# LEGNO MORTO: UNA CHIAVE PER LA BIODIVERSITÀ

# DEAD WOOD: A KEY TO BIODIVERSITY

Atti del Simposio Internazionale
29-31 maggio 2003
Mantova (Italia)

*Proceedings of the International*
*Symposium 29th-31st May 2003*
*Mantova (Italy)*

a cura di *edited by*
F. Mason, G. Nardi, M. Tisato

**CNBF**
MiPAF - Corpo Forestale dello Stato
Centro Nazionale per lo Studio e la Conservazione
della Biodiversità Forestale
Verona - Bosco della Fontana

Supplemento n. 2 al n. 95 di Sherwood - Foreste ed alberi oggi • *Spediz. in A. P. - 45% - art. 2, comma 20 lettera b) legge 662/96 - Filiale EPI 52100 AREZZO aut. nr.747 del 26/08/97*

# LEGNO MORTO: UNA CHIAVE PER LA BIODIVERSITÀ
# DEAD WOOD: A KEY TO BIODIVERSITY

Atti del Simposio Internazionale
29-31 maggio 2003
Mantova (Italia)

*Proceedings of the International Symposium*
*29th-31st May 2003*
*Mantova (Italy)*

**A cura di** ***Edited by***
**Franco Mason, Gianluca Nardi, Mara Tisato**

**Traduzione inglese** ***English translation***
Alison M. N. Garside (pp. 41-43; 45-48; 49-50; 55-56)
Daniel Whitmore (pp. 91-93)

**Revisione testi in inglese** ***Revision of the English texts***
Sönke Hardersen / Daniel Whitmore
www.cnbfverona.org

**Citazione del volume** ***Volume citation***
Mason F., Nardi G. & Tisato M. (eds.), 2003 - Proceedings of the International Symposium "Dead wood: a key to biodiversity", Mantova, May 29th-31st 2003. Sherwood 95, Suppl. 2, 100 pp.

**Citazione del singolo contributo** ***Single contribution citation***
Vallauri D., 2003 - **Dead wood, a gap in French managed forests**. 7-9. In: Mason F., Nardi G. & Tisato M. (eds.), Proceedings of the International Symposium "Dead wood: a key to biodiversity", Mantova, May 29th-31st 2003.
Sherwood 95, Suppl. 2.

ISBN 88-901223-0-7
Pubblicazione cofinanziata (50%) dalla Commissione Europea e dal Ministero delle Politiche Agricole e Forestali, nell'ambito del progetto LIFE Natura NAT/IT/99/6245
*Publication co-financed (50%) by the European Commission and Ministry of Agriculture and Forestry LIFE Nature Project NAT/IT/99/6245*
Sito Web del progetto LIFE Natura NAT/IT/99/6245
*Web site of the project Life NAT/IT/99/6245*
http://www.corpoforestale.it

## Informazioni CNBF *Informations CNBF*

**Direzione Laboratori**
Via Carlo Ederle, 16/a
I-37100 VERONA (Italy)
Tel. +39 045 8345445
Fax +39 045 8301569
E-mail natcons@tin.it

**Sede Operativa**
Bosco della Fontana
Strada Mantova, 29
I-46045 MARMIROLO (MN) (Italy)
Tel./fax +39 0376 295933
E-mail entomolabcfs@tin.it

**In collaborazione con** ***In collaboration with***
Museo Civico di Storia Naturale di Verona
Società Entomologica Italiana
Ministero Ambiente e Tutela del Territorio Direzione Conservazione Natura
Istituto Sperimentale Assestamento Forestale e Alpicoltura

**Coordinamento editoriale** ***Editorial co-ordination***
Silvia Bruschini - Compagnia delle Foreste - AREZZO (Italy)

**Progettazione grafica** ***Graphic design***
Elena Palazzini - Ecoalleco s.r.l. - AREZZO (Italy)

**Editore** ***Publisher***
Compagnia delle Foreste
via Pietro Aretino 8, I-52100 AREZZO (Italy)
Tel./Fax +39.0575.370846
E-mail sherwood@compagniadelleforeste.it
Sito www.compagniadelleforeste.it

**Stampa** Tipolitografia Petruzzi C. & C. snc - CITTÀ DI CASTELLO (PG)

**Supplemento** 2 al n. 95 di Sherwood - *Foreste ed Alberi Oggi* - Dicembre 2003

## Indice

**Foto di copertina**
Archivio CNBF (F. Donini); Picchio rosso maggiore (G. Allegro).

# Index

## Poster

## SALUTO DELLE AUTORITA'
## *WELCOME ADDRESS*

**Maurizio Zillich**
Responsabile del Centro Nazionale
Biodiversità Forestale (Verona, Italia)

**Francesco Lanfredi**
Assessore alla Cultura del Comune
di Marmirolo (Mantova, Italia)

**Dario Franchini**
Presidente del Parco del Mincio
(Mantova, Italia)

**Augusto Vigna Taglianti**
Presidente del Comitato Scientifico
Fauna d'Italia (Roma, Italia)

**Giuseppe Di Croce**
Capo del Corpo Forestale dello Stato
(Roma, Italia)

**Alessandro La Posta**
Dirigente Divisione II Tutela flora e fauna
Ministero dell'Ambiente e della tutela
del territorio (Roma, Italia)

**Alberto Venchi**
Consulente per la Commissione Europea
per LIFE Natura (Roma, Italia)

**In cover photos**
CNBF Archives (F. Donini); Great spotted woodpecker (G. Allegro).

Presentiamo qui gli Atti del simposio “Legno morto: una chiave per la biodiversità”, tenutosi a Mantova nel maggio del 2003. Il simposio ha focalizzato l’attenzione sul ruolo della conservazione del legno morto nel mantenimento e nella valorizzazione della biodiversità forestale. Esistono innumerevoli specie di licheni, funghi, muschi, vertebrati e invertebrati la cui esistenza è legata ai microhabitat in alberi vivi cavi o senescenti, o in alberi morti caduti o in piedi.

Il simposio di Mantova ha rafforzato l’importanza della ricostituzione di condizioni forestali più naturali con interventi gestionali che favoriscano il legno morto, questione che si è dimostrata essere di prioritario interesse ovunque in Europa. Il simposio ha preso atto del fatto che, in Europa, esiste una notevole variazione, nella disponibilità di nozioni scientifiche riguardo alle specie saproxiliche, e nell’approccio dei gestori forestali nei confronti dell’argomento legno morto. Tuttavia, in tutta Europa, è urgente che venga notevolmente rinforzata la gestione del legno morto. Quest’ultima deve assumere una sempre maggiore importanza a livello amministrativo e silvicolturale, per permettere all’Unione Europea di venire incontro ai suoi obblighi nell’ambito della Convenzione sulla Biodiversità.

La tavola rotonda che si è tenuta durante il simposio si è concretizzata nella formulazione di una “Raccomandazione” in tre punti sul problema del legno morto, da essere trasmessa ai corpi istituzionali e dell’Unione Europea. La compilazione del testo è stata affidata ad un comitato di redazione composto da Sönke Hardersen (Germania); Franco Mason (Italia); Erik Sandström (Svezia); Jirí Schlaghamersky (Repubblica Ceca); Martin C.D. Speight (Irlanda) e Daniel Vallauri (Francia).

La “Raccomandazione” riassume le priorità identificate dai partecipanti al simposio. La nostra speranza è che venga presa in seria considerazione dai corpi istituzionali europei competenti. Sarà cura del Centro Nazionale per la Biodiversità di Verona informare coloro che hanno partecipato al simposio sui futuri sviluppi di questa iniziativa.

*The Proceedings are presented here of the symposium “Dead wood: a key to biodiversity”, held in Mantova in May 2003. The symposium focussed on the role of dead wood conservation in maintenance and enhancement of forest biodiversity. There are innumerable species of lichens, fungi, mosses, vertebrates and invertebrates whose existence depends on the microhabitats provided by hollow or senescent living trees, or by standing or fallen dead trees.*

*The Mantova symposium reinforced the importance of the reconstitution of more natural forest conditions by management practices that favour dead wood, demonstrated as being a matter for critical concern everywhere in Europe. The symposium noted that, within Europe, there is significant variation in the availability of scientific knowledge on saproxylic species, as well as in the approaches of forest managers to the subject of dead wood. However, all over Europe, it is urgent to considerably strengthen the management of dead wood. It needs to take on an ever greater importance at administrative and sylvicultural levels, in order for the European Union to meet its obligations under the Biodiversity Convention.*

*Round-table discussion during the symposium resulted in formulation of a three point "Recommendation" on the dead wood issue, for transmission to institutional and European Union bodies. Compilation of the text was achieved through the medium of an editorial committee comprising Sönke Hardersen (Germany); Franco Mason (Italy); Erik Sandström (Sweden); Jirí Schlaghamersky (Czech Republic); Martin C.D. Speight (Ireland) and Daniel Vallauri (France).*

*The “Recommendation” summarises priorities identified by the symposium participants. It is our hope that it will be given serious consideration by the competent European institutional bodies. It will be the task of the National Centre for Biodiversity, in Verona, to inform those who attended the symposium on the future development of this initiative.*

Sönke Hardersen, Franco Mason, Erik Sandström,
Jirí Schlaghamersky, Martin C.D. Speight, Daniel Vallauri

## La Raccomandazione "Saproxilici" del Simposio di Mantova

I partecipanti al simposio "Legno morto: una chiave per la biodiversità", tenutosi a Mantova, maggio 2003, raccomandano, sulla base delle informazioni fornite dalle relazioni esposte nel corso dell'incontro, che:

**1)** venga allestito un "workshop" a livello internazionale fra specialisti nello studio della flora (inclusi funghi, licheni e muschi) e della fauna (vertebrata e invertebrata) saproxiliche e i responsabili della gestione e del monitoraggio delle foreste incluse nella serie di siti della Rete Natura 2000, con l'obiettivo di riesaminare il mantenimento di questi organismi e il loro inserimento nel monitoraggio delle condizioni forestali, in diversi tipi di foreste e in diverse parti d'Europa, prendendo (almeno) una foresta in ogni Stato membro dell'UE come studio di riferimento, col particolare scopo di identificare qualsiasi procedimento che possa diventare l'oggetto di una standardizzazione;

**2)** le specie saproxiliche menzionate come caratteristiche/tipiche di tipologie forestali all'interno del Manuale d'Interpretazione della Direttiva Habitat siano incrementate, in modo da coprire una maggiore diversità di habitat forestali minacciati inseriti nella Direttiva;

**3)** sia data urgente considerazione alla messa a punto di un database computerizzato che contenga le informazioni biologiche disponibili sui saproxilici elencati come caratteristici/tipici nel Manuale d'Interpretazione, da essere utilizzato come strumento interpretativo in tutti gli Stati membri.

## The Mantova Symposium "Saproxylic's" Recommendation

*The participants in the symposium "Dead wood: a key to biodiversity", held in Mantova, May 2003, recommend, on the basis of the information provided by the presentations during the course of the meeting, that:*

***1)*** *a workshop at international level be arranged between specialists in the study of saproxylic flora (including fungi, lichens and mosses) and fauna (vertebrate and invertebrate) and those responsible for managing and monitoring forests selected for inclusion in the Natura 2000 series of sites, with a view to reviewing maintenance of these organisms and how they might be used in monitoring forest conditions, in different types of forest and different parts of Europe, taking (at least) one forest in each EU member State as a case study and with the particular objective of identifying any procedures that might be open to standardisation;*

***2)*** *the saproxylic species mentioned as characteristic/typical of forest types within the Interpretation Manual of the Habitats Directive be augmented, to cover a greater diversity of the threatened forest habitats listed in the Directive;*

***3)*** *urgent consideration be given to how a computerised database can be provided, of the biological information available for the saproxylics listed as characteristic/typical in the Interpretation Manual, for use as an interpretative tool in all member States.*

**ORGANISMO SAPROXILICO**

Una specie dipendente, in qualche stadio del proprio ciclo vitale, dal legno morto di alberi senescenti o tronchi caduti, o da altri saproxilici.

**SAPROXYLIC ORGANISM**

A species dependent, at some stage of its life cycle, upon the dead wood of senescent trees or fallen timber, or upon other saproxylics.

# DEAD WOOD, A GAP IN FRENCH MANAGED FORESTS

## *LEGNO MORTO, UNA LACUNA NELLA GESTIONE FORESTALE FRANCESE*

Daniel Vallauri

*WWF-France, 6 rue des fabres, F-13001 Marseille, France. E-mail dvallauri@wwf.fr*

**Summary:** Dead wood is a key component of old-growth forests, which is lacking in most managed forests. Therefore a rich biodiversity of cavity dwellers and saproxylic species (fungi, invertebrates, birds) is severely threatened. This paper is based on a review of the literature on dead wood in temperate old-growth forests. Each hectare of old-growth forest includes on average 40 to 200 $m^3$ of dead wood, 40 to 140 dead trees, 10 to 40 snags, and 10 to 20 trees bearing at least one cavity. After a brief comparison of managed forests in French regions and Europe, some suggestions for a better management are presented. A reasonable goal for managed forests in France would be to restore a minimum of 15 $m^3$/ha of dead wood, with at least 2 "chablis" and 2 "volis" with a diameter larger than 40 cm.

**Key words:** Dead wood, biodiversity, forest management.

The forester anticipates the death of the trees, fact that has three major ecological drawbacks: the disappearance of old and very old trees (>200 years-old), of senescent and hollow trees, and of dead wood ("chablis" and "volis").

The ecologists (Dajoz 2000; Falinski 1978; Franklin *et al.* 1987; Speight 1989, among others) and many foresters currently acknowledge that dead wood is a key component for the conservation of biodiversity, because:

- its recycling corresponds to the catabolic phase of the forest dynamics, whose animal, plant and fungal diversity is as important as that of the anabolic phase of growth;
- it is a functional compartment that ensures the storage of a huge energetic mass and nutrients in the ecosystem;
- it is initiating original segments of the food chain that is essential to many forest-dwelling species (including the scavenging micro-organisms);
- it is a source of original and varied microhabitats that are indispensable for the survival of many species of rodents, bryophyta, bats, birds and insects. Besides, these microhabitats facilitate the natural regeneration of trees (Harmon *et al.* 1986; Stöckli 1996; Pichery 2001);
- it is an associated biodiversity that includes thousands of species, and particularly species that have become rare like the stag beetle, the oak beetle, the hermit beetle, the collared flycatcher, the three-toed woodpecker, the noctules… - just to mention a few flagship species.

To understand the biological impoverishment generated by a too intensive forest management, we have reviewed the data of the literature on dead wood in old-growth forests (full bibliography on old-growth topics, more than 1.500 references in Vallauri *et al.* 2001, full review in Vallauri *et al.* 2002). Here is a short summary of the key ideas, followed by a few recommendations for conservation in French forests.

## DEAD WOOD IN OLD-GROWTH FORESTS

In France, data are lacking. Koop & Hilgen (1987) estimate the volume of dead wood in the strict reserves of Fontainebleau (France) to 103 $m^3$/ha (from 92 to 145 $m^3$/ha including 28 to 44 $m^3$/ha of snags). Elsewhere in the world (see data compiled in Table 1, in Vallauri *et al.* 2002), the volume of dead wood always exceeds at least 40 $m^3$/ha and can reach 200 $m^3$/ha. The strict reserve of the Bialowieza National Park (Poland) has from 60 to 100 $m^3$/ha depending on the type of forests (Falinski 1978). According to the literature, dead wood accounts for 5 to 30% of the standing timber volume on average.

In old-growth forests, there are on average 40 to 140 dead trees per hectare, 10 to 40 snags per hectare (diameters >20 cm), 10 to 20 trees bearing at least one cavity.

The ground area occupied by dead wood in old-growth forests is always inferior to 25% of the forest area (Harmon *et al.* 1986 for the United States). Dead wood is distributed in a very variable way, depending on the main causes of tree mortality and forest succession (storms, fire…).

The stock of dead wood is dynamic in the long run because it's constantly transforming. So the management of this stock and the included microhabitats over time is essential. The rate of natural mortality enables us to assess the dead wood "production" which, in a balanced ecosystem, equals the production of "living" wood.

In the strict reserve of the Bialowieza National Park, Falinski (1978) reckons this mortality to be at 2 to 4,5 snags/ha/year and 4 $m^3$/ha/year. In 25 mature stages of mixed old-growth forests in the Michigan and Wisconsin (Tyrrell & Crow 1994), the mortality rate ranges from 2 to 8,4 (4,8 on average) stems/ha/year (diameter: uprooted tree >20 cm and snags >10 cm).

The wood decomposition rate essentially depends on the nature of the wood, the mesoclimates and microclimates. In a linden and hornbeam wood of the strict reserve of the Bialowieza National Park (Poland), Falinski (1978) estimates the yearly decomposition rate to be at 2,9 m³/ha/year (calculation over ten years). In the USA, the degradation of the wood of many species has been closely examined (see synthesis and modelling by Xiwei Xin, 1999). On average, the yearly decomposition rate is equal to 1 to 10% depending on the species, and the dead wood's half-life, that is the necessary duration for the decomposition of half the volume, alters from less than 10 years for certain maple, birch and aspen trees to nearly 100 years for the Douglas fir (Tyrrell & Crow 1994).

## DEAD WOOD IN MANAGED FORESTS

The volume of dead wood is very low in the forests of Western Europe (Table 1). In France for example, 90% of the plots measured by IFN (National Forest Inventory) have less than 5 m³/ha of dead wood (Vallauri *et al.* 2002). In Europe, dead wood average volume, at national or regional level, exceeds 10 m³/ha only in Switzerland (Brassel & Brändli 1999) and northern Sweden (Fridman & Walheim 2000).

To add to this rarity, the spatial distribution of dead wood is very fragmented, which is a major handicap for the conservation of many species. The forests with a higher volume of dead wood are mainly located in areas that are neither very productive nor accessible by the mechanized operating machines since 1950s, particularly in the mountains, as shown by the mapping made for France for example (Figure 1).

|  | Volume of deadwood (m³/ha) | Nature of data | Sources |
|---|---|---|---|
| France | 2,23 | National average | Vallauri *et al.* 2002 |
|  | 6,75 | Departmental maximum (Savoie) |  |
| Germany | 1 to 3 | Regional average (Bavaria) | Ammer, 1991 |
| Belgium | 3,3 | Regional average (Wallonie) | Lecomte (in press) |
| Switzerland | 12 | Federal average | Brassel & Brändli, 1999 |
|  | 4,9 | Average "Plateau" region |  |
|  | 11,6 | Average "South of the Alps" region |  |
|  | 12,2 | Average "Prealps" region |  |
|  | 19,5 | Average "Alps" region |  |
| Finland | 2-10 | Production forests average | Siitonen, 2001 |
| Sweden | 6,1 | National average | Fridman & Walheim, 2000 |
|  | 12,8 | Regional maximum (North) |  |

**Table 1 -** Average volume of deadwood in the forests in a few European countries.

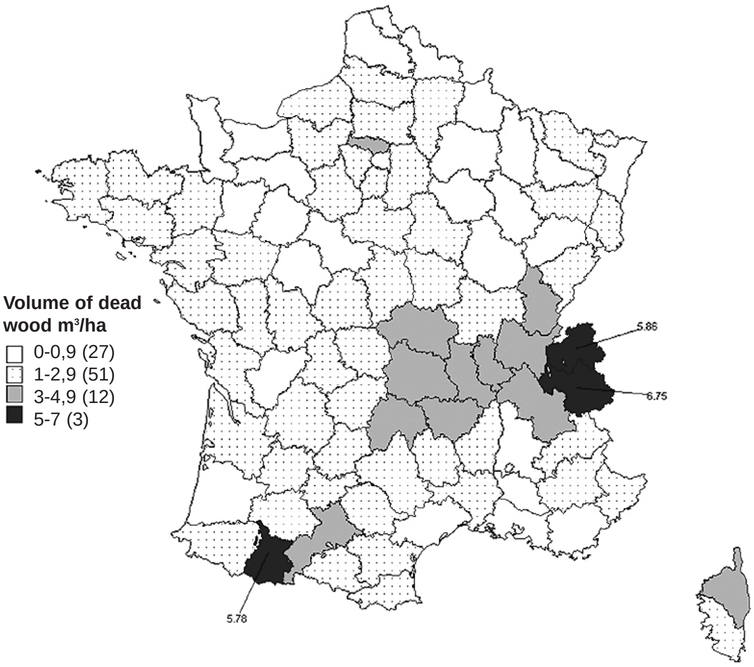


**Figure 1** - Departmental distribution of the volume of dead wood of less than 5 year-old per hectare. Average departmental volume in m³/ha and number of departments in the class in brackets (source: IFN, 2002 but data from before the 1999 storms, WWF©).

## TOWARDS AN ECOLOGICAL MANAGEMENT OF "DEAD WOOD SILVICULTURAL STANDARDS" TO PRESERVE DEAD WOOD?

Some managers have given silvicultural recommandations in order to guide the management of dead wood. The ONF (French Forest Department) noticed for instance in its "Declaration for taking biodiversity into account" that "the preservation of a few senescent or dead trees (one per ha at least) is very good for biodiversity". The ONF technical guide (1998) clarifies the selecting criteria of dead or hollow trees (diameter larger than 35 cm, cavities' diameter larger than 3 cm). After the great storms of December 1999, WWF-France has recommended to take profit from the opportunity to preserve 2 snags and 2 uprooted trees of indigenous essence at least at zero cost.

On the northern American continent, the forest Ministry of British Columbia or USDA Forest Service have emitted several regional standards. For instance, in Arizona and New Mexico, Ganey (1999) reports a recommendion to keep from 4,9 to 7,4 snags or standing dead trees per hectare (diameter larger than 46 cm and height of at least 9 meters), recommandation especially driven by raptors needs.

## A PROPOSAL BASED ON FRENCH FOREST MANAGEMENT REALITIES

What could be recommended in France, mitigating ecological needs, current gap and economical context? Let us make a first suggestion below:

- **a basic rule**: to manage better what dies naturally, i.e. leave the opportunity to die naturally (ageing, non removed snags and uprooted trees). It seems useless to us to make the forest even more artificial by cutting trees or creating uprooted trees under the pretext of "speeding" natural processes. Dead wood is an indicator of biodiversity but also of naturalness, and would be restored rapidly, as far as silvicultural rules are applied;
- **a general proposal**: the progressive retention of dead trees of indigenous spe-

cies, with the target of restoring a dead wood compartment of 15 $m^3$/ha, i.e. nearly 1/3 of the minimum volume generally present in an old-growth forest. Managers should aim also to fill the great gap concerning big trees by preserving at least 2 uprooted trees and 2 snags with a diameter larger than 40 cm per hectare for their great cavity-dwelling and saproxylic potential;

- **a wish**: that scientific research broaden the knowledge in French managed and protected forests.

## CONCLUSIONS

In the ecosystem, life and death are related. Dead wood is indispensable to the life of a whole series of animal and plant species, which follow one another over time to exploit this resource. An old-growth forest containing at least 40 $m^3$/ha of decomposing deadwood is incomparably richer in biodiversity than an artificial coniferous tree plantation that contains neither dead wood nor underbrush.

In order to develop a good forest management, foresters should choose two complementary ways:

- the protection of forests free from any logging activities, in which the natural functions (in particular the geochemical cycles) are neither disturbed nor truncated. This can be undertaken by a reorientation of the forest management in protected areas and the creation of new large-surface strict reserves (at the scale of a watershed, minimum viable size of 10.000 ha), as 224 French scientists asked in their “Scientists’ call for the protection of forests in France” (September 2001, ***www.multimania.com/appelscience/appel.html***);
- in productive forests, the improvement of the rules that enable to maintain the microhabitats necessary for the life of the species depending on old trees, cavities, and dead wood. The biological information given in this article shows that it is not only by preserving one small-diameter tree per hectare that biodiversity conservation would be improved. The preservation of 15 $m^3$/ha of regularly distributed wood (including 2 uprooted trees and 2 snags with a diameter larger than 40 cm per hectare) is likely to improve the biodiversity very quickly (Vallauri *et al*. 2002, 2003). It represents, in France, a maximum loss of earnings of 15 Euros/ha/year (at 20 Euros per $m^3$ of standing tree) and is of no danger regarding pests (Nageleisen, in press).

## References

Ammer U., (von) 1991 - **Konsequenzen aus den Ergebnissen der Totholzforschung für die forstliche Praxis**. Forstw. Cbl., 110: 149-157.

Brassel P., Brändli U-B. (eds.), 1999 - **Inventaire forestier national suisse. Résultats du deuxième inventaire 1993-1995**. Haupt, Berne, Stuttgart, Vienne, 442 pp.

Dajoz R., 2000 - **Insects and forests: the role and diversity of insects in the forest environment**. Editions Tec & Doc, Paris, 668 pp.

Falinski J.B., 1978 - **Uprooted trees, their distribution and influence in the primeval forest biotope**. Vegetatio, 38 (3): 175-183.

Franklin J.F., Shugart H.H., Harmon M.E, 1987 - **Tree death as an ecological process.** Bioscience 37 (8): 550-556.

Fridman J., Walheim M., 2000 - **Amount, structure and dynamics of dead wood on managed forestland in Sweden**. Forest ecology and management, 131: 23-26.

Ganey J.L., 1999 - **Snag density and composition of snag populations on two national forests in the northern Arizona**. Forest ecology and management, 117 (1-3): 169-178.

Harmon M.E., Franklin J.F., Swanson F.J., Sollins P., Gregory S.V., Lattin J.D., Anderson N.H., Cline S.P., Aumen N.G., Sedell J.R., Lienkaemer G.W., Cromarck JR., Cummins K.W., 1986 - **Ecology of coarse woody debris in temperate ecosystems**. Advances in Ecological Research., 15: 133-302.

Koop H., Hilgen P., 1987 - **Forest dynamics and regeneration mosaic shift in unexploited beech (*Fagus sylvatica*) stands at Fontainebleau (France)**. Forest ecology and management, 20: 135-150.

Lecomte H., (in press) - **L’inventaire permanent des ressources forestières de Wallonie**. Actes du colloque "Inventaire et suivi de la biodiversité en Région wallonne", La Marlagne, Mars 2000.

Nageleisen L.M. (in press) - **Les arbres morts sont-ils dangereux pour la forêt?** Xylobios Worshop, Mont Rigi (Belgique), 11 et 12 mars 2002.

ONF, 1998 - **Arbres morts, arbres à cavités. Pourquoi, comment?** Guide technique, Office National des Forêts, Fontainebleau, 32 pp.

Pichery Ch., 2001 - **Eléments de réflexion pour une meilleure gestion du bois mort en forêt**. Rapport ENGREF/FIF, Nancy, 95 pages + annexes.

Siitonen J., 2001 - **Forest management, coarse woody debris and saproxylic organisms: Fennoscandian boreal forests as an example**. Ecological Bulletins, 49: 11-41.

Speight M.C.D., 1989 - **Saproxylic invertrebrates and their conservation**. Strasbourg, Council of Europe, 82 pp.

Stöckli B., 1996 - **La régénération des forêts de montagne sur du bois mort**. La forêt, 49 (2): 6-12.

Tyrrell L.E., Crow T.R., 1994 - **Dynamics of dead wood in old-growth hemlock-hardwood forests of northern Wisconsin and northern Michigan**. Canadian Journal of Forest Research, 8: 1672-1683.

Vallauri D., Gilg O., Poncet L., Schwoehrer C., 2001 - **Scientific references for a representative and functional conservation network of old-growth forests**. WWF, RNF, Paris, 90 pp. and CD-Rom (***http://www.wwf.fr/pdf/References.pdf***).

Vallauri D., André J., Blondel J., 2002 - **Le bois mort, un attribut vital de la biodiversité de la forêt naturelle, une lacune des forêts gérées**. Rapport WWF, Paris, 34 pp. (***http://www.wwf.fr/pdf/Bois%20mort.pdf***)

Vallauri D., (coord.) 2003 - **Livre blanc sur la protection des forêts naturelles en France**. Forêts métropolitaines. Lavoisier, Tec & Doc, WWF, Paris, 261 pp.

Xiwei Xin, 1999 - **The decay of forest woody debris: numerical modelling and implications based on some 300 data cases from North America**. Oecologia, 121 (1): 81-98.

# MAMMIFERI E UCCELLI IN UN HABITAT FORESTALE DELLA PIANURA PADANA: IL BOSCO DELLA FONTANA

## *MAMMALS AND BIRDS IN A WOODLAND OF THE PO PLAIN: BOSCO DELLA FONTANA*

Paolo Paolucci

*Dipartimento di Agronomia ambientale e produzioni vegetali - gruppo di Entomologia. Università degli Studi di Padova.*
*Agripolis, Viale dell'Università 16, I-35020 Legnaro (PD), Italy. E-mail paolo.paolucci@unipd.it*

**Summary:** This work deals on the typical vertebrates of lowland forests, particularly the species with a clear preference for the dead wood. Small mammals and birds are the main vertebrates which take advantage of this important ecological niche. Some birds, like woodpeckers, use dead trees to feed on saproxylic invertebrates; others, like nuthatch, tawny owl, hoopoe and tits, nest in crevices of old trunk. Also some mammals, like common and edible dormice, stone marten and bats, take refuge in crevices in the breeding season and during hibernation. Finally, mice and shrews are essentially opportunistic predators which feed on a wide variety of saproxylic invertebrates on the forest floor.

**Key words:** Dead wood, Mammals, Birds, Lowland Forest, Italy.

Gli habitat forestali della Pianura Padana, pur nella loro esigua estensione e nella loro frammentazione ed isolamento, costituiscono importanti riserve di biodiversità. Essi rappresentano la cenosi che un tempo ricopriva il nostro territorio e conservano ancora esempi relitti e testimonianze delle antiche faune planiziali (cfr. MINELLI *et al.* 2001).

Per le avifaune migranti, che dai quartieri di svernamento transitano sul nostro paese, costituiscono importanti oasi di sosta, dove riposare e recuperare le riserve consumate nel lungo viaggio; per altre specie di animali, i cui habitat ottimali si sono fortemente ridotti nel corso degli ultimi decenni, diventano importanti rifugi.

Da una recente ricerca (LONGO e NADALI 2001) è risultato che la fauna vertebrata terrestre di Bosco della Fontana (Marmirolo, MN) è costituita da poco meno di 150 specie: un centinaio di uccelli, 15 tra anfibi e rettili e oltre 20 mammiferi. Si tratta di una fauna sicuramente ricca se consideriamo che molte delle specie presenti sono scomparse da quasi tutto il resto della pianura Padana. Tra l'altro, oltre la metà delle specie di uccelli e di mammiferi presenti, si possono considerare tipicamente forestali oppure legate per l'intero loro ciclo vitale, o per parte di esso, ai vecchi tronchi deperiti o morti.

Tale ricchezza faunistica si deve probabilmente proprio alla presenza importante di riserve di legno deperiente, lasciato marcire e cadere al suolo. I vecchi alberi morti, sia quelli ancora in piedi sia quelli già schiantati e i grossi rami cariati costituiscono un importante luogo dove, in tempi e modi diversi, vari vertebrati ricercano il cibo, nidificano o semplicemente si rifugiano.

## LEGNO MORTO COME RISERVA TROFICA: L'ESEMPIO DEI PICCHI

La maggior parte dei picidi sono importanti predatori di faune saproxiliche e la scarsa disponibilità di tronchi morti o marcescenti è la causa principale della loro rarefazione o scomparsa da una vasta porzione della pianura. Delle tre specie tipicamente planiziali, il più diffuso è certamente il picchio rosso maggiore, *Picoides major* (Linné, 1758). Plastico e in grado di adattarsi a diverse situazioni ambientali, comprese le artificiali piantagioni di pioppi e i parchi cittadini, il picchio rosso maggiore è divenuto la specie di picide più comune. Diverso il destino del picchio verde, *Picus viridis* Linné, 1758, che invece ha subito la massiccia, inesorabile riduzione delle formazioni boscate della pianura; questa specie era tipica soprattutto dei filari di vecchi salici, olmi, pioppi, gelsi, i cui tronchi, invasi frequentemente dalle grosse formiche del genere *Camponotus* Mayr, 1861, erano visitati con assidua costanza dal grosso picide soprattutto in inverno, quando le immagini, le uova e le grosse larve di questo imenottero formicide rappresentavano una delle riserve trofiche più costanti e relativamente facili da raggiungere. La riduzione, e in molti casi la scomparsa, di queste realtà paesaggistiche della pianura Padana, ha provocato in alcuni casi una modificazione di comportamento stesso del picchio verde, che, in sostituzione delle formiche saproxiliche, oggi saccheggia frequentemente i formicai delle specie praticole, similmente al più piccolo torcicollo, *Jynx torquilla* Linné, 1758 e preda inoltre un gran numero di altri invertebrati (FRUGIS *et al.* 1988).

**Foto 1** - Per il picchio muratore (*Sitta europaea*) la scomparsa dei vecchi alberi è uno dei fattori limitanti della sua attuale distribuzione nella Pianura Padana.

