ASSESSING THE CONSERVATION STATUS OF SELECTED INSECTS IN THE MALTESE ISLANDS

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Dedication

To my parents Charmaine and Michael, and my sister Michaela

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Abstract

The main aim of this dissertation is to present an evaluation of the conservation status of selected groups of insects of the Maltese fauna, including a reassessment of selected species listed in Schembri and Sultana (1989). Species were evaluated using IUCN criteria based on data from literature published over the last 30 years. Selected species within 48 selected families from Coleoptera, Diptera, and Lepidoptera were considered on the basis of the information available. The conservation status using IUCN categories as well as notes are provided for each species that was (re)evaluated.

Overall, a total of 381 species were successfully (re)assessed, including 95 species from Schembri and Sultana (1989). The overall percentages of IUCN categories that were evaluated is as follows: 'Least Concern' – 6.3%, 'Near Threatened' – 5.5 %, 'Vulnerable' – 13.6%, 'Endangered' – 27.3%, 'Critically Endangered' – 15.5%, 'Possibly Extinct' – 13.6%, 'Data Deficient' – 17.6%, and 'Not Applicable' 0.3%. There was a significant change in the IUCN conservation status of selected species that were mentioned in Schembri and Sultana (1989), with 59% of species evaluated being in a threatened or near threatened category, an increase from 1% to 11% of species classified as 'Possibly Extinct', and from 0% to 3% in the 'Least Concern' and 'Near Threatened' categories; and a decrease in the 'Vulnerable' (from 21% to 18%) and the 'Endangered' (from 30% to 24%) categories. This may be due to using a more objective approach when evaluating the species with the standardised IUCN criteria, rather than the previous subjective approach. When comparing distribution type (endemic vs non-endemic), no significant difference was found on extinction risk. This was probably due to the fact that even non-endemic species are frequently threatened at the local scale because of their small extent of occurrence and area of occupancy at the national scale, in turn largely a consequence of the small size of the islands. Moreover, the last recorded locations of 'Critically

Endangered' and 'Possibly Extinct' species, as well as all the distribution data for threatened species, were visualised on QGIS maps, which display clustering in locations such as Buskett, Marsa, Salina, Mġarr, Rabat, Dingli, Marsaskala, Marsaxlokk, Girgenti, Mellieħa, Għar Lapsi in Malta, and Ramla, Marsalforn, Victoria and Xlendi in Gozo. These locations include habitats such as sand dunes, salt marshes, and freshwater pools, and are considered vulnerable due to human impact, climate change, and habitat loss. Therefore, these locations should be of conservation priority. In conclusion, long-term monitoring as well as further research into the ecology of the species evaluated, as well as assessment of both direct and indirect impacts that are contributing to insect population decline, is recommended in order to develop better conservation strategies for the preservation of the Maltese insect fauna.

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List of Abbreviations

IUCN: International Union for Conservation of Nature

ERA: Environment and Resource Authority

ETIB: The Equilibrium Theory of Island Biogeography

EU: European Union

NGO: Non-Governmental Organisation

ODZ: Outside Development Zone

NBSAP: National Biodiversity Strategy and Action Plan

CBD: Convention on Biological Diversity

OAR: Open Access Repository

GBIF: Global Information Facility

EX: Extinct

EW: Extinct in the Wild

CR: Critically Endangered

EN: Endangered

VU: Vulnerable

NT: Near Threatened

LC: Least Concern

DD: Data Deficient

NE: Not Evaluated

NA: Not Applicable

PE: Possibly Extinct

QGIS: Quantum Geographic Information System

PAST: Palaeontological Statistics

EPPO: European and Mediterranean Plant Protection Organisation

Chapter 1: Introduction

1.1. Background information

The Maltese Islands, despite their small size, are rich in biodiversity (Schembri, 1990). They present a high environmental heterogeneity, including many diverse habitats, for example caves, Mediterranean shrublands (such as garrigues, steppes, and maquis), temporary freshwater pools and streams, and saline marshlands (Schembri, 1997). These support a wide range of species, including many which are rare or endemic. One of the most diverse groups of animals present on the islands are insects, with over 4,000 species currently inhabiting them (Mifsud D. pers. comm., 2026). Assessing the threats on insect species on islands, and hence their conservation status, is particularly important for biodiversity conservation due to their isolation from the mainland, which make them particularly vulnerable (Fordham and Brook, 2010).

1.2. Rationale

In recent years, many studies recording the description of new insect species from the Maltese Islands have been published. However, a paper giving an overview of all insect species found in the Maltese Islands has not been published since 2000 (Mifsud, 2000). Furthermore, the last catalogue published about threatened and endemic insect species of the Maltese Islands was the 'Red Data Book for the Maltese Islands' (Schembri and Sultana, 1989). Given the continued profound environmental changes that affected the islands in the last 25 years, an updated, accurate evaluation of the conservation status of Maltese insects (especially for endemic species) is urgently needed.

1.3. Aims and Objectives

The primary aim of this work is to reassess the conservation status of the selected insect species of the Maltese Islands, according to the criteria established by the IUCN. The present study will mainly focus on selected groups of Coleoptera, Lepidoptera, and Diptera due to a lot of good information available in the scientific literature. This study will not be considering the following groups, for two reasons: (1) there is insufficient information available on some groups, and (2) given the focused nature of the dissertation, a full evaluation of all the groups is not feasible: Hemiptera, Hymenoptera, Orthoptera, Thysanura, Diplura, Collembola, Ephemeroptera, Odonata, Blattoidea, Dermaptera, Psocoptera, Phthiraptera, Strepsiptera, Siphonaptera, and Trichoptera.

To this aim, we addressed the following objectives:

- To compile a comprehensive list of insect species belonging to well-studied groups among Coleoptera, Lepidoptera and Diptera
- To critically assess the existing conservation status of these insect species by reviewing and evaluating the current IUCN classifications and recent literature, also in comparison with previous assessments (Schembri and Sultana, 1989)
- To propose future research directions based on the knowledge gaps found, and provide recommendations for conservation strategies targeting threatened insect populations

This dissertation is structured into six chapters. Chapter 2 gives a background on island biogeography, describes the main threats to Maltese biodiversity, and reviews the existing framework for conservation assessment as well as the existing literature on records of the selected insect groups on the Maltese Islands. Chapter 3 outlines the materials and methods for the present study, detailing the method used for data collection and analysis. Chapter 4 presents and describes the findings of the present study, giving details on the IUCN classification of each species. Chapter 5 examines the results and discusses future research directions, as well as recommendations on conservation strategies for stakeholders. Finally, Chapter 6 concludes by summarising the findings and the proposals for future research.

Reevaluating the conservation status of the Maltese insects since the last catalogue in 1989 (Schembri and Sultana, 1989) will achieve a deeper understanding of the current conservation status of Maltese biodiversity. Additionally, it will help organisations like ERA implement better management strategies to conserve vulnerable and important species, as well as inform conservation NGOs about their current status.

Chapter 2: Literature Review

2.1. Island Biogeography Theory in the Maltese Islands

This chapter discusses briefly island biogeography theory, bringing up case studies from both the Mediterranean and globally, as well as highlighting its limitations as a framework and its connection to extinction. After that, the Maltese climate and vegetation is discussed.

2.1.1. Island Biogeography Theory

Island organisms have always been of deep concern to conservation. Island environments play two well-studied roles on island organisms: (i) as sanctuaries for widespread taxa found on adjacent landmasses, and (ii) as centres for evolution, and thus active sources of unique species including endemics and higher taxa (Whittaker et al., 2023). However, how much endemic species an island contributes to taxonomy depends on island geography (island area, isolation, and variety of biotopes) and geological history (Dennis et al., 2008; Whittaker et al., 2023).

Island biogeography is the study of factors that affect the geological distribution of organisms in isolated environments, particularly islands. The most important theory that governs this field is MacArthur and Wilson's ETIB. This theory states that the number of species of a given taxon found on an island will be the product of opposing forces leading to the gain and loss of species, resulting in a dynamic equilibrium involving a continued turnover of the species present through time, whose rates of loss and gain are predictable using island area and island isolation (MacArthur and Wilson, 1967). Prior to the ETIB was the static theory of islands (Dexter, 1978), which theorised that island communities remain mostly constant over geological time. Evolutionary processes such as speciation were thought to be the only mechanisms for biological change. It was believed that few successful colonisation events would occur because of a limited number of ecological niches on the island, which once completely filled, there would be no space and resources available for new immigrants. Hence, they may not be successfully established. The ETIB challenges this by saying that, rather than island communities are static, they exhibit a dynamic equilibrium between species colonisation and extinction, or species turnover. It displays two curves: an immigration curve and an extinction curve (see Figure 2.1). The immigration curve is descending because the most successful dispersing species would colonise initially, followed by a significant decrease in the overall rate of immigration. On the other hand, the extinction curve is ascending because as more species inhabit the island through time, more species would become extinct exponentially. This is intensified by factors such as population size and negative biotic interactions among different species. The equilibrium point is represented by *S*, in which the immigration and extinction curves intersect. This point represents the number of species present on an island at equilibrium. It varies across islands, depending on the island's size, and degree of isolation from the mainland. Moreover, different equilibrium points can result from these factors, as shown in Figure 2.2.

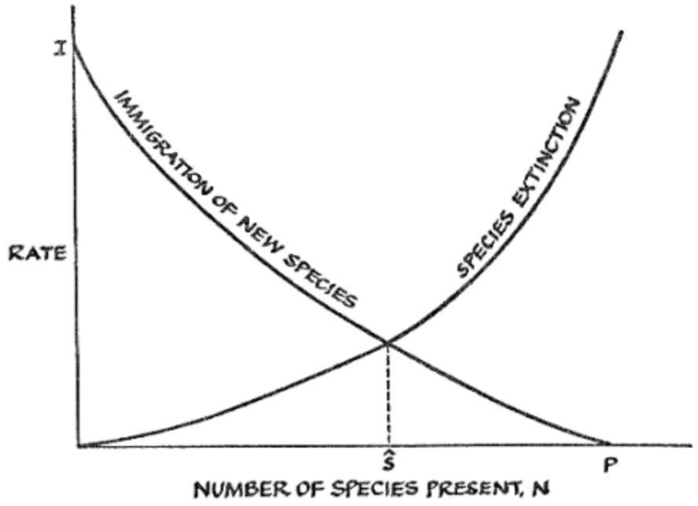

Figure 2.1 The equilibrium model of species present on a single island. The equilibrium number of species is reached at the point of intersection between the rate of immigration and the rate of extinction. Figure taken from MacArthur and Wilson (1967).

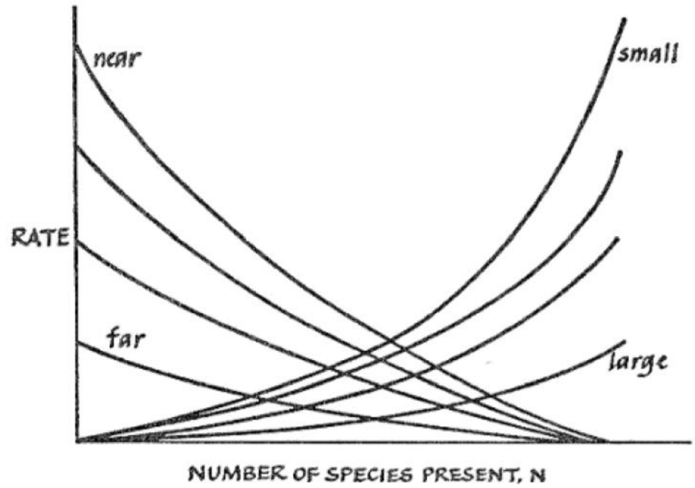

Figure 2.2 The equilibrium models of species of several different islands which vary in size and degree of isolation. An increase in isolation (near to far) decreases the immigration curve, while an increase in area (small to large) decreases the extinction curve. Figure taken from MacArthur and Wilson (1967).

A pattern that was observed before the ETIB but was quickly integrated, is the species-area relationship (Matthews et al., 2021). It refers to distinct ways of measuring how the number (richness) of species varies with the area sampled. In islands, there is the island species-area relationship. The main pattern is that the species richness increases as the area increases up to a point, therefore the shape of the graph would be a curve. A small exception called 'the small-island effect' can occur. This is a phenomenon where islands of smaller size have a fluctuating relationship between area and species richness. There are case studies that exemplify this effect on two types of islands where immigration is stronger: (i) when more dispersive organisms arrive (Lomolino and Weiser, 2001; Chisholm et al., 2016), and (ii) on less isolated archipelagos (Chisholm et al., 2016; Schrader et al., 2020). Explanations on this effect include (i) stochastic effects (for example, disturbance) or (ii) habitat/ niche limitations in tiny islands of few simple habitats (Whitehead and Jones, 1969). However, there are studies that support the role of habitat diversity in the small-island effect (Chen et al., 2020, Matthews et al., 2020). All these studies demonstrate that area is only a partial explanation for species richness variation. It is uncertain whether the islands in the Maltese archipelago experiences this effect, as there are no studies that discuss it.

2.1.1.1. ETIB Criticism and Limitations

Notably, the ETIB has its criticisms and limitations. The theory assumes that changes in the environment are relatively unimportant most of the time, and that once an island has formed, they maintain an equilibrium richness marked by continued species turnover through ecological processes. Nevertheless, since rates of immigration, speciation and ecological processes are relatively slower than environmental changes, an equilibrium is never fully established, and is therefore considered transient and trivial (Williamson, 1989; Whittaker, 2000). Whittaker (2000) highlights the problems with ETIB, and states that its oversimplified framework has been known for a long time, but its assumptions were deemed to be sufficiently useful that they were worth running with. However, new ideas emerged that were considered to make ETIB a broader framework. Figure 2.3 shows these ideas as four extremes: (i) dynamic equilibrium; (ii) dynamic non-equilibrium; (iii) static equilibrium; and (iv) static non-equilibrium.

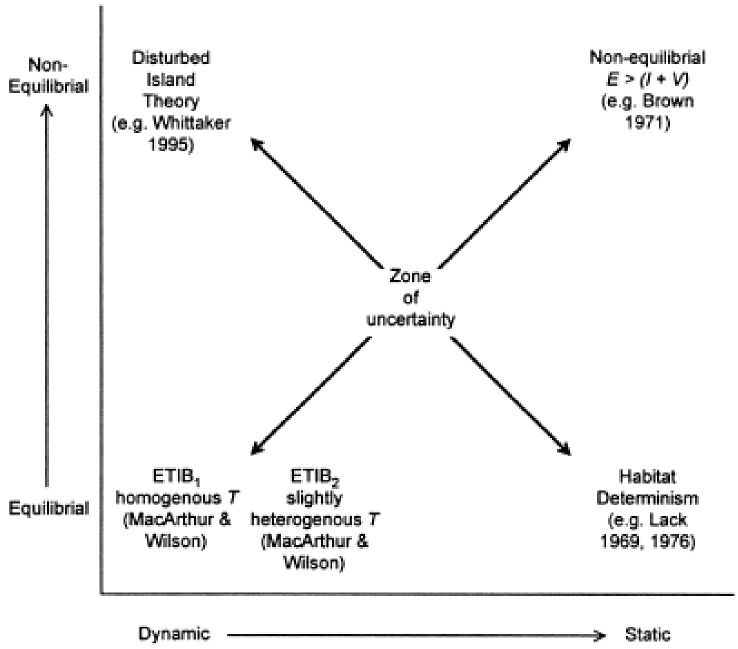

Figure 2.3 Proposed diagram that represents the extremes of island species turnover. Figure taken from Whittaker (2000), which was redrawn from Whittaker (1998). I= immigration, V=species, T=turnover, E= extinction. $ETIB_1$ represents the core model of MacArthur and Wilson (1967), and $ETIB_2$ represents the broader position from their book.

The dynamic equilibrium hypothesis is the ETIB. While the core model is stochastic (homogeneous) represented by $ETIB_1$, MacArthur and Wilson (1967) saw that some turnover could be static, hence their fuller theory is represented as slightly heterogeneous by $ETIB_2$ (Whittaker, 2000). On the other end of the dynamic-static continuum is habitat determinism, which is a hypothesis that argues that species stays mostly stable over time with little turnover due to having the right habitat. This was proposed by David Lack, who also made it clear that this idea was based on analyses on island birds, and did not extend to all other taxa (Lack, 1969). This has been supported by subsequent studies on islands with little to no human disruption over thousands of years (Walter, 1998). The dynamic non-equilibrium hypothesis describes islands where environmental disturbances happen so frequently that species never settle into equilibrium. This often occurs across a few generations, hence it can be observed through the human lifespan (Whittaker, 1995). Finally, the static non-equilibrium hypothesis refers to when isolated islands are undergoing extinction slowly over thousands of years, however, when observed across ecological time, the species composition looks 'static', even though it is technically in a non-equilibrium state (Brown, 1971). This occurs much more rarely. Moreover, most researchers are concerned with changes that can be observed in a human lifespan (Whittaker, 2000). These extremes demonstrate that it is difficult to explain island biogeography using just one theory.

Another criticism of ETIB is that it only works on the population dynamics scale—one of the four proposed scales for working with islands by Haila (1990). Scale is important to take into account when analysing species-area relations, because it depends on the range of variation in the study and what is ecologically relevant to the particular species of study. Whittaker (2000) suggested that it is more useful to keep area constant and study other factors. Haila (1990) proposed a framework with four scales: (i) the individual scale (wherein a patch of land is considered an island if an organism completes a stage of its life cycle), (ii) the population dynamics scale (wherein the organism's entire life cycle happens on the island, and the population is independent from the mainland for several generations), (iii) the population differentiation scale (wherein populations stay isolated long enough to become genetically distinct), and (iv) the evolutionary scale (wherein populations diverge into entirely new species). The ETIB is restricted to the population dynamics scale only. Through these criticisms and limitations, ETIB remains a viable theory to use, however, it cannot be applied to every island, as real island communities are very complex systems with many factors interacting with each other, making it hard to prove with just one theory.

In the case of the Maltese archipelago, it is unlikely that ETIB can be applied to its biogeography in order to study its endemic species for two reasons. First, they are land-bridge islands, whereas ETIB applies more so to oceanic islands. Second, the archipelago includes too few islands to be statistically modelled (Fattorini pers. comm., 2025). Nonetheless, there have been biogeographical studies on the islands (Thake, 1985).

2.1.1.2. Extinction

Understanding island biogeography can be useful to explain extinction and how it occurs on islands. This is crucial for implementing conservation measures to island species. The equilibrium theory argues that as richness increases, extinction rate will increase until balancing the forces of species gain (see Figure 1). When habitats are fragmented into smaller and more isolated patches, the immigration rate decreases and the extinction rate increases, as the newly formed patches become supersaturated – the habitat contains too many species that it can sustain. This creates what is called an extinction debt, which is a phase of extinction until the habitat reaches a new equilibrium (Ewers and Didham, 2006). For example, a case study on forest arthropods in the Azorean Islands suggested that more than half of the forest arthropod species will be driven to extinction due to habitat loss, which results in an extinction debt (Triantis et al., 2010). Another study focusing on the effects of habitat fragmentation on forests globally revealed that it reduces biodiversity by 13-75%, and the effects are the greatest in the smallest and most isolated fragments, emphasising that they magnify over time as more species die out (Haddad et al., 2015). Long-lived species and populations nearing extinction are more likely to have an extinction debt. Nevertheless, habitat restoration and landscape management are still viable conservation measures as long as the nearly extinct species exists (Kuussaari et al., 2009). Therefore, knowing whether a species is experiencing an extinction debt through more empirical studies on taxa and ecosystems will help overcome this biodiversity conservation challenge.

2.1.2. The Biogeography of the Maltese Islands

The Maltese Islands have been extensively studied for their biogeography throughout the years. Their position in the Mediterranean Sea, as well as their role in natural history, make them unique for biogeographers to study. Thake (1985) highlighted this with their paper, interpreting Maltese biogeography in terms of sea level fluctuations and tectonic events which established and severed land connections with Sicily. They hypothesised that the terrestrial biota of the Maltese Islands came from Europe and presumably also from North Africa during the Messinian Crisis. The study used the mollusc family Clausiliidae to illustrate this, while also bringing up examples from other papers.

The geographical position of the Maltese archipelago is located approximately 96km south from Sicily and 290km north from North Africa (Schembri, 1993). The islands make up a landmass total of 316km^2; with Malta having a total of 245.7km^2 and Gozo having a total of 67.1km^2. The elevation from sea level is about 253m, and it is situated on a shallow shelf which forms part of the African continental plate (Reuther, 1984). The islands were connected to the mainland, then separated through a rise of sea level, causing them to be geographically isolated.

According to Thake (1985), the Maltese Islands emerged during the late Miocene, and were isolated from Sicily and from the Pelagian Islands by the flooding of the Mediterranean basin at the beginning of the Pliocene. This isolated the fauna, allowing several endemics to evolve, though only few survive to the present day. The Maltese Islands were connected to Sicily again during the Middle Pleistocene, when more Sicilian, Italian and Eurasian fauna were allowed to migrate for an unknown period of time. There was a second period of isolation, where a few more endemics evolved, until the Pleistocene glacials connected the islands again (Thake, 1985). The two types of endemics that can form are neo-endemics and paleo-endemics. Neo-endemics evolve *in situ* on the islands, while paleo-endemics are relict forms of species which may have become extinct on the mainland and are still present on the islands (Major, 1988). Therefore, the endemics on the Maltese Islands are of intrinsic scientific interest, for they may give insight into the phylogeny and the biogeography of their taxonomic group, as well as insight into their evolution (Cassar et al., 2008).

2.1.2.1. Climate

The climate of the Maltese Islands has been described to be typically Mediterranean with characteristic mild, wet winters and hot, dry summers (Chetchuti et al., 1992). The yearly rainfall defines a wet period between October and March, and a dry period between April and September. Furthermore, the Maltese Islands receive sunshine all year round, as well as north-westerly winds. This makes the climate strongly bi-seasonal, particularly when speaking about water availability (Chetchuti et al., 1992). These characteristics affect the landscape of the islands, including their vegetational communities and their geography (Schembri, 1997). The Maltese Islands may be classified as land-bridge islands, as they are still physically connected to Sicily and Europe through a shallow shelf between Malta and Sicily that was exposed during low sea level periods in prehistory. Moreover, the islands' topography has similar geological structure to the Ragusa peninsula of Sicily, resulting in similar and shared species (Schembri, 1997).

2.1.2.2. Landscape and Vegetation

Despite this extreme environment, there are a number of habitats and vegetation assemblages that occur in the islands. There are four major habitats, that is, communities that form part of a successional sequence towards a climax habitat: woodland, maquis, garigue, and steppe. Moreover, there are also minor habitats, which are habitats that are rarer or more specialised. These include: saline marshlands, sand dunes, rocky shores, caves, cliff side habitats, and freshwater pools and watercourses. Finally, there are disturbed habitats, which are habitats that have been affected by humans, including: agricultural areas, rubble walls along roadsides, and disturbed seaside habitats (Schembri, 1997). In general, the plant communities must be able to resist very arid periods during the summer months, therefore many have adaptations to survive. Some have a period of dormancy – in the form of tubers or underground bulbs; some plants are evergreen with adaptations to reduce transpiration such as small leaves; other plants are short-lived and remain dormant as seeds during the summer, germinating as soon as the rainy season starts (Schembri, 1997).

Due to the diversity of habitats on these small islands, there are many specialised arthropods that are only found there. For example, *Isidus moreli* is a rare click beetle from the subfamily Elaterinae that only lives in coastal sand dunes such as in Mellieħa and breeds under rotten wood (Wurst and Mifsud, 2012). Other species can reveal deep history in paleogeography through their distribution and ecology, like *Cryptocephalus plantaris,* a Siculo-Maltese endemic beetle, meaning that it could have originated from before the Pleistocene, when Malta and Sicily were connected (Sassi, 2012; Baviera and Sassi, 2020). There could be many others that remain undocumented in the literature, but are going extinct before being discovered and recorded. Therefore, it is crucial to recognise the threats that Maltese fauna face, as well as the current mitigation measures that are being taken.

2.2. Threats to the Maltese Fauna and Addressing Biodiversity Concerns

This chapter discusses the specific threats to the Maltese biodiversity (with special emphasis on insects), followed by a discussion on the challenges conservationists have to tackle when considering biodiversity concerns and sustainability, especially on islands.

2.2.1 Threats to Maltese Island fauna

Very often, the Maltese Islands experience conflicts between human activities and conservation priorities due to having high surface area constraints. Bradshaw et al. (2010) ranked Malta as one of the top 20 worst performers in terms of positive environmental impact out of 228 global countries. Moreover, the land is currently enduring excessive development and over-construction, which puts stress on Maltese biodiversity (Stevens et al., 1995). Other indirect anthropogenic threats such as climate change also put pressure, as the flora and fauna are not adapted to the new environment, consequently affecting ecological processes such as phenological cycles, dormancy periods, species interactions, amongst others (Tavilla et al., 2023; Schweiger et al., 2010).

Human influence has created many anthropogenic habitats such as abandoned fields, private and public gardens, road verges, and land cleared of natural vegetation for a variety of purposes (Stevens et al., 1995). Most of the land has been developed in some way, either for agriculture, or for buildings. Virtually no entirely wild areas remain in the Maltese Islands (Schembri and Baldacchino, 1992, as cited from Stevens et al., 1995).

There are many human activities which impact Maltese biodiversity. The first one is the generation and disposal of waste. Despite there being four official dumping sites for waste disposal, waste is thrown away in rural areas and unofficial dumping sites, causing serious environmental problems in many natural habitats (Stevens et al., 1995).

Another important threat is the negative impact of overtourism. In many destinations, not just in Malta, the host countries have experienced a negative side of high rates of tourist influxes, mostly surfacing from overcrowding, traffic congestion, misbehaviours by visitors and more relevantly, damage to the physical environment (Briguglio and Avellino, 2019). There are studies that refer to the increasing demand caused by tourism on the scarce resources of the country, particularly land, water and housing (Martin et al., 2018). These demands are increasingly felt on the Maltese islands' natural environment as well as its resident population, to a more extreme degree due to its already sparse resources (Martin et al., 2018).

Another threat is unsupervised quarrying and deforestation or clearing of land for agricultural and/or bird hunting activities. There are a number of abandoned quarries that have not been restored, while new quarries are being established in ecologically sensitive areas, disturbing habitats and causing extinction of plant and animal species (Stevens et al., 1995). For example, a single farmer caused the deforestation of a small evergreen oak forest remnant at Wied Ħazrun, Rabat, spraying the trees with herbicide, burning them and cutting them down (Stevens et al., 1995). Moreover, trappers use herbicides to clear vegetation, or plant alien tree species such as acacia or eucalyptus to attract birds (Lanfranco, 1991). Both these activities can lead to poorer soil and less biodiversity, as removal of native plants impacts insects that pollinate, feed on, or decompose them (Schembri and Lanfranco, 1993).

Another threat is the overexploitation of wildlife communities, especially freshwater communities, where water sources are used for irrigation, or are contaminated with agricultural runoff, which leads to a reduced flow rate and, as a result, loss of habitat and biodiversity (Schembri and Lanfranco, 1993; Lanfranco and Schembri, 1986). What exacerbates this is the persecution of animals such as insects and spiders as well as reptiles, birds and mammals (Schembri and Sultana, 1989). Furthermore, development near ODZs and outside traditional urban areas, as well a near abandoned agricultural land is also putting pressure on the biodiversity. Neglected dry stone walls in agricultural land provide vital habitats for many flora and fauna, therefore overdevelopment threatens wildlife to the point of extinction (Lanfranco, 1989). Finally there is the spread of alien and invasive species, which compete with the native fauna, consequently affecting the native insect communities (Schembri and Lanfranco, 1996).

Studying the human influences on the Maltese environment can help confirm what causes the gain and loss of species, and so be more equipped to conceive tangible conservation strategies.

2.2.2 Debates Concerning Conservation - A Case study on the Canary Islands

On a global scale, many island environments are also highly prone to anthropogenic changes and despoliation, and wider exploitation, hence studying species turnover due to these factors is crucial to island conservation (Whittaker et al., 2023). However, environmental and biodiversity conservation on islands present distinctive challenges, which have been subject to debate.

The top priority for most conservation work is to avoid future extinctions of distinct taxa. This reflects a range of ethical and values-based concerns, alongside more practical concerns on the loss of important ecosystem goods and services that distinct island taxa provide (Russell and Keuffer, 2019). However, this presents a challenge on which species and populations to save, as the resources and the societal and/or political support can be inadequate, and the threats can be impractical to mitigate entirely (Whittaker et al., 2023). For these reasons, choices must be made about which populations, species, communities, or landscapes to finance in conservation.

Priority is frequently given to more charismatic species such as some mammals or birds, rather than to less charismatic ones, such as arthropods or plant species, as the former tend to be more appealing to conserve to the public (Colléony et al., 2017). Attention can be given to species that are perceived to be ecologically important – for example, keystone species and engineer species– as protecting them would mean protecting the ecosystem that they are in, along with other resident species (Boogert et al., 2006; Dennis and Fattorini, 2025). Furthermore, some taxa may be regarded as substitutes for unknown biodiversity in other groups, or as umbrella taxa, the conservation of which will serve to protect other species (Sibarani et al., 2019; Dennis and Fattorini, 2025). Each of these ideas, while not specific to islands, may be applied to them.

Another challenge is balancing environmental needs with socio-economic needs. A case study where this has occurred is the Canary islands. The Canarian archipelago is known to be one of the most biodiverse territories within the EU, possessing more than 12,500 terrestrial species in a land area of 7,500km^2 (Whittaker et al., 2023). Over the last half-century, there has been a sudden influx of mass tourism, driving a huge increase in population and abrupt socio-economic and cultural changes. Tourism has increased from around 70,000 visitors per year in 1960 to a colossal 15 million visitors per year in 2019 (Whittaker et al., 2023). This drastic change has had profound consequences on the natural ecosystems on the archipelago, especially on the two most popular islands Gran Canaria and Tenerife. The increased resident and transient populations have placed huge demands on space for houses, hotels, roads, and infrastructure, with increasing demands for food, goods, water and other resources, while simultaneously producing more waste (García-Falcón and Medina-Muñoz, 1999). The water table has been depleted, forcing the population to source water from the central volcanic massif (García-Falcón and Medina-Muñoz, 1999). On top of this, unsustainable development of buildings, harbours, roads and golf courses in large parts of both the arid south and the agricultural land have fragmented coastal ecosystems and has driven the abandonment of about half the agricultural area (Fernandez-Palacios and Whittaker, 2008). The final outcome has been a sweeping transformation in the nature and geography of human impact on Canarian landscapes, accompanied by a transition from a net exporter to net importer of food (Fernandez-Palacios and Whittaker, 2008).

However, since the establishment of the EU's Natura 2000 network, the regional government has achieved remarkable progress on recognising protected conservation areas on the islands. It led to the inception of the Canary Islands Network for Protected Natural Areas, which is a conservation organisation that controls 146 protected areas across the islands. In addition to these areas, there are two catalogues of protected species: one at national (Spanish state) level that protects 173 Canarian species; and one at regional (Canarian) level, that protects 450 endemic species or those non-endemic species with significant populations or have high emblematic value on the islands (Martin-Esquivel et al., 2005). Although this conservation action has improved circumstances, there are still political and economic pressures, such as reducing protected areas that have potential commercial value in development, as well as the uncertain consequences of climate change (García-Falcón and Medina-Muñoz, 1999; Fernandes et al., 2015). In spite of this, the Canary Islands serve as a good example of how protected area frameworks and Red-listing models can be successfully tailored to insular contexts.

Notwithstanding this, there is also the challenge of adjusting the Red-list criteria for generally smaller ranges and often uncertain taxonomic status for insular species. A study by Martín (2009) argued that the IUCN criteria were designed to ensure objectivity in assessing threat levels, using thresholds that are absolute in some cases and relative in others, but that these do not translate well to islands settings. A key concern raised in the paper is that scarcity in islands is often a natural pattern of species distribution, and if this is not factored in when applying absolute thresholds for area of occupancy or fragmentation, it leads to an overestimation of threat – resulting in overly long Red Lists that fail to clearly distinguish which species genuinely deserve priority conservation. This makes criteria like B and D of the IUCN less consistent as benchmarks for establishing conservation priorities like the Canary Islands, precisely because of this mismatch between the criteria's assumptions and insular ecological realities (Martin, 2009). This links to the limitations of the IUCN criteria within insular contexts.

On the other hand, the number of threatened and extinct species on islands may be underestimated. A similar study to the one at present was conducted on the status of the invertebrate fauna on the South Atlantic island of St Helena (Gray et al., 2019). The researchers stated that the invertebrate extinctions on the island exceeded global background extinction rate, therefore the threat of other species going extinct remains high. The study used the document 'IUCN Red List Categories and Criteria Version 3.1. Second Edition', which was used in the present study, and still arrived to the conclusion that there are higher extinction rates on islands. However, it has emphasised that there are significant opportunities for further research in many areas of conservation, as species records from the island are lacking (Gray et al., 2019).

Being able to assess the challenges that are faced with conservation research, whether they can be resolved or reduced as much as possible, is a challenge within itself. The Maltese Islands may face a similar situation to the Canary Islands in the near future due to the economy's overdependence on international tourism, with recent studies highlighting this concern (Briguglio and Avellino, 2019). Furthermore, there are research areas in conservation of the Maltese Islands, especially when it comes to insects, where further contributions are needed. Since there is no current alternative to the IUCN Criteria that is specific for islands, these will still be used in the current study, but endemic and non-endemic species will be distinguished to avoid placing the same attention to species that, being distributed also out of the Maltese archipelago, are in fact of lower conservation interest. In conclusion, the scope of the present study is to broaden the current knowledge on the status of threatened species in order to eliminate some knowledge gaps in the existing literature, and so contribute to more informed decision-making when considering economic development. It is not within the scope of this study to examine and critique the IUCN Criteria.

2.2.3. Frameworks for Conservation Status Assessment

The most widely used framework for conservation status assessment is the IUCN Red List – a document which, since its inception in 1964, has become the world's most comprehensive information source on the global extinction risk status of animal, fungus and plant species (IUCN, 2025). However, the recent categories and criteria were only fully established in 1994. Before then, more subjective species categories were used in IUCN Red Data Books and Red Lists (Extinct, Endangered, Vulnerable, Rare, and Indeterminate), that only depended upon expert opinion rather than objective criteria, for almost 30 years. The development of the current categories and criteria only began in 1989 following a request from the IUCN Species Survival Commission (SSC) Steering Committee, with the first paper discussing a new foundation for the categories published in 1991 (Mace and Laude, 1991). Other revisions followed throughout the years, up until the latest revision, which was published in 2001. All new IUCN assessments since 2001 have used version 3.1. of the categories and criteria (IUCN, 2001).

The present study would also be updating the conservation status of selected groups of the Maltese insect fauna using the most recent categories and criteria, since Schembri and Sultana (1989) used the outdated conservation status system.

2.2.3.1 IUCN Red List Criteria and Categories

The IUCN Red List is a powerful tool that is used to inform and catalyse action for conservation and policies crucial to safeguarding natural resources necessary for survival and sustainability (IUCN, 2025). Moreover, it gives information about the range, the population size, the habitat and ecology, the use and/or trade, the threats and the conservation actions of each species assessed, helping to inform policymakers and conservation action (IUCN, 2025).

The document is useful for many stakeholders, including government agencies, wildlife departments, conservation-related NGOs, natural resource planners, educational organisations, students, schools, and the business community. It involves many partner organisations, experts in different taxonomic groups to compile the species information for the data. More than 172,600 species have been assessed up to this point, with more than 48,600 species threatened with extinction, including 44% of reef building corals, 41% of amphibians, 38% of trees, 38% of sharks and rays, 3% of conifers, 26% of mammals, 26% of freshwater fishes and 11.5% of birds (IUCN, 2025). Not only the number of included species increases with the continuous addition of species previously not evaluated, but also the reassessment of existing species is done frequently to keep the information up-to-date. This has helped many conservationists in reversing the effects of biodiversity loss of many species, however, biodiversity is still declining at an unprecedented rate.

The goal of the IUCN Red List is to reverse or at least stop the decline of global biodiversity. To do this, their aim is to increase the number of species assessed to at least 260,000, and to reassess 142,000 of those species by 2030 to ensure up-to-date information on their status for monitoring trends. This is set according to The IUCN Red List 2021-2030 Strategic Plan, which has many goals to achieve this target. One of its goals are of interest in the present study, which states that: “Selected invertebrates, including reassessments of all dragonflies by 2025 and

2030 and swallowtail butterflies by 2030; groups of beetles, butterflies, bumblebees, fireflies, grasshoppers, hoverflies, molluscs, and mayflies, added to the IUCN Red List by 2030" (IUCN, 2021). There are research gaps when it comes to the conservation of invertebrates; around 97% of all known animals are invertebrates, yet only 31% of all animal assessments are of invertebrates on the IUCN Red List (IUCN, 2025).

