pode apoiar futuras decisões em formulação de políticas e servir de base para futuras revisões na área.

Palavras-Chave: Revisão; Mudanças do Clima; Interações Ecológicas; Bibliometria; Research Weaving.

Abstract

The effects of Ocean warming and Ocean acidification in the intertidal zone predator-prey interaction is a growing topic of concern to the scientific community in the last decade. In this review, we aim to understand how the scientific community explored this issue via a research weaving technique, a combination of systematic collection of articles to a dataset, and a bibliometric and literary review of data concerning geography, institutions, journals, and bibliographic content in each study. We collected articles published between 2010 and 2021 about how both stressors impacted predation in the intertidal zone, via experimental or observational methods. The dataset (comprised of 224 articles) showed a strong web of co-authoring across institutions and countries from the northern hemisphere. This review also revealed a plethora of methods used to delve into how climate change-induced stress affected intertidal predation, as studies design leaned towards single-based driver trials to detriment of the multi-drivers approach. The researchers also preferred model organisms such as Mollusks, Echinoderms, and Crustaceans, with little published data on fellow invertebrates, vertebrates, and algae taxa. We also provide a brief literature review about various impacts of ocean acidification, warming, or their interaction in predation-related variables, affecting organisms from the genetic to a greater ecological scope. Our findings can help to guide how future studies can approach this issue, by evaluating what is already done and gaps in emerging themes that can be fulfilled. This can support future policy-making decisions and give the base to future reviews in the area.

Keywords: Review; Climate Change; Ecological Interactions; Bibliometrics; Research Weaving

1. INTRODUCTION [1]

Climate change affects an array of marine ecosystems, including coastal zones. A direct consequence of post-industrialization anthropic actions, such as ample reliability in fossil fuels, deforestation, industrial activities, agricultural and livestock production (Mintzer and Leonard, 1994; Burroughs, 2007; Brierley and Kingsford, 2009; Masselink and Gehrels, 2014; IPCC, 2014; 2019). Since 1970, the ocean has absorbed ~90% atmospheric excess heat attributed to anthropogenic influences (Vallis, 2012; IPCC, 2019). The global ocean heat content at the ocean's 700m superior layer had likely increased by 6.28 ± 0.48 ZJ year^{-1} since 1993 and very likely decreased by 0.017−0.027 pH units per decade since the late 1980s (IPCC, 2019). According to IPCC RCP 8.5/2081-2100 scenario (2014; 2019), it is expected a 4.3ºC increase of the ocean's superficial temperature and a mean drop of -0.315 in surface pH units, without mitigation measures by a global effort.

This recent increase in gas emissions provokes changes in both oceans and coastal physical systems. Induced oceanic temperature increase triggered a rise in mean sea level (via thermal expansion and added meltwater), impacts thermohaline and sea current circulation, and a decrease of O_2 content (as warmer waters reduce solubility). Oceanic systems were also impacted by changes in sea surface salinity (due to alterations in the global water cycle) and a drop in pH levels, as surface layers absorb and react to the excess CO_2 creating a surplus output of H^+ ions (Mintzer and Leonard, 1994; Lozán *et al*., 2001; Burroughs, 2007; Hoegh-Guldberg and Bruno, 2010; Eissa and Zaki, 2011; Vallis, 2012; Masselink and Gehrels, 2014; IPCC, 2014; Frölicher and Laufkötter, 2018; IPCC, 2019). Such physical-chemical alterations impact biological processes, from molecular to ecosystemic levels (Ewald *et al*., 2013; Nagelkerken and Munday, 2016), e. g., genes expression, cellular physiology and homeostasis, bone and shell formation, populations dynamics, community structuring, and both interspecific and intraspecific ecological interactions (Stachowicz *et al*., 2002; Burroughs, 2007; Brierley and Kingsford, 2009; Yang and Rudolf, 2010; Eissa and Zaki, 2011; Harley, 2011; Miller *et al*., 2014).

The impacts of climate change-induced stressors in trophic interactions is a complicated issue. This complexity can be related to various degrees of effects in marine species across different trophic levels, with specimens having a mismatched response to the same climatic

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[1] This dissertations follows guidelines from the journal "Global Change Biology" © John Wiley & Sons Ltd.

drivers (Parmesan, 2006), even to species with close phylogenetic links (i.e., same genus). Climate change can also lead to a species' decline in population, extinction, and overall range shifts in some areas, creating novel interaction of different populations in communities. Previous research has shown that these direct and indirect effects of climate change can influence interspecific and intraspecific interaction from ways that a species cope with novel parasites and mutuals (Sih *et al*., 2011; Nagerkelken and Munday, 2016), increased competition to resources (Grémillet and Boulinier, 2009; Hoegh-Guldberg and Bruno, 2010; McCormick *et al*., 2013) and effects in herbivory via shifts in community phase and overgrazing (Vergés *et al*., 2014).

One strongly affected interaction, predation has a crucial function in ecosystems amongst interspecific interactions. Predators affect both the abundance and diversity of other species, either by prey consumption or alteration in their behavior, being considered a key interaction in some communities (Sanford, 1999; Laws, 2017). Thus, small climatic stressing in the predator diffuses through inferior trophic levels, shaping the communities composition and the operation of the ecosystem itself (Sanford, 1999; Laws, 2007; Estes *et al*., 2011; Harley, 2011; Miller *et al*., 2014; Draper and Weissburg, 2019). However, both predator and prey behavior are particularly susceptible to increasing oceanic temperature and acidification (Miller *et al*., 2014; Draper and Weissburg, 2019). Hunting and escape behaviors can be affected when occurring simultaneously with physiological pressures from temperature increasing (Persson, 1986; Laws, 2017; Miller *et al*., 2014; Nagelkerken and Munday, 2016; Allan *et al*., 2017; Draper and Weissburg, 2019). Prey and predators tend to be more active in warmer environments, due to higher metabolic rates, inducing overproduction of hormones, enzymes, and stress antioxidants (Ewald *et al*., 2013; Miller *et al*., 2014; Wu *et al*., 2017). This overactive metabolism can boost predation rates (Laws, 2017), as bolder preys are prone to have higher chances to meet predators (Werner and Anholt, 1993; Sanford, 1999; Nagelkerken and Munday, 2016). In acidified waters, evidence suggests that higher CO_2 content can suppress the ability of predator and prey to sense chemical and mechanical cues that mediate detection by both ends of the interaction (Harvey *et al*., 2013; Draper and Weissburg, 2019; Contolini *et al*., 2020). Acute acidification exposure can also lead to decrease prey capture and handling and rise handling time and impacts in visual and olfactory performances (Allan *et al*., 2017).

Studies regarding intertidal organisms and their interactions towards oceanic temperature rise and acidification already indicate how climate changes affect coastal ecosystems (Helmuth *et al*., 2006a; 2006b; Harley, 2011). As predation modules the structure and species abundance of intertidal communities, its effects should always be integrated into climate change projecting frameworks (Harley, 2011). Moreover, intertidal organisms are ideal models for the understanding of climate change effects in ocean systems or coastal ecosystems, as they face a high physical-chemic variation in their tidal, diary, and yearly cycles (Harley, 2011; Vinagre *et al*., 2016). Intertidal organisms have great adaptative potential, due to evolved mechanisms to relieve impacts of their habitat unstable conditions (Helmuth *et al*., 2006a; Harley, 2011; Legrand *et al*., 2018). Yet, the capacity of each organism to deal with said variations is limited within a tolerance window, like thermal or acidification tolerance (Pörtner and Farrel, 2008; Riebensal and Gattuso, 2015). Intertidal species display tolerance reduction to (natural or climate change driven) environmental variations, due to how close they live to their critical thermic or acidic limit (Stillman, 2003; Helmuth *et al*., 2006; Harley, 2011; Nagelkerken and Munday, 2016; Vinagre *et al*., 2016; Legrand *et al*., 2018).

In the past years, reviews about impacts of climate change drivers in the intertidal zone saw an increasing interest (e.g., Sanford, 2002; Helmuth *et al*., 2006; Hawkings *et al*., 2008, 2009; Clarke *et al*., 2017; Gilman, 2017; Chemello *et al*., 2018; Bass *et al*., 2021). This is evidenced by numerous previous reviews centered around single-stressor or multistressor (i.e., Ocean acidification and Warming) impacts in the morphology (e.g. Byrne and Przeslawski, 2013; Cattano *et al*., 2018; Noor and Das, 2019), physiology (e.g. Kroeker *et al*., 2014; Ducker and Falkenberg, 2020) behavior (e.g. Clements and Hunt, 2015; Cattano *et al*., 2018; Clements and Comeau, 2019; Draper and Weissburg, 2019; Noor and Das, 2019) and ecology (e.g. Dupont *et al*., 2010; Kroeker *et al*., 2010; Hendricks *et al*., 2010; Węsławski *et al*., 2011; Harvey *et al*., 2013; Steneck and Wahle, 2013; Bass *et al*., 2021) of marine organism. There is also interest in reviewing marine predator-prey interaction beyond climate-change-driven impacts (e.g., Bowen and Lidgard, 2012; Scott *et al*., 2012; Weis and Cadelmo, 2012; Daewel *et al*., 2013; Kubicka *et al*., 2017). Intertidal zones are projected to be at very high risk by 2100 under IPCC RCP8.5 (2019) projections, ongoing literature reviews and analysis of climate-change drivers' impacts in ecological aspects can aid future scientific production and conservation strategies. As predation has extensive importance in modulating the community structure of intertidal zones, we can only achieve a better holistic vision of such climate change effects by not ignoring their influence on predation.

By using a systematic bibliographic review method combined with research weaving analysis, this review addresses how recent literature examines the impacts of ocean warming and acidification on prey-predator interactions of intertidal organisms. Research weaving is a new method of broad synthesis that combines bibliometrics with a systematic mapping of a theme. Weaving can provide a qualitative, quantitative, and visual description of a research field without ignoring the collaborative network of authors, institutions, and countries in the collaborative network (Nakagawa *et al*., 2019). This is important to give a snapshot of the state of literature in the field in the last decade, as climate change biology is an extremely important growing field in the scientific community. Also, the possible inconsistency in the knowledge across the globe can impact our holistic view of the matter, with further consequences in conservation policies. We aim to give not only a holistic overview of the publications' findings but also point out possible biases, knowledge gaps, and limitations present in the selected studies.

2. METHODOLOGY

We employed a research weaving analysis, which combines a bibliometric analysis with a systematic literature review (Nakagawa *et al*., 2019; Lam-Gordillo *et al*., 2020) using the PRISMA-EcoEvo (v. 1.0) extension guidelines (O'Dea *et al*., 2021) (Figure 1), is specifically built for ecology and evolutionary biology systematic reviews and meta-analysis. Studies used for this review were extracted by searching articles published between January 2010 to November 2021, as experimental research and observation on marine climate change increased drastically by the 2010s (Bass *et al*., 2021). We selected Google Scholar and Web of Science databases, using the string: "Climate change OR Ocean acidification OR Ocean warm* AND Predation OR Predator OR Prey OR Predator-Prey Interaction AND Intertidal". Web of Science research was further refined by only screening articles from the "Marine Freshwater Biology" category. All grey literature (i.e., dissertations and theses) was excluded.

Then, we screened the reference list of the selected papers for possible missing studies. Next, we used the following criteria to exclude chosen articles: (1) studies that did not use any future scenarios for temperature and/or acidification as climatic variables; (2) studies that cited organisms as predators or prey in their communities, but not examining how the stressors could impact their predator-prey interactions; (3) if an organism was not disclosed as an intertidal dweller by the selected study or further investigation. In the end, 224 articles were selected for categorization (Appendix I), being 69 multi-stressor (Ocean Warming vs. Ocean Acidification) and 155 single-stressor based (109 Ocean acidification; 46 Ocean warming). Every paper was categorized alphabetically based on key characteristics (Appendix I, Table 1), being: (1) author(s); (2) year of publication; (3) author's keywords; (4) Predator and/or Prey Taxa; (5)

Driver; (6) Predation Related Variables; (7) Lab or Field study design; (8) Journal Abbreviation; (9) Original Dataset (Web of Science, Google Scholar or Article's References). The bibliometric analysis was performed using the "biblioshiny" web interface from the bibliometrix-R package (Aria and Cuccurullo, 2017) in R v4.1.0 (R Core Team, 2021) with data from the 224 studies imported via Clarivate Analytics Web of Science v1.0. The bibliometric networking mapping was generated via "biblioshiny" and VOSviewer v1.6.17 (van Eck and Waltman, 2010). Thematic keyword mapping was created via "biblioshiny", with a map divided by four areas: Motor themes, which are flagship themes that guided the search (i.e., themes utilized by the researcher to obtain articles to the database); Basic themes, that forms the base of knowledge commonly shared by articles in the database; Emerging or Declining themes, that need more exploration by the scientific community and Niche Themes are themes that are employed in conjunction by a larger number of studies. The taxonomic tree was created using the NCBI Taxonomy Database and iTOL v6.4 (Letunic and Bork, 2021).

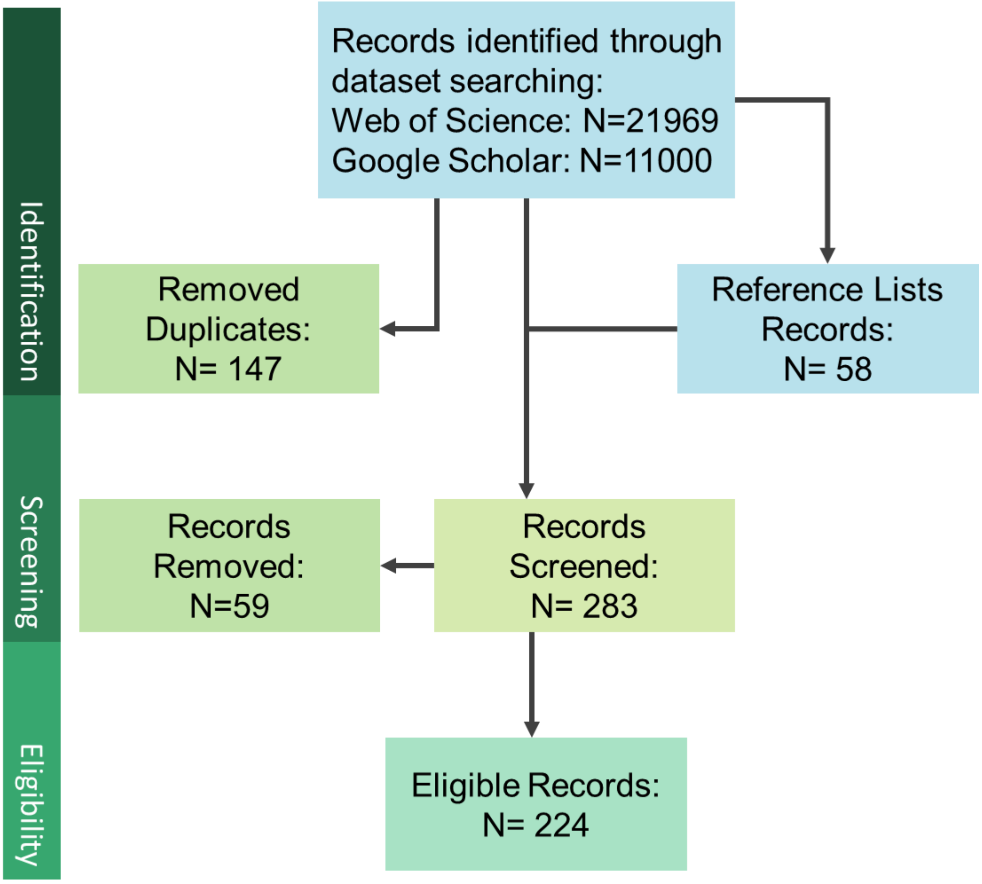

Figure 1 PRISMA flow diagram showing the process of studies selection, from identification, screening and eligibility of the systematic review, mapping out the funneling of the studies. The removing criteria of the screening phase is described in the methods section.