È noto che gli habitat forestali ricchi di alberi vecchi e di tronchi morti in piedi sono l'habitat ideale per il delicato picchio rosso minore, *Picoides minor* (Linné, 1758) (Olsson *et al.* 1992; Nilsson 1997). Tra l'altro, secondo Roselaar (1985), pare che più che l'altezza o la specie di alberi presenti, per il piccolo picide sia particolarmente importante la disponibilità di legno deperito e morto da tempo, più tenero e facilmente scavabile. Per tali motivi, nella pianura Padana questa specie è confinata in poche località e molto recentemente è stata osservata anche a Bosco della Fontana, proprio durante il periodo riproduttivo (Longo e Nadali 2001).

## IL LEGNO MORTO COME LUOGO PER LA RIPRODUZIONE: GLI UCCELLI

Assai più ricca è la schiera degli animali che sfruttano le cavità di tronchi e rami per costruirvi il nido. Molti uccelli, come le cince, sono in grado di occupare per la nidificazione qualunque piccola cavità: affatto esigenti, alle volte anche una stretta, vecchia fessura creata da un fulmine sui tronchi può servire a questi piccoli passeriformi come luogo nel quale allevare le due-tre nidiate dell'anno. Nella ricerca del cibo la cincia bigia, *Parus palustris* Linné, 1758, la cinciallegra, *P. major* Linné, 1758 e la cinciarella, *P. caeruleus* Linné, 1758 posseggono ben divisi compiti e nicchie trofiche: la prima è una frenetica esploratrice delle chiome leggere dei salici e dei fiori; la più grossa cinciallegra è perfettamente adattata ad aggredire anche grossi semi e frutti che riesce a spaccare con forti colpi di becco; da ultima, la delicata cinciarella è un'agile acrobata, sempre intenta a frugare con il corto becco tra i muschi e i licheni che coprono i rametti più alti delle chiome.

Il piccolo, attivissimo picchio muratore (Foto 1), *Sitta europaea* Linné, 1758 utilizza in genere le cavità dei tronchi poste ad una certa altezza e di cui riduce sapientemente l'apertura con fango. Unico uccello in grado di scendere dai tronchi rugosi a testa in giù, lo si avverte soprattutto per il caratteristico canto.

La presenza delle cavità nei tronchi è determinante anche per il successo riproduttivo di alcuni strigiformi; la civetta comune, *Athene noctua* (Scopoli, 1769) e ancor più l'allocco, *Strix aluco* Linné, 1758, abbisognano infatti di grandi cavità nei tronchi dove deporre le uova e allevare la prole. Il grosso allocco, la specie di strigiforme planiziale di maggiori dimensioni, ha costumi tipicamente forestali e, anche se in grado di vivere nelle aree urbane ricche di parchi e giardini, predilige i vecchi boschi maturi sia per nidificare sia per cacciare le sue prede principali: i piccoli roditori boschivi e gli uccelli silvani.

**Foto 2** - La nottola (*Nyctalus noctula*) è un tipico chirottero forestale, particolarmente legato alla presenza di cavità nei tronchi degli alberi.

Diverse altre specie di uccelli sfruttano le nicchie dei tronchi come l'upupa, *Upupa epops* Linné, 1758, il torcicollo, il codirosso, *Phoenicurus phoenicurus* (Gmelin, 1789), il pigliamosche, *Muscicapa striata* Pallas, 1764, lo storno, *Sturnus vulgaris* Linné, 1758, la passera mattugia, *Passer montanus* (Linné, 1758) e la passera d'Italia, *P. italiae* (Vieillot, 1817).

## UN LUOGO DOVE RIFUGIARSI: IL CASO DEI MAMMIFERI

Sono soprattutto le piccole specie di mammiferi che utilizzano come rifugio le spaccature nei tronchi e le cavità degli alberi. Infatti a parte la faina, *Martes foina* (Erxleben, 1777) che utilizza a volte tali nascondigli, sono i gliridi e i chirotteri i veri padroni di questi habitat. Tra i primi il moscardino, *Muscardinus avellanarius* (Linné, 1758) è un roditore arboricolo ancora diffuso negli habitat boschivi della pianura, anche se la forte riduzione delle siepi campestri ne ha seriamente compromesso l'areale. Il ghiro, *Myoxus glis* (Linné, 1766), comune e ampiamente diffuso nella fascia prealpina e collinare, risulta raro negli ambienti forestali di pianura e confinato a poche località; tra queste il Bosco della Fontana, dove la sua presenza costituisce una interessante novità essendo un'area forestale completamente isolata già da molto tempo. La scoperta di questa specie è recente e testimonia l'interesse faunistico che gli ambienti forestali planiziali rivestono. Entrambi i gliridi si riproducono volentieri nelle cavità degli alberi e ancor più le utilizzano gli esemplari non riproduttivi.

**Foto 3** - Tra le specie più interessanti di Bosco della Fontana vi è il topo selvatico dal dorso striato (*Apodemus agrarius*); i boschi della pianura Padana centro-orientale costituiscono il limite occidentale della sua amplissima distribuzione.

Molte sono le specie di chirotteri che sono in grado di utilizzare questi ambienti; tra le tante quelle appartenenti ai generi *Pipistrellus* Kaup, 1829, *Nyctalus* Bowdich, 1825, alcuni *Myotis* Kaup, 1829, il pipistrello di Savi, *Hypsugo savii (*Bonaparte, 1837), e il barbastello, *Barbastella barbastellus* (Schreber, 1774). La nottola comune (Foto 2), *Nyctalus noctula* (Schreber, 1774) e la nottola di Leisler, *N. leisleri* (Kuhl, 1818) sono le specie più forestali; si radunano d'estate in colonie numerose sfruttando come luogo per partorire e allevare i piccoli i fori e le crepe sui tronchi, anche ad altezze considerevoli. Meno esigenti sono il pipistrello albolimbato, *Pipistrellus kuhli* (Natterer in Kuhl, 1819), il pipistrello nano, *P. pipistrellus* (Schreber, 1774) e il pipistrello di Savi, originariamente forestali ma che da secoli si sono adattati perfettamente a vivere nelle vicinanze delle abitazioni. Di tutte queste specie ben tre, il pipistrello albolimbato, quello di Savi e la nottola comune, sono state per ora segnalate nel Bosco della Fontana (Scaravelli e Bertozzi, in stampa).

## LEGNO MORTO A TERRA: UN HABITAT PER I MOLTI MICROMAMMIFERI

I tronchi caduti al suolo e le cataste di rami costituiscono per insettivori e roditori terragni un'importante nicchia trofica e una ricca disponibilità di rifugi. Tre le specie che più di altre sfruttano tali situazioni ambientali ve ne sono due particolarmente importanti: il toporagno della Selva di Arvonchi, *Sorex arunchi* Lapini e Testone, 1998 e il topo selvatico dal dorso striato (Foto 3), *Apodemus agrarius* Pallas, 1771. Nel primo caso si tratta di una specie recentemente separata sistematicamente dall'affine, e più montano, toporagno comune, *Sorex araneus* Linné, 1758; tipico degli habitat forestali padani, pare legato a stazioni fresche, soggette a periodici allagamenti primaverili quali sono i boschi di pianura. La sua dieta è costituita da piccoli invertebrati dal tegumento molle, spesso appartenenti a faune saproxiliche, che ricerca nel terreno smosso sotto i tronchi e tra i detriti lignei al suolo (cfr. Longo e Nadali 2001).

Il topo selvatico dal dorso striato è un piccolo roditore, inconfondibile per la presenza sul dorso di una linea nera piuttosto marcata. Il suo ampio areale di distribuzione va dalla Cina sino all'Europa centro orientale, e in Italia è presente unicamente negli habitat boscosi, freschi e umidi della pianura Padana centro-orientale, dalla Lombardia al Friuli-Venezia Giulia.

L'accumulo sul terreno di cortecce, branche marcescenti e altri detriti vegetali, ne favoriscono la presenza, poiché rappresentano luoghi in cui ricercare invertebrati di varie specie che costituiscono una importante frazione della sua dieta (cfr. Longo e Nadali 2001).

## CONCLUSIONI

Da questa sintesi sulla fauna vertebrata di Bosco della Fontana, e in particolare sugli uccelli e sui mammiferi in grado di utilizzare il legno morto, è emersa chiaramente l'importanza che rivestono le realtà forestali gestite con particolare attenzione agli aspetti naturalistici. Gli interventi selvicolturali che sono stati adottati a Bosco della Fontana negli ultimi anni hanno sicuramente contribuito ad incrementare la biodiversità di un'area che, anche se di modeste dimensioni, faunisticamente rappresenta uno degli ambienti più ricchi del territorio padano, a conferma che la presenza di alberi deperienti e di riserve di legno morto risulta di vitale importanza per la fauna e costituisce una chiave per la biodiversità proprio, e soprattutto, in habitat isolati come i relitti boschi planiziari.

## Bibliografia

Frugis S., Malaguzzi G., Vicini G., Cristina P., 1988 - **Guida ai Picchi del mondo**. Monografie del Museo Regionale di Scienze Naturali, Torino, 7: 352 pp.

Longo L., Nadali A., 2001 - **Vertebrati di un bosco planiziario padano: Bosco della Fontana**. Quaderni Conservazione Habitat, 1. Corpo Forestale dello Stato, Centro Nazionale per lo Studio e la Conservazione della Biodiversità Forestale di Bosco Fontana, Gianluigi Arcari Editore, 112 pp.

Minelli A., Ruffo S., Stoch F. (eds.), 2001 - **Le Foreste della Pianura Padana**. Quaderni Habitat. Ministero dell'Ambiente, Museo Friulano di Storia Naturale di Udine, 158 pp.

Nilsson S. G., 1997 - ***Dendrocopos minor* Lesser spotted woodpecker**. In: Hagemeijer W. J. M. & Blair J. M. (eds.), 1997, The EBCC atlas of european breeding birds. Their distribution and abundance. Europaen Bird Census Council by T. & AD Poyser, 903 pp.

Olsson O., Nilsson I.N., Nilsson S.G., Pettersson B., Stagen S., Wiktander U., 1992 - **Habitat preferences of the Lesser Spotted Woodpecker *Dendrocopos minor***. Ornis Fennica. 69: 119-125.

Roselaar C.S., 1985 - ***Dendrocopos minor* Lesser Spotted Woodpecker**. In: Cramp S. (eds.), 1985. Handbook of the birds of Europe, the Middle East and North Africa. The birds of the Western Palearctic. Vol.IV, Terns to Woodpeckers. Oxford University Press, 960 pp.

Scaravelli D., Bertozzi M., 2003 - **Primi dati sui Chirotteri della Riserva Naturale Statale Bosco della Fontana** 94-95. In: Mason F., Nardi G. & Tisato M. (eds.), Proceedings of the International Symposium "Dead wood: a key to biodiversity", Mantova, May 29-31 2003. Sherwood 95, supplement 2.

# SAPROXYLIC INVERTEBRATES OF FLOODPLAINS, A PARTICULARLY ENDANGERED COMPONENT OF BIODIVERSITY

## *INVERTEBRATI SAPROXILICI NELLE PIANURE ALLUVIONALI, UNA COMPONENTE DELLA BIODIVERSITÀ PARTICOLARMENTE A RISCHIO*

Jirí Schlaghamersky

*Masaryk University, Brno, Faculty of Science, Department of Zoology and Ecology, Kotlárská 2, CZ-611 37 Brno, Czech Republic.*
*E-mail jiris@sci.muni.cz*

**Summary:** Dead wood and moribund trees are characteristic structural elements of forests, providing a dominant resource of dead organic matter and special microhabitats. Many invertebrates are saproxylic, i.e. dependent on this resource either through trophic or topic links. Many saproxylic species have become rare and threatened, often restricted to remnants of primeval forests. Most such stands still exist in mountainous areas at higher altitudes while very few lowland forests have an unbroken history of existence and a close to natural state. However, in some floodplains of large rivers forests did prevail throughout the ages. Today, floodplain forests are among the most endangered habitats in Europe. Data on the saproxylic fauna in floodplains is very limited. Since 1996, the saproxylic communities of some arthropod taxa (Araneae; Coleoptera; Diptera: Brachycera; Hymenoptera: Formicidae) have been studied in old floodplain forests, dominated by oak and ash, in South Moravia (Czech Republic). Some aspects of species richness and the impact of inundation shall be presented.

**Key words:** Dead wood, floodplains forests, Czech Republic, saproxilic community.

Dead wood and moribund trees are characteristic structural elements of forests, providing a dominant resource of dead organic matter as well as special microhabitats. In other terrestrial ecosystems they present a less important component but might still increase their structural and biological diversity. Many invertebrates, mainly insects as beetles or two-winged flies, are adapted to utilise this resource. Such species are called saproxylic (Speight 1989). Besides direct and indirect trophic links this includes also topic links, i.e. the specialisation on characteristic structures serving as microhabitats or shelters. The level of dependence on dead wood existing in individual species that are either part of a saproxylophagous food chain or utilise the provided microhabitats, differs from case to case, allowing us, for instance, to distinguish between obligatory and facultative saproxylics. As most such definitions, the term "saproxylic" becomes rather fuzzy on its "edges".

Besides their important ecological role, saproxylic invertebrates constitute a major part of biodiversity in terrestrial ecosystems in general and particularly of woodlands. In commercially managed forests their microhabitats have become a scarce resource thus hosting significantly impoverished saproxylic communities. This is partially due to the very essence of forestry, i.e. the extraction of woody biomass, but also to forestry practise governed by the view that dead wood presents a breeding ground for forest pests. Logging debris, old rotten trunks and tree stumps, are being removed, burned or burried. Because of this development many saproxylic species, including numerous invertebrates, have become very rare. Those with restricted mobility and high requirements on habitat quality have become extremely rare and are considered relicts of primeval forests. These species can also be put to use as bioindicators of close to natural stands of an unbroken history of forestation. In Europe, most such stands still exist in mountainous areas at higher altitudes, which were less accessible to human exploitation. On the contrary, the lowlands were usually the first areas colonised by man and thus lowland forests have been subject to exploitation of high intensity over long periods of time. Many forests were clear-cut for good, turning the land into meadows, pastures or arable land. The remaining ones were managed as coppices and dead wood of larger diameters was probably often scarce for hundreds of years. One situation were lowland forests did prevail throughout the ages, were the floodplains of large rivers. Here, re-occurring floods prevented other types of land use or made sustainable logging or woodland pasture economically favourable alternatives.

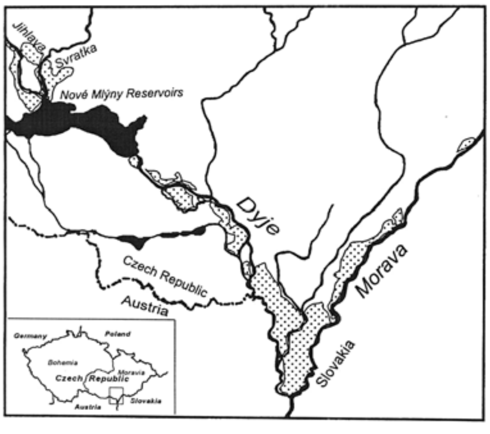


**Figure 1** - The situation of floodplain forests (dotted) in South Moravia (Czech Republic).

**Photo 1** - Large diameter dead wood, both fallen and standing, and temporary pools still characterise some South Moravian floodplain forests including commercially managed ones (photograph from the Confluence site studied).

Old trees of large diameters were preserved in pastures and since the end of the 18th century many low forests were turned back into high forests, thus probably improving the situation for some saproxylic invertebrates. However, the character of this wetland ecosystem was radically changed by massive river regulation, which cut off most of the natural floodplains from the natural flood pulse and made different types of land use more feasible. Also the trend to plant non-indigenous tree species, including the change of entire stands into hybrid poplar plantations poses a serious threat. Another change of tree species composition took place in the second half of the 20th century due to Dutch elm disease almost erradicating the previously abundant elm trees with their specialised fauna. Today, close to natural floodplain forests are among the most scarce and endangered ecosystems in Europe. We can assume the same for their saproxylic fauna, which is threatened by the lack of microhabitats (due to traditional forest management) as well as by the sheer lack of macrohabitats (i.e. the small total area, its fragmentation and changes in its character, its water regime). Although saproxylic invertebrates have received rather substantial scientific attention in Europe within the last two decades, data on the saproxylic fauna of lowland forests, particularly such on floodplains, are very limited. Since 1996, the saproxylic communities of some arthropod taxa (Coleoptera; Diptera: Brachycera; Hymenoptera: Formicidae; Araneae) have been studied in old floodplain forests in South Moravia (Czech Republic). The obtained results may shed a little more light on the saproxylic invertebrate communities of floodplain forests.

## MATERIALS AND METHODS

Since 1996 the author has studied saproxylic communities of several invertebrate taxa in forests at the rivers Dyje (Thaya) and Morava (March) in South Moravia, i.e. the south-eastern part of the Czech Republic (Figure 1). In the most intensive field research phase in 1996 and 1997, the focus was on the comparison of two sites located in a distance of some 20 km: one with a close to natural water regime (exposed to flooding), the other not flooded since 1972 due to river regulation. Both are "hardwood" floodplain forests, i.e. dominated by oak (*Quercus robur* L.) and ash (*Fraxinus angustifolia* Vahl), which is the dominant type of floodplain forests in the area. The proportion of elm (*Ulmus laevis* Pallas and *U. minor* Miller) has decreased dramatically due to Dutch elm disease. The studied stands (3,4 and 6,9 ha respectively) were in order 150 and 120 years old and both rich in dead wood. The flood-exposed site is a commercial stand with temporary and permanent pools in terrain depressions (Photo 1). The non-flooded site is a research plot set aside in 1968 and not exposed to floods since the last inundation in 1972. Emergence traps were used for quantitative sampling of insects emerging from oak logs of a moderately advanced stage of decomposition (6 traps per site operated in two seasons with enclosed logs exchanged after the first season). Window traps were used to sample the total assemblage of flying saproxylic beetles. Complementary material was collected using tree photoeclectors and by hand collecting of beetles. In total some 14.000 adult specimens of beetles (Coleoptera), 8.000 adult specimens of two-winged flies (Diptera Brachycera; from emergence traps only), 5.500 adult ants (Formicidae), and 1.700 adult and juvenile specimens of spiders (Araneae; tree photoeclectors only) were collected and analysed (Figure 2). A number of specialists for individual taxonomic groups were involved in species identification. For further details see SCHLAGHAMERSKY (1999, 2000); KUBCOVÁ & SCHLAGHAMERSKY (2002) and URBÁNKOVÁ & SCHLAGHAMERSKY (2002).

## RESULTS

Looking at Coleoptera (SCHLAGHAMERSKY 2000), 310 species recorded on the study sites within the above-mentioned study were classified as (potentially) saproxylic. This number is by no means complete as the Staphylinidae were only partially analysed and Ptiliidae were not identified at all due to a lack of specialists. Adding species collected from the same or very close sites from 1990 to 1996 (DROZD 1997), 389 saproxylic species of 57 families were recorded. Of those, 321 species were found on the non-flooded site and 197 species on the flood-exposed site (98 species in common). This material included a species new to science - *Malthinus moravicus* Svihla, 1997, Cantharidae (SVIHLA 1997). The comparison of total species numbers might be misleading as the previously collected material analysed by DROZD (1997) had been more intensive on the non-flooded site. For the saproxylic beetle community of lying oak logs in a single - moderately advanced - stage of decomposition estimates based on the emergence trap data and several algorithms ("species richness estimators") indicate that true species richness (Staphylinidae and Ptiliidae excluded) is 130 to 160 species on the non-flooded site and about 120 species on the flooded site (94 and 80 species respectively were actually caught by the emergence traps). Species richness and evenness were higher on the non-flooded site both in the oak log community and regarding the total assemblage collected by the window traps. On the other hand, numbers of individuals were generally higher on the flood-exposed site. Mean annual densities of saproxylic beetles emerging from the studied oak logs ranged between 129 ± 21 and 295 ± 77 individuals per 100 $dm^3$ wood (± standard error of the mean) with higher densities reached at the flood-exposed site.

The percentage of individuals belonging to species that might act as forest pests was very low (SCHLAGHAMERSKY 2000, 2001). 39 of the recorded saproxylic beetle species should be considered threatened in the Czech Republic (ROZKOSNY & VANHARA

1995, 1996). These were species either restricted to old forest stands or to wetland sites.

Brachycera were analysed from the oak log emergence traps (Urbánková & Schlaghamersky 2002), yielding 13 obligate, 44 facultative and 105 potential saproxylic species (27 families). On each site 108 (potentially) saproxylic species were found with only 54 species in common. As in beetles, species diversity was somewhat higher on the non-flooded site. Mean emergence densities ranged between 104 ± 18 and 335 ± 61 individuals per 100 $dm^3$ wood, again reaching higher values on the flood-exposed site. The material included two species probably new to science and one recorded for the first time in the Czech Republic.

In regard to Formicidae (Schlaghamersky 2000), 14 species were classified as (potentially) saproxylic, 11 of which were collected by the oak log emergence traps. Again, species richness and diversity were higher on the non-flooded site (13 versus 8 species recorded on site or 10 versus 5 species recorded in the oak logs). On the flood-exposed site, an extraordinary flood in summer 1997 almost erradicated ants from the lying oak logs. The presence and abundance of ant colonies in the studied oak logs was clearly linked with the occurrence of myrmecophilous Coleoptera and Brachycera. The arboricolous *Liometopum microcephalum* (Panzer, 1798), present on the flood-exposed site, is a threatened species that is reaching the northern border of its range in the area.

Regarding Araneae, only the material collected by means of open tree photoeclectors on three standing dead tree trunks was analysed. 41 arboricolous species (of 82 recorded species belonging to 17 families) were found. This included species living in the tree crowns and specialised bark dwellers (about on third). Of the species found, 16 are regarded rare in the Czech Republic. One species was recorded for the first time in the Czech Republic, another one in Moravia. With *Midia midas* (Simon, 1884) (Linyphiidae), a rare relict of primeval forests was found. This species has been found exclusively in rotten trees (cavities, bird nests, rotten wood, bark).

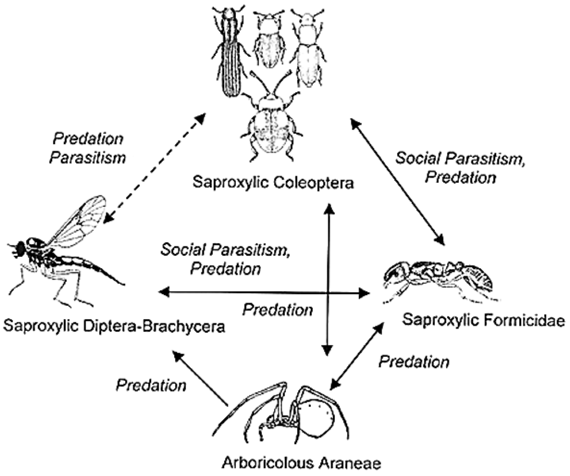


**Figure 2** - The groups of saproxylic invertebrates studied by the author in South Moravia (arrows indicate potential interactions between their representatives).

## DISCUSSION AND CONCLUSIONS

The saproxylic invertebrate communities, comprising representatives of a number of higher taxa (often phylogenetically remote) and trophic groups, have a substantial share in the total biodiversity of floodplains. For instance saproxylic beetles make up for about one third of species of Coleoptera living in South Moravian hardwood floodplain forests. At least north of the Alps, floodplains of lowland rivers present a refuge or even migration path for thermophilous invertebrate species, including saproxylic ones (in South Moravia for instance the ant *Liometopum microcephalum* or beetles as *Triplax collaris* (Schaller, 1783) (Erotylidae), *Cicones undatus* (Guérin-Ménéville, 1844) (Colydiidae), *Dircaea australis,* Fairmaire, 1856 (Melandryidae), *Mordellaria aurofasciata* (Comolli, 1837) (Mordellidae), *Trichoferus pallidus* (Olivier, 1790), *Cerambyx cerdo,* Linné, 1758, *Tetrops starki* Chevrolat, 1859, and *Saperda perforata* (Pallas, 1773) (all Cerambycidae). On the other hand, species that were considered boreomontane, have also been found in South Moravian floodplains, the beetle *Liodopria serricornis* (Gyllenhal, 1813) (Leiodidae). Such species are probably assumed montane elements just because few lowland forests remained in a close to natural state, thus providing the required saproxylic microhabitat.

The species diversity of the saproxylic assemblages studied in South Moravia was higher on the non-flooded site (except for spiders, however, the data set was small in this case). The ground storey of floodplain forests with a close to natural water regime is a rather extreme habitat and a significant impact of inundation on saproxylic communities has been shown. Ants are particularly sensitive to floods. On the other hand, this habitat hosts big populations of many hygrophilous species. As only remnants of such habitats have been preserved in Europe, these species can be assumed to be particularly endangered. We know much less about the ecology of brachycerous flies, particularly when it comes to larvae. This is also reflected by the fact, that many species found had to be included under potential saproxylics. It seems that saproxylic communities of Brachycera are dominated by facultative saproxylics and less sensitive to higher humidity and flooding then beetles or ants.

Even for invertebrates without a direct trophic link to dead wood, as spiders, moribund or dead trees and their parts present an important habitat enrichment and provide a niche for some saproxylics.

## References

Drozd P., 1997 - **Brouci jihomoravské luzní oblasti** [The beetles of the South Moravian floodplain area (in Czech)]. Doctoral thesis, Mendel University of Agriculture and Forestry, Brno, 93 pp.

Kubcová L., Schlaghamersky J., 2002 - **Zur Spinnenfauna der Stammregion stehenden Totholzes in südmährischen Auenwäldern**. Arachnol. Mitt., 24: 35-61.

Rozkosny R., Vanhara J. (eds.), 1995 - **Terrestrial Invertebrates of the Pálava Biosphere Reserve of UNESCO II.** Folia Fac. sci. nat. Univ. Masaryk. Brun., Biol., 93: 207-406.

Rozkosny R., Vanhara J. (eds.), 1996 - **Terrestrial Invertebrates of the Pálava Biosphere Reserve of UNESCO III**. Folia Fac. sci. nat. Univ. Masaryk. Brun., Biol., 94: 407-630.

Schlaghamersky J., 1999 - **The impact of flooding on saproxylic beetles and ants in South Moravian floodplain forests**. 277-287. In: Tajovsky K., Balík V. & Pizl V. (eds.), Soil Zoology in Central Europe. ISB AS CR, Ceské Budejovice.

Schlaghamersky J., 2000 - **The saproxylic beetles (Coleoptera) and ants (Formicidae) of Central European floodplain forests**. Folia Fac. sci. nat. Univ. Masaryk. Brun., Biol., 103: 1-204.

Schlaghamersky J., 2001 - **Dead wood in floodplain forests - biodiversity multiplier or forest pest breeding ground?** 207-216. In: Kulhavy J., Hrib M. & Klimo E. (eds.), Proceedings of the international conference Management of Floodplain Forests in Southern Moravia, Zidlochovice 13-16 5 2000, Mendel University of Agriculture and Forestry, Brno.

SPEIGHT M.C.D., 1989 - **Saproxylic invertebrates and their conservation**. Council of Europe, Strasbourg, 66 pp.

SVIHLA V., 1997 - ***Malthinus moravicus* sp. n. (Coleoptera: Cantharidae) - surprising discovery of new species in Central Europe**. Klapalekiana, 33: 101-102.

URBÁNKOVÁ M., SCHLAGHAMERSKY J., 2002 - **The impact of inundation on floodplain forest *Brachycera* (Diptera) associated with oak logs**. 253-260. In: TAJOVSKY K., BALÍK V. & PIZL V. (eds.), Studies on Soil Fauna in Central Europe. ISB AS CR, Ceské Budejovice.

## Acknowledgements

A major part of the author’s field work on which this contribution is based was supported by an annual scholarship (HSP III) of the German Academic Exchange Service. Further support was given by the Institute of Forest Ecology, Mendel University, Brno (grant VS 96077 "The Identification of Stress and Stress Response in Forest Ecosystems"). Most of the data analysis, follow-up field research and the preparation of the present contribution have been conducted at the Department of Zoology and Ecology, Faculty of Science, Masaryk University, Brno, (grant MSM 143100010 "Spatial and Temporal Biodiversity Dynamics of Ecosystems in Central Europe"). The work would not have been possible without a number of specialists, who identified parts of the material or checked the author’s identification free of charge.

# SELEZIONE DEI SITI DI NIDIFICAZIONE E PREFERENZE AMBIENTALI DEL PICCHIO DORSOBIANCO (*DENDROCOPOS LEUCOTOS*)

## *SELECTION OF NESTING SITES AND HABITAT PREFERENCES OF THE WHITE-BACKED WOODPECKER (DENROCOPOS LEUCOTOS)*

Mauro Bernoni

*Scaletta di Piazza Padella 6, I-00062 Bracciano (RM), Italy. E-mail mbernoni@inwind.it*

**Summary:** Between 1987 and 2002 twenty-one nest holes of white-backed woodpecker, a species associated in Italy with mature beech woodlands and highly endangered in the westernmost parts of its large Palearctic range, have been found in the Apennines. The main study area considered has been the Abruzzo National Park, a zone characterised by a particularly favourable conservation state of its forestal ecosystem. Our field research has aimed, on one hand, to identify the environmental characteristics of the species' breeding areas and, on the other, given the purposive selection of its breeding sites, to identify their characteristics, also with the aim of providing suggestions for beech woodland management. The results show how the species purposely selects mature, old or rotting trees, with large dead parts. Lesser importance is attached to the tree's diameter, that in many instances is very small. All nest holes have been found in high trunk beech trees, confirming the species' preference.

**Key words:** White backed woodpecker, nesting site, Picidae, beech woodlands.

Nell'ambito delle specie che si riproducono nelle foreste, i Piciformi rappresentano certamente la categoria sistematica più specializzata e sensibile dal punto di vista ambientale, tanto da venire considerati dei veri e propri indicatori ecologici (Del Hoyo *et al.* 2002). Hanno bisogno infatti di boschi maturi, diversificati sul piano delle specie arboree, ricchi di alberi secchi e di insetti; le foreste naturali che la selvicoltura ha fatto quasi scomparire sono il loro habitat d'elezione ed il numero di specie di Picchi presenti è in genere direttamente proporzionale alla qualità dell'ambiente.

Il Picchio dorsobianco (*Dendrocopos leucotos*, Bechstein, 1803) è la più esigente e specializzata tra le specie presenti in Europa, minacciata in tutta la porzione più occidentale del suo ampio areale paleartico dalla forestazione produttiva, che lo ha portato sull'orlo dell'estinzione in nord Europa, mentre nell'Europa centro-meridionale la sottospecie *lilfordi* (Sharpe e Dresser, 1871) risulta poco conosciuta e studiata, con un areale disgiunto tra Caucaso e Turchia, Balcani, Italia centrale e Pirenei (Cramp 1985).

L'entità della popolazione nidificante in Italia può essere stimata (Bernoni 1999) a 240-300 coppie l'80% delle quali presenti nel Parco Nazionale d'Abruzzo e zona di protezione esterna; le valutazioni espresse da Pinchera e Pellegrini (1999) relative ad una presunta sovrastima della popolazione del Parco Nazionale d'Abruzzo appaiono del tutto infondate e riferibili per lo più alla difficoltà nel reperire i nidi (3 nidi trovati in 3 anni di ricerca), che solo l'intensificazione del numero di visite e l'utilizzo di tecniche combinate di ricerca può superare. Si pensi a questo proposito che nel 2003 sono stati trovati due nidi occupati a solo 680 m di distanza (dati inediti) e che nel 1993, furono reperiti 8 nidi ed individuati complessivamente 10,5-12,5 territori su di un'area di 820 ha (Bernoni 1994a) con una densità media dunque compresa tra 1,3 ed 1,5 coppie/km$^2$.

## Materiali e metodi

Il Picchio dorsobianco è risultato diffuso in Italia principalmente nell'area del Parco Nazionale d'Abruzzo e nei Monti Ernici-Simbruini, un territorio relativamente omogeneo a cavallo tra Lazio, Abruzzo e Molise, dove si estendono le più vaste e meglio conservate faggete d'alto fusto del nostro paese (AA.VV. 1987), l'habitat chiave per la conservazione di questa specie. La specie risulta estinta nell'Appennino settentrionale (Tellini Florenzano 1999). Recenti ricerche (Bernoni 1999) hanno confermato la presenza di un secondo nucleo e la nidificazione anche nella zona dei Monti Reatini (Nuria - Nurietta - Terminillo), dei Monti Giano e Cagno, anche questi a cavallo tra Abruzzo e Lazio, in un settore circa 50 km a nord del primo. Le segnalazioni per il Velino-Sirente e la Majella (Abruzzo) fanno ritenere che si possa trattare di esemplari erratici o coppie isolate, mentre quelle per il Gargano (Di Carlo 1965) non hanno trovato conferma recente. Dati incerti e da confermare provengono invece dalla Basilicata e dalla Campania (Regione Basilicata 1996; Fraissinet *et al.* 2001).