The present study would address this goal by contributing a list of selected taxonomic groups with a (re)assessed conservation status, that can be used to improve the current knowledge on global biodiversity. More details about the categories and criteria used in the present study may be found in Chapter 3: Materials and Methods.

2.2.3.2. Current National Biodiversity Strategy and Action Plan

The most recent document that outlines the strategy to address threats on Maltese biodiversity is the NBSAP to 2030, published by ERA in September 2024. Its main aim is "to provide a strategic direction on the management and protection of biodiversity by being the principal instrument for implementing the United Nations Convention on Biological Diversity at national level" (ERA, 2024). The NBSAP was first adopted in 2012, for the period up to 2020. Its final outcomes were reviewed and a new NBSAP was published for the period up to 2030. This document describes five policy areas with 79 actions within 22 targets, using the achievements and outcomes of the NBSAP to 2020 as its foundation. The document also highlights that conservation is a dynamic process and therefore requires constant review and improvements in order to manage its targets.

With this in mind, the present study may assist in the achievement of the following targets on the NBSAP: targets 2, 3, and 4, which fall under the first policy area – conserving and restoring nature; targets 5, 6, and 7, which fall under the second policy area – addressing the drivers of biodiversity loss; targets 10 and 13, which are under the third policy area – using biodiversity sustainably; targets 15, 16, and 17, which are part of the fourth policy area – mainstreaming and awareness raising; and targets 19, 20 and 21 from the fifth policy area – enhancing implementation and cooperation. It will be most applicable to target 2, as it is the one mainly concerned with eliminating any knowledge gaps on the conservation status of Maltese species.

2.3. Historical context of Insect records from the Maltese Islands

There are few comprehensive treatments of the Maltese insect fauna. One of the earliest works was a series of lectures delivered by Gavino Gulia and published as "*Corso elementare di entomologia maltese*" (Gulia, 1858). It contains some Maltese insect taxa, however, most identifications are considered doubtful by Maltese entomologists (Mifsud, 2000). Another early publication (Gulia, 1913) contained some more updated information for the time. In the same period, a notable publication was from a prisoner of war who collected insects by himself, listing taxa from Lepidoptera, Hemiptera and Coleoptera (Andres, 1916). There were also publications which recorded other insects, pests, and gall-inducing insects, such as Borg (1939), Caruana Gatto (1926), Saliba (1963) and Mifsud (1997).

In the late 1980s, two significant publications which concerned the Maltese biodiversity conservation were published. Schembri et al. (1987) was one of them, which gave a comprehensive list of ecologically important localities in the Maltese Islands, including rare flora and fauna (including insects) that define the conservational value of these localities. The other publication was the 'Red Data Book for the Maltese Islands' by Schembri and Sultana (1989). In it, three chapters provide an annotated list of approximately 261 threatened, rare, and/or endemic insect species are documented in the Maltese islands: one chapter titled 'Insects excluding Lepidoptera and Coleoptera' which includes 37 species (Schembri, 1989); one chapter titled 'Lepidoptera' which includes 38 species (Sammut and Valletta, 1989); and one chapter titled 'Coleoptera' which includes 185 species (Cilia, 1989). These chapters included the conservation status of each taxon, which has not been updated since. More reviews followed, such as those by Schembri (1993) and Mifsud (2000), which reviewed the present knowledge of insects of the Maltese Islands at that time. However, these publications were only overviews of insect records, and did not evaluate their conservation status.

Table 2.1 below compares the number of species recorded from Schembri and Sultana (1989) with the number of studies that have been done on each insect order after 1989, in order to display and compare the amount of literature available on each order.

Table 2.1 The number of species of endemic and threatened species recorded from Schembri and Sultana (1989) compared to the number of studies since 1989.

Insect Order	**Number of endemic and/or threatened species recorded from Schembri and Sultana (1989)**	**Number of Studies related to the orders between 1989 and 2020**
Thysanura	1	0
Odonata	2	4
Dictyoptera	2	0
Orthoptera	8	3
Dermaptera	1	1
Hemiptera	6	25
Homoptera	2	3
Trichoptera	2	1
Hymenoptera	12	30
Diptera	1	28
Lepidoptera	38	23o
Coleoptera	185	51
Siphonaptera	0	1
Psocoptera	0	1
Neuroptera	0	1

Based on the information from Table 2.1, the taxa which have the largest number of threatened species are Coleoptera, Lepidoptera, and Hymenoptera; while the groups which have had the most studies were Coleoptera, Hymenoptera, and Diptera. New studies on groups not mentioned in Schembri and Sultana (1989) were also published, such as on Psocoptera (Lienhard and Mifsud, 2015), Siphonaptera (Mifsud, Borg and Sultana, 2008), and Neuroptera (Pantaleoni, Loru and Mifsud, 2017). Although Hymenoptera and Hemiptera are among the groups with the most studies – because of their agricultural importance (Rakhshani, Tomanovic, and Mifsud, 2015; Mifsud et al., 2011) and their role as invasive species in the case of Hemiptera (Mifsud and Watson, 1999) – the present study focused the analysis on groups of Coleoptera, Diptera, and Lepidoptera, because they have the most endemic species and the most available data. Moreover, studies on Coleoptera, Diptera and Lepidoptera lean toward records of new species and endemics (Lillig, Mifsud and Grimm, 2012; Fibiger et al., 2006; Ebejer, 2012).

2.3.1. Records of Selected groups of Insects

2.3.1.1.Coleoptera

2.3.1.1.1. Conservation importance and endemism

The order Coleoptera is the most studied of the three selected groups and one of the most populated groups with endemic species. They are also known to represent 40% of the known world insect diversity and 25% of the known world animal diversity (Stork, 2018). As a major part of global biodiversity, they occupy all levels of trophic chains as predators, phytophagous, saprophagous, and coprophagous organisms. Therefore they are involved in many ecosystem services, such as pollination, decomposition, pest predation, and weed herbivory (Grimbacher and Catterall, 2007). Moreover, they are prey organisms for many species, for example reptiles, birds, amphibians, and small mammals (Young, 2015; Sloggett, 2012; Nichols; 2009).

Endemism is rather common in Coleoptera, as their short lifespan and high dispersibility enabled them to fill various ecological niches, for example through evolving interactions with endemic plants (McKenna et al., 2019). Oceanic islands like the Azores have a high number of endemic Coleopteran species due to their remoteness, as well as their high plant diversity which encourage specialisation and species dependence (Terzopoulou et al., 2015). In the Mediterranean basin, there exists a high degree of species richness and endemism due to its geological diversity and its location between the African and Eurasian landmasses (Rosenbaum et al., 2002). On islands like the Malta, Gozo, and Comino, which although contain a variety of topographic features and habitats, adaptive radiation would not be able to occur due to their size, their relatively recent appearance, and their closeness to the mainland. It is more likely that species are relictual endemics. For instance, a Maltese endemic such as the Maltese Field Beetle *Pimelia rugulosa* ssp. *melitana* may be flightless, however, the entire genus of *Pimelia* is also flightless, therefore it is not possible that it evolved flightlessness in response to island isolation (Lillig, Borg Barthet, and Mifsud, 2012). Flightlessness, amongst other factors, constricts beetles to one particular habitat or location, limiting its dispersal ability to other places.

2.3.1.1.2. Threats

Coleoptera species populations are declining at a fast rate (Carpaneto et al., 2015; Carpaneto et al., 2007; Harris et al., 2019). This is primarily due to climate change, habitat destruction and anthropogenic disturbances (Harris et al., 2019; Carpaneto et al., 2015; Mifsud, Jach and Schuh, 2004). Beetles can be used as indicators in the assessment of anthropogenic disturbances, which makes them highly valuable in restoration ecology (Alignan et al., 2018). For example, in La Crau (France), after the cessation of sheep grazing on steppe and former cultivated fields, the beetle species richness of the area increased significantly (Fadda et al., 2008).

2.3.1.1.3. Maltese species records

Coleoptera is well-studied in the Maltese Islands, with over 1,500 species recorded, making it possibly one of the largest orders on the islands (Cassar and Mifsud, 2024). There are 51 studies about Coleoptera that have been published since 1989 (see Table 2.1). The only publication that deals with all Coleoptera families for the Maltese Islands is that of Cameron and Caruana Gatto (1907). Since then many families have been revised (Mifsud and Colonnelli, 2010; Mifsud and Bily, 2002; Mifsud and Audisio, 2008). The most recent study dealing with Coleoptera is Mifsud and Nardi (2020) on water beetles (Gyrinidae, Haliplidae, Dytiscidae).

2.2.3.1.2. Lepidoptera

2.3.1.2.1. Lepidoptera Conservation and endemism

Lepidoptera are also one of the largest orders of insects, with over 160,000 described species and estimates of around 500,000 total extant species (Kristensen et al., 2007). It comprises the butterflies (around 20,000 species in two or three superfamilies) and moths (the greater majority, spread over 30 superfamilies) (Kristensen et al., 2007). Butterflies and moths are regarded as one of the best studied groups of insects (Hill et al., 2021). They are mostly known as great pollinators, but they provide many other ecosystem services such as nutrient recycling, food resources, and soil formation (Merckx et al., 2013). There are also economically important species, such as the domesticated silk moth *Bombyx mori,* and many pests.

Despite Lepidopterans arguably being the best known group of insects, not many studies have been done on island endemism specifically. However, there are case studies that discuss their conservation priorities. For example, Grande Comore in the Comore Islands has a high endemic butterfly species richness in its forest habitats, which are above 500 m elevation, but a low endemic species richness in man-modified habitats at low elevation. Additionally, man-modified habitats had a higher species-rich communities of non-endemic butterfly species and lower species richness in the forest habitats (Lewis, Wilson and Harper, 1998). In this case, conservation methods must treat endemics and non-endemics separately, because they may have different habitat ranges and tolerances to human disturbance. Regarding the Mediterranean region, there has been a paper published that discusses how Lepidopteran endemics occur, specifically for butterflies. López-Villalta (2010) indicated a strong trend in restricting their diet to a particular genus of host plants for Mediterranean butterflies in the case of non-insular endemics. It is not made clear if this trend also extends to insular endemics, as well as moths, however, there are studies that show insular endemics being more specialised and more susceptible to due to habitat fragmentation (New, 2008; Sfenthourakis et al., 2021). In the Maltese Islands, an example of an endemic species is the Swallowtail butterfly, *Papillo machaon* ssp. *melitensis,* whose host plant is *Ferula melitensis.* In general, butterflies are good dispersers, so island endemics are uncommon among them.

2.3.1.2.2. Threats

Similar to Coleoptera, Lepidopterans are also declining especially because of habitat loss (Dennis, 2010; Dennis and Fattorini, 2025). Global warming has been reported to cause migration shifts in both butterflies and moths to Northern areas, causing concern of invasive species in countries such as the UK (Sparks et al., 2007). In addition, species having low immigration probabilities may be unlikely to re-colonise islands from the mainland if they become extinct (Dapporto and Dennis, 2009). Global warming is also causing a shift in the phenological cycle, resulting in plant-insect asynchrony (Pelini et al., 2009). Many species generally have one or two restricted time periods in the year in which they can reproduce under favourable conditions, and plant asynchrony or early emergence due to climate change may not promise them a suitable environment (Chuang and Peterson, 2016). Other species may be able to add an additional generation per year in response to higher temperatures, which may result in invasive species and pest outbreaks. This could have consequences on agriculture and biodiversity (Altermatt, 2010).

2.3.1.2.3 Maltese species records

A total of 700 species of Lepidopterans have been recorded on the Maltese Islands, making them one of the most well-studied groups on the islands (Cassar and Mifsud, 2024). One of the earliest records is 'The Lepidoptera of the Maltese Islands' by Borg (1934). Since Schembri and Sultana (1989), there have been around 23 other papers related to Maltese Lepidoptera, with the most recent one being Zerafa (2015).

2.3.1.3. Diptera

2.3.1.3.1. *Conservation and endemism*

Diptera are also a well-studied diverse group comprising of up to 160,000 extant species worldwide (Courtney et al., 2017). They are one of the most successful groups of insects, as they have managed to colonise all continents including Antarctica, due to their efficient habitat exploitation, life habits, and interactions with humans (Skevington and Deng, 2002). Many species depend on plants for their nutrition, for example decaying vegetation, pollen, nectar or honeydew (Skevington and Deng, 2002). Others feed on animal organic material such as carrion, vertebrate blood, insect haemolymph or dung. Some groups are parasitoids of other arthropods or molluscs, and others produce plant galls. The adults of some species are predaceous (Skevington and Deng, 2002).

Although endemism in Diptera is not very common, many faunas show endemic species. For example, there are oceanic island endemics in the Azores (Raposeiro, Hughes and Costa, 2009). A family that exemplifies high levels of endemism is Tipulidae, or the crane flies. In the Mediterranean region, species of the family Tipulidae have been found to have higher levels of endemism than lacewings, butterflies, and vertebrates (Oosterbroek, 1994).

2.3.1.3.2. Threats

Habitat destruction and the arrival of invasive species are a big threat to Dipterans, especially to geographically restricted populations. Hoverflies (Syrphidae) are one of the main concerns, as they have a critical role in pollination and decomposition of organic matter. One study in the Netherlands recently claimed that hoverflies are experiencing a faster extinction rate than wild bees over recent years, with a rate of 1.0 species per year for hoverflies, and 0.4 species per year for bees (Zeegers et al., 2024). In Chile, 33.33% of hoverfly species are directly threatened by anthropogenic disturbances (Barahona-Segovia et al., 2021). For carrion-feeding flies, the decrease in megafauna can be devastating, as their carcasses are used as breeding sites. An example would be *Microcerella bermuda* which is an endemic flesh fly to Bermuda, that has not been recorded in more than a hundred years, including the most recent survey (Courtney et al., 2017). Therefore, the wider inclusion of Dipterans in conservation policymaking should be promoted. .

2.3.1.3.3. Maltese Species Records

Around 1,000 species of Diptera have been recorded from the Maltese archipelago, making it the second largest insect order in the Maltese Islands (Cassar and Mifsud, 2024). The earliest record is Newstead (1911) who recorded sandflies of medicinal importance. The latest updated catalogue including all the species of Diptera of the Maltese Islands is Ebejer and Gatt (2021). On the other hand, the latest taxonomic record of Diptera is from Darmanin and Cerretti (2019). There are a total of 28 papers about Diptera that have been published after 1989.

Chapter 3: Materials and Methods

3.1 Introduction

The present study aimed to reassess the conservation status of selected insects from the Maltese Islands using a qualitative research approach. This approach was used since necessary data derives from anecdotical information present in specialised publications or unpublished records. This chapter discusses how data was selected, what databases were used, how the data was collected and analysed, and any limitations may be present within the method.

3.2. Research Design

Several similar works were used as models to design the method, which included publications from the IUCN. For example, the 'European Red List of Butterflies' by Van Swaay et al. (2010), 'The conservation status and distribution of Mediterranean dung beetles' by Numa et al., (2020), and the 'European Red List of saproxylic beetles' by Cálix et al., (2018) .

3.2.1. Search Strategy

In the present study, literature containing records of insect species in the Maltese islands that have been published in the last 30 years will be evaluated. Most of the literature was found by checking all issues of the Maltese journal 'The Bulletin of the Entomological Society of Malta', which is the most apparent source of insect records from the study area. Literature analysis was supplemented by using Google Scholar and the OAR of the University of Malta as search engines for literature. In addition, the GBIF public database was used to collect unpublished records. The filters used are described in the section 3.3.1.

3.2.2. Geographic and Taxonomic scope

The geographical scope of literature was limited to the Maltese Islands, therefore data found only on neighbouring islands like Sicily, Lampedusa and Linosa was not included. The taxonomic scope was limited to Coleoptera, Lepidoptera, and Diptera. Both species and subspecies within these three groups were assessed in the present study. Only selected taxa from these groups were looked at, depending on the importance of their evaluation and the amount of data sources available. Species which had a sub-cosmopolitan or cosmopolitan distribution – unless classified in Schembri and Sultana (1989) – were also not considered for evaluation. The groups selected are shown in Table 3.1. Taxa marked with an '*' contain species which were classified in Schembri and Sultana (1989).

Table 3.1 The taxa which were evaluated in this study.

Coleoptera	Diptera	Lepidoptera
Buprestidae*	Ceratopogonidae	Autostichidae*
Cantharidae*	Limoniidae	Gelechiidae*
Cerambycidae*	Psychodidae	Lycaenidae*
	Simuliidae	Noctuidae*
Chrysomelidae: Cryptocephalini	Tephritidae	Nymphalidae
Curculionoidea: Apionidae	Tipulidae	Pieridae*
Curculionoidea: Curculionidae*	Trichoceridae	Psychidae*
Curculionoidea: Raymondionymidae	Trixoscelididae	Pterolonchidae*
Dytiscidae*	Ulidiidae	Pterophoridae*

Elateridae*		Pyralidae*
Gyrinidae		Satyridae*
Haliplidae*		Symmocidae*
Hydraenidae*		Tineidae*
Hydrophilidae*		Torticidae*
Kateretidae		
Leiodidae: Cholevinae		
Monotomidae		
Nitidulidae*		
Phalacridae		
Pselaphidae*		
Scarabaeoidea: Geotrupidae		
Scarabaeoidea: Scarabaeidae*		
Scarabaeoidea: Trogidae		
Staphylinidae*		
Tenebrionidae*		

Target species from the above taxa were identified through consultation with experts, published red lists, and taxonomic literature specific to Malta's insect fauna (Schembri and Sultana, 1989; Mifsud, 2000). Species were classified into threat categories as described in sections 3.3.2 and 3.3.3.

3.3. Data Collection

Data on habitat preferences and ecology, geographical distribution, threats, and conservation measures was taken from literature, expert observations and public databases of all selected Coleoptera, Diptera and Lepidoptera endemic to or native to the Maltese Islands. Any references which were used were stored in the reference management software 'Mendeley'.

Some occurrence records for Coleoptera, Diptera and Lepidoptera from the Maltese Islands were obtained from the GBIF public database. GBIF search parameters included: country or area= Malta, Taxon scientific name= Lepidoptera AND Coleoptera AND Diptera, and event date = BETWEEN 1989 AND 2024. Facebook group posts from "Maltese Entomology and Wildlife" was also consulted, though none of the records were used for classification due to possible unreliability.

3.3.1. Data Quality Assessment and Filtering

Raw occurrence data records went through quality control measures specifically for data source characteristics. For GBIF records, filtering criteria included removing entries with: (1) flagged suspicious geospatial errors or coordinate issues (for example, marine coordinates), (2) uncertain taxonomic information at species level, (3) duplicate records from the same location and date, and (4) records lacking sufficient metadata for verification. Only records classified as "PRESERVED_SPECIMEN", "HUMAN_OBSERVATION," or "OCCURRENCE" in the 'Basis of Record' field were kept.

3.3.2. Global versus Regional Assessment

There are two levels of assessing the extinction risk of a species: the Global level and the regional level. The category of a species at Global level can have a different category at the regional level. For instance, a species found worldwide classed as LC could be highly threatened in a particular region and fit the category VU at the regional level.

There are ten categories according to IUCN Red List: EX, EW, CR, EN, VU, NT, LC, DD, NE, and NA (see Figure 3.1). The threatened categories are CR, EN, and VU. Two documents were used to determine which category the species are classed in: *IUCN Red list Categories and Criteria, Version 3.1., Second edition* (IUCN, 2012a) for the Global level; and *Guidelines for Application of IUCN Red List Criteria at Regional and National Levels: Version 4.0* (IUCN, 2012b) for the regional level. Instead of the category EX, PE was used. For endemic insects, the Global level criteria were used, while for non-endemic insects, the regional level criteria were used.

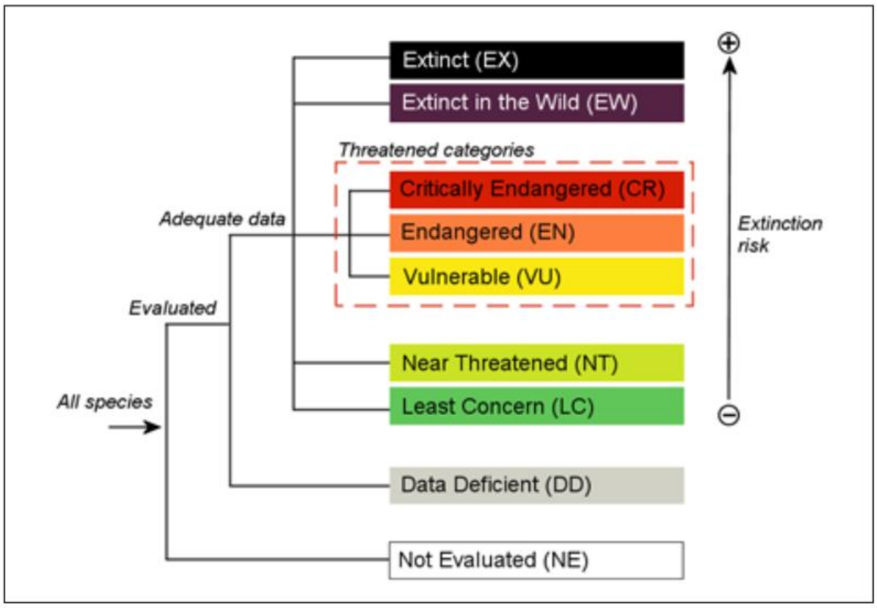

Figure 3.1 The IUCN Categories structured according to extinction risk and their evaluation (IUCN, 2012a).

The following definitions were used to distinguish between DD, NE, and NA. DD means that not enough data exists in the literature to evaluate the risk. NE means that the species has not been assessed yet for its IUCN status. Finally, NA means that the species has been evaluated, and it was found to be ineligible for assessment within a specific area (Fattorini, S., pers. comm., 2026).

3.3.3. Criteria used for category classification

There are five criteria used to evaluate if a taxon belongs in an IUCN Red List threatened category: A, B, C, D, and E. Only one criterion is needed to determine whether a taxon is CR, EN, or VU. The main criterion which will be used to choose the category is criterion B, which was defined as 'Geographic range in the form of either B1 (extent of occurrence) and/or B2 (area of occupancy)'. According to criterion B as listed in 'IUCN Red List Categories and Criteria, Version 3.1., Second Edition', a taxon is considered threatened if it matches B1 and/or B2, and at least 2 of the 3 following conditions:

(a) Severely fragmented OR number of locations = 1 (CR) , less or equal to 5 (EN), less or equal to 10 (VU).
(b) Continuing decline observed, estimated, inferred or projected in any of: (i) extent of occurrence; (ii) area of occupancy; (iii) area, extent and/or quality of habitat; (iv) number of locations or subpopulations; (v) number of mature individuals
(c) Extreme fluctuations in any of: (i) extent of occurrence; (ii) area of occupancy; (iii) number of locations or subpopulations; (iv) number of mature individuals.

For every taxon, the criteria used was listed in the database as follows: for example, 2Bab(iii) would be referring to criterion 2B and condition a and b(iii).

Criterion B was chosen among the other criteria because it is the easiest to apply to most insects and to the type of data available for this study. Moreover, it is used for severe fragmentation or taxa with restricted geographical ranges, which is often the case with isolated subpopulations of insects which are also found in other regions, and insects which are restricted to one habitat.

Additionally, it is useful for assessing any declines or fluctuations within a population of the taxon.

3.3.4. Data Storage and Preparation

The data that was collected was stored as a database on Excel. Three Excel sheets were used in this database: (1) 'ESM papers data' (data from literature of the Entomological Society of Malta); (2) 'Other papers data' (data from literature of other publications and public databases); and (3) 'IUCN category'(data with revised IUCN category for each species).

The data headings that were entered into 'ESM papers data' is as follows:

- Issue date
- Volume
- Publication
- Taxonomic Group (s)
- Species
- Author (s)
- Chorological category
- Introduced or native
- Global Distribution
- Material Examined
- Notes/Comments

The data headings that were entered into 'Other papers data' were as follows:

- Date Published
- Journal
- Publication
- Taxonomic Group (s)
- Species
- Author
- Chorological Category
- Introduced or local
- Global Distribution
- Material Examined
- Notes/Comments

The data headings that were entered into the 'IUCN category' were as follows:

- Order
- Family
- Genus (subgenus) and Specific epithet
- Author (s)
- IUCN Category (Malta)
- Criteria for Malta
- IUCN Category (Europe)
- Criteria for Europe
- IUCN Global
- Criteria for Global Assessment
- Chorological Category

The ‘IUCN Category’ database was presented in the results, as well as notes about the classification of each species. Moreover, the paper Taglianti et al. (1999) was used to standardize the chorotypes of each species.

3.4. Analysis Framework

The mapping tool QGIS was used to visualise the data through graphical representations of sighting locations of target species. The occurrence records were imported into QGIS as point vector layers using coordinate data from scientific literature. In addition, pie charts were plotted to illustrate the percentages of species in each category, and Chi-square tests were conducted to evaluate specific associations (see section 3.4.1).

3.4.1. Analysis

Several Chi-square tests were performed in the software PAST in order to further analyse the following possible signification associations:

- A relationship between orders and IUCN status
- A relationship between families and IUCN status
- A relationship between Distribution type (Endemic vs non-endemic) and IUCN status
- A relationship between Regional level (Malta vs Europe vs Global) and IUCN status
- A relationship between the classifications in Schembri and Sultana (1989) and the classifications of the species after the present study’s evaluation.

These Chi-square tests were useful to investigate any population changes and any differences between each pair of variables. Contingency tables of each Chi-square test may be found in the Appendix.

A Kernel density estimation was planned to be performed in QGIS in order to generate heat maps of species distributions for species which had the most reliable data. However, due to rarity of species recorded, this was not possible. Instead, maps were plotted in QGIS of the the distribution data of all species in the threatened categories, and the last recorded locations of CE and PE species to visualise any clusters of in areas of conservation priority. Moreover, four example species were selected and their material coordinates were mapped in order to visualise the fluctuations of specimen records in different locations.

3.5. Limitations

This research acknowledges many limitations. Due to a limited timeframe and limited data on other groups of insects, the present study will only be focusing on the three most well-studied insect groups of the Maltese islands: Coleoptera (beetles), Lepidoptera (butterflies and moths), and Diptera (flies), and it will only be focusing on selected groups within these orders. Any species within these selected groups which did not have enough data were classified as DD.

Secondly, another limitation due to time limits is that the data collected was mostly from past literature, therefore no data was collected from field observations. This limits the study to data that has already been collected by past literature or observers. Hence, any recent changes in population size could not be detected.

Chapter 4: Results

4.1. Overview

Overall, 381 species were evaluated for their IUCN conservation status. These included 3 orders, and 48 families. They were organised according to families in alphabetical order into Tables 4.1 – 4.23, with notes accompanying each species from each table. All IUCN classifications for European and Global levels were obtained from the IUCN Red List website, except for the endemic species, which were evaluated in the present study.

The abbreviations for the Chorological categories (standardised using Vigna Taglianti et al., 1999) in Tables 4.1- 4.23 are:

- CEM – Central Asiatic Europeo-Mediterranean
- TEM – Turano-Europeo-Mediterranean
- ITAL – Italian subendemic
- TEU – Turano-European
- CAM – Centralasiatic-Mediterranean
- NAF – North African subendemic
- SICI – Sicilian subendemic
- EUR – European
- MED -Mediterranean
- WME – West-Mediterranean
- EME -East-Mediterranean
- CME – Central Mediterranean
- MAL – Maltese Endemic
- MIR – Mediterranean-Iranian
- COS – Cosmopolitan

- PAL – Palaearctic
- EUM – European-Mediterranean
- SEM – South European Mediterranean
- TUM - Turanic-Mediterranean
- AFM– Afrotropical Mediterranean
- ATM – Atlanto-Mediterranean
- AEM - Asian-European-Mediterranean
- MCAU – Mediterranean-Caucasus
- ASM – Asiatic-Mediterranean
- SIM -Siculo-Maghrebine
- CWM - Central West Mediterranean
- EUSMI – South European-Mediterranean-Iranian
- SMCA – South Mediterranean Central Asiatic
- SCO – Sub-cosmopolitan
- SEM – South East Mediterranean
- EUMI – European Mediterranean Iranian
- UN – Unknown.

4.2. Coleoptera

Table 4.1 Buprestidae IUCN classifications.

Species	Author (s)	IUCN (Malta)	Criteria Malta	Chorological Category
Acmaeoderella (Omphalothorax) adspersula adspersula	Illiger, 1803	CE	B1ab(iii) +B2ab(iii)	MED
Acmaeoderella (Acmaeoderella) discoidea	Fabricius, 1787	VU	B1ab(iii) +B2ab(iii)	TEM
Acmaeoderella (Euacmaeoderella) lanuginosa lanuginosa	Gyllenhal, 1817	CE	B1ab(iii) +B2ab(iii)	WME
Anthaxia aprutiana	Gerini, 1955	LC		ITAL
Anthaxia (haplanthaxia) millefolii polychloros	Abeille de Perrin, 1894	EN	B1ab(iii)+B2ab(iii)	WME
Anthaxia (Anthaxia) manca	Linnaeus, 1767	DD		CAEM
Anthaxia (Anthaxia) thalassophila thalassophila	Abeille de Perrin, 1900	CE	B1ab(iii) +B2ab(iii)	TEU
Agrilus (Agrilus) derasofasciatus	Lacordaire, 1835	CE	B1ab(iii) +B2ab(iii)	PAL
Agrilus (Agrilus) roscidus	Kiesenwetter, 1857	VU	B1ab(iii) +B2ab(iii)	CEM

Species	Author (s)	IUCN (Malta)	Criteria Malta	Chorological Category
Aphanisticus pygmaeus	Lucas, 1849	CE	B1ab(iii) +B2ab(iii)	CAM
Buprestis (Buprestis) novemmaculata novemmaculata	Linnaeus, 1767	EN	B1ab(iii) +B2ab(iii)	PAL
Capnodis tenebrionis	Linnaeus, 1761	EN	B1ab(iii) +B2ab(iii)	CEM
Chrysobothris (Chrysobothris) solieri	Gory and Laporte, 1839	DD		CEM
Melanophila cuspidata	Klug, 1829	EN	B1ab(iii)+B2ab(iii)	TEM
Trachys corusca	Ponza, 1805	EN	B1ab(iii) +B2ab(iii)	MED
Ptosima flavoguttata	Herbst, 1784	PE		CAEM

4.2.1. Notes on Species in Buprestidae

Acmaeoderella (Omphalothorax) adspersula adspersula Illiger, 1803

It was recently found from Marfa, Mellieħa in 2019 (Mifsud, Cassar and Bily, 2020).

Acmaeoderella (Acmaeoderella) discoidea Fabricius, 1787

It was recorded from seven locations (Għargħur, Mosta, Wied is-Sewda, Munxar, Buskett, Wied il-Għasel, and possibly Baħrija. All locations show a continuing decline in area extent and quality of habitat.

Acmaeoderella (Euacmaeoderella) lanuginosa lanuginosa Gyllenhal, 1817

It was only recorded in one location in 1993 from Għar Lapsi (Mifsud and Bily, 2002).

Anthaxia aprutiana Gerini, 1955

It was recorded from eight locations (Għajn Riħana, Mtaħleb, Wied id-Dis, Wied Qannotta, Buskett, Wied Faħam, Għasri, Victoria), all of which show continual decline in area extent and quality of habitat (Mifsud and Bily, 2002). Specimens were also incorrectly named as *Anthaxia nitidula* and *Anthaxia scylla* in Cilia (1989). Including these specimens, it was also found in Birżebbuġa, Chadwick Lakes, Wied il-Għasel and Wied Qirda.

Anthaxia (haplanthaxia) millefolii polychloros Abeille de Perrin, 1894

It was found in four locations. It was collected from Fiddien in 1989. It was collected again by Curletti (1994) from Buskett, Chadwick Lakes and Wied Inċita (as cited from Mifsud and Bily, 2002). All locations show a continuing decline in area extent and quality of habitat.

Anthaxia (Anthaxia) manca Linnaeus, 1767

It was recorded as 'Data Deficient' by Cilia (1989). There have been no records since its last collection from Buskett in 1977 (Mifsud and Bily, 2002).

Anthaxia (Anthaxia) thalassophila thalassophila Abeille de Perrin, 1900

It was recorded as *Athaxia scutellaris* in Cilia (1989) and described as 'Vulnerable'. It has not been recorded since its last collection from Buskett in 1985. Also recorded from Wardija in 1980.

Agrilus (Agrilus) derasofasciatus Lacordaire, 1835

It was recorded as *Agrilus obscuricollis* in Cilia (1989), and this was classified as 'Possibly Rare' in 'Boschetto'. It has since been reclassified as *A. derasofasciatus* and only recorded once from Dingli in 1994 (Mifsud and Bily, 2002).

Agrilus (Agrilus) roscidus Kiesenwetter, 1857

It was found in seven locations (Mtaħleb, Kalkara, Dingli, Birżebbuġa, Għasri, Wied Lunzjata, Victoria) by Mifsud and Bily (2002). All locations show a continuing decline in extent and quality of habitat.

Aphanisticus pygmaeus Lucas, 1849

It was recorded only once from Għajn Riħana in 1999 (Mifsud and Bily, 2002).

Buprestis (Buprestis) novemmaculata novemmaculata Linnaeus, 1767

It was only found in Buskett in 1994 and Żejtun in 2005. No records since (Mifsud, Cassar, and Bily, 2020).

Capnodis tenebrionis Linnaeus, 1761

Cilia (1989) classified it as 'Vulnerable'. It was recorded in five fragmented locations (Rabat, Dingli, St. Julians, Għajn Riħana, Żejtun) by Mifsud and Bily (2002), and as an uncommon pest of stone fruit trees.

Chrysobothris (Chrysobothris) solieri Gory and Laporte, 1839

Species is listed on EPPO and possibly introduced. No material collected from Mifsud and Bily (2002).

Melanophila cuspidata Klug, 1829

It was collected by Andres (1916) in Cospicua. It was recorded only again from Girgenti in 1997 (Mifsud and Bily, 2002).

Trachys corusca Ponza, 1805

Found from three locations (Marsa, Wied il-Għasel, Qrendi), all of which contain habitats that are continually declining in quality.

Ptosima flavoguttata Herbst, 1784

Recorded as *Ptosima undecimmaculata* and as 'Possibly Rare' in Cilia (1989). It was only found in one location (Bingemma), and has not been recorded since.

Table 4.2 Cantharidae IUCN Classifications.

Species	Author (s)	IUCN (Malta)	Criteria Malta	IUCN (Europe)	Chorological Category
Cantharis praecox	Gené, 1836	EN	B1ab(iii) +B2ab(iii)	NE	ITAL
Malthinus scapularis	Marseul, 1878	NT		NE	ITAL
Malthinus latirufus	Pic, 1901	CE	B1ab(iii) +B2ab(iii)	NE	NAF
Malthodes bifurcatus	Kiesenwetter, 1852	EN	B1ab(iii) +B2ab(iii)	NE	SICI
Malthodes cameroni	Pic, 1903	EN	B1ab(iii) +B2ab(iii)	EN	MAL

4.2.2. Notes on Species in Cantharidae

Cantharis praecox **Gené, 1836**

It was found in five locations (Żejtun, Marsa, Fiddien, Bidnija, Blata l-Bajda), all of which contain threatened habitats (Švihla and Mifsud, 2006).

Malthinus scapularis **Marseul, 1878**

It was found in over ten locations in threatened habitats (Švihla and Mifsud, 2006).

Malthinus latirufus **Pic, 1901**

It is known only from Tunisia and Malta, therefore restricted distribution. It was found in Ta' Baldu and recorded as *Malthodes* sp. by Cameron and Caruana Gatto (1907). It was found again from Baħrija in 2002 (Švihla and Mifsud, 2006). No record since.

Malthodes bifurcatus **Kiesenwetter, 1852**

It was described as *Malthodes malcolmi* in Cilia (1989) and classified as 'Vulnerable'. It was synonymised with *Malthodes bifurcates* and found in five recorded locations (Buskett, Żejtun, Baħrija, Girgenti, Mistra), mostly recently found from Mistra in 1996 (Švihla and Mifsud, 2006). No record since.