3. RESULTS

3.1 BIBLIOMETRIC RESULTS

3.1.1 Geographic and institutional analysis

A total of 33 countries (16.92% of all countries) produced knowledge in the subject, with the majority of studies performed by the global north (84.84%, 27 out of 33 countries), with a concentration in the USA (50 publications), United Kingdom (33 publications) and China (26 publications). The irregularity of participating countries is further shown in the southern hemisphere, with only 6 publishing countries, with a strong concentration in Chile (14 publications) and Australia (23 publications) (Figure 2 and Figure 3). The data mapping shows (Figure 4) a strong network of collaborations clustered by institutions from the USA, UK, China, and Germany (shown by the bigger nodes in the mapping). However, the distance between nodes and the high number of clusters shows an absence of a relationship between all countries, revealing a lack of evenly spread international collaboration on the theme in the last decade. The institutional raking (Figure 5) and networking (Figure 6) show a lack of interconnection between the bigger publishers in the subject. As the most relevant institutions, the universities of Hong Kong (participation in 31 studies), Sydney (participation in 27 studies), and Plymouth (participation in 19 studies) represent 34.37% of participation in all studies, but there are few interconnections between these institutes. The clustering of the bibliometric analysis shows strong collaboration bonds between institutions, as the clusters are separated with few interconnections. The biggest purple clustering indicates collaboration between British institutions centered in the Plymouth Marine Lab. Other British institutions' cross collaborations are shown in the orange clustering. Other clusterings worth nothing are the red clustering (representing American institutions), blue clustering (centered in Chilean institutes), light-blue clustering (European institutions), Brown clustering (centered in the University of Hong Kong and other Asian institutes), and the yellow clustering (denoting a highly international collaboration network between Asian and European institutions). The result of the institutional analysis corroborates the geographical analysis, showing few strong associations between institutions.

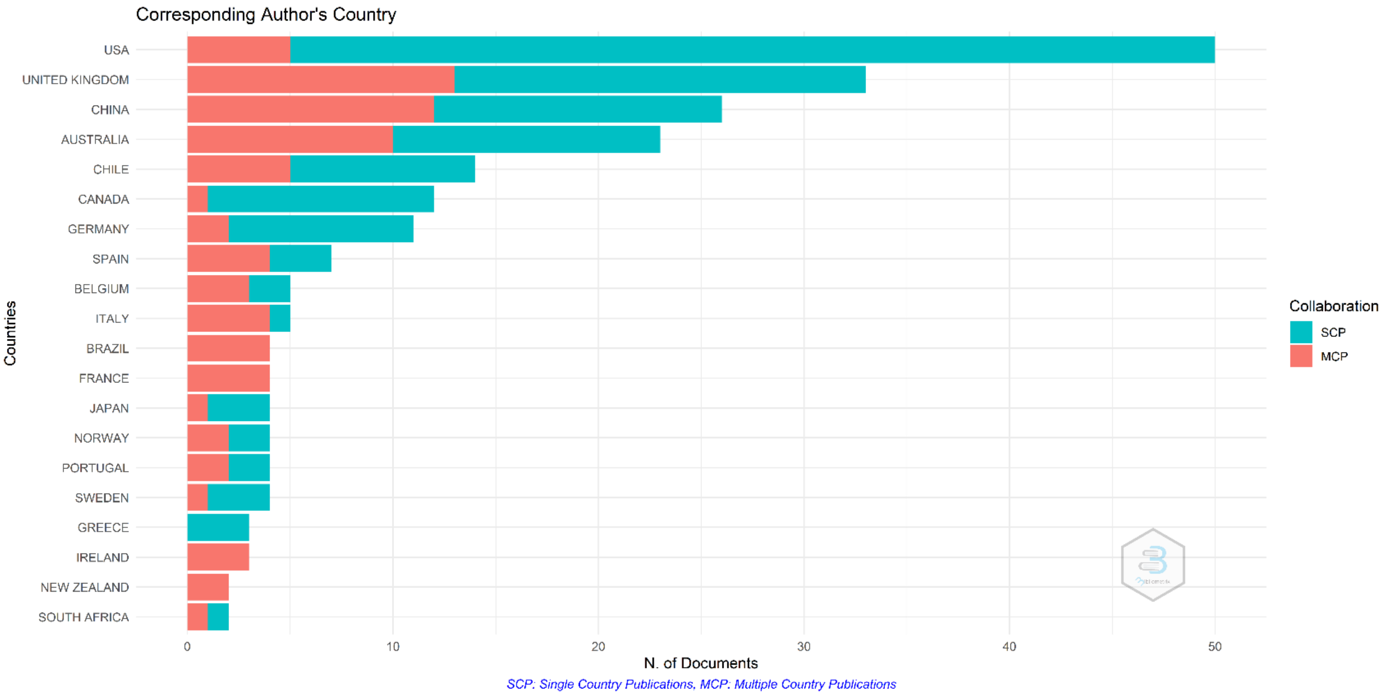

Figure 3 Number of studies published by each country. SCP (in blue) are single countries publication, MCP (in red) are multiple countries publications.

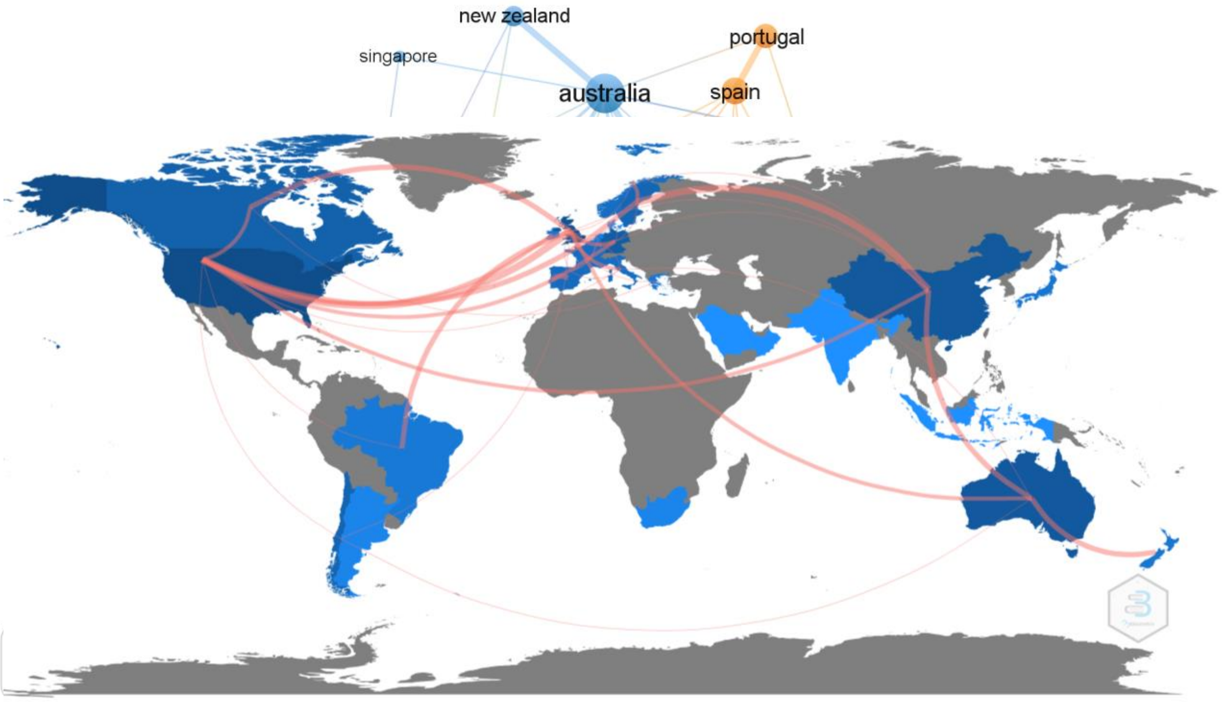

Figure 4 Co-citation network between each country. Nodule size represents number of documents by each country, color of each cluster and line thickness shows stronger relationships

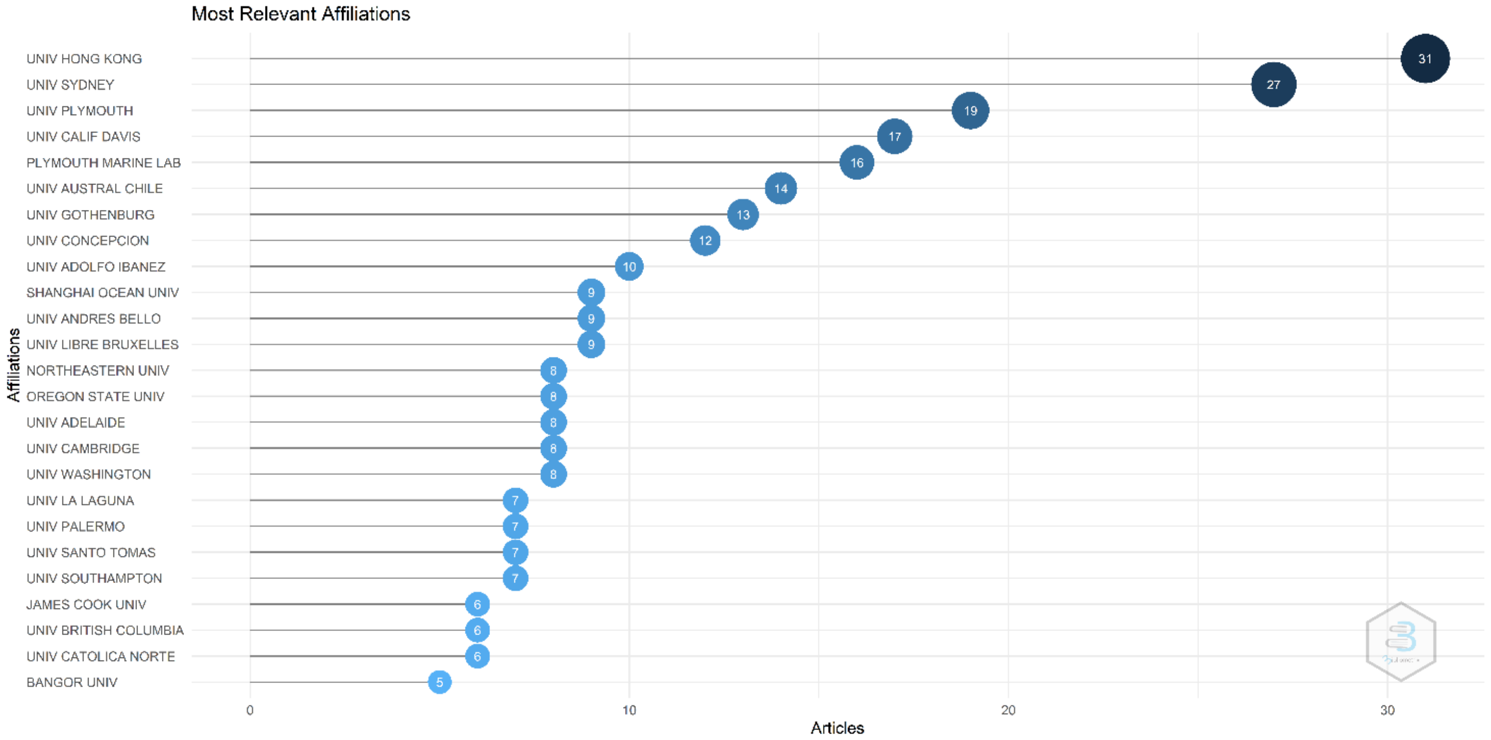

Figure 5 List of the most relevant twenty institutions that published in the field since 2010. Size of the line and circle denotes number of publications.

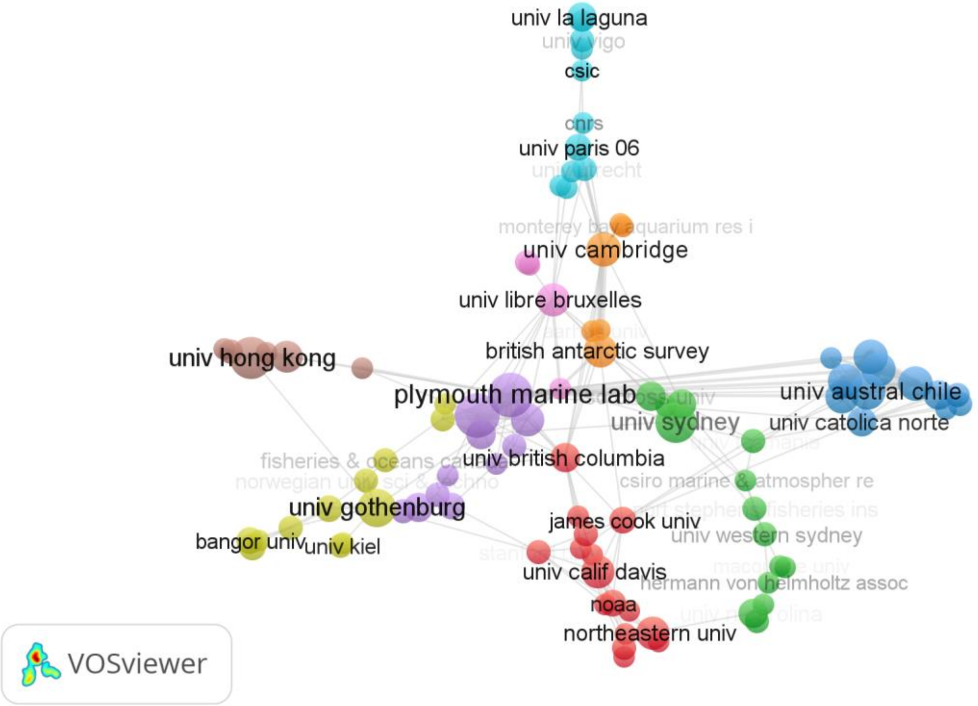

Figure 6 Co-citation network between institutions. Nodule size represents number of documents by each institute and color of each cluster and line thickness shows stronger relationships.

3.1.2 Publication analysis

The 224 articles utilized in this review were published in 65 different journals. The higher standard deviation of mean productions is due to the concentration of articles realized by the three most relevant sources (Journal of Experimental Marine Biology and Ecology, Marine Ecology Progress Series, and Marine Environmental Research) (Figure 7). Together, these sources represent 34.48% of all publications, with 87.19% (56 journals) of the sources published one article about the field in the 2010-2021 period.

The co-citation network (Figure 8) of the 25 most relevant sources shows a strong relationship between publishing and citations around the red cluster journals. These sources are specialized and more aligned in publication climate-change and ecology-related topics. This could contribute to a rights H-index of these sources. The more distant nodules show less published and less co-cited sources. These sources have a wider publications scope, leading to less publication about the field in their overall literature, and fewer relationships, e.g., the nodes of Oecology and Aquatic toxicology being apart from other clusters.