L'area di studio principale, anche se nel corso degli anni sono state compiute ricerche in tutti i principali rilievi montuosi

Ricerca svolta con il finanziamento del Centro Studi Ecologici Appenninici del Parco Nazionale d'Abruzzo, Lazio e Molise.

| Fonte | Area geografica | Sottospecie | Numero alberi | Diametro albero a petto d' uomo (dbh) | Altezza albero | Diametro albero ad altezza nido | Altezza nido |
|---|---|---|---|---|---|---|---|
| Wesolowski & Tomialojc (1986) | Polonia (Bialowieza) | *leucotos* | 13 | - | - | - | 17,8 (5-35) |
| Ruge & Weber (1974) | Germania (Baviera) | *leucotos* | 16 | - | - | - | 9,2±6,2 (3-38) |
| Håland & Toft (1983) | Norvegia | *leucotos* | 19 | - | - | - | 4,2±1,6 (1,8-7,5) |
| Aulén (1988) | Svezia | *leucotos* | 124 | 32,8±8,9 | 12,5±4,7 | 23,5±4,0 | 6,9±2,7 |
| Grangé (1993) | Francia (Pirenei) | *lilfordi* | 7 | 35,0±7,7 | 17,7±2,7 | - | 10,5±6,3 |
| Presente ricerca | Italia (P.N. d'Abruzzo) | *lilfordi* | 21 | 59,3±36,8 (25-200) | 17,5±4,3 (7,0-26,0) | 29,5±4,9 (25-35) | 11,1±3,0 (6,0-17,0) |
| Matsuoka (1979) | Giappone | *namiyei* | 11 | 56,5 (23-100) | 16,3 (7,5-22) | 23,4 (20-40) | 13,3 (6,5-20) |

**Tabella 1** - Confronto tra le caratteristiche del sito di nidificazione e del nido rilevate da diversi autori, per tre sottospecie di *Dendrocopos leucotos*. Sono indicati il valore medio e, se disponibili, la deviazione standard e il range di variazione. I diametri sono in cm, le altezze in m. Dati non disponibili (-).

dell'Appennino centrale, coincide con i confini del Parco Nazionale d'Abruzzo esteso circa 50.000 ha, dei quali oltre il 50% coperti da vaste faggete d'alto fusto, a quote comprese tra i 1.100 ed i 1.900 metri di quota.

La raccolta dati relativa alle nidificazioni di Picchio dorsobianco nel Parco Nazionale d'Abruzzo procede ormai, seppure frammentariamente, da oltre un decennio ed è iniziata nel 1987.

Le difficoltà legate alla individuazione della presenza della specie sono state in parte superate con la messa a punto di una metodologia specifica (Bernoni 2001); l'attività territoriale che precede lo scavo dei nidi e l'attività di scavo stessa, la presenza di trucioli di legno al piede dell'albero, la scelta di tipologie arboree caratteristiche, le specifiche esigenze in termini di struttura del bosco, i versi dei giovani alimentati dai genitori possono in alcuni casi agevolare il lavoro del ricercatore, ma l'individuazione di un singolo albero tra le migliaia che coprono le montagne dell'area costituisce sempre un'impresa difficile a causa della notevole estensione dei territori che oscilla tra 50 e 100 ettari circa, delle difficoltà di spostamento con la neve e della morfologia dell'area. A questo fine si è preferito indagare l'area ad ovest di Pescasseroli (AQ) ed Opi (AQ) che, per quanto più sfruttata sul piano forestale, è anche più facilmente accessibile e percorribile a piedi, vasta circa 1.500 ha e compresa in una fascia altitudinale tra i 1.200 ed i 1.800 m, ma per gran parte tra i 1.350 ed i 1.600 m.

Sul piano metodologico per classificare gli alberi caratterizzati dalla presenza di nidi occupati si è utilizzato il metodo proposto da Aulén (1988) che individua sei tipologie a crescente stato di decadimento della pianta:

**1.** albero vitale senza segni di decadimento;
**2.** segni di decadimento, per esempio uno o più grandi rami morti;
**3.** albero ancora vivo, ma solo uno o pochi rami con le foglie;
**4.** albero morto recentemente con il legno ancora piuttosto compatto;
**5.** albero morto da alcuni anni con legno marcito in alcune zone;
**6.** molto legno marcito; il tronco può cadere da un momento all'altro (tronco spesso rotto con pochi o nessun ramo).

La posizione del nido sull'albero è stata classificata secondo le seguenti categorie: tronco, ramo principale (che si diparte dal tronco), ramo secondario (che si diparte da un altro ramo). Sono stati inoltre misurati l'esposizione, l'altezza del nido, l'altezza ed il diametro a petto d'uomo dell'albero; il diametro ad altezza nido è stato invece stimato.

É stata inoltre rilevata la presenza di corteccia sul tronco e sui rami principali e di funghi del legno, la struttura del bosco circostante nel raggio di 50 m, l'eventuale presenza entro tale diametro di radure grandi (diametro >50 m) o piccole (diametro <50 m).

## RISULTATI

Nel corso delle diverse ricerche condotte (1987-2003) nell'area sulle faggete, sono stati reperiti 21 nidi. I principali dati relativi alle caratteristiche degli alberi sono riassunti in Tabella 1 e confrontati con quelli di analoghe indagini svolte in altre aree geografiche.

Nessun albero interessato da nidi era completamente vivo: in 8 casi (38,1%) le piante erano completamente morte e 3 di queste (14,3%) presentavano il legno in stato di forte decadimento; in 13 casi (61,9%) gli alberi erano vivi, e presentavano solo una limitata porzione secca (33,3%) oppure erano per lo più morti, con alcuni rami verdi (28,6%).

La localizzazione più numerosa del nido è risultata quella sul tronco (52,4%) contro il 47,6% totalizzato dai rami principali.

Le esposizioni prevalenti del foro del nido sono risultate con il 19,0% ciascuna est, sud-est, sud ed ovest. Il quadrante compreso tra est e sud è risultato quello preferito con 12 nidi (57,1%).

L'altezza sul livello del mare dei nidi, pur condizionata dalla distribuzione altitudinale delle faggete è risultata curiosamente molto stabile con un range compreso tra 1.300 e 1.550 m, un valore medio di 1.466 m (s.d. ±66,4); probabilmente una quota intermedia consente di posizionare i nidi nella porzione centrale dei pendii e di raggiungere più facilmente tutte le aree del territorio.

Il diametro a petto d'uomo della pianta (dbh) è risultato pari a 59,3 cm (s.d. ±36,8); l'elevata deviazione standard va letta alla luce di casi isolati di alberi molto grandi (fino a 200 cm), ma più frequenti sono i casi di nidi che si trovano in alberi di medie dimensioni: nel 23,8% dei casi (5) il diametro era minore o uguale a 35 cm, nel 47,6% minore o uguale a 45 cm.

Il diametro stimato ad altezza nido (valore medio 29,5 cm) mostra che vengono scelti tronchi e rami relativamente piccoli; in questo caso il valore modesto della deviazione standard (±4,9) ci indica una certa regolarità nella selezione operata dalla specie.

Anche nel caso dell'altezza del nido il valore medio è relativamente regolare con 11,1 m (s.d. ±3,0) seppure con isolati casi di nidi molto bassi (<8 m; 2 casi) o molto alti (>15 m; 3 casi).

Il diametro medio delle piante d'alto fusto circostanti è risultato pari a 38,1 cm (s.d. ±9,1), decisamente inferiore dunque al diametro medio degli alberi che ospitano nidi, segno dunque che la specie compie una scelta della pianta.

La presenza di radure entro 50 m dal nido nel 52,3% dei casi sembra suggerire una certa preferenza della specie per tali situazioni, ma non va dimenticato che la specie seleziona strutture boschive mature nelle quali il crearsi di piccole radure, per la caduta degli alberi è evento piuttosto frequente.

## DISCUSSIONE E CONCLUSIONI

La scelta operata sugli alberi dal Picchio dorsobianco è certamente rivolta ad intervenire sul legno morto, caratterizzato da una minore resistenza meccanica allo scavo.

Le conclusioni che si possono trarre da questa ricerca sono soprattutto di tipo conservazionistico.

La strategia volta alla protezione di questa rara specie deve fondamentalmente mirare alla tutela delle piante mature, morte, marcescenti o danneggiate da eventi meteorologici, che costituiscono il sito di nidificazione elettivo e rappresentano la principale sede di ricerca del cibo. Tali tipologie arboree e forestali sono inoltre fondamentali per la conservazione di altre specie rare nell'Appennino: Picchio rosso mezzano (*Dendrocopos medius*), Picchio rosso minore (*Dendrocopos minor*), Balia dal collare (*Ficedula albicollis*) e Rampichino alpestre (*Certhia familiaris*). Le aree caratterizzate dalla presenza di tali condizioni (Bernoni 1994b) garantiscono infatti una maggiore densità del Picchio dorsobianco e delle altre specie citate e vanno tutelate, quanto meno con una gestione forestale mirata a preservare gli esemplari secchi e marcescenti, anche se di diametro non elevato, in particolare se riuniti in piccole "isole". Questa tipologia si è infatti rivelata particolarmente interessante per garantire la fedeltà al sito di nidificazione che in almeno due casi è stata confermata rispettivamente per 10 e per 8 anni.

## Bibliografia

AA.VV., 1987 - **Statistiche forestali**. ISTAT, 38: 148 pp.

Aulén G., 1988 - **Ecology and Distribution History of the White-backed Woodpecker *Dendrocopos leucotos* in Sweden**. Swedish Univ. of Agric. Sciences. Dept. of Wildlife Ecol. Uppsala. Report 14: 256 pp.

Bernoni M., 1994a - **Il Picchio dorsobianco (*Picoides leucotos lilfordi)* nel Parco Nazionale d'Abruzzo**. Contributi scientifici alla conoscenza del Parco Nazionale d'Abruzzo, 46: 69 pp.

Bernoni M., 1994b - **Primi dati sul Picchio dorsobianco *Picoides leucotos* nel Parco Nazionale d'Abruzzo**. Atti VI Convegno Italiano di Ornitologia (Torino 1991), Mus. reg. Sci. nat. Torino: 491-492.

Bernoni M., 1999 - **Lo status del Picchio dorsobianco *Picoides leucotos* in Italia centrale: nuove scoperte e prospettive di conservazione**. Avocetta, 23: 103.

Bernoni M., 2001 - **Il Picchio dorsobianco nell'Appennino: tecniche di ricerca e nuove aree di indagine**. Avocetta, 25: 84.

Cramp S., 1985 - **The Birds of the Western Palearctic**. Vol IV. Oxford Univ. Press. 960 pp.

Del Hoyo, J., Elliott, A., Sargatal J. (eds.), 2002 - **Handbook of the Birds of the World. Vol. 7**. Jacamars to Woodpeckers. Lynx Edicions, Barcelona. 613 pp.

Di Carlo E.A., 1965 - **Viaggio a scopo ornitologico nelle Puglie**. Riv. Ital. Orn., 35: 167-236.

Fraissinet M., Cavaliere V., Conti P., Milone M., Moschetti G., Piciocchi S., Scebba S., 2001 - **Check-list degli uccelli della Campania**. Riv. Ital. Orn., 71: 9-25.

Grangé J.L., 1993 - **Données préliminaires sur la biologie de reproduction du Pic à dos blanc pyrénéen (*Dendrocopos leucotos lilfordi*) en Béarn**. Nos Oiseaux, 42: 17-28.

Håland A., Toft G.O., 1983 - **Hvitryspettens forekomst og habitat-valg på Vestlandet.** Vår Fuglefauna, 6: 3-14.

Matsuoka S., 1979 - **Ecological significance of the Early Breeding in White-backed Woodpeckers *Dendrocopos leucotos***. Tori, 28: 63-75.

Pinchera F., Pellegrini M., 1999 - **Spaziatura e densità dei siti di riproduzione di Picinae in due aree dell' Appennino Centrale**. Riv. Ital. Orn., 69: 105-114.

Regione Basilicata, 1996 - **Basilicata regione - notizie n. 5-6**. Risorsa natura in Basilicata: le aree protette regionali. Ufficio Stampa Consiglio Regionale della Basilicata. Potenza. 216 pp.

Ruge K., Weber W., 1974 - **Biotopwahl und Nahrungserwerb beim Weissrückenspecht (*Dendrocopos leucotos*) in den Alpen**. Vogelwelt, 94-95: 138-147.

Tellini Florenzano G., 1999 - **Note sui cambiamenti dell'avifauna appenninica nel corso di due secoli**. Atti Conv. Studio e attività di conservazione dei Rapaci in Italia, Miratoio di Pennabili 5.6.1999, Ente Parco Sasso Simone e Simoncello: 45-53.

Wesolowski T., Tomialojc L., 1986 - **The breeding ecology of woodpeckers in a temperate primaeval forest - preliminary data**. Acta Ornithologica, 22 (1): 1-21.

# IL PICCHIO ROSSO MAGGIORE (*PICOIDES MAJOR*) SPECIE-CHIAVE NELLA PIOPPICOLTURA ITALIANA

## *THE GREAT SPOTTED WOODPECKER* (PICOIDES MAJOR) *A KEY-SPECIES IN THE ITALIAN POPLAR STANDS*

*Gianni Allegro*

*Istituto di Sperimentazione per la Pioppicoltura, PO Box 116, Strada Frassineto 35, I-15033 Casale Monferrato (AL), Italy.*
*E-mail allegro@populus.it*

**Summary:** The great spotted woodpecker has to be considered a valuable help in the natural control of the poplar borers, as it can destroy a remarkable amount of xylophagous insects larvae and shows a functional response to the pest density, thus contributing to lower pest populations and to prevent outbreaks. Nests and roost-holes are mostly excavated in dead trees and in snags sizing at least 15 cm in diameter; their preservation in poplar stands is highly recommended, as their presence facilitates the settling of the predator and enhances its efficacy. Moreover, dead wood can host a rich saproxylic fauna which is not harmful to living trees and is more and more threatened in the restricted and fragmented relict riparian woodlands.

**Key words:** Great spotted woodpecker, poplar growing, xylophagous insects, dead wood.

La pioppicoltura specializzata costituisce in Italia un'importantissima fonte di materia prima legno per l'industria, arrivando a fornire circa il 50% del legno di origine nazionale (Bisoffi e Coaloa 2000). Piemonte, Lombardia, Emilia-Romagna, Veneto e Friuli-Venezia Giulia sono le regioni che ospitano le maggiori superfici a pioppeto, contribuendo nel loro insieme a formare circa il 70% dell'intera pioppicoltura nazionale (Coaloa 1999). Le elevate produzioni di legno ottenibili per unità di superficie (mediamente 20 m$^3$ha$^{-1}$ anno$^{-1}$ contro i 2 m$^3$ha$^{-1}$anno$^{-1}$ dei boschi naturali) sono rese possibili dalle cure colturali intensive che comprendono anche l'eliminazione di ogni specie vegetale concorrente ed il controllo delle più importanti avversità di origine entomatica o fungina. Questa logica di tipo intensivo ha sempre fatto sì che i pioppeti specializzati venissero assimilati più a una coltura agraria che ad una formazione (seppure estremamente semplificata) di tipo forestale. Soltanto in anni recenti una logica più sensibile verso i problemi dell'ambiente ha iniziato a portare in primo piano il ruolo ecologico non trascurabile dei pioppeti specializzati lungo le aste fluviali degli ambienti padani, con una maggiore attenzione rivolta anche al ruolo e alla conservazione degli ausiliari e agli aspetti della biodiversità nelle piantagioni (Bogliani 1988; Allegro e Sciaky 2003). Da questo nuovo modo di concepire la pioppicoltura è nato l'interesse, verso la fine degli anni '80 del secolo scorso, di approfondire le conoscenze sul ruolo ecologico del Picchio rosso maggiore (PRM), *Picoides major* (Linné, 1758), nei pioppeti specializzati, ed in particolare i suoi rapporti con gli insetti xilofagi, temibili avversità della pioppicoltura, e con alcuni parametri ambientali e colturali, tra i quali la presenza di piante morte all'interno delle piantagioni. I risultati di queste indagini hanno costituito l'oggetto di tre pubblicazioni (Allegro 1991, 1993, 1996) e hanno permesso di definire alcune linee gestionali del pioppeto finalizzate alla conservazione di questo prezioso ausiliario.

**Foto 1** - Maschio di Picchio rosso maggiore all'ingresso del nido in pioppeto.

## MATERIALI E METODI

Un primo filone di indagine è stato volto a studiare l'alimentazione dei nidiacei del PRM per verificare in quale misura gli insetti xilofagi entrassero nella loro dieta. A tale scopo in 3 pioppeti interni alla golena del Po a Casale Monferrato (AL) sono state individuate 3 cavità nido occupate da covata e a fianco del loro ingresso è stata posizionata una fotocamera munita di "winder" e di comando a distanza. Per mezzo di un telecomando azionato da un capanno mimetico posto nelle vicinanze del nido, per diversi giorni e fino all'involo dei pulli è stata fotografata ogni singola visita dei genitori che, come è noto, portano le prede da offrire ai nidiacei ben visibili ai lati del becco. Sempre dal capanno sono stati altresì raccolti dati riguardanti la frequenza delle visite, l'alternanza dei due genitori nelle visite di nutrizione e il territorio esplorato nella ricerca del cibo (Allegro 1996).

Una seconda indagine ha tentato di chiarire le preferenze del PRM per quanto riguarda lo scavo delle cavità nido o dormitorio all'interno del pioppeto. A tal fine, in alcune piantagioni nella zona di Casale Monferrato sono stati raccolti dati sulla dimensione e la posizione delle piante utilizzate dal PRM, sul loro stato sanitario, sulla presenza di eventuali stroncature del fusto e sull'altezza da terra e l'orientamento delle cavità (Allegro 1996).

Infine è stato condotto uno studio sulla predazione del PRM nei confronti delle larve della Saperda maggiore del pioppo, *Saperda carcharias* (Linné, 1758), (Coleoptera, Cerambycidae), un pericoloso parassita xilofago della coltura. In particolare sono state verificate le "life tables" dell'insetto, in modo da evidenziare i principali fattori di mortalità naturale e l'importanza relativa della predazione da parte del PRM. I controlli, eseguiti in pioppeto con cadenza mensile, hanno permesso di mettere in evidenza anche la fenologia della predazione. Inoltre, mediante osservazioni condotte in 28 pioppeti padani (principalmente localizzati lungo il corso orientale del Po piemontese e in Lomellina), sono state ricercate le correlazioni tra il livello di predazione delle larve ed alcuni fattori come il grado di complessità ambientale (espresso mediante indice sulla base dell'isolamento del pioppeto o, all'opposto, sulla sua contiguità con aree di bosco naturale), l'età del pioppeto, la densità delle popolazioni di *S. carcharias*, la presenza di piante morte e di cavità nido/dormitorio (Allegro 1991).

## RISULTATI

L'alimentazione dei nidiacei del PRM è risultata costituita in larga parte da insetti (larve di Lepidotteri, Dermatteri, Afidi, ecc.) e da Opilioni raccolti sui tronchi o sulla chioma dei pioppi e da piccoli frutti; soltanto una ridottissima frazione delle prede era costituita da larve xilofaghe che, come hanno messo in evidenza le successive indagini, vengono catturate dal PRM quasi esclusivamente durante il periodo invernale. Il maschio (Foto 1) ha prestato cure parentali più assidue, con una frequenza di 5-7 visite di nutrizione/ora contro le circa 3 della femmina. Nel 70-80% dei casi il "range" di foraggiamento non ha superato i 120-140 metri dal nido, per una superficie esplorata di circa 3 ettari (Allegro 1996).

Nei pioppeti osservati, i nidi e le cavità per il riposo notturno erano scavati dal PRM in grande maggioranza nelle piante morte o con apice spezzato, e comunque all'interno di porzioni di legno morto e parzialmente degradato. Erano state scelte piante con diametro a petto d'uomo superiore a 15 cm e le cavità erano state scavate in genere oltre i 3 metri di altezza da terra e con foro d'uscita prevalentemente orientato in direzione est e sud (Allegro 1996).

La predazione da parte del PRM sulle larve xilofaghe della Saperda maggiore è risultata pressoché esclusivamente concentrata nel periodo di riposo vegetativo del pioppo, da novembre a marzo, quando l'insetto è presente all'interno dei tronchi allo stato di larva di quinta età (Allegro 1991). La capacità di estrarre larve dall'interno del legno si rivela pertanto utile al predatore soprattutto durante i periodi in cui scarseggiano le prede più "facilmente" catturabili sulla superficie della vegetazione.

Dallo studio delle "life tables" della Saperda maggiore è emerso che sono molto importanti (70-80% della popolazione totale) le mortalità a carico dei primi stadi di sviluppo (uova e larve giovani), causate soprattutto dalla reazione dei tessuti corticali della pianta, da parassitoidi oofagi e da infezioni fungine. Si è osservato poi un ulteriore 10-20% di mortalità a carico delle larve più sviluppate, attribuibile in larga misura all'azione del PRM. La mortalità totale è stata valutata intorno al 90-95% dell'intera popolazione, valore che rapportato alla limitata fertilità dell'insetto (circa 50 uova/femmina) testimonia di una specie con popolazioni tendenzialmente in equilibrio, difficilmente soggette a grosse fluttuazioni (Allegro 1991).

L'entità della predazione del PRM sulle popolazioni larvali svernanti della Saperda è risultata significativamente correlata con il livello di complessità ambientale, rivelandosi più elevata ($r=0,55$; $p<0,01$) nei pioppeti confinanti con boschi naturali (46,5%) rispetto ai pioppeti accorpati su vaste superfici (27,6%) e a quelli isolati (13,7%).

È stata inoltre dimostrata una correlazione significativa tra la percentuale di larve predate e la presenza di cavità nido o dormitorio nei tronchi ($r=0,50$; $p<0,01$); quest'ultima variabile è a sua volta strettamente associata con la disponibilità di pioppi morti in piedi o stroncati all'interno del pioppeto ($r=0,71$; $p<0,01$) (Allegro 1991). Questa correlazione dimostra una volta di più il fatto che il PRM scava preferenzialmente la propria dimora nelle porzioni di legno morto.

È stata inoltre verificata, almeno per quanto riguarda i pioppeti accorpati su vaste estensioni, una stretta associazione tra il livello di predazione e la densità di popolazione della Saperda maggiore ($r=0,69$; $p<0,01$), per cui è possibile ipotizzare una risposta funzionale del PRM al variare delle popolazioni del parassita xilofago, le cui oscillazioni di popolazione verrebbero così smorzate e tendenzialmente stabilizzate dal predatore (Allegro 1991).

## DISCUSSIONE E CONCLUSIONI

Il PRM è una presenza comune nei pioppeti specializzati padani. Ciò è reso possibile dal suo eclettismo alimentare e dal fatto di non dipendere, per le sue esigenze di alimentazione e di nidificazione, dalla vegetazione del sottobosco (Bogliani 1988), che viene frequentemente rimossa con le lavorazioni del terreno. L'importanza del predatore quale fattore di limitazione di insetti economicamente dannosi all'interno delle piantagioni di pioppo è stata sottolineata con studi che hanno messo in evidenza i fattori che ne possono favorire l'insediamento e l'attività. Tra questi gioca un ruolo primario la disponibilità di piante morte in piedi o comunque caratterizzate da porzioni morte (purché di adeguate dimensioni), perché all'interno del legno morto il PRM scava le sue cavità nido o dormitorio. Le piantagioni in cui il predatore può insediarsi possono giovarsi di una sua maggiore efficacia, in quanto costituiscono la parte centrale del suo territorio di caccia. Dal punto di vista della gestione del pioppeto, è pertanto importante non rimuovere le piante morte o stroncate da agenti atmosferici quando queste hanno raggiunto un diametro a petto d'uomo di almeno 15-20 cm. Non esistono a questo proposito controindicazioni di carattere fitosanitario salvo che per le piante uccise da marciume radicale (causato da *Rosellinia necatrix* o *Armillariella mellea*), che andrebbero preferibilmente rimosse per evitare il contagio delle piante sane e l'estendersi dell'infezione (Allegro 1993).

Oltre ad avere un effetto favorevole sulla nidificazione di diverse specie di uccelli che nidificano in cavità (Bogliani 1988), la conservazione di legno morto in pioppeto può anche determinare un sensibile aumento della biodiversità con l'insediamento di una ricca fauna saproxilica che, data la sua elevata specializzazione, non può essere di minaccia alcuna per le piante vive e vigorose destinate alla produzione di legno. Ciò è auspicabile anche in relazione all'estrema riduzione e alla frammentazione dei boschi naturali ripari negli ambienti di pianura, di cui i pioppeti in molte situazioni rappresentano, nonostante la loro estrema semplificazione, gli unici fragili surrogati disponibili.

## Bibliografia

ALLEGRO G., 1991 - **Il Picchio rosso maggiore (*Picoides major* L.) nella limitazione naturale delle popolazioni della Saperda maggiore del pioppo (*Saperda carcharias* L.)**. Avocetta, 15: 33-41.

ALLEGRO G., 1993 - **Un prezioso alleato della pioppicoltura: il Picchio rosso maggiore**. L'Inf. Agr., 49 (25): 73-76.

ALLEGRO G., 1996 - **Osservazioni sul comportamento del Picchio rosso maggiore, *Picodes major*, in pioppeto durante il periodo riproduttivo**. Riv. ital. Orn., 66 (1): 17-27.

ALLEGRO G., SCIAKY R., 2003 - **Assessing the potential role of ground beetles (Coleoptera, Carabidae) as bioindicators in poplar stands, with a newly proposed ecological index (FAI)**. Forest Ecology and Management, 175: 275-284.

BISOFFI S., COALOA D., 2000 - **Problemi attuali e prospettive della pioppicoltura italiana**. Economia Montana - Linea Ecologica, 32 (6): 54-58.

BOGLIANI G., 1988 - **Densità e scelta dell'habitat degli uccelli nidificanti in pioppeti coltivati**. Riv. ital. Orn., 58 (3-4): 129-141.

COALOA D., 1999 - **Condizioni favorevoli all'espansione della pioppicoltura**. L'Inf. Agr., 55 (36): 79-82.

## Ringraziamenti

Si ringrazia in modo particolare il Prof. Giuseppe Bogliani dell'Università di Pavia, senza i cui preziosi consigli questa ricerca non sarebbe stata possibile.

# PICCHI, LEGNO E FERTILITÀ DEI SUOLI FORESTALI

## *WOODPECKERS, WOOD AND FERTILITY OF FOREST SOILS*

Riccardo Groppali

*Dipartimento di Ecologia del Territorio dell'Università di Pavia, Via S. Epifanio 14, I-27100 Pavia, Italy. E-mail groppali@et.unipv.it*

**Summary:** The importance of woodpeckers in the reintegration of forest soil fertility consists in the continuous fragmentation of wood during food research and the excavation of holes and nests in trees. Such fragments are more easily attacked by micro-decompositors, so accelerating the process of complete mineralization.

**Key words:** Soil fertility, wood decomposition, woodpeckers.

L'importanza dei picchi in ambiente forestale è notevole sotto molti aspetti (Groppali 1992), uno dei quali consiste nell'accelerare la decomposizione del legno, che costituisce il 30% circa della biomassa prodotta localmente ogni anno (Speight 1989): la lignina viene infatti aggredita solo da funghi specializzati, che richiedono un'umidità sufficiente e il contatto con l'aria (Dix e Webster 1995).

Gli scavi dei picchi sono importanti perché fanno penetrare acqua e aria nelle porzioni aeree di tronchi e rami e nel legno caduto al suolo, oltre a determinare il rilascio di frammenti legnosi sul terreno, mentre lo scortecciamento parziale di alberi e arbusti li priva del loro rivestimento protettivo.

Inoltre le schegge di legno prodotte possono trattenere una maggior umidità, che favorisce la proliferazione dei decompositori sulle superfici, più ampie, disponibili per l'attacco microbico (Reisinger e Kilbertus 1980).

## LEGNO E ALIMENTAZIONE

Alcune specie di picchi ricavano una parte significativa delle loro prede scavando nel legno o sollevando le cortecce degli alberi:

- per il picchio nero, *Dryocopus martius* (Linné, 1758), in Russia possono essere ricordati più di 650 scolitidi in uno stomaco (Blagosklonov 1968), e circa 950 larve e pupe e 55 scolitidi adulti in un altro (Cramp 1985), mentre nell'alimentazione dei nidiacei larve e adulti di questi coleotteri superano il 22% (Cuisin 1980);
- in sette stomaci di picchio rosso maggiore, *Picoides major* (Linné, 1758), del Norditalia gli xilofagi costituivano il 33% delle prede (Groppali 1991), e la specie può catturare in media oltre il 27% delle larve presenti nel legno dei pioppi coltivati nella Valpadana centrale (Camerini 1988);
- uno stomaco di picchio dorsobianco, *Picoides leucotos* (Bechstein, 1803), della Karelia conteneva 228 larve di scolitidi (Cramp 1985), e la specie alimenta i nidiacei per il 60% con larve di cerambicidi (Blume *et al.* 1971);
- le larve xilofaghe costituivano il 37% delle prede rinvenute in sette stomaci di picchio rosso minore, *Picoides minor* (Linné, 1758), della Moldavia, il 43% in undici della Russia e il 58% in quattordici della Francia (Cramp 1985);
- uno stomaco di picchio tridattilo, *Picoides trydactylus* (Linné, 1758), della Karelia conteneva 268 larve e adulti di coleotteri xilofagi (Cramp 1985), e la specie è in grado di predare il 98-100% degli scolitidi scortecciando alberi fortemente infestati, il 75% operando su alberi mediamente colpiti e il 40% su quelli danneggiati leggermente (Short e Horne 1990).

La demolizione del legno morto può essere quasi sistematica: ad esempio una popolazione di picchio nero ha attaccato fino a 800 ceppi parzialmente marcescenti in un'area di 32 ettari (Cramp 1985). Inoltre la degradazione legnosa può essere accelerata dall'asportazione della corteccia, e la ricerca di prede sotto di essa è tipica dei picchi tridattilo e dorsobianco, e viene spesso adottata anche dal picchio nero: ad esempio durante l'inverno in un peccето presso Mosca il 5% circa degli alberi presenti era stato completamente scortecciato da questa specie (Blagosklonov 1968).

Le dimensioni dello scavo possono essere anche notevoli, soprattutto nei picchi più grandi: ad esempio il nero può scavare serie verticali di fori più o meno allineati per raggiungere l'interno di tronchi che ospitano formicai, e a volte li riunisce in fenditure lunghe 1 m e profonde più di 20 cm (Bezzel 1989).

## LEGNO E NIDIFICAZIONE

Tutti i Picidi italiani scavano il nido nel legno, magari limitando il lavoro alla preparazione dell'imboccatura e approfittando di porzioni interne già cave o in via di degrado (come fa spesso il picchio verde, *Picus viridis* Linné, 1758), oppure producendo ogni anno una nuova cavità (come i picchi nero, tridattilo e di solito il rosso maggiore).

I nidi scavati entro alberi vivi espongono i tessuti legnosi all'aria, riducendovi anche il contenuto idrico e facilitando l'attacco fungino (Rayner 1986), ma in generale vengono utilizzati alberi almeno parzialmente secchi, con il 40% dei casi per il picchio rosso maggiore e la totalità nel minore (Blagosklonov 1968). In tali cavità, le cui pareti interne sono soggette a un progressivo deterioramento, che le rende più facilmente aggredibili anche da parte di uccelli non scavatori, si insediano poi altri nidificanti, appartenenti in Italia a 26 specie, di cui nove dipendono direttamente dai nidi abbandonati dai picchi (Groppali 1992).

Il nido non è l'unico scavo prodotto, in quanto vengono fatte escavazioni parziali in numerosi alberi, per scegliere poi quello con le migliori caratteristiche per la nidificazione, e costruiscono ripari invernali. Il materiale derivante da queste operazioni viene fatto ricadere quasi interamente al suolo.

| Nome italiano | Nome scientifico | Profondità | Larghezza | Diametro dell'ingresso |
|---|---|---|---|---|
| Picchio nero | *Dryocopus martius* (Linné, 1758) | 43 | 25 | 11 |
| Picchio dorsobianco | *Picoides leucotos* (Bechstein, 1803) | 31 | 16 | 5 |
| Picchio rosso maggiore | *Picoides major* (Linné, 1758) | 35 | 13 | 5 |
| Picchio rosso mezzano | *Picoides medius* (Linné, 1758) | 27 | 12 | 4 |
| Picchio rosso minore | *Picoides minor* (Linné, 1758) | 14 | 12 | 4 |
| Picchio tridattilo | *Picoides trydactylus* (Linné, 1758) | 28 | 12 | 4 |
| Picchio cenerino | *Picus canus* Gmelin, 1788 | 29 | 11 | 6 |
| Picchio verde | *Picus viridis* Linné, 1758 | 42 | 17 | 6 |

**Tabella 1** – Dimensioni medie in centimetri dei nidi delle specie di Picidi italiani (da dati di Glutz von Blotzheim e Bauer 1980).

Le dimensioni medie dei nidi delle specie italiane sono indicate nella Tabella 1.

La quantità di schegge di legno derivanti dallo scavo del nido può essere veramente notevole: il picchio nero ne produce circa 1.000, con le più grandi lunghe 11 cm, larghe 2 e spesse 3-5 mm (Bezzel 1989).