Malthodes cameroni **Pic, 1903**

It was described as 'Very Rare' by Cilia (1989). There were some disputes over its taxonomic status in the past, but it was finally confirmed by Švihla and Mifsud (2006) to be a valid endemic species. It was found in four locations (Selmun, Wied Ħas-Sabtan, Mellieħa, Dwejra), and it was last found in Dwejra in 2003. It was classified as EN under criteria B1ab(iii) +B2ab(iii) at both European and Global level.

Table 4.3 Cerambycidae IUCN classifications

Species	Author (s)	IUCN (Malta)	Criteria Malta	Chorological Category
Agapanthia asphodeli	Latreille, 1804	LC		MED
Agapanthia cyanarae	Germar, 1817	DD		EUR
Cerambyx cerdo	Linnaeus, 1758	EN	B1ab(iii) +B2ab(iii)	COS
Cerambyx scopolii	Fuesslins, 1775	DD		EUR
Calamobius filum	Rossi,1790	VU	B1ab(iii) +B2ab(iii)	PAL
Certallum ebulinum	Linnaeus, 1767	CE	B1ab(iii) +B2ab(iii)	MIR
Chlorophorus pilosus glabromaculatus	Goeze, 1777	EN	B1ab(iii) +B2ab(iii)	WME
Chlorophorus varius	Muller, 1766	EN	B1ab(iii) +B2ab(iii)	EUM
Gracilia minuta	Fabricius, 1781	EN	B1ab(iii) +B2ab(iii)	EUR
Icosium tomentosum atticum	Ganglbauer, 1882	EN	B1ab(iii) +B2ab(iii)	EME
Hesperophanes sericeus	Fabricius, 1787	DD		MED
Nathrius brevipennis	Mulsant, 1839	EN	B1ab(iii) +B2ab(iii)	MED
Niphona picticornis	Mulsant, 1839	LC		MED
Oberea erythrocephala melitana	Schrank, 1776	DD		EUR

Species	Author (s)	IUCN (Malta)	Criteria Malta	Chorological Category
Penichroa fasciata	Stephens, 1831	VU	B1ab(iii) +B2ab(iii)	MED
Ropalopus clavipes	Fabricius, 1775	DD		EUM
Saperda punctata	Linnaeus, 1767	PE		EUM
Stenidea troberti	Mulsant, 1843	EN	B1ab(iii) +B2ab(iii)	MED
Trichoferus griseus	Fabricius, 1792	EN	B1ab(iii) +B2ab(iii)	MED
Trichoferus fasciculatus	Faldermann, 1837	LC		MED
Trichoferus holosericeus	Rossi, 1790	EN	B1ab(iii) +B2ab(iii)	MED

4.2.3. Notes on Species in Cerambycidae

***Agapanthia asphodeli* Latreille, 1804**

Very common and distributed species (Mifsud, 2002).

***Agapanthia cyanarae* Germar, 1817**

It was mentioned in Cilia (1989) as 'Data Deficient'. Doubtful record (Mifsud, 2002).

***Cerambyx cerdo* Linnaeus, 1758**

It was classified as 'Vulnerable' in Cilia (1989). Since then, it has been found in five locations (Dockyard, Addolorata Cemetery, Maqluba, Marsa, San Anton Gardens). Habitats are of continual decline in quality (Mifsud, 2002). Classified as 'NT' under criteria A3c at European Level, and 'VU' under criteria A1c+2c at Global level.

***Cerambyx scopolii* Fuesslins, 1775**

It was mentioned in Cilia (1989) as 'Data Deficient'. Most likely incorrect record (Mifsud, 2002).

***Calamobius filum* Rossi,1790**

It was classified as 'Possibly Rare' in Cilia (1989). Since then, it has been found in seven locations (Ta' Baldu, Girgenti , Mtaħleb, Wied Qirda, Mġiebaħ, Baħrija, Żejtun) from Mifsud (2002).

***Certallum ebulinum* Linnaeus, 1767**

It is known only from Wied is-Sewda from Mifsud and Booth (1997). No material mentioned in Mifsud (2002). Habitat is declining in quality.

***Chlorophorus pilosus glabromaculatus* Goeze, 1777**

It was classified as 'Possibly Rare' in Cilia (1989). Since then, it has been found in five locations (Birkirkara, Buskett, Għajn Riħana, Wied Ħas-Sabtan, Sliema) from Mifsud (2002). It was classified as LC at European level.

***Chlorophorus varius* Muller, 1766**

It is known from five locations (Buskett, Wied Inċita, Wied Qannotta, Baħrija, Ġnejna). No material was mentioned in Mifsud (2002).

***Gracilia minuta* Fabricius, 1781**

It was classified as 'Very Rare' in Cilia (1989). It was found in five locations since then (Buskett, Chadwick Lakes, Marsaskala, Marsa, Verdala). Habitats are observed to continue declining in quality (Mifsud, 2002). It was classified as LC at European level.

***Icosium tomentosum atticum* Ganglbauer, 1882**

It was found in four locations (Rabat, Naxxar, Wied Babu, Msida) with the most recent collected being from Wied Babu in 2002 (Mifsud, 2002). Habitats are observed to continue declining in quality. Collected using light traps.

***Hesperophanes sericeus* Fabricius, 1787**

It was recorded only once for the first time in only one location, Rabat, in Mifsud (2002). Classified as LC at European level.

***Nathrius brevipennis* Mulsant, 1839**

It was found in three severely fragmented locations (Kalkara, Marsalforn, Victoria), which are all declining in quality (Mifsud, 2002). Classified as LC at European level.

Niphona picticornis **Mulsant, 1839**

Very common and distributed species (Mifsud, 2002).

Oberea erythrocephala melitana **Schrank, 1776**

It was mentioned in Cilia (1989) as ‘Data Deficient’. Subspecies is of uncertain taxonomic status (Mifsud, 2002).

Penichroa fasciata **Stephens, 1831**

It is known from ten locations (Ħal-Far, Wied Babu, Sliema, Rabat, Buskett, Naxxar, Msida, Qrendi, Marsa, and Kalkara), which are all of declining quality (Mifsud, 2002). Classified as LC at European level.

Ropalopus clavipes **Fabricius, 1775**

It was classified as ‘Possibly Extinct’ in Cilia (1989), though doubtful record (Mifsud, 2002).

Saperda punctata **Linnaeus, 1767**

Very rare, recorded only from Valletta. In Europe it is widely distributed but has a rare occurrence. Mifsud (2002) noted that it could be extinct from Malta. Classified as NT at European level.

Stenidea troberti **Mulsant, 1843**

Classified as ‘Very Rare’ in Cilia (1989). Synonymous with *Deroplia troberti.* Since then, it has been found in Buskett and Wied Qannotta (Mifsud, 2002).

Trichoferus griseus **Fabricius, 1792**

It was recorded from Cospicua by Andres (1916) and Kalkara by Mifsud and Booth (1997). No record since. Classified as LC at European level.

Trichoferus fasciculatus **Faldermann, 1837**

Very common and distributed species (Mifsud, 2002). Classified as 'LC' at European level.

Trichoferus holosericeus **Rossi, 1790**

It was found in four locations (Marsaxlokk, Mdina, St. Andrews, Naxxar), most recently collected from Naxxar in 2001 (Mifsud, 2002). Larvae develop in broad leaf tree trunks. Habitats are of declining quality. Classified as LC at European level.

Table 4.4 Chrysomelidae: Cryptocephalini IUCN classifications

Species	Author (s)	IUCN (Malta)	Criteria Malta	Chorological Category
Cryptocephalus macellus	Suffrian, 1860	EN	B1ab(iii) +B2ab(iii)	TEM
Cryptocephalus plantaris	Suffrian, 1868	VU	B1ab(iii)+B2ab(iii)	SICI
Pachybrachis siculus	Weise, 1891	CE	B1ab(iii)+B2ab(iii)	SICI

4.2.4. Notes on Species in Chrysomelidae: Cryptocephalini

Cryptocephalus plantaris **Suffrian, 1868**

It was found in six locations (Miġra Ferħa, Buskett, Mellieħa, Żejtun, Wied Babu, Comino), all of which contain habitats of declining quality (Sassi, 2012).

Pachybrachis siculus **Weise, 1891**

It was found in Kortin in Mellieħa by Sassi (2012) as a new record. No published record since.

Cryptocephalus macellus **Suffrian, 1860**

It was found in three locations (Buskett, Baħrija, Wied Babu), all of which contain habitats of declining quality (Sassi, 2012).

Table 4.5 Curculionoidea IUCN Classifications

Family	Species	Author (s)	IUCN (Malta)	Criteria Malta	Chorological Category
Apionidae	*Aspidapion aeneum*	Fabricius, 1775	DD		PAL
Apionidae	*Aspidapion radiolus*	Marsham, 1802	LC		PAL
Apionidae	*Catapion pubescens*	Kirby, 1811	PE		CEM
Apionidae	*Eutrichapion vorax*	Herbst, 1797	DD		PAL
Apionidae	*Holotrichapion pisi*	Fabricius, 1801	DD		PAL
Apionidae	*Malvapion malvae*	Fabricius, 1775	VU	B1ab(iii)+B2ab(iii)	PAL
Apionidae	*Omphalapion dispar*	Germar, 1817	PE		PAL
Apionidae	*Perapion violaceum*	Kirby, 1808	VU	B1ab(iii)+B2ab(iii)	PAL
Apionidae	*Perapion hydropathi*	Marsham, 1802	CE	B1ab(iii)+B2ab(iii)	EUM
Apionidae	*Protapion apricans*	Herbst, 1797	PE		WPA
Apionidae	*Protapion dentipes*	Gerstaecker, 1854	CE	B1ab(iii)+B2ab(iii)	NME
Apionidae	*Pseudapion rufirostre*	Fabricius, 1775	EN	B1ab(iii)+B2ab(iii)	CEM
Apionidae	*Taeniapion rufescens*	Gyllenhaal, 1833	VU	B1ab(iii)+B2ab(iii)	SEUM
Curculionidae	*Amaurorhinus bewickianus*	Wollaston, 1960	EN	B1ab(iii)+B2ab(iii)	MED
Curculionidae	*Anthonomus amygdali*	Hustache, 1930	VU	B1ab(iii)+B2ab(iii)	MED
Curculionidae	*Aspropartheni*s *maculicollis*	Chevrolat, 1873	PE		ITAL
Curculionidae	*Aulacobaris coerulescens*	Scopoli, 1763	EN	B1ab(iii)+B2ab(iii)	MED
Curculionidae	*Brachypera crinita*	Boheman, 1834	NT		MED
Curculionidae	*Brachypera lunata*	Wollaston, 1854	CE	B1ab(iii)+B2ab(iii)	PAL

Family	Species	Author (s)	IUCN (Malta)	Criteria Malta	Chorological Category
Curculionidae	*Brachypera zoilus*	Scopoli, 1763	PE		PAL
Curculionidae	*Ceutorhynchus leprieuri*	C. Brisout, 1881	CE	B1ab(iii)+B2ab(iii)	MED
Curculionidae	*Ceutorhynchus melitensis*	A. Schultze, 1900	VU	B1ab(iii)+B2ab(iii)	ITAL
Curculionidae	*Charagmus gressorius*	Fabricius, 1792	CE	B1ab(iii)+B2ab(iii)	PAL
Curculionidae	*Charagmus intermedius*	Kuster, 1847	CE	B1ab(iii)+B2ab(iii)	MED
Curculionidae	*Chiloneus hoffmanni*	Gonzales, 1970	VU	B1ab(iii)+B2ab(iii)	SICI
Curculionidae	*Choerorhinus squalidus*	Fairmaire, 1858	CE	B1ab(iii)+B2ab(iii)	MED
Curculionidae	*Coelositona ocellatus*	Kuster, 1849	PE		MED
Curculionidae	*Coniocleonus pseudobliquus*	G. Muller, 1921	PE		MED
Curculionidae	*Conorhynchus mendicus*	Gyllenhal, 1834	EN	B1ab(iii)+B2ab(iii)	WME
Curculionidae	*Cosmobaris alboseriata*	Reitter, 1908	EN	B1ab(iii)+B2ab(iii)	EME
Curculionidae	*Cycloderes belonis*	Desbrochers, 1872	PE		SICI
Curculionidae	*Derelomus chamaeropis*	Fabricius, 1792	EN	B1ab(iii)+B2ab(iii)	WME
Curculionidae	*Dichromacalles diocletianus*	Germar, 1817	CE	B1ab(iii)+B2ab(iii)	SEU
Curculionidae	*Donus philantus*	Olivier, 1790	NT		WME
Curculionidae	*Hypera jucunda*	Capiomont, 1868	PE		NAM
Curculionidae	*Larinus cynarae*	Fabricius, 1787	CE	B1ab(iii)c(iv) +B2ab(iii)	MED
Curculionidae	*Larinus scolymi*	Olivier, 1807	NT		SEM
Curculionidae	*Larinus ursus*	Fabricius, 1792	EN	B1ab(iii)+B2ab(iii)	MED
Curculionidae	*Leptolepurus meridionalis*	Jacquelin du Val, 1854	CE	B1ab(iii)+B2ab(iii)	MED

Family	Species	Author (s)	IUCN (Malta)	Criteria Malta	Chorological Category
Curculionidae	*Limobius mixtus*	Boheman, 1834	EN	B1ab(iii)+B2ab(iii)	WME
Curculionidae	*Lixus anguinus*	Linnaeus, 1767	EN	B1ab(iii)+B2ab(iii)	WME
Curculionidae	*Lixus brevirostris*	Boheman, 1836	EN	B1ab(iii)+B2ab(iii)	WME
Curculionidae	*Lixus juncii*	Boheman, 1836	NT		PAL
Curculionidae	*Malvaevora timida*	Rossi, 1792	VU	B1ab(iii)+B2ab(iii)	MED
Curculionidae	*Mecinus circulatus*	Marsham, 1802	EN	B1ab(iii)+B2ab(iii)	EUM
Curculionidae	*Mecinus fairmairei*	Tournier, 1873	CE	B1ab(iii)+B2ab(iii)	ITAL
Curculionidae	*Mecinus simus*	Mulsant and Rey, 1858	EN	B1ab(iii)+B2ab(iii)	MED
Curculionidae	*Mecinus variabilis*	Rosenhauer, 1856	EN	B1ab(iii)+B2ab(iii)	SEU
Curculionidae	*Melaleucus spoliatus*	Boheman, 1836	VU	B1ab(iii)+B2ab(iii)	WME
Curculionidae	*Melicius gracilis*	Rosenhauer, 1856	CE	B1ab(iii)+B2ab(iii)	EUM
Curculionidae	*Mogulones peregrinus*	Gyllenhal, 1837	VU	B1ab(iii)+B2ab(iii)	MED
Curculionidae	*Otiorhynchus affaber*	Boheman, 1843	PE		MED
Curculionidae	*Otiorhynchus cribricollis*	Gyllenhal, 1834	EN	B1ab(iii)c(i) +B2ab(iii)	SEU
Curculionidae	*Otiorhynchus moriger*	Reitter, 1914	LC		MAL
Curculionidae	*Otiorhynchus ovatulus*	Boheman, 1843	CE	B1ab(iii)+B2ab(iii)	MAL
Curculionidae	*Otiorhynchus schembrii*	Magnano, 1992	EN	B1ab(iii)c(iv)+B2ab(iii)c(iv).	MAL
Curculionidae	*Pachytychius hordei*	Brullé, 1832	EN	B1ab(iii) +B2ab(iii)	MED
Curculionidae	*Rhinocyllus conicus*	Frölich, 1792	VU	B1ab(iii) +B2ab(iii)	CME

Family	Species	Author (s)	IUCN (Malta)	Criteria Malta	Chorological Category
Curculionidae	*Rhinusa antirrhini*	Paykull, 1800	CE	B1ab(iii) +B2ab(iii)	EUM
Curculionidae	*Rhinusa herbarum*	H. Brisout, 1862	CE	B1ab(iii) +B2ab(iii)	SEU
Curculionidae	*Rhinusa moroderi*	Reitter, 1906	CE	B1ab(iii) +B2ab(iii)	MED
Curculionidae	*Rhytideres plicatus*	Olivier, 1790	LC		MED
Curculionidae	*Shenophorus parumpunctatus*	Gyllenhal, 1837	EN	B1ab(iii) +B2ab(iii)	MED
Curculionidae	*Sibinia arenariae*	Stephens, 1831	CE	B1ab(iii)c(iii) +B2ab(iii)c(iii)	TUM
Curculionidae	*Sibinia femoralis*	Germar, 1824	EN	B1ab(iii) +B2ab(iii)	CME
Curculionidae	*Sibinia primita*	Herbst, 1795	DD		EUM
Curculionidae	*Sitona discoideus*	Gyllenhal, 1834	NT		WME
Curculionidae	*Sitona virgatus*	Fåhraeus, 1840	EN	B1ab(iii) +B2ab(iii)	WME
Curculionidae	*Sitona lineatus*	Linnaeus, 1758	LC		PAL
Curculionidae	*Sitona macularius*	Marsham, 1802	LC		PAL
Curculionidae	*Smicronyx brevicornis*	F. Solari, 1952	EN	B1ab(iii) +B2ab(iii)	MED
Curculionidae	*Smicronyx jungermanniae*	Reich, 1797	VU	B1ab(iii) +B2ab(iii)	CME
Curculionidae	*Strophomorphus porcellus*	Schoenherr, 1832	VU	B1ab(iii) +B2ab(iii)	WPA
Curculionidae	*Styphloderes exsculptus*	Boheman, 1843	EN	B1ab(iii) +B2ab(iii)	WME
Curculionidae	*Styphlus transjonicus*	Osella and Zuppa, 1994	PE		ITAL
Curculionidae	*Torneuma maltense*	Magnano and Mifsud, 2001	VU	B1ab(iii)+B2ab(iii)	MAL
Curculionidae	*Torneuma strictum*	Magnano and Mifsud, 2001	EN	B1ab(iii)+B2ab(iii)	MAL

Family	Species	Author (s)	IUCN (Malta)	Criteria Malta	Chorological Category
Curculionidae	*Trachyphloeus laticollis*	Boheman, 1843	CE	B1ab(iii)c(iii) +B2ab(iii)c(iii)	WME
Curculionidae	*Trachyphloeus melitensis*	Borovec and Osella, 1993	CE	B1ab(iii)+B2ab(iii)	SICI
Curculionidae	*Trichosirocalus centrimacula*	A. Schultze, 1899	PE		MED
Curculionidae	*Tychius argentatus*	Chevrolat, 1859	VU	B1ab(iii) +B2ab(iii)	MED
Curculionidae	*Tychius bicolor*	C. Brisout, 1862	VU	B1ab(iii) +B2ab(iii)	TUM
Curculionidae	*Tychius grenieri*	C. Brisout, 1861	PE		MED
Curculionidae	*Tychius meliloti*	Stephens, 1831	VU	B1ab(iii) +B2ab(iii)	CAM
Curculionidae	*Tychius pusillus*	Germar, 1842	EN	B1ab(iii) +B2ab(iii)	CME
Raymondionymidae	*Alaocyba melitensis*	Magnano and Mifsud, 1998	CE	B1ab(iii) +B2ab(iii)	MAL

4.2.4. Notes on Species in Curculionoidea

***Aspidapion aeneum* Fabricius, 1775**

It was only recorded once by Cameron and Caruana Gatto (1907) with no location mentioned. No record since. Mifsud and Colonnelli (2010).

***Aspidapion radiolus* Marsham, 1802**

A very common species with many records available (Mifsud and Colonnelli, 2010).

***Catapion pubescens* Kirby, 1811**

It was recorded in Marsaxlokk and Girgenti by Cameron and Caruana Gatto (1907) with no record since (Mifsud and Colonnelli, 2010).

***Eutrichapion vorax* Herbst, 1797**

It was mentioned in Mifsud and Colonnelli (2010), however, no material was examined.

***Holotrichapion pisi* Fabricius, 1801**

Same as *Eutrichapion vorax.*

***Malvapion malvae* Fabricius, 1775**

It was found in seven locations (Baħrija, Fiddien, Għadira, Marsa, Mistra, Naxxar, St. Thomas Bay), last recorded in 2010 (Mifsud and Colonnelli, 2010).

***Omphalapion dispar* Germar, 1817**

It was only found in St. Paul's Bay and in an unspecified location by Cameron and Caruana Gatto (1907). No record since (Mifsud and Colonnelli, 2010).

***Perapion violaceum* Kirby, 1808**

It was found in six locations (Baħrija, Fiddien, Rabat, Mistra, Wied tal-Isqof, Ramla) , last being recorded in Ramla in 2003 (Mifsud and Colonnelli, 2010).

Perapion hydropathi Marsham, 1802

It was only found in Baħrija in 2002 on *Rulex* sp. No record since.

Protapion apricans Herbst, 1797

It was collected only in Girgenti and in an unspecified location by Cameron and Caruana Gatto (1907). No record since (Mifsud and Colonnelli, 2010).

Protapion dentipes Gerstaecker, 1854

It was found in Girgenti by Cameron and Caruana Gatto (1907). Since then, it has been also found in Baħrija in 1990, 1993, and 1996. No record since.

Pseudapion rufirostre Fabricius, 1775

It was found by Cameron and Caruana Gatto (1907) in an unspecified location, however since then it has been found in three locations (Baħrija, St. Thomas Bay, Wied tal-Isqof). It was last recorded in Baħrija in 1996 (Mifsud and Colonnelli, 2010).

Taeniapion rufescens Gyllenhaal, 1833

It was recorded in 1901 by Cameron and Caruana Gatto (1907). Since then, it was found in nine locations (Girgenti, Guardamangia, Marsa, Mtaħleb, Munxar, Żejtun, Għasri, Comino).

Amaurorhinus bewickianus Wollaston, 1960

It was found in five locations (White Tower Bay, St Thomas Bay, Marsaxlokk, Marsaskala, Qbajjar), all of which contain habitats which are declining in quality (Mifsud and Colonnelli, 2010).

Anthonomus amygdali Hustache, 1930

It was found in seven locations (Buskett, Dingli, Mellieħa, Naxxar, Wied Has-Sabtan, Wied Babu, Għasri), all of which contain habitats which are declining in quality (Mifsud and Colonnelli, 2010).

Asproparthenis maculicollis **Chevrolat, 1873**

It was last found from Għadira in 1971. No record since (Mifsud and Colonnelli, 2010).

Aulacobaris coerulescens **Scopoli, 1763**

It was found in four locations (St. Thomas Bay, Qbajjar, Ramla, Għasri), all of which contain habitats which are declining in quality (Mifsud and Colonnelli, 2010).

Brachypera crinita **Boheman, 1834**

It was found in over ten locations, including some which contain threatened habitats such as sand dunes and salt marshes (Mifsud and Colonnelli, 2010).

Brachypera lunata Wollaston, 1854

It was only found in Ramla, Gozo in 1996. No record since (Mifsud and Colonnelli, 2010).

Brachypera zoilus Scopoli, 1763

It was only found in Wied Qannotta, in 1984. No record since (Mifsud and colonnelli, 2010).

Ceutorhynchus leprieuri **C. Brisout, 1881**

It was only found in Qbajjar, Gozo in 2010. No record since (Mifsud and Colonnelli, 2010).

Ceutorhynchus melitensis **A. Schultze, 1900**

It was found in six locations (Marsa, Msida, Selmun, Żejtun, Għasri, San Lawrenz), all of which contain habitats which are declining in quality (Mifsud and Colonnelli, 2010).

Charagmus gressorius **Fabricius, 1792**

It was recorded in Ta' Baldu in Cameron and Caruana Gatto (1907), and again in Mellieħa in 2004. No record since (Mifsud and Colonnelli, 2010).

Charagmus intermedius Kuster, 1847

It was only found from Ta' Baldu in Cameron and Caruana Gatto (1907). Never found again (Mifsud and Colonnelli, 2010).

Chiloneus hoffmanni Gonzales, 1970

It was found in eight locations (Għar Ħasan, Mellieħa, St. Thomas Bay, Żurrieq, Wied Anġlu, Wied il-Għasel, Nadur, Comino), all of which contain habitats which are declining in quality (Mifsud and Colonnelli, 2010). One specimen was described as *Chiloneus deluccai* by Pesarini, 1970 and mentioned in Cilia (1989) as an endemic, mentioned as a specimen of *Desbrochersella hoffmanni* in Mifsud and Colonnelli (2010), but this later became synonymous to *Chiloneus hoffmanni.*

Choerorhinus squalidus Fairmaire, 1858

It was found in Cameron and Caruana Gatto (1907) in an unspecified location, and most recently found from Buskett in 2003. Not recorded since (Mifsud and Colonnelli, 2010).

Coelositona ocellatus Kuster, 1849

It was found in Cameron and Caruana Gatto (1907) in Mellieħa, and never found again (Mifsud and Colonnelli, 2010).

Coniocleonus pseudobliquus G. Muller, 1921

It was found in Cameron and Caruana Gatto (1907) in an unspecified location and never found again (Mifsud and Colonnelli, 2010).

Conorhynchus mendicus Gyllenhal, 1834

It was found in four locations (Marsaxlokk, Miġra Ferħa, St. Thomas Bay, Dwejra), all of which contain threatened habitats of declining quality (Mifsud and Colonnelli, 2010).

Cosmobaris alboseriata **Reitter, 1908**

It was found in St. Thomas Bay in 2002, 2003 and Żejtun in 1997, 1998, and 2001. No record since (Mifsud and Colonnelli, 2010).

Cycloderes belonis **Desbrochers, 1872**

It was only found in Marsa in 1901 by Cameron and Caruana Gatto (1907), no record since.

Derelomus chamaeropis **Fabricius, 1792**

It was found in three locations (Marsaskala, Mellieħa, Qbajjar), which are severely fragmented and contain threatened habitats of declining quality (Mifsud and Colonnelli, 2010).

Dichromacalles diocletianus **Germar, 1817**

It was found in Baħrija Valley and Ramla in 1990, which are severely fragmented locations and contain threatened habitats of declining quality (Mifsud and Colonnelli, 2010).

Donus philanthus **Olivier, 1790**

This species was found in over ten locations, all of which contain threatened habitats such as sand dunes, which could threaten it in the future (Mifsud and Colonnelli, 2010).

Hypera jucunda **Capiomont, 1868**

It was found in Cameron and Caruana Gatto (1907) in an unspecified location and never recorded again (Mifsud and Colonnelli, 2010).

Larinus cynarae **Fabricius, 1787**

It was found in Cameron and Caruana Gatto (1907) in an unspecified location, then found again recently from Burmarrad, Wied Arkata in 2003 (Mifsud and Colonnelli, 2010).

***Larinus scolymi* Olivier, 1807**

This species is found in over ten locations, all of which contain threatened habitats such as sand dunes, which could threaten it in the future (Mifsud and Colonnelli, 2010).

***Larinus ursus* Fabricius, 1792**

It was found in Cameron and Caruana Gatto (1907) in Buskett, then recently found in Mellieħa, St. Thomas Bay, and Wied Babu (four locations), all of which contain habitats declining in quality (Mifsud and Colonnelli, 2010).

***Leptolepurus meridionalis* Jacquelin du Val, 1854**

It was only found in Ramla, Gozo, most recently in 2010. It is associated with coastal sand dunes, which are a threatened habitat on the Maltese Islands (Mifsud and Colonnelli, 2010).

***Limobius mixtus* Boheman, 1834**

It was found in four locations (Ta' Baldu, Selmun, Mistra, Dwejra), all of which contain habitats which are declining in quality (Mifsud and Colonnelli, 2010).

***Lixus anguinus* Linnaeus, 1767**

It was found in Cameron and Caruana Gatto (1907) in an unspecified location, but recently found in Baħrija, St. Thomas Bay, Wied il-Kbir, Qbajjar, and Wied tax-Xlendi (five locations). They are severely fragmented locations and contain habitats which are declining in quality (Mifsud and Colonnelli, 2010).

***Lixus brevirostris* Boheman, 1836**

It was found in Għasri and Xagħra in Gozo. No records from Malta. There is a continuing decline observed in the quality of habitat (Mifsud and Colonnelli, 2010).

***Lixus juncii* Boheman, 1836**

It was found in 11 locations, some of which contain threatened habitats such as sand dunes, which could threaten it in the future (Mifsud and Colonnelli, 2010).

***Malvaevora timida* Rossi, 1792**

It was found in eight locations (Dingli, Mellieħa, Msida, St. Thomas Bay, Wied Tal-Isqof, Żejtun, Wied Babu, Għammar), all of which contain habitats that are declining in quality (Mifsud and Colonnelli, 2010).

***Mecinus circulatus* Marsham, 1802**

It was found in Cameron and Caruana Gatto (1907) in an unspecified location, since then it was found in Marsa, Ta' Qali, and Żejtun (three locations). It is present in habitats that are observed to be declining in quality (Mifsud and Colonnelli, 2010).

***Mecinus fairmairei* Tournier, 1873**

It was only found from St. Thomas Bay in 1991. No record since (Mifsud and Colonnelli, 2010).

***Mecinus simus* Mulsant and Rey, 1858**

It was found in Cameron and Caruana Gatto (1907) in an unspecified location, but recently found from Msida and Żejtun. Both locations contain habitats which are observed to be continually declining in quality (Mifsud and Colonnelli, 2010).

***Mecinus variabilis* Rosenhauer, 1856**

It was found in three locations (Mellieħa Bay, St. Thomas Bay, Wied il-Għasel), all of which contain habitats which are observed to be continually declining in quality (Mifsud and Colonnelli, 2010).

***Melaleucus spoliatus* Boheman, 1836**

It was found in Cameron and Caruana Gatto (1907) in Mellieħa, and since then it has been found in Baħrija, Marsaxlokk, St. Thomas Bay, Xrobb l-Għaġin, Miġra Ferħa, Żejtun. It is severely fragmented and found in habitats that are of declining quality in the Maltese Islands such as sand dunes and salt marshes (Mifsud and Colonnelli, 2010).

***Melicius gracilis* Rosenhauer, 1856**

It was found only from Buskett in 1993 and never found again (Mifsud and Colonnelli, 2010).

***Mogulones peregrinus* Gyllenhal, 1837**

It was found in Cameron and Caruana Gatto (1907) in an unspecified location, and since then it has been found in eight locations (Baħrija, Buskett, Landrijiet, Mellieħa, St. Thomas Bay, Żejtun, Wied Babu, Qbajjar), all of which exhibit habitats of declining quality (Mifsud and Colonnelli, 2010).

***Otiorhynchus affaber* Boheman, 1843**

It was classified as 'Rare' in Cilia (1989). It was found in Cameron and Caruana Gatto (1907) in an unspecified location and never recorded again (Mifsud and Colonnelli, 2010).

***Otiorhynchus cribricollis* Gyllenhal, 1834**

It was found in Dingli by Cameron and Caruana Gatto (1907) and most recently in Ramla, Gozo (1999). No records since.

***Otiorhynchus moriger* Reitter, 1914**

It was classified as 'Very Rare' in Cilia (1989). Recently it has been found in many locations and is very common around the Maltese Islands (Mifsud and Colonnelli, 2010).

Otiorhynchus ovatulus **Boheman, 1843**

It was only found in Ramla, Gozo. It is endemic and it is associated with coastal sand dunes, which are a threatened habitat on the Maltese Islands (Mifsud and Colonnelli, 2010). Classified as CE at European and Global level.

Otiorhynchus schembrii **Magnano, 1992**

It was only found in St. Thomas Bay in 2010 and Wied Babu in 1994 and 1995. Not recorded since (Mifsud and Colonnelli, 2010). Classified as EN at European and Global level.

Pachytychius hordei **Brullé, 1832**

It was known from five severely fragmented locations (Marsa, Mellieħa, Santa Lucija, Ramla, Mgarr ix-Xini). It was found from Ramla most recently, in 2010, and not recorded since.

Rhinocyllus conicus **Frölich, 1792**

It was found in nine locations (Delimara, Għar Lapsi, Marsaxlokk, Munxar, Ta' Qali, Wardija, Wied il-Kbir, Marsalforn, Qbajjar), which contain threatened habitats (Mifsud and Colonnelli, 2010).

Rhinusa antirrhini **Paykull, 1800**

It was only found in Buġibba in 1994. No records since (Mifsud and Colonnelli, 2010).

Rhinusa herbarum **H. Brisout, 1862**

It was only found in Mtaħleb in 1996. No records since (Mifsud and Colonnelli, 2010).

Rhinusa moroderi **Reitter, 1906**

It was found in four severely fragmented locations (Marsa, Munxar, Wied id – Dis), in habitats which are threatened.

Rhytideres plicatus **Olivier, 1790**

It is widely distributed and found in many locations, with many records available (Mifsud and Colonnelli, 2010).

Shenophorus parumpunctatus **Gyllenhal, 1837**

It is known from four locations (Ġnejna, Fiddien,, Għajn Riħana, Wied Qannotta) which are severely fragmented with continuing decline of habitat observed (Mifsud and Colonnelli, 2010).

Sibinia arenariae **Stephens, 1831**

It was collected by Cameron and Caruana Gatto (1907), but was only recently collected from Marsaxlokk in 1994 (Mifsud, and Colonnelli, 2010). No records since. It is restricted to salt marshes.

Sibinia femoralis **Germar, 1824**

It was found in four locations (Mellieħa, St. Thomas Bay, Ramla, Qbajjar), with the most recent collected specimen from Qbajjar in 2010. It is mainly found in sand dunes (Mifsud and Colonnelli, 2010).

Sibinia primita **Herbst, 1795**

No material was examined, so the presence of this species on Malta is not demonstrated, but Mifsud and Colonnelli (2010) noted that its presence on the Maltese Islands cannot be excluded.

Sitona discoideus **Gyllenhal, 1834**

This species was found in more than ten locations. However, some of the locations contain threatened habitats such as sand dunes (Mifsud and Colonnelli, 2010).

***Sitona virgatus* Fåhraeus, 1840**

It was recorded as *Sitona virgatus melitensis* in Cilia (1989) with no classification. Since then, it has been redescribed and found in five severely fragmented locations (Ġnejna, Qarraba bay, Selmun, Għasri, Għammar), with the most recent collected specimen from Għammar in 2003 (Mifsud and Colonnelli, 2010).

***Sitona lineatus* Linnaeus, 1758**

Widely distributed species with many records available (Mifsud and Colonnelli, 2010).

***Sitona macularius* Marsham, 1802**

Widely distributed species with many records available (Mifsud and Colonnelli, 2010).

***Smicronyx brevicornis* F. Solari, 1952**

It was found in four locations (Buskett, Mellieħa, Wied Babu, Dwejra), all of which are threatened by development.

***Smicronyx jungermanniae* Reich, 1797**

It was found in six locations, two of which are severely fragmented (Comino, Mellieħa, Għar Lapsi, Wied Babu, Marsaxlokk, Delimara). Mainly found near freshwater and salt marshes (Mifsud and Colonnelli, 2010).

***Strophomorphus porcellus* Schoenherr, 1832**

It was found in seven locations (Binġemma, Ġnejna, Rabat, Fomm ir-Riħ, Baħrija, Ramla, Qattara), all of which contain threatened habitats (Mifsud and Colonnelli, 2010).

***Styphloderes exsculptus* Boheman, 1843**

It was found in four severely fragmented locations (Marsaxlokk, Ċirkewwa, Ramla, Munxar), all of which contain sand dunes, which are threatened habitats showing continuous decline in quality.

***Styphlus transjonicus* Osella and Zuppa, 1994**

It was previously misidentified as *Orthochaetes setiger* but correct by Germann (2019). Only one specimen was recorded by Cameron and Caruana Gatto (1907) with no location. Never recorded again.

***Torneuma strictum* Magnano and Mifsud, 2001**

It was found in five locations (Bidnija, Buskett, Mellieħa, St. Thomas Bay, Wardija) as reported by Mifsud and Colonnelli (2010). No record since. Classified as EN at European and Global level.

***Torneuma maltense* Magnano and Mifsud, 2001**

It was found in eight locations (Bidnija, Buskett, Maqluba, Mtaħleb, Wardija, Wied Babu, Wied Qirda, San Blas) as reported by Mifsud and Colonnelli (2010), which all contain habitats which are decreasing in quality. Classified as 'VU' at European and Global level.

***Trachyphloeus melitensis* Borovec and Osella, 1993**

It was found by Cameron and Caruana Gatto (1907) with no location, and most recently in Mellieħa Bay in 2004 (Mifsud and Colonnelli, 2010). No record since.

***Trachyphloeus laticollis* Boheman, 1843**

It was found in St. Paul's Bay and Mrabat, with only one specimen each time. The last collected specimen was from Mrabat in 1990. No record since (Mifsud and Colonnelli, 2010).

