Sessione
Il pianeta condiviso

Comunicazioni

Alone in the park Facing the biodiversity crisis

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Data speaks loudly: we are facing a monumental biodiversity crisis, and we are the only responsible. We must be clear: this is not completely new. During the existence of our species there have been several times in which we drove to the extinction even large faunas (such as the case of South America's endemic mammals during Cenozoic). However, nowadays our impact is global and there are not completely safe areas, and the actual impact rate is so fast that, for the first time, we can measure population decline in many species and loss of biodiversity along the lifetime of a single human being.
Scientists are yelling since years about habitat loss and degradation, global warming, pollution, resource overexploitation, invasive species, dramatic reduction of ecosystemic services.
Simply, it is not enough. But what can we do, as scientists and as citizens?
Quoting Albert Einstein, *we cannot solve our problems with the same thinking we used when we created them*. We must begin being truly aware that humans are the problem, but we are also the only possible solution. We cannot save ourselves alone because we are stronger together.

Effects of noise pollution on the colonial ascidian *Clavelina lepadiformis*

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Recently, anthropogenic activities had significantly increased noise levels in marine environments, raising the attention about their effects on marine life (Camerlenghi, 2021). Now underwater noise is recognized as an emerging pollutant but is impact on animal life remains poorly understood, particularly in invertebrates. Most studies have focused on vertebrates, leaving a knowledge gap about noise effects on sessile invertebrates.

In our study, we used the colonial ascidian *Clavelina lepadiformis* as a model organism for investigating the consequences of noise exposure under controlled laboratory conditions. Ascidians are filter-feeding tunicates, the sister group of vertebrates, and represent a key component of sea benthic communities.

As adults, *C. lepadiformis*, like other colonial tunicates, can reproduce both asexually, by budding from the stolon or from the body wall of the zooid which helps expanding and maintaining the colony, and sexually, from internal fertilization of eggs that develop into lecithotrophic larvae (Berrill, 1950)

To explore the effects of acoustic pollution, we set out a series of laboratory experiments focusing on different life stages of *C. lepadiformis*. We exposed the animals to a nature-like noise recorded in the environment in water filled tanks using an underwater speaker.

Firstly, we conducted an analysis of oxidative stress in adult individuals collected from both noise-exposed and control tanks after 3 and 6 days. In addition, juvenile individuals were monitored at different time exposure (24h -10 days of treatment) to evaluate cardiac activity as stress response. Moreover, we analyzed the filtration capacity of adult zooids by comparing noise-exposed individuals with untreated controls (1h-24h of treatment).

These multidisciplinary approaches, combining behavioral, physiological, and functional parameters, underline the sensitivity of sessile invertebrates like *C. lepadiformis* to acoustic disturbance. Further investigations will be essential to better understand the ecological implications of noise pollution on benthic communities and to evaluate the long-term consequences on their population dynamics and ecosystem roles.

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Tracking cats through time: ancient DNA and isotopes reveal feline lives in Viking and medieval Germany

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Understanding how domestic animals adapted to and moved within human landscapes is essential for reconstructing past socio-ecological systems. Given their long history alongside humans as pest-control agents and companions, domestic cats (*Felis catus*) offer a unique window into daily life, food economies, and human connectivity across time and space.
This study investigates the genomic background and dietary habits of over 90 cats recovered from two urban contexts in northern Germany: the Viking site of Haithabu (8th–11th centuries AD) and the medieval town of Schleswig (11th–13th centuries AD). Drawing on one of the largest archaeogenetic datasets of domestic cats to date, this work offers valuable insights into feline population dynamics over several centuries. Located in a strategic position with natural protection and navigational access, both sites played a central role in regional and long-distance trade routes that linked northern Europe to wider economic networks during the Middle Ages. Their well-preserved stratigraphy and rich faunal assemblages make them ideal case studies for exploring long-term human-animal interactions.
Despite chronological and socio-economic differences between the two sites, mitochondrial DNA data revealed a shared genetic ancestry across all individuals - assigned to clade IV (*Felis lybica lybica*), specifically haplogroups A, C, and D - suggesting a long-established and relatively stable maternal gene pool in the region likely rooted in dispersal processes starting from the Roman period. The high mtDNA genetic variation was likely shaped by the influx of cats from different regions via trade networks centered on these key European commercial hubs. Nuclear data support minimal admixture with European wildcats (*Felis silvestris*), in line with previous findings and reinforcing the dominance of domesticated lineages.
Stable carbon (^{13}C μ = -19.1 $\pm$ 0.7‰) and nitrogen (^{15}N μ = 10.5 $\pm$ 1.1‰) isotope data indicate varied trophic behaviors, with most cats showing mixed diets including marine-derived protein reflecting human subsistence strategies and the cats' opportunistic access to food sources.
By combining genetic and isotopic data, this research highlights the ecological flexibility of domestic cats and their integration within evolving urban networks. These animals serve as sensitive bioproxies for tracing cultural trajectories during a period of intense transformation in northern Europe.