Ovviamente, anche nell'ipotesi che tutti i picchi del medesimo territorio cambiassero nido ogni anno, la quantità di frammenti legnosi prodotti sarebbe piuttosto ridotta, ma va considerato l'attacco (che a volte è il primo) all'integrità superficiale di esemplari arborei, che accelera le successive fasi di degradazione della massa legnosa precedentemente intatta.

Le densità riproduttive dei picchi in ambienti forestali sono comunque molto difformi, e sono di norma poco elevate. Alcune specie possono essere comunque piuttosto abbondanti nei territori adatti: ad esempio la densità riproduttiva può raggiungere un massimo di 5,7 coppie per 10 ettari nel picchio rosso maggiore, di 3,6 nel picchio verde, di 2,4 nel picchio rosso mezzano e di 1,7 nel picchio rosso minore (dai dati riportati in Glutz von Blotzheim e Bauer 1980).

Un fenomeno in grado di incrementare il numero di nidi e dei rifugi scavati dai picchi è costituito dall'occupazione di tali cavità (dell'anno precedente o spesso anche appena approntate) da parte di altre specie: in pianura tale comportamento è molto frequente negli storni, che in aree riccamente popolate utilizzano tutte le cavità dismesse e spesso occupano quelle meno sorvegliate. Ciò costringe alla realizzazione di una nuova cavità, incrementando in tal modo l'attività di scavo operata dai picchi.

## Picchi, legno e fertilità forestale

La frammentazione del legno in ambienti forestali, operata dai picchi, ne facilita quindi la decomposizione e accelera della restituzione della fertilità al suolo.

La quantità di legno frammentato a opera del picchio rosso maggiore è stata calcolata nella Riserva "Bosco Siro Negri" del Parco del Ticino (Lombardia, Pavia): il materiale legnoso al suolo dell'area protetta è stato computato in 3,4 $dm^3/m^2$ e il lavoro di dislocazione operato del picchio in 358,4 $cm^3/m^2$ (Groppali e Pedrazzani 1996). Nella medesima indagine è stata rilevata inoltre la netta preferenza per le porzioni legnose non o solo parzialmente degradate, delle quali il picchio operava spesso il primo attacco, per la probabile presenza al loro interno di larve di insetti xilofagi di buone dimensioni (Speight 1989). Ugualmente interessante è stata la forte prevalenza degli scavi effettuati in *Corylus avellana* L., seguito a distanza da *Quercus robur* L. e *Ulmus minor* Miller, con scarsi attacchi a *Carpinus betulus* L. e quasi nessuno a *Populus alba* L.: una presenza abbondante di picchi rossi maggiori in ambienti forestali ricchi di legno morto e collegata quindi alla varietà delle essenze disponibili.

Un numero sufficiente di picchi in ambiente forestale, favorito dalla mancata asportazione di legno morto o deperiente e dalla sua conseguente presenza in buona quantità, può quindi garantire (oltre al controllo di alcuni insetti potenzialmente dannosi e alla disponibilità di siti di nidificazione per varie specie ornitiche) una restituzione più rapida della fertilità al suolo, tramite l'accelerazione della decomposizione della porzione legnosa della biomassa prodotta.

## Bibliografia

Bezzel E., 1989 - **Uccelli 2**. Zanichelli, Bologna, 227 pp.

Blagosklonov C., 1968 - **Guide de la protection des oiseaux utiles**. Ed. MIR, Moscou, 295 pp.

Blume D., Friedmann H., Niethammer G., Schifter H., Skutch A.F., Steinbacher J., 1971 - **I Piciformi**. 64-125. In: Grzimek (ed.), Vita degli animali - Uccelli 3. Bramante, Milano.

Camerini G., 1988 - **Nuovi dati sulla presenza e sull'alimentazione del picchio rosso maggiore (*Picoides major*) nelle coltivazioni di pioppo**. Pianura, 2: 31-48.

Cramp S., 1985 - **Handbook of the Birds of Europe the Middle East and North Africa**. The Birds of Western Palearctic, 4. - Oxford Univ. Press, Oxford, 960 pp.

Cuisin M., 1980 - **L'influence des pics sur les milieux forestiers.** 407-414. In: Pesson P. (ed.), Actualités d'écologie forestière, Pesson P. Ed., Gauthier-Villars, Paris.

Dix N.J., Webster J., 1995 - **Fungal ecology.** Chapman & Hall, London, 549 pp.

Glutz von Blotzheim U.N., Bauer K.M., 1980 - **Handbuch der Vögel Mitteleuropas**. 9. Akademische Verlagsgeselleschaft, Wiesbaden, 1130 pp.

Groppali R., 1991 - **Differenze nell'alimentazione insettivora tra picchio rosso maggiore, *Picoides major*, e picchio verde, *Picus viridis***. Atti VI Conv. It. Orn., Torino: 423-424.

Groppali R., 1992 - **I picchi italiani e il loro ruolo in ambienti di origine naturale e antropica**. Inf. Fitop., 42 (7-8): 17-25.

Groppali R., Pedrazzani R., 1996 - **Importanza del picchio rosso maggiore *Picoides major* nella degradazione del legno morto e deperiente in ambiente forestale**. Atti Soc. It. Sc. Nat. e Mus. Civ. St. Nat. Milano, 135 (2): 374-378.

Rayner A.D.M., 1986 - **Water and the origins of decay in trees.** 321-341. In: Ayres P.G., Boddy L. (eds.), Water Fungi and Plants. Cambridge Univ. Press, Cambridge.

Reisinger O., Kilbertus G., 1980 - **Mécanismes et facteurs de biodégradation en milieu forestier**. 61-86. In: Pesson P. (ed.), Actualités d'écologie forestière, Gauthier-Villars, Paris.

Short L.L., Horne J.F.M., 1990 - **Woodpeckers - a world perspective and conservation concerns**. Uppsala Univ. Agr. Sc., 17: 5-12.

Speight M.C.D., 1989 - **Saproxylic invertebrates and their conservation**. Counc. Eur., Nat. Environ., 42, Strasbourg, 66 pp.

# INDAGINI SULLE PREFERENZE AMBIENTALI DELLA CIVETTA CAPOGROSSO (*AEGOLIUS FUNEREUS*) NIDIFICANTE IN CASSETTE NIDO

## *RESEARCH ON THE HABITAT CHOICE OF TENGMALM'S OWL (AEGOLIUS FUNEREUS) BREEDING IN NESTING BOXES*

Francesco Mezzavilla, Saverio Lombardo

*Associazione Faunisti Veneti, c/o Museo civico di Storia Naturale, S. Croce 1730, I-30135 Venezia, Italy. E-mail f.mezza@libero.it*

**Summary:** Researches on Tengmalm's Owl, carried out in three area of Venetian Alps, begun in 1987 and has tended above all to define the breeding biology and habitat choice of this species. By mean of nesting boxes installed in different wood typology, we have studied the habitat preferred. In Cansiglio Tengmalm's Owl preferred nest boxes in Spruce wood (77,6%) and less in mixed wood (11,9%), Beech (7,4%) and Fir (2,9%). In a different way in the Natural Reserve of Somadida the species preferred nest boxes installed in mixed wood (57,2%) and secondly in Spruce wood (42,8%). Such diversity is probably due to the woodland structure. In a third area (Tovanella - Bosconero Natural Reserve), we have found only a nest, not supporting any considerations.

**Key words:** Tengmalm's Owl, habitat, Veneto (NE Italy), breeding biology

La Civetta capogrosso (*Aegolius funereus* (Linné, 1758)) in Europa presenta una distribuzione che va dall'area settentrionale scandinava fino alla Grecia. Nell'Europa continentale e meridionale il suo areale risulta più discontinuo dato che la specie si insedia soprattutto nelle fasce montane dominate da foreste di conifere o latifoglie di notevole estensione ed età (Mikkola 1983; Cramp 1985; Korpimaki 1997). In tali ambienti manifesta una stretta dipendenza dal Picchio nero (*Dryocopus martius* (Linné, 1758)) il quale produce cavità negli alberi che successivamente possono essere occupate dalla civetta per nidificare. In letteratura finora non sono state trovate notizie di riproduzioni avvenute al di fuori di tali cavità ad esclusione delle cassette nido installate dall'uomo.

In Italia è presente nell'arco alpino dove manifesta maggiori densità nel settore orientale e centrale mentre diminuisce progressivamente verso occidente. Fino a circa venti anni fa la sua distribuzione era poco nota e basata su poche segnalazioni (Cova 1969). Dalla fine degli anni '80 del secolo scorso però, sono iniziate alcune ricerche mirate ad approfondire le conoscenze mancanti. Di seguito si riportano parte dei dati, relativi alle preferenze ambientali, da noi raccolti in tre aree forestali venete: Altopiano del Cansiglio (province di: Belluno, Treviso, Pordenone), Riserva Naturale di Somadida (comune di Auronzo, Belluno) e Riserva Naturale di Tovanella - Bosconero (Termine di Cadore, Belluno). Precedenti nostre pubblicazioni non avevano mai preso in esame questa tematica (Sperti *et al.* 1991; Mezzavilla *et al.* 1994; Mezzavilla e Lombardo 1997, 1998).

## MATERIALI E METODI

Le indagini sono iniziate in Cansiglio nel 1987 con l'installazione di 50 nidi artificiali. Nel 1990 sono diventati 96 ma in seguito si è rilevata una progressiva riduzione (75 nidi nel 2000) a causa di lavori nel bosco, atti vandalici e rottura naturale dovuta a schianti degli alberi. Nel 2001 grazie a nuove installazioni il loro numero è aumentato a 91. I nidi sono stati posti a gruppi nelle aree maggiormente frequentate dalla specie. Nel 1990 i nidi erano posizionati nelle seguenti tipologie ambientali: faggeta (23 nidi), pecceta (54), bosco misto (17) e abetina (2) in correlazione all'estensione nell'area delle suddette tipologie boschive. Anche a Somadida nel novembre del 1990 sono stati installati 25 nidi in modo abbastanza proporzionale alle tipologie boschive esistenti: bosco misto (11 nidi), pecceta (14) ed il loro numero (25) è rimasto immutato negli anni successivi.

Nella Riserva Naturale di Tovanella - Bosconero invece, sono stati installati sette nidi nel 1994 e due nel 1997, di cui due in faggeta, sei in bosco misto ed uno in pecceta.

I controlli sono stati attuati con modalità diverse a causa del grado di accessibilità dei siti ed in particolare della copertura nevosa che rendeva molto difficili gli spostamenti. In Cansiglio il numero dei controlli è sempre stato elevato con una media annuale di circa 3-4 visite nei primi dieci anni, poi si è ridotto a 2-3. A Somadida i controlli sono stati più limitati (1-2 / anno) a causa del perdurare del manto nevoso e del conseguente periodo riproduttivo più ridotto (maggio-giugno). Infine presso la Riserva di Tovanella - Bosconero è stato effettuato quasi sempre un unico controllo all'anno a causa del difficile accesso all'area e della modesta presenza della specie.

I controlli sono stati attuati con l'impiego di una scala in alluminio alta 3,8 m con la quale era possibile raggiungere il nido e visionare il suo interno. Tale metodo, anche se molto scomodo, ha permesso una migliore precisione nei controlli. Si ricorda infatti che in fase riproduttiva può non essere sufficiente grattare la base dell'albero per far sporgere dal foro di accesso la femmina in cova, come suggerito da Ravussin *et al.* (1999). Senza un'osservazione accurata si rischia di vanificare il controllo o di non rilevare altre specie in riproduzione come Cincia mora (*Parus ater* Linné, 1758), Cincia dal ciuffo (*P. cristatus* Linné, 1758), Cinciallegra (*P. major* Linné, 1758) e Picchio muratore (*Sitta europaea* Linné, 1758).

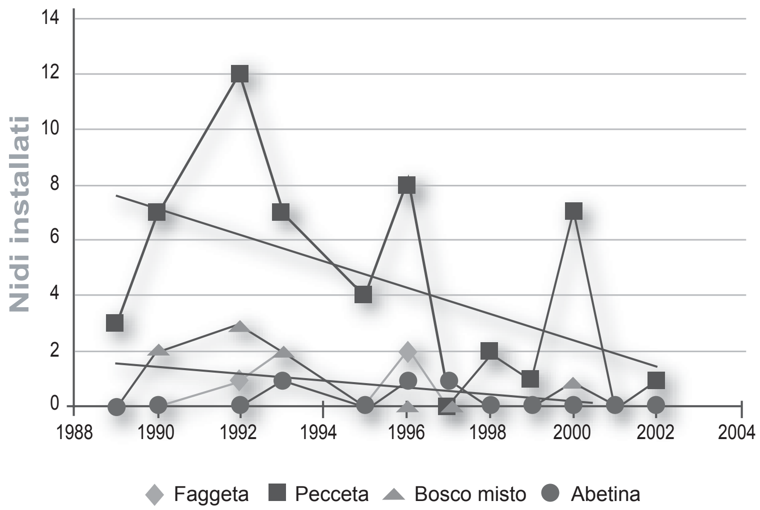


**Figura 1** - Distribuzione dei nidi rilevati in Cansiglio nelle diverse tipologie boschive. Le linee indicano la tendenza delle nidificazioni in pecceta (sopra) e in bosco misto (sotto).

## RISULTATI

L'installazione delle cassette nido permette un migliore controllo della riproduzione della Civetta capogrosso ed un aumento delle coppie nidificanti. La specie infatti si sposta facilmente dai siti usuali di nidificazione costituiti dai nidi di Picchio nero, alle cassette nido dove trova migliori condizioni ambientali. Un esempio eclatante ci viene fornito dalla Finlandia dove, grazie all'impiego di circa 23.000 cassette nido (Saurola 2003), si sono ottenuti risultati molto interessanti nello studio dei rapaci.

Tale possibilità è stata in parte riscontrata anche nel corso di queste indagini. Fino al 2002 in Cansiglio sono state rilevate 68 nidificazioni in cassetta nido, 9 a Somadida e soltanto una nel Bosconero. Nella prima località a seguito dell'installazione dei nidi artificiali, nel corso di soli tre anni, si è osservato un rapido insediamento della specie nelle cassette nido. Quello che è risultato subito evidente è stata la preferenza data ai nidi installati nelle aree di pecceta. Confrontando infatti le nidificazioni avvenute nelle diverse tipologie ambientali rilevate in Cansiglio mediante analisi di varianza (ANOVA) si è ottenuto un valore di $F_{3,44}$ = 11,02 (P< 0,05) che testimonia un diverso grado di riproduzione nei vari ambienti. In particolare mediante il test di Tukey si sono trovate significative differenze (P<0,05) tra le nidificazioni avvenute nelle seguenti tipologie: faggeta vs. pecceta; pecceta vs. bosco misto; pecceta vs. abetina. Gli altri confronti non sono risultati significativi (P>0,05).

Tale diversità appare facilmente rilevabile anche dal grafico di Figura 1 dove si nota il valore sempre elevato assunto dalle nidificazioni in pecceta rispetto a quelle rinvenute nelle altre tipologie. La media di nidificazioni per tipologia, riferita ai 12 anni in cui sono stati rilevati casi di riproduzione risulta essere: faggeta = 0,42; pecceta = 4,33; bosco misto = 0,66; abetina = 0,25. Il bosco misto pur inserendosi al secondo posto, evidenzia un valore di poco superiore alla faggeta ma entrambi, assieme alla abetina, sono nettamente meno preferiti dalla Civetta capogrosso.

Sempre in Figura 1 si nota una progressiva riduzione del tasso di occupazione delle cassette nido, sia di quelle poste in pecceta che di quelle installate nel bosco misto. Tale riduzione nel tempo è stata evidenziata anche dagli ornitologi scandinavi (Sonerud 1985) e potrebbe essere causata dal grado di predazione che aumenta con il procedere degli anni.

Per quanto concerne Somadida il modesto numero di nidificazioni rilevato (7), permette di fare solo poche considerazioni. Si nota un aumento del tasso di occupazione nel bosco misto rispetto il Cansiglio. Escludendo le tre nidificazioni riscontrate in abetina, si ha una differenza molto significativa ($c^2$= 9,3; gdl= 1; P<0,01) nel tipo di bosco frequentato nelle due località. Questo fa ipotizzare che a Somadida intervengono altri fattori nella scelta delle tipologie ambientali utilizzate in fase riproduttiva (esposizione, temperatura media, densità di prede). Attualmente però non siamo in grado di spiegare tale fenomeno.

Per quanto concerne i nidi installati presso la Riserva del Bosconero, l'unica nidificazione rilevata non permette di fare alcuna considerazione.

## CONCLUSIONI

Dalle ricerche svolte prima di installare le cassette nido, si è rilevato che il Picchio nero si riproduce quasi esclusivamente in alberi di faggio, determinando una nidificazione "dipendente" nel medesimo ambiente da parte della Civetta capogrosso. In presenza di cassette nido installate in altre tipologie ambientali la specie comunque si sposta facilmente ed occupa anche altri ambienti. In Cansiglio l'ambiente preferito risulta essere la pecceta dove è stato riscontrato il 77,6% delle nidificazioni, seguito dal bosco misto con l'11,9%, dalla faggeta 7,4% e dall'abetina 2,9%. A Somadida invece le diverse condizioni ambientali e la tipologia boschiva favoriscono l'insediamento nel bosco misto 57,2% rispetto alla pecceta 42,8%. Questo fenomeno anche se non è stato indagato in maniera approfondita potrebbe essere imputabile alla particolare struttura boschiva della pecceta che risulta piuttosto chiusa. Ciò sfavorisce l'attività di caccia della Civetta capogrosso e nel contempo anche lo sviluppo di uno strato basale vegetale adatto all'insediamento di abbondanti popolazioni di micromammiferi, usuali prede di questo strigide.

## Bibliografia

Cova C., 1969 - **Atlante degli uccelli italiani**. Hoepli, Milano, 428 pp.

Cramp S., 1985 - **Handbook of the birds of Europe the Middle East and North Africa**. Oxford University Press, Oxford, 960 pp.

Korpimaki E., 1997 - **Tengmalm's Owl**. 420-421. In: Hagemeijer E. J., Blair M. (eds.). The EBCC Atlas of European breeding birds: their distribution and abundance. Poyser, London.

Mezzavilla F., Lombardo S., Sperti M., 1994 - **First data on biology and breeding success of Tengmalm's Owl (*Aegolius funereus*) in Cansiglio**. Atti VI Convegno Italiano di Ornitologia (Torino 1991), Mus. reg. Sci. nat. Torino: 325-334.

Mezzavilla F., Lombardo S., 1997 - **Biologia riproduttiva della Civetta capogrosso (*Aegolius funereus*) nel bosco del Cansiglio**. Fauna, 4: 101-114.

MEZZAVILLA F., LOMBARDO S., 1998 - **Nidificazione di Civetta capogrosso, *Aegolius funereus*, nel primo anno d'età in Cansiglio**. Gruppo Natura Bellunese. Atti Convegno "Aspetti naturalistici della provincia di Belluno": 325-326.

MIKKOLA H., 1983 - **Owls of Europe**. Poyser, Calton, 398 pp.

RAVUSSIN P., TROLLIET D., WILLENEGGER L., BEGUIN D., MATALON G., 1999 - **Choix du site de nidification chez la Chouette de Tengmalm *Aegolius funereus*: influence des nichoirs**. Nos Oiseaux suppl., 5: 41-51.

SAUROLA P., 2003 - **Life of the Ural Owl *Strix uralensis* in a cyclic environment: some results of a 36 - year study**. Avocetta, 27: 76-80.

SONERUD G.A., 1985 - **Nest hole shift in Tengmalm's Owl *Aegolius funereus* as defence against nest predation involving long-term memory in the predator**. Journal of Animal Ecology, 54: 179-192.

SPERTI M., MEZZAVILLA F., LOMBARDO S., 1991 - **Nidification de la Chouette de Tengmalm, *Aegolius funereus*, dans la foret de Cansiglio (nord-est de l'Italie)**. 247-254. In: JUILLARD M. (red.), Rapaces Nocturnes. Actes du 30 Colloque interregional d'ornithologie. Porrentruy.

## Ringraziamenti

Le indagini sono state svolte in Cansiglio con il supporto di Veneto Agricoltura e dell'Azienda dei Parchi e delle Foreste Regionali della Regione Friuli-Venezia Giulia, a Somadida dell'Azienda di Stato Foreste Demaniali di Vittorio Veneto e nella Riserva di Tovanella-Bosconero dell'ASFD di Belluno. A tutti questi Enti vanno i nostri ringraziamenti.

# TWO LOWLAND BEECH-OAK FOREST AREAS ABANDONED FOR MORE THAN 30 YEARS: WHAT DO BIRD AND BEETLE COMMUNITIES TELL US?

## *DUE AREE FORESTALI PLANIZIARIE A FAGGIO E QUERCIA ABBANDONATE DA PIÙ DI 30 ANNI: COSA CI INDICANO LE COMUNITÀ DI UCCELLI E COLEOTTERI?*

Sönke Hardersen

*NABU-Naturschutzstation, Bahnhofstrasse 15, D-47559 Kranenburg, Germany. E-mail S.Hardersen@gmx.net*

**Summary:** Two natural forest reserves were established in the "Reichswald", Nordrhein-Westfalia, Germany, in 1970. To evaluate the conservation value of these beech-oak forests in relation to forested sections, birds and saproxylic beetles were surveyed. In the natural forest reserves a more complete community of typical beech-forest birds was found with the total number of threatened bird species also higher. The total number of saproxylic beetles was similar in all sections. However, a comparison of highly specialized and threatened beetles indicated a more complete beetle-community of xylodetriticolous beetles with higher numbers of threatened beetles in the natural forest reserves.

**Key words:** Birds, conservation, forest, natural forest reserve, saproxylic beetles.

Birds and saproxylic beetles are both considered good indicators of habitat quality in forests (e.g. Matthäus 1992; Köhler 2002). However, birds and saproxylic beetles have different life strategies and utilize different ecological niches. To my knowledge results of ornithological studies and research of saproxylic beetles have so far not been compared in Germany.

## THE STUDY AREA

The nature conservation area "Geldenberg" (578 ha) is part of the "Reichswald" forest (ca. 4.000 ha) located in Nordrhein Westfalia, Germany. It is protected because of the importance of the old-growth beech-oak forests in an area scarce in woodlands. Moreover, the area is protected under the EU Habitats Directive.

In 1970, two sections of beech-oak forest (total area 49,4 ha) were chosen as natural forest reserves (Naturwaldzellen) and consequently all management practices ceased. Other sections of beech-oak forest were used in accordance with the "Forest 2000" program of Nordrhein-Westfalia (MURL 1991).

| Common Name | Scientific Name |
|---|---|
| Black Woodpecker | *Dryocopus martius* |
| Great Spotted Woodpecker | *Dendrocopos major* |
| Lesser Spotted Woodpecker | *Dendrocopos minor* |
| Marsh Tit | *Parus palustris* |
| Mistle Thrush | *Turdus viscivorus* |
| Nuthatch | *Sitta europaea* |
| Pied Flycatcher | *Ficedula hypoleuca* |
| Redstart | *Phoenicurus phoenicurus* |
| Short-Toed Treecreeper | *Certhia brachydactyla* |
| Stock Dove | *Columba oenas* |
| Tawny Owl | *Strix aluco* |
| Wood Warbler | *Phylloscopus sibilatrix* |

**Table 1** - List of bird species selected for the survey covering the nature conservation area "Geldenberg" (1999 & 2001).

The study sites are situated 35-90 meters above sea level with average rainfall of 750 mm and an average temperature of 15,5 °C. The climate is mild with only moderate seasonal variations of temperature.

## THE FOREST SECTIONS USED FOR THE COMPARISON

### Section 111 (natural forest reserve "Rehsol")

This section, which covered 22 ha, consisted of 70-200 year old beech-oak forest. The southern 15 ha were used for this study. Here the number of dead oak and beech trees was high. Most oak trees were sub-vital. The canopy was almost without gaps.

### Section 150 (natural forest reserve "Geldenberg")

The southern 19 ha of this 22 ha natural forest reserve were used for this study. In the 120-200 year old beech-oak forest most oak trees were sub-vital. The amount of dead wood was actually higher than in section 111 with a considerable number of dead oak trees. The canopy was almost without gaps.

### Section 149

This section was covered by an oak-beech forest, which was approximately 180 years old. This section had a total area of 21 ha of which a 14 ha sub-section, dominated by oak trees, was used for this study. It had a relatively open canopy. In comparison with the natural forest reserves, the amount of dead wood was smaller. However, there was still a considerable number of dead oak and beech trees present.

### Section 118B

This section was covered by a beech-oak forest which was 140-180 years old. Oak made up for only 10% of mature trees. Due to recent tree

| Common name | Scientific name | Red Data List | Sect. 111 1999 | Sect. 111 2001 | Sect. 150 1999 | Sect. 150 2001 | Sect. 149 1999 | Sect. 149 2001 | Sect. 118B 1999 | Sect. 118B 2001 | Sect. 85A 1999 | Sect. 85A 2001 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Great Spottet Woodpecker | *Dendrocopos major* | +/+ | 1 | 3 | 3 | 5 | 1 | 2 | 1 | 1 | 0 | 0 |
| Short-Toed Treecreeper | *Certhia brachydactyla* | +/+ | 2 | 6 | 7 | 7 | 4 | 4 | 3 | 2 | 1 | 1 |
| Redstart | *Phoenicurus phoenicurus* | 3/2 | 0 | 1 | 3 | 4 | 0 | 0 | 0 | 1 | 0 | 0 |
| Stock dove | *Columba oenas* | +N/+ | 2 | 3 | 1 | 0 | 1 | 0 | 1 | 2 | 0 | 0 |
| Nuthatch | *Sitta europaea* | +/+ | 3 | 5 | 6 | 6 | 5 | 5 | 3 | 2 | 1 | 1 |
| Lesser Spottet Woodpecker | *Dendrocopos minor* | 3/2 | 1 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| Mistle Thrush | *Turdus viscivorus* | +/+ | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| Black Woodpecker | *Dryocopus martius* | 3/3 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Marsh Tit | *Parus palustris* | +/+ | 3 | 2 | 3 | 3 | 0 | 4 | 1 | 2 | 1 | 0 |
| Pied Flycatcher | *Ficedula hypoleuca* | V/3 | 2 | 4 | 4 | 4 | 1 | 0 | 0 | 1 | 0 | 0 |
| Tawny Owl | *Strix aluco* | +/+ | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 0 |
| Wood Warbler | *Phylloscopus sibilatrix* | V/+ | 1 | 1 | 1 | 2 | 0 | 1 | 0 | 0 | 0 | 0 |

**Table 2** - Number of territories of selected bird species in the sections surveyed.

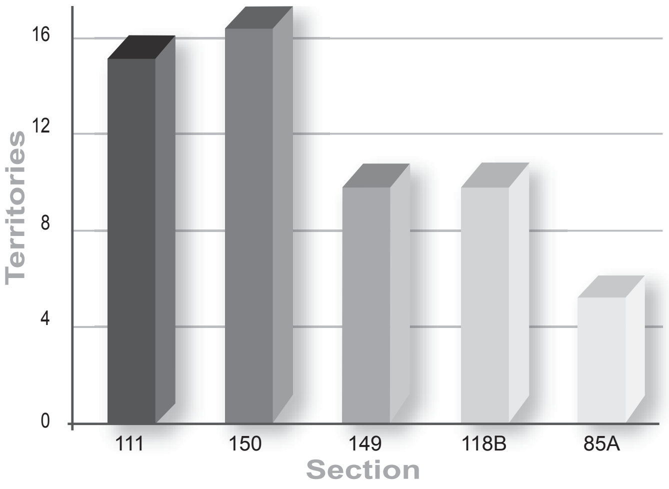


**Figure 1** - Number of "typical beech-forest birds" in the sections surveyed.

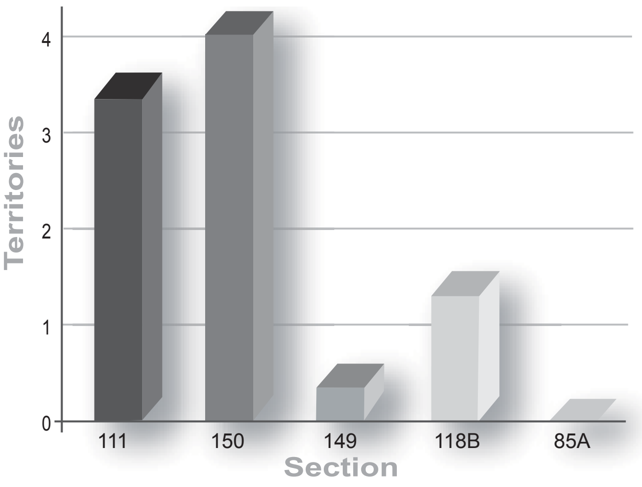


**Figure 2** - Number of bird species of the "Red Data List NRW" in the sections surveyed.

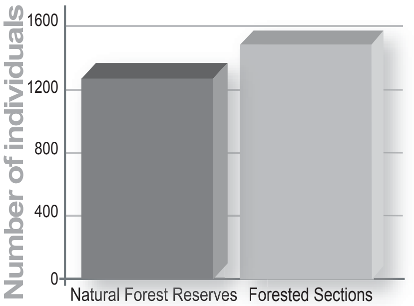


**Figure 3** - Average number of individuals of saproxylic beetles.

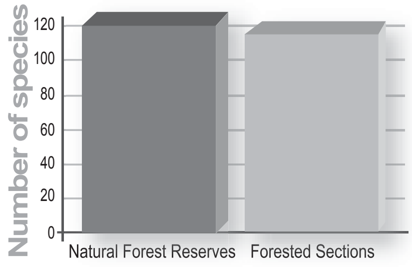


**Figure 4** - Average number of species of saproxylic beetles.

fellings, the canopy was in parts relatively open. Young beech trees were established on approximately 40% of the 12 ha used for this study. The number of dead trees in this area was relatively small. However, some large dead oaks and beeches were present.

### Section 85A

Measuring 5 ha, this section was the smallest used for this study. Moreover, it was relatively isolated from other old-growth sections. It was surrounded by spruce-and douglas-fir stands. The beech-oak forest was 150-180 years old and only one large dead oak was present, as well as some old tree-stumps and branches.

## METHODS

### Ornithological survey

In 1999 and 2001, selected bird species (Table 1) were surveyed over the whole nature conservation area "Geldenberg" (578 ha). Every section of the forest was visited seven times between late March and early June. Bird sightings of selected species were marked on a map and bird behaviour was also noted (e.g., call, song etc.). Based on these data "paper territories" were established according to the criteria given by the Dutch Ornithological Organization SOVON (VAN DIJK 1996).

### Saproxylic beetles

Collection of beetles was carried out between 21 April and 23 August 2002, using a variety of methods. At each of five visits, manual collection of beetles was carried out. In each section one "window trap" and one "sticky trap" were set up using old dead or dying oak and beech. Trap-exposure was continuous, with each trap being inspected four times during exposure. "Klopfschirm"- samples and "dead wood sieving" were carried out three times in each forest section. For more details see KÖHLER (1996, 2002).
Beetles were identified using "Die Käfer Mitteleuropas" (FREUDE *et al.* 1964-1983) as well as affiliated supplementary volumes

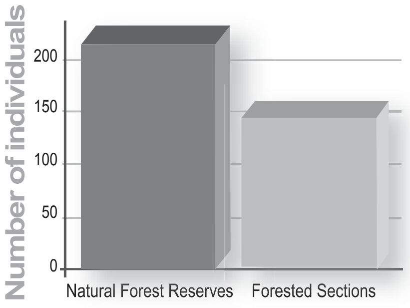


**Figure 5** - Average number of individuals of xilodetricolous beetles.

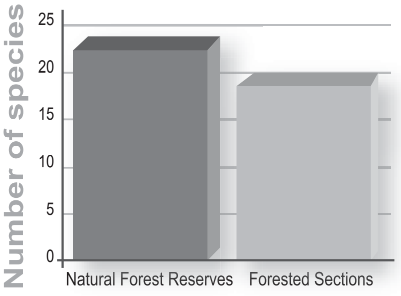


**Figure 6** - Average number of species of xylodetricolous beetles.

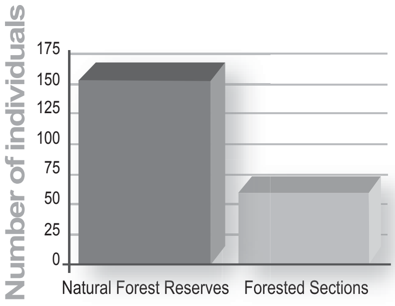


**Figure 7** - Average number of individuals of beetles of the Red Data List of Germany.

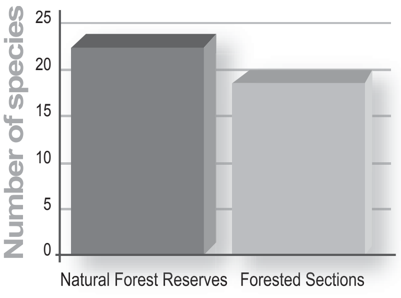


**Figure 8** - Average number of species of beetles of the Red Data List of Germany.

(Lohse & Lucht 1989, 1992, 1993; Lucht & Klausnitzer 1998).