Trichosirocalus centrimacula **A. Schultze, 1899**

It was collected by Cameron and Caruana Gatto (1907) with no notes about a specific location. No record since (Mifsud and Colonnelli, 2010).

Tychius argentatus **Chevrolat, 1859**

It was found in six locations (Buskett, Chadwick Lakes, Fiddien, Mistra, Żejtun, Ramla), with the most recently collected specimens from Buskett and Ramla in 2010 (Mifsud and Colonnelli, 2010).

Tychius bicolor **C. Brisout, 1862**

It was found in seven locations (Dingli, Marsaxlokk, Mellieħa Bay, Miġra Ferħa, Munxar, Żejtun, Għasri). It is associated with salt marshes, which are a threatened habitat.

Tychius grenieri **C. Brisout, 1861**

It was collected by Cameron and Caruana Gatto (1907) with no notes about a specific location. No record since (Mifsud and Colonnelli, 2010).

Tychius meliloti **Stephens, 1831**

It is known from six locations (Buskett, Marsaskala, Marsaxlokk, Mtaħleb, Żejtun, Ta' Baldu). Material was collected from salt marshes in Marsaskala and Marsaxlokk, which are threatened habitats in the Maltese Islands (Mifsud and Colonnelli, 2010).

Tychius pusillus **Germar, 1842**

It is known from two locations (Wied il-Għasel, Wied Ħas-Sabtan). Last collected in 1996 from Wied Has-Sabtan. (Mifsud and Colonnelli, 2010).

Alaocyba melitensis **Magnano and Mifsud, 1998**

Recorded only from Buskett by Magnano and Mifsud (1998) and noted as an endemic species. No record since. Classified as CE at European and Global level.

Table 4.6 Dytiscidae IUCN Classifications.

Species	Author (s)	IUCN (Malta)	Criteria Malta	Chorological Category
Agabus (Gaurdytes) bipustulatus	Linnaeus, 1767	EN	B1ab(iii) +B2ab(iii)	PAL
Colymbetes fuscus	Linnaeus, 1758	EN	B1ab(iii) +B2ab(iii)	CEM
Dytiscus circumflexus	Fabricius, 1801	EN	B1ab(iii) +B2ab(iii)	TEM
Hydaticus (Prodaticus) leander	Rossi, 1790	EN	B1ab(iii) +B2ab(iii)	ATM
Laccophilus interruptus	Panzer, 1795	DD		UN
Meladema coriaceum	Laporte, 1835	DD		WME

4.2.5. Notes on Species in Dytiscidae

***Agabus (Gaurdytes) bipustulatus* Linnaeus, 1767**

It was found in Fiddien in 2003 and Qrendi in 2001, no record since (Mifsud and Nardi, 2020).

***Colymbetes fuscus* Linnaeus, 1758**

It was found in four locations (Għajn Riħana, Ta' Baldu, Marsaxlokk, Qrendi), all of which have threatened habitats such as salt marshes. The last collected specimen was from Qrendi in 2003 (Mifsud and Nardi, 2020).

***Dytiscus circumflexus* Fabricius, 1801**

It was classified as 'Vulnerable' in Cilia (1989). It was recorded for the first time in 'Sara Valley', Gozo by Mifsud and Nardi (2020). Previously it was only recorded in Malta, but no specified locations were accessible.

***Hydaticus (Prodaticus) leander* Rossi, 1790**

It was found in three severely fragmented locations (Naxxar, Mellieħa, Żurrieq), with the last collected specimen being from Mellieħa, Kortin in 2004.

***Laccophilus interruptus* Panzer, 1795**

It is synonymous to *Laccophilus hyalinus* , which according to Mifsud and Nardi (2020), could be a misidentification.

***Meladema coriaceum* Laporte, 1835**

It is synonymous to *Meladema coriacea,* which was mentioned in Mifsud and Nardi (2020), but no material was examined.

Table 4.7 Elateridae IUCN Classifications.

Species	Author (s)	IUCN (Malta)	Criteria Malta	Chorological Category
Cardiophorus belonis	Desbrochers des Loges, 1870	VU	B1ab(iii)+B2ab(iii)	MAL
Cardiophorus exaratus	Erichson, 1840	EN	B1ab(iii) +B2ab(iii)	WME
Cardiophorus ulcerosus	Gené, 1836	NT		MED
Cebrio (Cebrio) benedicti	Fairmaire, 1849	VU	B1ab(iii) +B2ab(iii)	MED
Harminius spiniger	Candèze, 1860	VU	B1ab(iii) +B2ab(iii)	MED
Haterumelater schembrii	Platia, 1985	CE	B1ab(iii)+B2ab(iii)	MAL
Isidus moreli	Mulsant and Rey, 1875	CE	B1ab(ii,iii) + B2ab(i,iii)	MED
Lacon punctatus	Herbst, 1779	EN	B1ab(iii) +B2ab(iii)	MED

4.2.6. Notes on Species in Elateridae

Cardiophorus belonis **Desbrochers des Loges, 1870**

It was classified as 'Vulnerable' by Cilia (1989). It was found in eight locations (Bidnija, Baħrija, Mdina, Wied Babu, Naxxar, Blata l-Bajda, Marsaxlokk, Munxar), which all contain threatened habitats (Wurst and Mifsud, 2012). It was classified as VU at European and Global level.

Cardiophorus exaratus **Erichson, 1840**

It was found in Mellieħa and Ramla, Gozo. It is restricted to coastal sand dune habitats, which are threatened on the Maltese Islands (Wurst and Mifsud 2012).

Cardiophorus ulcerosus **Gené, 1836**

It is a species found in over ten locations, though it is found in Ramla, Mellieħa, and St. Thomas Bay, which contain threatened habitats (Wurst and Mifsud, 2012).

Cebrio (Cebrio) benedicti **Fairmaire, 1849**

It was found in ten locations (Qrendi, Birkirkara, Baħrija, Siġġiewi, Żebbuġ, Pembroke, Marsa, Rabat, Wied Qirda, Naxxar), all of which contain threatened habitats. It is a synonym of *Cebrio fiorii* (Wurst and Mifsud, 2012).

Harminius spiniger **Candèze, 1860**

It was found in seven locations (Binġemma, Birkirkara, Kalkara, Rabat, Mellieħa, Wied Babu, Żejtun), all of which contain threatened habitats. It has a restricted distribution in the Mediterranean, being found only in Italy, Malta, and Algeria (Wurst and Mifsud, 2012).

Haterumelater schembrii **Platia, 1985**

It was recorded only from Wied Babu in 1979. No record since (Wurst and Mifsud, 2012).

Isidus moreli **Mulsant and Rey, 1875**

It was classified as 'Possiby Rare' by Cilia (1989). Found in two locations (Mellieħa, Ramla), but it has not been recorded in Mellieħa since 1903. It was recorded recently in Ramla in 2004. It is listed in the Red List of Threatened Species and is on the IUCN Red List globally. It is strictly associated with sand dune habitats (Wurst and Mifsud, 2012). It was classified as EN at European level.

Lacon punctatus **Herbst, 1779**

It was classified as 'Data Deficient' by Cilia (1989). Since then it has been found in two locations (Wied Moqbol, Żejtun), with the most recent collection being from Żejtun in 2012 (Wurst and Mifsud, 2012).

Table 4.8 Gyrinidae IUCN Classifications.

Species	Author (s)	IUCN (Malta)	Criteria Malta	Chorological Category
Gyrinus (Gyrinus) urinator	Illiger, 1807	CE	B1ab(iii)+ B2ab(iii)	EUM

4.2.7. Notes on Species in Gyrinidae

***Gyrinus (Gyrinus) urinator* Illiger, 1807**

Found only in Buskett in 2001 as a new record. Not recorded since. (Mifsud and Nardi, 2020).

Table 4.9 Haliplidae IUCN Classifications.

Species	Author (s)	IUCN (Malta)	Criteria Malta	Chorological Category
Haliplus (Neohaliplus) lineaticollis	Marsham, 1802	PE		EUR

4.2.8. Notes on Species in Haliplidae

***Haliplus (Neohaliplus) lineaticollis* Marsham, 1802**

In Cilia (1989) it was reported as declining with no location mentioned. No record since.

Table 4.10 Hydraenidae IUCN Classifications.

Species	Author (s)	IUCN (Malta)	Criteria Malta	Chorological Category
Aulacochthebius exaratus	Mulsant, 1885	CE	B1ab(iii) +B2ab(iii)	MED
Hydraena subimpressa	Rey, 1885	CE	B1ab(iii) +B2ab(iii)	EUM
Ochthebius (Asiobates) crenulatus	Mulsant and Rey, 1850	EN	B1ab(iii) +B2ab(iii)	CME
Ochthebius cortomaltese	Villastrigo, Hernando, Millan and Ribera, 2020	CE	B1ab(iii) +B2ab(iii)	MAL
Ochthebius (Asiobates) dilatatus	Stephens, 1829	LC		ATM
Ochthebius (Asiobates) maculatus	Reiche, 1869	EN	B1ab(iii) +B2ab(iii)	MED
Ochthebius (Calobius) quadricollis	Mulsant, 1844	NT		WME
Ochthebius celatus	Jach, 1989	EN	B1ab(iii) +B2ab(iii)	MED
Ochthebius eyrei	Jach, 1990	EN	B1ab(iii) +B2ab(iii)	MED
Ochthebius fossulatus	Mulsant, 1844	CE	B1ab(iii) +B2ab(iii)	MED
Ochthebius punctatus	Stephens, 1829	RE		ATM

4.2.9. Notes on Species in Hydraenidae

Aulacochthebius exaratus Mulsant, 1885

It was recorded in Ġnejna and Dwejra, though it has not been recorded in Ġnejna for over a 100 years (Mifsud and Nardi, 2020). The specimen from Ġnejna was recorded as *Ochthebius exaratus* in Cilia (1989) and renamed *Aulacochthebius exaratus.*

Hydraena subimpressa Rey, 1885

It was recorded in three locations (Wied il-Qlejgħa, Ta' Baldu, Buskett), but has not been found in Wied il-Qlejgħa or Ta' Baldu for over a century. It has a restricted distribution, and is associated with freshwater pools in Buskett (Mifsud and Nardi, 2020).

Ochthebius (Asiobates) crenulatus Mulsant and Rey, 1850

It was found in four locations (Ġnejna, Buskett, Wied il-Luq, Dwejra). It was classified as 'Near Threatened' by Mifsud, Jach and Schuh (2004), but it is reclassified as 'Endangered', because the locations are severely fragmented, and some records have not been found in over a century.

Ochthebius cortomaltese Villastrigo, Hernando, Millan and Ribera, 2020

It was found in Ġnejna Bay in 2020, and only recorded from Malta (Villastrigo et al., 2020). No record since. It was evaluated as CE at European and Global level.

Ochthebius (Asiobates) dilatatus Stephens, 1829

Very common species with many records available. Was known as *Ochthebius impressicollis imperfectus* in Cilia (1989), also describing it as 'very common', before being reclassified (Mifsud, Jach, and Schuh, 2004).

Ochthebius (Asiobates) maculatus Reiche, 1869

It was found in three locations (Żejtun, Baħrija, Dwejra) in valley systems and freshwater pools. Mifsud, Jach, and Schuh (2004) noted that the specimens can be of closely related subspecies.

Ochthebius (Calobius) quadricollis Mulsant, 1844

It was noted as being very common, with a many records available, though it is found near coastal rock pools, which are threatened.

Ochthebius celatus Jach, 1989

It was found in three locations (Mtaħleb, Żurrieq, Xrobb L-Għaġin). It was classified as 'Near Threatened' in Mifsud, Jach and Schuh (2004), but is reclassified as EN, because of the number of locations, and it is restricted to threatened coastal rock pools. A specimen was recorded as *Ochthebius subinteger* in Cilia (1989).

Ochthebius eyrei Jach, 1990

It was found in three locations (Marsaskala, Żejtun, Qattara). It was classified as 'Vulnerable' in Mifsud, Jach and Schuh (2004) but it is reclassified as EN due to severe fragmentation of locations, as well as its association with small freshwater or saline pools.

Ochthebius fossulatus Mulsant, 1844

It was only known from Magħluq ta' Marsaskala, which is a salt marsh. No record since (Mifsud, Jach and Schuh, 2004).

Ochthebius punctatus **Stephens, 1829**

Only known record is a specimen from Cameron and Caruana Gatto (1907), with no specified location. No recent material was collected since. It was classified as 'Regionally Extinct' by Mifsud, Jach, and Schuh (2004).

Table 4.11 Hydrophilidae IUCN Classifications.

Species	**Author (s)**	**IUCN (Malta)**	**Criteria Malta**	**Chorological Category**
Berosus affinis	Brullé, 1835	DD		MED
Coelostoma orbiculare	Fabricius, 1775	DD		PAL
Dactylosternum insulare	Laporte de Castelnau, 1840	DD		UN
Helophorus (empleurus) rufipes	Bosc, 1791	DD		MED
Helophorus (Trichelophorus) alternans	Gené, 1836	DD		MED
Helophorus(magalelophorus) aquaticus	Linnaeus, 1758	DD		MED
Helophorus porculus	Bedel, 1881	DD		MED
Helophorus dorsalis v. *emanciatus*	Marsham, 1802	DD		MED
Helophorus algiricus	Motschulsky, 1860	DD		MED
Helophorus pallidipennis v. *reitteri*	Mulsant and Wachanru, 1852	DD		MED

4.2.10. Notes on Species in Hydrophilidae

Berosus affinis Brullé, 1835

It was classified as 'Vulnerable' by Cilia (1989). There have been no records or studies mentioning it since.

Coelostoma orbiculare Fabricius, 1775

Same as *Helophorus porculus.*

Dactylosternum insulare Laporte de Castelnau, 1840

It was classified as 'Vulnerable' by Cilia (1989). It is synonymous with *Dactylosternum abdominale.* There are no studies that mention it again.

Helophorus (empleurus) rufipes Bosc, 1791

It was classified as 'Vulnerable' by Cilia (1989). Its basionym is *Opatrum rufipes.* No records since.

Helophorus (Trichelophorus) alternans Gené, 1836

It was classified as 'Vulnerable' by Cilia (1989). No records since.

Helophorus (magalelophorus) aquaticus Linnaeus, 1758

It was classified as 'Vulnerable' by Cilia (1989). No records since.

Helophorus porculus Bedel, 1881

It was classified as 'Data Deficient' by Cilia (1989). There was very little information at the time, and there is still not enough information about this species.

Helophorus dorsalis v. _emanciatus_ Marsham, 1802

Same as *Helophorus porculus.*

Helophorus algiricus Motschulsky, 1860

Same as *Helophorus porculus.*

Helophorus pallidipennis v. *reitteri* Mulsant and Wachanru, 1852

Same as *Helophorus porculus.*

Table 4.12 Kateretidae IUCN Classifications

Species	Author (s)	IUCN (Malta)	Criteria Malta	Chorological Category
Brachypterus curtulus	Wollaston, 1864	EN	B1ab(iii)+B2ab(iii)	WME
Kateretes rufilabris	Latreille, 1807	PE		EUM

4.2.11. Notes on Species in Kateretidae

***Brachypterus curtulus* Wollaston, 1864**

It was found in two reported locations (Marsa, Żejtun). In both cases, it was found in habitats of declining quality.

***Kateretes rufilabris* Latreille, 1807**

It was found in two locations (Ta' Baldu, Salina), though it was last recorded from Salina in 1977. No records since.

Table 4.13 Leiodidae: Cholevinae IUCN Classifications

Species	Author (s)	IUCN (Malta)	Criteria Malta	Chorological Category
Catops coracinus	Kellner, 1846	EN	B1ab(iii) +B2ab(iii)	PAL
Ptomaphagus (Ptomaphagus) tenuicornis mauritanicus	Jeannel, 1934	EN	B1ab(iii) +B2ab(iii)	WME

4.2.12. Notes on Species in Leiodidae

***Catops coracinus* Kellner, 1846**

It was found in three recorded locations (Żejtun, Buskett, St. Thomas Bay). No record since (Růžička and Mifsud, 2016).

***Ptomaphagus (Ptomaphagus) tenuicornis mauritanicus* Jeannel, 1934**

It was found in three locations (Dingli, Munxar, Bidnija), with last location recorded in 1999. Habitats are observed to be of declining quality (Růžička and Mifsud, 2016).

Table 4.14 Malachiidae IUCN Classifications

Species	Author (s)	IUCN (Malta)	Criteria Malta	Chorological Category
Attalus melitensis	Peyron, 1877	VU	B1ab(iii)+ B2ab(iii)	MAL

4.2.13. Notes on Species in Malachiidae

***Attalus melitensis* Peyron, 1877**

It was found in eight recorded locations (Dingli, Mellieħa, Għar Lapsi, Munxar, Baħrija, Marsaskala, Buskett, Dwejra). Seems to be endemic, but presence in Sicily and Italy needs to be verified. Habitats of declining quality (Svihla and Mifsud, 2006). It was classified as VU at European and Global level.

Table 4.15 Monotomidae IUCN Classifications.

Species	Author (s)	IUCN (Malta)	Criteria Malta	Chorological Category
Rhizophagus unicolor	P.H. Lucas, 1849	VU	B1ab(iii) +B2ab(iii)	MED

4.2.14. Notes on Species in Monotomidae

***Rhizophagus unicolor* P.H. Lucas, 1849**

It was found in eight locations (Bidnija, Buskett, Msida, Qormi, Wied Babu, Żejtun, Żurrieq, Mellieħa). Habitats are observed to be of declining quality (Mifsud and Jelinek, 2012).

Table 4.16 Nitidulidae IUCN Classifications.

Species	Author (s)	IUCN (Malta)	Criteria Malta	Chorological Category
Meligethes lindbergi	Rebmann, 1940	EN	B1ab(iii)+ B2ab(iii)	MED
Meligethes rotundicollis	C. Brisout de Barneville, 1863	EN	B1ab(iii)+ B2ab(iii)	MED
Meligethes nigriscens	Stephens, 1830	VU	B1ab(iii)+ B2ab(iii)	PAL
Omosita discoidea	Fabricius, 1775	CE	B1ab(iii)+ B2ab(iii)	PAL
Pria dulcamarae	Scopoli, 1763	DD		UN

4.2.15. Notes on Species in Nitidulidae

Meligethes lindbergi **Rebmann, 1940**

It was found in five locations (Dwejra, Għadira , Naxxar, Dingli, Għar Lapsi). Described as 'rare' by Mifsud and Audisio (2008).

Meligethes rotundicollis **C. Brisout de Barneville, 1863**

It was found in two locations (Dingli, Ħagar Qim). New record at the time of Mifsud and Audisio (2008). No records since.

Meligethes nigriscens **Stephens, 1830**

It was found in six locations (Baħrija, Buskett, St. Thomas Bay, Wied Ħas-Sabtan, Żejtun, Ramla), all of which contain threatened habitats which are decreasing in quality (Mifsud and Audisio, 2008).

Omosita discoidea **Fabricius, 1775**

It was only found in Marsa in 1997, and never recorded again (Mifsud and Audisio, 2008).

Pria dulcamarae Scopoli, 1763

Mifsud and Audisio (2008) mentioned this, and said it was only added to the Red Data Book since it was described by Caruana Gatto as 'not common'. No records on GBIF, possibly introduced.

Table 4.17 Phalacridae IUCN Classifications.

Species	Author (s)	IUCN (Malta)	Criteria Malta	Chorological Category
Tinodemus mifsudi	Švec, 2000	CE	B1ab(iii)+B2ab(iii)	MAL
Tinodemus polygramma	Flach, 1888	EN	B1ab(iii) +B2ab(iii)	MED
Olibrus affinis	Sturm, 1807	LC		AEM
Olibrus castaneus	Baudi di Selve, 1870	EN	B1ab(iii) +B2ab(iii)	MED
Olibrus pygmaeus	Sturm, 1807	CE	B1ab(iii) +B2ab(iii)	EUM
Olibrus reitteri	Flach, 1888	CE	B1ab(iii) +B2ab(iii)	MED

4.2.16. Notes on Species in Phalacridae

***Tinodemus mifsudi* Švec, 2000**

It was found from Baħrija in 1997, in a habitat that is observed to be continually declining in quality. No record since (Mifsud and Svec, 2012). It was classified as CE at European and Global level.

***Tinodemus polygramma* Flach, 1888**

It was found from Girgenti 1902 and Baħrija in 2002, with a restricted Mediterranean distribution (Mifsud and Svec, 2012).

***Olibrus affinis* Sturm, 1807**

Widely distributed and common species with many records (Mifsud and Svec, 2012).

***Olibrus castaneus* Baudi di Selve, 1870**

It was found in six locations, two of them being in Comino (Marsaskala, Marsa, Buskett, Xlendi, Santa Maria Bay, Il-Ħazina). It was last found in Marsaskala by Cameron and Caruana Gatto (1907). All habitats are observed to be continually declining in quality.

***Olibrus pygmaeus* Sturm, 1807**

It was found from Girgenti in 1901 and no material examined since, though Svec (2004; 2007) reported its presence in Malta (Mifsud and Svec, 2012).

***Olibrus reitteri* Flach, 1888**

It was found from Ħaġar Qim in 1989 and no material examined since, though reported in Svec (2004; 2007).

Table 4.18 Pselaphidae IUCN Classifications.

Species	**Author (s)**	**IUCN (Malta)**	**Criteria Malta**	**Chorological Category**
Brachygluta perforata	Aubé, 1833	PE		SEU

4.2.17. Notes on Species in Pselaphidae

Brachygluta perforata **Aubé, 1833**

It was last reported by Baudi (1889), confirmed by Poggi (1980) but no record since. It was mentioned in Sabella and Mifsud (2016) but no material examined with no locations other than 'Malta', though presence is confirmed.

Table 4.19 Scarabaeoidea IUCN Classifications

Family	Species	Author (s)	IUCN Category (Malta)	Criteria for Malta	Chorological Category
Geotrupidae	*Geotrupes douei*	Gory, 1841	DD		MED
Geotrupidae	*Thorectes intermedius*	O. G. Costa, 1839	NT		WME
Scarabaeidae	*Aethiessa floralis*	Fabricius, 1787	VU	B1ab(iii) +B2ab(iii)	SME
Scarabaeidae	*Amphimallon scutellare*	P. H. Lucas, 1846	DD		CME
Scarabaeidae	*Anoxia australis*	Gyllenhal, 1817	NA		SEUM
Scarabaeidae	*Aphodius (Alocoderus) hydrochaeris*	Fabricius, 1798	DD		TUM
Scarabaeidae	*Aphodius (Anomius) castaneus*	Illiger , 1803	EN	B1ab(iii) +B2ab(iii)	WME
Scarabaeidae	*Aphodius (Bodiloides) ictericus ghardimaouensis*	Balthasar, 1929	PE		MED
Scarabaeidae	*Aphodius (Bodilus) beduinus*	Reitter, 1892	VU	B1ab(iii) +B2ab(iii)	CME
Scarabaeidae	*Aphodius (Bodilus) lugens*	Crentzer, 1799	PE		TUM
Scarabaeidae	*Aphodius (Calamosternus) algiricus*	Mariani and Pittino, 1983	EN	B1ab(iii) +B2ab(iii)	WME
Scarabaeidae	*Aphodius (Calamosternus) mayeri*	Pilleri, 1953	DD		MED
Scarabaeidae	*Aphodius (Chilothorax) lineolatus*	Illiger, 1803	DD		MED
Scarabaeidae	*Aphodius (Eudolus) quadriguttatus*	Herbst, 1783	PE		TEM
Scarabaeidae	*Aphodius (Euorodalus) tersus*	Erichson, 1848	PE		WME
Scarabaeidae	*Aphodius (Labarrus) lividus*	A. G. Olivier, 1789	EN	B1ab(iii) +B2ab(iii)	MED
Scarabaeidae	*Aphodius (Melinopterus) consputus*	Creutzer, 1799	PE		EUM
Scarabaeidae	*Aphodius (Bodilopsis) rufus*	Moll, 1782	PE		PAL

Family	Species	Author (s)	IUCN Category (Malta)	Criteria for Malta	Chorological Category
Scarabaeidae	*Aphodius (Subrinus) sturmi*	Harold, 1870	DD		CAEM
Scarabaeidae	*Aplidia hirticollis*	Burmeister, 1855	EN	B1ab(iii) +B2ab(iii)	EUWM
Scarabaeidae	*Brindalus porcicollis*	Illiger, 1803	CE	B1ab(iii) +B2ab(iii)	MED
Scarabaeidae	*Bubas bison*	Linnaeus, 1767	VU	B1ab(iii) +B2ab(iii)	WME
Scarabaeidae	*Bubas bubalus*	Olivier, 1811	DD		MED
Scarabaeidae	*Cetonia (Cetonia) aurata pisana*	Heer, 1841	DD		CME
Scarabaeidae	*Cheironitis ungaricus irroratus*	P. Rossi, 1790	PE		SME
Scarabaeidae	*Copris (Copris) hispanus cavolinii*	V. Petagna, 1792	EN	B1ab(iii) +B2ab(iii)	CEM
Scarabaeidae	*Euoniticellus fulvus*	Goeze, 1777	PE		TEM
Scarabaeidae	*Lasiotrichius succinctus*	Pallas, 1782	DD		UN
Scarabaeidae	*Onthophagus (Onthophagus) taurus*	Schreber, 1759	NT		CEM
Scarabaeidae	*Onthophagus (Palaeonthophagus) andalusicus*	Waltl, 1835	VU	B1ab(iii) +B2ab(iii)	SMCA
Scarabaeidae	*Oryctes (Oryctes) nasicornis grypus*	Illiger, 1803	NT		SEUM
Scarabaeidae	*Oxythyrea funesta*	Poda von Neuhaus, 1761	LC		EUMI
Scarabaeidae	*Pentodon bidens punctatus*	Villers, 1789	LC		TUM
Scarabaeidae	*Phyllognathus excavatus*	Forster, 1771	VU	B1ab(iii) +B2ab(iii)	TUM
Scarabaeidae	*Platytomus laevistriatus*	Perris, 1870	PE		WME
Scarabaeidae	*Platytomus tibialis*	Fabricius, 1798	PE		SCO
Scarabaeidae	*Pleurophorus caesus*	Panzer, 1796	LC		SCO

Family	Species	Author (s)	IUCN Category (Malta)	Criteria for Malta	Chorological Category
Scarabaeidae	*Protaetia (Potosia) incerta*	A. Costa, 1852	VU	B1ab(iii) +B2ab(iii)	CME
Scarabaeidae	*Protaetia (Potosia) mayeti*	Le Comte, 1906	DD		UN
Scarabaeidae	*Protaetia (Potosia) opaca*	Fabricius, 1787	VU	B1ab(iii) +B2ab(iii)	WME
Scarabaeidae	*Psammodius pierottii*	Pittino, 1979	DD		EUSMI
Scarabaeidae	*Rhyssemus plicatus*	Germar, 1817	VU	B1ab(iii) +B2ab(iii)	MED
Scarabaeidae	*Scarabaeus (Ateuchetus) semipunctatus*	Fabricius, 1792	PE		WME
Scarabaeidae	*Scarabaeus (Ateuchetus) variolosus*	Fabricius, 1787	LC		MED
Scarabaeidae	*Tropinota (Tropinota) squalida squalida*	Scopoli, 1763	LC		WME
Trogidae	*Trox fabriciii*	Reiche, 1853	EN	B1ab(iii) +B2ab(iii)	WME
Trogidae	*Trox litoralis*	Pittinio, 1991	EN	B1ab(iii) +B2ab(iii)	EME

4.2.18. Notes on Species in Scarabaeoidea

***Geotrupes douei* Gory, 1841**

Last specimen collected was from 1901/2, with no mention of locality. No record since. Classified as 'LC' at European and Global level.

***Thorectes intermedius* O. G. Costa, 1839**

This species was recorded in more than ten locations, though it is found in many threatened locations such as Marsa, St Thomas Bay, and Armier Bay (Pivotti et al., 2011). Classified as 'LC' at European and Global level.

***Aethiessa floralis* Fabricius, 1787**

It was found in five locations (Żejtun, St. Thomas Bay, Rabat, Naxxar, Kortin). Last recorded from Kortin, Mellieħa in 2005 (Pivotti et al., 2011).

***Amphimallon scutellare* P. H. Lucas, 1846**

Doubtful taxonomic status (Pivotti et al., 2011).

***Anoxia australis* Gyllenhal, 1817**

It was first recorded in Cilia (1989). It was recorded and renamed as a specimen of *Anoxia matutinalis matutinalis* in Pivotti et al. (2011), recorded in three locations (Mellieħa, Għadira , Armier) and it was classified as not applicable since it might be a recent introduction.

***Aphodius (Alocoderus) hydrochaeris* Fabricius, 1798**

Last specimen collected was from Marsa in 1927. No record since.

***Aphodius (Anomius) castaneus* Illiger , 1803**

It was found in three locations (Paradise Bay, Mosta, Mellieħa), last being recorded from Mellieħa in 2004. Classified as 'LC' at European level.

Aphodius (Bodiloides) ictericus ghardimaouensis **Balthasar, 1929**

It was found in three locations (Ġnejna, Żebbieħ, iċ-Ċnus), however its most recent specimen dates to 1977 from iċ-Ċnus. Has not been recorded since (Pivotti et al., 2011). It is classified as 'Least Concern' on the IUCN Red List. Classified as LC at European and Global level.

Aphodius (Bodilus) beduinus **Reitter, 1892**

It was found in eight locations (Pembroke, Buskett, Munxar, Qrendi, Mosta, Naxxar, Wied Qirda, Xagħra), with habitats observed to be continually declining in quality (Pivotti et al., 2011). Classified as LC at European and Global level.

Aphodius (Bodilus) lugens **Crentzer, 1799**

It was last recorded in Baudi (1891). No record since (Pivotti et al., 2011).

Aphodius (Calamosternus) algiricus **Mariani and Pittino, 1983**

It was found in four locations (Mosta, Mellieħa, Żejtun, Għasri). Not recorded since 2003 from Żejtun (Pivotti et al., 2011). Classified as 'LC' at European and global level.

Aphodius (Calamosternus) mayeri **Pilleri, 1953**

Records found in British Museum of Natural History were mentioned in paper Pivotti et al. (2011) but no mention of date collected or location. Classified as 'LC' at European and Global level.

Aphodius (Chilothorax) lineolatus **Illiger, 1803**

Only one observation from Cameron and Caruana Gatto (1907), with no location given. No record since Pivotti et al. (2011). Classified as LC at European and Global level.

***Aphodius (Eudolus) quadriguttatus* Herbst, 1783**

It was recorded from Malta by Cameron and Caruana Gatto (1907) based on the material collected by Commander James John Walker between 1874 and 1876 with no locations mentioned other than 'Malta'. Since then, there have been no records in the Maltese Islands (Pivotti et al., 2011).

***Aphodius (Euorodalus) tersus* Erichson, 1848**

It was recorded from Marsa by Cameron and Caruana Gatto (1907) and never recorded again (Pivotti et al., 2011). Classified as LC at European and Global level.

***Aphodius (Labarrus) lividus* A. G. Olivier, 1789**

It was found in four locations (Marsa, Rabat, Żejtun, Mdina). Last found from Żejtun in 2001 (Pivotti et al., 2011).

***Aphodius (Melinopterus) consputus* Creutzer, 1799**

It was recorded on the basis of material collected by Commander James John Walker between 1874 and 1876, with no location mentioned. Since then, no records have been found (Pivotti et al., 2011).

***Aphodius (Bodilopsis) rufus* Moll, 1782**

It was recorded by Andres (1916) in Conspicua, and since then it has never been recorded again.

***Aphodius (Subrinus) sturmi* Harold, 1870**

Based on historical material from the British Museum of Natural History labelled 'Malta', with no specified location. No record since (Pivotti et al., 2011).

Aplidia hirticollis **Burmeister, 1855**

It is known from three locations (Balzan, Naxxar, Mosta). Pivotti et al., (2011) noted that the species has a distribution restricted to Central-Northern Malta. Last collected from Naxxar in 2005.

Brindalus porcicollis **Illiger, 1803**

Recent records are restricted to Ramla, Gozo, though it was recorded from Mellieħa by Cameron and Caruana Gatto (1907). Most recent published specimen was collected in 2002 (Pivotti et al., 2011).

Bubas bison **Linnaeus, 1767**

This species was classified as 'Possibly Rare' by Cilia (1989). It was found in nine locations and described as 'relatively frequent' in Pivotti et al. (2011). Classified as LC at European and Global level.

Bubas bubalus **Olivier, 1811**

It is probably an incorrect record. It was not recorded since collection from Comm. James John Walker between 1874 - 1876, as mentioned in Pivotti et al. (2011) with no locations other than 'Malta'. Classified as LC at European and Global level.

Cetonia (Cetonia) aurata pisana **Heer, 1841**

New record at the time of Pivotti et al. (2011). No record since.

Cheironitis ungaricus irroratus **P. Rossi, 1790**

It was classified as 'Rare' by Cilia (1989) using its synonym *Cheironitis hungaricus.* It was last recorded by Cameron and Caruana Gatto (1907) from Chadwick Lakes and not recorded since.

***Copris (Copris) hispanus cavolinii* V. Petagna, 1792**

It was found in three locations and described with a very restricted distribution in the Maltese Islands (Wied Inċita, Dingli , Wied il-Kbir). It was recorded as *Copris hispanus* in Cilia (1989).

***Euoniticellus fulvus* Goeze, 1777**

It was recorded by Cameron and Caruana Gatto (1907) in Ġnejna, and not recorded since.

***Lasiotrichius succinctus* Pallas, 1782**

Present not confirmed in Malta. Possibly introduced (Pivotti et al., 2011).

***Onthophagus (Onthophagus) taurus* Schreber, 1759**

It was classified as 'Possibly Rare' by Cilia (1989). It was found in 11 locations and described as common in Pivotti et al. (2011), with some locations being threatened.

***Onthophagus (Palaeonthophagus) andalusicus* Waltl, 1835**

This species was classified as 'Rare' by Cilia (1989). Found in eight locations and described as rarer than *O. taurus* but not uncommon (Pivotti et al., 2011). It was assessed as LC in The IUCN Red List in 2014. Classified as LC at European and Global level.

***Oryctes (Oryctes) nasicornis grypus* Illiger, 1803**

It was classified as 'Vulnerable' in Cilia (1989). Since then, it has been found in over ten locations, though it is present in threatened habitats (Pivotti et al., 2011).

***Oxythyrea funesta* Poda von Neuhaus, 1761**

Same as *Tropinota (Tropinota) squalida squalida.*

***Pentodon bidens punctatus* Villers, 1789**

A common species with many records available.

***Phyllognathus excavatus* Forster, 1771**

Classified as 'Possibly Vulnerable' by Cilia (1989). Found in six locations (Rabat, Marsa, Għammieri, Għaxaq, Żejtun, Wied Babu, Ramla) and described as 'very common' in Pivotti et al. (2011).

***Platytomus tibialis* Fabricius, 1798**

Last reported location was from Attard in Pittino and Mariani (1986). It is exclusively found in sand dunes and in coastal areas. No record since.

***Platytomus laevistriatus* Perris, 1870**

No material or location reported. Its presence was recorded by Schatzmayr (1946). No records since (Pivotti et al., 2011).

***Pleurophorus caesus* Panzer, 1796**

Very common and distributed species (Pivotti et al., 2011).

***Protaetia (Potosia) incerta* A. Costa, 1852**

It was found in nine locations, including threatened locations such as Kortin in Mellieħa, Buskett, Dingli, and Wied l-Arkata in Burmarrad. *Potosia cuprea metallica* was recorded in Cilia (1989) was renamed as a specimen of *Protaetia incerta* (Pivotti et al., 2011). *Potosia lugubris* was recorded by Valletta (1979) and mentioned in Cilia (1989), but the specimen collected should refer to *Protaetia incerta.*

***Protaetia (Potosia) mayeti* Le Comte, 1906**

Uncertain taxonomic status. Pivotti et al. (2011) noted that this should be a distinct species, but Sabatinelli and Schembri (1990) consider this a variety of *Protaetia incerta*.

***Protaetia (Potosia) opaca* Fabricius, 1787**

It was found in seven locations (Mellieħa, Burmarrad, Wardija, Marsa, Siġġiewi, Żejtun, Valletta). Last collected from Siġġiewi in 2005. Pivotti et al., (2011) noted that it has an association with honey bees. Classified as LC at European level.

***Psammodius pierottii* Pittino, 1979**

No material examined. Pivotti et al. (2011) noted that Maltese records of *Psammodius asper* should refer to this species.