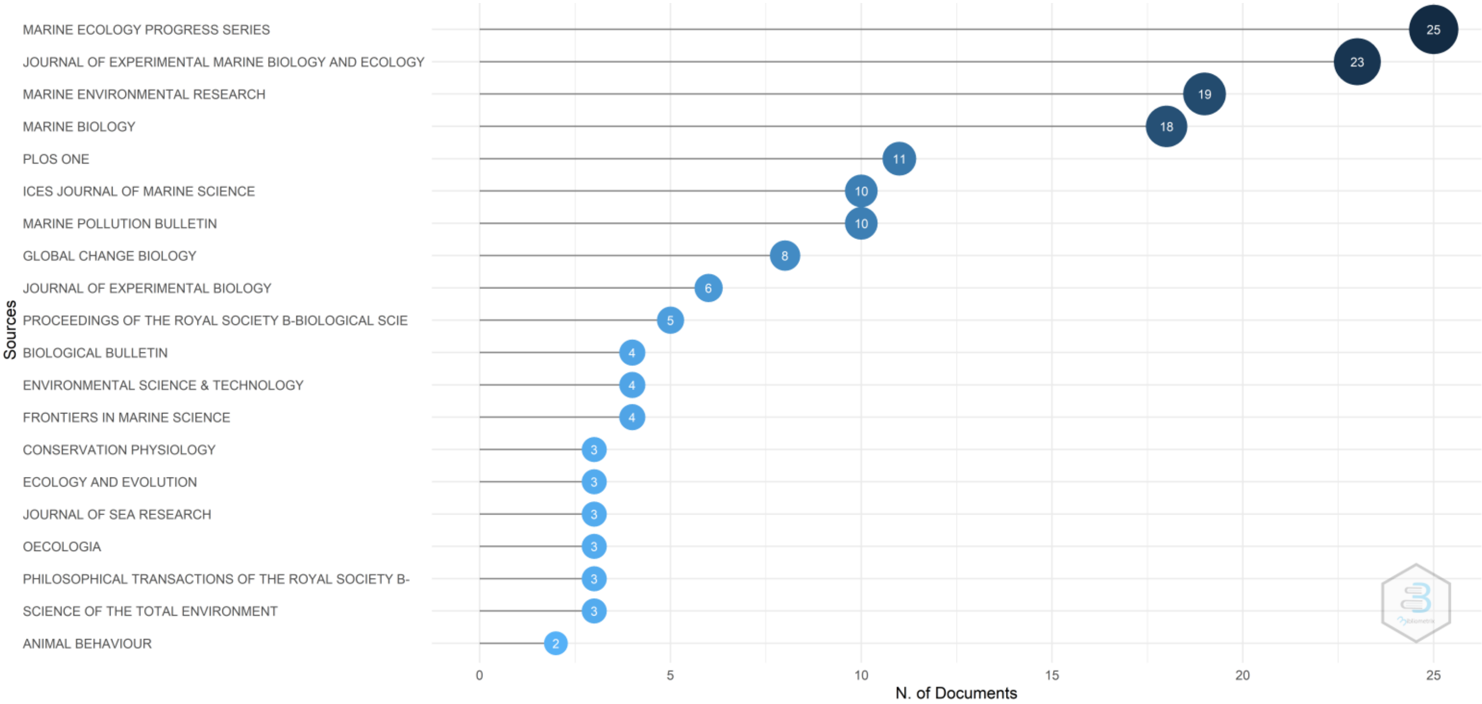

Figure 7 List of the most relevant twenty-five journals that published in the field since 2010. Size circle denotes number of publications.

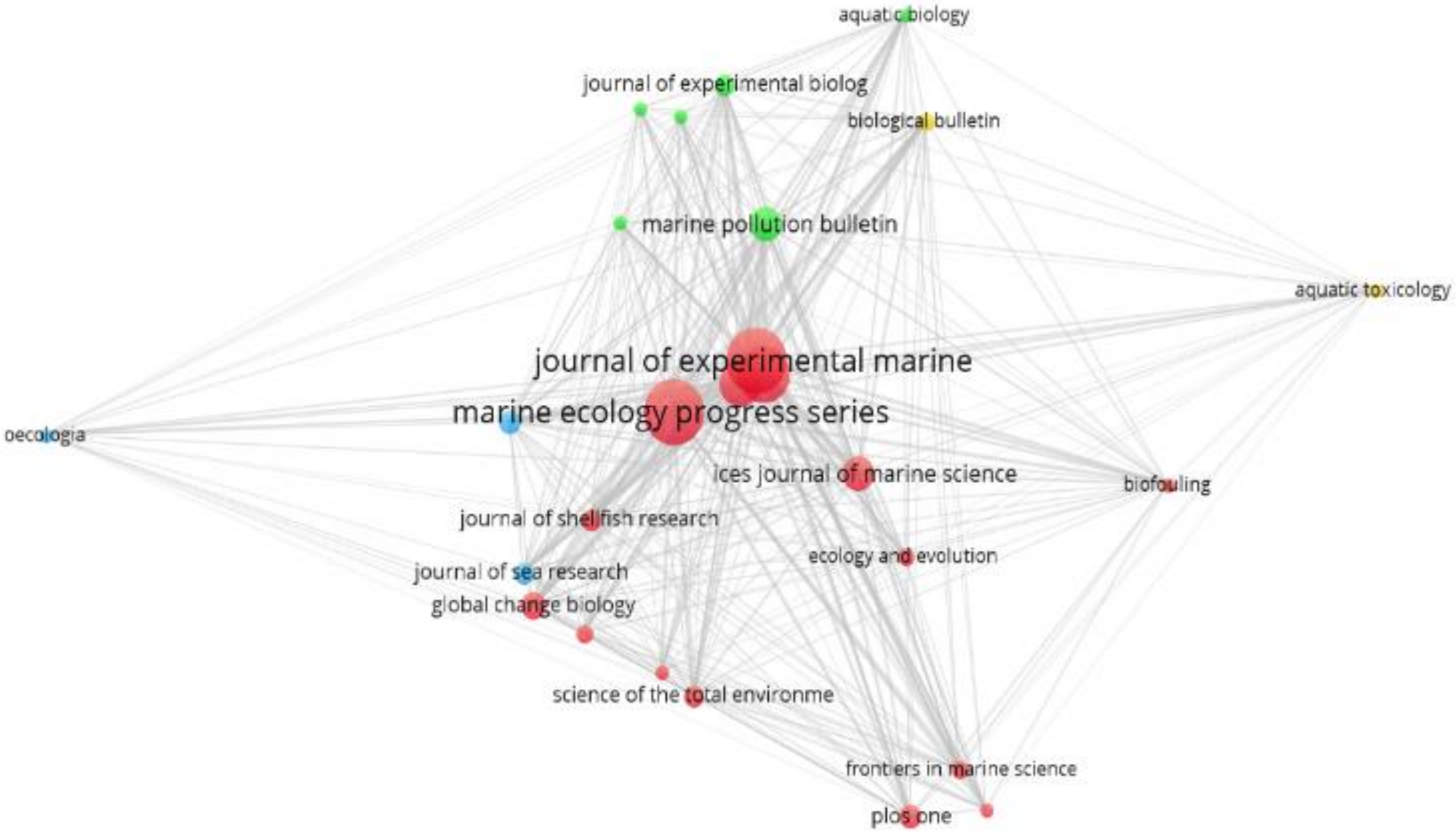

Figure 8 Co-citation network between journals. Nodule size represents number of documents by each participating journal and color of each cluster and line thickness shows stronger relationships

3.1.3 Bibliographical content analysis

Via the thematic mapping of authors' keywords (Figure 9) we were able to convey how themes explored by each paper fit into Motor, Basic, Emerging, or Declining, and Niche Themes. This also reflects in the most influent basic themes e.g., “Ocean acidification”, “Calcification”, “Ocean warming”, “Predation” and “Multiple stressors” which are under the intent of the review process. The purple node (“Skeleton”, “Gene expression” “*Mytilus coruscus*”) demonstrates themes that recently evolved from emerging/declining themes to basic themes, showing a growing interest in those subjects in the overall literature. In the brown node (“Global Change Biology”, “Benthic Ecology”) are possible rising or declining themes that require attention by the community, as fewer articles present these as keywords in conjunction. Niche themes show a strong number of studies employing the same niche themes together in their studies (e.g., articles studying gastropods’ shell density via micro-ct, grey nodule), which can show a tendency of scientific groups funneling their methods and publications to few themes. The occurrence of synonyms in different quadrants (e.g., “Carbon dioxide” in emergency/declining vs. “co” in basic themes; “Predator-prey” in motor themes vs. “Predation” in basic themes) also displays a need in unifying terminology, with standardization of terms in keywording curbing the theme duplication in future thematic mapping.

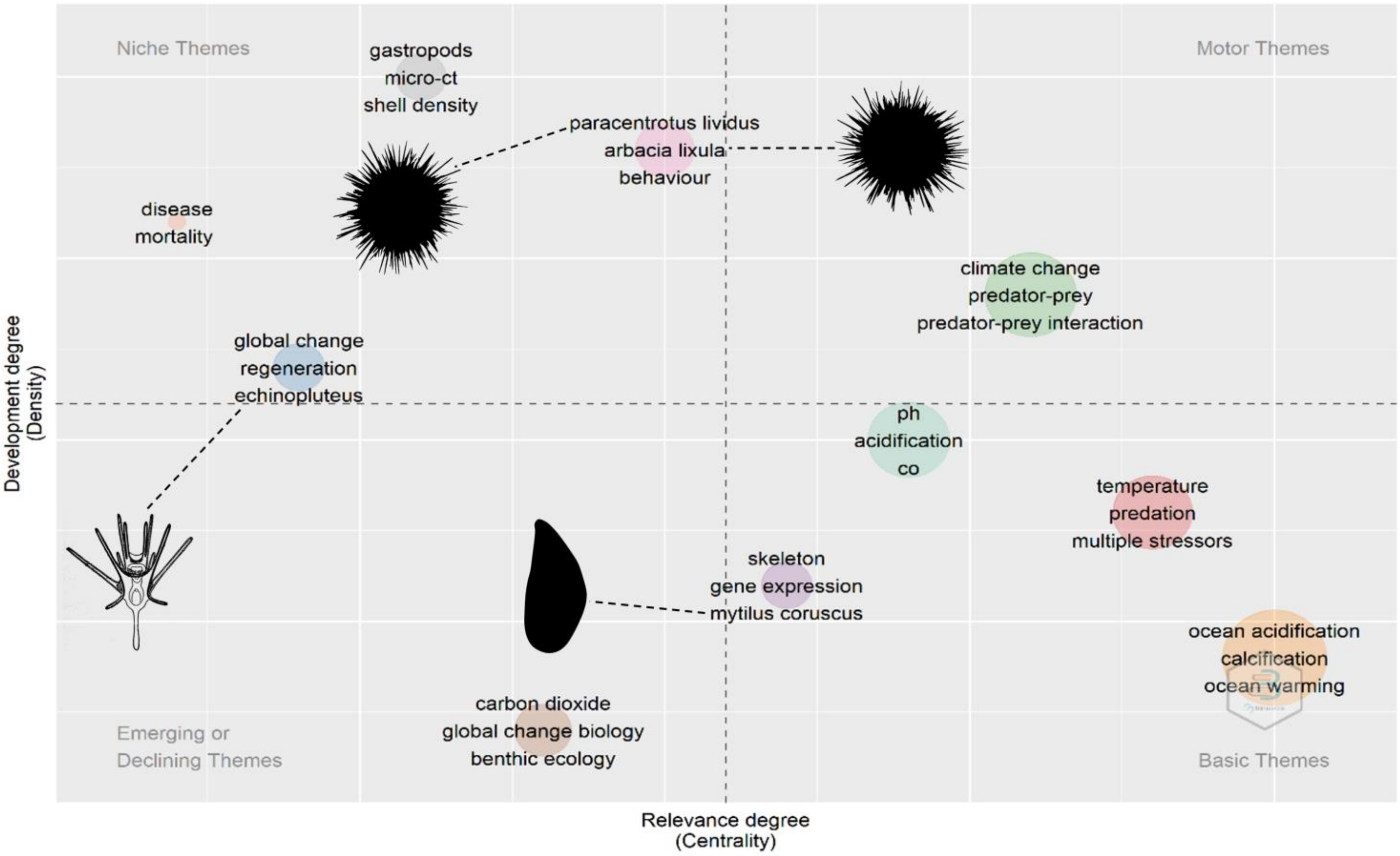

Figure 9 Thematic map of keywords based on co-word analysis through authors keyword co-occurrences.

The co-citation network (Figure 10) shows great interconnections between themes, even in different clusters. Each nodule represents different subjects of studies by the articles in the database. All nodules’ clusters groups are intertwined, showing a bigger linking between each thematic. As the center cluster, ocean acidification is the principal theme across our dataset, with ocean warming also being part of the center group, being less expressive. The themes of the bigger green clusters show the linking of different themes around ocean acidification and impacts on organisms’ morphological traits. The yellow group shows the interconnection of themes around the climate change impacts at levels of communities and ecosystems, as the red and blue groups show nodules on species and/or taxa levels and their interconnection with the center clusters.

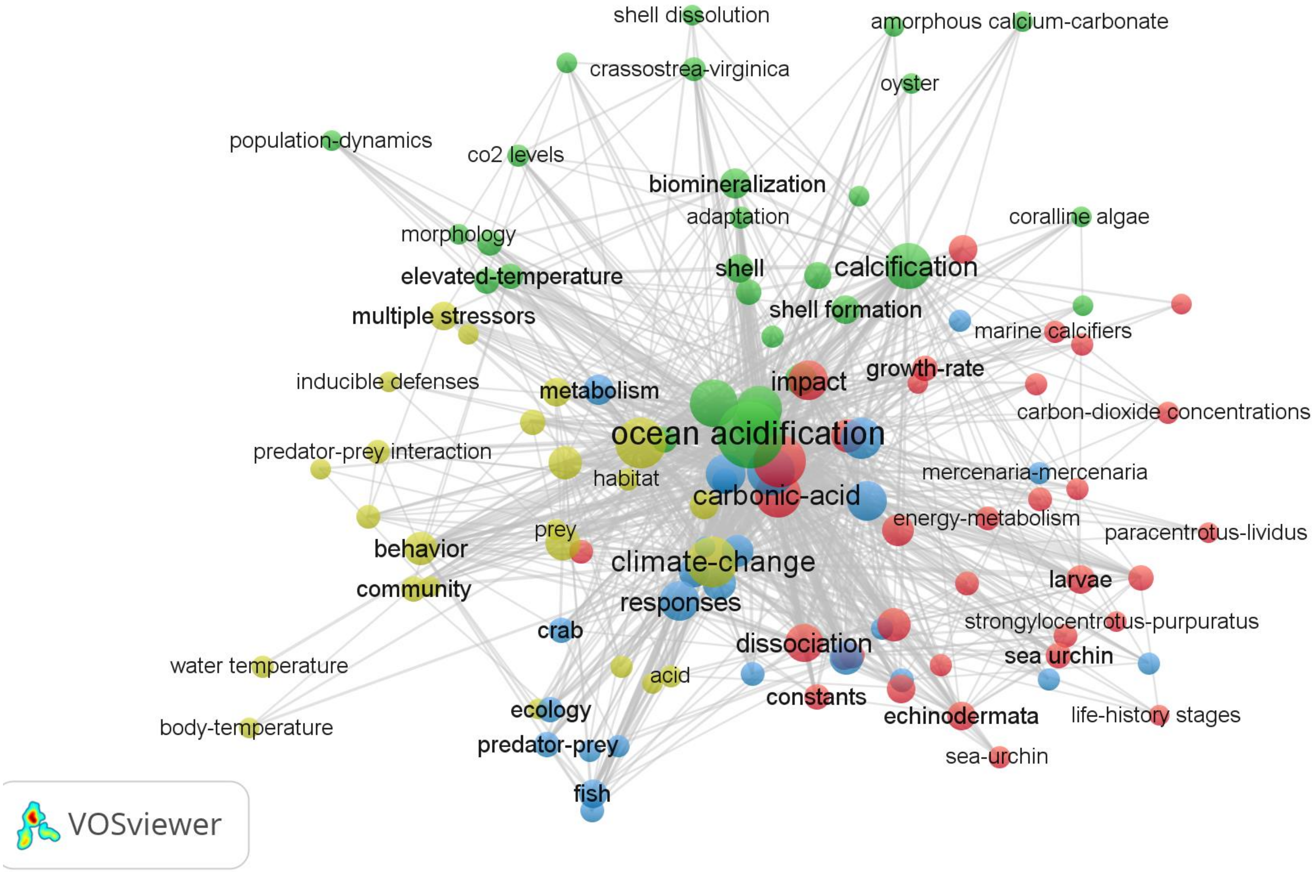

Figure 10 Co-citation network between the 50 most used key words in the selected studies. Nodules size represents word occurrence in each study and cluster color and line thickness represents relationship of terms among the studies in the dataset.