## RESULTS

### Ornithological survey

In Table 2, the number of territories of the selected bird species are presented.

In Figure 1, the number of "typical beech-forest birds" as defined by Schumacher (pers. com.) is presented for each section. In the natural forest reserves an average of greater than 12 territories/10 ha of "typical beech-forest birds" were found, whereas the average number of territories in the forested sections was considerably lower.

In Figure 2 the number of species of the "Red Data List NRW" (LÖBF 1999) is presented. In the natural forest reserves (sections 111 & 150) an average of between 3 and 4 territories/10 ha were found. In contrast, in the forested sections a maximum of 1,3 territories/10 ha were present. Section 85A was the only part where no bird species of the "Red Data List NRW" were found.

### Saproxylic beetles

In Figure 3, the average of the total number of individuals of saproxylic beetles is presented. On average the number of individuals was higher in the forested sections. Reasons for this result are mainly:

**1)** large numbers of bark beetles were found in recently dead oak trees in section 149;

**2)** the relatively high abundance of flowers on the outer border of the section 85A.

In contrast, the average number of saproxylic species (Figure 4) was almost identical in the natural forest reserves and in the forested sections.

Xylodetriticolous beetles live mainly in large dead trees, which are already partly decayed. Species-rich communities of xylodetriticolous beetles can therefore indicate old forests with a long history of dead wood as well as large quantities of dead trees. The average number of individuals and species of xylodetriticolous beetles for sections surveyed are given in Figure 5 and 6. Numbers of individuals and species of xylodetriticolous beetles were higher in the natural forest reserves.

In Figure 7 and 8 the number of individuals and species of beetles of the Red Data List of Germany are given. Average numbers of individuals and species of threatened beetles were higher in the natural forest reserves.

## DISCUSSION

### Bird survey

The ornithological survey showed that lowland beech-oak forest areas in Nordrhein-Westfalia abandoned for more than 30 years were inhabited by a different bird-community than forested sections. The natural forest reserves were inhabited by a bird-community more typical of beech-forests. This result is supported by Hardersen & Markgraf-Maué (in press). The data presented in this paper also indicate that the natural forest reserves provided habitat for a higher number of threatened birds listed in the "Red Data List NRW" than the forested sections.

Bird-species with a clear preference for the natural forest reserves were: Pied Flycatcher (*Ficedula hypoleuca*), Redstart (*Phoenicurus phoenicurus*) and Wood Warbler (*Phylloscopus sibilatrix*). Other bird species which where also found more frequently in natural forest reserves were: Lesser Spottet Woodpecker (*Dendrocopos minor*), Black Woodpecker (*Dryocopus martius*), Great Spottet Woodpecker (*Dendrocopos major*) and Tawny Owl (*Strix aluco*). However, the evidence for these species was not as strong as for the aforementioned.

### Beetle survey

The total number of saproxylic beetles was relatively similar in the sections surveyed. Only comparisons of highly specialized beetles (e.g. xylodetriticolous beetles) and of threatened beetles showed that the more complete beetle-communities with higher numbers of individuals, especially of threatened saproxylic beetles were found in the natural forest reserves.

However, a comparison of threatened beetle species with studies from 14 similar forests (Köhler 2002) showed that the "Geldenberg" conservation area was low in numbers of threatened oak specific saproxylic beetles. The main reason for the low abundance of rare beetles is likely to be that large, dead trees were not present at some stage in the past. In the nature conservation area "Geldenberg" only small sections of old beech-oak forests remained after the second world war. Accordingly these were very likely poor in dead wood.

A large proportion of the rare and threatened beetles found in the nature conservation area "Geldenberg" depend on oak trees. However, without human interference oaks, which for centuries were selectively promoted by man, are slowly being displaced by beech trees. To provide sufficient habitat for oak-specific saproxylic beetles in the long term, it will be necessary to maintain oak-rich forests in the nature conservation area "Geldenberg", using appropriate management techniques.

## CONCLUSIONS

The ornithological and saproxylic beetle surveys both indicated that the natural forest reserves provided habitat for higher numbers of rare and threatened species compared to the forested sections. In the larger parts of forested beech-oak sections, which contained a higher numbers of dead trees, more threatened species and more typical species of old beech-oak forest occurred.

These comparisons, which showed clear differences, were carried out in the oldest and most "valuable" beech-oak forest in the nature conservation area "Geldenberg". All sections, including the forested ones, were inhabited by rare species. Thus, managed forests can also provide habitat for rare species (e.g. birds and beetles) and can have high conservation value.

The natural forest reserves in the conservation area "Geldenberg" only covered an area of 22 ha each. In comparison with other natural forest reserves in Germany, these are small. It seems likely that forest reserves of this size are not sufficient for the survival of all saproxylic beetles. Bird species require even larger habitats, especially those with large home-ranges. Therefore, the natural forest reserves in the nature conservation area "Geldenberg" should be increased considerably in size.

## References

FREUDE H., HARDE K. W., LOHSE G.A. (eds.), 1964-1983 - **Die Käfer Mitteleuropas Band 1-11**. Goecke & Evers, Krefeld.

HARDERSEN S., MARKGRAF-MAUÉ K., (in press) - **Vergleichende ornithologische Siedlungsdichteuntersuchung einer Naturwaldzelle mir einem naturnah bewirtschafteten Wald.** Charadrius.

KÖHLER F., 1996 - **Käferfauna in Naturwaldzellen und Wirtschaftswald**. Vergleichsuntersuchungen im Waldreservat Kermeter in der Nordeifel. Schriftenr. LÖBF/LAfAO NRW (Recklinghausen), 6: 1-283.

KÖHLER F., 2002 - **Neue Untersuchungen zur Totholzkäferfauna (Coleoptera) im Waldnaturschutzgebiet Geldenberg bei Kleve**. Mitt. Arb. gem. Rhein. Koleopterologen (Bonn), 12: 71-111.

LÖBF, 1999 - **Rote Liste der gefährdeten Pflanzen und Tiere in Nordrhein-Westfalen**. 3. Fassg. LÖBF-Schr. R. 17. 644 pp.

LOHSE G.A., LUCHT W. (eds.), 1989 - **Die Käfer Mitteleuropas**. Erster Supplementband mit Katalogteil (Bd. 12). Goecke & Evers, Krefeld, 346 pp.

LOHSE G.A., LUCHT W. (eds.), 1992 - **Die Käfer Mitteleuropas**. Zweiter Supplementband mit Katalogteil (Bd. 13). Goecke & Evers, Krefeld, 375 pp.

LOHSE G.A., LUCHT W. (eds.), 1993 - **Die Käfer Mitteleuropas**. Dritter Supplementband mit Katalogteil (Bd. 14). Goecke & Evers, Krefeld, 403 pp.

LUCHT W., KLAUSNITZER B. (eds.), 1998 - **Die Käfer Mitteleuropas**. Vierter Supplementband (Bd. 15). Gustav Fischer Verlag Jena, 398 pp.

MATTHÄUS G., 1992 - **Vögel - Hinweise zur Erfassung und Bewertung im Rahmen landschaftsökologischer Planungen**. 27-38. In: TRAUTNER J. (eds.), Arten - und Biotopschutz in der Planung: Methodische Standards zur Erfassung von Tierartengruppen. Ökologie in Forschung und Anwendung, 5.

MURL, 1991 - **Wald 2000**. Gesamtkonzept für eine ökologische Waldbewirtschaftung des Staatswaldes in Nordrhein-Westfalen, 35 pp.

VAN DIJK A.J., 1996 - **Broedvogels inventarisieren in proeflakken (handleiding Broedvogel Monitoring Project)**. SOVON, Beek-Ubbergen, 62 pp.

## Acknowledgements

I thank Frank Köhler who carried out the beetle study and let me use the data for this publication as well as the "Forstamt Kleve" for the good collaboration. I am also grateful to Petra Bernert, Klaus Markgraf-Maué, Helge Sorich and Ulrich Wille who took part in the ornithological surveys.

# DEAD WOOD: OBJECTIVES, RESULTS AND LIFE-PROJECTS IN SWEDISH FORESTRY

## *LEGNO MORTO: OBIETTIVI, RISULTATI E PROGETTI LIFE NELLA SELVICOLTURA SVEDESE*

Erik Sandström

*Skogsstyrelsen (National Board of Forestry), S-551 83 Jönköping, Sweden. E-mail erik.sandstrom@svo.se*

**Summary:** This paper briefly presents objectives and results for dead wood in Swedish forestry and experiences of it in Life-projects. Swedish forests cover almost 25% of the EU forest area. In 1994 the forest policy gave equal importance to the environmental and production goals. Dead wood in sufficient quantity for a diversity of qualities is a precondition for preserving the biodiversity of fungi, lichens, mosses and insects. This is an important part of the environmental goal. The aim is to increase the amount of dead wood by 40% from 1998 until 2010. Nine Life-projects with the support of the EU improve our methods to promote the environment. These co-operations include 77 participants in 6 countries. Dead wood and how to convince people of its significance is an important component in many of these projects.

**Key words:** Dead wood, Life-fund, European Union, Sweden, forest policy.

The aim of this paper is to briefly present the objectives and results concerning dead wood in Swedish forestry as well as the experiences of this topic in our Life-co-operations.

Swedish forests cover almost 25% of the EU forest area. Forestry has for a long time been, and still is an important part of the Swedish economy. Therefore, any distortions of the free market for forest-based products may create considerable problems for Sweden. As Sweden entered EU the forest area/person was 20 times bigger in Sweden than in the previous EU 12. A consequence is that heavy subsidies in forestry would be very expensive for the taxpayers. Another consequence is that forests are closer to the people in Sweden than in many other European countries. This is also reflected in the right of common access to the forests, which distinguishes Swedish forests from those in most other EU countries.

### DEAD WOOD IN THE IMPLEMENTATION OF SWEDISH FOREST POLICY

The principle of sectoral integration of environmental issues was introduced in the Forestry Act in 1975. In 1994, Swedish forest policy put equal emphasis on the environmental and production goals. Biodiversity is a major part of the environmental goal and dead wood in sufficient quantity for a diversity of qualities is a major precondition for biodiversity.

The importance of dead wood is obvious when you consider that in Swedish forests there are some 6.000 obligate species depending on dead wood. Some 2.500 of these are fungi, and about as many are insects. There are another thousand species that are facultative on dead wood.

Knowledge is a limiting factor when you estimate the demands that species have of their environment. For some 3.600 species the knowledge is currently good enough to be compiled and analysed. Fungi are more than 50% of these species and insects are more than one third. There are 805 species that depend on dead wood on the national

**Photo 1** - More than 50 % of the red-listed species depending on dead wood on Swedish forestland are fungi (Photo by JOHAN NITARE).

**Photo 2** - Dead wood is of major importance to aquatic biodiversity in streams since it introduces objects that create variations in the flow of water (Photo by ERIK SANDSTRÖM).

Swedish red list. They represent 40% of the red-listed species that are found on forestland. Oak is the tree species that hosts most red-listed species. If you include living as well as dead trees, there are some 300 red-listed species that depend on oak.

The current status for dead wood can be described by Photo 1 and 2 from the National Forest Survey, 1996-2000. The total volume of dead wood, incl. hard as well as soft wood is 6,5 m$^3$/ha. There is almost twice as much dead wood in the north than in the south of Sweden. Some two thirds of this volume are lying dead trees and the rest is standing dead trees. Due to the predominance of conifers, more than 80% is dead wood of conifer trees. Some 20% of the volume of hard dead wood consists of trees larger than 30 cm diameter at breast height.

Therefore, the goal has been set to increase the amount of hard dead wood by 40% from 1998 until 2010. Monitoring results indicate that a development in this direction is taking place. In Figure 1 an indication is given of how the Swedish work for biodiversity is distributed according to environmental properties of the land.

## SOME COMPLETED LIFE-CO-OPERATIONS FOR THE SWEDISH FOREST ADMINISTRATION

Nine co-operation projects with the Life-fund of the European Union play an important role in ameliorating our methods to promote the environment. These co-operations include 77 participants in 6 countries. Two proposals are in the revision phase. Obviously, dead wood is an important component in a number of these projects and this paper reviews some of the components. Please find further information at ***http://www.svo.se/eng/life/default.htm***

The LIFE-Nature project "white-backed woodpecker landscapes and new Nature reserves" undertook a variety of conservation actions on 10 areas of the western Taiga that are important for these Woodpecker populations. The idea was to combine a variety of instruments in core areas. Conditions for the woodpeckers were improved in 21.427 ha of core areas. 25 Natura 2000 sites were created totaling 2.008 ha. Landowners agreed to voluntary preservation on an extra 2.000 ha. The project served as a role model for a new method of combining instruments for biodiversity promotion and co-operation between forest owners, environmental and forestry authorities as well as NGO: dead and dying wood was created through for instance girdling and blowing-up trees.

The project "Local Participation in Sustainable Forest Management based on Landscape Analysis" has integrated environmental and landscape aspects into forestry development at five locations in Sweden and Finland, in particular with respect to small private holdings. It has gathered experience of local co-operation between the local forest authorities and forest owners, as well as other organisations concerned. The need for action to promote dead wood as well as other aspects of sustainability of forests was reviewed in a participatory manner. Some of the actions for dead wood were:

- in the Vindeln municipality a nature preservation policy including the increase of dead wood to 2 m$^3$/ha;
- in the Kolmården demonstration area fire frequency maps for the natural state were drawn. These help to understand the need for different qualities of dead wood. Inventories of dead trees and big trees were also carried out;
- in the Linderödsåsen demonstration area one of the participatory landscape analyses concluded that there was a need for increased consideration of veteran trees. An aerial photo inventory of giant trees was also done.

The project "Demonstration of sustainable forestry to protect water quality and aquatic biodiversity" shows how to manage forests without damaging aquatic ecosystems. This is being done through catchment planning and field demonstrations that will be followed by guided tours to demonstration areas. Dead wood is of major importance to aquatic biodiversity in streams since it introduces objects that create variations in the flow of water. The field demonstrations include the importance of dead wood for aquatic biodiversity. Logs are dead wood that can be used for many purposes, for instance the blocking of small ditches if you want to recreate wetlands. Another opportunity is to put them into small streams to avoid damage from logging machinery. Of course such logs must be removed when the logging operation is finished.

## MONITORING METHODS IN FIVE COUNTRIES

The project "Demonstration of methods to monitor sustainable forestry" included five countries and twelve demonstration areas. New monitoring methods have been developed and relevant methods have been tested in these countries. For this paper, I have selected four topics relating closely to dead wood.

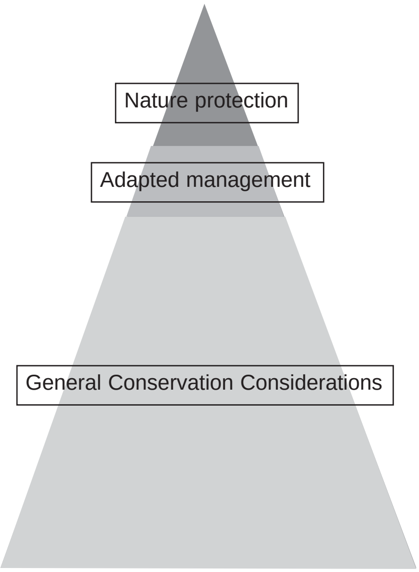


**Figure 1** - Adaptation of Swedish government support to forestry depending on the environmental properties of the forestland.

The Gap Analysis exercise was a common feature for all countries and all demonstration areas. It was a comparison between the quality of the output from current monitoring systems and the needs for monitoring results indicated by the Criteria and Indicators of the pan-European process on sustainable forest management. All the participating countries agreed that the project should suggest only six new indicators to be added to those of the pan-European process. Half of them relate to biodiversity, and these three indicators have a clear reference to dead wood. They are "Total area of forest-related key habitats", "Giant trees" and "Dead wood". Key habitats are small areas with high biodiversity values. For giant trees, it was noted that a rather flexible definition would be needed.

Unexpected important knowledge has resulted, like for instance in Sweden, where a detailed inventory of a demonstration area seems to provide a new understanding of the frequency of certain red-listed species, in particular insects. Vällen is situated some 100 miles north of Stockholm. The area has been visited frequently by leading entomologists for 100 years. Long-term systematic inventories were conducted (2 years, several window-traps in different locations).

The result was the identification of 23.095 specimens belonging to 88 taxa. In total, 96 red-listed species were found, of which 63 were new for the area. Thus, in-spite of many excursions during 100 years, two, thirds of the identified red-listed species were new to the area. The findings represented 72% of the red-listed wood-living beetles in the whole county. One species new to science was found, i.e. *Dorcatoma jansonii* Büche & Lundberg, 2002 (Anobiidae). Nine species that had been identified 20-100 years ago were not found and are supposed to be extinct from the area. Locations where many red-listed species were found had 10-30 times more dead wood than the ordinary forest. Our conclusion is that similar approaches are needed to be able to understand and preserve biodiversity.

Boischaut is typical of the French central lowland regions. It is situated some 250 km south of Paris. There are 48.000 ha of homogeneous oak woodland and some management records for 300 years. A participatory indicator selection was done. Dead wood was singled out as a very important indicator. It was estimated according to: species, standing trees, lying trees, big branches in the crown and big stumps. The volume had decreased from 2,2 m$^3$ (1986) to 1,6 m$^3$ (1998). The objective for the future was set at 5 m$^3$.

A dead wood inventory was also carried out in the Vällen area. The reason was that existing estimates of dead wood are mostly provided by the National Forest Survey (NFS). The results are hard to relate to needs in a landscape perspective. A total inventory was made by stands in 25 ha squares, which were selected by random sampling. Properties of the stand and of the dead wood were noted as well as type and position of substrates, including 4 degrees of wood softness. The cost was 30 Euro/sampled ha. The result deviated considerably from that of the NFS for the region. Of course, NFS does not claim to provide results that are valid for any landscape within a region. The result was assessed representative for 15.000 ha, i.e. the cost was 0,6 Euro/ha.

## LIFE-ENVIRONMENT PROJECTS IN PHASE III

The project "Demonstration of ways to increase peoples' recreational benefits from urban woodlands" has the objective of stimulating and improving recreation for the general public in urban woodlands. It helps city people find their way into and learn about sustainable forest management, incl. the importance of dead wood. It has demonstration areas close to Paris and around Stockholm.

The Chêne d'Antin in the Sénart forest in France was very old and is now dead. Foresters burned the inside of this tree in order to preserve it and it serves as a spiritual centre of the forest, invoking reverence for the old trees and nature. This is really dead wood promoting biodiversity conservation. The project includes educational activities in Sénart and around Stockholm. These provide an understanding of *inter alia* biodiversity including dead wood for school children, immigrants, disabled people and ordinary citizens. In Sénart, an inventory of veteran trees has also been carried out.

The project ”Coastal Woodlands” will demonstrate new and innovative ways to include the coastal woodlands in Integrated Coastal Zone Management (ICZM) near the Baltic Sea. It is also aiming at the development of recommendations for a strategy concerning forestry and nature protection issues in an ICZM near the Baltic Sea. The future of dead wood is affected by a number of project demonstrations, for instance of models for integrated inventories and conservation actions; and of models for a more effective use of existing methods and legislation for nature protection as well as principles for sustainable management. Traditional rural forest management and low-intensive agriculture have survived to a larger extent in the archipelago. In many places, it has never been substituted by modern forestry. Therefore there is a wealth of veteran trees of pine as well as deciduous trees.

## CONCLUDING REFLECTIONS

When we think of dead wood for the future and Life-projects, some issues deserve attention. Firstly for the EU/Life - programme it is currently a matter of life or death. It is being evaluated before the possible continuation in a fourth phase at a time when there is considerable budget pressure on the EU. It would be a major loss for the European environment if an instrument that provides such a good stimulus to innovative environmental work as well as to integration between European countries should be discontinued. Secondly, we have two Life-project proposals that are currently in the revision phase including Forests for Water. For the applications this autumn we are thinking about dead wood in a Life-Environment project.

For the promotion of dead wood in Sweden I would be glad to see a diversification of the dead wood objective. It would focus the need for very special qualities, for instance those provided by very old trees in specific locations. For many such qualities the regeneration may be a major problem. Thus I see a need to preserve living trees that can develop certain qualities in a hundred years or so in order to preserve the species depending on dead wood. We also look forward to new knowledge to help us set a dead wood objective for Swedish forestry beyond 2010.

# GUIDELINES AND AIMS OF THE PROJECT LIFE NAT/IT/99/006245 “BOSCO DELLA FONTANA: URGENT CONSERVATION ACTIONS ON RELICT HABITAT”

## LINEE GUIDA E OBIETTIVI DEL PROGETTO LIFE NAT/IT/99/006245 “BOSCO DELLA FONTANA: AZIONI URGENTI DI CONSERVAZIONE IN HABITAT RELITTI”

Franco Mason

*MiPAF - National Forest Service. National Centre for the Study and Conservation of Forest Biodiversity of Verona - Bosco della Fontana.*
*Direction and Laboratories, Via Carlo Ederle 16/a I-37100 Verona, Italy. E-mail fmason@tin.it*

**Summary:** The Nature Reserve “Bosco della Fontana” (239 ha) is one of the last oak-hornbeam relicts still existing on the Veneto Plain. During the 1950s alien species were introduced after heavy post-war logging: *Quercus rubra* L., *Platanus hybrida* Brot. and *Juglans nigra* L. The particularly invasive *Q. rubra* is threatening the floral harmony of this formation. The Life project involves the elimination of alien species and their transformation into dead wood (CWD) by reproducing the effects of natural perturbations (in this case, gale-force winds). To complete the restructuring of the dead wood components the plane trees are converted into “habitat trees” through pre-senescence. Knowledge on the role of forest dynamics is stressed when carrying out projects of reconstitution of the dead wood compartment.

**Key words:** Dead wood, saproxylics, alien species, artificial *chablis*.

The forests that covered the entire Veneto Plain in pre-Roman times (Bracco & Marchiori 2002) are today confined to a few isolated relicts covering a total surface area of approx. 8.000 hectares with grave problems: biogeographical isolation, structural simplification, poor timber supply, absence of dead wood and its microhabitats, introduction of alien species, difficulty of pedunculate oak (*Quercus robur* L.) renewal (Mason 2002a).

The State Nature Reserve “Bosco della Fontana” (NRBF) (Oak-Hornbeam wood, 230 ha, province of Mantova) is one of these relicts that, despite the presence of the problems listed, is evolving, with suitable assistance, from being a composite coppice into an old-growth forest (cfr. Peterken 1996), i.e. a structurally mature forest with dead wood. The supply of 278 $m^3$/ha, 26,3 $m^3$/ha of dead wood (CWD) and the 30 m tall upper canopy, are witness to this change.

The invasiveness of Red oak (*Quercus rubra* L.) risks thwarting this process; an alien species introduced into the NRBF between 1952 and 1955 along with the London plane (*Platanus hybrida* L.) and Black walnut (*Juglans nigra* L.), in fifty years has accumulated a supply of at least 1.500 $m^3$, with individuals of more than 50 cm dbh and up to 29 m tall, which exhibits an extremely strong competitive potential against the native species, chiefly Pedunculate oak and Hornbeam (*Carpinus betulus* L.). Limiting the spread of Red oak therefore requires well-aimed silvicultural interventions and careful monitoring. In fact, even small gaps in the canopy, like those produced in 1988 by felling to eliminate the Plane trees in accordance with the management plan in force between 1980 and 1990 (Corpo Forestale dello Stato 1990) triggered a wave of natural renewal and led to the consolidation of a new spontaneous generation of this mesophilic and shade tolerant species (Rameau *et al.* 1989). To avoid Red oak taking precedence over the native species and spreading into other stands as yet “uncontaminated” it was therefore decided to eliminate it systematically in a ten-year programme. The trunks of Red oak, instead of being cut and removed following conventional practices, are uprooted and left there to decay for site conservation requirements, especially saproxylic organisms(1). The Red oak is thus used to artificially produce new dead wood by imitating the effects produced by wind, in particular: *chablis* (uprooted trees) and *volis* (standing broken trunks) (cf. Oldeman 1990).

The forestry operations included in the NRBF also favour:

- light entering the canopy with positive effects on the biology and particularly for the adult stages of saproxylic insects (Fuller & Peterken 1995);
- diversification of the biostatic phase, fixed at a simplified structure on two levels inherited from the composite coppice;
- the triggering of renewal eco-units in order to move closer to the sylvan mosaic in equilibrium and to the requisites of an MDA (Minimum Dynamic Area, cf. Mason 2002a);
- restoration of at least four microhabitats that are missing in conventionally managed forests, in which the plants are felled with a simple cut and the rooted stump remains. Uprooting instead creates a mound of earth, a hollow where leaves and dampness accumulate, CWD in decomposition and an area covered by the crown that

---

**(1)** Saproxylic organism: a species dependent, at some stage of its life cycle, upon dead wood of senescent trees or fallen timber, or upon other saproxylics.

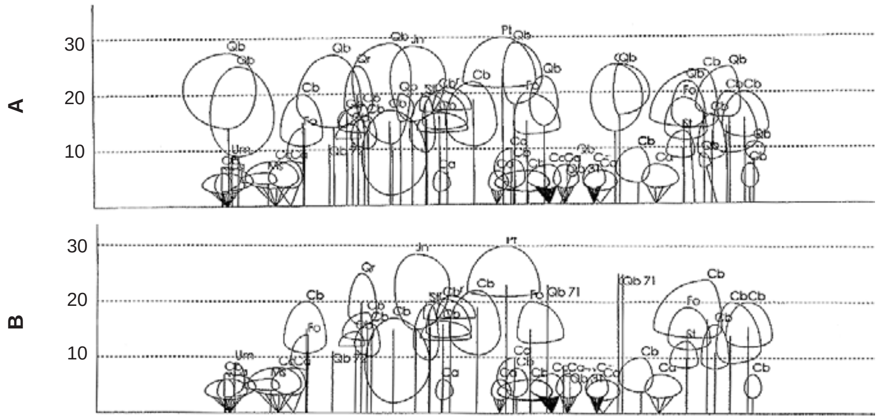


**Figure 1 -** Removed of red oak from the sylvan mosaic of the NRBF, computer simulation: **a)** before the intervention, **b)** after the intervention.

**Photo 1 -** Dendrothelmic tree hole on a senescent beech (*Fagus sylvatica* L.).

keeps the soil moist;

- turnover of the forest soil horizons reproducing the re-mixing that takes place in the forests with natural dynamics.

## THE FOREST DYNAMICS IN THE NRBF, REFERENCE DESIGN

In order to verify the effects of the forestry operations, a simulation was done on two stands of the NRBF with the largest number of Red oaks (Figure 1), where 51 $m^3$/ha and 45 $m^3$/ha of CWD will be produced for the project, respectively. This amount is the same as that in natural forests, e.g. Bialowieza (cf. Peterken 1996) and in the areas of the NRBF more exposed to winds. For example, in one of the three areas in the long-term forest monitoring area in the northern part of the NRBF (Mason 2002b), gale-force winds in June 1993 produced a concentration of CWD of 73 $m^3$/ha, therefore even higher than what will be artificially produced.

An important index of naturalness (Mason 2002b), that is useful for comparing different forests and whose case study would be worth further development, is the ratio between volume of "living" wood (provision) and volume of "dead" wood (CWD) (RLDW, Rate Living/Dead Wood), which in the stands where the CWD volume of Red oak is higher, varies from 4,6 to 3,6 and deviates from the value of 5 reached in the stands more battered by the windstorm in 1993.

From the same monitoring area other information has been obtained on the parameters of CWD dynamics, including the frequency of *volis* (8%) and *chablis* (92%). The *volis* are formed almost exclusively on hornbeam at a height of between 5 and 6 metres above the ground, while the Pedunculate oaks create only *chablis*. These and many other data on the CWD dynamics (e.g., direction of fall of the trunks, qualitative repartition of the CWD) collected in the NRBF were used to "design" the artificial *chablis* and *volis*.

In the project's first four years (1999-2003) 474 $m^3$ of CWD of Red oak and 290 habitat trees of Plane have been produced. At the end of the ten years of the project, totalling up the pre-existing CWD caused by the windstorm in June 1993 and that produced "artificially", the forest will have at least 7.000 $m^3$ of CWD with a ratio between provision and CWD (RLDW) of around 7.

## CWD AND MICROHABITATS

The operations for CWD restoration are carried out with a forestry winch (*chablis*) and using explosives (*volis*) (Cavalli & Mason 2003). The artificial *chablis* open gaps of 250-300 $m^2$ on average, imitating the dynamics of the "small eco-units" surveyed in the NRBF (Mason 2002b). No individual of Red oak must escape the elimination treatment in order to avoid that, profiting from the gaps, new seedlings develop. The creating of artificial *chablis* means that the current 22% of gaps would increase, at work completion, to approx. 30% of the forest area, making new spaces available for the flowers necessary for feeding the adult stages of the saproxylic insects. Around 80% of the open spaces will be re-forested with Pedunculate oak, while 20% will be left to evolve naturally and increase the complexity of the sylvan mosaic.

A different destine is reserved for the Plane trees which, unlike Red oak, do not renew agamically in the NRBF and therefore do not spread to other stands. The 1.435 individuals in the NRBF undergo "pre-senescence" transforming them into "habitat trees" and leaving them to age indefinitely, with the aim of compensating for the lack of senescent trees. The holes made artificially in the trunks represent new microhabitats for the many saproxylic species of fungi, mosses, invertebrates and vertebrates.

The Plane trees in the Life project represent "transition" microhabitats until the still relatively young pedunculate oaks (the oldest in the NRBF are just over two hundred years-old), reach the stage of decay and over-maturity, i.e. the most interesting and specialised microhabitats for saproxylic organisms. These include the over-mature/senescent tree microhabitats for the Syrphid Diptera dealt with in Syrph the Net by Speight *et al.* (2000), which are representative of the species found on over-mature/senescent trees:

- insect workings: wet/humid tunnels made through wood by other insects, especially cerambycids, scolytids or *Cossus* (Lepidoptera, Cossidae), usually with insect faeces (partially-digested wood) and seeping sap;
- loose bark;
- rot-holes;
- dendrothelmic(2) tree holes (Photo 1) on living trees (cfr. also Dajoz 1998);
- sap runs/lesions: wet tree wounds maintained by sap and/or the activities of fungi or saproxylic invertebrates. These have a variety of origins, including mechanical damage caused by man or storms, or fire, and may or may not be evident externally;
- trunk cavities: large dry tree holes formed in the trunk of living trees.

On the occasion of the symposium in

---

**(2)** Dendrothelm: a rain-fed temporary water body on a tree.

Mantova, Martin Speight explained that the presence of senescent tree microhabitats, unlike fallen or standing dead trunks, is a priority for this family of insects.

## THE OLD-GROWTH FOREST, “UMBRELLA” FOR THE CONSERVATION OF SAPROXYLIC ORGANISMS

The reasons for deciding to artificially increase the dead wood and its microhabitats are obvious: to preserve a relict forest formation from floral degradation and avoid the risk of extinction for the surviving saproxylic species on the site. The operations aim to re-establish all the components of the dead wood compartment and reproduce the qualitative and quantitative mosaic and space and time continuity of the habitats for the saproxylic fauna, which are generally hypothesised to have poor mobility.

Because the forests of the Veneto Plain are more or less extinct, there is no model available to use as a reference for reinstating an “old-growth forest”. There is therefore no other choice except to work towards perfecting a hypothetical model of “old-growth forest” using knowledge on forestry dynamics and the dead wood that slowly becomes available. A methodological decision that it is hoped can ensure suitable conditions in the future for the conservation of saproxylic organisms and lessen the probability of their extinction.

## References

Bracco F., Marchiori S., 2002 - **Floristic and vegetational aspects**. 17-49 In: Minelli A., Ruffo S., Stoch F., (eds.) Woodlands of the Po Plain. A fragmented labyrinth Italian habitats. Ministero dell’Ambiente e della Tutela del Territorio, Museo Friulano di Storia Naturale Comune di Udine.

Cavalli R., Mason F. (eds.), 2003 - **Tecniche di ripristino del legno morto per la conservazione delle faune saproxiliche. Il progetto LIFE Natura NAT/IT/99/6245 di "Bosco della Fontana" (Mantova, Italia) - *Techniques for re-establishment of dead wood for saproxylic fauna conservation. LIFE Nature project NAT/IT/99/6245 "Bosco della Fontana" (Mantova, Italy).*** Rapporti scientifici, *Scientific Reports*, 2. Centro Nazionale per lo Studio e la Conservazione della Biodiversità Forestale di Verona - Bosco della Fontana. Gianluigi Arcari Editore, Mantova, 112 pp.

Corpo Forestale dello Stato, 1990 - **Piano di gestione del Bosco della Fontana** (MN). MiPAF, Ufficio Gestione Beni ex A.S.D.F di Verona e Peri, 88 pp..