***Rhyssemus plicatus* Germar, 1817**

It was found in ten locations (Xlendi, Delimara, Buskett, Fomm ir-Rih, Marfa, Miġra Ferħa, St Thomas Bay, Dwejra, Mosta, Ta' Kantra). Last record was from Ta' Kantra in 2002 (Pivotti et al., 2011).

***Scarabaeus (Ateuchetus) semipunctatus* Fabricius, 1792**

Classified as 'Very Rare' by Cilia (1989). It is associated with sand dunes, and it was found in Mellieħa and from Ramla in Gozo. Classified as VU at European and Global level.

***Scarabaeus (Ateuchetus) variolosus* Fabricius, 1787**

A common species with many records available (Pivotti et al., 2011). Classified as LC at European and Global level.

***Tropinota (Tropinota) squalida squalida* Scopoli, 1763**

Noted as very common with many records available (Pivotti et al., 2011).

Trox fabriciii Reiche, 1853

It was found in two locations (Żejtun, Għasri), last record from Għasri in 1994.

Trox litoralis Pittinio, 1991

It was found in four locations (Żejtun, Wied Qannotta, Ramla, Dwejra). Habitats observed to be of declining quality.

Table 4.20 Staphylinidae IUCN Classifications

Species	Author (s)	IUCN (Malta)	Criteria Malta	Chorological Category
Achenium (Achenium) striatum	Latreille, 1804	EN	B1ab(iii)(iv)c(iii) +B2ab(iii)(iv)	MED
Achenium (Micrachenium) tenellum	Erichson, 1840	DD		MED
Amaurops mifsudi	Poggi, 1999	EN	B1ab(iii)+B2ab(iii)	SICI
Astenus (Astenognathus) filiformis championi	Coiffait, 1971	DD		UN
Astenus (Astenognathus) filiformis luteipennis	Coiffait, 1971	DD		UN
Astenus (Astenognathus) walkeri	Fauvel, 1900	PE		MAL
Atheta (Atheta) linderi	Brisout de Barneville, 1863	PE		MED
Atheta (Atheta) nr. Crassicornis	Fabricius, 1792	PE		EUM
Biblopiectus (Bibloplectus) limatus	Normand, 1939	EN	B1ab(iii) +B2ab(iii)	WME
Bledius (bledius) tricornis	Herbst, 1784	DD		PAL
Bledius (Bledius) unicornis	Germar, 1825	CE	B1ab(iii)(iv)(v) + B2ab(iii)(v)	EUM
Bledius (Euceratobledius) furcatus	A.G., Olivier, 1811	CE	B1ab(iii) +B2ab(iii)	EUM
Brachygluta (Brachygluta) aubei	Tournier, 1868	EN	B1ab(iii) +B2ab(iii)	WME
Brachygluta (Brachygluta) dentiventris	Saulcy, 1876	VU	B1ab(iii) +B2ab(iii)	WME
Brachygluta (Brachygluta) helferi helferi	Schmidt-Göbel, 1836	PE		EUM
Brachygluta (Brachygluta) hipponensis	Saulcy, 1876	EN	B1ab(iii) +B2ab(iii)	WME
Euplectus bonvouloiri siculus	Raffray, 1910	EN	B1ab(iii)+B2ab(iii)	SICI
Euplectus corsicus	Guillebeau, 1888	DD		WME

Species	Author (s)	IUCN (Malta)	Criteria Malta	Chorological Category
Gabrius doderoi	Gidelli, 1920	CE	B1ab(iii)(iv) +B2ab(iii)	MED
Micropeplus porcatus	Paykull, 1789	DD		MED
Rybaxis longicornis	Leach, 1817	EN	B1ab(iii) +B2ab(iii)	CAM
Scopaeus gracilis	Sperk, 1835	PE		MED
Stenus (Tesbus) brunnipes maximus	Puthz, 1968	NT		SIM
Tachyusa (Caliusa) balteata	Erichson, 1839	DD		PAL
Trissemus (Trissemus) olivieri	Raffray, 1871	NT		WME
Trogophloeus (Taenosoma) championi	Bernhauer, 1912	DD		MAL
Trogophloeus (Taenosoma) siculus	Mulsant and Rey, 1878	DD		MED
Tychus jacquelinii	Boieldieu, 1859	EN	B1ab(iii) +B2ab(iii)	WME
Tychus opuntiae	Schmidt-Göbel, 1836	VU	B1ab(iii)+B2ab(iii)	SICI

4.2.19. Notes on Species in Staphylinidae

***Achenium (Achenium) striatum* Latreille, 1804**

It was found in Dwejra, Bidnija, Ġnejna, Victoria most recently, was found in Wied Qannotta and Salina in 1970s but was not found again there. Most recent collection is from Dwejra in 2015.

***Achenium (Micrachenium) tenellum* Erichson, 1840**

Uncertain taxonomic status (Sabella and Mifsud, 2016).

***Amaurops mifsudi* Poggi, 1999**

It was found in four severely fragmented locations (Wied il-Luq, Mgarr ix-Xini, Daħlet Qorrot, Qrendi), all of which have habitats which are continually declining of quality (Sabella and Mifsud, 2016).

***Astenus (Astenognathus) filiformis luteipennis* Coiffait, 1971**

'Data Deficient' in Cilia (1989). Doubtful taxonomic status.

***Astenus (Astenognathus) filiformis championi* Coiffait, 1971**

'Data Deficient' in Cilia (1989). Doubtful taxonomic status.

***Astenus (Astenognathus) walkeri* Fauvel, 1900**

It is an endemic species recorded last in Bordoni (1973). No record since.

***Atheta (Atheta) linderi* Brisout de Barneville, 1863**

It was classified as 'Vulnerable' in Cilia (1989). Last recorded in Schembri (1982) from Għar il-Friefet in Birżebbuga, which is threatened. No record since.

***Atheta (Atheta) nr. crassicornis* Fabricius, 1792**

Same as *Atheta (Atheta) linderi.*

Bibloplectus (Bibloplectus) limatus **Normand, 1939**

It was found in two locations (Chadwick Lakes and Wied il-Luq), where it was last found in Wied il-Luq in 1997. No records since (Sabella and Mifsud, 2016).

Bledius (bledius) tricornis **Herbst, 1784**

It was recorded as 'Very Rare' by Cilia (1989) and no record since. Doubtful occurrence on the Maltese Islands.

Bledius (Bledius) unicornis **Germar, 1825**

It was reported as 'Very Rare' by Cilia (1989) and decreasing in numbers by Caruana Gatto (1926). Its type locality is salt marshes, which are a threatened habitat.

Bledius (Euceratobledius) furcatus **A.G., Olivier, 1811**

It was reported as 'Very Rare' by Cilia (1989) and decreasing in numbers by Caruana Gatto (1926). Its type locality is sand dunes, which are a threatened habitat.

Brachygluta (Brachygluta) aubei **Tournier, 1868**

It was found in two locations (Marsaxlokk, Marsaskala), both of which contain salt marshes which are both threatened habitats on the Maltese islands (Sabella and Mifsud, 2016). It was recorded as *Bryaxis globulicollis aubei* in Cameron and Caruana Gatto (1907) and in Cilia (1989).

Brachygluta (Brachygluta) dentiventris **Saulcy, 1876**

It was found in seven locations (Chadwick Lakes, Wied Qannotta, Għajn Riħana, Magħluq ta' Marsaskala, Il-Ballut ta' Marsaxlokk, Dwejra, Ghasri). It was recorded as *Bryaxis cameroni* in Cameron and Caruana Gatto (1907).

***Brachygluta (Brachygluta) helferi helferi* Schmidt-Göbel, 1836**

It was found in Chadwick Lakes in 1979 and never found again (Sabella and Mifsud, 2016).

***Brachygluta (Brachygluta) hipponensis* Saulcy, 1876**

It was found in five locations (Għadira , Marsaxlokk, Salina, Marsaskala, Mellieħa), and known to occur in sand dunes. Last record was from Mellieħa in 2005 (Sabella and Mifsud, 2016). It was recorded as *Brachygluta simplex hipponensis* in Cilia (1989) but it has since been reclassified.

***Euplectus bonvouloiri siculus* Raffray, 1910**

This species was found in Buskett in 2002 and in Daħlet Qorrot in Gozo in 2015. No records since (Sabella and Mifsud, 2016).

***Euplectus corsicus* Grimmer, 1841**

Incorrect record. Sabella and Mifsud (2016) mentioned that a specimen of *Euplectus brunneus* collected by James John Walker between 1874 and 1876 and mentioned in Cameron and Caruana Gatto (1907), as well as Cilia (1989), should refer to *Euplectus corsicus.* The only location available was a specimen under the label 'Malta'. No record since.

***Gabrius doderoi* Gidelli, 1920**

It was recorded as having a restricted distribution in the Mediterranean (Cilia, 1989). It was last recorded from Qrendi in 1996 (Farrugia, 2019).

***Micropeplus porcatus* Paykull, 1789**

It was classified as 'Data Deficient' in Cilia (1989) as *Micropeplus porcatus insularis* and never recorded again. It was renamed as *Micropeplus porcatus* (Sabella and Mifsud, 2016).

***Rybaxis longicornis* Leach, 1817**

It was found in Chadwick Lakes in 2015 and in Ramla in 1990. Sabella and Mifsud (2016) noted this as a new record and that it is found in freshwater and salty environments.

***Scopaeus gracilis* Sperk, 1835**

It was recorded in two locations (Marsa, Wied il-Qlejgħa) in Cameron and Caruana Gatto (1907) and not recorded since. Mentioned as *Scopaeus gracilis siculus* in Cilia (1989) and described as 'rare', but it was confirmed to be *Scopaeus gracilis* by Frisch (1998).

***Stenus (Tesbus) brunnipes maximus* Puthz, 1968**

This subspecies was described in 1968, and recorded in Farrugia (2019) with over ten locations. It is found in threatened habitats, such as saltmarshes, freshwater streams, and sand dunes.

***Trissemus (Trissemus) olivieri* Raffray, 1871**

It was found in 11 locations, five of which are Ramla, Mistra, Golden Bay, Dwejra, Daħlet Qorrot, which contain threatened habitats.

***Trogophloeus (Taenosoma) championi* Bernhauer, 1912**

It was renamed as *Carpelimus (Trogophloeus) alutaceus*, which is synonymous (Gildenkov, 2015). No material examined since.

***Trogophloeus (Taenosoma) siculus* Mulsant and Rey, 1878**

Uncertain taxonomic status. It was first recorded by Luigioni (1929) and never found again.

***Tachyusa (Caliusa) balteata* Erichson, 1839**

Doubtful taxonomic status.

Tychus jacquelinii **Boieldieu, 1859**

It was found in three locations (Mistra Bay, Buskett ,Chadwick Lakes), all recorded from 1997, and all of which contain habitats of declining quality. It was a new record by Sabella and Mifsud (2016).

Tychus opuntiae **Schmidt-Göbel, 1836**

It was found in seven locations (Mtaħleb, Miġra Ferħa, Dingli Cliffs, Għasri, Dwejra, Ramla, Daħlet Qorrot). It was first found in Wardija by Poggi (1980) but not recorded from there since (Sabella and Mifsud, 2016).

Table 4.21 Tenebrionidae IUCN Classifications

Species	Author (s)	IUCN (Malta)	Criteria Malta	Chorological Category
Akis subterranea	Solier, 1837	EN	B1ab(iii)+B2ab(iii)	ITAL
Allophylax picipes melitensis	Baudi di Selve, 1876	NT		MAL
Alphasida (glabrasida) grossa melitana	Küster, 1894	VU	B1ab(iii)+B2ab(iii)	MAL
Ammobius rufus	Lucas, 1846	EN	B1ab(iii) +B2ab(iii)	MCAU
Blaps gigas	Linnaeus, 1767	LC		TUM
Blaps mucronata	Latreille, 1804	EN	B1ab(iii)+B2ab(iii)	EUM
Catomus rotundicollis	Guérin-Méneville, 1825	LC		WME
Cheirodes brevicollis	Wollaston, 1864	EN	B1ab(iii)+B2ab(iii)	MED
Clitobius (Clitobius) subplumbeus	Erichson, 1843	EN	B1ab(iii) +B2ab(iii)	ATM
Cnemeplatia atropos	A. Costa, 1847	EN	B1ab(iii)+B2ab(iii)	ASM
Corticeus bicolor	A.G. Olivier, 1790	PE		EUM
Corticeus unicolor	Piller and Mitterparcher, 1783	PE		EUM
Cossyphus moniliferus moniliferus	Chevrolat, 1833	VU	B1ab(iii)+B2ab(iii)	ATM
Crypticus gibbulus	Quensel, 1806	DD		MED
Dendarus lugens	Mulsant and Rey, 1854	LC		ITAL
Dichillus pertusus	Kiesenwetter, 1861	PE	B1ab(iii)+B2ab(iii)	EME

Species	Author (s)	IUCN (Malta)	Criteria Malta	Chorological Category
Eledona agricola	Herbst, 1783	CE	B1ab(iii)+B2ab(iii)	TUM
Erodius (erodius) siculus melitensis	Reitter, 1914	VU	B1ab(iii)+B2ab(iii)	MAL
Gonocephalum rusticum	A.G. Olivier, 1790	NT		TUM
Gonocephalum setulosum setulosum	Faldermann, 1837	EN	B1ab(iii)+B2ab(iii)	TUM
Gunarus parvulus	Lucas, 1846	DD		MED
Heliopathes (heliopates) avarus dwejrensis	Scupola and Mifsud, 2001	CE	B1ab(iii)+B2ab(iii)	MAL
Helops rossii	Germar, 1817	EN	B1ab(iii) +B2ab(iii)	EME
Isomira melanophthalma	Lucas, 1846	LC		WME
Leptoderis collaris	Linné, 1767	EN	B1ab(iii)+B2ab(iii)	MED
Myrmechixenus picinus	Aubé, 1850	EN	B1ab(iii)+B2ab(iii)	MAL
Nalassus aemulus aemulus	Küster, 1850	CE	B1ab(iii)+B2ab(iii)	WME
Omophlus melitensis	Baudi di Selve, 1870	LC		MAL
Opatroides punctulatus punctulatus	Brullé, 1832	LC		MED
Opatrum (Colpophorus) emarginatum	Lucas, 1846	EN	B1ab(iii) +B2ab(iii)	SME
Opatrum melitense	Küster, 1849	CE	B1a(i,iii,iv)+B2ab(ii,iii,iv)	MAL
Pentaphyllus testaceus	Hellwig, 17932	CE	B1ab(iii)+B2ab(iii)	EUM
Phaleria acuminata acuminata	Küster, 1852	EN	B1ab(iii) +B2ab(iii)	MED
Phaleria bimaculata bimaculata	Linnaeus, 1767	NT		MED
Phtora crenata	Germar, 1836	VU	B1ab(iii)+B2ab(iii)	WME

Species	Author (s)	IUCN (Malta)	Criteria Malta	Chorological Category
Pimelia (pimelia) rugulosa melitana	Reitter, 1915	VU	B1ab(iii)+B2ab(iii)	MAL
Pimelia sardea goryi	Solier, 1836	DD		MAL
Pseudoseriscius cameroni	Reitter, 1902	CE	B1a(i,iii,iv)+B2ab(ii,iii,iv)	MAL
Scaurus aegyptiacus	Solier, 1838	CE	B1ab(iii)+B2ab(iii)	MED
Scaurus tristis	A. G. Olivier, 1795	VU	B1ab(iii)+B2ab(iii)	MED
Sclerum multistriatum	Forskål, 1775	PE	B1ab(iii)+B2ab(iii)	TUM
Stenosis freyii	Koch, 1940	PE	B1ab(iii)+B2ab(iii)	ITAL
Stenosis hispana elongata	Solier, 1838	DD		UN
Stenosis melitana	Reitter, 1894	LC		ITAL
Stenosis schembrii	Canzoneri, 1979	EN	B1ab(iii)+B2ab(iii)	MAL
Tentyria bipunctata	Latrielle, 1802	DD		MED
Tentyria grossa grossa	Besser, 1832	VU	B1ab(iii)+B2ab(iii)	MED
Tentyria laevigata leachii	Baudi di Selve, 1875	VU	B1ab(iii)+B2ab(iii)	MAL
Trachyderma lima	L. Petagna, 1819	EN	B1ab(iii)+B2ab(iii)	MED
Trachyscelis aphodioides	Latreille, 1809	VU	B1ab(iii) +B2ab(iii)	MED
Xanthomus pallidus	Curtis, 1830	EN	B1ab(iii)+B2ab(iii)	EUM

4.2.20. Notes on Species in Tenebrionidae

Akis subterranea **Solier, 1837**

It was found in two mentioned locations (Vittoriosa, Filfla). Other material was collected but not location was given (Mifsud and Scupola, 1998). Both locations are threatened habitats. It is synonymous with *Akis melitana* which was classified as 'Data Deficient' in Cilia (1989), also noting that it was previously common but it is on the decline.

Allophylax picipes melitensis **Baudi di Selve, 1876**

It is found in over ten locations, all of which contain threatened habitats.

Alphasida (glabrasida) grossa melitana **Küster, 1894**

It was found in eight severely fragmented locations (Mellieħa, Marfa Ridge, Salina Bay, Floriana, Manoel island, Rabat, Ħagar Qim), all of which contain habitats of declining quality. It is described as very common (Mifsud and Scupola, 1998). It was classified as VU at European and Global level.

Ammobius rufus **Lucas, 1846**

It was mentioned in Cilia (1989) as having a restricted distribution in Gozo. It has been found in Malta too. It is found in five locations (White Tower Bay, Armier, Golden Bay, Ramla, Mellieħa Bay), all of which are sand dune habitats, which are threatened and declining in quality (Grimm, Lillig and Mifsud, 2020).

Blaps gigas **Linnaeus, 1767**

Very common and widely distributed species found in over ten locations.

***Blaps mucronata* Latreille, 1804**

It was found in three locations and is noted to be not as common as *B. gigas* on the Maltese islands. It is found in anthropophilic habitats (Lillig, Borg Barthet and Mifsud, 2012).

***Catomus rotundicollis* Guérin-Méneville, 1825**

Very common and widely distributed species.

***Cheirodes brevicollis* Wollaston, 1864**

It was found in three locations (Armier, Naxxar, Mellieħa), which all contain threatened habitats of declining quality (Lillig, Borg Barthet, and Mifsud, 2012). It was collected using light traps.

***Clitobius (Clitobius) subplumbeus* Erichson, 1843**

The specimens from Malta were misidentified as *Clitobius ovatus*, but were re-identified as this species. It was found in four locations (Marsaskala, Marsaxlokk, Qolla l-Bajda, Qbajjar). It has a restricted distribution and is generally found under stones close to saltmarshes and coastal habitats with sediment deposits (Grimm, Lillig, and Mifsud, 2020).

***Cnemeplatia atropos* A. Costa, 1847**

It was found in two locations (Qormi and Blue Grotto, Żurrieq) and locally rare. It was collected from under bark of *Eucalyptus* and in leaf litter under a carob tree (Lillig, Borg Barthet, and Mifsud, 2012).

***Corticeus bicolor* A.G. Olivier, 1790**

It was recorded by Cameron and Caruana Gatto (1907) with no location but never recorded again (Lillig, Mifsud and Grimm, 2012).

Corticeus unicolor **Piller and Mitterparcher, 1783**

It was recorded by Cameron and Caruana Gatto (1907) with no location but never recorded again (Lillig, Mifsud and Grimm, 2012).

Cossyphus moniliferus moniliferus **Chevrolat, 1833**

It was found in six locations and it is noted to be restricted to clay slope habitats (Lillig, Borg Barthet and Mifsud, 2012).

Crypticus gibbulus **Quensel, 1806**

It was found in one location but mentioned it could be more widespread and common (Lillig, Borg Barthet, and Mifsud, 2012). However, further data is needed to prove this.

Dendarus lugens **Mulsant and Rey, 1854**

It has a restricted distribution in the Mediterranean. In the Maltese Islands it is not common but it is widely distributed, as it is found in over ten locations (Lillig, Borg Barthet and Mifsud, 2012).

Dichillus pertusus **Kiesenwetter, 1861**

It was only recorded once in Malta in the early 1900s from 'Porto Reale' and never recorded again (Lillig, Borg Barthet, and Mifsud, 2012).

Eledona agricola **Herbst, 1783**

It was found on bracket fungi in large numbers like *Pentaphyllus testaceus*. Only recorded from one location (Lillig, Borg Barthet and Mifsud, 2012).

***Erodius (erodius) siculus melitensis* Reitter, 1914**

It was mentioned in Cilia (1989) as being 'endemic'. Found in six locations (Marfa Ridge, Għadira Bay, Golden Bay, Armier, White Tower Bay, Ramla), all of which contain threatened sand dune habitats (Mifsud and Scupola, 1998). It was classified as VU at European and Global level.

***Gonocephalum rusticum* A.G. Olivier, 1790**

It is recorded in 11 locations, therefore it is near threatened (Mifsud and Scupola, 1998).

***Gonocephalum setulosum setulosum* Faldermann, 1837**

It was found in five locations (Valletta, Cospicua, Marsaskala, St Thomas Bay, Qolla l-Bajda), and has a restricted distribution towards the South of the Maltese Islands (Mifsud and Scupola, 1998).

***Gunarus parvulus* Lucas, 1846**

Its presence in Malta needs validation but it is not excluded. It is based on a single specimen found from Mellieħa bay under bark of an acacia tree. Found by Grimm in 1986 (Lillig, Mifsud and Grimm, 2012).

***Heliopathes (heliopates) avarus dwejrensis* Scupola and Mifsud, 2001**

It is found in two severely fragmented locations (Dwejra and Marfa Ridge), which are both declining in quality of habitats (Mifsud and Scupola, 1998). It was classified as 'CE' at European and Global level.

Helops rossii **Germar, 1817**

It was classified as 'Very Rare' in Cilia (1989). It has been found in Chadwick Lakes, Ħas-Sabtan Valley, and Marsaxlokk. It was also collected in Wied il-Qlejgħa in 1975. It is rare and has a restricted distribution in the Maltese Islands, which also has an association with old trees, that require conservation action.

Isomira melanophthalma **Lucas, 1846**

Very common and widely distributed species found in over ten locations.

Leptoderis collaris **Linné, 1767**

It was found in four locations (Ħaż-Żebbuġ, Mellieħa, Rabat, Mdina), and noted to be on the decline (Lillig, Borg Barthet and Mifsud, 2012).

Myrmechixenus picinus **Aubé, 1850**

It was found in four locations. It is associated with forested areas, which are a threatened habitat in the Maltese Islands (Lillig, Borg Barthet and Mifsud, 2012). It was classified as EN at European and Global level.

Nalassus aemulus aemulus **Küster, 1850**

It was found only from Ramla, Gozo in 1999 in small numbers (10 specimens) and in Armier Bay recently in 2013 (Grimm, Lillig and Mifsud, 2020). Restricted to coastal sand dunes.

Omophlus melitensis **Baudi di Selve, 1870**

Very common and widely distributed species.

Opatroides punctulatus punctulatus **Brullé, 1832**

Very common and widely distributed species.

***Opatrum (Colpophorus) emarginatum* Lucas, 1846**

It was found in four locations (Mellieħa, Għajn Tuffieħa, Golden Bay, Ramla). It is a relatively common species in Malta mainly confined to the North-Western parts where it is generally found in agricultural fields and arid places (Mifsud and Scupola, 1998).

***Opatrum melitense* Küster, 1849**

It was classified as 'Very Rare' by Cilia (1989). It was only found once in its original description and was never found again. There is some taxonomic debate regarding its occurrence as an endemic species, since the material that was examined was collected over 180 years ago and was lost (Mifsud and Scupola, 1998). It has been proved that the historical material belongs to *O. emarginatum* (Mifsud and Scupola, 1998; Lillig, Mifsud and Grimm, 2012).

***Pentaphyllus testaceus* Hellwig, 1793**

It was found in only one location, but encountered in large numbers on bracket fungi. The location is not mentioned (Lillig, Borg Barthet, and Mifsud, 2012).

***Phaleria acuminata acuminata* Küster, 1852**

It was mentioned in Cilia (1989) as having a restricted distribution in Gozo. It has been found in three locations (Għajn Tuffieħa bay, Golden Bay, Ramla), all of which contain sand dune habitats which are declining in quality (Grimm, Lillig and Mifsud, 2020).

***Phaleria bimaculata bimaculata* Linnaeus, 1767**

This species was found in over ten locations. It is associated with sand dunes, which are a threatened habitat (Lillig, Borg Barthet, and Mifsud, 2012).

***Phtora crenata* Germar, 1836**

It was found in seven locations and is associated with brackish water and salt marshes, which are threatened in the Maltese Islands (Lillig, Borg Barthet and Mifsud, 2012).

***Pimelia (pimelia) rugulosa melitana* Reitter, 1915**

It was found in seven locations (Salina, Mellieħa, Marfa Ridge, Armier, Valletta, Floriana, St. Thomas Bay), all of which contain threatened habitats of declining quality (Lillig, Borg Barthet, and Mifsud, 2012). It was classified as VU European and Global level.

***Pimelia sardea goryi* Solier, 1836**

It was described as 'Common' by Cilia (1989). Doubtful taxonomic status.

***Pseudoseriscius cameroni* Reitter, 1902**

It was found in White Tower Bay and Marfa Ridge. It is an endemic species which is restricted exclusively to sand dune habitats. It has had fluctuations in populations, being found in Mellieħa then thought extinct, then being rediscovered again in Ramla, Gozo. It is listed in Annex II and Annex IV of Council Directive 92/43/EEC of 21 May 1992 (Lillig, Mifsud and Grimm, 2012). It was classified as 'CE' at European and Global level.

***Scaurus aegyptiacus* Solier, 1838**

It was found only once from Sara Valley in Gozo and nowhere else. No material examined (Lillig, Borg Barthet and Mifsud, 2012).

***Scaurus tristis* A. G. Olivier, 1795**

It was found in seven locations. It is not a very common Mediterranean species. Habitats are of continual decline of quality (Mifsud and Scupola, 1998).

Sclerum multistriatum **Forskål, 1775**

It was recorded by Cameron and Caruana Gatto (1907) without location material and never recorded again (Mifsud and Grimm, 2012).

Stenosis freyii **Koch, 1940**

It was collected only once in Golden Bay, which is a threatened habitat (Lillig, Borg Barthet and Mifsud, 2012).

Stenosis hispana elongata **Solier, 1838**

Mifsud and Scupola (1998) indicated that its presence still needs to be confirmed as there is discourse whether subspecies is doubtful.

Stenosis melitana **Reitter, 1894**

It was mentioned in Cilia (1989) but not evaluated. Nowadays, it is a very common and widely distributed species.

Stenosis schembrii **Canzoneri, 1979**

It was described as 'Data Deficient' and 'Endemic' in Cilia (1989). Found in three severely fragmented locations (Marsa, St Thomas Bay, Bidnija), all of which contain disturbed habitats (Mifsud andScupola, 1998). It was classified as 'EN' at European and Global level.

Tentyria bipunctata **Latrielle, 1802**

It was described with doubtful taxonomic status (Cilia, 1989).

Tentyria grossa grossa **Besser, 1832**

It was found in six locations around the Valletta Harbour and near Dingli. It was described as 'not very common' on the Maltese Islands (Lillig, Borg Barthet and Mifsud, 2012).

***Tentyria laevigata leachii* Baudi di Selve, 1875**

It was described as 'Endemic' in Cilia (1989). Noted to be common and widely distributed, but it is found in over ten locations which are fragmented and contain disturbed habitats (Mifsud and Scupola, 1998). It was classified as VU at European and Global level.

***Trachyderma lima* L. Petagna, 1819**

It was found in three locations and is noted to be rare in its distribution range on the Maltese Islands (Lillig, Borg Barthet and Mifsud, 2012). It is found in anthropophilic habitats.

***Trachyscelis aphodioides* Latreille, 1809**

In Mifsud and Scupola (1998) it was recorded in Ramla tat-Torri and Ramla in Gozo. It was mentioned in Lillig, Borg Barthet and Mifsud (2012), and described in seven locations (Ramla, Comino, Għadira, Ġnejna, Għajn Tuffieħa, Paradise Bay, Ramla tat-Torri) as a coastal sand dune species.

***Xanthomus pallidus* Curtis, 1830**

It was only known from Ramla, Gozo, but was recently recorded from Golden Bay in 2013 (Grimm, Lillig and Mifsud, 2020). Restricted to coastal sand dunes.

4.3. Diptera

Table 4.22 Diptera IUCN Classifications

Family	Species	Author (s)	IUCN (Malta)	Criteria Malta	Chorological Category
Ceratopogonidae	*Culicoides imicola*	Kieffer, 1913	EN	B1ab(iii) +B2ab(iii)	PAL
Ceratopogonidae	*Culicoides jumineri*	Callot and Kremer, 1969	DD		MED
Ceratopogonidae	*Culicoides kingi*	Austen, 1912	DD		ATM
Ceratopogonidae	*Culicoides paolae*	Boorman, 1996	LC		MED
Ceratopogonidae	*Culicoides univittatus*	Vimmer, 1932	EN	B1ab(iii) +B2ab(iii)	SEUM
Ceratopogonidae	*Forcipomyia (Euprojoannisia) alacris*	Winnertz, 1852	VU	B1ab(iii) +B2ab(iii)	CEM
Limoniidae	*Cheilotrichia cinerascens*	Meigen, 1804	EN	B1ab(iii) +B2ab(iii)	MED
Limoniidae	*Dicranomyia chorea*	Meigen, 1818	EN	B1ab(iii) +B2ab(iii)	MED
Limoniidae	*Dicranomyia sericata*	Meigen, 1830	EN	B1ab(iii) +B2ab(iii)	MED
Limoniidae	*Ellipteroides lateralis*	Macquart, 1835	DD		MED
Limoniidae	*Erioconopa diuturna*	Walker, 1848	VU	B1ab(iii) +B2ab(iii)	MED
Limoniidae	*Erioptera fuscipennis*	Meigen, 1818	EN	B1ab(iii) +B2ab(iii)	MED
Limoniidae	*Helius flavus*	Walker, 1856	CE	B1ab(iii) +B2ab(iii)	MED

Family	Species	Author (s)	IUCN (Malta)	Criteria Malta	Chorological Category
Limoniidae	*Limonia nubeculosa*	Meigen, 1804	VU	B1ab(iii) +B2ab(iii)	MED
Limoniidae	*Molophilus obscurus*	Meigen, 1818	CE	B1ab(iii) +B2ab(iii)	MED
Limoniidae	*Symplecta hybrida*	Meigen, 1804	EN	B1ab(iii) +B2ab(iii)	MED
Limoniidae	*Symplecta pilipes*	Fabricius, 1787	VU	B1ab(iii) +B2ab(iii)	MED
Limoniidae	*Symplecta stictica*	Meigen, 1818	EN	B1ab(iii) +B2ab(iii)	MED
Psychodidae	*Segentomyia minuta*	Rondani ,1843	NT		MED
Psychodidae	*Phlebotomus (Larroussius) perniciosus*	Newstead, 1911	NT		MED
Simuliidae	*Simulium (Eusimulium) velutinum*	Santos Abreu, 1922	EN	B1ab(iii) +B2ab(iii)	MED
Tephritidae	*Myopites stylatus*	Fabricius, 1775	EN	B1ab(iii) +B2ab(iii)	MED
Tephritidae	*Myopites variofasciatus*	Becker, 1903	NT		MED
Tephritidae	*Myopites zernyi*	Hering, 1939	DD		EUM
Tephritidae	*Tephritis divisa*	Rondani, 1871	DD		EUM
Tephritidae	*Tephritis formosa*	Loew, 1844	DD		EUM
Tephritidae	*Tephritis nigricauda*	Loew, 1856	DD		EUM
Tephritidae	*Tephritis vespertina*	Loew, 1844	CE	B1ab(iii) +B2ab(iii)	MED

Family	Species	Author (s)	IUCN (Malta)	Criteria Malta	Chorological Category
Tephritidae	*Terellia serratulae*	Linnaeus, 1758	CE	B1ab(iii) +B2ab(iii)	MED
Tephritidae	*Plioreocepta poeciloptera*	Schrank, 1776	PE		MED
Tipulidae	*Nephrotoma appendiculata pertenua*	Oosterbroek, 1978	VU	B1ab(iii) +B2ab(iii)	MED
Tipulidae	*Nephrotoma cornicina*	Linnaeus, 1758	DD		MED
Tipulidae	*Tipula mediterranea*	Lackshevitz, 1930	EN	B1ab(iii) +B2ab(iii)	MED
Tipulidae	*Tipula oleracea*	Linnaeus, 1758	NT		MED
Trichoceridae	*Trichocera annulata*	Meigen, 1818	EN	B1ab(iii) +B2ab(iii)	MED
Trixoscelididae	*Trixoscelis approximata*	Loew, 1865	CE	B1ab(iii) +B2ab(iii)	MED
Trixoscelididae	*Trixoscelis flagellata*	Carles-Tolra and Ventura, 2001	CE	B1ab(iii) +B2ab(iii)	MED
Ulidiidae	*Ceroxys urticae*	Linnaeus, 1758	EN	B1ab(iii) +B2ab(iii)	MED
Ulidiidae	*Herina ghilianii*	Rondani, 1869	CE	B1ab(iii) +B2ab(iii)	MED
Ulidiidae	*Otites atripes*	Loew, 1858	NT		MED

4.3.1. Notes on Species in Diptera

Culicoides imicola **Kieffer, 1913**

It was found in four locations (San Ġwann, Mellieħa, Sannat, Għarb) and recorded to be in 'very low abundance' (Gatt, 2015a).

Culicoides jumineri **Callot and Kremer, 1969**

No material was given in Gatt (2015a).

Culicoides kingi **Austen, 1912**

Same as *Culicoides jumineri.*

Culicoides paolae **Boorman, 1996**

Very common and widely distributed species (Gatt, 2015a).

Culicoides univittatus **Vimmer, 1932**

It was collected in three locations from Fiddien, Rabat and Wied Għajn Riħana, and last collected in 1994. It was never found again (Gatt, 2015a).

Forcipomyia (Euprojoannisia) alacris **Winnertz, 1852**

It was found in less than ten locations, some of which (Mistra, Baħrija, Wied Inċita, Wied Għajn Riħana), are observed to have continual decline of quality of habitats (Gatt, 2015a).

Cheilotrichia cinerascens **Meigen, 1804**

It was found from Buskett in 1980 and Fiddien in 1992. Never found again (Ebejer, 2015b).

Dicranomyia chorea **Meigen, 1818**

It was found from Baħrija in !977, and Buskett last in 1994. Not recorded since (Ebejer, 2015b).

***Dicranomyia sericata* Meigen, 1830**

It was found from Qormi in 1977, and Wied Inċita in 1994. Not recorded since (Ebejer, 2015b).

***Ellipteroides lateralis* Macquart, 1835**

It was noted as being recorded in the Catalogue of Palaearctic Diptera and the World Catalogue of Craneflies in Ebejer (2015b) but no material examined.

***Erioconopa diuturnal* Walker, 1848**

It was found in six locations (Baħrija, Fiddien, Ġnejna, Rabat, Wied Qannotta, Wied ir-Ramla), all of which contain habitats that are observed to be of declining quality (Ebejer, 2015b).

***Erioptera fuscipennis* Meigen, 1818**

It was found from Baħrija in 1985 and Wied Inċita in 1987. Not recorded since (Ebejer, 2015b).

***Helius flavus* Walker, 1856**

It was found from Fiddien in 1992. Not recorded since (Ebejer, 2015b)/

***Limonia nubeculosa* Meigen, 1804**

It was found in six locations (Balzan, Għar il-Friefet, Buskett, Fawwara, Fiddien, Mġarr ix-Xini), all of which contain habitats of declining quality (Ebejer, 2015b).

***Molophilus obscurus* Meigen, 1818**

It was found in Baħrija in 1975 and never recorded again (Ebejer, 2015b).

***Symplecta hybrida* Meigen, 1804**

It was found from Fiddien, Wied il-Mistra, Wied Qannotta, and Ramla dunes, all of which contain habitats of declining quality (Ebejer, 2015b).

***Symplecta pilipes* Fabricius, 1787**

It was found in Balzan, Fiddien, Fomm ir-Riħ, Salina, Wied Qannotta and Wied ir-Ramla, all of which contain habitats which are observed to be of declining quality (Ebejer, 2015b).

***Symplecta stictica* Meigen, 1818**

It was found in Mgiebaħ in 1996, Salina in 1977, and Ramla, Gozo in 1992 and never recorded again. All of them contain habitats which are observed to be of declining quality (Ebejer, 2015b).

