Forensic entomology and climatic change

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Abstract

Forensic entomology establishes the postmortem interval (PMI) by studying cadaveric fauna. The PMI today is still largely based on tables of insect succession on human cadavers compiled in the late 19th- or mid-20th centuries. In the last few years, however, the gradual warming of the climate has been changing faunal communities by favouring the presence of thermophilous species. To demonstrate how globalisation and climate change are overcoming geographic barriers, we present some cases of southern and allochthonous species found in north-east Italy during our entomo-forensic investigations.

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1. Introduction

1.1. Forensic entomology methods

Forensic entomology is the science, which applies knowledge of insects (and other arthropods) to civil proceedings and criminal trials. In the latter, study of cadaveric fauna is a valid method of establishing the time of death, and may support histological and chemical analyses and help police investigations. The main aim of forensic entomology is to establish the PMI (postmortem interval), i.e. the time, which has elapsed since death or, more exactly, how long a dead body has been exposed to the environment. Most of the invertebrate fauna found on corpses are insects, mostly Diptera (maggots) and Coleoptera. They are selectively attracted by the decomposing status of the body, and form complex communities within necrophagous species and their predators, parasites and parasitoids. Rapid and continuous changes in the carrion micro-ecosystem do not allow a steady state or equilibrium to be reached among animal communities until decomposition. There is thus a series of faunal successions, which allow us to estimate when (and where) death occurred. Identification of species, knowledge of their life histories, duration of each stage with varying temperatures, and other abiotic factors allow us to establish the PMI with great precision. Evaluation of PMI is still largely based on the tables of faunal succession on human cadavers described by Megnin [1] and Jonston and Villeneuve [2] in the 19th century, with changes proposed by other more recent authors, according to geographic region, latitude, ecosystem, climate, etc. In Europe, forensic entomology is well studied and has long been applied by entomologists in Great Britain and central-northern Europe, so that the tables of faunal successions mostly refer to continental species and insect’s life-cycles are calculated on the average temperate climate. Instead, the Italian peninsula has both a subtropical-like (Mediterranean) climate along the coasts of the central-southern regions and a temperate/continental one in the north (Po Plain and Alps) and along its mountain spine (Apennine chain). The typical fauna and arthropod successions therefore vary between the two regions and also the most widespread species have different life histories, according to environmental trends. The arthropod successional patterns in northern Italy may generally be compared with those of Europe, but a different situation arises for Mediterranean necrophagous fauna,
which was little known in the past, and not documented either in North Africa, the near east or southern Europe.

1.2. Effects of global warming on environment and fauna

During the 20th century, the world’s climate warmed by 0.6 °C [3], starting from 1910 onwards. Two main periods of warming are recorded: from 1910 to 1945, and from 1976 to today, the latter rate of increase being about double that of the former [3] (Fig. 1). The temperature increase in the last thirty years has been the greatest ever recorded during the past 1000 years. The Mediterranean basin and the Italian climate follow the global trend. The temperature of the Mediterranean Sea has increased in the last few years and the thermic-buffer power of the water contributes to keeping the land warmed. While Italy is becoming hotter, the barrier created by the Alps differentiates the peninsula from continental Europe, which undergoes the effects of warming more slowly.

There is ample evidence that climatic warming influences a broad range of organisms: species with southern distribution are shifting northwards, but northern or widely distributed species have few opportunities to find new areas at higher latitudes or elevations, so that they are confined to cool niches or become extinct.

2. Results

2.1. Variations in necrophagous invertebrate communities

Our researches have mainly been developed in north-east Italy, from the Po plain to the Alps. Necrophilous fauna, collected from human bodies and vertebrate carrion or captured with flesh traps, confirms the presence of thermophilous species even at medium and elevated altitudes. These findings, compared with those from old museum or private collections, show the recent changes in range and adaptations of some species to new areas. In mountains, valley fauna is moving to higher altitudes at speeds greater than the isothermal shift of 8–10 m per decade. This phenomenon is most evident where the Alpine glaciers have receded and pioneer species are colonising newly discovered areas.

2.2. Some examples from our findings

The black soldier fly Hermetia illucens L. (Diptera: Stratiomyiidae), a species from tropical areas of America, was reported for the first time in Italy in 1956 [4] (it had probably been introduced during the Second World War by U.S. troops). But only in recent years has it become widespread throughout Italy, even in the north, up to 1300 m above sea level. The maggots breed on waste, rotten fruit and dead animals and, being very resistant to insecticides, are winning competitors and predators of autochthonous flies: we even found this species on remains in fields treated with pesticides [5,6]. Tachinaephagus zealandicus (Hymenoptera: Encyrtidae) is another allochthonous species new to Italy. We found it in a case of an indoor homicide [7]. This small wasp is a parasitoid of flies from Australia, employed in the control of fruit flies and myases in Africa and America. It may have been imported accidentally with fruit or voluntarily introduced for biological warfare. We found many other necrophilous species, such as Hydrotaea capensis (Diptera: Muscidae), breeding on indoor cadavers [7], Nercrobia violacea (Coleoptera: Cleridae) [7] and Megaselia scalaris (Diptera: Phoridae), species reported from southern Italy and circum-Mediterranean lands, but rare in northern areas like the Veneto (unpublished data).

3. Discussion and conclusions

It is evident that arthropod fauna is rapidly changing, for many reasons, the most important of which is the warming of the climate. The global rise in temperature.
means that thermophilous species can extend their cool margins, shifting from south to north and from low-lying land to higher elevations. This phenomenon has been extensively studied for mosquitoes and other insects bearing diseases. Species adapted to the lower temperatures of northern lands or mountains have few suitable habitats to colonise and become niche-species or disappear. Global warming leads to the survival and dispersal of tropical and subtropical species, mainly those able to modify their seasonal cycles. When long distances have been covered, their movements are often mediated by human activity [8,9].

Entomological forensic studies are suitable for collecting new or rare species, because a body is a very attractive bait for insects: it may be considered as an “energy spot” in an ecosystem. Findings on cadavers are therefore very useful in recording specimens, which would otherwise be dispersed in the environment. However, in PMI evaluations, great caution must be applied when using data collected by researchers from other countries. Changes in range and precipitation, which may lead species to change their time of hatching, length of lifecycle and diapause, must all be taken into consideration. Global warming makes Italy much more similar to countries in the Mediterranean basin than to the rest of Europe. The barrier of the Alps contributes towards keeping this difference with respect to a continental climate. Fauna is naturally shifting from south and east towards the north, and is enriched by non-native species introduced, in the same direction, by people and the transport of goods.

References