Dajoz R., 1998 - **Les insects et la forêt**. Rôle et diversité des insectes dans le milieu forestier, pp. TEC & DOC Editions, Paris, XIV + 594 pp.

Fuller R.J., Peterken G.F., 1995 - **Woodland and scrub**. 327 - 361. In: William J.S. & Hill D.A., (eds.) Managing Habitats for Conservation. Cambridge University Press.

Mason F., 2002a - **Problems of conservation and management**. 91 - 137 In: Minelli A., Ruffo S., Stoch F. (eds.) Woodlands of the Po Plain. A fragmented labyrinth. Italian habitats. Ministero dell’Ambiente e della Tutela del Territorio, Museo Friulano di Storia Naturale Comune di Udine.

Mason F., 2002b - **Dinamica di una foresta della Pianura Padana**. **Bosco della Fontana, Primo contributo, monitoraggio 1995**. Rapporti scientifici 1. Centro Nazionale Biodiversità Forestale Verona-Bosco della Fontana. Arcari Editore, Mantova 208 pp.

Oldeman R.A.A., 1990 - **Forests: Elements of Silvology**. Springer-Verlag, Berlin, pp.624.

Peterken G.F., 1996 - **Natural Woodland.** Ecology and Conservation in Northern Temperate Regions, 522 pp.

Rameau J.C., Mansion D., Dumé G., 1989 - **Flore Forestière Française**. Giude écologique illustré. 1 Plaines et collines. Institut pour le développement forestier, 1785 pp.

Speigth M.C.D., Castella E., Obrdlik P., 2000 - **Microsite features used by European Syrphidae (Diptera): species of the Atlantic, Continental and Northern Regions**. 17-49 In: Speight M.C.D., Castella E., Obrdlik P., Ball S. (eds.) Syrph the Net, the database of European Syrphidae, Vol. 23, Syrph the Net publications, Dublin.

# POSSIBLE MANAGEMENT ACTIONS TO INCREASE THE AMOUNT OF DEAD AND MARCESCENT WOOD

## *POSSIBILI AZIONI GESTIONALI PER INCREMENTARE LA QUANTITÀ DI LEGNO MORTO E MARCESCENTE*

Raffaele Cavalli(1), Francesco Donini(2)

*(1) Dipartimento Te.S.A.F., Università degli Studi di Padova, Agripolis, V.le dell'Università 16, I-35020 Legnaro (PD), Italy. E-mail raffaele.cavalli@unipd.it*
*(2) MiPAF - National Forest Service. National Centre for the Study and Conservation of Forest Biodiversity of Verona - Bosco della Fontana. Laboratories, Strada Mantova 29, I-46045 Marmirolo (MN), Italy.*

**Summary:** Analysis of interventions for the elimination of red oak, obtained by simulating the effects of meteoric events, and interventions of London plane, for producing habitat trees, has demonstrated the validity of the tested techniques in terms of both work productivity and costs. The differences between the various operations can be reduced by improving some working methods or using more suitable equipment. It is hypothesised that the tested techniques can be applied in other environments that differ by their morphological characteristics and infrastructure (slope and roughness of the terrain, road network).

**Key words:** Dead wood, mechanisation, damage from meteoric events.

The basic operational unit adopted for the elimination of Red oak and London plane matches the size of the eco-units identified in Bosco della Fontana (Marmirolo, Mantova Province) as being at the equilibrium stage or first canopy closure. The operations carried out simulated the consequences of meteoric events that produce broken trees (Photo 1), wholly or partially uprooted trees (Photo 2) and standing dead trees (Photo 3). As well as these types, so-called habitat trees (Photo 4) were produced, in which different types of cavities were made (basal slits) for initiating processes of marcescence at the foot of the trees and holes excavated for use as nests by the saproxylic and saprophytic fauna, such as woodpeckers, owls and tits. The different types were created with the use of conventional forestry machinery and tools (tractor with winch and relative accessories, chainsaw, bark-stripper), as well as a series of supporting equipment (stepladder, trestle, drill, electricity generator etc.) (Table 1). For the types "standing broken snag" and "fallen broken snag", explosive charges were used in addition to the basic forestry machinery and tools (BULL *et al.* 1981).

Two foresters carried out the different operations who were experienced in the use of the equipment. The composition of the team depended on the number and complexity of the operations and the need to work in conditions of complete safety.

The work productivity was measured and operating costs evaluated for each operation. Work productivity was determined by analysing the working times using the methods proposed by BERTI *et al.* (1989), adopting the second level survey, which was demonstrated as being invaluable for accurately checking each single phase of the various operations.


**Photo 1 -** Standing snag (produced using explosives).

For the analysis of operating costs those due to machinery and equipment use were considered and those relating to labour, according to the method proposed by HIPPOLITI (1997).

## ANALYSIS OF WORK PRODUCTIVITY

The various types of intervention involve different times for their execution, either because of the tree dimensions, or the intrinsic difficulties in each situation. The morphology of the terrain, weather conditions, characteristics of the trees, human and equipment efficiency all affect the carrying out of each operation. It is therefore possible to define the net productivity and gross productivity for each type, expressed in trees/h per team (DONINI 2002).

## OPERATIONS ON RED OAK

The differences between net and gross productivity (Table 2) depend on the weight

**Photo 2 -** Artificially uprooted tree.

**Photo 3 -** Standing dead tree (the operator is debarking the tree by means of a bark-stripper).

of subsidiary times on the total time of the operation. In general a broken standing snag and broken fallen snag and artificially uprooted tree have subsidiary times that on average reach percentages close to 80-90% of the average gross time of realisation. The percentages related to creating a dead leaning tree and standing dead tree are lower, at around 50-60%. In all types of operation the weight of the subsidiary times is influenced by the number of phases that lead to the realisation of the different actions. The requirement for a lot of preparatory work before commencing the actual task in fact involves a notable commitment in terms of time that is difficult to avoid.

The phases on which it is possible to intervene to optimise subsidiary times are the fixing of the winch cable to the tree to break or fell and the collecting of the equipment. In particular, the use of a modular stepladder in a light alloy for climbing up the trees would be particularly useful, because it can be positioned more rapidly than a traditional ladder. Another operation is that of collecting the equipment, which could be improved by avoiding the equipment and machinery being scattered too much around the site.

A problem that cannot be ignored is the rewinding of the cable on the winch drum, during which a worker manually maintains the cable under light tension to avoid any slowing down of the coils wound on the drum and the consequent compressing when the cable is put back in traction. The problem could be resolved by a system of small rollers immediately after the idler that could exert sufficient pressure on the cable to tauten the section winding on the drum. This would partly remedy incorrect winding and would reduce the times of recovery of the cable that could be rewound without manual accompaniment. Another not insignificant element is surely the professionalism of the foresters who carry out the operations, which are of a type mid-way between true forestry and that of the upkeep of natural areas.

The net productivity of the different interventions differs and is influenced by whether the ring-barking phase is included or not. In fact, the net productivity of an artificially uprooted tree, which doesn't include this phase, is much higher than the other types of intervention. In the light of this, a different method is proposed for ring barking with the aim of shortening working times. This could be done faster by using a chainsaw, notching the external circumference of the trunk with two oblique converging cuts, 4-5 cm deep. It has in fact been observed that the size of the surface area treated is of no importance to the efficacy of the intervention whereas the depth of the incision is. For this operation it would be useful to attach a special woodcarving bar to the chainsaw to make cutting easier.

The use of explosive charges for producing the types standing broken snag and fallen broken snag greatly increases gross work productivity compared to what can be achieved using a chainsaw and tractor with winch (from 0,6 trees/h per team to 2,2 trees/h per team). It is clear, however, that the work organisation must respond to the needs to co-ordinate the work done by the personnel qualified in the use of the charges who, given the characteristics of the management of the explosives, should be enabled to work throughout the entire day on which they are at the work-site.

Furthermore, for reasons of safety, it is advisable that the holes prepared and the explosive charges applied and detonated on different days.

| Type of intervention | Operations | Main equipment used |
|---|---|---|
| Standing and fallen snags (with winch) | Making the directional notch and the felling cut<br>Breaking the trunk<br>Devitalising the standing snag | Chainsaw<br>Tractor and winch<br>Chainsaw and bark-stripper |
| Standing and fallen snags (using explosive charges) | Making holes for the explosive charges<br>Breaking the trunk<br>Devitalising the standing snag | Drill and electric generator<br>Explosive charges<br>Chainsaw and bark-stripper |
| Artificially tree uprooted | Uprooting | Tractor and winch |
| Leaning dead tree | Uprooting<br>Devitalising the trunk | Tractor and winch<br>Chainsaw and bark-stripper |
| Standing dead tree | Devitalising the trunk | Chainsaw and bark-stripper |
| Habitat tree | Basal slits<br>Devitalising the trunk<br>Nest holes | Chainsaw<br>Chainsaw and bark-stripper<br>Chainsaw, drill and electric generator |

**Table1 -** Type of intervention and equipment used to carry out the operations for simulating the consequences of exceptionally bad weather.

**Photo 4 -** Habitat tree.

| Type of intervention | Gross time min/100 | Gross productivity trees/h per team | Total unit cost /tree |
|---|---|---|---|
| Standing and fallen broken snag (with winch) | 100,12 | 0,60 | 38,73 |
| Standing and fallen broken snag (using explosive charges) | 22,79 | 2,2 | 56,96 |
| Artificially uprooted tree | 50,71 | 1,20 | 23,07 |
| Leaning dead tree | 79,41 | 0,80 | 33,74 |
| Standing dead tree | 25,71 | 2.30 | 9,57 |

**Table 2 -** Gross times and productivity and total unit costs of the interventions on red oak.

| Type of intervention | Gross time min/100 | Gross productivity trees/h per team | Total unit cost /tree |
|---|---|---|---|
| A | 100,87 | 0,60 | 35,05 |
| B | 105,83 | 0,56 | 37,01 |
| C | 98,01 | 0,60 | 34,54 |
| D | 99,30 | 0,60 | 35,28 |
| E | 110,94 | 0,54 | 39,32 |
| F | 124,75 | 0,50 | 43,88 |

**Table 3 -** Gross times and productivity and total unit costs of the interventions on plane trees (habitat trees): type A, nest holes for Marsh Tit and Blue Tit; type B, nest holes for Marsh Tit, Blue Tit, Great Tit and Tree Sparrow; type C, nest holes for Wryneck, Nuthatch and Starling; type D, nest holes for Spotted Flycatcher; type E, nest holes for Little Owl and Starling; type F, nest holes for Tawny Owl. On all types, as well as creating nest holes, basal slits are cut.

On the basis of the gross productivity that can be reached by a team authorised to use explosives and the length of time in which that team can work, which depends on the time the explosives are delivered at the start of the working day, it is possible to determine how many trees must be preprepared.

## OPERATIONS ON PLANE TREES

Also in the creation of habitat trees the high amounts of subsidiary time strongly affect gross productivity. The incidence of subsidiary times is relatively constant between the various types of cavities and is on average 50% of the total gross time. To reduce subsidiary times, the tree climbing operations can be improved by substituting the trestle with a lightweight alloy stepladder, of the type used in the construction of supports of cable cranes. These stepladders can be equipped with a small platform at the top that facilitate the worker's movements and therefore doing the job, easier.

As mentioned above, the equipment reorganisation phase can have a big influence in terms of time. It is therefore necessary to avoid excessive scattering of the tools around the work-site and to position the tool cart as close as possible to the area of operation, facilitating and speeding up the preparatory work for creating the nest-holes which requires to be done on the tool cart, such as the sectioning of the plug to obtain the cover and drilling the hole in the cover.

Gross productivity, like net productivity, is relatively similar for the different types and this is understandable given the similarity of the phases used in realising the different models. In fact the creation of the different nest holes is not characterised by a variability that would involve substantial differences in the times needed to make them. The differences found, in particular that between type F and the others, are linked to the chainsaw being used for longer to make the larger holes (Table 3).

## COST ANALYSIS

### Operations on Red oak

The cost of the different types of operations is more or less proportional to the time spent. A comparison shows that in general the types that require both the winch and ring-barking (standing and fallen snags and leaning dead trees) have higher costs; on the contrary, the use of the winch alone (artificially uprooted tree) or just ring-barking (dead standing tree) involves much lower costs and times (Table 2). Therefore, in other situations, this aspect can be taken into consideration in deciding which types to select at the planning stage, according to the result that each offers and the times and costs they require. A comparison between the two methods used for producing a standing snag and fallen snag is especially interesting. It shows that, although the use of the winch saves 32% of the unit cost, the use of explosives is worthwhile in terms of productivity. It should also be considered that all the operations involving the use of explosives can be done with equipment easily transported by hand. Regarding this it might be more expedient to use drills that can be attached to the chainsaw body instead of drills powered by an electricity generator. Among the positive effects linked to explosives use, which certainly cannot be ignored, are the characteristics of the trunk cut, which present similar decortication to that caused by snapping due to natural causes.

### Operations on plane trees

The differences in cost of the different types of holes are not marked, except for model F, the larger dimensions of which require longer use of the chainsaw and more time for positioning and sealing the cover (Table 3).

## CONCLUSIONS

The work undertaken provides an important result in terms of renovation of a natural state. It was discovered that the interventions reproduced the types produced by meteoric events perfectly, a result already in itself extremely positive in forests strongly affected by humans.

Notwithstanding the fact that the environment in which the various techniques were experimented has no difficulties from the point of view of slope or rough terrain, the practicability of the different operations can be foreseen in habitats with different morphological characteristics. Of the four types, one, the standing dead tree, demonstrates absolutely no difficulty even on sloping or rough terrain; another type, i.e. the standing or fallen broken snag, can be achieved with the use of explosives and therefore in a way that is not affected by the land morphology. Only in two types, uprooted tree and leaning dead tree, for which the use of a tractor and winch are necessary, problems could arise in the case of difficult access to the work-site. Regarding this it would be important to be able to precisely evaluate the time required for the uprooting of a tree, depending on the species and the terrain, elements that can influence the spatial spread of the roots and their resistance. The necessary force could then be established in relation to the height at which to fix the traction cable. These elements would therefore allow the suitability of using independent, portable or independent winches (e.g. Ackja Winde) to be evaluated, perhaps used with block and tackle or lifting blocks to increase the force of traction.

## References

BERTI S., PIEGAI F., VERANI S., 1989 - **Manuale di istruzione per il rilievo dei tempi di lavoro e della produttività nei lavori forestali**. Quaderni dell'Istituto di Assestamento e Tecnologia forestale, 4: 83 pp.

BULL L.E., PARTRIDGE D.A., WILLIAMS G.W., 1981 - **Creating snags with explosive**. USDA Forest Service Research Note 393. La Grande, OR: Pacific Northwest Forest and Range Experiment Station, 4 pp.

DONINI F., 2002 - **Meccanizzazione degli interventi di recupero degli habitat forestali nella Riserva Naturale Orientata Biogenetica "Bosco della Fontana"**. Tesi di Laurea (non pubblicata), Facoltà di Agraria, Università degli Studi di Padova, Padova, 79 pp.

HIPPOLITI G., 1997 - **Appunti di meccanizzazione forestale**. Studio Editoriale Fiorentino, Firenze, 318 pp.

# “HABITAT TREES” AND OTHER ACTIONS FOR BIRDS

## *“ALBERI HABITAT” E ALTRI INTERVENTI FORESTALI PER L’AVIFAUNA*

Luca Longo

*MiPAF - National Forest Service. National Centre for the Study and Conservation of Forest Biodiversity of Verona - Bosco della Fontana. Laboratories, Strada Mantova 29, I-46045 Marmirolo (MN), Italy. E-mail longolc@tin.it*

**Summary:** As part of the LIFE Nature Project in Bosco della Fontana (Province of Mantova), among the various actions aimed at eliminating alien tree species and increasing the volume of standing and fallen dead wood to encourage saproxylic fauna, one of the most important was the creation of the so-called “habitat trees” stands out. The task was to create holes in London plane trees (*Platanus* spp.) for use by different species of birds as roosting and/or nesting sites. This paper presents the data relating to the occupation of these holes gathered over the three years of the project and the more important observations on woodpeckers in the reserve during the same period, the birds that will benefit most in the future from these actions.

**Key words:** Habitat trees, nest holes, saproxylic birds, dead wood.

“Habitat trees” are the most innovative of the forestry operations carried out as part of the LIFE Nature Project (NAT/IT/99/6245) in Bosco della Fontana (Province of Mantova). It is a technique of re-naturalisation that involves the premature ageing of London plane trees (*Platanus* spp.) by creating holes in them that can be used by different species of birds as roosting and/or nest sites (LONGO 2003). This paper presents the data relating to the occupation of the holes gathered during the three years of the project (2000-2002); it will also give a brief report of the more interesting observations on woodpeckers in the reserve over the same period, mainly in relation to the other forestry operations that were carried out.

## MATERIALS AND METHODS

The sizes of the nest holes hollowed out in the habitat trees are similar to those of the nest-boxes that are usually installed to encourage species that nest in the holes of trees (Table 1) (PREMUDA *et al.* 2000). They were made almost exclusively on plane trees (*Platanus* spp.); the plane trees in the reserve do not grow from seeds, so trees can therefore survive for a long time, slowly decaying, without further problems created by establishing trees. The techniques for creating the habitat trees can be found in CAVALLI & MASON (2003) where they are described in detail.

During the three years of the project a total of 112 habitat trees were created for birds and checked every fifteen days throughout the breeding seasons in the first (2000) and third year (2002). For each occupied hole the following data were gathered: nesting species, number of eggs laid, number of nestlings hatched, number of young leaving the nest. Analyses of these data has allowed the following parameters to be determined for the different types of habitat tree and nesting species: percentage occupation, hatching rate, rate of fledging, breeding success, average clutch size.

## RESULTS

The percentage of occupied holes increased between the first and third year of the project from 38,5% to 66,9% (Table 2).

| Type of hole | Dimensions (cm) | Target species |
|---|---|---|
| A | 12 x 25 x 12<br>Ø hole = 2,6 | *Parus palustris* (Linné, 1758)<br>*Parus caeruleus* (Linné, 1758) |
| B | 12 x 25 x 12<br>Ø hole = 3,2 | *Parus major* (Linné, 1758)<br>*Passer montanus* (Linné, 1758) |
| C | 11 x 25 x 15<br>Ø hole = 3,8 | *Jynx torquilla* Linné, 1758<br>*Sitta europaea* Linné, 1758 |
| D | 12 x 40 x 12<br>hole = 11 x 5 | *Muscicapa striata* Pallas, 1764 |
| E | 18 x 40 x 18<br>Ø hole = 7 | *Athene noctua* (Scopoli, 1769)<br>*Upupa epops* Linné, 1758 |
| F | 21 x 80 x 21<br>hole = 21 x 21 | *Strix aluco* Linné, 1758 |

**Table 1** - Type, dimensions and target species of the nest holes created in the habitat trees.

These percentages are even higher if the types D and E holes are excluded from the total, which were created to encourage the nesting of spotted flycatchers (*Muscicapa striata*) and little owls (*Athene noctua*), species that occasionally use holes in trees and which, as had been forecasted, only occupied a few of these cavities; by doing this, the occupation percentages rise from 38,5 to 42,1% and from 66,9 to 76,2%. Considering the different types of hole separately, it is worth highlighting the extremely high occupation rate reached in the third year for the holes of type B and C: 84% and even 100%. An unexpected and in many ways surprising result.

A total of five species nested in the holes of the habitat trees: great tit (*Parus major*), blue tit (*Parus caeruleus*), tawny owl (*Strix aluco*), nuthatch (*Sitta europaea*) and spotted flycatcher (*Muscicapa striata*).

For the type A holes, the data related to occupation appear to indicate some preference for those positioned higher above the ground. This is easily justified given that these holes are better protected from attacks by terrestrial predators and subject to less disturbance. The same cannot be said for the type B holes, where the highest occupation percentage was in the holes closer to the ground (Table 3). The occupation percentages for this type were anyway always very high and fairly similar for the different heights. On the basis of the gathered data it would therefore appear that the factor “hole height

| Type of hole | Year 2000 | Year 2002 |
|---|---|---|
| A | 12,5% | 33,3% |
| B | 61,1% | 84% |
| C | 20% | 100% |
| D | - | 40% |
| E | 60% | 57,1% |
| F | 75% | 87,5% |

**Table 2** - Holes occupied during the first (2000) and third (2002) breeding seasons (in %).

| H from ground | Holes A Created | Holes A Occupied | % | Holes B Created | Holes B Occupied | % |
|---|---|---|---|---|---|---|
| 1 m | 6 | 1 | 16,6 | 11 | 10 | 90,9 |
| 2 m | 8 | 3 | 37,5 | 12 | 10 | 83,3 |
| 3 m | 6 | 1 | 16,6 | 11 | 9 | 81,8 |
| 4 m | 7 (+1*) | 4 | 57,1 | 16 (+4*) | 13 | 81,2 |

**Table 3** - Holes of type A and type B, and their height above the ground, occupied during the third breeding season (2002). An asterisk (*) indicates the habitat trees that broke in autumn 2001.

above the ground" only influences the smaller holes slightly or not at all. This result can be explained by taking into account that the species frequenting this type of hole is usually the great tit, which is extremely eclectic and very adaptable in its choice of nest.

The results relating to the breeding parameters are still being processed and will be the subject of a future paper. At present, the only ones available are for the great tit, for which the hatching rate was 87,5%, that rate of fledging 97,6%, while breeding success was 85,4%, and average clutch size 7,9 eggs.

Amongst the many data collected during the project on woodpeckers, it is worth mentioning, because of its importance and rarity, the over-wintering in 2000-01 of a specimen of black woodpecker (*Dryocopus martius*), a phenomenon never before verified in the province of Mantova and totally new to the Lombardy plain (LONGO *et al.* 2002), and the observation in spring 2002, in the middle of the breeding season, of a male lesser spotted woodpecker in song (*Picoides minor*), the first confirmed report in the past century not just for Bosco della Fontana Nature Reserve but also for the entire Mantova area (LONGO 2001).

Obviously it is not yet possible to draw any conclusions on the effects that the forestry operations aimed at increasing the total volume of standing and fallen dead wood in this project have had on the different woodpecker populations in the reserve. In fact, the stages of more advanced decay are still lacking, i.e. those more suitable for hosting saproxylic organisms. However, with the arrival of the first xylophage insects it has been possible to observe the use, for trophic reasons, of some of the woodpeckers many "treated" (cf. CAVALLI & MASON 2003) Red oaks (*Quercus rubra* L.). Regarding this, the most frequently used have been the standing snags, created using either a winch or with explosives, and standing dead trees after ring-barking.

## CONCLUSIONS

The nest hole occupation of nearly all the habitat trees proves this operation's success beyond doubt which, at the start of the project, was only hoped. This once again shows that the elimination in the past of most of the old and marcescent trees was one of the factors limiting the growth of populations of saproxylic species. It appears that the habitat tree nest holes can guarantee greater protection against predators than traditional nest-boxes (CAVALLI & MASON 2003) and better thermal insulation. Temperature data-loggers placed in some holes and, for comparison, in different nest-boxes, have demonstrated that the maximum and minimum temperatures registered in the nest holes of the habitat trees are "significantly" lower than those measured in the nest-boxes (LONGO *et al.* 2001). How this can affect the reproductive biology of the different species will be the subject of a future study.

The data gathered on woodpeckers also clearly demonstrates the validity of this project and are an important success for the current management of the reserve. The arrival or return of species highly demanding from the ecological viewpoint, like the black woodpecker or the lesser spotted woodpecker, are without doubt linked to the increased volume of fallen dead wood and senescent trees that began in the mid-eighties with the cessation of timber extraction and has been greatly promoted by the forestry operations carried out within the LIFE Project (LONGO *et al.* 2002).

## References

CAVALLI R., MASON F. (eds.), 2003 - **Tecniche di ripristino del legno morto per la conservazione delle faune saproxiliche. Il progetto LIFE Natura NAT/IT/99/6245 di "Bosco della Fontana" (Mantova, Italia) - *Techniques for re-establishment of dead wood for saproxylic fauna conservation. LIFE Nature project NAT/IT/99/6245 "Bosco della Fontana" (Mantova, Italy).*** Rapporti scientifici, *Scientific Reports*, 2. Centro Nazionale per lo Studio e la Conservazione della Biodiversità Forestale di Verona - Bosco della Fontana. Gianluigi Arcari Editore, Mantova, 112 pp.

LONGO L., 2001 - **Uccelli**. 40-41. In: LONGO L. & NADALI A. (eds.). Vertebrati di un bosco planiziario padano: Bosco della Fontana. Quaderni Conservazione Habitat, 1. Corpo Forestale dello Stato, Centro Nazionale per lo Studio e la Conservazione della Biodiversità Forestale di Bosco Fontana, Gianluigi Arcari Editore 40-41.

LONGO L., 2003 - **Gli alberi habitat: prescrizioni per la realizzazione ed il monitoraggio delle cavità di nidificazione. *Habitats tree: instructions for creating and monitoring nest holes.*** 63-68. In: CAVALLI R., MASON F. (eds.), 2003 - Tecniche di ripristino del legno morto per la conservazione delle faune saproxiliche. Il progetto LIFE Natura NAT/IT/99/6245 di "Bosco della Fontana" (Mantova, Italia) - *Techniques for re-establishment of dead wood for saproxylic fauna conservation. LIFE Nature project NAT/IT/99/6245 "Bosco della Fontana" (Mantova, Italy).* Rapporti scientifici, *Scientific Reports*, 2. Centro Nazionale per lo Studio e la Conservazione della Biodiversità Forestale di Verona - Bosco della Fontana. Gianluigi Arcari Editore, Mantova.

LONGO L., MARTIGNONI C., BERTOLI R., 2002 - **Svernamento di Picchio nero, *Dryocopus martius*, nella Riserva Naturale di Bosco della Fontana (Mantova)**. Riv. ital. Orn., 72 (1): 81-82.

LONGO L., NADALI A., DONINI F., 2001 - **Il Progetto Life-Natura (NAT/IT/006245) di Bosco della Fontana: gli interventi a favore dell'avifauna**. Avocetta, 25 (1): 108.

PREMUDA G., BEDONNI B., BALLANTI F., 2000 - **Nidi Artificiali**. Calderini edagricole, Bologna, 414 pp.

## Acknowledgements

My grateful thanks go to all my colleagues at the National Centre for the Study and Conservation of Forest Biodiversity in Verona - Bosco della Fontana, in particular Dr. Francesco Donini, Oscar Conti and Marco Ascari, without whose help many of the things achieved within the ambits of this project would not have been possible, to the personnel of the Verona State Forests Administration and Rosita Mantovani, for her helpful collaboration.

# COLEOTTERI SCOLITIDI IN QUERCE DEL BOSCO DELLA FONTANA

## *AMBROSIA BEETLES IN THE OAK STANDS OF BOSCO DELLA FONTANA*

Jean-Paul Rukalski, Massimo Faccoli

*Dipartimento di Agronomia Ambientale e Produzioni Vegetali - Entomologia, Università di Padova. Viale dell'Università, 16/a, Agripolis 35020 Legnaro (PD), Italy. E-mail rukikur@hotmail.com ; E-mail massimo.faccoli@unipd.it*

**Summary:** The aims of the work were to investigate how ambrosia beetle populations (Coleoptera, Scolytidae) are affected by: a) artificial increase of dead wood amount; b) different tree treatments; c) different host species. In spring 2000, 42 oaks (*Quercus rubra* and *Q. robur*) were cut in different ways. At the same time, 27 window flight traps and 15 trunk window traps were set up on the treated trees. Traps were emptied every 2 weeks. The monitoring period lasted 5 months (April-September). Treatments affected significantly the ambrosia beetle colonisation, with dead and uprooted trees being the most attractive. However, pedunculate oaks (*Q. robur*) were generally more attractive to ambrosia beetles than red oaks (*Q. rubra*). The two types of trap showed significant differences in the number of catches with highest values in the window flight trap.

**Key words:** Wood decomposition, monitoring, Italy, colonisation, Scolytidae.

Fra gli insetti forestali, gli xilofagi s.l. svolgono una fondamentale azione accelerando fra l'altro la degradazione del legno, sostanza organica stabile e di difficile decomposizione. Non tutti gli xilofagi intervengono però negli stessi modi e tempi nei processi di aggressione del legno. Alcuni sono infatti frequenti solo su tronchi recentemente abbattuti, altri invece, definiti "saproxilici", sono legati alla presenza di legno già più o meno alterato da funghi o da altri xilofagi (SPEIGHT 1989). Negli ecosistemi forestali il legno ospita dunque una varietà di insetti che nell'ambito di microsuccessioni colonizzano tale substrato nei diversi stadi della sua decomposizione. Il legno morto rappresenta pertanto un insostituibile habitat in grado di accogliere una fauna del tutto peculiare ed estremamente importante in termini di biodiversità (TAGLIAPIETRA 2003).

I coleotteri scolitidi (Coleoptera, Scolytidae (= Ipidae)), colonizzando alberi ancora vivi o recentemente abbattuti, sono fra i primi insetti xilofagi che intervengono nei processi di decomposizione del legno, favorendo il successivo ingresso di altre specie xilofaghe. L'importanza ecologica di questi coleotteri si manifesta inoltre attraverso un'azione selettiva svolta nei confronti di piante indebolite da vari fattori di stress. La capacità di alimentarsi a carico di materiale fresco e l'accertata possibilità per numerose specie di trasportare spore di funghi patogeni (BATRA 1979), fanno infine degli scolitidi un fattore predisponente l'avvio di cambiamenti nell'ecosistema grazie a repentine quanto imponenti pullulazioni.

Sulla base di queste premesse, nell'ambito del presente lavoro si è voluto valutare:

- l'effetto dell'incremento numerico degli alberi morti su popolazioni di coleotteri scolitidi;
- i migliori strumenti utilizzabili per il campionamento dell'ipidofauna di querceto;
- gli eventi traumatici a carico delle piante che maggiormente influenzano la consistenza quali-quantitativa dell'ipidofauna di querceto;
- la risposta di diverse specie di scolitidi a differenti substrati trofici.

## MATERIALI E METODI

Lo studio, condotto nell'ambito del progetto Life-Natura 99-6245 presso la Riserva Naturale Bosco della Fontana (Marmirolo - MN), ha previsto il trattamento diversificato di numerosi alberi di quercia rossa (*Quercus rubra* L.) allo scopo di incentivare l'insediamento e la diffusione della fauna saproxilica presente in foresta (MASON 1998). A tal fine nel febbraio del 2000, venti querce rosse di età compresa tra i 40 e i 50 anni e in apparenti buone condizioni fisiologiche sono state sottoposte a interventi di sradicamento, stroncatura e cercinatura (DONINI 2002). Oltre alle piante devitalizzate artificialmente, un gruppo di alberi sani (6 farnie (*Quercus robur* L.) e 8 querce rosse) e 8 farnie cadute naturalmente 1-2 anni prima dell'inizio dello studio, sono stati infine utilizzati come controllo (Tabella 1).

L'effetto dei trattamenti sulle faune xilofaghe è stato poi seguito grazie a due diversi tipi di trappole ad intercettazione (Tabella 1): la *window flight trap* o trappola a finestra, e la *trunk window trap* o trappola a finestra da tronco (SIITONEN 1994). Il modo di operare di questi due dispositivi è simile e prevede che gli insetti, urtando in volo una barriera di plexiglas, cadano in un barattolo di raccolta. Le trappole sono state collocate in bosco il 18 aprile 2000, lasciate per cinque mesi e mezzo (fino al 4 ottobre), e controllate con frequenza quindicinale. Dalla miscellanea raccolta dalle trappole sono stati infine individuati e determinati i coleotteri appartenenti alla famiglia Scolytidae.

## RISULTATI

### Le catture

Complessivamente sono stati catturati 155.399 scolitidi ripartiti in cinque specie, tutte appartenenti alla tribù degli Xyleborini: *Xyleborus saxesenii* (Ratzeburg, 1837), *X. monographus* (Fabricius, 1792), *X.* (= *Xylosandrus*) *germanus* (Blandford, 1894), *X. dispar* (Fabricius, 1792) e *X. dryographus* (Ratzeburg, 1837). In particolare,

| Tipo di intervento | *Quercus rubra* | *Quercus robur* | Trap A | Trap B |
|---|---|---|---|---|
| Pianta in piedi non trattata (sana) | 8 | 6 | 7 | 7 |
| Albero cercinato (morto in piedi) | 8 | 0 | 4 | 4 |
| Albero sradicato | 4 | 0 | 4 | 0 |
| Albero stroncato ("Snag") | 8 | 0 | 4 | 4 |
| Pianta caduta naturalmente | 0 | 8 | 8 | 0 |
| Totale | 28 | 14 | 27 | 15 |

**Tabella 1** - Ripartizione degli alberi e delle trappole in relazione ai tipi di intervento realizzati. (A) *Window flight trap;* (B) *Trunk window trap.*

*X. saxesenii* è stata la specie più frequente costituendo circa il 72,4% degli scolitidi catturati (Figura 1).

Per ogni specie il picco di cattura più alto è stato registrato il 3 maggio, mentre i valori più bassi si sono avuti a fine estate (settembre). Le catture hanno comunque mostrato andamenti diversi per ciascuna delle specie con picchi di cattura distribuiti in vari momenti lungo tutta la buona stagione.

