TREE BIOLOGY AND SAPROXYLIC COLEOPTERA: ISSUES OF DEFINITIONS AND CONSERVATION LANGUAGE

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RÉSUMÉ. — *Biologie des arbres et Coléoptères saproxyliques: questions de définitions et de langage de conservation.* — La définition la plus usitée des invertébrés saproxyliques est celle présentée par Martin Speight dans *Saproxylic invertebrates and their conservation* (Conseil de l'Europe, 1989). Toutefois cette définition associe les organismes saproxyliques aux 'arbres moribonds ou morts'. Il apparaît maintenant que l'on peut admettre que les arbres vivants sains sont plus importants pour beaucoup d'invertébrés saproxyliques et que la définition demande à être modifiée. Une nouvelle révision de la définition est que les organismes saproxyliques sont des espèces impliquées dans ou dépendantes du processus de décomposition fongique du bois, ou des produits de cette décomposition, et qui sont associées à des arbres tant vivants que morts. Par convention deux autres regroupements d'organismes sont inclus dans cette définition: i) les espèces associées aux écoulements de sève et à leurs produits de décomposition, et ii) les organismes autres que les champignons qui se nourrissent directement du bois. Une compréhension de base des aspects-clés de la biologie et de l'écologie des arbres – les processus de vieillissement et de décomposition - est un outil essentiel pour les spécialistes d'invertébrés impliqués dans la conservation des Coléoptères saproxyliques. Une bonne appréciation de la terminologie des arbres est également essentielle si l'on veut réussir à promouvoir la conservation des Coléoptères saproxyliques.

Mots-Clés: Définitions, biologie des arbres, vieillissement, décomposition, communication.

SUMMARY.— The most widely used definition of saproxylic invertebrates is the one presented by Martin Speight in *Saproxylic invertebrates and their conservation* (Council of Europe, 1989). That definition however associates saproxylic organisms principally with 'moribund or dead trees'. It is now appreciated that healthy living trees are arguably more important for many saproxylic invertebrates and so the definition requires modification. A new revised definition is that saproxylic organisms are species which are involved in or dependent on the process of fungal decay of wood, or on the products of that decay, and which are associated with living as well as dead trees. Conventionally two further groupings of organisms are included within the definition: i) sap-run associates, i.e. species dependent on fluxes of sap and its decomposition products, and ii) organisms other than fungi that feed directly on wood. A basic understanding of the key aspects of tree biology and tree ecology – the aging and decay processes of trees as well as tree form and tree habitats – is an essential tool for invertebrate specialists involved in the key conservation of saproxylic Coleoptera. A good appreciation of tree terminology is also essential if we are to successfully promote conservation of saproxylic Coleoptera.

Key Words: Definitions, tree biology, aging, decay, communication.

For key conservation species there are a number of important things which need to be understood and appreciated, but for which little or no information exists in the conservation literature: How old are the trees (and deadwood) that support important saproxylic Coleoptera? Which densities of trees are preferred? Or, put another way, should the host tree be open-grown or close-grown in form? How many trees are required to support viable populations?

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We also need to be clear in our use of language in order to communicate effectively. What do we mean by terms such as: Saproxylic, Wood pasture, or pasture-woodland, Woodland, Forest.

How should we manage our trees and shrubs in order to promote effective conservation of saproxylic Coleoptera?

Entomologists need to understand and appreciate some basic tree biology in order to answer these questions.

A NEW DEFINITION OF SAPROXYLIC BASED ON TREE BIOLOGY

Martin Speight's *Saproxylic invertebrates and their conservation* (Speight, 1989) was a major advance in the conservation of saproxylic invertebrates and has been very influential in the wider conservation movement. He defined saproxylics as 'species of invertebrate that are dependent, during some part of their life cycle, upon the dead or dying wood of moribund or dead trees (standing or fallen), or upon wood-inhabiting fungi, or upon the presence of other saproxylics.'

Speight's thinking has been developing since then and his work on hoverflies (Diptera: Syrphidae) in particular has led him to modify his definition (Speight & Good, 2003). These authors point out that most saproxylic hoverflies depend on microhabitats occurring almost exclusively in live (old or senescent) trees, and that they use microhabitats that are a normal component of ancient forest, developing there as trees senesce naturally.

The Proceedings of the International Symposium on 'Dead wood: a key to Biodiversity' held in Mantova in 2003 offered a slightly revised definition: a species dependent, at some stage of its life cycle, upon the dead wood of senescent trees or fallen timber, or upon other saproxylics (Anon, 2003). This new definition allowed both vertebrates and fungi to be encompassed by the definition as well as invertebrates.