Anthropogenic impacts on insect-microbe relationships: the case of herbicides

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The long-standing coexistence between humans and other species has been increasingly shaped by intensive land use and chemical management practices, such as the widespread application of herbicides. While designed to act selectively on plant physiology, herbicides often permeate ecosystems, where they can disrupt ecological and evolutionary dynamics among non-target organisms. Insects, in particular, are embedded in symbiotic networks with microbial partners that are essential to their development, immune function, and survival. These relationships, ranging from mutualism to pathogenicity, form a fundamental axis of insect ecology.
This study investigates how herbicide contamination interferes with insect-microbe interactions, focusing on host-pathogen dynamics in two model beetle species. In *Tenebrio molitor* adults, chronic exposure to a pendimethalin-based herbicide (residual doses: 0.05–13 ppm) altered immune responses to the entomopathogenic fungus *Beauveria bassiana*, evidenced by upregulation of antimicrobial peptides, despite no effect on host survival. Notably, herbicide exposure also inhibited fungal growth. In *Tribolium castaneum* larvae, similar levels of exposure increased susceptibility to the natural pathogen *Bacillus thuringiensis*, resulting in delayed development and reduced pupation success. These findings highlight how human-induced environmental change (via agrochemical use) can destabilize insect-microbe relationships and reshape host-pathogen dynamics. By disrupting symbiotic equilibriums, such contaminants may drive unforeseen ecological and evolutionary consequences. This work underscores the need to integrate microbial symbioses into ecological risk assessments.

Tuna's tale through museomics: millennia of evolution and adaptation between Mediterranean human coastal populations and Atlantic bluefin tuna

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For millennia, Mediterranean coastal communities have relied on fishing as a primary source of sustenance, with evidence of this practice dating back 40,000 years. Understanding the historical extent of human dependence on coastal resources is therefore essential for assessing long-term socio-economic development, human health, and the anthropogenic impact on the environment. Among the apex predators of the Mediterranean Sea, the Atlantic bluefin tuna (*Thunnus thynnus*) holds a prominent position, serving as both a keystone species and a vital resource for traditional sustenance. With few natural predators aside from humans, its exploitation was historically related to subsistence and small-scale commercial fisheries, primarily conducted by coastal and island communities using traditional methods such as *tonnare*. This study aims to achieve four key objectives: 1) to investigate the historical and cultural significance of tuna in the diets of Mediterranean coastal populations, 2) to assess potential differences in pollutant levels in tuna specimens from the pre-industrial and post-industrial eras, 3) to examine adaptive changes—at both genetic and epigenetic levels—in ancient and contemporary Mediterranean bluefin tuna populations, as well as among past and present communities engaged in traditional tuna fishing practices. Our study shows: significant differences in polycyclic aromatic hydrocarbons levels between ancient and modern bluefin tuna vertebrae; evidence of distinct population structures between ancient and contemporary tuna specimens; potential adaptive responses of tuna to anthropogenic pressures; potential variations in the allele frequencies of detoxification of pollutants-related genes between populations that historically consume tuna fish and those that do not. By integrating historical, genetic, and ecological perspectives, this research will provide a comprehensive understanding of the long-term interactions between Atlantic bluefin tuna and human populations in the Mediterranean area. Our findings will not only shed light on the extent of human influence on marine ecosystems but also reveal the adaptive responses of both species to environmental and anthropogenic pressures. Ultimately, this study underscores the need for sustainable fisheries management and conservation strategies, ensuring the resilience of bluefin tuna populations and the preservation of traditional coastal livelihoods against ongoing environmental change.