### I trattamenti

Le farnie hanno mostrato una generale maggiore attrattività rispetto alle querce rosse. Inoltre, i vari trattamenti evidenziano fra loro differenze statisticamente significative (Figura 2), così come le interazioni tra specie di insetti e trattamenti.

Complessivamente le piante cadute a terra naturalmente (farnie morte da 1-2 anni) e gli alberi sradicati sono più attrattivi rispetto ai substrati predisposti con altri tipi d'intervento. Al contrario le piante non trattate (sane) sono, come prevedibile, le meno attrattive per gli scolitidi (Figura 2).

### Le trappole

Indipendentemente dal tipo di trattamento, le catture medie per trappola sono state statisticamente superiori nella *window flight trap* rispetto alla *trunk window trap*. È stata inoltre accertata un'interazione significativa fra specie di scolitide e trappole, con catture di *X. saxesenii* e *X. germanus* superiori nelle *window flight trap*.

## DISCUSSIONE

### Le catture

Le specie di scolitidi rinvenute nelle trappole appartengono tutte agli Xyleborini LeConte, 1876, una tribù delle Ipinae Reitter, 1894, che in Italia annovera due generi (*Xyleborus* Eichhoff, 1864 e *Xylosandrus* Reitter, 1913) (Abbazzi *et al.* 1995; Faccoli 2000). Le femmine degli Xyleborini scavano nel legno profonde gallerie che si ramificano o dilatano a formare delle vere e proprie camere entro le quali verranno deposte le uova. Le larve non si cibano però direttamente di tessuti legnosi, nutrimento molto povero, ma di funghi simbionti del gruppo delle "*Ambrosia*" (Schmidberger, 1836) veicolati nell'albero ospite dalla madre. Questi scolitidi sono quindi detti xilomicetofagi poiché vivono nel legno ma si nutrono di funghi.

Tra i primi organismi a penetrare nel legno di alberi recentemente morti, gli Xyleborini svolgono una funzione ecologica di primaria importanza permettendo l'ingresso di funghi e batteri che avviano in profondità processi di decomposizione bio-chimica del legno. L'aumentata porosità derivante dalla loro attività di scavo garantisce inoltre una maggior capacità di ritenzione idrica della necromassa legnosa, riducendo così il rischio di combustione (Schowalter 1994). Gli scolitidi xilematici rappresentano anche l'anello di una importante rete trofica che vede la partecipazione di predatori s.l. simbionti e commensali.

L'andamento temporale delle catture può fornire preziose informazioni circa la bioecologia delle specie indagate. Per tutte le specie di *Xyleborus* si è potuto infatti osservare un picco di cattura ad inizio maggio che corrisponde all'arrivo in massa di adulti attratti dalle piante ospiti. Le catture osservate nelle settimane successive sono dovute allo sfarfallamento scalare degli individui di prima e in qualche caso seconda generazione. Picchi secondari possono inoltre essere costituiti da catture di esemplari "riemergenti", di individui a sviluppo rallentato, e, verso la fine della buona stagione, di adulti in cerca di ricoveri invernali.

### I trattamenti

Le farnie cadute a terra naturalmente sono più recettive rispetto ai substrati predisposti in altro modo. Le querce rosse trattate solo un mese prima dell'inizio della prova presentavano probabilmente tessuti ancora freschi e quindi meno attrattivi per gli scolitidi. Tuttavia i tre tipi di trattamento applicati alle querce rosse ne hanno comunque aumentato l'attrattività, come dimostrato dalle maggiori catture osservate sulle piante trattate rispetto a quelle sane (Figura 2). In particolare lo sradicamento sembrerebbe il procedimento più

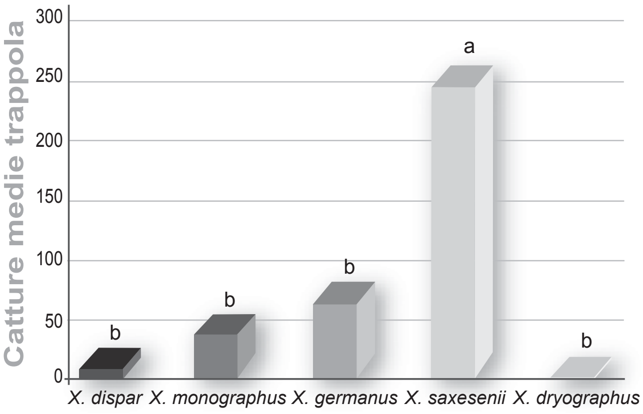


**Figura 1** - Confronto fra catture medie delle cinque specie. A lettere diverse corrispondono differenze significative all'analisi della varianza (ANOVA, P<0,05).

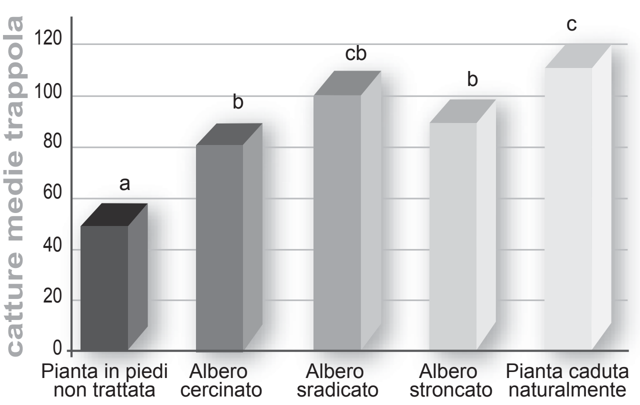


**Figura 2** - Ripartizione delle catture medie secondo i diversi tipi di trattamento. A lettere diverse corrispondono differenze significative all'analisi della varianza (ANOVA, P<0,05).

efficace nel favorire un attacco da parte di scolitidi (Figura 2). In generale, a parità di trattamento, le farnie sono risultate essere più attrattive per gli Xyleborini rispetto alle querce rosse. Questo può essere dovuto al minor vigore vegetativo delle farnie (Mason 2002) legato all'età (120-200 anni) e/o probabilmente ad attacchi di oidio.

### Le trappole

La *window flight trap* e la *trunk window trap* sono note per la loro alta efficienza e selettività, catturando gli insetti "attivamente" ma in quantità differenti (Økland 1996). L'efficacia della *window flight trap* è infatti esaltata dal comportamento di volo degli scolitidi (Chénier e Philogène 1989), e in particolar modo degli Xyleborini che sono abili volatori (Glick 1939). Si spiegherebbe così il maggior numero di catture medie ottenute in questa trappola rispetto a quelle della *trunk window trap*, più efficace nel catturare insetti emergenti da limitate porzioni di tronco (Kaila 1993).

In conclusione, i risultati ottenuti dal presente lavoro suggeriscono lo sradicamento quale migliore tecnica per incrementare l'ipidofauna di querceto e l'uso della *window flight trap* per il suo monitoraggio. Gli interventi finalizzati all'aumento della biodiversità dovrebbero infine considerare la maggior attrattività delle farnie rispetto alle querce rosse.

## Bibliografia

Abbazzi P., Colonnelli E., Masutti L., Osella G., 1995 - **Coleoptera Polyphaga XVI (Curculionoidea)**. 1-68. In: Minelli A., Ruffo S. & La Posta S. (eds.), Checklist delle specie della fauna italiana, 61. Calderini, Bologna.

Batra L.K., 1979 - **Insect-Fungus symbiosis. Nutrition, mutualism and commensalism**. Ed. Allanheld, Osmum & Co., Montclair, New Jersey, 276 pp.

Chénier J.V.R., Philogène B.J.R., 1989 - **Evaluation of three trap designs for the capture of conifer-feeding beetles and other forest coleoptera**. Canadian Entomologist, 121: 159-167.

Donini F., 2002 - **Meccanizzazione degli interventi di recupero degli habitat forestali nella Riserva Naturale Orientata Biogenetica "Bosco della Fontana"**. Tesi di Laurea (non pubblicata), Facoltà di Agraria, Università degli Studi di Padova, Padova, 79 pp.

Faccoli M., 2000 - **Bioecologia di Coleotteri Scolitidi. *Ips typographus* (Linnaeus) e specie di recente interesse per la selvicoltura italiana. III Contributo. Reperti su specie di scolitidi nuove per il territorio italiano**. Bollettino dell'Istituto di Entomologia "Guido Grandi" della Università degli Studi di Bologna, 54: 77-90.

Glick P.A., 1939 - **The distribution of insects, spiders and mites in the air**. USDA, Techn. Bull., 673: 32 pp.

Kaila L., 1993 - **A new method for collecting quantitative samples of insects associated with decaying wood or wood fungi**. Entomol. Fennica, 4: 21-23.

Mason F., 1998 - **Some aspects of habitat conservation management and their implications for the public access: the case of Bosco Fontana natural reserve (Mantova Province, northern Italy)**. 179-185. In: Krott M. & Nilson K. (eds.), 1st Forum on Urban Forestry, Wuppertal.

Mason F., 2002 - **Dinamica di una foresta della Pianura Padana. Bosco della Fontana, Primo contributo, monitoraggio 1995**. Rapporti scientifici 1. Centro Nazionale Biodiversità Fortestale Verona-Bosco della Fontana. Gianluigi Arcani Editore, Mantova, 208 pp.

Økland B., 1996 - **A comparison of three methods of trapping saproxylic beetles**. Eur. J. Entomol., 93: 195-209.

Schmidberger J., 1836 - **Naturgeschichte des Apfelborkenkäfers *Apate dispar***. Beitr. Obstbaumzucht Naturgesch. Obstbaumen schadlichen Insekten, 4: 213-230.

Schowalter T.D., 1994 - **Coarse Woody Debris Chewers in the Columbia River Basin**. Interior Columbia Basin, Ecosystem Management Project 43-0E00-4-9223. ***http://www.ichemp.gov/science/schowalt.pdf***.

Siitonen J., 1994 - **Decaying wood and saproxylic Coleoptera in two old spruce forests: a comparison based on two sampling methods**. Ann. Zool. Fennici, 31: 89-95.

Speight M.C.D., 1989 - **Saproxylic invertebrates and their conservation**. Council of Europe, Strasbourg, 66 pp.

Tagliapietra A., 2003 - **Importanza biologica del legno morto. *The biological importance of dead wood***. 23-29. In: Cavalli R. & Mason F. (eds.) - Tecniche di ripristino del legno morto per la conservazione delle faune saproxiliche. Il progetto LIFE Natura NAT/IT/99/6245 di "Bosco della Fontana" (Mantova, Italia): *Techniques for re-establishment of dead wood for saproxylic fauna conservation*. *LIFE Nature project NAT/IT/99/6245 "Bosco della Fontana" (Mantova, Italy).* Rapporti scientifici, Scientific Reports, 2. Centro Nazionale per lo Studio e la Conservazione della Biodiversità Forestale di Verona - Bosco della Fontana. Gianluigi Arcari Editore, Mantova.

# NARRATING DEAD WOOD: EXPERIENCES IN TEACHING AND DISSEMINATION

## *RACCONTARE IL LEGNO MORTO: ESPERIENZE DIDATTICO-DIVULGATIVE*

Emma Minari, Donatella Avanzi, Rosina Fezzardi

*MiPAF - National Forest Service. National Centre for the Study and Conservation of Forest Biodiversity of Verona - Bosco della Fontana. Laboratories, Strada Mantova 29, I-46045 Marmirolo (MN), Italy. E-mail didalabcfs@tin.it*

**Summary:** The steps taken within the LIFE Nature project, for the conservation and the increase in amount of dead wood at Bosco della Fontana, needed an adequate information support aimed at popularisation to be fully integrated with the research activities. This need was due to the fact that the forest management activities undertaken at Bosco della Fontana may seem destructive and illogical to everyday visitors. Public awareness was achieved with projects for normal visitors, schools, university students and the participants of fairs and specialized meetings. Starting from the direct contact with students, supported by an adequate schoolroom, a progressively larger level of popularisation was obtained through the use of multimedia networks. A brief overview on the three years of the project and the future prospects is presented.

**Key words:** Lombardy, dead wood, conservation, public awareness, dissemination.

Teaching and disseminating the subjects of the Bosco della Fontana LIFE Nature project (NAT/IT/99/6245) (Cavalli & Mason 2003): a fairly arduous task but also a stimulating challenge. Without references (except for the "Animal Inn" of the U.S. Ministry of Agriculture with the protagonist-guide "Sally Snag") and specific information, it was necessary to gradually transform past activities and adapt them to the new context and most especially the new aim: make the importance understood of the presence of dead wood in the forest.

Why should people be made aware of this? First of all to spread a conservationist viewpoint rather than exploitation of the wood and its natural resources; this latter point of view is extremely widespread, especially amongst people who have always lived in close proximity to woods. Moreover, considering the aggressive visual impact of the operations carried out, it was considered a duty to undertake a good campaign of awareness to lessen the expected criticisms from non-experts.

Naturally enough, to disseminate the subjects and problems inherent in the Bosco della Fontana LIFE Nature project from all points of views, it was necessary to establish different relationships with the many categories of people who have different expectations and interests. It was firstly decided to examine the most likely users: from children of compulsory schooling age, to those in high schools specialising in science, humanities and the arts, students doing university degree courses in environmental subjects (particularly Forestry and Environmental Sciences, Biological Sciences and Natural Sciences), the ordinary visitors to the Reserve (for example residents in neighbouring towns), the occasional visitors, and attendants at trade fairs and specialist conferences. The next step was to establish how to tackle each of these categories, taking as a basic principal the fact that, when involved and made aware, youngsters often reveal themselves to be valid allies in spreading greater environmental awareness amongst adults. The various initiatives were therefore started, but with the greatest efforts being made for the youngest.

Guided field trips of LIFE Nature.

With children of compulsory schooling age it was decided to take, as a starting-off point for a fuller discussion, the most representative organisms linked to the dead wood environment (woodpeckers, saproxylic Coleoptera, wood fungi), highlighting the more curious and characteristic aspects, to then go through the entire food chain and the types of dead wood there can be in a forest (broken tree stumps, trees that have fallen to the ground or in the watercourses, etc.). Once “in tune” with this environment and its inhabitants, it becomes almost automatic to make observations on the lack of decaying wood in known woods and on what this lack implies. With this premise it is also easier to introduce the more unpleasant part of the project: the use of healthy plants, like Red oak and Plane trees, to obtain dead wood, or even more incomprehensible, living trees bearing dead wood (habitat trees). Regarding this, the

Listening out for birds with directional microphones.

situation that has been created locally over the centuries is helpful: Bosco della Fontana is a small plains wood completely isolated in the middle of a huge expanse of farmland and is all that remains of a much vaster ancient forest, the "pollution" of highly invasive exotic plants only worsens the precarious equilibrium of the site. Their use for re-establishing such an important component such as dead wood in all its many aspects is therefore more comprehensible. Naturally this is based on the active involvement of the pupils and the use of different teaching aids: games, simulations and group work, observation of exhibits and evidence, laboratory experiments conducted with the help of entomological cassettes and stereomicroscopes, exercises, bird-watching by closed-circuit television, observation of live insects in appropriately laid out terraria, guided field trips. Direct experience is always preferred to a simple theoretical presentation. There is therefore often direct contact with the insects that live in dead wood (especially at the larval stage) like the characteristic stag beetle or the less well-known oak cerambycids, and with the birds who frequent these environments, like the great spotted woodpecker or nuthatch. The activities during the course of the project have therefore been specified and concentrated more on insects and birds, with the emphasis on saproxylics. The habitat trees, obtained from Plane trees, are viewed in terms of an “apartment block” in which the first floor is reserved for insects (for example rat-tailed maggot *Syrphid larvae*), while the second is inhabited by saproxylic birds such as the tawny owl or great tit. It has been noted that especially the proposals based on knowledge of the insects on dead wood have received a lot of approval; this is probably because the young, unlike the majority of adults, are immune to the psychological mechanisms of repulsion and disgust when faced with insects, and are often spontaneously intrigued and well-disposed to contact with this world that reveals surprising and unimaginable aspects. In addition, these are activities that generally receive little coverage in classical environmental education and are therefore probably all the more appealing for the new angle they give to the school programmes.

For the high school pupils it was decided to change the type of approach according to the orientation of the studies. With the students of scientific and humanist orientated schools insects are collected in the field and then studied in the laboratory with the help of experts from the National Centre for the Study and Conservation of Forest Biodiversity at Bosco della Fontana. Collection aimed at examining the different environments that can be found in the forest context, is also done next to fallen trunks or with aerial traps to capture insects that habitually live at the level of the crowns of the tallest oak trees and cannot be observed during a simple walk through the wood.

Students from the art-based high schools were more difficult to involve in similar initiatives. In the first and second year of the project two prize-winning competitions were therefore set up aimed at the pupils of the Istituto d’Arte di Guidizzolo in the province of Mantova: with the first the LIFE project logo was designed, while the second produced explanatory panels on the stages of decay of a dead tree. These initiatives involved a series of lessons and introductory outings on the subjects to be developed and were shown to be a valid alternative for increasing the awareness of this particular type of user.

The university students were given field demonstrations of the operations carried out in the LIFE project, often corresponding to the actual interventions included in the project; in addition, periodic assistance was provided for technical-applied training sessions of the different degree courses.

The local community was informed about the subjects and aims of the LIFE project with promotional meetings and initiatives within the Reserve for local residents and school pupils.

Visitors who enter the Reserve, even with a purely recreational intent always have the opportunity to learn about the management of the site thanks to the presence of explanatory panels, mainly sited in the proximity of the operations carried out.

In order to disseminate this positive experience also outside the context of Bosco della Fontana, specialist trade fairs and conferences were attended, as is normal practice, in order to have more external contacts; in particular the “Green Week” in Brussels (annual EU demonstration on the environment) has made the Bosco della Fontana LIFE project become known by many other European beneficiaries of the LIFE instrument. Ad hoc seminars have also been held at other Reserves in order to verify the feasibility of these types of interventions in other areas.

Overall the experience of these years has been positive and its continuation and development is desirable for many reasons: an increase in visitors to the Reserve, a tendency towards a change in the type of use (from the simple walk to a visit aimed at understanding the management), a constructive exchange with the managers of other Reserves and most of all, the attainment of a structure capable of tackling this subject in all its complexity.

## References

CAVALLI R., MASON F. (eds.), 2003 - **Tecniche di ripristino del legno morto per la conservazione delle faune saproxiliche. Il progetto LIFE Natura NAT/IT/99/6245 di "Bosco della Fontana" (Mantova, Italia) -** ***Techniques for re-establishment of dead wood for saproxylic fauna conservation. LIFE Nature project NAT/IT/99/6245 "Bosco della Fontana" (Mantova, Italy).*** Rapporti scientifici, *Scientific Reports*, 2. Centro Nazionale per lo Studio e la Conservazione della Biodiversità Forestale di Verona - Bosco della Fontana. Gianluigi Arcari Editore, Mantova, 112 pp.

# *OSMODERMA EREMITA* S.L. IN EUROPA MERIDIONALE: STATO DELLE CONOSCENZE E PROBLEMI DI CONSERVAZIONE (COLEOPTERA, CETONIIDAE)

## OSMODERMA EREMITA *S.L. IN SOUTHERN EUROPE: STATE OF THE ART AND CONSERVATION ISSUES (COLEOPTERA, CETONIIDAE)*

Paolo Audisio(1), Alberto Ballerio(2), Giuseppe Maria Carpaneto(3), Gloria Antonini(1),
Emiliano Mancini(1), Giorgia Coletti(1), Emanuele Piattella(1), Alessio De Biase(1)

*(1) Dipartimento di Biologia Animale e dell'Uomo, Università di Roma "La Sapienza", Viale dell'Università 32, I-00185 Roma, Italy.*
*E-mail paolo.audisio@uniroma1.it*
*(2) Viale Venezia 45, I-25123 Brescia, Italyy. E-mail alberto.ballerio.bs@numerica.it*
*(3) Dipartimento di Biologia, Università di Roma "Roma Tre", Viale G. Marconi 446, I-00146 Roma, Italy. E-mail carpanet@uniroma3.it*

**Summary:** Present knowledge on *O. eremita* s.l. geographic distribution, ecology, and conservation issues in southern Europe and Italy are shortly reported. Preliminary results from analyses on different European populations of *O. eremita* s.l. using mtDNA genes (COI and COII) as molecular markers are also presented. The results suggest a likely specific rank of genetic differentiation among sampled populations of *O. eremita* (Scopoli) (from central Italy and southern Sweden) and *O. lassallei* Baraud & Tauzin (from Croatia). The definition of the actual taxonomical arrangement of the four presumed southern European "species" of *Osmoderma* (*O. eremita*, *O. lassallei*, *O. cristinae* Sparacio and *O. italicum* Sparacio) is extremely important in order to establish a correct conservation plan for the whole European *Osmoderma* populations.

**Key words:** Saproxylic fauna, Coleoptera, Cetoniidae, *Osmoderma*, molecular taxonomy.

La forte riduzione negli ambienti naturali e seminaturali dei grandi alberi secolari e delle associate comunità saproxiliche è un fenomeno che interessa gran parte dell'Europa, in particolare quella meridionale. D'altra parte, alcune pratiche colturali quali il capitozzamento di alcune specie arboree lungo filari ai margini di corsi d'acqua o di strade interpoderali e nei parchi cittadini, hanno favorito la disponibilità di nuovi microhabitat potenziali per le comunità saproxiliche, anche in ambienti di scarsa qualità ambientale.

In questo quadro complessivo si inserisce il problema della distribuzione e della conservazione di uno dei più noti e vistosi coleotteri della fauna europea, il Cetonide *Osmoderma eremita* (Scopoli 1763), tra le poche specie di invertebrati compresi nell'elenco delle entità ufficialmente protette a livello della Comunità Europea attraverso la Direttiva Habitat (1992) e i suoi allegati. Anche a seguito di questo nuovo status ufficiale di soggetto di interesse comunitario, su *O. eremita* sono state intraprese negli ultimi anni una serie di ricerche finalizzate sia al miglioramento delle conoscenze sull'autoecologia e l'etologia della specie (Luce 2001; Ranius 2001, 2002b; Jönsson 2003), sia allo studio del suo potenziale ruolo di bioindicatore e delle prospettive di conservazione e di monitoraggio degli habitat colonizzati (Ranius e Jansson, 2002; Ranius 2002a).

Parallelamente, una serie di contributi a carattere più strettamente tassonomico (Baraud e Tauzin 1991; Tauzin 1994a, 1994b, 1996, 2000, 2002; Sparacio 1994, 2001; Massa 1995; Krell 1996), hanno recentemente messo in luce la possibile presenza in Europa meridionale di almeno tre o quattro entità distinte, potenzialmente e alternativamente interpretabili come gruppi di popolazioni, sottospecie o specie biologiche distinte e allopatriche.

Questo breve contributo vuole dunque fare il punto sullo stato delle conoscenze della specie a livello italiano e dell'Europa meridionale e sulle opportune strategie volte alla sua conservazione, con indicazioni sullo status tassonomico delle diverse entità coinvolte, desunte da preliminari risultati di indagini molecolari.

## ECO-ETOLOGIA E FENOLOGIA

L'eco-etologia e la fenologia di *O. eremita* s.l. sono sintetizzate in una serie di contributi di recente pubblicazione (Martin 1993; Luce 2001; Baratelli 1997; Prunier 1999; Ranius 2000, 2001, 2002b, 2002c; Vernon e Vannier 2001; Jönsson 2003; Larsson *et al.* 2003) o in fase di stampa (Ranius *et al.* in stampa). La specie presenta un ciclo biologico relativamente semplice, che vede per un triennio lo sviluppo delle larve entro ammassi di rosura lignea sedimentati all'interno di cavità arboree di una cospicua ed eterogenea varietà di essenze vegetali (prevalentemente querce, faggi, salici e castagni, ma occasionalmente anche platani, pioppi, betulle, olmi, aceri e in alcuni casi perfino pruni, meli, robinie, gelsi, tassi, abeti, e altri ancora). Le larve alla fine del periodo preimaginale si costruiscono un bozzolo ninfale di forma subova-

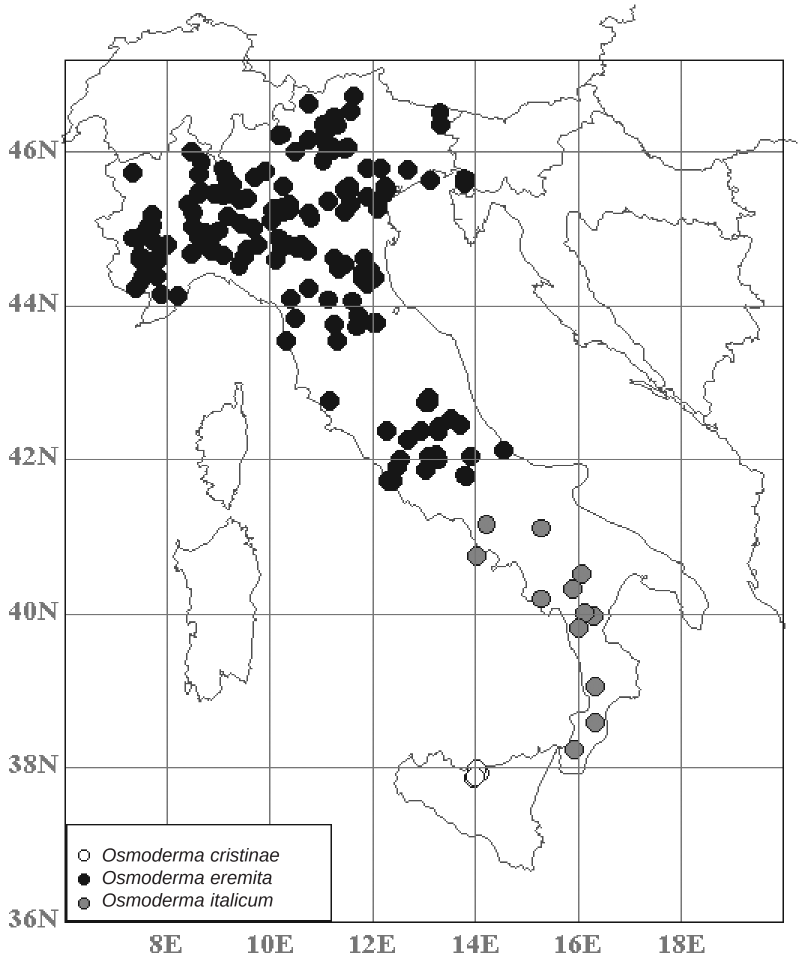


**Figura 1** – Distribuzione in Italia di *Osmoderma eremita* s.l..

le, costituito da escrementi e residui lignei compattati. Gli adulti sfarfallano generalmente nella tarda primavera o all'inizio dell'estate, si accoppiano, e le femmine depongono durante l'estate un numero variabile di uova (in media una trentina), che rapidamente cominciano a svilupparsi entro gli ammassi lignei. Gli adulti, salvo casi relativamente rari, non sopravvivono all'autunno e non vanno in ibernazione, ma muoiono entro la fine dell'estate. In un'unica cavità arborea sono in genere raggruppate alcune decine di individui di entrambi i sessi e numerose larve ai vari stadi di sviluppo. I maschi adulti compaiono per poche settimane sulla superficie dei tronchi, di norma nel primo pomeriggio delle assolate giornate estive (da giugno ad agosto, a seconda della latitudine), pattugliando in genere a turno gli sbocchi verso l'esterno delle cavità colonizzate. I maschi emettono un penetrante odore (spesso assimilato a quello del "cuoio di Russia") percepibile anche dall'Uomo a decine di metri dal punto di emissione. Recentemente (Larsson *et al.* 2003) è stato dimostrato come questo feromone è in effetti un lattone, precisamente un (R)-(+)-g-decalattone, rilasciato in grande quantità e il cui ruolo è di attrarre le femmine, oltre probabilmente a quello di segnalare la disponibilità di un adatto sito riproduttivo e trofico. Gli adulti mostrano di norma una certa filopatria, con sporadici voli pomeridiani estivi a medio raggio, sebbene si evidenzi per la specie una struttura di tipo metapopolazionale (Ranius 2000; Ranius e Hedin 2001; Hedin e Ranius 2002).

La tipologia di alberi attaccati mostra alcuni caratteri comuni, quali un diametro del tronco significativo (raramente al di sotto del mezzo metro), associato ad una altezza relativamente ridotta, la presenza di un'ampia cavità interna parzialmente occupata da rosura lignea, e la disponibilità di uno o più sbocchi verso l'esterno di almeno 4-5 cm di diametro. La quasi totalità degli alberi attaccati è costituita da esemplari vecchi e con grado di cavitazione interna più o meno elevato, ma quasi sempre ancora vitali. I pochi reperti segnalati su alberi morti e tronchi abbattuti sembrano in effetti associati ad abbattimenti recenti da parte dell'uomo, di fulmini o del vento.

## TASSONOMIA E DISTRIBUZIONE GEOGRAFICA

Nel corso degli ultimi anni in Eurasia sono state identificate dagli specialisti diverse "specie" di *Osmoderma* Serville, 1828. Tauzin (1994a, 1994b, 1996, 2000, 2002) identifica due differenti specie europee: *O. eremita* (Scopoli 1763), specie ampiamente distribuita in Europa (nominata *O. eremitum* dall'autore francese, per un errore sulla natura dell'epiteto specifico latino *eremita*, ritenuto un aggettivo e non un sostantivo invariabile: Massa 1995) e *O. lassallei* Baraud e Tauzin, 1991 (Balcani). Inoltre sono note altre due specie affini del Vicino Oriente: *O. brevipenne* Pic, 1904 (Turchia meridionale) e *O. richteri* Medvedev, 1953 (Georgia). Sparacio (1994) descrive poi *O. cristinae* come specie endemica della Sicilia, mentre più tardi Krell (1996) considera le tre forme europee di *Osmoderma* come semplici sottospecie di *O. eremita*. D'altra parte Sparacio (2001), in una recente revisione delle *Osmoderma* europee, rivaluta nuovamente *O. lassallei* e *O. cristinae* ad un rango specifico, introducendo e descrivendo una quarta possibile specie distinta di questo complesso, *O. italica* Sparacio, 2001 (ovviamente da emendare in *O. italicum*), considerata endemica dell'Italia meridionale peninsulare (Campania, Basilicata e Calabria). Nello stesso lavoro Sparacio (2001) riporta inoltre che alcuni vecchi esemplari museali studiati, provenienti dalla Svizzera (Basilea) e dalla Germania (Insel Askold), sarebbero da riferire ad *O. barnabita* (Motschulsky 1845), una specie est-paleartica affine, ma distinta, precedentemente nota solo di Siberia orientale e Cina settentrionale (Tauzin 1994a).

Da quanto evidenziato finora, risulta abbastanza chiaro come il quadro tassonomico complessivo di *O. eremita* s.l. risulti ancora non ben definito, e continuamente esposto ad interpretazioni differenti a carattere essenzialmente soggettivo. Al momento *O. eremita* s.str. risulterebbe comunque distribuita nell'Europa centro-settentrionale e occidentale, a Sud fino all'Italia centrale, *O. lassallei* nell'Europa orientale e nei Balcani, *O. cristinae* in Sicilia settentrionale e infine la problematica *O. italicum* in Italia meridionale (Figura 1; basata su un insieme di dati storici pubblicati, dati museali inediti e reperti recenti inediti, elencati nel dettaglio in Ranius *et al.* in stampa).

Va inoltre ricordato che *O. eremita* è stata descritta originariamente della "Carniola"

**Figura 2** – Dendrogramma costruito sulla base delle distanze genetiche tra gli individui di *O. eremita* (OE) e *O. lassallei* (OL) (provenienza degli esemplari nel testo).

(attualmente in Slovenia), dove recenti reperti segnalano la presenza di "*O. lassallei*" (Sparacio 2001). Il tipo della specie risulta disperso e Tauzin (1994b) ha purtroppo contribuito ad aumentare la confusione stabilendo (contro le raccomandazioni del Codice di Nomenclatura Zoologica) un neotipo di *O. eremita* su materiale raccolto in Italia presso Firenze, e quindi certamente non rappresentativo della possibile "specie" balcanico-orientale. L'argomento sarà affrontato in dettaglio in altra sede, ma è evidente come *O. lassallei* potrebbe risultare un sinonimo oggettivo di *O. eremita*, mentre le popolazioni occidentali sinora attribuite a *O. eremita* potrebbero mancare di un epiteto formalizzato.