***Sergentomyia minuta* Rondani ,1843**

It is a widely distributed Mediterranean species that is found in over 10 locations on the Maltese Islands, and is found in threatened habitats (Gatt, Williams and Mifsud, 2009).

***Phlebotomus (Larroussius) perniciosus* Newstead, 1911**

It is a widely distributed Mediterranean species that is found in over ten locations on the Maltese Islands and is found in threatened habitats (Gatt, Williams and Mifsud, 2009).

***Simulium (Eusimulium) velutinum* Santos Abreu, 1922**

It was found in four locations (Buskett, Ġnejna, Wardija, Ramla), all of which contain habitats which are of declining quality (Gatt, 2015b).

***Myopites stylatus* Fabricius, 1775**

It was found in Buskett and Rabat, both of which contain habitats which are observed to be of declining quality (Ebejer, 2015a).

***Myopites variofasciatus* Becker, 1903**

It was found in over ten locations and is widely distributed on the Maltese Islands, but it is also found in some threatened habitats such as sand dunes in Ġnejna and Għadira , and salt marshes in Marsaxlokk, which could make it vulnerable in the future (Ebejer, 2015a).

***Myopites zernyi* Hering, 1939**

No material was given in Ebejer (2015a) but mentioned a specimen was recorded by Schembri et al. (1991). No record since.

***Tephritis divisa* Rondani, 1871**

A new record by Ebejer (2015a). No record since.

***Tephritis formosa* Loew, 1844**

One record from Baħrija in 1992 mentioned in Ebejer (2015a). No record since.

***Tephritis nigricauda* Loew, 1856**

One record from Mtaħleb in 1999 mentioned in Ebejer (2015a). No record since.

***Tephritis vespertine* Loew, 1844**

It was found once from Buskett in 1994 and never recorded again (Ebejer, 2015a).

***Terellia serratulae* Linnaeus, 1758**

It was found once from Ramla, Gozo in 1992 and never found again (Ebejer, 2015a).

***Plioreocepta poeciloptera* Schrank, 1776**

It was recorded by Zetterstedt in 1849 and never recorded again (Ebejer, 2015a).

***Nephrotoma appendiculata pertenua* Oosterbroek, 1978**

It was found in seven locations (Balzan, Marfa Ridge, Qormi, Rabat, Wied Inċita, Wied is-Sewda, Comino). Last recorded from Comino in 2002. All contain habitats of declining quality (Ebejer, 2015b).

***Nephrotoma cornicina* Linnaeus, 1758**

It has not been found since 1992, but presence is still possible according to Ebejer (2015b).

***Tipula mediterranea* Lackshevitz, 1930**

It was found in Baħrija in 1994 and Ġnejna in 1996. No record since (Ebejer, 2015b).

***Tipula oleracea* Linnaeus, 1758**

It was found in 11 locations, five of which are Ġnejna, Ramla, Salina, Wied Inċita, Mistra, which contain threatened habitats (Ebejer, 2015b).

***Trichocera annulata* Meigen, 1818**

It was found in four locations (Balzan, Buskett, Wied Inċita, Wied Qannotta), which all contain habitats of declining quality (Ebejer, 2015b).

***Trixoscelis approximata* Loew, 1865**

It was found once in Verdala Palace in 2014. A new record in Woznica (2015). Not recorded again.

***Trixoscelis flagellata* Carles-Tolra and Ventura, 2001**

Same as *T. approximata.*

***Ceroxys urticae* Linnaeus, 1758**

It was found in Salina last in 1994 and Wied Għajn Riħana in 1989. No record since (Ebejer, 2015a).

***Herina ghilianii* Rondani, 1869**

It was found in Fiddien in 1978, Mtaħleb in 1991 and Wied Għajn Riħana in 1977. Not recorded since (Ebejer, 2015a).

***Otites atripes* Loew, 1858**

It was found in more than ten locations in the Maltese Islands. It was found in many threatened habitats and may become threatened in the near future (Ebejer, 2015a).

4.4. Lepidoptera

Table 4.23 Lepidoptera IUCN Classifications

Family	Species	Author (s)	IUCN (Malta)	Criteria Malta	Chorological Category
Autostichidae	*Oecogonia delluccai*	Amsel, 1952	CE	B1ab(iii) +B2ab(iii)	MAL
Gelechiidae	*Epidola melitensis*	Amsel, 1955	PE		MAL
Gelechiidae	*Megacraspedus lativalvellus*	Amsel, 1954	PE		MAL
Lycaenidae	*Lycaena phlaeas*	Linnaeus, 1761	EN	B1ab(iii)(iv) + B2ab(iii)(iv)	MED
Lycaenidae	*Aricia agestis*	Denis and Schiffermuller, 1775	CE	B1ab(iii)(iv) + B2ab(iii)(iv)	EUR
Noctuidae	*Brithys encausta*	Fabricius, 1792	DD		MED
Noctuidae	*Mythimna putrescens vallettai*	Boursin, 1952	PE		MAL
Noctuidae	*Blepharita vallettai*	de Laever, 1980	PE		MAL
Noctuidae	*Polymixis canescens*	Boisduval, 1827	DD		MED
Noctuidae	*Catocala elocata*	Esper, 1787	DD		PAL
Noctuidae	*Catocala conjuncta*	Esper, 1787	DD		EUM
Noctuidae	*Catocala nymphagoga*	Esper, 1787	DD		EUM
Noctuidae	*Ephesia nymphaea*	Esper, 1787	DD		EUM
Noctuidae	*Grammodes bifasciata*	Petagna, 1787	DD		MED

Family	Species	Author (s)	IUCN (Malta)	Criteria Malta	Chorological Category
Noctuidae	*Phragmatobia fuliginosa melitensis*	Bang-Haas, 1927	DD		MAL
Nymphalidae	*Coenonympha pamphilus*	Linnaeus, 1758	VU	B1ab(iii) +B2ab(iii)	EUR
Pieridae	*Gonepteryx cleopatra ab. Vallettai*	Howarth, 1977	DD		MAL
Psychidae	*Sciopetris melitensis*	Rebel, 1919	CE	B1ab(iii) +B2ab(iii)	MAL
Pterolonchidae	*Pterolonche vallettae*	Amsel, 1955	PE		MAL
Pterophoridae	*Agdistis symmetrica*	Amsel, 1955	PE		MAL
Pterophoridae	*Agdistis melitensis*	Amsel, 1954	PE		MAL
Pyralidae	*Phycitodes saxicola vallettae*	Amsel, 1951	CE	B1ab(iii) +B2ab(iii)	MAL
Satyridae	*Hipparchia aristaeus algirica vallettai*	Delattin, 1952	PE		MAL
Satyridae	*Maniola jurtina hyperhispulla*	Thompson, 1973	VU	B1ab(iii) +B2ab(iii)	MAL
Symmocidae	*Symmoca melitensis*	Amsel, 1952	PE		MAL
Tineidae	*Antitinea deluccae*	Amsel, 1955	PE		MAL
Torticidae	*Aphelia peramplana vallettai*	Bradley, 1953	EN	B1ab(iii) +B2ab(iii)	MAL
Torticidae	*Cydia sammuti*	Diakonoff, 1986	CE	B1ab(iii) +B2ab(iii)	MAL

4.4.1. Notes on Species in Lepidoptera

***Oecogonia delluccai* Amsel, 1952**

Sammut and Valletta (1989) classified it as 'Possibly Very Rare'. It had been recently collected at the time from Mtaħleb in 1982, when its known locality was only Salina Bay, which was developed. Classified as CE at European and Global level.

***Epidola melitensis* Amsel, 1955**

Sammut and Valletta (1989) classified it as 'Possibly Extinct'. It was recorded from Ġnejna in 1952 and Wied il-Lunzjata in Gozo in 1973, but no record since. Classified as PE at European and Global level.

***Megacraspedus lativalvellus* Amsel, 1954**

Sammut and Valletta (1989) classified it as 'Possibly Extinct', as it was recorded by De Lucca in 1952 in Salina. No record since. Classified as PE at European and Global level.

***Lycaena phlaeas* Linnaeus, 1761**

Sammut and Valletta (1989) classified it as 'Vulnerable'. It was found in two locations, last recorded in Ħaż-Żebbuġ in 2004. Seguna (2005) noted that this species was reestablishing itself in the Maltese Islands.

***Aricia agestis* Denis and Schiffermuller, 1775**

Sammut and Valletta (1989) classified it as 'Vulnerable'. It was last recorded from Ħaż-Żebbuġ in 2005. It was noted as previously quite common but becoming very rare (Seguna, 2005). Classified as LC at European level.

***Brithys encausta* Fabricius, 1792**

Doubtful taxonomic status (Seguna, 2005).

***Leucania putrescens vallettai* Boursin, 1952**

It was described as 'Rare' by Sammut and Valletta (1989) as *Mythimna putrescens vallettai.* It was renamed as *Leucania putrescens vallettai* by Seguna (2005). No record since.

***Blepharita vallettai* de Laever, 1980**

It was described as widely distributed by Sammut and Valletta (1989). There have been a few records on GBIF from 1970s, in Mġarr, Gozo and Għajnsielem, Gozo. Synonymous with *Mniotype deluccai.*

***Polymixis canescens* Boisduval, 1827**

It was described as 'Data Deficient' by Sammut and Valletta (1989). Its type locality has been built over, but at the time there were leftover colonies, but no mention of locations. No records since (Seguna, 2005).

***Catocala elocata* Esper, 1787**

Sammut and Valletta (1989) noted that it is restricted to Wied il-Luq in Buskett. It was mentioned that small colonies might exist where white poplar grows. There have been no records since.

***Catocala conjuncta* Esper, 1787**

Same as *Catocala elocata.*

***Catocala nymphagoga* Esper, 1787**

Same as *Catocala elocata.*

***Ephesia nymphaea* Esper, 1787**

Same as *Catocala elocata.*

***Grammodes bifasciata* Petagna, 1787**

Sammut and Valletta (1989) noted that it is restricted to Wied tal-Baħrija and described it as 'Very Rare'. No record since.

***Phragmatobia fuliginosa melitensis* Bang-Haas, 1927**

It was described as very common and widely distributed (Sammut and Valletta, 1989). No records since.

***Coenonympha pamphilus* Linnaeus, 1758**

It was found in seven locations, which were collected using GBIF records. Sammut and Valletta (1989) noted that it was on the decline since it is dependent on wild thyme that is threatened due to development. Classified as LC at European level.

***Gonepteryx cleopatra* ab. *vallettai* Howarth, 1977**

Only two specimens were recorded in Buskett in Sammut and Valletta (1989). No record since. Classified as DD at European and Global level.

***Sciopetris melitensis* Rebel, 1919**

Sammut and Valletta (1989) labelled this as 'Possibly Extinct', as it was not found again since Amsel redescribed it in 1953. However, it was rediscovered by Hättenschwiler et al. (2007) in Ħal Għargħur and fully described (as cited in Zerafa, Sammut, and Hättenschwiler, 2008). Classified as CE at European and Global level.

Pterolonche vallettae Amsel, 1955

Sammut and Valletta (1989) labelled this as ‘Possibly Very Rare’. It was recorded from Mistra and Lippija in 1953 by Anthony Valletta, and not recorded since. Valletta (1973) noted that it could still occur at Lippija, but this statement was made over 40 years ago. Classified as PE at European and Global level.

Agdistis symmetrica Amsel, 1955

Sammut and Valletta (1989) recorded this as ‘Data Deficient’, since it was last recorded in 1953 from Baħar iċ-Ċagħaq. No record since. Classified as PE at European and Global level.

Agdistis melitensis Amsel, 1954

Sammut and Valletta (1989) recorded it as ‘Very Rare’. The last record was from Rabat in 1982, when previously it was recorded in 1952 and 1953 in Salina Bay. It is noted that its type locality was developed. No record since. Classified as PE at European and Global level.

Phycitodes saxicola vallettae Amsel, 1951

Sammut and Valletta (1989) recorded it as ‘Very Rare’. At the time, it was recorded in Mtaħleb in small numbers, when it was thought to be extinct from its type locality in Mistra, which has been developed. No records since. Classified as CE at European and Global level.

Hipparchia aristaeus algirica vallettai Delattin, 1952

Sammut and Valletta (1989) recorded it as ‘Possibly Extinct’. There have been no records since its last collection from Naxxar in 1939. Classified as PE at European and Global level.

Maniola jurtina hyperhispulla Thomspon, 1973

Sammut and Valletta (1989) did not provide a classification, as it was described as very common and widely distributed. It has become very rare and localised recently, however, many observations of the species were available on the Facebook group 'Maltese Entomology and Wildlife'. Classified as VU at European and Global level.

Symmoca melitensis Amsel, 1952

Sammut and Valletta (1989) recorded it as 'Possibly Extinct'. It was last recorded in 1955 by Amsel. No records since. Classified as PE at European and Global level.

Antitinea deluccae Amsel, 1955

Sammut and Valletta (1989) recorded it as 'Possibly Extinct'. It was recorded once from Xlendi in 1953 and never recorded again. The locality has now been developed. Classified as PE at European and Global level.

Aphelia peramplana vallettai Bradely, 1953

No classification by Sammut and Valletta (1989) and recorded as *Aphelia amplana vallettai.* It is noted that most places where it was found have been developed, though records are still available. It was mentioned to occur in Wied Inċita. Wied il-Għasel, and Għar Lapsi. Classified as EN at European and Global level.

Cydia sammuti Diakonoff, 1986

Sammut and Valletta (1989) recorded this as 'Data Deficient', since it was recently described at the time from Buskett in 1981. No record since. Classified as CE at European and Global level.

4.5. Analysis

4.5.1. Extinction Risk

381 species of insects were analysed in this work, with around 99% of them evaluated for their conservation status for Malta, excluding all NA taxa (0.3% - see Figure 4.1). The NA slice describes species which have not been analysed due to not being eligible for assessment within a specific area, such as vagrants, non-native species, or domesticated populations. The overall percentage of species evaluated in each order is shown in Figure 5, with the majority of species evaluated belonging to the order Coleoptera (82%).

The pie chart with the percentages of species in each IUCN category for Malta as a regional level is shown in Figure 4.1. This includes both endemic and non-endemic species. On the whole, the majority of species were classified as EN (27.3% - 104 species), along with CE (15.5% - 59 species) and VU (13.9% - 53 species) being the categories that follow. The LC and NT categories make up about 11% of the species assessed – with LC equalling to 24 species, and NT equalling to 21 species. Moreover, 13.6% of the species were classified as PE, comprising of 52 species, though it is possible that there could be more species in this category, especially in the DD category, which comprise of 67 species and make up 17.6%.

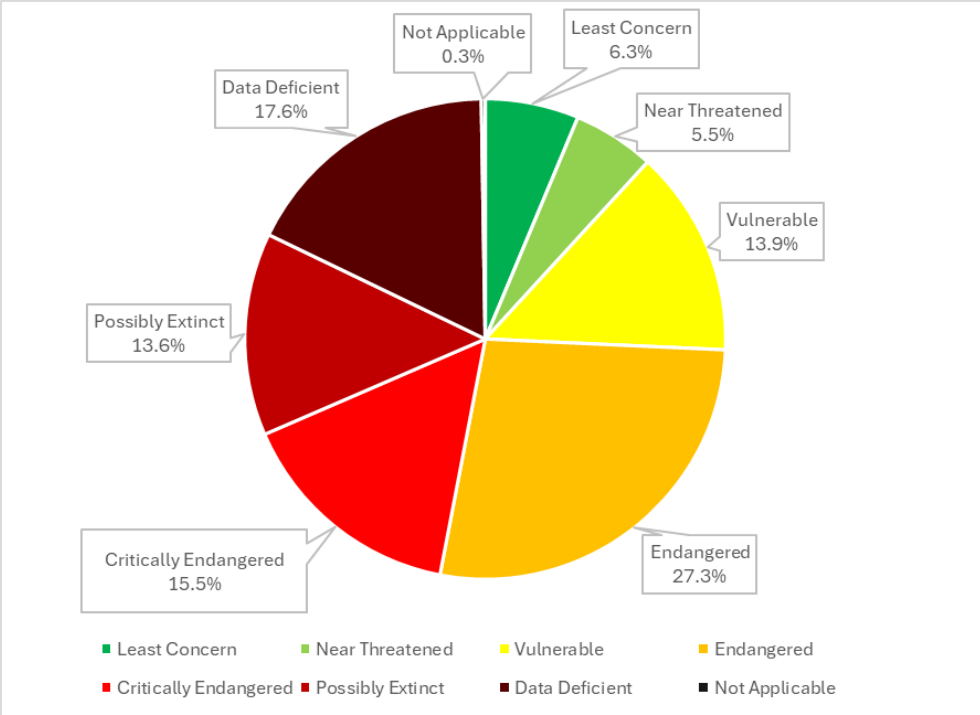

Figure 4.1 IUCN categories (Malta) for all species listed in the present study. The majority make up the EN category.

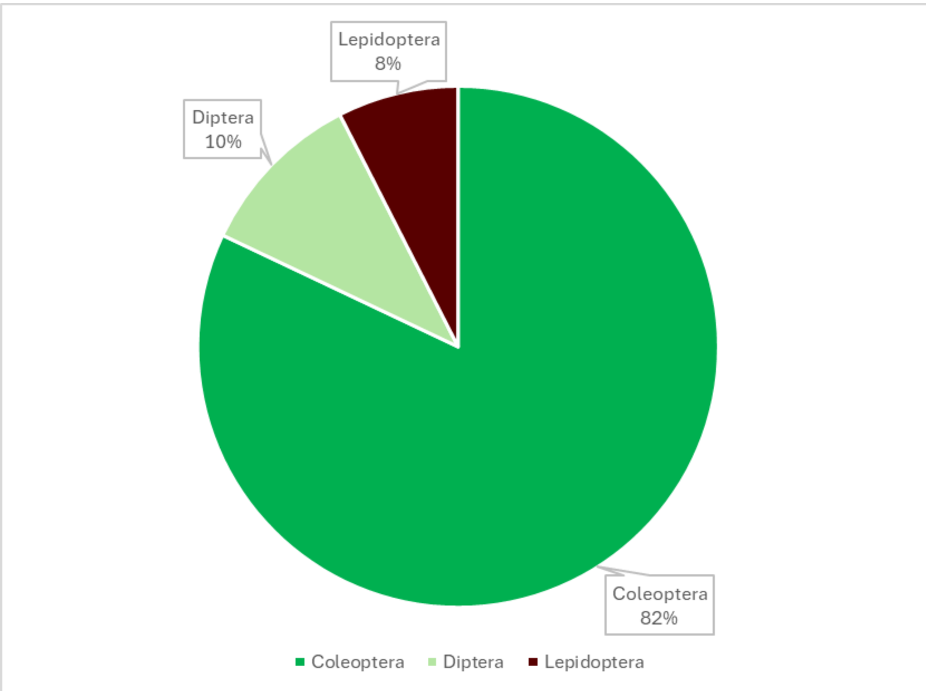

Figure 4.2 The percentage of species evaluated from each order (Coleoptera, Diptera and Lepidoptera). Coleoptera made up the largest majority of the species evaluated.

Pie charts showing the distribution of IUCN classifications within the three orders at National Level (Malta) were also plotted. These are displayed in Figures 4.3, 4.4, and 4.5. The IUCN Classifications for Coleoptera were distributed as follows (see Figure 4.3): LC (23 species – 7.3%), NT (16 species – 5.1%), VU (46 species – 14.7%), EN (89 species – 28.4%), CE (48 species – 15.3%), PE (41 species – 13.1%), DD (49 species – 15.7%) and NA (one species – 0.3%). The categories EN, DD, and VU represented the categories which were the most populated.

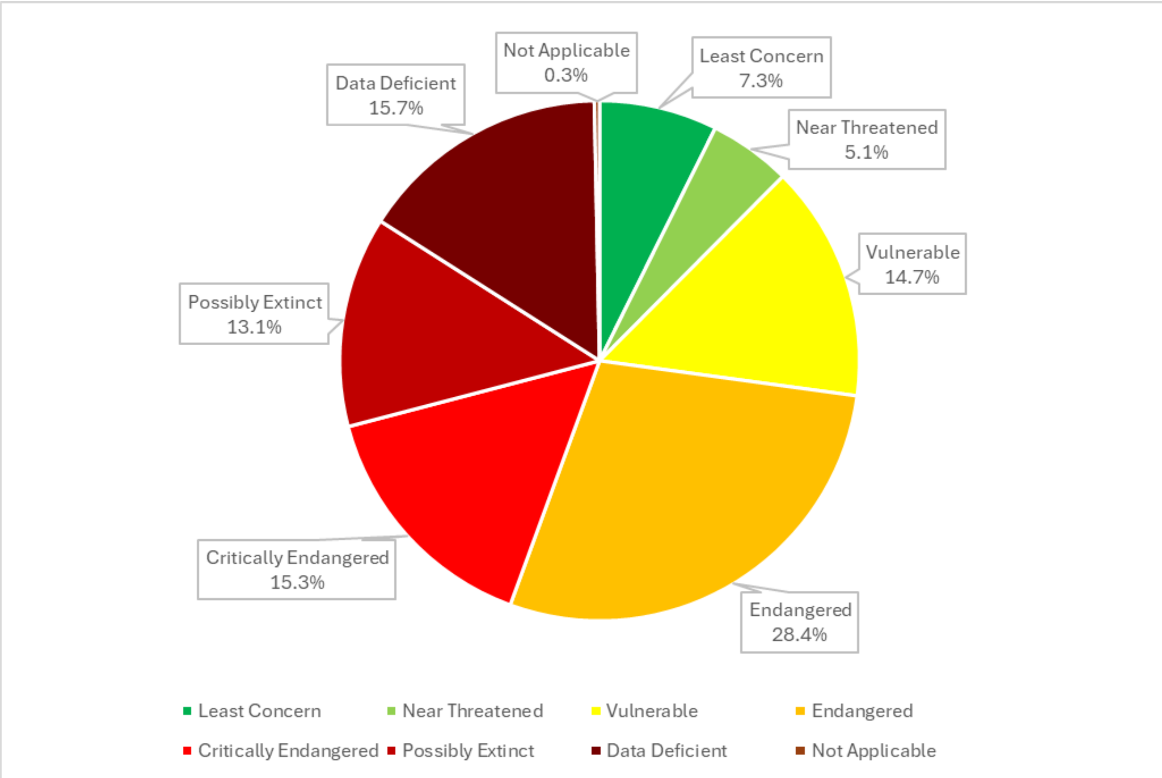

Figure 4.3 Distribution of Coleoptera IUCN Classifications at National Level (Malta). The majority of species were classified as EN (28.4%), followed by CE (15.3%) and VU (14.7%).

In Diptera, the categories were distributed as follows (see Figure 4.4): LC (one species – 2%), NT (five species – 12%), VU (five species – 13%), EN (13 species – 33%), CE (six species – 15%), PE (two species – 5%), DD (eight species – 20%). There were no species which were categorised in NA. Therefore, the three categories which were most populated were EN, DD, and NT.

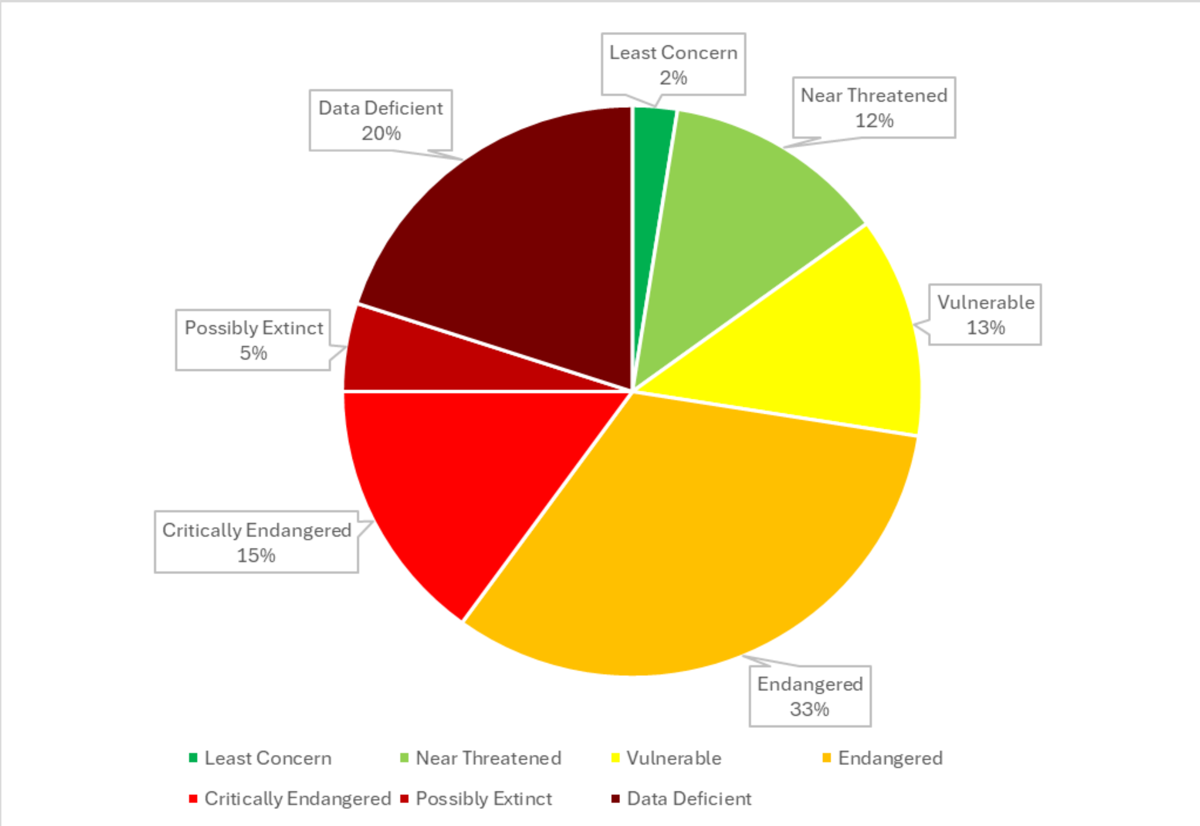

Figure 4.4 Distribution of Diptera IUCN Classifications at National Level (Malta). The majority of the species were classified as EN (33%), followed by CE (15%), and VU (13%).

In Lepidoptera, the categories were distributed as follows (see Figure 4.5): VU (two species – 7%), EN (two species -7 %), CE (five species – 18%), PE (nine species – 32%), and DD (ten species – 36%). There were no species which were categorised in LC, NT, and NA. Therefore, the three most populated categories were DD, PE, and CE for the Lepidoptera assessed.

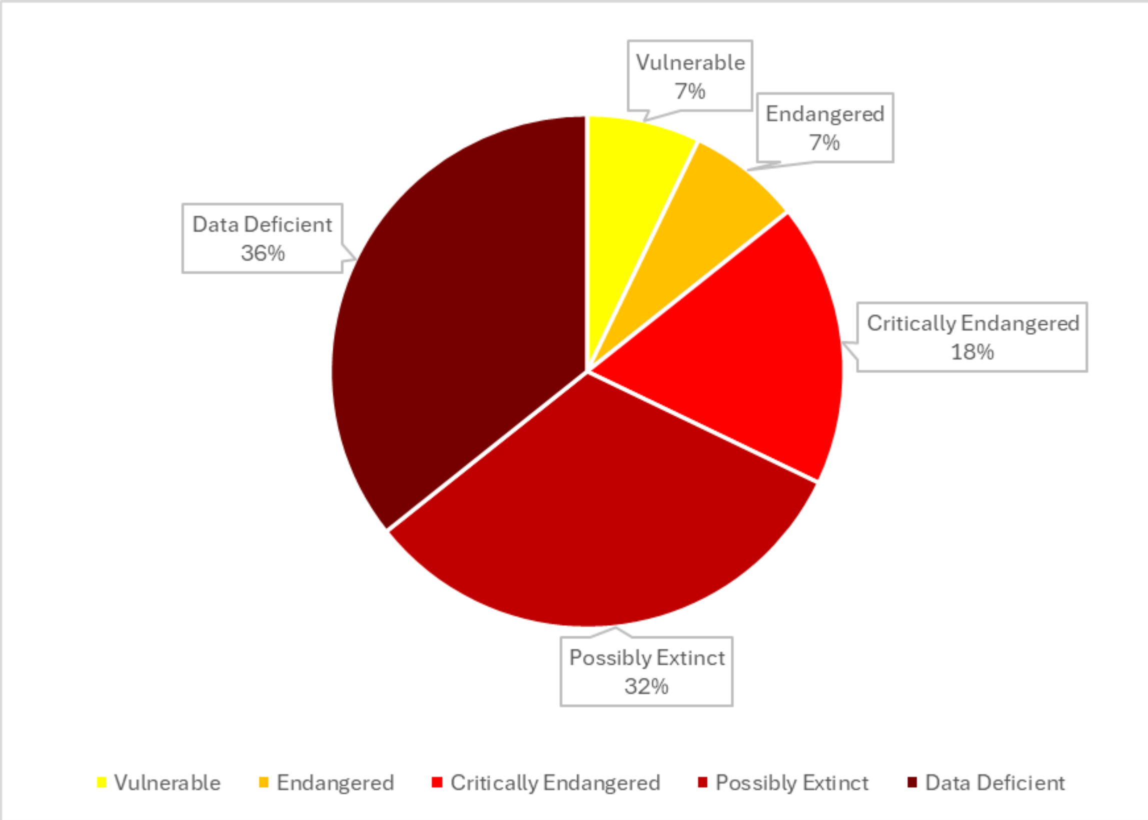

Figure 4.5 Distribution of Lepidoptera IUCN Classifications at National Level (Malta). The majority were classified as DD (36%), followed by PE (32%), and CE (18%).

A Chi-square test was conducted to investigate the relationship between order and IUCN conservation status, and it was found that there was a significant difference between in conservation status among orders ($\chi^2 = 29.872$, df = 14, p <0.008, for deviation from a uniform distribution). However, another Chi-square test was conducted to investigated the relationship between family and IUCN conservation status. Superfamilies such as Scarabaeoidea and Curculionoidea were partitioned into families. IUCN conservation status also varied significantly among families ($\chi^2 = 408.99$, df = 282, p <0.0001, for deviation from a uniform distribution). Contingency tables may be found in the Appendix (see Tables 7.1 – 7.8).

4.5.2. Endemic, Subendemic, Mediterranean, and Palaearctic IUCN Categories

The species were divided according to their chorological category, and pie charts were created to visualise their distribution. A total of 44 endemic species were evaluated across the different taxonomic groups. Figure 4.6 shows that the majority of the species fall within a threatened category (VU, EN, CE), comprising 58% of the endemic species evaluated. The IUCN categories (Malta, Europe, Global) with the most endemic species were found to be CE (27% - 12 species), and PE (23% - ten species). The following categories with the most species were VU (18% - eight species) and EN (14% - six species). Five species were classified as DD (11%), while no species were classified as NA. The LC category contains two species (5%), while the NT category contains only one species (2%).

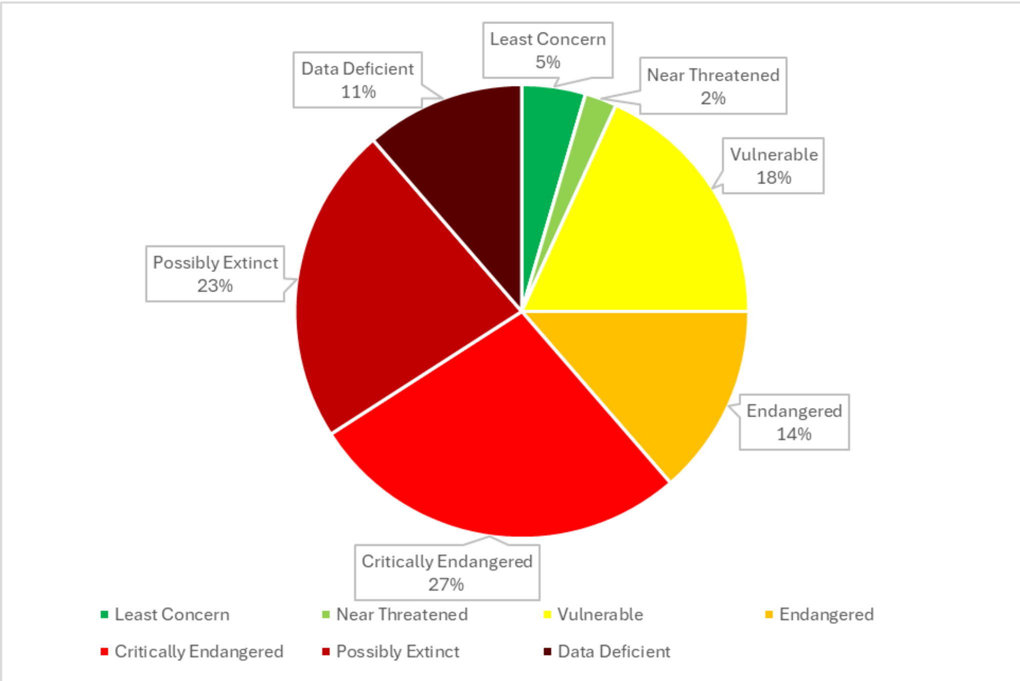

Figure 4.6 All the IUCN category distributions for national (Malta), regional (Europe), and Global levels for endemic species of the Maltese Islands. The majority of the endemic species fall within a threatened category (VU, EN, CE).

Figure 4.7 presents the IUCN categories for all non-endemic species at National level. A total of 337 species were evaluated. The distribution of species within each category is as follows: LC (22 species – 6.5%), NT (20 species – 5.9%), VU (45 species – 13.4 %), EN (98 species 29.1 %), CE (47 species -13.9%), PE (42 species – 12.5%), DD (62 species – 18.4 %) and NA (one species -0.3%).

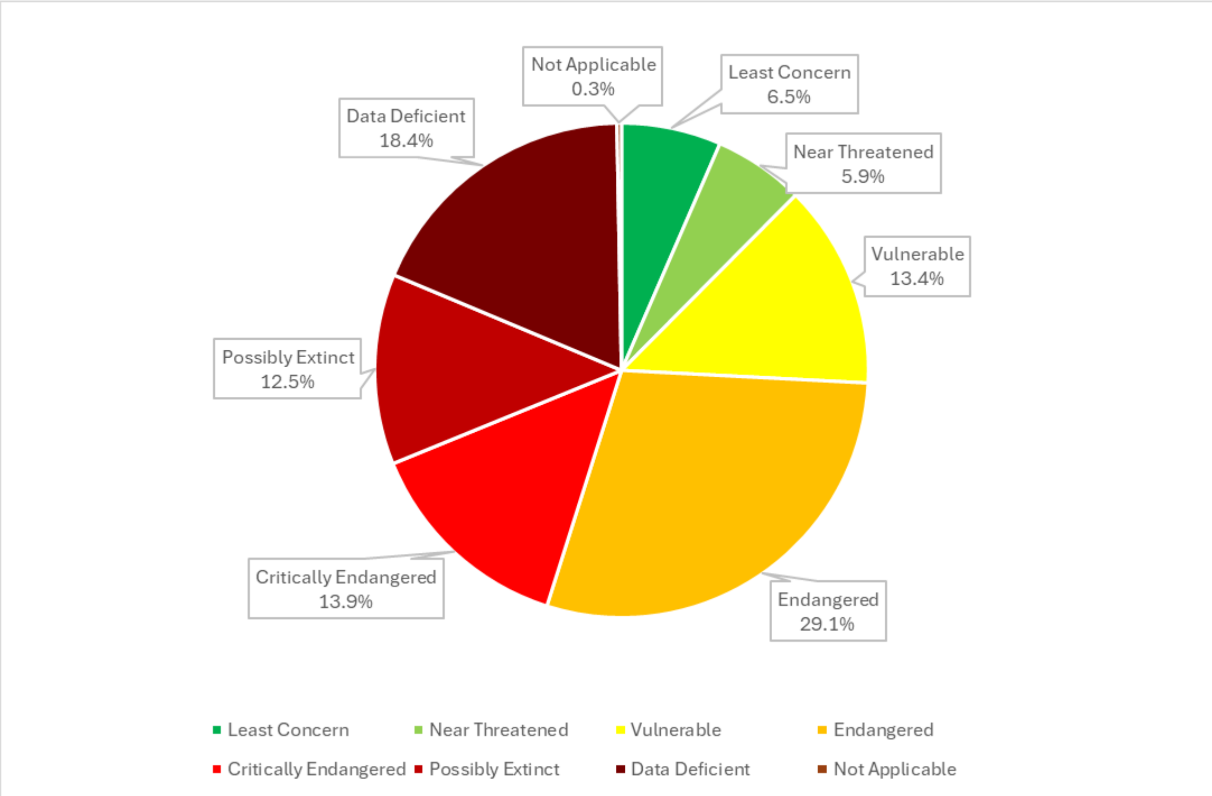

Figure 4.7 IUCN categories for all non-endemic species at National Level (Malta). The majority were classified as EN (29.1%), followed by CE (13.9%) and VU (13.4%).