Rewriting coexistence: anthropogenic pressures and decline of native freshwater fishes in Sardinia

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Freshwater fishes are among the most threatened vertebrates due to long-term anthropogenic impacts such as habitat degradation, alteration of flow regimes, and the spread of non-native species. These pressures, exacerbated by climate change, have caused significant range contractions and, in some cases, local extinctions of native freshwater fish populations.
In Sardinia, only 7 out of 22 recorded freshwater fish species are native. Among them, *Anguilla anguilla* (CR), *Salmo ghigii* (CR), and *Alosa fallax* (VU) are currently threatened and at high conservation risk. By analyzing historical distribution data from 802 sampling sites across Sardinia over a long time period (1940–2022), we observed significant habitat range contractions for native fish species. In particular, the most pronounced declines were recorded for the Mediterranean trout (*S. ghigii*) and the European eel (*A. anguilla*), which showed decreases in occurrence of 53% and 50%, respectively.
The twaite shad (*A. fallax*), once widely distributed in Sardinia's major rivers, is now detected in only 1% of surveyed sites. Its populations are mostly landlocked in reservoirs due to river fragmentation caused by barrier construction. Although isolation has in some cases shielded native Mediterranean trout from genetic introgression due to non-native trout stocking, it has also heightened their susceptibility to inbreeding and extreme floods and drougth events. Genetic analyses on the Mediterranean trout revealed the presence of non-introgressed populations, only in some isolated mountain streams.
These results highlight the effect of long-term impact of human activity on insular freshwater ecosystems. In this contetext, the urgent need for conservation measures, in line with the EU Habitats Directive (92/43/EEC), is evident.

Human and animal evolution, the strange case of feralization in the Sardinian pig

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Animal domestication has significantly transformed Earth's biosphere promoting the artificial selection that has changed the animals evolutionary trajectories. In addition to this intertwining story, many domestic animals returned to the wild due to human intentional actions or unintentional episodes leading to feralization and to feral animals often showing wild features as a consequence of new and intriguing evolutionary processes. Despite its relevance, study of feralization is still relatively neglected. Feralization arises in many animal populations however *Sus scrofa* is an optimal model to delve deeper into this process. We investigated the evolutionary trajectories followed by feral swine in Sardinia, affected by resultant of natural selection and traditional husbandry (artificial selection), genetic drift and gene flow with sympatric wild boar. Using an interdisciplinary approach, we collected historical, genetic and phenotypic traits and addressed them as co-evolved elements. To get successfully the research goal, we grappled with characterization of swine populations' genetic structure using genome approaches. Using over 3,000 Single Nucleotide Polymorphism we found sign of selection in specific genomic regions including genes linked to litter size, sense of smell and number of teats. The screening of genomic variability was useful to highlight the effect of a peculiar artificial selection that modulates its weightiness due to the concomitant action of natural selection. In particular, results suggested that Sardinian cultural diversity in pig husbandry acts pushing down gene flow towards wild boar while favoring adaptations to life in the wild, creating a unique genetic pattern in feral pigs, different both from the domestic and the wild genetic makeup.
Our contribution opens a discussion on topics of global interest in Anthropocene environments and for rewinding Europe program: the preservation of cultural heritage linked to human traditions and related impacts on biodiversity, agriculture, economy, human and animal health.

Neanderthals versus Sapiens in Southern Italy: the reconstruction of dietary habits inferred from zooarchaeological and paleogenome data

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In the last twenty years detailed zooarchaeological analyses on faunal assemblages from different sites in southern Italy referable to both Mousterian and Upper Palaeolithic technocomplexes (MIS 4-3), giving us the possibility of identifying differences in animal exploitation between Neanderthal and AMH populations. In Apulia, it was possible to highlight a specific treatment of ungulate carcasses by Neanderthals, not recorded in Sapiens assemblages
During the Late Mousterian, this region was characterized by frequent and prolonged drought climate conditions that could have caused the scarcity of vegetable foods and, consequently, a lack of important nutritional compounds. Neanderthals may have responded to this crisis by increasing the exploitation of ungulates: bone grease rendering was likely one of the dominant activities conducted on-sites. Considering the ethnographic data related to the economic subsistence patterns
of hunter-gatherers, we merged zooarchaeological and palaeoecological data with the nutritional value of the anatomical parts in medium-large ungulate carcasses. Additionally, a paleo genome analysis was carried out to investigate possible genetic bases of the differences in fat metabolism between Neanderthals and Sapiens. Our results show a low daily energy intake from carbohydrates for Late Mousterian populations in Southern Italy, in contrast to a surplus of animal protein and fats. In addition, analysis of the FADS genes involved in the LC-PUFA biosynthesis, underline the importance for these human groups of 18-carbon unsaturated fatty acid intake from animal resources, to address the low availability of these compounds from plant resources. The acquisition of these data opens up interesting new scenarios on possible differences between Neanderthals and Sapiens both in their possible metabolic processes and in the adoption of different techniques in food processing. In particular, the gluconeogenesis and external fermentation of food are discussed.