Our time-based review (Figure 11) revealed a preference towards single-based studies based on ocean acidification. The time series showed a growing interest in this area starting from 2011, reaching its peak of 13 studies in 2017. This demonstrates a growing trend of ocean acidification experiments in the decade. In contrast, warming-based studies received less attention, reaching a minimum in 2015, with a growing interest up to 2020. Multi-driver-based experiments display a growth since the beginning of the decade, surpassing both single-based approaches by 2015, dipping in numbers by 2018, with continuous growth by the end of the decade. Our database only covered studies from parts of 2021, resulting in a plunge of numbers by this year.

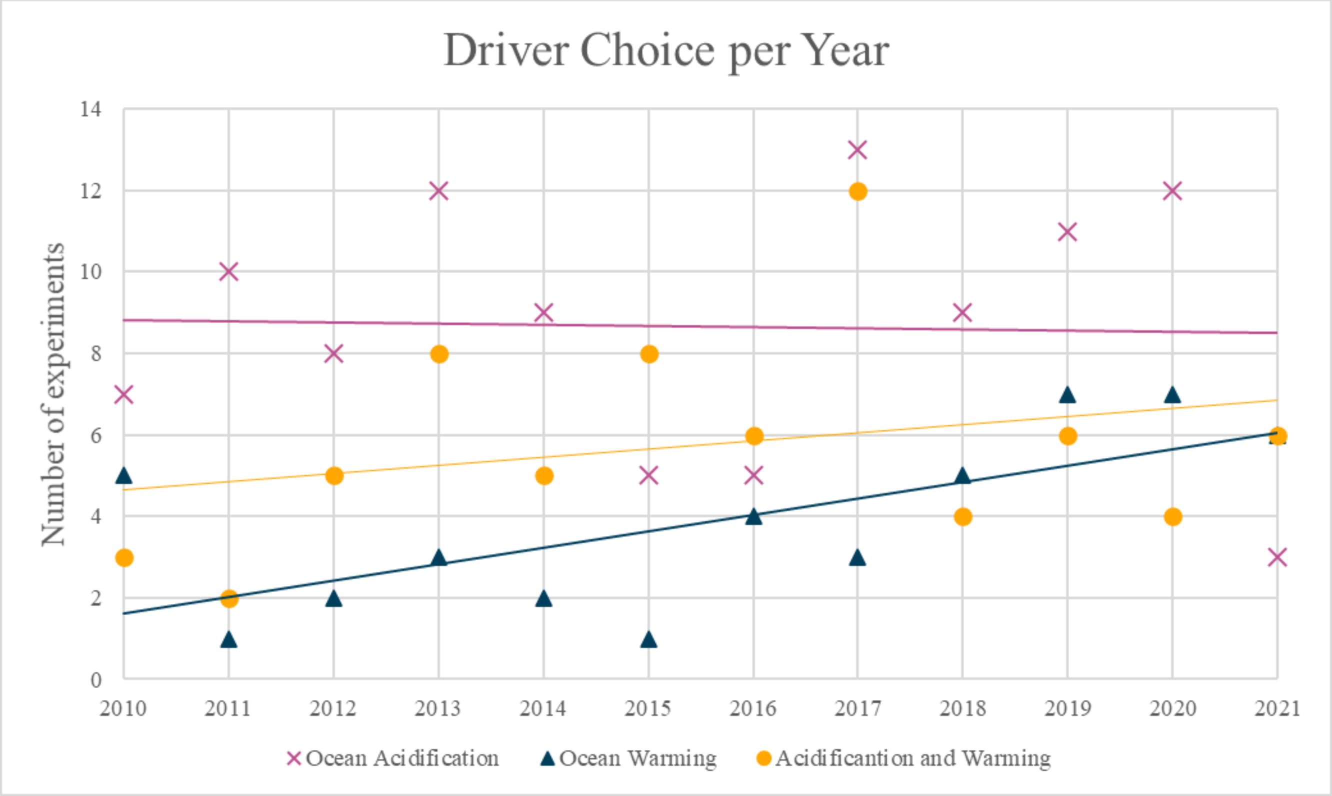

Figure 11 Time based analysis of climate change driver per study per year.

3.2 TAXONOMIC AND DRIVER-BASED ANALYSIS

The taxonomic analysis (Figure 12 and Figure 1 from Appendix II) showed a strong bias towards studies utilizing Mollusca (139 studies), Echinodermata (57 studies), and Arthropoda (55 studies) taxa. They are represented 251 times in the 224 studies (considering some studies are multi-taxa based). There is also an overall preference for studies based on invertebrate taxa, with the notable exception of fish-based studies. In the five least represented taxa (Platyhelminthes, Bryozoa, Birds, Nematoda, and Mammals), only one type of driver-based study was performed. When add to each other, the most represented taxa (Mollusks, Echinoderms, and Arthropoda) had bigger participation than other taxa, with a more complex history of multi-driver and single driver approaches in these studies.

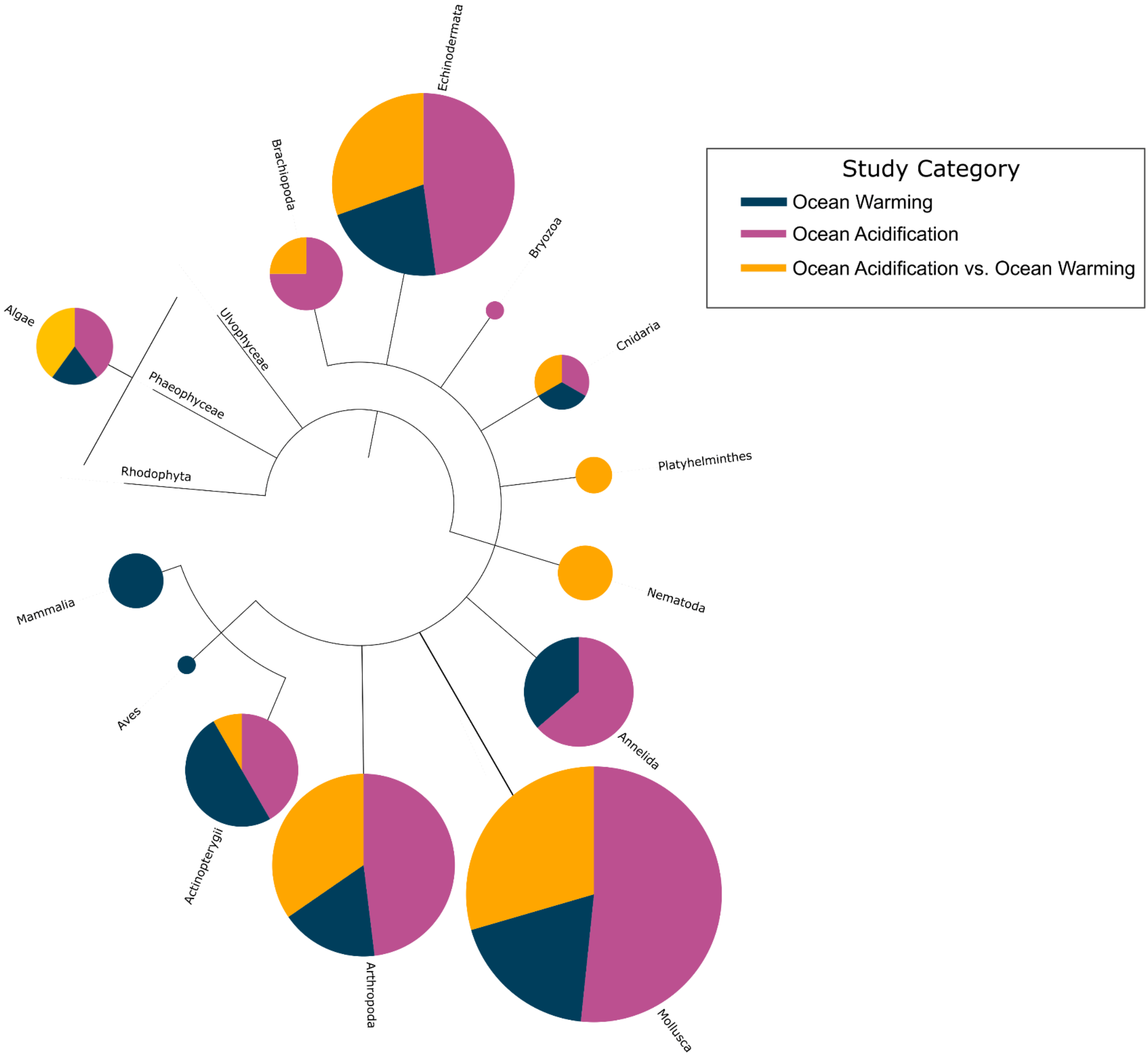

Figure 12 Taxonomic tree of taxa represented in the data base. The pie charts represents which driver was utilized in experiments about the taxa, with the size representing the taxa overall presence in the data base studies

4. DISCUSSION

We reviewed the outlook in the state of publishing in the predator-prey interaction in the intertidal zone by the last decade, summarizing the findings and evolution of the theme. Taxa were tested and measured by an array of stressor-related metrics and categorical variables. This diversity of approaches assessed both direct and indirect effects of ocean warming and acidification in predator-prey interaction in the intertidal zone by the 2010s. Researchers assembled studies in ecological, behavioral, morphological, physiological, and genetic aspects of the climate change impacts in predation. We also pinpoint how to improve upcoming scientific publications in the field in the near future. There is growing interest in the theme, proved by several publications in high impact factor peer-revied journals. The large literature productions are supported by a big network of institutions of the temperate global north, utilizing environments, communities, and organisms found exclusive in these areas. Even though the rates of warming and acidification are expected to be higher outside the tropics (Eissa and Zaki, 2011; Collard *et al*., 2014; IPCC, 2019), temperate organisms are less vulnerable to further stressor-driven impacts. For example, tropical species already live near upper thermal limits, small temperature increases can disproportionally affect their fitness (Vinagre *et al*., 2016). The unevenness of data distributions between the two hemispheres can lead to bias in the state of knowledge of the field. This issue is not exclusive to our data-set of articles, with this inequality affecting almost all scientific fields (Collyer, 2016). Expanding existing pathways to the most tropical global south can help access the full scenario of climate change impacts, limiting possible bias towards temperate species and further increasing the field relevance in the global scientific community.

The most used keynotes denoted the relevant themes evaluated alongside the impacts of climate change drives in predator-prey interactions of the intertidal zone. Even in our database of more niche studies, the higher number and diversity of keywords showed great diversity and interest in the field in the last decade. This corroborates trends of growing attention in climate change-related studies by the last two decades (Bass *et al*., 2019; Lam-Gordillo *et al*., 2020). However, the interconnection of co-occurring keynotes reveals some knowledge gaps. This is demonstrated by outlying themes with few co-occurrences of little relevance, like studies about larval development and marine calcifiers. However, the mapping suffered from redundant keywords, with different papers using the same context with different wording (e.g., “Larval” and “Development vs. “Larval development”; “Predator” and “Prey” vs. “Predator-prey”), which can mask more relevant themes as less pertinent. This can be resolved by a possible standardization of keywording, as proposed by Lam-Gordillo *et al*. (2020). The motor themes of "Climate Change", "Predator-prey" and "Predator-prey interaction" align with the string used for article selection, showing the success of the string in database article searching. Mapping only covered the 50 most relevant keywords, with the vast majority of themes not having co-occurrence connections to other themes that are not basic. The keyword mapping also revealed the variety of different approaches (i.e., measuring morphological, physiological, behavioral, and ecological variables) researchers employed to assess ocean acidification and warming impacts. Climate change biology is a growing field (Bass *et al*., 2021), hence the big range of methodologies is natural, displaying a field with great interdisciplinarity. However, this can create a big discrepancy of methodology across the literature, making it harder to compare different studies systematically or via meta-analyses. Reviewing this field is extremely important as a tool to understand the strength of climate change drivers in current and future scenarios (Lam-Gordillo *et al*., 2020).

The articles' dataset described a range of predation responses by intertidal organisms against warming stress. These responses were direct or indirect (i.e., experiments bearing stressor-related findings that are not related to the main study goal). On a bigger scope, ocean warming affected community compositions, richness, and abundance of intertidal predator and prey species. Weitzman *et al*. (2019) monitored intertidal sites of the Alaskan coastline between 2012-2019. As the region suffered a rise in marine heatwave events, they determined that rocky intertidal communities shifted from macro-algal-dominated to filter-feeder species during and after said events. The decline of rockweeds and fleshy algae cover was followed by an increase of mussel and barnacle cover, as top predators (e.g., sea stars) populations were reduced. Intertidal sites also endured from the homogenization of community structure. The study also found that heatwave overrode local biological drivers. As reported by Sadykova *et al*. (2020) and Amstutz *et al*. (2021) ocean warming at a slower pace also drove intertidal communities shifts, impacting and prevailing over predation pressure. Ocean warming also is responsible for epidemics in intertidal predator and prey species. An outbreak of bald sea urchin disease in *Paracentrotus lividus* was coupled with the increase in sea surface temperatures and the high density of urchins in the communities. The disease enhances their vulnerability to predation and causes changes in their size-frequency distribution. It is suggested that although larger specimens are more affected, small morbid or infected individuals have a higher predation rate. The high mortality of *P. lividus* can affect local macroalgal assemblages and size picking by their predators, exuding effects both upwards and downwards by the trophic levels (Girard *et al*., 2011).

In a smaller scope, ocean warming mostly impacts prey morphological and behavioral defenses and physiologic performances. Some studies in the dataset explored how warming impacted mollusk shell morphology, with warming negatively impacting shell length and mass, thickness, and microstructure (Reed *et al.*,2012; Lord and Whitlatch, 2013; Miller, 2013; Irie and Morimoto, 2016; Freytes-Ortiz and Stallings, 2018; Gilliand and Pechenik, 2018; Telesca *et al*., 2018, 2019; Hu *et al*., 2021). Physiological studies showed higher metabolic rates and O2 in both predators and prey in warming sites, impacting their performance in defense and attack behaviors performance (Thatje *et al*., 2010; Twiname *et al*., 2019; Briceño *et al*., 2020; Falkenberg *et al*., 2021). Warming studies also focused on how warming impacted prey dislodging defenses. Higher temperatures during low tides led to a lower tenacity of attachment in the rock by the limpet (*Lottia gigantea).* This made the prey less resistant to simulated attacks by captive sea-birds species (*Haematopus bachmani)* (Pound *et al*., 2020).

Acidification studies were prevalent among single-driver experiments. This prevalence may be related to a surge in ocean acidification studies in the past ten years in general (Riebensal and Gattuso, 2015; Bass *et al*., 2021). The theme of climate change-driven ocean acidification was considered new, with few publications by the start of the 2010s, with a huge focus on short-term experiments on marine calcifying organisms (Hofmann *et al*., 2010). This line of study design continued strong by the last decade. Wernberg *et al*. (2012) argue that the “over-representation” of acidification studies in the literature it’s due to being a novel climate change-specific stressor, whereas temperature is a recognized driver of species distributions and interactions. The surge in interest may only reflect a lack of data in the pCO_2 impacts pre-2010. Nonetheless, this gap was possibly well covered, with the “over-representation” of single-factor acidification studies may now be a bias in the representation of climate change impacts in real scenarios.