The problem with all of these definitions is that they assume that saproxylic organisms require trees to be old, senescent, moribund or falling apart, or at least dropping items of dead wood from time to time. However, knowledge of tree biology demonstrates that young trees will produce dead branches which will be used by some saproxylic species (e.g. fungi and invertebrates), that heartwood decay begins during a tree's biological maturity, and that relatively large boughs in the lower canopy die – but remain attached for a considerable length of time - as the tree attains full canopy development and shades them out. Thus a biologically mature tree is able to support a wide variety of saproxylic organisms, including rare and threatened species. Rare and threatened species are not exclusive to individual trees past biological maturity. We tend to be trapped by the forester's definition of maturity in trees, which is about commercial maturity, or when a particular tree is at peak value for exploitation. This stage is normally well before the onset of heartwood decay, which would severely reduce timber value, and typically well before the tree's biological maturity.

We also tend to be trapped in concepts of tree health that have been developed for forestry and arboriculture. It is a natural part of a tree's development that, as it ages, it steadily builds up dead and decaying branches, decaying heartwood, etc. The presence of such dead and decaying tissues has nothing to do with the health of the tree concerned. The living woody tissues of trees are separate from the dead tissues, and are not 'infected' by their presence. Most fruiting wood-decay fungi are exploiting the dead woody tissues and are rarely an indication of 'infection' or 'disease' in live wood tissue. Some may, however, have implications for structural integrity – some fungi are believed to cause failure of branches, roots and even trunks, although rarely has this been demonstrated scientifically.

A new working definition has therefore been developed which encompasses living healthy trees with internal decay as well as some dead branches, acknowledges the process of succession of decaying wood and recognizes that fungi drive the decay process: *Saproxylic organisms are species which are involved in or dependent on the process of fungal decay of wood, or on the products of that decay, and which are associated with living as well as dead trees. Conventionally two further groupings of organisms are included within the definition: i)* *sap-run associates are included within the term saproxylic, ie species dependent on fluxes of sap and its decomposition products, and ii) organisms other than fungi that feed directly on woo*d. This is a slight variation from the one presented at the Vivoin Symposium, which has been modified to acknowledge some of the discussion which followed the presentation.

AGING AND DECAY PROCESSES

Saproxylic Coleoptera species have very particular requirements. These include: type of decay, stage in the decay process, the precise location of the decay, and the situation of the host tree.

Alexander (2003) described the aging and wood-decay processes in trees and shrubs from an invertebrate ecologist's perspective. He stated the obvious - that dead and decaying wood are produced by living trees – although the obvious is all too often forgotten. He described how the variety and volume of decaying wood increases as a tree ages, and how ancient trees tend to be completely hollow and have reduced canopy height. Such trees offer unique habitats for saproxylic organisms, although the rate of production of decaying wood has slowed right down by this stage. An ancient tree is not necessarily moribund or senescent, but should be viewed as a vibrant living organism with the potential for a long and healthy future.

Heartwood decay is caused by specialist wood-decay fungi, which break down either the cellulose - leaving the lignin as a red- or brown-rot, e.g. *Laetiporus sulphureus* and *Fistulina hepatica* in oaks, or both the cellulose and the lignin, which is described as white-rot, e.g. *Inonotus dryadeus* in oak. Other types of rot are also possible, but these are the two commonest forms. In most cases – and especially under natural conditions – these heartwood decay fungi do not attack the living tissues of the outer tree rings. It seems likely that in the rare cases where a heart-rot fungus does break into the living tissue, this happens after the tree has been seriously stressed in some way and its natural defences weakened.

Heartwood decay is the most important type of wood decay for beetle conservation as the accumulations of wood mould in the base of the hollowing trunks support the greatest variety of rare, threatened and endangered saproxylic species.

Dead and decaying aerial branches also support unique assemblages of saproxylic Coleoptera. Branches may dies from a variety of causes. Shading out of lower canopy branches as the tree canopy reaches optimum size has already been mentioned. As a tree moves from full canopy development into its ancient phase, the upper canopy branches gradually decline and die – this is referred to as retrenchment. The full canopy development cannot be sustained by the live outer annual rings, the new rings becoming thinner and thinner as the trunk girth continues to expand, and so the tree reduces the canopy to rebalance its physiological capabilities. And of course branches may be damaged by wind storms, heavy snow falls, and the activities of people.

The lower canopy dead aerial branches are decayed by fungi which specialize in this sheltered and humid environment maintained by the tree canopy above. Typical fungi include *Peniophora quercina*, *Vuilleminia comedans* and *Stereum hirsutum*. The decay which results is the specialist habitat for many saproxylic Coleoptera, notably *Phloiophilus edwardsi* (Phloiophilidae), *Abdera quadrifasciata* (Melandryidae) and *Tetratoma desmaresti* (Tetratomidae).