Settlement dynamics and memory of places in the SUs 13-11 of the Oscurusciuto rock shelter

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The Oscurusciuto rock shelter opens on the right side of the ravine of Ginosa (Taranto, southern Italy). Its stratigraphic sequence (at least 10 occupation layers) covers a time span between MIS 4 and about 43-42 ky ago, providing relevant information on the settlement dynamics, behavior and economy of the late Neanderthal groups and contributing to make Oscurusciuto an international key site. This study focuses on the evolution of the camp organization, as shown by palimpsest stratigraphic units (SUs) 13 and 11 (about 55 ky ago), with the aim of reconstructing the settlement dynamics and the long-lasting processes that shaped the site structure over time. From a methodological standpoint, an interdisciplinary approach was applied, based on the central role of spatial archaeology. Data from hearth thin sections, sedimentology, Raw Material Units (RMUs), lithic technology, zooarchaeology were analyzed from a geomatic perspective to shed light on the formation processes of the contexts, as well as the preservation and functional interconnection between the activity areas. To this end, a three-step protocol was designed, which includes: 1) characterization and selection of relevant data, 2) taphonomic, and 3) functional analysis of the contexts.

The results of the study indicate the formation of SUs 13-11 in a low energy setting, with displacement processes of the materials that are primarily attributable to human activity (e.g., entropy of the camps, voluntary/not voluntary removal of materials). The palimpsest effect represents the main factor affecting the high-resolution visibility of the site spatial organization. SU 13 is a short-term palimpsest with a good archaeological visibility of the settlement organization, while SU 11 is a long-term palimpsest analytically dissected into two sub-units (also coherent from a sedimentological point of view). Despite the limited extension of the studied area, significant results allow us to recognize the long-lasting permanence of a recurrent settlement pattern along the stratigraphic series of SUs 13 and 11, made (mainly) by a succession of long-term occupations, with a gradual accumulation of changes.

These results suggest that the archaeological record reflects the dialectical relationship between long-lasting processes and the historical memory of places. The latter, from a cognitive perspective, may have acted as a strategic survival factor, maintaining the Group cohesion and knowledge of critical resources.

Reading the past through insects: entomological insights from three Italian archaeological sites

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Archaeoentomology is a discipline that studies insects and other arthropods from archaeological contexts, contributing to the reconstruction of past events, climatic and environmental changes, dietary habits, and—particularly in burial contexts—funerary practices, season of death, and the hygienic and health conditions of individuals.
In this work we present three Italian case studies that show the variety and richness of information that insects can provide in archaeological investigations.
Entomological investigations follow a standardized protocol aimed at preserving both the archaeological context and the integrity of biological remains. Field sampling was carried out in three Italian archaeological sites using tools allowing for the recovery of insect fragments and associated materials without causing damages.
The sediment was oven-dried and sieved to facilitate the isolation of entomological specimens from the matrix.
All specimens and fragments were then selected and examined under a stereomicroscope for taxonomic identification verified through comparison with reference collections.
The first case concerns three mummified hermits preserved at the Sanctuary of Madonna della Corona (Verona), where entomological analyses contributed to reconstructing funerary practices and confirming the authenticity of the liturgical vestments worn by the individuals. The second study focuses on the hypogeal crypts of the Pieve di San Cristoforo in Pian di Marte (Perugia), which include drainage channels—sealed in the 19th century—that once connected the burial environment to the outside. These channels allowed the entry of insect species unrelated to the decomposition of buried bodies but valuable for reconstructing the historical ecology of the surrounding area. The third case involves the discovery of a World War I soldier in the Venetian Prealps, for whom entomological analysis provided useful elements to determine the season of death and reconstruct peri-mortem events.
In all cases, Diptera and Coleoptera emerged as the most representative and informative insects, confirming their central role in entomological analyses of forensic, funerary and archaeological contexts.
These case studies demonstrate that archaeoentomology, through a rigorous and multidisciplinary approach, can provide essential data not only for the reconstruction of funerary dynamics but also for a broader understanding of the environmental and historical conditions of archaeological sites.