Single-driver studies about ocean acidification produced results mostly centered on morphological responses and consequences to high H^+ content in ocean water. Shell dissolution rates are a great indicator of pCO_2 water levels (IPCC, 2019). Acidification diminishes saturation of aragonite and calcite, species of calcium carbonate ($CaCO_3$), disrupting calcification in shell-forming marine organisms (Coleman *et al*., 2014). As shells are the first line of defense of predator attacks, they are the first step of understanding a bigger picture of impacts in population dynamics and communities structuring. Some studies also linked impacts in shell morphology to predator consumption rate. In a study of mangrove species, acidification led to reducing the shell strength of oysters *(Saccostrea glomerata)*. Subsequently, the gastropod *Morula marginalba* was able to drill and consume oysters and gastropods at a higher rate compared to reference sites (Amaral *et al.*, 2012). Opposite results were obtained with rocky intertidal species. Acidification impaired *Nucella* spp. predation to mussel prey *(Mytilus californianus)*. However, results indicate that impacts in predator performance are population-specific, with responses relating to prior exposure to acute acidification (Contolini *et al.*, 2020). Structural strength was also tested in a species of fouling Annelida (*Hydroides elegans*), with results pointing to acidification as a powerful driver in weakening the structure and mineralogy of protective tubes (Chan *et al*., 2012, 2013; Lane *et al*., 2013; Meng *et al*., 2019a). Acidification also impacted organisms' genomic expression of predator defenses, like the mRNA transcripts of carbonic anhydrases, important to the biomineralization process in oysters larvae (Dickinson *et al*., 2012; Wang *et al.*, 2017), and the expression of energy-producing genes of clams (Peng *et al.*, 2017).

Findings in ecological research showed that acidification was able to start cascading effects in a model shoreline food web, composed of sea star predators (*Leptasterias hexactis*), herbivorous snail prey (*Tegula funebralis*), and a macroalga (*Mazzaella flaccida*) for snail grazing. Low pH affected snails' anti-predator behavior but enhanced snail consumption of macroalgae. Grazing rates were higher than snail predation by sea stars. The results implied that bolder prey behavior caused a spur in the basal resource (i.e., the macroalgae), weakening behaviorally regulated trophic cascades (Jellison and Gaylord, 2019). Behavioral experiments tested acidification boldness and lateralization of prey fishes. Results differed by study, with acidification causing a shyer personality in juvenile pool fish *Girella laevifrons* (Benítez *et al*., 2017) and a bolder Goldsinny wrasse (*Ctenolabrus rupestris*) in predator olfactory cue avoidance (Sundin and Jutfelt, 2016). Responses to predator cues were also delayed in the species of snail *Tritia obsolete* (Froehlich and Lord, 2020) and *Concholepas concholepas* (Manríquez *et al*., 2014a), and in the green shore crabs *Carcinus maenas* (Richardson *et al*., 2021) and clam *Mya arenaria* (Glaspie *et al*., 2017). Acidification led to blue crab *Callinectes sapidus* predators having a higher encounter rate to prey, offset by crabs taking longer to forage and not eating entire prey, resulting in no net change in predation-related mortality (Glaspie *et al*., 2017).

Policymakers shifted their view from single-species-based conservation to a broad view of the structure and function of communities and ecosystems. Studies should move to a holistic view of multiple stressor effects in several species and their interactions (Bass *et al*., 2021) as the cumulative effects of two or more drivers on organisms (being addictive, antagonistic, or synergistic) impact distinct trophic levels in different degrees (Crain *et al*., 2008; Riebensal and Gattuso, 2015; Allan *et al*., 2017; Bass *et al*., 2021). For example, evidence suggests the effects of acidification in mollusks shell morphology not occurring at future temperature ambient level (Kroeker *et al*., 2014), with acidification also not impacting the startle response in a wide-ranging marine mollusk (Clements *et al*., 2021). Acidifications also had a lesser effect on fish escape behavior and predation success in both single-based and combined stressor studies (Allan *et al*., 2017). Some studies forgo predator or prey from the experimental design, focusing on the response by one of the parts to a stressor. Studies usually reserve this design for impacts in morphological and physiological defense/attack traits, as behavioral and ecological studies (with a bigger scope) are usually modulated by the sensing and interaction of the opposite predator and prey species. Although the responses of a single organism to driver-based changes in the ocean can be the outset to understanding future changes, it is hard to forecast the response of interactions and communities by assessing only single-organism studies designs (Riebensal and Gattuso, 2015). The holistic view can also be improved via field experiments and observation. The majority of studies in our dataset utilized a lab experiment approach. While lab studies design is not confounded by noisy data that muddles the interpretation, *in situ* experiments result in data with less abstraction from real scenarios (Calisi and Bentley, 2009; Riebensell and Gattuso, 2015). As experiments are means of solving specific questions from a bigger picture, near-future studies should carry more field studies. Thus, experiments about impacts of climate change drivers in intertidal zone predation in the near future should expand, from single-driver/single-species approaches to multi-driver responses at the ecosystem level, with a balanced combination of lab and field approaches.

With studies about climate change-driven impacts in predator-prey interactions growing in number by the last decade, our analysis revealed the outlook on what is already well-reported and the gaps and inconsistencies that should be covered in near future studies. Here we pinpoint some goals this type of research should achieve in new studies. Institutions and countries should increase participation in the global south networking, this way the scientific community can assess the problem with a global outlook. The great number of synonyms in keywording and the overall text (e.g., stressor and driver, Predations and predator-prey interaction, pH and acidification) can hamper further analysis by future reviews in the area. The new publications are in daring need of themes standardization. There is also the necessity to move from single-drive to multi-driver studies, as the complexity of interactions across stressors in organisms of different taxa cannot be assessed by these types of studies. Future studies also should focus on the multi-driver response of less represented taxa, like vertebrates, Nematoda, and Platyhelminthes, which are only represented by a few ocean warming studies, or even taxa not represented in our dataset.

The studies about the impacts of climate-driven stressors are very relevant, as some intertidal zone areas, warming, and acidification area are already well above end-of-century IPCC projections, with further increase of impacts by 2100 (Cattano *et al*., 2018). Near future research of these impacts in predator-prey interactions is challenged by multiple knowledge gaps resulting from heterogeneity in terminology, lack of consistency in the selection of organisms, and inconsistencies in networking between countries and institutions. Although the articles in our dataset reveal an array of results, it is also important to notice a possible publication bias towards experimental positive outcomes. Publication biases can be rooted in a highly competitive academic system that drives researchers to submit mainly statistic-significant positive results. In turn, these results tend to be more considered for publication, more positively reviewed by peers, and more likely to be cited once published (Joober *et al.*, 2012; Harlos *et al.*, 2017). Moreover, our work can be expanded to encompass impacts of other non-climatic stressors (e.g., introduced species, eutrophication, over-fishing) (Wernberg *et al*., 2012) and interspecific interactions beyond prey-predator interactions. We hope this review improves the understanding and management of climate change-driven impacts in predation, being a valuable tool for science-based conservation policy and management of the intertidal zone.

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Appendix I - The table highlights all the information categorized and applied to bibliometric analysis (Authors, Years, Keywords, Predator and/or Prey Taxa, Driver, Predation Related Variables, Study Design, Journal Abbreviation, and Dataset) for the 224 studies utilized in this review. “N/A” represents unavailable data, as some articles do not include keywording. “A” represents ocean acidification, “W” represents ocean warming and “AxW” represents both stressors. “WOS” represents Web of Science, “GS” represents Google Scholar and “REF” represents articles extracted from previously selected articles.

Authors	Year	Keywords	Predator and/or Prey Taxa	Driver	Predation Related Variables	Design	Journal	Dataset
Alenius & Munguia	2012	Ocean acidification; behavior; Crustacea; Isopoda; *Paradella dianae*; intertidal; invasive species	Arthropoda	A	Mortality, Oxygen consumption, Swimming speed, Conglobating time, Crawling time, Resting time	LAB	Mar Ecol Prog Ser	GS
Amaral, Cabral & Bishop	2012	Acidification; Anti-predator defence; Armouring; Crabs; Macroinvertebrates Oysters; pH; Predation	Mollusc; Arthropoda	A	Force of fracture, Consumption rate	LAB	Mar. Ecol.-Prog. Ser.	REF
Amstutz et al	2021	Anthropogenic climate change; Community composition; Extreme events; Limpets; Physiological stress; Range shifts; Rocky shore; Surface aspect	Mollusc	W	Community composition, Species richness, Abundance, Percentage cover	FIELD	Mar. Environ. Res.	WOS
Appelhans et al	2012	Acidification; pH; CO2; Interactions; Predation; Sea star; Crab; Mussel	Echinoderm; Arthropoda; Mollusc	A	Force of fracture, Consumption rate	LAB	Rev Biol Trop	WOS
Appelhans et al	2014	Ocean acidification; CO2; Predation; Metabolism; Calcification; Sea star*; Asterias rubens*; Selection; Juvenile	Echinoderm	A	Growth, Feeding rates, Prey size preferences	LAB	Mar Ecol Prog Ser	WOS

Authors	Year	Keywords	Predator and/or Prey Taxa	Driver	Predation Related Variables	Design	Journal	Dataset
Arribas et al	2017	Asteriidae; physical stress; rocky intertidal; Patagonia; predation; anthropogenic impact	Echinoderm	AxW	Mean density, Mean Biomass	FIELD	Mar Environ Res	GS
Asnaghi et al	2014	Acidification; pH; Carbon cycling; Coastal zone; *Paracentrotus lividus*; Feeding; Mineralogical composition	Echinoderm	A	Shell thickness, Mg/Ca ratio	LAB	Mar Biol	WOS
Asnaghi et al	2019	Ocean acidification; Temperate reefs; Sea urchins; Macroalgae; *Paracentrotus lividus*; Trophic cascade	Echinoderm	A	Force of fracture	LAB	Mar Environ Res	WOS
Aurelio et al	2013	N/A	Fish	W	Food consumption, Feeding frequency	LAB	Mar Biol	GS
Auzoux-Bordenave et al	2019	N/A	Mollusc	A	Growth, Shell calcification, Shell strength	LAB	Hydrobiologia	WOS
Babarro et al	2018	*Mytilus galloprovincialis*; *Xenostrobus securis*; Protective structure; Byssus attachment; Climate change	Mollusc	AxW	Byssus attachment	LAB	Ocean Sci J	WOS
Bamber, Jackson & Mansfield	2018	pH; CO2; Cnidaria; resource holding potential; intraspecific contest	Cnidaria	A	Consumption time	LAB	J Exp Mar Biol Ecol	WOS
Baragi & Anil	2015	*Balanus amphitrite*; *Chaetoceros calcitrans*; Cyprid; Nauplii; Ocean acidification; Warming	Arthropoda	AxW	Larval developmental rate	LAB	Mar Environ Res	WOS
Barclay et al	2019	Mollusca; Biomechanics; Seawater pH; Predation; *Tegula funebralis*; *Nucella ostrina*	Mollusc	A	Shell growth, Force of fracture	LAB	J Exp Mar Biol Ecol	WOS

Authors	Year	Keywords	Predator and/or Prey Taxa	Driver	Predation Related Variables	Design	Journal	Dataset
Barclay et al	2020	Climate change; Gastropods; Biominerals; Acidification; Shell dissolution; Shell microstructure; Shell density; Micro-CT; *Tegula funebralis*; *Nucella ostrina*	Mollusc	A	Shell density, Shell composition, Shell microstructure	LAB	Mar Ecol Prog Ser	WOS
Beal et al	2020	*Mya arenaria; Mercenaria mercenaria*; Sediment buffering; Shell hash; Predator exclusion; Bivalve recruits	Arthropoda; Mollusc	A	Shell length, Recruitment	FIELD	J Toxicol Env Heal A	GS
Bechmann et al	2011	N/A	Mollusc; Arthropoda	A	Larval developmental rate, Shell growth, Food consumption, Settlement success	LAB	Mar Biol	GS
Bellucci & Smith	2019	N/A	Echinoderm	W	Crawling behavior, Righting behavior, Bilateral movement tendency	FIELD; LAB	Mar Ecol Prog Ser	GS
Beniash et al	2010	Hypercapnia; Ocean acidification; Calcification; Shell structure; Energy metabolism; Oxygen consumption; Mollusks	Mollusc	A	Dry shell mass, Dry mass of soft tissues, Shell thickness, Shell microhardness, Expression of biomineralization genes	LAB	Mar Pollut Bull	REF
Benitez et al	2017	Carbon dioxide; Hypercapnic conditions; Physiology; Behavior; Intertidal pool; Fish	Fish	A	Lateralization; Boldness and Curiosity	LAB	Mar Ecol Prog Ser	GS
Briceño et al	2020	Climate change; *Jasus edwardsii*; predator-prey interaction; respiratory physiology	Arthropoda; Mollusc	W	Metabolic Rate	LAB	J Exp Mar Biol Ecol	REF

Authors	Year	Keywords	Predator and/or Prey Taxa	Driver	Predation Related Variables	Design	Journal	Dataset
Byrne et al	2013a	Calcifying larvae; Echinopluteus; Global change; Ocean acidification; Ocean warming	Echinoderm	AxW	Arm length, Arm Symmetry	LAB	Mar Pollut Bull	GS
Byrne et al	2013b	climate change; development; Eastern Antarctica; echinopluteus; pCO 2; sea urchin; temperature	Echinoderm	AxW	Larval morphometrics	LAB	Glob. Change Biol.	REF
Byrne et al	2014	N/A	Echinoderm	AxW	MgCO3 percentage, Shell thickness, Crushing force	LAB	Environ. Sci. Technol.	REF
Calosi et al	2013	Carbon capture and storage (CCS); Ocean acidification; *Arbacia lixula*; *Paracentrotus lividus*; Acid-base and ionic regulation; Distribution	Echinoderm	A	Species density	FIELD; LAB	J Shellfish Res	GS
Cameron et al	2019	Pecten maximus; ocean acidification; king scallop; extrapallial fluid pH; calcification; condition factor	Mollusc	AxW	Calcification rate	LAB	Mar Environ Res	WOS
Campanati et al	2016	*Balanus amphitrite*; cyprid attachment; early-life stages; low oxygen; multiple stressors; naupliar larvae; ocean acidification	Arthropoda	A	Larval development, Feeding rate	LAB	ICES J. Mar. Sci.	REF
Campanati et al	2018	*Saccostrea cucullatn; Reishia clavigera;* Larvae; Ocean acidification; Predator; Prey	Mollusc	A	Larval growth, Metabolic rate, Shell Morphometrics	LAB	Biol Bull-Us	WOS
Carey, Dupont & Sigwart	2016	N/A	Mollusc	A	Shell morphometry	LAB	Ices J Mar Sci	WOS

Authors	Year	Keywords	Predator and/or Prey Taxa	Driver	Predation Related Variables	Design	Journal	Dataset
Ceballos-Osuna et al	2013	Arthropoda larvae; embryo; juvenile; pH; hypercapnia; cardiac performance; heart rate; sub-lethal effect	Arthropoda	A	Maxilliped activity	LAB	J. Exp. Biol.	REF
Chan et al	2012	N/A	Annelida	A	Tube composition, Tube hardness, Tube elasticity	LAB	PLoS One	REF
Chan et al	2013	N/A	Annelida	A	Tube biomineral composition, Ultrastructure, Tube hardness, Tube elasticity	LAB	Plos One	GS
Chan et al	2016	*Amphiura filiformis*; echinopluteus; global climate change; *Strongylocentrotus purpuratus*; video motion analysis	Echinoderm	A	Larval growth rate, Larval mortality rates, Larval swimming	LAB	J Exp Biol	WOS
Chan, Grünbaum & O'Donnell	2011	ocean acidification; invertebrate larvae; swimming performance; sublethal effect; functional morphology; biomechanics	Echinoderm	A	Larval swimming behavior, Arm lengths, Distances between pairs of arms, Body lengths and widths, Stomach lengths and widths	LAB	Mediterr Mar Sci	GS
Chatzinikolaou et al	2017	climate change; *Columbella rustica*; micro-CT; gastropods; *Nassarius nitidus*; ocean acidification; shell density	Mollusc	AxW	Shell structure, Shell density	LAB	Front Mar Sci	GS
Chatzinikolaou et al	2019	Climate change; *Hexaplex trunculus; Nassarius nitidus*; experiment; high temperature; low pH	Mollusc	AxW	Food reaching success, Response time, Food reaching time, Food reaching speed, Path index	LAB	Mediterr. Mar. Sci.	WOS
Chatzinikolaou, Keklilogiou & Grigoriou	2021	climate change; ocean acidification; shell density; shell thickness; shell porosity; gastropod; micro-CT	Mollusc	AxW	Shell density, Shell thickness, Closed porosity	LAB	Funct Ecol	WOS