High canopy dead branches resulting from retrenchment are thought to be the specialist habitat for a different suite of species, or which *Mesosa nebulosa* (Cerambycidae) is an example.

OTHER KEY FACTORS WHICH AFFECT THE COMPOSITION OF THE SAPROXYLIC FAUNA

One of the most striking things that a saproxylic Coleoptera conservationist encounters when looking for information on the ecology of particular species in the literature is that the key facts which would guide conservation efforts are rarely documented. Key questions which practical conservationists need answering include the following:

— How many trees are needed to maintain population viability?

— What density of trees is favoured? Do the species require open-grown trees or close-grown trees, or does this not matter?

— What age structure of trees is needed? If a particular species requires ancient trees then all age groups need to be well-represented in order to bring on new generations of host trees.

— Is management history important? The less mobile species tend to be confined to sites or places where conditions have always been favourable, or least have always maintained viable populations. More mobile species are better able to colonise newly suitable sites or places. This suggests that conservation efforts for the less mobile species need to be very carefully targeted, at sites already known to support the species, or where its occurrence is strongly suspected.

— Is grazing by large herbivores important in maintaining the appropriate vegetation structure? Or can this be mimicked by mechanical means?

All too often, literature records use terms such as 'woodland'or 'forest'. These terms do not provide the essential details as outlined above. Such terms mean different things to different people and are therefore unhelpful in conservation management. Standard conservation prescriptions for 'woodland'rarely include grazing by large herbivores (wild or domesticated livestock) and yet this may be crucial. 'Forests'in Britain and Ireland come in many forms. Historically a forest in England is an area of land covered by 'forest law'and does not necessarily include trees at all – Exmoor and Dartmoor Forests in SW England are open moorlands. In contrast, historic forests such as the New Forest and Sherwood Forest are well-known for their long history of large, old and decaying trees and which support notably rich and diverse saproxylic Coleoptera faunas. The modern usage of 'forest'is however very different, and refers to large tracts of country which have been planted with trees – often of non-native tree species - purely for timber-growing and economic purposes. Such forests hold little of interest to saproxylic Coleoptera conservation. Thus, in England at least, the term forest is not a useful one to a conservationist.

'Minimum intervention'is often recommended as a good approach to woodland conservation, allowing 'natural processes'to re-establish and maintain our native wildlife. But in most cases the full suite of natural processes are no longer available and so we need to decide whether they are sufficient or whether we should intervene, and to what extent. It is very much the absence of wild herbivores that is of great concern in western Europe, as these are almost certainly key drivers of the woodland structure under which our native saproxylic Coleoptera developed following the last glaciation (Vera, 2000). Does 'woodland'lacking aurochsen, wild horses, wild boar, bison, etc, actually support viable populations of our saproxylic Coleoptera species? In Britain at least, it is sites kept open by wild herbivores or domestic livestock that support the greatest variety of saproxylic Coleoptera. Grazing reduces tree competition and favours the development of the large open-grown trees which provide the greatest variety of decaying wood habitats.

SO WHAT MAKES A USEFUL RECORD?

It is important that when the discovery of a species of conservation interest is reported in the literature that every effort is made to note as much of the following as feasible:

— Tree and/or fungus species with which it was associated, and the extent of that association; if fungal identification expertise is not available take a sample for later examination by an expert;

— The age class of the tree – girth at breast height is a good measure of age and should always be recorded;

— Age classes of other trees in the vicinity;

— The form of tree – is it open-grown or close-grown? This can be assessed by looking for well-developed lower canopy branches or their broken stumps.

— The situation of the tree – one of many? How close are others?

— Position and condition of the decaying wood with which the species was associated: decay class, rot type – brown or white? microhabitat, position of decaying wood, e.g. attached branches, trunk, trunk base, roots, etc.

— Is the site known to have supported suitable trees historically?

— Which large herbivores are represented in the site and how many?

— Other details, comments, etc., as appropriate.

CONCLUSIONS

Trees should be the primary focus of saproxylic studies, not 'forest', 'woodland'etc, as such terms are ill-defined and open to misinterpretation.

It is important to recognize that living healthy trees – aging and decaying naturally – are key to saproxylic conservation.

Large herbivores are an important driver in tree composition and vegetation structure.

If entomologists fail to get the language right, and do not provide sufficient detail of species'needs, then we cannot expect conservationists to successfully protect our interests.

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