Figure 4.8 presents the IUCN categories for the subendemic species at National Level (Malta). A total of 20 subendemic species were evaluated, consisting of species that are also present in Sicily, North Africa, and Italy. The distribution of species according to their IUCN categories is as follows: LC (three species – 15%), NT (one species – 5%), VU (four species – 20%), EN (four species – 20%), CE (four species – 20%), and PE (four species – 20%).

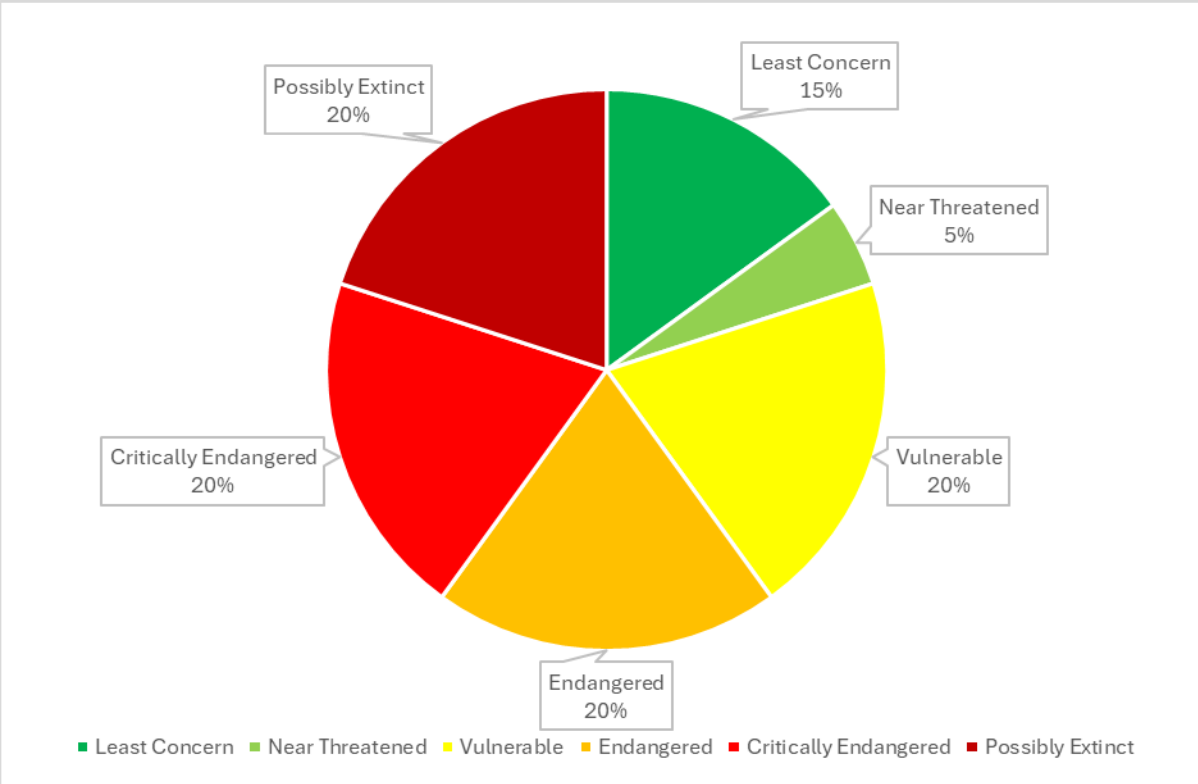

Figure 4.8 IUCN categories for subendemic species at National Level (Malta).

Figure 4.9 presents the IUCN categories with a Mediterranean distribution at National Level (Malta). A total of 261 species were evaluated, and this consists of species with Mediterranean, Afrotropical-Mediterranean, European-Mediterranean, Turanic-European-Mediterranean, Central-Asiatic-Mediterranean, Mediterranean-Causasus, Mediterranean-Iranian, Central-Asiatic-European Mediterranean, and Atlanto-Mediterranean. The distribution of species according to their IUCN categories is as follows: LC (15 species – 5.7%), NT (17 species –

6.5%), VU (35 species – 13.4%), EN (83 species – 31.8%), CE (37 species – 14.2%), PE (29 species – 11.1%), DD (44 species – 16.9%) , and NA (one species – 0.4%).

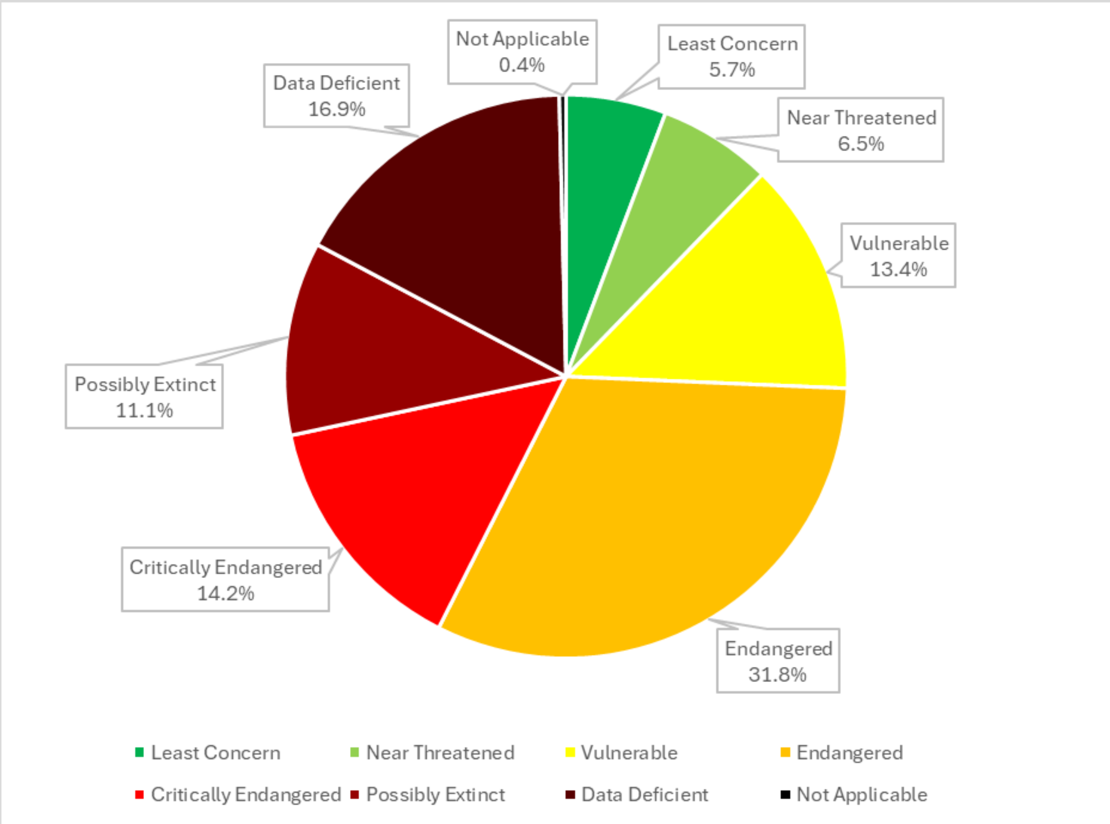

Figure 4.9 IUCN categories for species with Mediterranean distribution at the National Level (Malta). The majority of species were classified as EN (31.8%), followed by CE (14.2%) and VU (13.4%).

Figure 4.10 presents the IUCN category distribution for Palaearctic species at the National level (Malta). A total of 28 species were assessed. The distribution of the species within each category is as follows: LC (three species – 11%), NT (one species – 3%), VU (five species – 18%), EN (five species – 18%), CE (three species – 11 %), PE (four species – 14%), and DD (seven species – 25%). There were no species which were categorised within NA. Overall, the most populated categories were DD, EN, and PE.

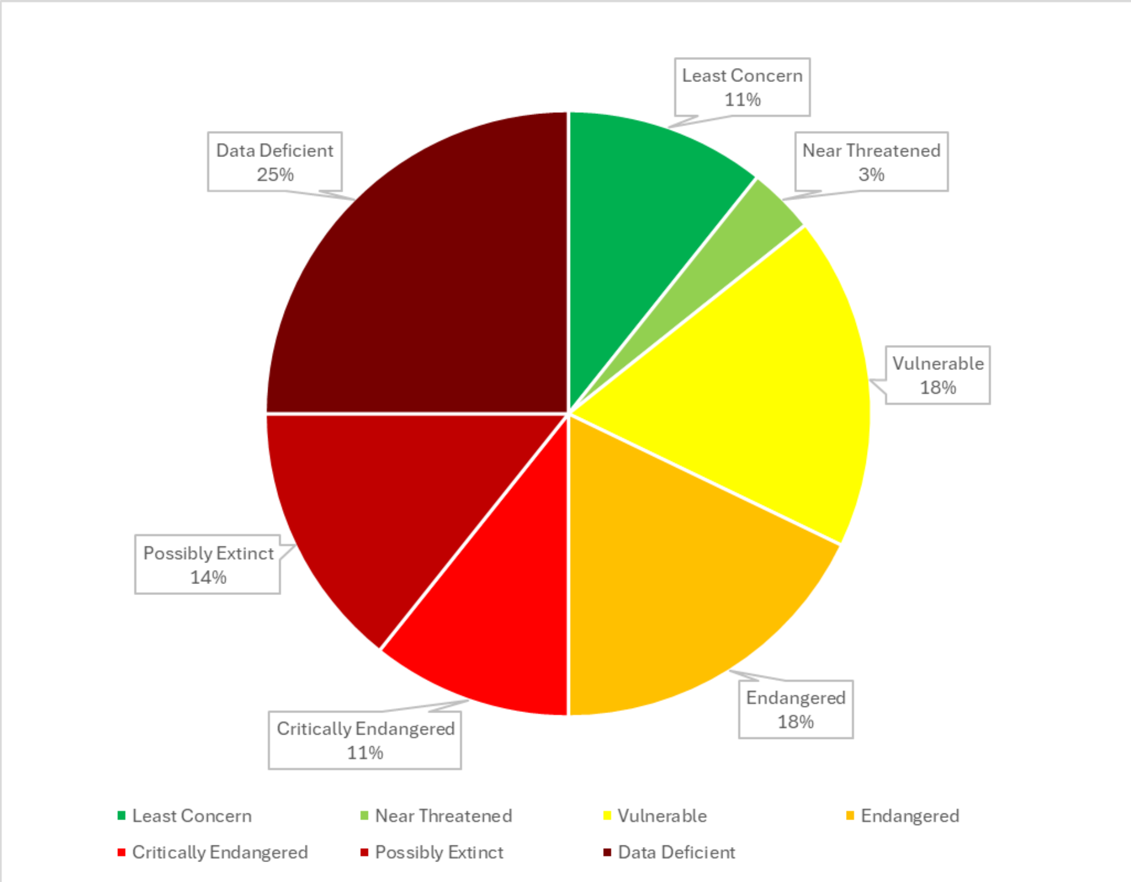

Figure 4.10 IUCN categories for species with Palaearctic distribution at the National Level (Malta). The majority were classified as DD (25%), followed by EN (18%) and VU (18%).

A Chi-square test was applied to investigate any relationships between Distribution type (endemic vs non-endemic) and the IUCN categories, and it was revealed that there were no significant associations (χ^2 = 13.936, df = 7, p = 0.052337, for deviation from a uniform distribution). Contingency tables may be found in the Appendix (see Tables 7.9 -7.10).

4.5.3. European Level and Global Level

The IUCN categories at European and Global level were found from the IUCN Red List website and listed in Tables 4.1 – 4.23, alongside the endemic species which were classified at a European and global level within the present study. Contrary to the IUCN (Malta) categories, both the IUCN (Europe) and the IUCN (Global) categories contained a majority of NE species – 313 species at European level and 328 species at Global level. These were omitted from the pie charts in Figures 4.11 and 4.12 to present a clearer picture of the evaluated species within each regional level, as they accounted for over 90% of the species assessed. This reflects how little species - present on the Maltese Islands and beyond - have been evaluated by the IUCN and listed in the IUCN Red List. The total species that were evaluated at European and Global level were 68 and 53 respectively.

At European Level, the distribution of the IUCN categories is as follows: LC (27 species – 40%), NT (three species – 4%), VU (ten species – 15%), EN (seven species – 10%), CE (12 species – 18 %), PE (eight species – 12%), and NA (one species – 1%) (see Figure 4.11).

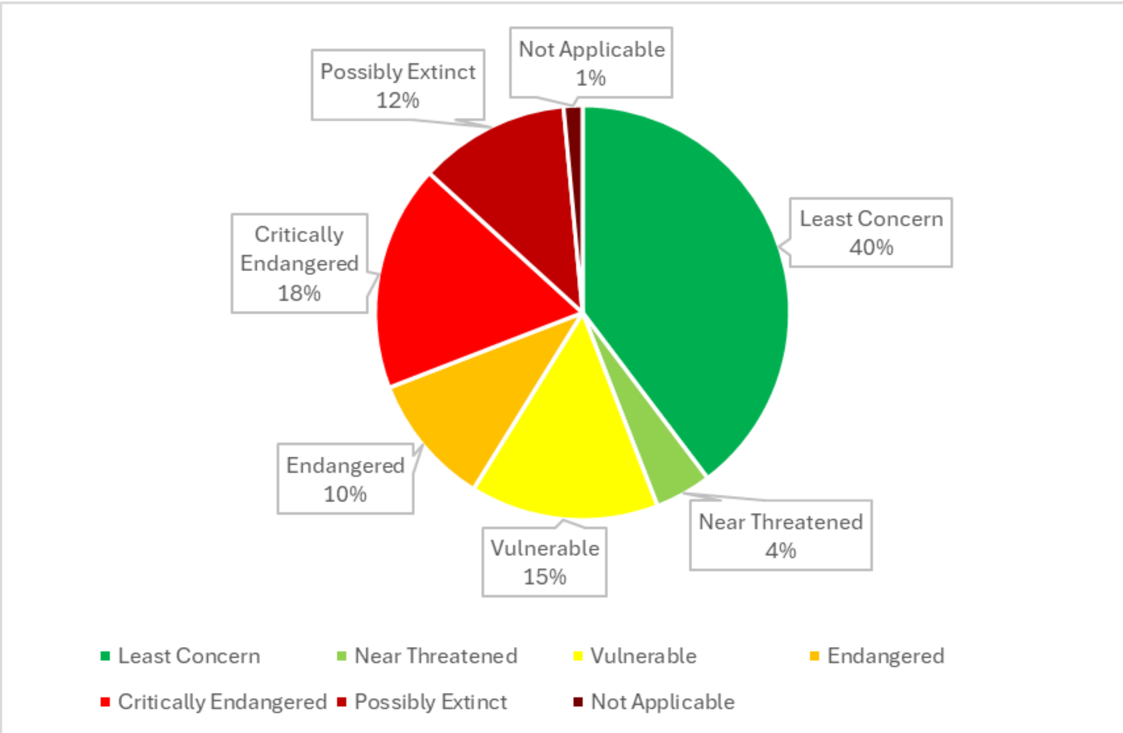

Figure 4.11 IUCN categories for all evaluated species, excluding NE species at European level. The majority were classified as LC (40%), followed by CE (18%) and VU (15%).

At Global level, the distribution of the IUCN categories is as follows: LC (14 species – 26%), NT (one species – 2%), VU (11 species – 21%), EN (six species – 11%), CE (12 species – 23%), PE (eight species – 15%), and NA (one species – 2%) (see Figure 4.12).

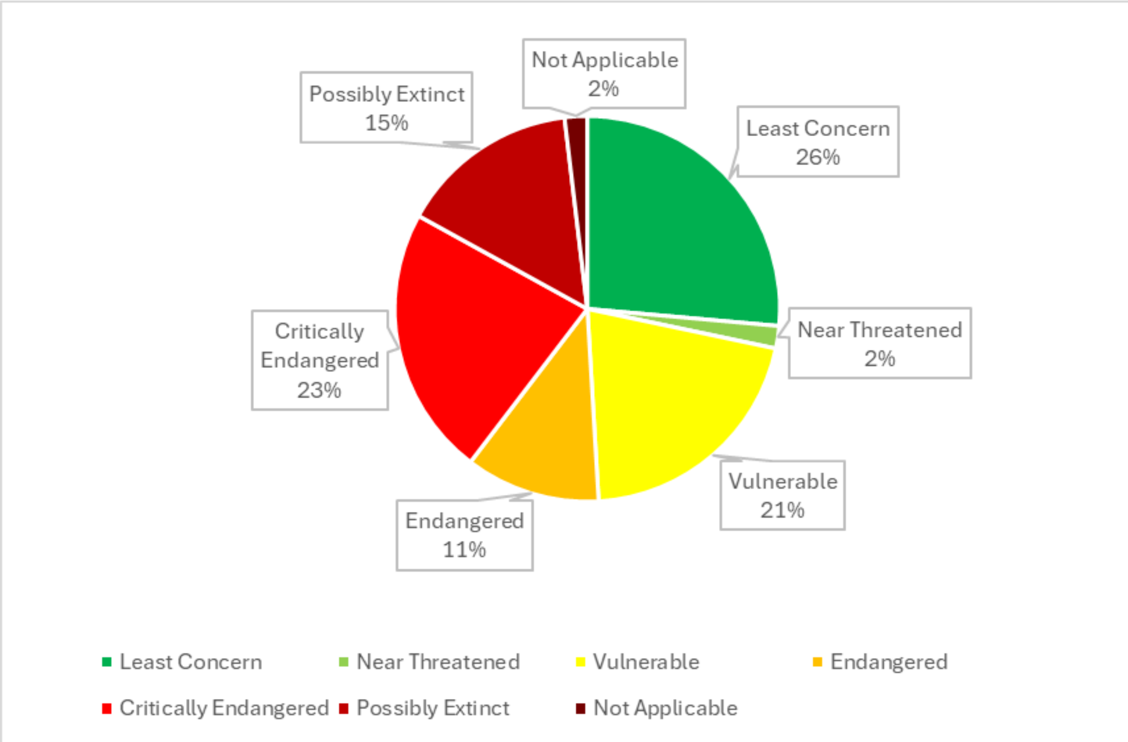

Figure 4.12 IUCN categories for all evaluated species, excluding NE species at Global level. The majority were classified as LC (26%), followed by CE (23%), and VU (21%).

In both Figures 4.11 and 4.12, the majority of evaluated species are of the LC category, with 40% or 27 species at European level, and 27% or 14 species at Global level. Moreover, more species are within the PE, CE and EN categories at a Global level than at a European level. Both regional levels have NT as their least populated category, with 5% or three species at European level, and 2% or one species at Global level. The endemic species represented all of the CE species at European and Global levels, and all of the NT species at the Global level.

When comparing the IUCN categories between all regional levels assessed (Malta, European, Global), there were some differences that could be taken note of. There were many instances where the IUCN category for Malta differed greatly from the IUCN categories at European and Global levels. For example, *Aricia agestis* was classified as CE for Malta, but at European and Global level it is classified as LC. Another example is *Scarabaeus semipunctatus* which was classified as PE, while at European and Global levels it is classified as VU. In contrast, none of the species classified as LC for Malta were classified in a threatened category at European and Global levels.

A Chi-square test was applied to investigate any relationships between regional level (Malta, Europe, and Global) and the IUCN categories, and it was revealed that there were significant associations ($\chi 2 = 797.3$, $df = 16$, $p < 0.001$, for deviation from a uniform distribution). A contingency table may be found in the Appendix (see Tables 7.11 – 7.12).

4.5.4. The Change in Status of Species in Schembri and Sultana (1989)

Pie charts were also created for the status of selected species from the Red Data Book for the Maltese Islands as they were previously, and as they have changed through their evaluation in the present study. The NE slice in Figure 4.13 represents species which in Schembri and Sultana (1989) were mentioned, but did not have a classification, often only having the description 'endemic' or 'restricted to the Mediterranean'. The rest of the categories (Vulnerable, Rare, Very Rare and Data Deficient) are as described in the Red Data Book. Species which were described as 'Possibly Rare' or 'Possibly Very Rare' were added to 'Rare' and 'Very Rare' respectively.

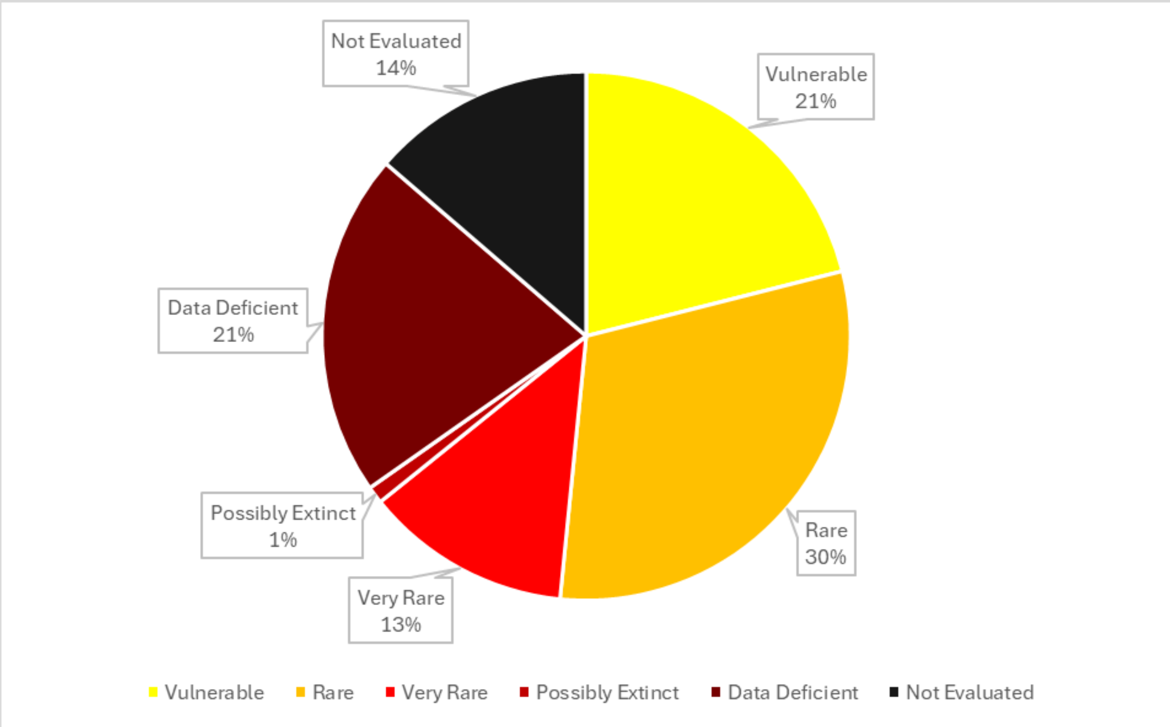

Figure 4.13 The previous conservation categories recorded in Schembri and Sultana (1989) for the selected groups. The majority were classified as Rare (30%), followed by Data Deficient (21%), and Vulnerable (21%).

On the other hand, Figure 4.14 shows how the species were classified in the present study. The distribution of the IUCN categories is as follows: LC (three species – 3%), NT (four species – 4%), VU (17 species -18%), EN (23 species – 24%), CE (13 species – 13%), PE (ten species – 11%), DD (25 species – 26%), and NA (one species – 1 %). Overall, five species can be considered as not threatened anymore from Schembri and Sultana (1989), which includes *Onthophagus taurus* (Table 4.19 Scarabaeoidea), *Stenosis melitana* (Table 4.21 Tenebrionidae), *Allophylax picipes melitensis* (Table 4.21 Tenebrionidae), *Otiorhynchus* *moriger* (Table 4.5 Curculionoidea) and *Stenus (Tesbus) brunnipes maximus* (Table 4.20 Staphylinidae).

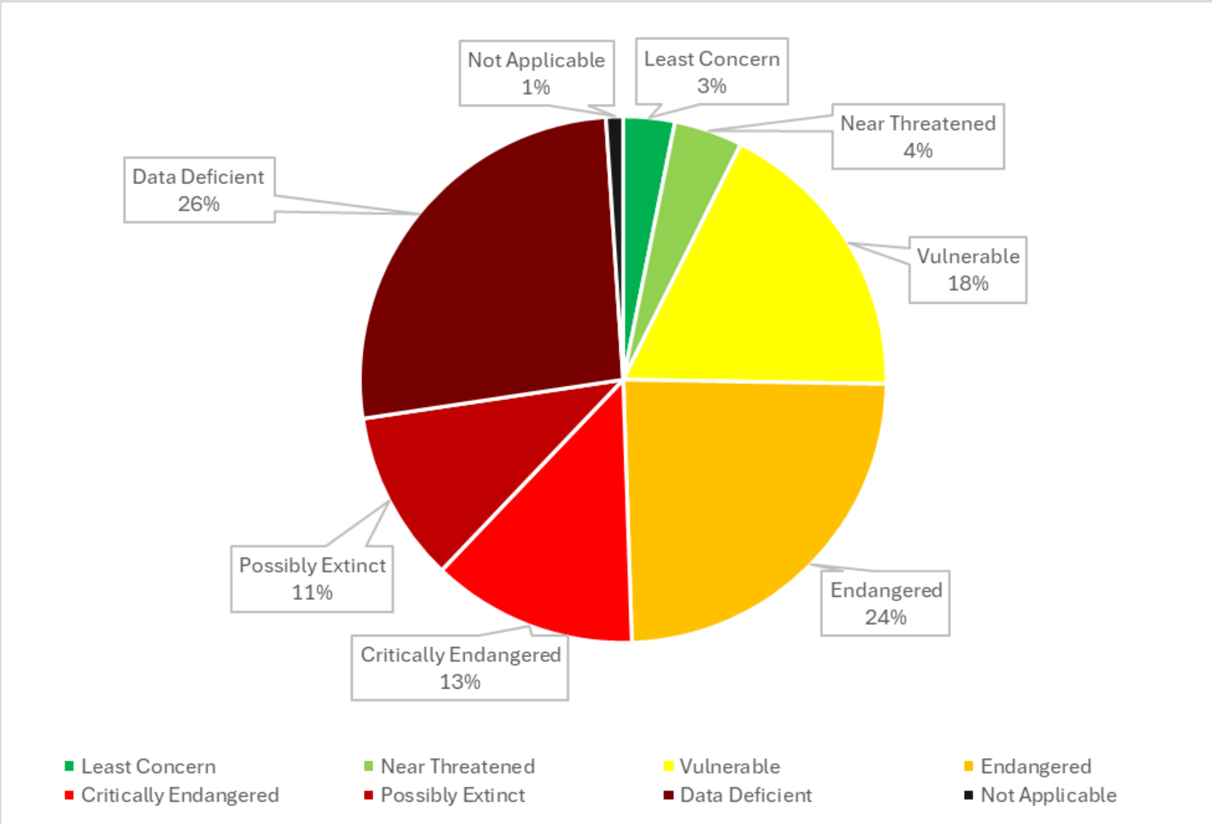

Figure 4.14 The IUCN categories for Schembri and Sultana (1989) after the present study's evaluation. The majority were classified as DD (26%), followed by EN (24%), and VU (18%).

A Chi-square test was applied to determine if there was a significant difference between the classifications of species in Figure 4.13 and Figure 4.13. A continency table with the raw data may be found in the Appendix (see Tables 7.13 – 7.14). It was revealed that there was a significant difference between the distributions of categories in Schembri and Sultana (1989) and the categories of the present work ($\chi 2 = 29.855$, df = 8, $p < 0.001$, for deviation from a uniform distribution).

4.5.5. Distribution of Selected IUCN Species on the Maltese Islands

Due to the rarity of records across all the species, it was not possible to do a distribution analysis as planned, as there were not enough records to visualise the data on maps using kernel distribution analysis in QGIS. A map of the all the distribution data of species within threatened IUCN categories (NT, EN,CE, PE, DD) was plotted and shown in Figure 4.15. However, to assess the population distributions of the most imperilled species (CE and PE species), two maps were created with the last known recorded locations as shown in Figure 4.16 and Figure 4.17 respectively.

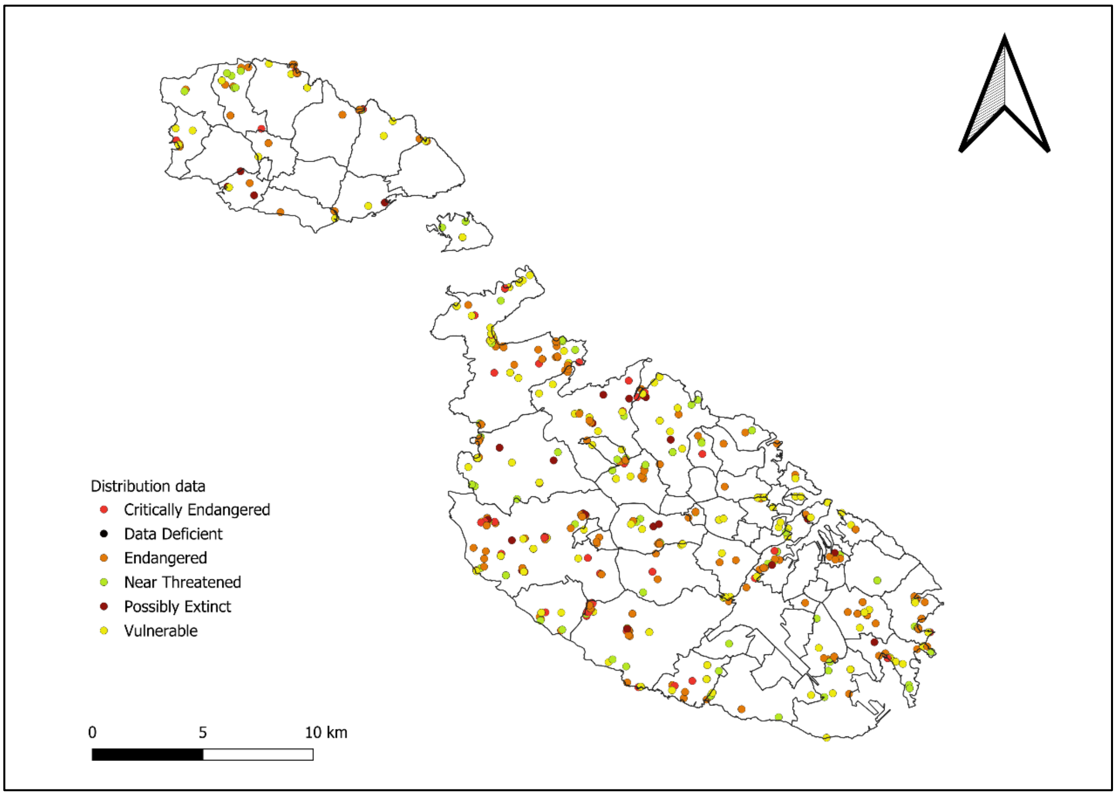

Figure 4.15 The available distribution data of the species classified in the IUCN categories Near Threatened (light green), Vulnerable (yellow), Endangered (orange), Critically Endangered (Red), Possible Extinct (Dark Red) and Data Deficient (Black) across the Maltese Islands.

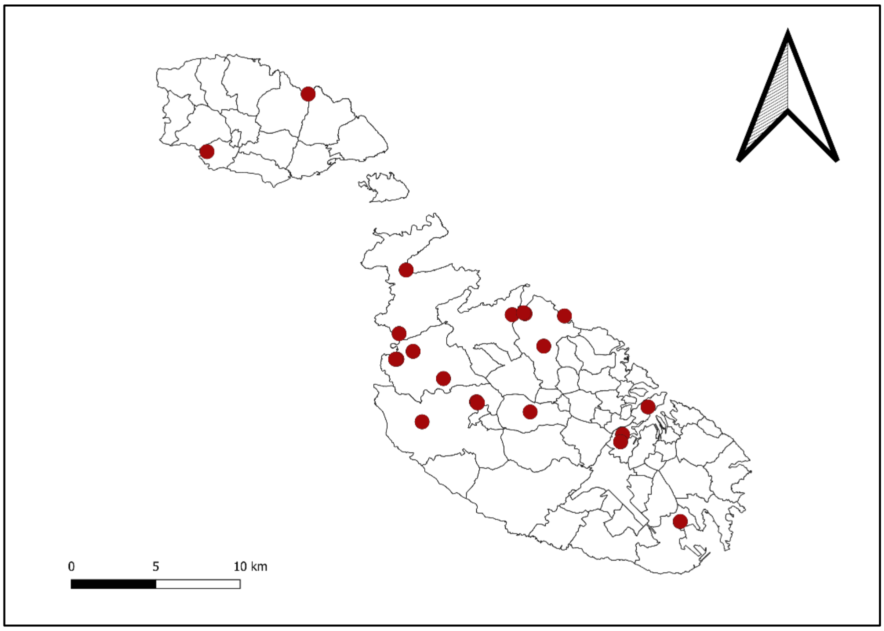

Figure 4.16 The last known recorded locations of species classified as 'Possibly Extinct' at a National Level (Malta). The locations with the most records are: Għammieri in Marsa, Rabat, Mġarr, Salina, Baħar iċ-Ċagħaq. The northernmost point is Ramla, while the southernmost point is Marsaxlokk.

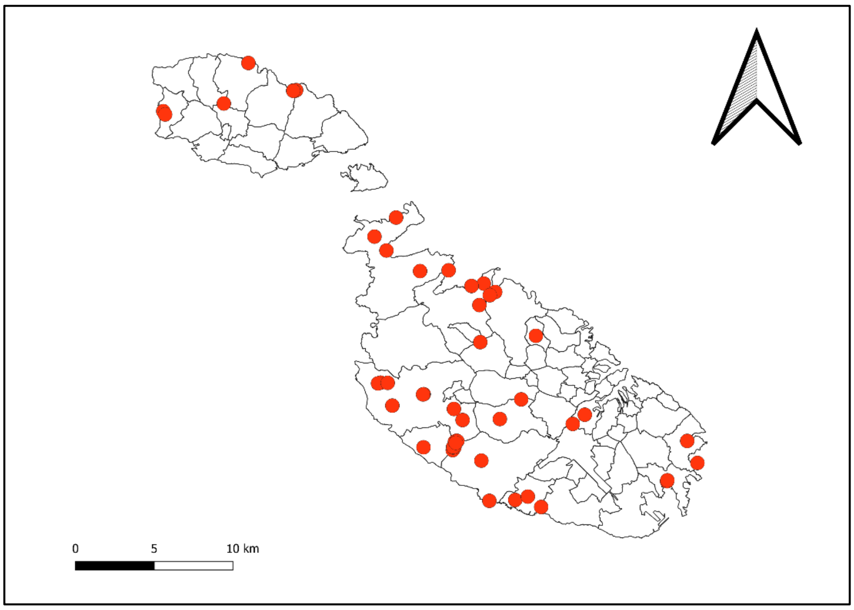

Figure 4.17 The last known recorded locations of species classified as 'Critically Endangered' at a National level (Malta). The locations with the most records are: Rabat, Dingli, Għar Lapsi,

Salina, Mellieħa, Girgenti, Marsascala, Ramla l-Ħamra, Xlendi, and Victoria. The Northernmost point is Marsalforn, while the southernmost point is Qrendi.

The four species which were chosen for the most reliable data were: *Achenium striatum, Sitonia virgatus, Pimelia rugulosa melitana,* and *Onthophagus andalusicus.* A map was plotted for each one of them on QGIS and presented in Figures 4.18 – 4.21.