Authors	Year	Keywords	Predator and/or Prey Taxa	Driver	Predation Related Variables	Design	Journal	Dataset
Cheng, Komoroske & Grosholz	2017	climate change; invasion; predator-prey; salinity; thermal optima; thermal performance curve; thermal safety margin; warming tolerance	Mollusc	W	Thermal tolerance (CTMax), Thermal performance	LAB	Mar Ecol Prog Ser	GS
Clemente et al	2014	Echinoids; Diadematid; Disease; Widespread die-off; Vibrio; Infection experiments; Canary Islands; Madeira	Echinoderm	W	Abundance, Post-disease settlement rate	FIELD; LAB	J Fish Dis	GS
Clements et al	2017	bivalve aquaculture; Crassostrea; ocean acidification; parasitism; pH; Polydora	Annelida	A	Parasite recruitment	LAB	Anim Behav	WOS
Clements et al	2020	Benthic ecology; Bivalves; Carbon dioxide; Environmental stress; Global change biology	Mollusc	A	Valve closure, Valve movement activity	LAB	Mar Environ Res	WOS
Clements et al	2018a	global change biology; marine bivalves; nutritional quality; ocean acidification; ocean warming; shellfish health	Mollusc	AxW	Mortality, Condition index, Dry tissue mass, Dry shell mass	LAB	Conserv Physiol	REF
Clements et al	2018b	Bivalve behaviour; Carbon dioxide; Global change; Heat wave; Ocean acidification; Valvometry	Mollusc	AxW	Valve gaping behavior	LAB	J. Exp. Mar. Biol. Ecol.	REF

Authors	Year	Keywords	Predator and/or Prey Taxa	Driver	Predation Related Variables	Design	Journal	Dataset
Clements et al	2021	antipredator response; carbon dioxide; environmental stress; global change biology; ocean acidification; ocean warming	Mollusc	AxW	Time to open shell	LAB	J Exp Mar Biol Ecol	GS
Clements, Bishop & Hunt	2017	N/A	Mollusc	W	Burrowing proportion, $GABA_A$ receptor functioning	LAB	Mar. Biol.	REF
Clements, Woodard & Hunt	2016	Benthic ecology; Burrowing behavior; Ocean acidification; pH; Post-settlement dispersal; *Mya arenaria*	Mollusc	A	Burrowing behavior, Dispersal of juvenile, Recruitment of juvenile	FIELD; LAB	Ecol Evol	REF
Cohen-Rengifo et al	2019	behavior; biomechanics; climate change; flow; hydrodynamics; ocean acidification; ocean warming; physiology; sea urchin	Echinoderm	AxW	Development time	LAB	Mar Ecol Prog Ser	GS
Coleman, Byrne & Davis	2014	Climate change; Predation; Shell strength; Shell growth; pH; Ocean acidification	Mollusc	A	Rate of shell repair, Shell thickness, Shell strength, Gastropod condition, $CaCO_3$ polymorph composition	LAB	Ices J Mar Sci	WOS
Collard et al	2016	CO2 seep; intertidal pools; long-term exposure; mechanical properties; ocean acidification; *Paracentrotus lividus*; sea urchin; skeleton	Echinoderm	AxW	Force of fracture	LAB	Oecologia	GS
Contolini, Kroeker & Palkovacs	2020	Intraspecific trait variation; Predator-prey interaction; Ocean acidification; Climate change; Contemporary evolution; Rocky intertidal	Mollusc	A	Consumption time, Search time, Handling time, Prey size selectivity	LAB	J Exp Mar Biol Ecol	WOS

Authors	Year	Keywords	Predator and/or Prey Taxa	Driver	Predation Related Variables	Design	Journal	Dataset
Contolini, Reid & Palkovacs	2020	Intraspecific variation; Climate change; Rocky intertidal; *Nucella; Mytilus*	Mollusc	AxW	Mean drilled mussel length	FIELD	Oecologia	REF
Crim, Sunday & Harley	2011	CO2; *Haliotis kamtschatkana*; Larvae; Ocean acidification; pH; Threatened and endangered species	Mollusc	A	Larval shell growth rates, Shell deformities, Larval survival, Metamorphose competency	LAB	Ices J Mar Sci	REF
Cross et al	2016	calcification; carbonate saturation; climate change; CO2; pH	Brachiopoda	A	Shell growth rates, Frequency of shell repair	LAB	Environ Sci Technol	WOS
Cross, Harper & Peck	2019	N/A	Brachiopoda	A	Shell condition index, Shell thickness	LAB	J Exp Mar Biol Ecol	WOS
Cross, Peck & Harper	2015	Calcification; Carbonate saturation; Climate change; CO2; pH	Brachiopoda	A	Shell growth rates, Frequency of shell repair	LAB	J Anim Ecol	GS
da Silva et al	2020	acclimation; background matching; camouflage; colour change; intertidal; luminance change; plasticity; thermal performance	Fish	W	Rate of luminance change, Achromatic perceptual distance	LAB	J Exp Mar Biol Ecol	GS
Davis et al	2013	N/A	Mollusc	AxW	Embryo development time	LAB	PLoS One	REF
de la Haye et al	2011	chemoreception; decision making; hermit crab; information gathering; ocean acidification; *Pagurus bernhardus*; pH; resource assessment; shell selection	Arthropoda	AxW	Time is taken to change shells, Rates of antennular flicking, Time spent in motion	LAB	Sci Rep-Uk	REF

Authors	Year	Keywords	Predator and/or Prey Taxa	Driver	Predation Related Variables	Design	Journal	Dataset
de la Haye et al	2012	Chemoreception; Hermit crab; Information gathering; Ocean acidification; Olfactory; pH	Arthropoda	A	Time is taken to contact food cue, Time spent with food cue, Time in motion, Rate of antennular flicking	LAB	Anim Behav	REF
deVries et al	2016	N/A	Arthropoda	AxW	Growth of body mass, Grow of carapace length, Cuticle length	LAB	J Exp Mar Biol Ecol	GS
di Giglio et al	2020	Ocean acidification; Echinoderms; *Asterias rubens*; Skeleton; Mechanics; Acclimation	Echinoderm	A	Ossicle corrosion, Three-point bending, Nanoindentation, Magnesium content of the skeleton	LAB	J Exp Biol	GS
Dickinson et al	2012	hypercapnia; ocean acidification; salinity; calcification; shell mechanical properties; energy status; mollusks; H-1-NMR spectroscopy	Mollusc	A	Body size, Shell mass, mRNA expression of carbonic anhydrase, Vickers microhardness, Fracture resistance	LAB	Mar Ecol Prog Ser	REF
Diederich & Pechenik	2013	Intertidal; Subtidal; *Crepidula*; Thermal stress; Physiological tolerance	Mollusc	A	Distribution, Thermal tolerance	FIELD; LAB	Geochem Geophy Geosy	GS
Dodd et al	2015	ocean acidification; *Panopeus herbstii*; foraging behaviour; predator-prey; predation; Crassostrea virginica	Arthropoda; Mollusc	A	Calcification rates, Prey consumption, Prey handling time, Predator persistence, Predator general activity	LAB	Aquat Biol	GS
Dodd et al	2021	N/A	Arthropoda; Mollusc	A	Calcification rates	LAB	P Roy Soc B-Biol Sci	GS
Dorey, Maboloc & Chan	2018	Ocean acidification; Metallic pollution; Developmental biology; Invertebrates; Larvae; Bioaccumulation	Echinoderm	A	Larval growth	LAB	J Sea Res	WOS

Authors	Year	Keywords	Predator and/or Prey Taxa	Driver	Predation Related Variables	Design	Journal	Dataset
Duarte et al	2014	Global Warming; Ocean Acidification; Calcification Rate; Mussel	Mollusc	AxW	Dissolution rate, Net calcification rate, Bodyweight	LAB	Afr J Mar Sci	REF
Dupont, Lundve & Thorndyke	2010	N/A	Echinoderm	A	Growth	LAB	J. Exp. Zool. Part B	REF
Eisenlord et al	2016	epizootic; sea star wasting disease; *Pisaster ochraceus*; host demography; mass mortality; climate change	Echinoderm	W	Body radius, Population size, Rates of disease progression	FIELD; LAB	Philos. Trans. R. Soc. B-Biol. Sci.	REF
Emanuel et al	2020	*Aulacomya atra*; climate change; *Choromytilus meridionalis*; condition index; metabolism; ocean acidification; shell dissolution	Mollusc	AxW	Shell dissolution, Breaking Force	LAB	Roy Soc Open Sci	WOS
Emerson et al	2017	sea urchin; spine; tube feet; regeneration; biomineralization; ocean acidification	Echinoderm	A	Tissue regeneration, Spine structure, Mechanical loading, Biomineralization gene expression, Righting response	LAB	Biol Bull-Us	REF
Evans & Watson-Wynn	2014	N/A	Echinoderm	A	Biomineralization gene expression	LAB	Limnol Oceanogr Lett	WOS
Falkenberg, Simons & Anderson	2021	N/A	Mollusc	W	Feeding rate, Oxygen consumption	LAB	Mar Biol Res	WOS
Findlay et al	2010a	ocean acidification; climate change; barnacle; biogeography	Mollusc	AxW	Initial size, Shell Ca content, Shell Mg content, Ca/Mg, Net calcification rate, Overall length, Mortality	LAB	Ecol Evol	WOS

Authors	Year	Keywords	Predator and/or Prey Taxa	Driver	Predation Related Variables	Design	Journal	Dataset
Findlay et al	2010b	N/A	Arthropoda	AxW	Growth rate, Shell calcium content	LAB	Mar. Biol.	REF
Findlay et al	2011	Barnacle; calcification; echinoderm; mollusc; ocean acidification	Mollusc; Echinoderm	A	Calcium concentration, Shell width, Shell height, Shell thickness	LAB	Estuar Coast Shelf S	GS
Fitzer et al	2015a	Biomineralization; CO; (2); mussels; ocean acidification; shell shape; shell thickness; temperature	Mollusc	AxW	Shell thickness	LAB	J R Soc Interface	REF
Fitzer et al	2015b	biomineralization; ocean acidification; temperature; mussels; CO2; multiple stressors	Mollusc	AxW	Elasticity and hardness of calcite and aragonite of shell, Fracture toughness	LAB	Mar Biol	REF
Freytes-Ortiz & Stallings	2018	N/A	Mollusc; Arthropoda	W	Shell length, Shell width, Wet weight, Wet weight growth, Handling time	LAB	J Exp Mar Biol Ecol	WOS
Froehlich & Lord	2020	Ocean acidification; Predator-prey; Cue; Crab; Predation; Nonlethal interactions	Mollusc; Arthropoda	A	Prey climbing behavior, Prey burial behavior, Burial and climbing responses, Prey movement,	LAB	Mar Environ Res	WOS
Gaylord et al	2011	biomineralization; early survivorship; environmental change; form and function; shell properties	Mollusc	A	Shell strength, Shell area, Shell thickness, Larval tissue mass	LAB	J. Exp. Biol.	REF
Gazeau et al	2010	N/A	Mollusc	A	Success of D-larvae, Shell length, Abundance, Shell growth rate, Shell thickness	LAB	Biogeosciences	REF

Authors	Year	Keywords	Predator and/or Prey Taxa	Driver	Predation Related Variables	Design	Journal	Dataset
Gazeau et al	2011	N/A	Mollusc	A	Proportion of viable D-veliger, Larval shell area, Larval shell length, Inco	LAB	PLoS One	REF
Gazeau et al	2014	ocean acidification; ocean warming; Mediterranean mussels; growth; survival; Mediterranean Sea	Mollusc	AxW	Shell length, Fresh weight, Shell weight, Respiration rate, Excretion rate, Calcification rate	LAB	J Exp Mar Biol Ecol	GS
Gestoso, Arenas & Olabarria	2015	Predator-prey interaction; Climate change*; Nucella lapillus; Xenostrobus securis; Mytilus galloprovincialis*; Non-indigenous species	Mollusc	AxW	Number individuals attacked, Feeding preference, Percentage of complete drill holes, Prey effectiveness, Consumption, Percentages of shell organic and inorganic compounds, Shell thickness	FIELD; LAB	Estuar Coast Shelf S	REF
Gestoso, Arenas & Olabarria	2016	Climate change; *Xenostro bussecuris; Mytilus galloprovincialis*; Invasive species; Ecological interactions; Mesocosm experiment	Mollusc	AxW	Condition index, Valve density, Shell thickness, Percentages of shell organic and inorganic compounds, Growth rates, Respiration rates	LAB	J Sea Res	WOS
Giacoletti et al	2017	Invasive species; Climate change; Multiple-stressor; *Stramonita haemastoma; Brachidontes pharaonis*; RCP8.5	Mollusc	W	Prey-size choice, Growth rates, Predation rates,	LAB	Mar Environ Res	GS
Gianguzza et al	2014	Climate change; Ocean warming; Ocean acidification; Calcification; Sea urchin	Echinoderm	AxW	Mean Growth, Mortality	LAB	Mar Ecol-Evol Persp	WOS

Authors	Year	Keywords	Predator and/or Prey Taxa	Driver	Predation Related Variables	Design	Journal	Dataset
Gilliand & Pechenik	2018	N/A	Arthropoda	W	Dry weight, Aperture length, Wet weight, Size of shell chosen	LAB	Biol. Bull.	REF
Gilliand, Pechenik & Clark	2021	behavior; climate change; hermit crab; *Pagurus longicarpus*; tide pool	Arthropoda	W	Shell initial state, Time taken to choose ideal shells	LAB	Invertebr. Biol.	WOS
Girard et al	2012	Disease; mortality; sea urchin; temperature; wave height	Echinoderm	W	Frequency of different sized individuals, Frequency of healthy, infected and dead individuals, Infection prevalence	FIELD	Ices J Mar Sci	REF
Glandon & Miller	2017	acidification; blue crab; climate change; Callinectes sapidus; consumption; growth	Arthropoda	AxW	Growth per molt, Inter-molt period duration, Food consumption	LAB	Mar Freshwater Res	GS
Glaspie & Seitz	2017	Australia; bivalve; pollution; predator-prey	Arthropoda; Mollusc	A	Handing time, Foraging time, Prey size	LAB	Global Change Biol	WOS
Glaspie, Longmire & Seitz	2017	Estuarine acidification; Climate change; pH; Chesapeake Bay; Arthropoda; Bivalve	Arthropoda; Mollusc	A	Foraging success, Handling time, Encounter rate, Search time, Feeding time, Foraging time, Non-foraging move time, Resting time	LAB	J. Exp. Mar. Biol. Ecol.	WOS
Goldenberg et al	2017	climate change; CO2 enrichment; direct and indirect effect; mesocosm; ocean acidification; predator-prey; species interaction; trophic compensation	Fish; Arthropoda; Nematodes; Annelida	AxW	Food consumption, Biomass	LAB	J Exp Mar Biol Ecol	GS

