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Forensic botany as a useful tool in the crime scene: Report of a case

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ABSTRACT

The ubiquitous presence of plant species makes forensic botany useful for many criminal cases. Particularly, bryophytes are useful for forensic investigations because many of them are clonal and largely distributed. Bryophyte shoots can easily become attached to shoes and clothes and it is possible to be found on footwear, providing links between crime scene and individuals. We report a case of suicide of a young girl happened in Siena, Tuscany, Italia. The cause of traumatic injuries could be ascribed to suicide, to homicide, or to accident. In absence of eyewitnesses who could testify the dynamics of the event, the crime scene investigation was fundamental to clarify the accident. During the scene analysis, some fragments of Tortula muralis Hedw. and Bryum capillare Hedw were found. The fragments were analyzed by a bryologists in order to compare them with the moss present on the stairs that the victim used immediately before the death. The analysis of these bryophytes found at the crime scene allowed to reconstruct the accident. Even if this evidence, of course, is circumstantial, it can be useful in forensic cases, together with the other evidences, to reconstruct the dynamics of events.

1. Introduction

The study of plants and of their role in criminal investigations is referred as “Forensic botany”.[1] During the past century the use of forensic botany was very limited in criminal or civil cases, because a little number of specialists are trained for this purpose. Furthermore, academic or specialized centers able to train specialist in this field are almost absent.[2] Neverthless the value of botanical trace evidence in criminal cases has been demonstrated and it is accepted as suitable scientific evidence by the courts of many conuntries because the ubiquitous presence of plant species makes forensic botany useful for many criminal cases.[3] Forensic Botany includes many subdisciplines, for example Palynology (the study of pollen and spores), Dendrochronology (the study of growth rings of trees stems and roots), Lichenology (the study of lichen communities), Mycology (the analysis and the identification of Fungi), Bryology (the study of Bryophytes). Particularly, bryophytes are useful for forensic investigations because many of them occur in every type of environment, even those unable to host vascular plants and other organisms. Furthermore, some studies demonstrate that fragments of bryophytes can easily remain attached to shoes and clothes, and even if the plant has been fragmented, their DNA can be analyzed.[4] Traditionally, “ bryophytes ” include the mosses, liverworts, and hornworts. Together, these groups comprise some 15 000–20 000 species and, if combined, are more diverse than the nonflowering vascular plants. The three bryophyte groups share a similar life cycle in which the gametophyte is perennial and dominant about size and longevity and the sporophyte is unbranched, monosporangiate and completes its entire development remaining attached to the maternal gametophyte. The sporophyte generation begins as a fertilized egg and eventually produces spores via meiosis in a terminal sporangium. In the last phase, the sporangium stops to be photosynthetic and so it dries and senesces. The sporophytes of many moss species mature in about a year but do not continue to grow after spore production and they are for the most part essentially annual.[5] The growth period of bryophyte species can be determined by examining annual segments on the stems, which have two different growth forms: the sympodial growth occurs when the apical meristems die at the end of the growing season and growth is continued by lateral buds, which in the next season

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Fig. 1. This picture shows the terrace, the walkway and the street where the victim was found. The arrows show the point of throwing and the point of impact of the victim.

initiate a new segment with lateral branches. Conversely, the monopodial growth occurs when the apical meristems continue growing for the whole life of the plant, resuming growth from the previous year. This kind of growth is more regular than sympodial one, and the annual segments are easier to identify because they are situated in an area where side slings change their dimension and positioning. Typically bryophytes (height 0,1–10 cm) grow close and form mats patches on ground, rock, wood and many other substrate, in all environments but not in the sea. Bryophytes are rootless and they have single-to multi-branched stems with leaves. The stems is fragile, so, fragments of the plants can easily breaks and the fragmentaction allows the vegetative reproduction. Furthermore, mosses (and to a lesser extent, liverworts and hornworts) are unique among land plants in that both the gametophyte and sporophyte generation have sufficient morphological variability and complexity to be phylogenetically informative. Nevertheless, they are hardy in a wide microclimatic range. For these reasons, they provide useful evidence for PMI determination, especially when it is not possible to use morphological-based and/or entomological-based methods.[6] That is why some authors[7,8] used mosses to establish the PMI of human skeletal remains from the growth rate of mosses. With regard to their usefulness in the field of forensic botany, it should be stressed that there are some published cases where, for instance, the study of moss, in particular the use of monopodial growth bryophytes, is extremely useful when the complete skeletonization of a human individual took place in a shorter period than the expected because of peculiar biological or environmental conditions. It should be considered that environmental conditions do not affect the development of annual growth units, even though they can influence the leaves' density and the final length of the plants or of their secondary branches. In this way, mosses can be used to disregard the microenvironmental conditions in these particular cases. Moreover, as demonstrated in some experiments,[4] bryophyte shoots can easily become attached to shoes and clothes and, because of the common occurrence of bryophytes in many areas, it is possible to find them on footwear, providing links between crime scene and individuals.

The present paper instead deals with a case in which the study of bryophytes represents a link between crime scene and individual. Due to the fact that forensic botany is a discipline that is still poorly understood by nonbotanists, sharing the details of this case would be instructive to the community of law enforcement or forensic operators who may be involved in similar cases in the future[9]: in fact, prosecutors are frequently unaware of the potential of botanical evidence to provide linkages between crime scenes and individuals. The forensic pathologist has a pivotal role in this

Fig. 2. Traces of removed mosses on the masonry parapet of the terrace (up) and under the shoes of the victim (down).