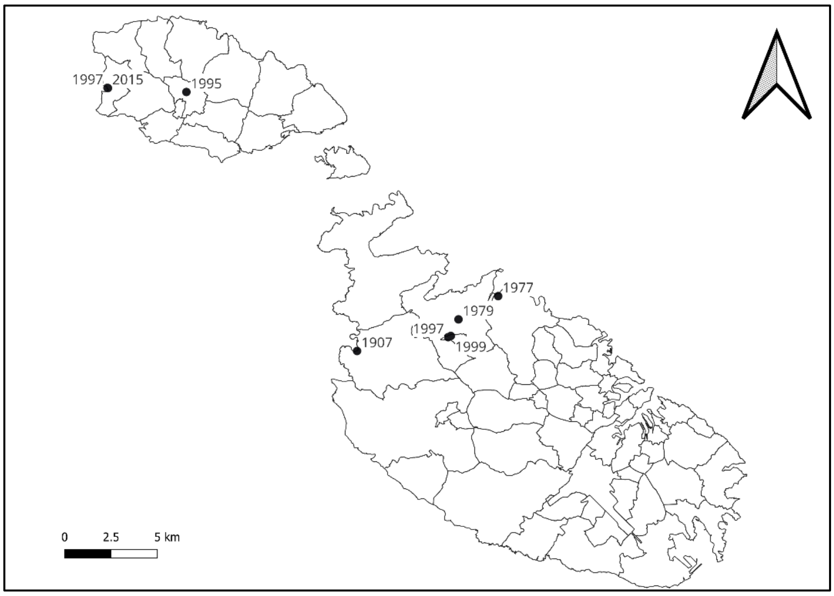

Figure 4.18 The known records of locations of *Achenium striatum*. The map shows the species records were found in several locations between 1977 – 1999, until it was only found again in 2015.

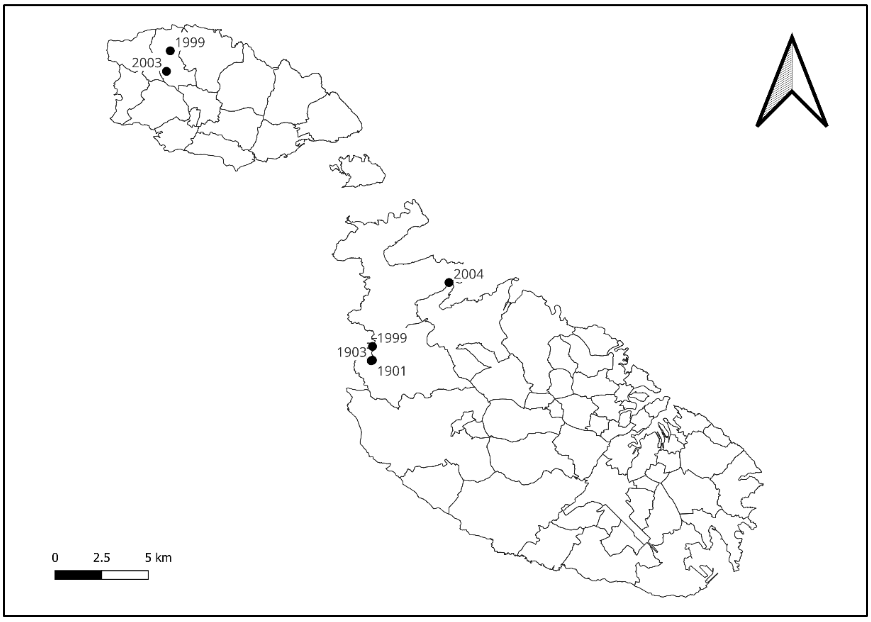

Figure 4.19 The known records and locations of *Sitonia virgatus*. The map shows a fluctuation in records where it was only found between 1901 -1903, before being rediscovered between 1999 – 2004.

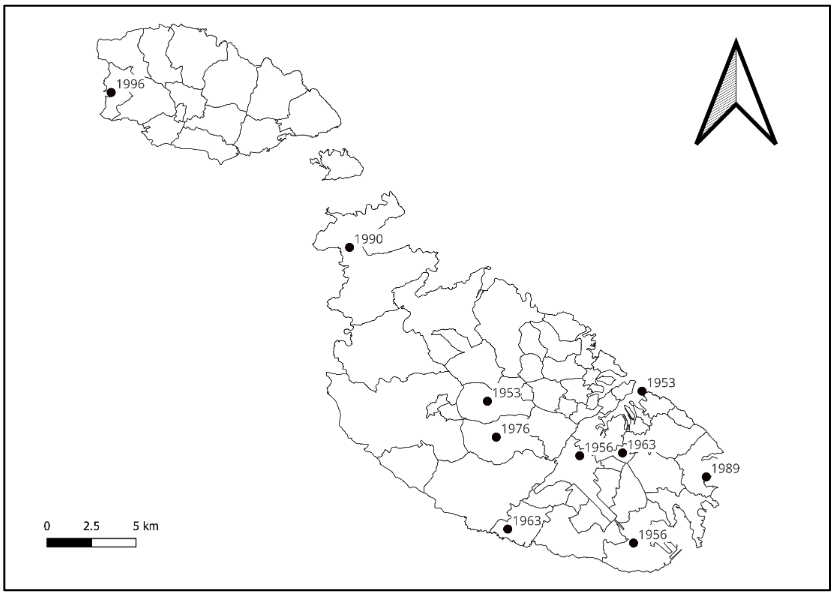

Figure 4.20 The known records and locations of *Pimelia rugulosa melitana*. The map shows the species being found frequently between 1953 – 1963, then recorded more than 10 years later in 1976, being last recorded in published papers in 1996.

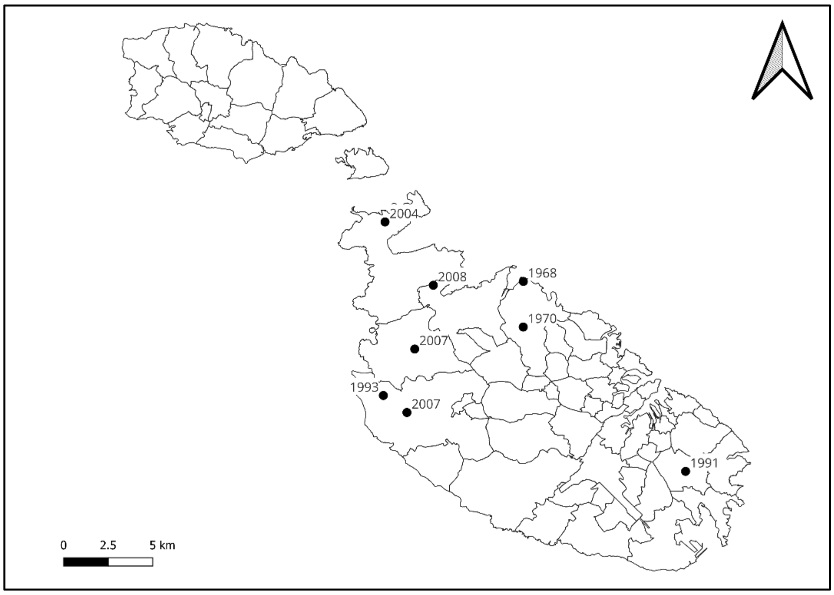

Figure 4.21 The known records and locations of *Onthophagus andalusicus.* The map shows that the species was recorded in 1968 and 1970, then recorded again between 1991 – 2008 sporadically. It has not been recorded since.

Chapter 5: Discussion

5.1. Overview

As previously noted in section 2.3. and in Chapter 3, not all of the taxa within the selected groups were classified in the present work. Nonetheless, as a result of this work, 381 species were evaluated and classified according to the updated IUCN categories. This successfully fulfils the first objective of the present work: to compile a comprehensive red-list of insect species belonging to well-studied groups such as Coleoptera, Lepidoptera and Diptera from the Maltese Islands.

In addition, another objective of the present work was to critically assess the existing conservation status of these insect species by reviewing and evaluating the current classifications in works like Schembri and Sultana (1989). This was done successfully for the majority of species considered, however, some challenges were discussed in the section 5.3. Moreover, the assessment of population distribution change was only partially fulfilled, due to some challenges. Finally, the objective of providing recommendations for future conservation strategies will be discussed in the section 5.2.

5.1.1. IUCN Conservation Status of All Species Assessed

Figure 4.1 shows that majority of the species assessed are in a threatened category (13.9% - VU, 27.3% - EN, 15.5% - CE), while a further 13.6% were classified as PE. This amounted to a total of 269 from the 381 species assessed, including the PE species. This strongly indicates the threat of extinction in many insects of conservation concern in the Maltese islands, and therefore, strategic conservation management plans are needed. Regarding the chi-square test results, proportions of IUCN categories varied significantly between orders and families. This may indicate the imbalanced number of Coleoptera, Diptera and Lepidoptera groups which were examined, with Coleoptera groups making up the majority, or the different number of species included in the various families (see Figure 4.2). This may have introduced some bias, but may reflect true differences in the conservation status of the different taxa. Specifically, among Coleoptera, the most represented category was EN (28.4%), followed by CE (15.3%) (see Figure 6). Among Diptera, the results were similar, with EN species accounting for 33% and CE species for 15%; however, in this group, a substantial fraction of species (20%) was classified as DD (see Figure 6). Lepidoptera showed the highest proportion of PE and DD species (32% and 36% respectively, see Figure 4.2). This indicates that (1) Coleoptera are better studied than Diptera and Lepidoptera, and (2) Lepidoptera face a higher extinction risk.

The same can be said among different families, as a significant association with the IUCN conservation status was also found. When looking at the most populated taxa (contain more than ten species assessed) from the contingency tables (see Appendix), a large number of Curculionidae, Tenebrionidae, Buprestidae, Staphylinidae and Cerambycidae species were classified in a threatened category, particularly in the EN category. Moreover, Scarabaeidae and Staphylinidae, had the largest numbers of PE species. This indicates the threat of extinction for the species in these families, and they must be taken into consideration in conservation strategies. On the other hand, Scarabaeidae, Tenebrionidae, Curculionidae and Cerambycidae also had the largest number of species within the LC category, with the largest being Tenebrionidae (seven species). This may seem that these groups are not imperilled. However, this might also be due to the many updates these groups have received in the published literature, which contrasts the available literature on other groups, including Diptera and Lepidoptera families. Therefore, more frequent updates on the other taxa should be conducted.

5.1.2. Distribution Type and IUCN Conservation Status

Concerning the extinction risk of endemic species (see Figure 4.6), from the 44 endemic species that were assessed, the majority also fell within a threatened category (VU – 18%, EN

– 14%, CE – 27%), along with 23% that are PE. The total threatened endemic species is 35 out of 44 species, including the PE category. This also demonstrates the need for more research on endemic species. It is worth mentioning that some rare species (for example *Otiorhynchus schembrii, Torneuma strictum, Alaocyba melitensis,* as explained in the species notes) have no records that have been published in the last ten years.

Additionally, 20 subendemic species were evaluated and this distribution type also had a threatened category majority (VU – 20%, EN – 20%, CE – 20%), as shown in Figure 4.8. The same can be stated about Mediterranean species, which was the largest distribution type assessed with a total of 261 species (see Figure 4.9), as well as for the Palaearctic species (Figure 4.10). When conducting the Chi-square test between Distribution type (endemic vs non-endemic) and IUCN conservation status, no significant difference was found. This contradicts the results of Carpaneto et al. (2015), who conducted a similar study on Italian saproxylic beetles and concluded that endemic species are more imperilled than the non-endemic species. The result from the present work could be because of the selection bias towards families of conservation concern, species from Schembri and Sultana (1989), as well as species with the most published data available. Moreover, although Carpaneto et al. (2015)'s study focused on Italian saproxylic beetles, which consisted of over 2,000 species, the present study took on a larger taxonomic scope by including groups from three different orders, which may have influenced this result. Additionally, as mentioned earlier in Chapter 2, non-endemic species may still be evaluated as threatened on small islands due to their small extent of occurrence and area of occupancy under the current IUCN criteria, overestimating the threat of extinction for non-endemics (Martín, 2009). Nonetheless, the proportions of PE and CE species were higher among endemics (23% and 27% respectively) than in non-endemics (12.5% and 13.9% respectively) (see Figures 4.6 and 4.7). The situation is reversed for the EN species, which were much higher among non-endemics (29.1%) than in endemics (14%). This may suggest a higher risk of immediate extinction for endemic species than non-endemic species, possibly due to an inherently more restricted and localised distribution.

5.1.3. Regional Level and IUCN Conservation Status

The European and Global regional levels were both investigated in the present study. Within the context of the species evaluated, not many species were found to be evaluated at these levels from the Maltese Islands. According to Figures 4.11 and 4.12, only 68 and 53 were evaluated respectively. Even so, these numbers constituted mainly of the endemic species studied. The IUCN classifications that were done in the present study may be used to supplement knowledge of the species assessed in the global IUCN Red List of Threatened Species.

The overwhelming majority of classifications of the species at European and Global level were noted as NE (see Figures 4.11 and 4.12). This reflects the need for more assessments of invertebrate species by the IUCN, as previously noted in Section 2.2.

5.1.4. Updates on the Species Selected from Schembri and Sultana (1989)

95 species from Schembri and Sultana (1989) were successfully updated as a result of the present work (see Figures 4.13 and 4.14). The species that were reclassified in a threatened or near threatened category made up 59% of the species (NT, VU, EN, CE) , while the rest were DD (26%) and PE (11%). It is within reason to predict that many of the DD species are also in a threatened category, though more research is needed to confirm this.

There were some records which were of doubtful taxonomic status, and distinct differences between them were unclear. Some species were renamed and updated taxonomically, thus their classifications in Schembri and Sultana (1989) became outdated. These are displayed in the table 5.1.

Table 5.1 Taxa from Schembri and Sultana (1989) with out-dated names and their current nomenclature.

Taxa	Former Nomenclature	Current Nomenclature
Buprestidae	*Agrilus obscuricollis*	*Agrilus derasofasciatus*
Buprestidae	*Anthaxia scutellaris*	*Anthaxia thalassophila thalassophila*
Buprestidae	*Ptosima undecimmaculata*	*Ptosima flavoguttata*
Buprestidae	*Anthaxia scylla*	*Athaxia aprutiana*
Cantharidae	*Malthodes malcolmi*	*Malthodes bifurcatus*
Curculionoidea	*Chiloneus deluccai*	*Chiloneus hoffmanni*
Hydraenidae	*Ochthebius exaratus*	*Aulacochthebius exaratus*
Hydraenidae	*Ochthebius impressicollis* v. *imperfectus*	*Ochthebius dilatatus*
Hydraenidae	*Ochthebius subinteger*	*Ochthebius celatus*
Nitidulidae	*Anthaxia nitidula*	*Anthaxia aprutiana*

Taxa	Former Nomenclature	Current Nomenclature
Pselaphidae	*Brachgluta globulicollis aubei*	*Brachygluta aubei*
Pselaphidae	*Brachygluta simplex hipponensis*	*Brachygluta hipponensis*
Scarabaeoidea	*Copris hispanus cavolinii*	*Copris hispanus*
Scarabaeoidea	*Potosia cuprea metallica*	*Protaetia incerta*
Scarabaeoidea	*Potosia lugubris*	*Protaetia incerta*
Scarabaeoidea	*Anoxia australis*	*Anoxia matutinalis matutinalis*
Staphylinidae	*Micropeplus porcatus insularis*	*Micropeplus porcatus*
Staphylinidae	*Trogophloeus (Taenosoma) championi*	*Carpelimus (Trogophloeus) alutaceus*
Staphylinidae	*Scopaeus (Anomognathus) gracilis siculus*	*Scopaeus gracilis*
Staphylinidae	*Euplectus brunneus*	*Euplectus corsicus*
Tenebrionidae	*Opatrum melitense*	*Opatrum emarginatum*

Taxa	Former Nomenclature	Current Nomenclature
Noctuidae	*Mythimna putrescens vallettai*	*Leucania putrescens vallettai*
Torticidae	*Aphelia amplana vallettai*	*Aphelia peramplana vallettai*

Other species were of doubtful taxonomic status or occurrence and need validation. These were included as species in the evaluation but categorised as DD. They are displayed in Table 5.2.

Table 5.2 Species mentioned in Schembri and Sultana (1989) which were of doubtful taxonomic status or occurrence.

Taxon group	Species	Doubtful taxonomic status or occurrence	Reason
Cerambycidae	*Agapanthia cynarae*	Occurrence	Not known from any nearby places (Mifsud, 2002).
Cerambycidae	*Cerambyx scopolii*	Taxonomic status	Reported as most likely incorrect (Mifsud, 2002).
Cerambycidae	*Ropalopus clavipes*	Occurrence	Possibly an accidental introduction (Mifsud, 2002).
Cerambycidae	*Oberea erythrocephala melitana*	Taxonomic status	Subspecies is of problematic taxonomic status (Mifsud, 2002).
Dytiscidae	*Laccophilus interruptus*	Taxonomic status	Possibly misidentification

Taxon group	Species	Doubtful taxonomic status or occurrence	Reason
			(Mifsud and Nardi, 2020).
Scarabaeoidea	*Amphimallon scutellare*	Taxonomic status	Possible misidentification (Pivotti et al., 2011).
Scarabaeoidea	*Bubas bubalus*	Occurrence	Possible incorrect record (Pivotti et al., 2011).
Scarabaeoidea	*Lasiotrichius succinctus*	Occurrence	Possible accidental introduction (Pivotti et al., 2011).
Scarabaeoidea	*Protaetia mayeti*	Taxonomic status	Debate on whether it is a distinct species or a variety of *P. incerta* (Pivotti et al., 2011).
Staphylinidae	*Trogophloeus (Taenosoma) siculus*	Taxonomic status	Possible misdentification (Pivotti et al., 2011).
Staphylinidae	*Bledius (Bledius) tricornis*	Occurrence	Presence needs validation (Farrugia, 2019).
Staphylinidae	*Achenium (Micrachenium) tenellum*	Taxonomic status	No material examined and needs validation (Farrugia, 2019).
Staphylinidae	*Tachyusa (Caliusa) balteata*	Taxonomic status	No material examined and needs validation (Farrugia, 2019).

Taxon group	Species	Doubtful taxonomic status or occurrence	Reason
Staphylinidae	*Astenus (Astenognathus) filiformis luteipennis*	Taxonomic status	Possible misidentification (Farrugia, 2019)
Staphylinidae	*Astenus (Astenognathus) filiformis championi*	Taxonomic status	Possible misidentification (Farrugia, 2019).
Tenebrionidae	*Gunarus parvulus*	Occurrence	Presence needs validation but not excluded (Lillig, Mifsud, and Grimm, 2012).
Tenebrionidae	*Stenosis hispana elongata*	Both	Presence needs validation and subspecies is doubtful (Mifsud and Scupola, 1998).
Tenebrionidae	*Pimelia sardea goryi*	Taxonomic status	Needs validation (Cilia, 1989).
Tenebrionidae	*Tentyria bipunctata*	Taxonomic status	Needs validation (Cilia, 1989).
Noctuidae	*Brythis encausta*	Taxonomic status	Needs validation (Seguna, 2005).

Although there have been improvements in the statuses of some species, there is still a large proportion of species which are either in a threatened category, or marked as DD (see Figures

4.13 and 4.14). Species in the PE category have also increased from 1% in Figure 4.13 to 11% in Figure 4.14.

With regards to the Chi-square tests from the results and analysis chapter, it was concluded that there was a significant difference between the classifications from Schembri and Sultana (1989), and the classifications that were done in the present work. When looking at the results, the number of species in the PE, NT and LC categories have increased. However, the other threatened categories (VU, EN, CE) have decreased as illustrated: VU from 21% to 18%, EN from 30% to 24%, and CE remained the same. This can indicate a change of population distribution within the last 37 years, as well as indicate that Schembri and Sultana (1989) were more pessimistic when classifying the species subjectively. In spite of this, more research on taxa and ecosystems is required to understand whether these species are experiencing an extinction debt.

5.2. Considerations For Future Conservation

As exemplified in Figures 4.15, 4.16 and 4.17, there is a number of locations which could be of conservation priority. The locations of the PE species (see Figure 4.16) seem to be widely distributed across the islands, which may indicate that the threat of extinction is present evenly in every locality – similar to the survey mentioned in Gray et al. (2019). Notwithstanding this, for the CE species, there seems to be clustering in certain locations (see Figure 4.17). The most common mentioned locations in the species notes included: Ġnejna, Mellieħa, Ramla in Gozo, Marsa, Buskett, St. Thomas Bay, Munxar, Wied Babu, and Għadira. The clustering of records may indicate that higher extinction rates is occurring at these locations, and therefore they should be of conservation priority. More research and sampling is encouraged in these locations in order to finetune conservation strategies.

The four selected species in Figures 4.18 – 4.21 exhibit the fluctuation of records across the studies they were mentioned in. These four species (*Achenium striatum, Sitonia virgatus, Pimelia rugulosa melitana,* and *Onthophagus andalusicus*) are all part of taxa which are well-studied in the Maltese Islands. Therefore, rather than being due to under-sampling, these fluctuations may reflect true rarity of these species. In contrast with study by Gray et al. (2019) on St. Helena – which was done on a remote island which was visited less frequently by researchers – the Maltese Islands have been periodically studied very well as shown by the many published papers scrutinised in this analysis. Nonetheless, potential sampling biases towards certain places, habitats and species should be taken into consideration when implementing conservation strategies.

5.2.1. Key Conservation Areas, Habitats, and Species

Many species which were classified were noted to be found in the following habitats: coastal sand dunes, salt marshes, old forested areas, and freshwater pools. There are documents by ERA which already promote the conservation of these habitats. Under Article 69 of the Environment Protection Act (Cap. 549), ERA is required to "prepare, and from time to time review, a list of protected areas, habitats and species which are to be protected for conservation and may in respect of all or any one or more of the protected areas, habitats or species make protection and conservation orders to regulate their protection, conservation and management" (Environment Protection Act, 2024). One subsidiary legislation that is related to the present study is S.L.549.44 Flora, Fauna and Natural Habitats Protection Regulations (2019). This document mentions several species of conservation concern that were evaluated in the present study. These consist of: *Cerambyx cerdo, Pseudoseriscus cameronii, Alaocyba melitensis, Amaurops mifsudi, Otiorhynchus ovatulus, Ptosima flavoguttata, Oryctes nasicornis, Catocala conjuncta, Catocala elocata, Catocala nymphaea, Catocala nymphagoga, Aricia agestis, Lycaena phlaeas, Maniola jurtina, Coenonympha pamphilus,* and *Gonepteryx cleopatra*.

However, these species only make up a small fraction of the actual number of threatened species. This list urgently needs to be updated with at least the most threatened species that are listed in the present work. This is especially needed for Coleopteran and Dipteran species, the latter of the two not being mentioned at all. Additionally, the endemic species mentioned also need to be included in regulations, especially since the majority are critically endangered and found in ecologically important habitats. To better align the current network of protected areas with this updated list of threatened species, all imperilled species should be accurately mapped and the areas with many species should be identified. Afterwards, a comparison can be made with how this map overlaps with the current network of protected areas in the Maltese Islands.

5.2.2. Ecology and Conservation

Some species were associated with specific host plants that could be used as indicators for their conservation status. These were very frequently mentioned in studies on Coleoptera, as well as Diptera, as some studies suggest that this association with host plants may assist with conservation. For example, host plants for Curculionidae included *Plantago* sp., broadleaf trees, Asteraceae, and sand dune plants, amongst others (Mifsud and Colonnelli, 2010). Another common microhabitat is drift wood in sand dunes, or under bark of old trees. Drift wood in sand dunes provide a niche habitat for many Curculionidae, for example, *Amaurorhinus bewickianus* (Mifsud and Colonnelli, 2010). Species of old trees and bushes such as oaks (*Quercus* spp.), Lentisk (*Pistacia lentiscus*), conifers (*Pinus* sp.), carob (*Ceratonia siliqua*), and fig (*Ficus* spp.) trees are often crucial habitats for Cerambycidae and Tenebrionidae species, as they are often found feeding on dead branches (Mifsud, 2002; Lillig et al., 2012). Moreover, many species live in *Posidonia oceanica* banquettes made of dead *Posidonia* leaves that have been washed up on beaches. It is common practice to remove both these habitats, to clean beaches in the case of drift wood and *Posidonia* banquettes, or to make space for new trees by cutting down or removing old trees (Carpaneto et al., 2015). Taken together, these practices should be regulated and enforced under future environmental policies.

Many members of Curculionidae, Scarabaeidae, and Tenebrionidae are associated with coastal sand dune plants (for example, *Otiorhynchus ovatulus, Leptolepurus meridionalis, Scarabeus semipunctatus, Ammobius rufus*, amongst others). A key strategy for the conservation of these species therefore may be enhancing efforts to restore vegetation in these habitats. Coastal sand dunes are threatened by overtourism, overdevelopment, invasive or alien species, rising sea levels, and potentially increasing storm intensity and frequency due to climate change (Fattorini, 2021). Revegetation of coastal sand dunes has been proved to lower the volume of eroded sand by over 30% (Sigren et al., 2014). Therefore, restoration of local sand dune plants and their protection is crucial for conserving these insects. This practice can also be implemented in salt marshes, as well as freshwater habitats, since vegetation diversity is reported to be decreasing in these habitats (Tavilla et al., 2023; Lanfranco, Bellia, and Cuschieri, 2020). Overall, more interdisciplinary research on ecology, taxonomy, and environmental monitoring is required to better understand the communities in these habitats.

For many of the selected species, such as the Dipteran species, their ecology and their biology is not known (Ebejer, 2015a; Ebejer, 2015b; Gatt, 2015a). For example, many selected species are monophagous, therefore knowing their host plants and taking action to protect them would greatly improve their conservation status. Furthermore, research could be done to investigate whether monophagous insects can adapt to feeding on other plants. Therefore, it is crucial to increase resources for funding and scientific research on the ecology of these species, especially for species with restricted distributions.

Finally, it is interesting to note that a lot of species were collected using light traps. This means that there are insect species, especially nocturnal species, which might be highly sensitive to light pollution. Examples of these include: *Icosium tomentosum atticum, Trichoferus helosericeus, Aplidia hirticollis,* and *Cheirodes brevicollis*. Grubisic et al. (2018) examined this factor as a possible threat to insect population decline, and they concluded that more research on the effects of artificial light at night is urgently needed, as although it is a less direct impact than habitat fragmentation and climate change, it is not well-studied. This can be taken into consideration when implementing conservation measures.

5.3. Limitations of the Present work

Due to the rarity of some species, a proper population analysis to determine any population changes was difficult to accomplish. This became a limitation, as, in general, collecting efforts that were done throughout the years for some species were not continuous or inconsistent. This situation was also present in Farrugia (2019). A long-term monitoring strategy is needed to properly assess population distribution changes throughout the years (Borges et al., 2018).

Another limitation of the present study is the lack of material specifically collected. However, the collection data recovered from the literature was enough to make an evaluation. Furthermore, most studies provided a locality as a location and did not provide exact locations or coordinates of the collected specimens. Hence, accurate locations were not attainable. To resolve this, more specific locations with coordinates should be used. Furthermore, the lack of recent material from fieldwork collection inhibits the formation of a clear picture of any population trends in the most recent years. In spite of this, for all species evaluated, collection records were published in relatively recent times, therefore the data is reliable, despite the lack of fieldwork collection in the present work.

It is important to note that the total extinction of an insect species is challenging to support by documentary evidence (Trizzino et al., 2013; as cited in Carpaneto et al., 2015). Therefore, if a species has not been found for many decades, it does not prove that the species is extinct.

Often, it is because there is a lack of long-term monitoring of a species, and so records are published sporadically in specific locations. A similar situation was described in Carpaneto et al., (2015), and they suggested that species that are seemingly extinct may recover rapidly due to sudden changes in climate or vegetation and may be found in higher numbers than before their last record (Mazzei et al., 2011).

Another limitation was distinguishing between the classifications DD, CE, and PE. There were many species for which this was a challenge, since some species possessed only single records, sometimes with no location; records that are over 40 years old; and records which have vague locations or no material, though the author indicates a presence. Most of these species were classified as DD, though they might be CE. It is recommended that more targeted research is done to better evaluate the DD species, as it is likely that these are also in a threatened category. A practical suggestion to counteract this would be to focus on locations where DD species were last found, collecting samples and conducting regular surveys on the habitats.

Chapter 6: Conclusions and Recommendations

In conclusion, the present study successfully fulfilled the objectives outlined in the introduction. A total of 381 species were evaluated for their IUCN conservation status and organised in a comprehensive list. In this context, 95 species from Schembri and Sultana (1989) were updated according to the new IUCN classification system, effectively renewing the outdated, less objective classification. The selected taxa included 44 endemic species: their conservation importance was highlighted, as the majority were categorised in a threatened category. With regard to the European and Global regional levels, the large percentage of unevaluated species strongly indicates that more assessments should be applied in order to assess the IUCN conservation status at these broader geographical scales.

Key conservation areas, habitats and species were highlighted, with conservation priority should be given to habitats such as coastal sand dunes, salt marshes, freshwater habitats, and old trees. It was also highlighted that many Coleopteran and Dipteran species lacked sufficient research into their ecology. Therefore, future research should focus on monophagous insects and their possible host plants, as well as further updates on the current network of conservation areas and their management. Another potential research direction is to compare the statuses of Maltese insect fauna with other countries and globally, to determine the position of Malta's progress with insect conservation on an international level.

It is highly recommended to include the species evaluated in subsidiary legislations such as S.L.549.44 Flora, Fauna and Natural Habitats Protection Regulations (2019). This will not only add to the existing knowledge of the current trends of the species, but will also contribute locally to the goals of the NBSAP to 2030, and internationally to the EU Habitats Directive or Directive 92/43/EEC. Furthermore, future work should focus on long-term monitoring of the species, interdisciplinary research to assess the state of habitats that are of conservation interest, as well as the regulation of both direct and indirect factors that are facilitating insect population decline. These factors include overtourism, overdevelopment, invasive or alien species, habitat destruction, and pollution. Taking these factors into account in planning or environmental management would improve insect conservation.

Overall, the extinction risk of the selected groups of the insect fauna was successfully evaluated, and the present work contributes to a more complete understanding of the status of the Maltese biodiversity. Revisions and further updates on the species which were both evaluated and not evaluated in the present study should continuously be conducted, in order to better and further provide a more accurate picture of the insect fauna status in the Maltese Islands.

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Appendix

Contingency tables for Chi-squared tests

Orders vs Conservation Status

Table 8.1 Contingency Table for comparing Orders and Conservation Status

	Coleoptera	Diptera	Lepidoptera
Least Concern	23	1	0
Near Threatened	16	5	0
Vulnerable	46	5	2
Endangered	89	13	2
Critically Endangered	48	6	5
Possibly Extinct	41	2	9
Data Deficient	49	8	10
Not Applicable	1	0	0

Result from PAST

Table 8.2 Order vs Conservation status results

Rows, columns:	8, 3	Degrees freedom:	14
Chi2:	29.872	p (no assoc.):	0.0079476
Monte Carlo p :	0.012		
Fisher´s exact			
Not available			
Other statistics			
Cramer´s V :	0.198	Contingency C :	0.26964

Family vs Conservation Status

Table 8.3 A contingency table for comparing family and conservation status part 1

	Kateretidae	Nitidulidae	Curculionidae	Scarabaeidae	Geotrupidae	Phalacridae	Cryptocephalini	Monotomidae	Elateridae	Tenebrionidae
Least Concern	0	0	4	5	0	1	0	0	0	7
Near Threatened	0	0	5	2	1	0	0	0	1	3
Vulnerable	0	1	13	8	0	0	1	1	3	9
Endangered	1	2	22	5	0	2	1	0	2	15
Critically Endangered	0	1	16	1	0	3	1	0	2	7
Possibly Extinct	1	0	11	11	0	0	0	0	0	5
Data Deficient	0	1	1	10	1	0	0	0	0	5

Table 8.4 A contingency table for comparing family and conservation status part 2

	Pselaphidae	Cantharidae	Buprestidae	Gyrinidae	Staphylinidae	Haliplidae	Hydrophilidae	Hydraenidae	Dytiscidae	Cerambycidae
Least Concern	0	0	1	0	0	0	0	1	0	3
Near Threatened	0	1	0	0	2	0	0	1	0	0
Vulnerable	0	0	2	0	2	0	0	0	0	2
Endangered	0	3	6	0	8	0	0	4	4	9
Critically Endangered	0	1	4	1	3	0	0	4	0	1
Possibly Extinct	1	0	1	0	5	1	0	1	0	1
Data Deficient	0	0	2	0	9	0	10	0	2	5

Table 8.5 A contingency table for comparing family and conservation status part 3

	Apionidae	Raymondionymidae	Malachiidae	Leiodidae	Trogidae	Tipulidae	Psychodidae	Limoniidae	Trichoceridae	Ulidiidae
Least Concern	1	0	0	0	0	0	0	0	0	0
Near Threatened	0	0	0	0	0	1	2	0	0	1
Vulnerable	3	0	1	0	0	1	0	3	0	0
Endangered	1	0	0	2	2	1	0	6	1	1
Critically Endangered	2	1	0	0	0	0	0	1	0	1
Possibly Extinct	3	0	0	0	0	0	0	1	0	0
Data Deficient	3	0	0	0	0	1	0	1	0	0

Table 8.6 A contingency table for comparing family and conservation status part 4

	Tephritidae	Simuliidae	Ceratopogonidae	Trixoscelididae	Noctuidae	Pieridae	Nymphalidae	Psychidae	Tineidae	Pterolonchidae
Least Concern	0	0	1	0	0	0	0	0	0	0
Near Threatened	1	0	0	0	0	0	0	0	0	0
Vulnerable	0	0	1	0	0	0	1	0	0	0
Endangered	1	1	2	0	0	0	0	0	0	0
Critically Endangered	2	0	0	2	0	0	0	1	0	0
Possibly Extinct	1	0	0	0	1	0	0	0	1	1
Data Deficient	4	0	2	0	9	1	0	0	0	0

Table 8.7 A contingency table for comparing family and conservation status part 5

	Symmocidae	Gelechiidae	Torticidae	Pyralidae	Pterophoridae	Satyridae	Lycaenidae	Autostichidae
Least Concern	0	0	0	0	0	0	0	0
Near Threatened	0	0	0	0	0	0	0	0
Vulnerable	0	0	0	0	0	1	0	0
Endangered	0	0	1	0	0	0	1	0
Critically Endangered	0	0	1	1	0	0	1	1
Possibly Extinct	1	2	0	0	2	1	0	0
Data Deficient	0	0	0	0	0	0	0	0

Result from PAST

Table 8.8 Family vs conservation status results

Rows, columns:	7, 48	Degrees freedom:	282
Chi2:	407.15	p (no assoc.):	1.49E-06
Monte Carlo p :	0.001		
Fisher´s exact			
Not available			
Other statistics			
Cramer´s V :	0.42147	Contingency C :	0.71828

Endemicity vs Conservation Status

Table 8.9 Contingency table for Endemicity and Conservation status

	Endemic	Non-Endemic
Least Concern	2	22
Near Threatened	1	20
Vulnerable	8	45
Endangered	6	98
Critically Endangered	12	47
Possibly Extinct	10	42
Data Deficient	5	62
Not Applicable	0	1

Result from PAST

Table 8.10 Endemicity vs Conservation status results

Rows, columns:	8, 2	Degrees freedom:	7
Chi2:	13.936	p (no assoc.):	0.052337
Monte Carlo p :	0.061		
Fisher´s exact			
Not available			
Other statistics			
Cramer´s V :	0.19125	Contingency C :	0.18785

Regional Level vs Conservation Status

Table 8.11 Contingency table for comparing Regional levels and conservation status

	Malta	Europe	Global
Least Concern	24	27	14
Near Threatened	21	3	1
Vulnerable	2	10	11
Endangered	104	7	6
Critically Endangered	59	12	12
Possibly Extinct	52	8	8
Data Deficient	67	1	1
Not Evaluated	0	313	328
Not Applicable	1	0	0

Result from PAST

Table 8.12 Regional levels vs conservation status results

Rows, columns:	9, 3	Degrees freedom:	16
Chi2:	797.3	p (no assoc.):	<0.000001
Monte Carlo p :	0.001		
Fisher´s exact			
Not available			
Other statistics			
Cramer´s V :	0.6042	Contingency C :	0.64962

Schembri and Sultana (1989) Previous Conservation Status vs Newly Evaluated Conservation Status

Table 8.13 Contingency table for comparing classifications between Schembri and Sultana (1989) and the classifications of the present work.

	Schembri and Sultana (1989)	Present work
Least Concern	0	3
Near Threatened	0	4
Vulnerable	20	17
Endangered	29	23
Critically Endangered	12	12
Possibly Extinct	1	10
Data Deficient	20	25

Not Applicable	0	1
Not Evaluated	13	0

Result from PAST

Table 8.14 Schembri and Sultana (1989) classifications vs present work results

Rows, columns:	9, 2	Degrees freedom:	8
Chi2:	29.855	p (no assoc.):	0.00022425
Monte Carlo p :	0.001		
Fisher´s exact			
Not available			
Other statistics			
Cramer´s V :	0.3964	Contingency C :	0.3685