Authors	Year	Keywords	Predator and/or Prey Taxa	Driver	Predation Related Variables	Design	Journal	Dataset
Gonzalez-Bernat et al	2013	N/A	Echinoderm	A	Larval length, Larval arm's length, Larval stomach area	LAB	Mar. Biol.	REF
Guo et al	2016	Ocean acidification; Embryo; Larva; *Paphia undulate*; Adaptation	Mollusc	A	Deformation rate, Larval shell length, Shell increment, Shell ultrastructure	LAB	Oikos	WOS
Hale et al	2011	N/A	Arthropoda; Mollusc; Annelida; Echinoderm	AxW	Number of species, Number of individuals, Species evenness, Species abundance	LAB	J Exp Mar Biol Ecol	GS
Hamilton et al	2016	Climate change; High CO2; Deoxygenation; Growth; Sebastes	Mammal	W	Spatial overlap	LAB	Sci Adv	GS
Harvell et al	2019	N/A	Echinoderm	W	Species abundance	FIELD	Mar Ecol Prog Ser	GS
Harvey & Moore	2017	Predator-prey; Climate change; Ocean warming; Ocean acidification; Trophic interactions; Ecological interactions; Compensatory	Mollusc	AxW	Rostro-carinal diameter, Tissue production, Survival rate	LAB	Mar Biol	WOS
Hernández et al	2010	*Diadema aff. antillarum*; Larval settlement; Seawater warming; Recruitment; Habitat	Echinoderm	W	Larval settlement, Recruitment, Adult abundance	FIELD	Mar. Ecol.-Prog. Ser.	REF
Hiebenthal et al	2013	N/A	Mollusc	AxW	Mean shell growth, Shell Increment rate, Shell breaking force	LAB	Aquacult Env Interac	WOS
Hu et al	2021	Ocean warming; Growth rate; Foraging performance; Predator-prey interactions; *Rapana venosa*; RCP 8.5	Mollusc	W	Shell length, Shell mass, Body mass	LAB	Can J Fish Aquat Sci	WOS

Authors	Year	Keywords	Predator and/or Prey Taxa	Driver	Predation Related Variables	Design	Journal	Dataset
Hurst, Abookire & Knoth	2010	N/A	Fish	W	Density, 0-age size, Growth rates	FIELD	J Exp Mar Biol Ecol	GS
Irie & Morimoto	2016	Calcification; Temperature; Shell thickness; Rearing experiment; Gastropoda; Heteroscedasticity	Mollusc	W	Callus-building period, Final callus thickness, Callus growth rates	LAB	Oecologia	GS
Jellison & Gaylord	2019	Carbon dioxide; Tidepool; Predator-prey interaction; Invertebrates; Behavior; Non-consumptive effects	Echinoderm; Mollusc; Algae	A	Out of water time, Probability of predator moving, Distance traveled by predator, Consumption, Strength of indirect and direct effects	LAB	P Roy Soc B-Biol Sci	WOS
Jellison et al	2016	predator-prey; avoidance behaviour; tidepool; marine stressors; global climate change; elevated carbon dioxide	Mollusc; Echinoderm	A	Path length, Path Shape, Proportion of time out of water	LAB	Philos T R Soc B	GS
Jochum et al	2012	multiple stressors; trait-mediated; functional trait; European green crab; Lough Hyne; biodiversity	Arthropoda	AxW	Biomass, Population density	FIELD	J Exp Mar Biol Ecol	GS
Johnson et al	2020	Ocean acidification; Echinoid; Skeleton; Micro-computed tomography; Scanning electron microscopy; Nanoindentation	Echinoderm	A	Pore surface area of the apical plates, Hardness of the apical plates	LAB	Plos One	WOS
Jutfelt et al	2013	N/A	Fish	A	Bodyweight, Lateralization index, Novel object investigation time	LAB	Coral Reefs	REF

Authors	Year	Keywords	Predator and/or Prey Taxa	Driver	Predation Related Variables	Design	Journal	Dataset
Karelitz et al	2019	Transgenerational plasticity; Ocean warming; Ocean acidification; Climate change; Acclimation; Developmental plasticity	Echinoderm	AxW	Body length, Postoral arm's length, Body rods length	LAB	Mar Biol	WOS
King & Sebens	2018	N/A	Mollusc	W	Growth rates, Predation rate	LAB	Front Mar Sci	WOS
Knights et al	2020	multiple stressors; climate change; biomineralization; mussels; environmental variability; functioning	Mollusc	AxW	Body volume, Shell width, Shell Length, Shell height, Distribution of grain areas	LAB	Mar Pollut Bull	WOS
Kong et al	2019	pH; Temperature; Anti-predation behaviour; Cluster; Mussel; Species-specific effect	Mollusc	AxW	Number of byssal threads, Weight byssal treads	LAB	Mar Ecol Prog Ser	WOS
Lagos et al	2016	Calcification; Shell growth; Scallop farming; Upwelling; Chile	Mollusc	AxW	Shell thickness, Shell dry weight, Wet biomass, Growth, Length, Calcification rate, Dissolution rate	LAB	Aquac. Environ. Interact.	REF
Landes & Zimmer	2012	Acidification; Warming; Environmental change; Calcification; Predator-prey interaction; Coastal benthic communities	Arthropoda; Mollusc	AxW	Length of closing muscle, Claw strength, Handling time, Shell breaking resistance	LAB	Mar Biol	WOS
Lane et al	2013	N/A	Annelida	A	Tube development, Larval settlement, Growth rate	LAB	Mar Ecol Prog Ser	REF
Lee, McGill & Fitzer	2021	Mussel; Biomineralisation; Carbon isotopes; Ocean acidification; Increased temperature	Mollusc	AxW	Calcite VPDB δ^{13}C, Aragonite VPDB δ^{13}C	LAB	Mar Environ Res	WOS

Authors	**Year**	**Keywords**	**Predator and/or Prey Taxa**	**Driver**	**Predation Related Variables**	**Design**	**Journal**	**Dataset**
Lee, Torres & Manriquez	2017	Meiofauna; Nematodes; Ocean warming; Ocean acidification; Microcosms; Chile	Nematoda	AxW	Meiofauna abundance, Species richness	LAB	Mar Ecol Prog Ser	WOS
Lemasson & Knights	2021	Predator-prey interactions; Multi-stressors; Climate change; Ecological interactions; Non-native species	Mollusc	AxW	Condition index, Valve density, Shell thickness	LAB	Environ Sci Technol	GS
Lesser et al	2010	Intertidal; Mussels; Physiology; Stable isotopes; Thermal stress; Oxidative stress; Heat shock proteins	Mollusc	W	Shell length, Condition indices, stable carbon (^{13}C) and nitrogen (^{15}N) isotope compositions, Relative expression of heat shock protein, Activity of superoxide dismutase	LAB	Comp. Biochem. Physiol. A-Mol. Integr. Physiol.	REF
Leung et al	2017	N/A	Mollusc	AxW	Vickers hardness, Elastic modulus of the shell	LAB	Sci Total Environ	GS
Leung, Russell & Connell	2017	N/A	Mollusc	A	Shell Growth, Feeding rate, Shell hardness, Elastic modulus, Relative ACC content, Calcite/aragonite rate, Mg/Ca in calcite	LAB	Environ. Sci. Technol.	REF
Leung, Russell & Connell	2019	N/A	Mollusc	W	Sheltering behavior, Respiration rate, Heat shock protein (Hsp70) concentration, Rock surface prey appearance	LAB	Mar Pollut Bull	GS

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Leung, Russell & Connell	2020	Adaptation; Calcification; Gastropod; Ocean acidification; Ocean warming; Physiology	Mollusc	AxW	Ingestion rate, Assimilation efficiency, Absorption rate, Respiration rate, Excretion rate, Energy budget, Flesh weight, Organ weight, Shell weight, Mechanical resilience, Organic matter content, Relative ACC content	LAB	One Earth	GS
Li et al	2015	ocean acidification; temperature; mussels; *Mytilus coruscus*; byssus; antipredation	Mollusc	AxW	Byssus attachment	LAB	Mar Environ Res	GS
Li et al	2016	Biofouling; climate change; ocean acidification; global warming; calcification; micro-CT scanning; finite element analysis; *Hydroides elegans*	Annelida	AxW	Tube density	LAB	J Shellfish Res	WOS
Li et al	2020	Ocean acidification; Predator prey interactions; Gastropod; Mussel; Barnacle	Mollusc; Arthropoda	A	Prey searching time, Prey species preference, Consumption rate	LAB	Biofouling	WOS
Lim & Harley	2018	Ocean acidification; Direct vs. indirect effects; Heart rate; *Caprella mutica; Caprella laeviuscula*; Biogenic habitat	Arthropoda	A	Heart rate, Population size, Abundance	LAB	PeerJ	REF

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Liu et al	2017	Ocean acidification; *Pinctada fucata*; Calcification; Gene expression	Mollusc	A	Shell growth, Shell hardness, Calcium content, Microstructure, Biomineralisation gene expression	LAB	Aquat Conserv	WOS
Lopez et al	2021	acidification; benthos; indicator species; invertebrates; ocean warming; predation experiments	Cnidaria; Arthropoda	AxW	Colony weight, Colony area	LAB	J Exp Mar Biol Ecol	WOS
Lord & Whitlatch	2013	Feeding; Oyster; Oyster drill; Season; Shell thickness; Temperature	Mollusc	W	Shell thickness, Prey size selection, Feeding rate	LAB	Mar Ecol Prog Ser	WOS
Lord, Barry & Graves	2017	Climate change; Ocean acidification; Global warming; Species interactions; Predation	Arthropoda; Mollusc; Algae	AxW	Feeding rate, Tissue growth, Shell growth	LAB	Mar Ecol Prog Ser	WOS
Lord, Harper & Barry	2019	Predation; Nonlethal; Shell structure; Crab; Snail	Mollusc	AxW	Shell growth, Lateral shell growth, Shell weight,	LAB	Sci Rep-Uk	WOS
Manriquez et al	2013	N/A	Mollusc	A	Self-righting, Body size, Growth, Predation risk, oxygen consumption	LAB	PLoS One	REF
Manriquez et al	2014a	Y-maze; Chemoreception; Decision-making; Early ontogeny; Mucous trail; pH; *Concholepas*	Mollusc	A	Avoidance behavior response, Prey detection response	LAB	Mar Ecol Prog Ser	WOS

Authors	Year	Keywords	Predator and/or Prey Taxa	Driver	Predation Related Variables	Design	Journal	Dataset
Manriquez et al	2014b	Hatching time; Hatching success; Early larval survival; Protoconch size; Protoconch thickness; Statolith size; Egg capsule wall thickness; Developmental plasticity	Mollusc	A	Protoconch thickness, Protoconch size, Egg capsule length, Egg capsule wall thickness	LAB	Mar Environ Res	WOS
Manriquez et al	2016	N/A	Mollusc	AxW	Shell tenacity, Shell size, Escape behavior, self-righting	LAB	Plos One	GS
Manriquez et al	2017	Growth; Grazing rate; Tenacity; Structural integrity; Self-righting; Foraging speed *Loxechinus albus*	Echinoderm	AxW	Growth, Structural integrity, Self-righting	LAB	Mar Ecol Prog Ser	GS
Manriquez et al	2021	Global change biology; Pinching strength; Self-righting; Metabolic rate; Nutritional status; *Acanthocyclus hassleri*	Arthropoda	AxW	Body size, Wet mass, Buoyant weight	LAB	Sci Total Environ	GS
McCarthy et al	2020	Global change; Water chemistry; Ocean acidification; Asteroidea; Growth; Regeneration; Righting time response	Echinoderm	A	Body growth, Arm regeneration, Righting Time Response	LAB	Mar Ecol Prog Ser	WOS
McIntyre et al	2011	Climate change; Southern elephant seals; Foraging ecology; Marine mammals; Bio-logging; Marion Island	Mammal	W	Time-at-depth index, Dive depth, Dive duration	FIELD	J Exp Mar Biol Ecol	GS

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Meadows et al	2015	Intertidal meiofauna; Nematodes; Copepods; Ocean acidification; pH; Ocean warming	Nematoda; Arthropoda	AxW	Community structure, Biomass, Structural and functional diversity	LAB	Mar Ecol Prog Ser	GS
Melatunan, et al	2013	Climate change; Ocean acidification; Phenotypic plasticity; Morphology; Growth; Shell thickness; Aspect ratio; Water loss; *Littorina littorea*	Mollusc; Arthropoda	AxW	Shell weight, Shell thickness, Shell length, Shell aspect ratio, Apertures length, Water loss	LAB	P Roy Soc B-Biol Sci	GS
Melzner et al	2020	climate change; trophic energy transfer; coastal ecology	Mollusc; Echinoderm	W	Body mass, Digestive gland index, Digestive gland mass, Condition index, Consumption, Density, Baseplate area	LAB	Biofouling	GS
Meng et al	2019a	Biofouling; biomineralization; calcification; ocean acidification; *Hydroides elegans*	Annelida	A	Tube length, Tube calcite/aragonite ratio, Tube compositions, Mineral density, Nanoindentation	LAB	Mar Environ Res	WOS
Meng et al	2019b	Ocean acidification; Oyster shells; Crystallography; Mechanical property; Calcification; Compensatory mechanism	Mollusc	A	Shell microstructural damage, Crystallographic orientation of the foliated layer, Shells hardness, Shell stiffness	LAB	Mar Pollut Bull	WOS
Menge et al	2016	N/A	Echinoderm	W	Settlement, Recruitment, Predation Rate, Wasting frequency	FIELD	PLoS One	REF
Mevenkamp et al	2018	Warming; Ocean acidification; Mortality; Nematodes; Platyhelminthes; Biotic interactions; Synergism	Platyhelminthes	AxW	Community composition, Predator density	LAB	Mar. Environ. Res.	REF

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Milano et al	2016	Mollusc shell; Acidification; Carbon dioxide capture and sequestration; Microstructure; Shell hardness; Scanning electron microscopy; Nanoindentation	Mollusc	A	Shell growth, Shell dissolution, Shell microstructures, Shell Hardness	LAB	Mar Biol	GS
Miller	2013	N/A	Mollusc	W	Shell thickness, Time of drilling, Ingestion rate, Attack time, Rasping stroke period	LAB	Global Change Biol	GS
Miller, Matassa & Trussell	2014	*Carcinus maenas*; climate change; foraging; *Nucella lapillus*; predation risk; predator-prey; species interactions; temperature	Arthropoda; Mollusc	W	Prey foraging rate, Tissue growth, Growth efficiency, Prey consumption, Predation risk	LAB	Mar Pollut Bull	GS
Moulin et al	2011	Ocean acidification; Sea urchin; Intertidal; Early development; LOEC; Acclimatization/adaptation	Echinoderm	A	Larval development	LAB	Ices J Mar Sci	REF
Murray, Fuiman & Baumann	2017	condition factor; fatty acid; growth distributions; *Menidia*; ocean acidification; survival	Fish	A	Body length, Bodyweight, Body condition, Tank effect	LAB	Prog Oceanogr	WOS
Navarro et al	2019	Warming; Salinity decrease; *Harpagifer*; Physiology; Antarctic; Magellan Region; Climate change	Fish	W	Ingestion rate, Oxygen uptake, Scope for growth	LAB	Global Change Biol	GS

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Newcomb et al	2019	Byssal thread; ecomechanics; multiple stressors; Mytilus; ocean acidification; ocean warming	Mollusc	W	Byssal thread breaking force, Byssal thread production	LAB	Conserv. Physiol.	REF
Nguyen et al	2012	climate change; noncalcifying larvae; ocean acidification; ocean warming; sea star	Echinoderm	AxW	Larval development time	LAB	P Roy Soc B-Biol Sci	GS
Nienhuis, Palmer & Harley	2010	ocean acidification; carbon dioxide; calcification; shell dissolution; shell deposition; *Nucella lamellosa*	Mollusc	A	Shell deposition, Shell dissolution	LAB	Mar Environ Res	REF
Onitsuka et al	2018	Climate change; Gastropods; Diel fluctuation; Periodic pCO(2) amplitude; pH; Larval shell; Survival	Mollusc	A	Malformation rates, Shell length	LAB	J Exp Mar Biol Ecol	GS
Pansch et al	2012	*Amphibalanus improvisus*; Barnacles; Cypris; Nauplius; Ocean acidification; Warming	Arthropoda	AxW	Barnacle settlement, Larval duration	FIELD; LAB	Sci Total Environ	REF
Pansch et al	2013	N/A	Arthropoda	A	Growth rate, Dislodging force	FIELD; LAB	Mar. Biol.	REF
Parker et al	2012	carbon dioxide; carry-over; climate change; ocean acidification; Saccostrea glomerata; Sydney rock oyster	Mollusc	A	Larval survival, Larval development, Shell length, Metabolic rate	LAB	Glob. Change Biol.	REF
Parker, Ross & O'Connor	2010	N/A	Mollusc	AxW	D-veliger stage survivor, Larval abnormality, Shell length	LAB	Mar. Biol.	REF

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Paul et al	2021	Biomarkers; Climate change; Multiple stressors; Kairomones; Detoxification; Predator and prey interaction	Fish	W	Bodyweight, Weight gain, Energy metabolism-related enzymes activity, Cellular energy allocation, Detoxification, and oxidative stress	LAB	Mar Biol	GS
Pechenik et al	2019	N/A	Mollusc	A	Larval growth, Metamorphose competency, Shell length	LAB	Plos One	GS
Pecquet, Dorey & Chan	2017	Bryozoan; Lecithotrophic larvae; Video motion analysis; pH; Global change	Bryozoa	A	Settlement, Larval swimming speed, Post-settlement individual size	LAB	Mar Ecol Prog Ser	WOS
Peng et al	2017	Ocean acidification; Burrowing behaviour; Metabolism; Gene expression	Mollusc	A	Digging depths, Enzyme activities of the Ca^{2+}/Mg^{2+}-ATPase, Gene expression, Oxygen consumption rate, Ammonia excretion rate	LAB	Mar Environ Res	WOS
Pires et al	2015	Polychaetes; Body regeneration; Biomarker; Climate change; pH decrease; Temperature increase; Salinity changes	Annelida	AxW	Regenerative capacity	LAB	J Exp Biol	GS
Poore et al	2013	Acidification; Warming; Herbivory; Multiple stressors; Macroalgae	Arthropoda; Algae	AxW	Growth, Feeding rates	LAB	Oecologia	REF

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Pound et al	2020	*Haematopus bachmani*; Owl limpet; *Lottia gigantea*; Low tide exposure; Black oystercatcher; Tenacity; Thermal history	Aves; Mollusc	W	Net force, Force distribution, Prey removing proportion, Pre-removal interaction time, Dislodging force	LAB	Global Change Biol	GS
Queirós et al	2015	climate change; dynamic bioclimatic envelope model; IPCC; mesocosm; ocean acidification; tomography; trophic interaction; warming	Mollusc	AxW	Behavioral response to prey cues, Behavioral response to predator cues	LAB	Mar Environ Res	GS
Ragagnin, et al	2018	Effects; Multiple stressors; Environmental changes; Ocean acidification; Photoperiod; *Pagurus criniticornis*	Arthropoda	A	Growth, Calcification, Displacement activity	LAB	Mar Environ Res	GS
Ragazzola et al	2021	Coralline algae; Mediterranean ecosystem; Heatwaves; Acidification; Peracarida; Polychaeta; 6-10) climate change	Annelida; Arthropoda; Algae	A	Calcification, Associated fauna assemblages, Predator abundance	LAB	J Exp Biol	GS
Rastrick et al	2014	Climate change; Ocean acidification; OA; Crustacea; Acid-base balance; Lactate	Arthropoda	AxW	Haemolymph pH, Haemolymph HCO_3, Haemolymph pCO_2	LAB	Plos One	GS
Reed, Thatje & Linse	2012	N/A	Echinoderm	W	Growth rates, Prodissoconch size, Shell Element/Calcium ratio	LAB	J Exp Mar Biol Ecol	GS
Richardson et al	2021	Predator-prey interactions; Ocean acidification; Olfactory disruption; Chemical ecology	Arthropoda; Fish; Mollusc	A	Time taken to find prey cue, Time taken to find predator cue	LAB	Aquat. Ecol.	WOS

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Ries	2011	Aragonite; Calcite; Mg-calcite; Mg-fractionation; Shell; Skeleton	Arthropoda; Echinoderm; Mollusc; Annelida	A	Calcite/aragonite ratio, Mg/CaC ratio	LAB	J Exp Mar Biol Ecol	REF
Rühl et al	2017	Climate change; CT scanning; early-life stage; electron microscopy; Juvenile; Mollusc; ocean acidification; ocean warming	Mollusc	AxW	Shell growth, Shell Mg^{2+}/Ca^{2+} ratio, Shell density, Shell length, Shell width, Shell thickness	LAB	Mar Environ Res	WOS
Russell et al	2013	primary productivity; biofilm; grazing; climate change; ocean acidification; physiological performance	Mollusc	AxW	Biofilm consumption, Resting metabolic rates	LAB	Philos. Trans. R. Soc. B-Biol. Sci.	REF
Sadler, Lemasson & Knights	2018	Climate change; Ecosystem engineer; Predation; Trophic cascade; Environmental change; Interaction	Mollusc	A	Shell thickness, Body volume, Feeding rate, Predation risk (mortality)	LAB	Ecol Evol	WOS
Sadykova et al	2020	Besag; York and Mollie (BYM) models; critical marine habitat; fish; integrated nested Laplace approximation; marine mammals; predator-prey; seaAvess; spatial joint modeling	Mammal	W	Species density, Spatial percentage difference, Local and common space percentage loss or gain, Weighted centroids and direction of change, Ecological costs	FIELD	P Roy Soc B-Biol Sci	GS

Authors	Year	Keywords	Predator and/or Prey Taxa	Driver	Predation Related Variables	Design	Journal	Dataset
Sanford et al	2014	climate change; carbon dioxide; invasive species; multiple stressors; ocean acidification; predator-prey interaction	Mollusc	A	Shell area of drilled prey, Number of drilled prey, Shell thickness, Shell area	LAB	Mar Biol	GS
Schalkhausser et al	2013	N/A	Mollusc	A	Clapping performance, Oxygen consumption rates	LAB	J Exp Mar Biol Ecol	GS
Sigwart, Green & Crofts	2015	N/A	Mollusc	A	Force to fracture	LAB	Aquat Biol	WOS
Small et al	2010	Ocean acidification; Physiology; Metabolic depression; *Necora puber*; Thermal tolerance; Carbon capture and storage	Arthropoda	A	Metabolic rates, Upper thermal tolerance, Haemolymph acid-base status, Shell mineralization	LAB	J Fish Biol	WOS
South et al	2018	climate change; feeding ecology; functional response; *Lipophrys pholis*	Fish; Arthropoda	W	Attack rate, Handling time, Maximum feeding estimate	LAB	Invertebr Biol	WOS
St-Pierre & Gagnon	2015	N/A	Echinoderm	W	Feeding rate, Prey size selection, Predator starvation	LAB	Comp Biochem Phys A	GS
Stumpp et al	2011	Larvae; Echinoderm; Ocean acidification; Respiration; Feeding	Echinoderm	A	Larval survival, Development, Growth, Aerobic metabolic rate, Feeding rate	LAB	J Exp Mar Biol Ecol	REF
Suarez et al	2020	Ocean warming; Thermal tolerance; Seasonality; *Anthothoe chilensis; Anemonia alicemartinae*	Cnidaria	W	Larval survival, Frequency of fission, Detachment rate	LAB	Mar Pollut Bull	WOS

Authors	Year	Keywords	Predator and/or Prey Taxa	Driver	Predation Related Variables	Design	Journal	Dataset
Sundin & Jutfelt	2016	chemoreception; choice flume; climate change; ecophysiology; predator avoidance; teleost	Fish	A	Lateralization, Swimming duration, Prey and predator olfactory preference	LAB	Sci Rep-Uk	WOS
Telesca et al	2018	N/A	Mollusc	W	Shell shape variation	LAB	Global Change Biol	GS
Telesca et al	2019	biomineralization; calcification; climate change; compensatory mechanisms; multiple stressors; Mytilus; ocean acidification; resistance	Mollusc	W	Shell calcification	LAB	J Exp Mar Biol Ecol	GS
Thatje, Casburn & Calcagno	2010	Anomura; Biogeography; Crustacea; Deep sea; Evolution; Physiology	Arthropoda	W	Metabolic rate, Frequency of wiping, Frequency of withdrawals into the shell, Time spent in the intermediate state, Time spent in the escaping state, Time spent in the emerging state	LAB	Aquaculture	GS
Thiyagarajan & Ko	2012	Portuguese oyster; *Crassostrea angulata*; Climate change; Ocean acidification; Larval calcification	Mollusc	A	Larval growth	LAB	Aquat Ecol	GS
Thomsen et al	2010	N/A	Mollusc	A	Settlement success, Growth rate	FIELD; LAB	Biogeosciences	REF
Tomatsuri & Kon	2019	Ocean acidification; Hermit crab; Direct; indirect effect; CO2 seep; Environmental stress	Arthropoda	A	Shell availability, Community structure, Survival rate	FIELD; LAB	J Sea Res	WOS

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Torossian et al	2020	Rocky intertidal; Nonconsumptive effect; Marine invertebrate; Heart rate; Metabolic enzymes; Climate change; Gulf of Maine	Mollusc	W	Cardiac responses, Biochemical responses	LAB	Mar Environ Res	GS
Turra et al	2020	Global change; Environmental impact; Water chemistry; Seawater pH; Physiological stress; Energy budget; Limb loss; Sexual dimorphism	Arthropoda	A	Mortality, Growth, Number of molts, Cheliped regeneration, Startle response, Lipid content, Calcium content	LAB	Mar Ecol Prog Ser	GS
Twiname et al	2019	Aerobic scope; Climate change; Arthropoda larvae; Escape speed; *Puerulus*; Respiratory metabolism; *Sagmariasus verreauxi*	Arthropoda	W	Aerobic performance, Escape performance	LAB	Estuar Coast	GS
Vargas et al	2013	ocean acidification; larval feeding; natural food supply; diatoms; nanoflagellates	Mollusc	A	Food particles biomass, Clearance rate, Ingestion rate	LAB	Mar Environ Res	GS
Vargas et al	2015	Acidification; Newly hatched larvae; Gastropod; Mussel juveniles; Feeding	Mollusc	A	Food availability, Clearance rate, Ingestion rate	LAB	J Plankton Res	GS

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Viotti et al	2019	pH variability; *Phorcus sauciatus*; CO2 vent; Gastropod; Atlantic ocean; Population dynamics	Mollusc	A	Population density, Shell morphology, Fracture resistance	FIELD; LAB	Ices J Mar Sci	WOS
Visconti et al	2017	*Arbacia lixula*; climate change; larvae morphology; sea urchin; thermal history	Echinoderm	AxW	Larval size, Body profile	LAB	Aquat Toxicol	GS
Waldbusser et al	2011	Biocalcification; Bivalve; Chesapeake Bay; Estuarine acidification; Oyster; pH	Mollusc	A	Biocalcification rate	LAB	Estuaries Coasts	REF
Waldbusser et al	2015	N/A	Mollusc	A	Shell development, Growth, Respiration rate, Initiation of feeding	LAB	Plos One	REF
Wang et al	2017	Ocean acidification; Carbonic anhydrase; Calcification; Crassostrea gigas; CO2 exposure	Mollusc	A	Temporal mRNA expression, Tissue distribution of CgCA mRNA transcript, Ca^{2+} content	LAB	Global Change Biol	WOS
Wang et al	2018	pCO(2); crab; feeding behavior; physiology; specific dynamic action; *Cancer pagurus*	Arthropoda; Mollusc	A	Consumption rate, Prey size selection, Foraging Behavior, Prey Profitability	LAB	Front Physiol	GS
Watson et al	2012	Calcium carbonate; calcification; ocean acidification; temperature; morphology; predation; solubility; mollusc; brachiopod; echinoid	Mollusc; Brachiopod; Echinoderm	AxW	Shell Mass, Shell organic content, Tissue organic content, Total inorganic content	FIELD	Molluscan Res	GS

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Weitzman et al	2021	marine heatwave; rocky intertidal; community structure; nearshore ecology; coastal habitat	Mollusc; Algae; Echinoderm;	W	Community structure, Diversity, Community similarity, Taxa variability	FIELD	Front. Mar. Sci.	WOS
Welladsen, Southgate & Heimann	2010	Hypercapnia; tropical mollusc; shell strength; nacre deposition; climate change; pearl oyster	Mollusc	A	Shell Strength, Organic Content of Shells	LAB	Mar Ecol Prog Ser	WOS
White et al	2013	N/A	Mollusc	A	Larval shell length	LAB	Plos One	REF
White et al	2014	Ocean acidification; Bay scallop; Early development; Hypercapnia; Shell development; Fertilization	Mollusc	A	Larval shell length	LAB	Cah Biol Mar	WOS
Wolfe, Dworjanyn & Byrne	2013	Climate change; Temperature; Ocean acidification; Intertidal; Juvenile; Echinoid	Echinoderm	AxW	Number of spines	LAB	Mar Ecol Prog Ser	WOS
Wong, Peterson & Kay	2010	Bottom type; Multiple predator effects; Predator interactions; Prey size selection; Poleward range shift; *Callinectes sapidus; Menippe mercenaria; Mercenaria*	Arthropoda; Mollusc	W	Consumption, Prey profitability, Prey selection, Foraging behavior, Encounter behavior	LAB	Mar Biol	WOS
Wright et al	2014	N/A	Mollusc	A	Calcification, Predation rate, Metabolic rate	LAB	Mar Pollut Bull	GS

Authors	Year	Keywords	Predator and/or Prey Taxa	Driver	Predation Related Variables	Design	Journal	Dataset
Wright et al	2018	N/A	Mollusc	A	Metabolic rate, Shell size, Shell strength, Prey consumption	LAB	Biol Bull-Us	GS
Wu et al	2017	pH; Temperature; Crab; Prey selection; Foraging behavior; Charybdis japonica	Arthropoda	AxW	Predation rate, Prey selection, Searching time, Breaking time, Eating time, Handling time,	LAB	Mar. Pollut. Bull.	REF
Xu et al	2017	Predator-prey interaction; Ocean acidification; Mussels; Muricid gastropods	Mollusc	A	Prey detection, Pray handling, Prey size preference, Consumption rate	LAB	Ocean Coast Res	GS
Yokoyama et al	2020	Ocean acidification; Metabolism; Intertidal; Gastropod; Shell repair	Mollusc	A	Body composition, Nucleic acid indicators of growth	LAB	Mar Pollut Bull	GS
Zhan et al	2016	Ocean acidification; Strongylocentrotus intermedius; Early development; Calcification	Echinoderm	A	Percentages of 1-, 2-, 4-, 8-,16-cell stage embryos	LAB	Mar Ecol Prog Ser	GS
Zhao et al	2017	Elevated pCO(2); *Mytilus coruscus*; Byssal thread; Gene expression; Mechanical properties	Mollusc	A	Byssal production, Byssus morphology, Byssal thread failure, Gene expressions of byssal proteins	LAB	Roy Soc Open Sci	GS
Zhao et al	2020	*Musculista senhousia*; Byssal threads; Biofouling; Transgenerational plasticity; Coastal acidification	Mollusc; Arthropoda	A	Byssal number, Byssus length, Diameter of byssal threads	LAB	Environ Pollut	GS
Zlatkin & Heuer	2019	CO2; mollusc; carbon dioxide; climate change	Mollusc	A	Tail-withdrawal reflex time	LAB	J Sea Res	GS

Appendix 2 – Taxonomic tree of species in the study's dataset. Names and clades as described by each study. Some unaccepted (synonyms) nomenclatures were updated by the NCBI taxonomy database. Taxa are described by color.