## ANALISI DI TASSONOMIA MOLECOLARE

Sono state condotte alcune analisi preliminari per un progetto di ricostruzione delle relazioni filogenetiche, in chiave molecolare, tra tutte le entità tassonomiche riconoscibili morfologicamente nell'ambito di *O. eremita* s.l. (Audisio *et al.*, in prep.). Il progetto, iniziato nell'estate 2002, ha visto finora la disponibilità di pochi individui attribuibili su base morfologica alle sole *O. eremita* s.str. (Lazio e Svezia meridionale) e *O. lassallei* (Croazia). Tali individui sono stati uccisi alla fine del periodo riproduttivo direttamente in capsule contenenti acetone puro per analisi, che si è dimostrato un ottimo mezzo di conservazione a medio-lungo termine dei campioni per successive analisi molecolari a livello del DNA (Fukatsu 1999). Seguendo i protocolli messi a punto presso il nostro laboratorio (De Biase *et al.* 2003), si è quindi proceduto all'estrazione del DNA dai muscoli metafemorali di tutti gli individui a nostra disposizione e alla successiva amplificazione e sequenziamento dei geni mitocondriali per le subunità I e II della citocromo **c** ossidasi. Per la CO-II sono già disponibili le sequenze dell'intero gene per un totale di 688 siti nucleotidici, mentre per la CO-I le sequenze sono ancora incomplete e non saranno prese in considerazione in questa breve nota preliminare.

Sulla base delle sequenze allineate della CO-II è stato possibile procedere al calcolo delle distanze genetiche secondo il modello di Kimura a 2 parametri (Kimura 1980). I risultati mostrano un certo livello di divergenza tra le popolazioni di *O. eremita* provenienti dall'Italia centrale (Lazio, Roma: OE1-1) e dalla Svezia (Isola di Hallands: OE2-1, OE2-2), pari a 0,009 (0,004 e.s.) e probabilmente associato alla loro elevata distanza geografica. La divergenza tra *O. eremita* e *O. lassallei* (Croazia, laghi di Plitvicka: OL1-1) risulta invece ben superiore, pari a 0,068 (0,010 e.s.), corrispondente ad una differenza media nel 7% dei siti nucleotidici (Figura 2).

Alla luce di questi risultati preliminari sembra verosimile che i dati molecolari potranno confermare la netta distinzione specifica almeno dei due taxa studiati, *O. lassallei* ed *O. eremita* s.str., anche se ulteriori dati su altri marcatori e campionamenti nelle potenziali aree di parapatria (per esempio tra l'Italia nord orientale e la Slovenia) contribuiranno senza dubbio alla definitiva caratterizzazione molecolare del loro status tassonomico. Alcune considerazioni morfologiche sembrano suggerire che le popolazioni dell'Italia meridionale (*O. italicum*) e della Sicilia (*O. cristinae*) (Figura 1) siano più strettamente affini a *O. lassallei* (Sparacio 2001; *in verbis* 2003) rispetto a *O. eremita* s.str.. Disponendo nei prossimi mesi di individui di entrambi i taxa, contiamo di poter sottoporre a verifica la presunta distinzione a livello specifico di *O. italicum* e *O. cristinae*, possibilmente con indicazioni su base molecolare anche sulla posizione filogenetica relativa di *O. lassallei*, *italicum*, *cristinae* ed *eremita* s.str..

## CONCLUSIONI E PROBLEMI DI CONSERVAZIONE

Molte delle strategie di conservazione che riguardano la specie (s.l.) potranno mutare di prospettiva, in funzione della risoluzione dei problemi tassonomici che la coinvolgono. Mentre *O. eremita* s.str. è infatti apparentemente ancora abbastanza frequente e diffusa sia in Italia centro-settentrionale che in Europa centro-occidentale, anche in ambienti a parziale o totale influenza antropica, le popolazioni attribuibili a *O. lassallei* in Europa sud-orientale sembrano meno numerose e più disperse, mentre quelle riferibili provvisoriamente a *O. italicum* sono piuttosto localizzate e sembrano addensate in pochi nuclei in aree montane di buona qualità ambientale, soprattutto della Calabria e della Basilicata. Anche *O. cristinae* sembra più fortemente a rischio, associata a poche località montane e submontane nemorali della Sicilia settentrionale, con dimensioni delle singole popolazioni apparentemente molto ridotte. Ove venisse confermato lo status di specie distinte di tutte le entità in gioco, soprattutto in Europa meridionale e in particolare in Italia meridionale e Sicilia sarebbe quindi estremamente urgente la messa a punto di un piano di monitoraggio rigoroso e ad ampio spettro per censire la maggior parte delle popolazioni e delle aree interessate dalla presenza delle *Osmoderma*.

Per quanto riguarda il significato delle stesse *Osmoderma* come "indicatrici" di buona qualità ambientale degli ecosistemi e delle associate comunità saproxiliche (recentemente sottolineato in alcuni lavori incentrati sull'Europa settentrionale: Ranius 2002a), il discorso sembra analogamente influenzato da fattori tassonomico-geografici, e da locali adattamenti. A titolo di esempio, *O. eremita* s.str. è infatti presente nelle aree di pianura dell'Italia settentrionale e centrale anche in ambienti a totale influenza antropica, e a nostro giudizio non può ormai fornire, di per sé, alcun significativo "segnale" di elevata qualità ambientale, pur rappresentando comunque un elemento a carattere relittuale degli antichi popolamenti planiziari forestali. Al contrario, le popolazioni dell'Italia meridionale e della Sicilia, salvo poche eccezioni, sembrano confinate ad ecosistemi di almeno discreta qualità ambientale, dove la conservazione di "antichi" nuclei forestali con scarso disturbo antropico pare ancora l'elemento-chiave per la presenza della specie.

In conclusione, al di là della semplice strategia operativa di preservare al massimo i nuclei relitti o i singoli individui di grandi dimensioni delle essenze forestali attaccate dalla specie (s.l.), anche in aree urbane e suburbane, e di mantenere opportuni corridoi faunistici di collegamento tra le popolazioni, pare decisamente più saggio operare dei monitoraggi ad ampio spettro che prendano in considerazione l'intera comunità saproxilica di questi habitat, nel suo insieme in grado di fornire certamente indicazioni più significative (Nilsson e Baranowski 1997; Grove 2002; Ranius e Jansson 2002) rispetto alla semplice presenza di una singola, seppur vistosa, entità, come *O. eremita* s.l..

## Bibliografia

Baratelli D., 1997 - **Note sulla presenza di *Osmoderma eremita* Serv. 1825 nella Riserva Naturale Palude Brabbia e piano di gestione della specie**. Riserva Naturale Palude Brabbia, Progetto LIFE 96NAT/IT/3170. Provincia di Varese. Relazione Tecnica non pubblicata, 16 pp.

Baraud J., Tauzin P., 1991 - **Une nouvelle espèce européenne du genre *Osmoderma* Serville (Coleoptera Cetoniidae Trichiinae)**. Lambillionea, 91: 159-166.

De Biase A., Antonini G., Mancini E., Audisio P., 2003 - **Molecular taxonomy of two sympatric sibling species of the pollen-beetle genus *Meligethes* (Coleoptera: Nitidulidae)**. Zootaxa, 190: 1-16.

Fukatsu T., 1999 - **Acetone preservation: a practical technique for molecular analysis**. Molecular Ecology, 8: 1935-1945.

Grove S.J., 2002 - **Saproxylic Insect Ecology and the Sustainable Management of Forests**. Annual Reviews of Ecology and Systematics, 33: 1-23.

Hedin J., Ranius T., 2002 - **Using radiotelemetry to study dispersal of the beetle *Osmoderma eremita*, an inhabitant of tree hollows**. Computers and electronics in agriculture, 35: 171-180.

Jönsson N., 2003 - ***Osmoderma eremita* on Hallands Väderö**. Examensarbete. [tesina di esame].

Kimura M., 1980 - **A simple method for estimating evolutionary rates of base substitution through comparative studies of nucleotide sequences**. Journal of Molecular Evolution, 16: 111-120.

Krell F.T., 1996 - **Zur Taxonomie, Chorologie und Eiodonomie einiger westpaläarktischer Lamellicornia (Coleoptera)**. Entomologische Nachrichten und Berichte, 40: 217-229.

Larsson M.J., Hedin J., Svensson G.P., Tolasch T., Francke W., 2003 - **The characteristic odour of *Osmoderma eremita* (Coleoptera: Scarabaeidae) identified as a male-released pheromone**. Journal of Chemical Ecology, 29 (3): 575-587.

Luce J.M., 2001 - **La Cètoine protégée *Osmoderma eremita* (Scopoli, 1763) peut elle être un outil de gestion de la biodiversité?** Pp. 243-263. In: Robert J.C., Guilbot R., Dommanget J.L. & Maurin H. (eds.). Inventaire et cartographie des invertébrés comme contribution à la gestion des milieux naturels français. Actes du séminaire tenu à Besançon les 8, 9 et 10 juillet 1999. Patrimoines naturels, M.N.H.N., Paris, 46, 332 pp.

Martin O., 1993 - **Fredede insekter i Danmark**. Del 2: Biller knyttet til skov. Entomologiske Meddelselser, 57: 63-76.

Massa B., 1995 - ***Osmoderma heremitum* meridionale Tauzin 1994 sinonimo di *Osmoderma cristinae* Sparacio 1994 (Insecta Coleoptera Cetoniidae)**. Il Naturalista siciliano, 19 (3-4): 307-308.

Nilsson S.G., Baranowski R., 1997 - **Habitat predictability and the occurrence of wood beetles in old-growth beech forests**. Ecography, 20: 491-498.

Prunier D., 1999 - **Quelques observations sur la biologie d'*Osmoderma eremita* Scop**. Le Coléopteriste, 35: 23-24.

Ranius T., 2000 - **Minimum viable metapopulation size of a beetle, *Osmoderma eremita*, living in tree hollows**. Animal Conservation, 3: 37-43.

Ranius T., 2001 - **Constancy and asynchrony of populations of a beetle, *Osmoderma eremita* living in tree hollows**. Oecologia, 126: 208–215.

Ranius T., 2002a - ***Osmoderma eremita* as an indicator of species richness of beetles in tree hollows**. Biodiversity and Conservation, 11: 931-941.

Ranius T., 2002b - **Population ecology and conservation of beetles and pseudoscorpions living in hollow oaks in Sweden**. Animal Biodiversity and Conservation, 25 (1): 53-68.

Ranius T., 2002c - **Influence of stand size and quality of tree hollows on saproxylic beetles in Sweden**. Biological Conservation, 103: 85-91.

Ranius T., Nilsson S.G., 1997 - **Habitat of *Osmoderma eremita* Scop. (Coleoptera: Scarabaeidae), a beetle living in hollow trees**. Journal of Insect Conservation, 1: 193-204.

Ranius T., Hedin J., 2001 - **The dispersal rate of a beetle, *Osmoderma eremita*, living in tree hollows**. Oecologia, 126: 363-370.

Ranius T., Jansson N., 2002 - **A comparison of three methods to survey saproxylic beetles in hollow oaks**. Biodiversity and Conservation, 11: 1759-1771.

Ranius T., Antonsson K., Jansson N., Johannesson J., 2001 - **Inventering och skötsel av gamla ekar i Eklandskapet söder om Linköping.** [Inventories and management of old oaks in an area south of Linköping, Sweden (in Swedish, English summary)]. Fauna och Flora, 96: 97-107.

Ranius T., Aguado L.O., Audisio P., Ballerio A., Carpaneto G.M., Chobot K., Gjurasin B., Hanssen O., Huijbregts H., Lakatos F., Martin O., Neculiseanu Z., Nikitsky N., Paill W., Pirnat A., Ruicanescu A., Süda I., Tamutis V., Telnov D., Tsinkevich V., Vignon V., Vögeli M., Zach P., in press - ***Osmoderma eremita* (Coleoptera: Cetoniidae) in Europe**. Animal Biodiversity and Conservation, in press.

Sparacio I., 1994 - ***Osmoderma cristinae* n. sp. di Sicilia (Insecta Coleoptera: Cetoniidae)**. Il Naturalista siciliano, (4) 17 (1993) (3-4): 305-310

Sparacio I., 2001 - **Osservazioni sulle *Osmoderma* Le Peletier et Audinet-Serville europee con descrizione di una nuova specie dell'Italia meridionale (Coleoptera Cetoniidae)**. Il Naturalista siciliano, 24 (2000) (3-4): 225-239.

Tauzin P., 1994a - **Le genre *Osmoderma* Le Peletier et Audinet-Serville 1828 (Coleopt., Cetoniidae, Trichiinae, Osmodermatini). Systématique, biologie et distribution (Première partie)**. L'Entomologiste, 50 (3): 195-214.

Tauzin P., 1994b - **Le genre *Osmoderma* Le Peletier et Audinet-Serville 1828 (Coleopt., Cetoniidae, Trichiinae, Osmodermatini). Systématique, biologie et distribution (Deuxième partie)**. L'Entomologiste, 50 (4): 217-242.

Tauzin P., 1996 - **Complément à la note sur le genre *Osmoderma* (Coléoptères, Cetoniidae, Trichinae)**. L'Entomologiste, 52 (3): 105-106.

Tauzin P., 2000 - **Localités connues de *Osmoderma eremitum* Scopoli en France**. Le Coléoptériste, 39: 133-136.

Tauzin P., 2002 - ***Osmoderma eremitum*: complèments sur sa distribution en France et nouvelle information sur la taxonomie du genre (Coleoptera, Cetoniidae, Trichiinae, Osmodermatini)**. L'Entomologiste, 58 (3-4): 145-151.

Vernon P., Vannier G., 2001 - **Freezing susceptibility and freezing tolerance in Palaearctic Cetoniidae (Coleoptera)**. Canadian Journal of Zoology, 79: 67-74.

## Ringraziamenti

Cogliamo l'occasione per ringraziare anche in questa sede il gran numero di colleghi, italiani e stranieri, che hanno contribuito a fornire agli autori i dati (molti dei quali inediti) a loro disposizione sulla distribuzione di *O. eremita* s.l. in Europa, utilizzati per la stesura di un importante contributo di Ranius et al. (in press), dal quale alcune delle informazioni qui presentate sono state riprese. Un ringraziamento particolare va soprattutto agli amici Prof. Thomas Ranius (Lund) e al Dr. Ignazio Sparacio (Palermo) per alcune informazioni inedite, per lunghe discussioni sulla distribuzione, la tassonomia e l'eco-etologia delle *Osmoderma* europee, e per la collaborazione prestata in ogni modo nel reperimento di materiale biologico da sottoporre alle nostre indagini molecolari.

# DEAD WOOD AND SAPROXYLIC SPECIES IN FENNOSCANDIAN BOREAL FORESTS: THREATS, CONSERVATION AND MANAGEMENT

## *LEGNO MORTO E SPECIE SAPROXILICHE NELLE FORESTE BOREALI SCANDINAVE: PROBLEMATICHE, CONSERVAZIONE E GESTIONE*

Juha Siitonen

*Finnish Forest Research Institute, Vantaa Research Centre, PO Box 18, FIN-01301 Vantaa, Finland. E-mail juha.siitonen@metla.fi*

**Summary:** The large-scale reduction of dead wood as a result of intensive forest management is the principal threat to flora and fauna in Fennoscandian boreal forests. Two conservation issues are emergent: the low proportion of old-growth forests, and the virtual elimination of fire disturbances and subsequent successions from both protected and managed forests. Restoration of formerly managed stands in forest reserves has recently started on a large scale. Since 1990s, new biodiversity-oriented management methods have been introduced into Fennoscandian forestry. The main methods include retention of important structures (green trees, snags and logs) in regeneration cutting, and selecting important key habitats which are left outside forestry operations.

**Key words:** Dead wood, saproxylic species, boreal forest, restoration, forest management.

> *Especially sick or stunted trees, snags, wind throws and snow breaks as well as logs, in particular large ones, offer the only living chances to numerous curiosities and rarities of our beetle fauna. In proportion as the silviculture in our country develops and becomes more intensive, such tree individuals (or parts of them) disappear ever more thoroughly from our forests, and the beetles entirely dependent on them became more and more rare and withdraw to ever more restricted areas, until they possibly become extinct in our country.*
>
> (Kangas, 1947)
>
> Unfortunately, the above prediction made almost sixty years ago by E. Kangas, a professor in forest entomology, has turned out to be accurate.

Boreal forest is the largest biogeographic region in Europe covering the northern parts of the continent. By far the largest part of boreal forest in Europe is found in Russia. Norway, Sweden and Finland belong to the Fennoscandian biogeographic area which is located mainly in the boreal zone. The forest area including both productive and poorly productive forests is ca. 30 million ha in Sweden, 23 million ha in Finland and 12 million ha in Norway (Stokland *et al.* 2003). Forest utilization has a long history in the Nordic countries, and has been particularly intensive since the 1960s.

The aim of the present paper is to give a short overview of dead wood and saproxylic species in Fennoscandian boreal forests, and to describe the new restoration and biodiversity-oriented management methods that have been introduced into Fennoscandian forestry since 1990s.

## DEAD WOOD IN BOREAL FORESTS

The volume of dead wood in a natural boreal forest varies considerably depending on the forest site type, latitude, altitude and successional stage. A large number of studies about the amount and quality of dead wood in different types of natural boreal forest in Fennoscandia have been published during the last ten years (for a review, Siitonen 2001). In southern and middle boreal old-growth forests the average volume of dead wood usually varies from 60 to 120 m$^3$/ha, and decreases to ca. 20 m$^3$/ha only in the northernmost forests close to the timberline.

The volume of dead wood can vary considerably even in the same site depending on recent disturbances and the successional stage of the stand. Most boreal forests are highly dynamic, and fire is the most important disturbance factor in natural conditions. In natural forests, the volume of dead wood is at its highest at the beginning of succession, right after a stand-replacing disturbance such as a forest fire or wind throw. The volume is at its lowest in the middle of succession in mature forest and relatively high again in old-growth forest (Siitonen 2001).

Different forest management practices have reduce the amount of dead wood in managed forests. These practices include:

- clear-cutting in which most of the timber volume (including dead trees) is extracted from the site;
- thinnings 2-3 times per rotation in which weakened and dying trees are harvested;
- salvage logging after natural disturbances in which dead trees are removed;
- efficient prevention of forest fires;
- relatively short rotation times (70-100 years) which truncate the stand development before large-diameter dead wood

**Photo1** - A freshly cut area with a group of retention trees.

**Photo 2** - Artificial snags made in connection with regeneration cutting.

starts to accumulate.

Measurements of dead wood were included into the national forest inventories both in Sweden (since 1994), Norway (1994) and Finland (1996). The results have recently been compiled and compared among the three countries (STOKLAND *et al.* 2003). The national average volume of dead wood in productive forests is 10 m$^3$/ha in Finland, 9,1 m$^3$/ha in Norway and 6,6 m$^3$/ha in Sweden. However, the regional variation is large, and the highest volumes are found in the northern boreal forests where the history of intensive forest use is the shortest. In the southern and middle boreal forests, the average volumes vary regionally from 3,4 to 8,5 m$^3$/ha. This means that the average volume of dead wood has been reduced by 90-95% as compared with natural forests.

## SAPROXYLIC SPECIES IN BOREAL FORESTS: SPECIES RICHNESS, HABITATS AND THREATS

Dead wood and fungi decomposing it are the main habitat for a very large number of species. The total number of saproxylic organisms including invertebrates, epixylic mosses and lichens, and wood-decomposing fungi is about 4.000-5.000 in Finland constituting 20-25% of all the forest-dwelling species (SIITONEN 2001). This proportion of saproxylics of all forest species is probably valid for other boreal and possibly temperate regions too.

Snags and logs are the most important microhabitats for boreal saproxylic species. Old living trees are relatively a much less important habitat for the boreal saproxylic fauna than for the temperate fauna. Very large living and dead standing trees are much less frequent in boreal than in temperate natural forests (NILSSON *et al.* 2002). In addition, the dominating boreal tree species (*Picea abies* L., *Pinus sylvestris* L., *Betula pendula* Roth and *B. pubescens* Ehrh.) do not usually become hollow while alive. A large part of the species is obviously adapted to natural disturbances such as fire, particularly species living on pine and deciduous trees (EHNSTRÖM 2001). However, at least part of the species living mainly on spruce are adapted to fire refugia with long continuity (SIITONEN & SAARISTO 2000).

The large-scale reduction of dead wood as a result of intensive forest management is the primary threat to flora and fauna in Fennoscandian boreal forests. For instance in Finland, 1.172 forest species have been red-listed according to the IUCN criteria, and reduction of decaying wood has been identified as one threat factor for 439 (37%) of these (RASSI *et al.* 2001).

## RESTORATION AND BIODIVERSITY-ORIENTED MANAGEMENT

Two conservation issues are emergent in the Fennoscandian boreal forests: the low proportion of old-growth forest, combined with the small average size of the reserves particularly in southern Fennoscandia, and the virtual elimination of fire disturbances and subsequent successions from both protected and managed forests.

The proportion of protected forests is relatively low in most parts of Fennoscandia except the northern boreal zone with mainly poorly productive sites. For instance in southern Finland, the proportion of strictly protected forest is 1,0% (ANONYMOUS 2002a). Furthermore, only about 5% of the protected forests in the southern boreal zone are older than 140 years (VIRKKALA *et al.* 2000). Even most of the protected forests incorporated into conservation areas have been previously managed. This is reflected in the low average volume of dead wood which is only 7,5 m$^3$/ha in protected forests in southern Finland (ANONYMOUS 2000a).

Restoration of formerly managed stands in forest reserves has started only recently. Restoration methods include prescribed burning of stands and artificial creation of dead wood by felling, girdling or flooding. So far, restoration actions have been carried mainly in different kinds of pilot projects on a relatively moderate scale: e.g. in Finland, the total forest area restored until present is 1.500 ha (ANONYMOUS 2003). However, the present goal is to restore a total area of 15.000 ha of forest during the next five years (ANONYMOUS 2002b).

Since 1990s, new biodiversity-oriented forest management methods have been introduced into Fennoscandian forestry. The main methods can be categorized into:

- retention of important structures (green eternity trees, snags and logs) in regeneration cutting;
- recognition and setting aside important key habitats;
- prescribed burning following regeneration cutting.

Retention of green trees and dead wood in regeneration cutting is presently a common practice (VANHA-MAJAMAA & JALONEN 2001). The average number of retention trees with a minimum diameter of 20 cm left in clear-cut areas has been 7-10 trees per ha (corresponding to a volume of 3,5 m$^3$/ha) during the last years in Finland (HÄNNINEN 2001), and is at least 10 trees per ha in Sweden according to the Forest Stewardship Council (FSC) criteria (ANONYMOUS 2000b) (Photos 1, 2).

Both restoration and retention cutting create young successional stands with varying amounts of dead wood in open conditions. Results from recent studies indicate that these methods are potentially powerful tools to revive populations of rare saproxylic species adapted to natural disturbances (Kaila *et al.* 1994; Martikainen 2001; Similä *et al.* 2002; Sverdrup-Thygeson & Ims 2002).

Key habitats are small habitat patches with special habitat qualities (Hansson 2001). In Sweden ca. 50 different types have been defined, in Finland the number is slightly lower. Key habitats include brook-side forests (Photo 3), undrained spruce mires, patches of herb-rich deciduous forest, ravines, rocky outcrop etc. The average size of key habitats is only about 0.5 ha. In practice, these sites are left out of any management to develop naturally.

The significance of key habitats to threatened and rare saproxylic species is poorly known. The main concern is that the key habitats are too small to maintain viable populations (Hansson 2001; Sverdrup-Thygeson 2002). Nevertheless, the key habitats will form local accumulations of dead wood, and this may be the most efficient way of increasing the average amount of dead wood in managed forests in the long term (Ranius *et al.* 2003).

Prescribed burning after regeneration cutting is considered to be an important biodiversity management tool (Granström 2001). The area treated with prescribed burning has been on the average 1.000 ha in Finland during the last ten years. During the same period, the area of spontaneous forest fires has varied from 100 to 1.000 ha per year (Anonymous 2002c). The present goal is to double the area of prescribed burning annually. In Sweden, 5% of the annual regeneration area will be burned according to the Forest Stewardship Council certification criteria. Prescribed burning benefits especially fire-dependent saproxylic species but also other disturbance-adapted species.

## CONCLUSIONS

The present restoration and management prescriptions are undoubtedly a step in the right direction. At least disturbance-adapted species favoring dead wood in open conditions will benefit. However, more long-term monitoring is needed to evaluate the efficiency of present actions in maintaining the diversity of saproxylic species - and particularly those species that require old-growth conditions.

**Photo 3** - A brook-side moist forest with large ferns constitutes a key habitat that will be left outside forestry operations to develop naturally.

## References

Anonymous, 2000a - **Metsien suojelun tarve Etelä-Suomessa ja Pohjanmaalla**. [The need of forest protection in southern Finland and Ostrobothnia (In Finnish)]. Working group memorandum, Ministry of Environment. Suomen ympäristö, 437: 284 pp.

Anonymous, 2000b - **Svensk FSC-standard för certifiering av skogsbruk**. [Swedish FSC standards for the certification of forest management (In Swedish)]. The Swedish FSC Council, Uppsala, 37 pp.

Anonymous, 2002a - **Metsien suojelun luokittelun ja tilastoinnin yhtenäistämistyöryhmä**. [Working group for the harmonization of forest protection classification and statistics (In Finnish)]. Working group memorandum, 2002: 15, Ministry of Agriculture and Forestry, 71 pp.

Anonymous, 2002b - **Etelä-Suomen, Oulun läänin länsiosan ja Lapin läänin lounaisosan metsien monimuotoisuuden turvaamisen toimintaohjelma**. [Forest biodiversity programme for southern Finland, the western parts of Ostrobothnia and the southwestern parts of Lapland (In Finnish)]. Suomen ympäristö, 583: 56 pp.

Anonymous, 2002c - **Finnish Statistical Yearbook of Forestry**. Finnish Forest Research Institute, Vantaa Research Centre, 376 pp.

Anonymous, 2003 - **Ennallistaminen suojelualueilla**. [Restoration in protected areas (In Finnish)]. Suomen ympäristö, 618: 220 pp.

Ehnström B., 2001 - **Leaving dead wood for insects in boreal forests - suggestions for the future**. Scand. J. For. Res. Suppl., 3: 91-98.

Granström A., 2001 - **Fire management for biodiversity in the European boreal forest**. Scand. J. For. Res. Suppl., 3: 62-69.

Hansson L., 2001 - **Key habitats in Swedish managed forests**. Scand. J. For. Res. Suppl., 3: 52-61.

Hänninen H., 2001 - **Luontokohteet ja säästöpuusto talousmetsien hakkuissa – seurantatulokset vuosilta 1996-99**. [Important habitats and retention trees in cuttings of managed forests – monitoring results from the years 1996-99 (In Finnish)]. Metsäntutkimuslaitoksen tiedonantoja, 812: 81-95.

Kaila L., Martikainen P., Punttila P., 1994 - **Dead trees left in clear-cuts benefit saproxylic beetles adapted to natural disturbances in boreal forest**. Biodiv. Conserv., 6: 1-18.

Kangas E., 1947 - **Kovakuoriaisfaunamme erikoisuuksia luonnonsuojelun kannalta**. [Curiosities of our beetle fauna from the point of view of nature conservation (In Finnish)]. Suomen luonto, 6: 45-55.

Nilsson S.G., Niklasson M., Hedin J., Aronsson G., Gutowski J.M., Linder P., Ljungberg H., Mikusinski G., Ranius T., 2002 - **Densities of large living and dead trees in old-growth temperate and boreal forests**. For. Ecol. Manage, 161: 189-204.

Martikainen P., 2001 - **Conservation of threatened saproxylic species: significance of retained aspen *Populus tremula* on clear-cut areas**. Ecol. Bull., 49: 205-218.

Ranius T., Kindvall O., Kruys N., Jonsson B.G., 2003 - **Modelling dead wood in Norway spruce stands subject to different management regimes**. For. Ecol. Manage., 182: 13-29.

Rassi P., Alanen A., Kanerva T., Mannerkoski I. (eds.), 2001 - **The 2000 red list of Finnish species**. [In Finnish with English summary]. Ministry of Environment, 428 pp.

Siitonen J., 2001 - **Forest management, coarse woody debris and saproxylic organisms: Fennoscandian boreal forests as an example**. Ecol. Bull., 49: 11-41.

Siitonen J., Saaristo L., 2000 - **Habitat requirements and conservation of *Pytho kolwensis*, a beetle species of old-growth boreal forest**. Biol. Conserv., 94: 211-220.

Similä M., Kouki J., Martikainen P., Uotila A., 2002 - **Conservation of beetles in boreal pine forests: the effects of forest age and naturalness on species assemblages**. Biol. Conserv., 106: 19-27.

Stokland J., Eriksen R., Tomter S., Korhonen K., Tomppo E., Rajaniemi S., Söderberg U., Toet H., Riis-Nielsen T., 2003 - **Forest biodiversity indicators in the Nordic countries. Status based on the national forest inventories**. TemaNord, 2003: 514, 106 pp.

Sverdrup-Thygeson A., 2002 - **Key habitats in the Norwegian production forest: a case study**. Scand. J. For. Res., 17: 166-178.

Sverdrup-Thygeson A., Ims R.A., 2002 - **The effect of forest clearcutting in Norway on the community of saproxylic beetles on aspen**. Biol. Conserv., 106: 347-357.

Vanha-Majamaa I., Jalonen J., 2001 - **Green tree retention in Fennoscandian forestry**. Scand. J. For. Res. Suppl., 3: 79-90.

Virkkala R., Korhonen K.T., Haapanen R., Aapala K., 2000 - **Metsien ja soiden suojelutilanne metsä- ja suokasvillisuusvyöhykkeittäin valtakunnan metsien 8. inventoinnin perusteella**. [Protection status of forests and mires by forest and peatland vegetation zones according to the 8th national forest inventory (In Finnish)] Suomen ympäristö, 395: 52 pp.

# IMPORTANZA DEGLI INSETTI XILOFAGI PRIMARI NELL'ECONOMIA FORESTALE

## *THE IMPORTANCE OF PRIMARY XYLOPHAGOUS INSECTS IN FOREST MANAGEMENT*

Gianfranco Curletti

*Museo Civico di Storia Naturale, Casella Postale 89, I-10022 Carmagnola (TO), Italy. E-mail musnat@comune.carmagnola.it*

**Summary:** Tree in healthy vegetative condition are able to prevent attacks by xylophagous insects. From this supposition, the Author proposes research that will focus on forest health based on a survey of the number of these populations.

**Key words:** Forests, primary xylophagous insects, forest degradation, research procedures.

Nel vasto e complesso mondo rappresentato dagli insetti fitofagi si possono distinguere diverse categorie ecologiche. Una di queste, basata sull'alimentazione, riguarda una distinzione tra quelle specie che si nutrono delle parti verdi della pianta (**fillofagi, poefagi**) e quelle che si nutrono delle parti legnose (**lignivori** o **xilofagi**). Se tale divisione è netta per la categoria che comprende le specie che si nutrono delle parti contenenti clorofilla (Phasmatodea, Orthoptera, Lepidoptera, Coleoptera Chrysomelidae, Coleoptera Bruchidae, gran parte dei Coleoptera Curculionoidea ecc.) più problematica è la distinzione dei lignivori, in quanto questi ultimi di solito si nutrono anche di foglie, gemme, germogli, almeno allo stadio adulto. È noto ad esempio che gli adulti dei Coleoptera Buprestidae e Cerambycidae si nutrono delle foglie delle piante ospiti, anche se in modo frugale. Per questo motivo, relativamente a questo contributo, i riferimenti a tale divisione saranno limitati esclusivamente agli stadi larvali, che comprendono svariate famiglie di coleotteri e più raramente di lepidotteri (Cossidae, Sesiidae).

Limitatamente ai lignivori, è possibile stabilire una seconda divisione, basata sullo stato di conservazione del legno. I rappresentanti di alcune famiglie di coleotteri si nutrono di legno marcescente e parzialmente decomposto (Rutelidae, Dynastidae, Cetoniidae, Passalidae, Lucanidae, Trogossitidae, Erotylidae, Passandridae, Anobiidae ecc.). Le specie rappresentate da questo gruppo sono comprese nella categoria dei **lignivori detritivori** o **saproxilici** o **saproxilofagi** (Lanza 1982). All'opposto, altre famiglie si nutrono di legno ancora vivo almeno parzialmente, i **lignivori** propriamente detti (Curletti 1994).

Grande attenzione è stata posta da parte della Comunità Europea alla protezione degli elementi saproxilici, in quanto considerati specie-ombrello per la protezione di ambienti peculiari, mentre mancano contributi sull'uso degli xilofagi non detritivori come insetti indicatori di particolari condizioni dell'ambiente.

I coleotteri xilofagi non saproxilici (tra cui numerosi taxa appartenenti alle famiglie Cerambycidae, Buprestidae, Melyridae, Bostrichidae, Scolytidae, Platypodidae ecc.)(1) possono a loro volta essere suddivisi in due importanti categorie: specie che si nutrono esclusivamente di tessuti sani e specie che in modo più o meno occasionale attaccano tessuti debilitati, contribuendo in modo determinante alla loro morte. Ai secondi è assegnato il nome di **ospiti secondari**, ai primi, che sono l'oggetto di questa relazione, il termine di **ospiti primari**(2) (Figura 1).

Si ritiene inutile sottolineare l'importanza che riveste quest'ultima categoria nell'economia forestale, i cui danni sono elencati in innumerevoli lavori. Ciò che tuttavia emerge dai contributi che riguardano l'argomento, è il fatto che solo raramente e in particolari condizioni questi possono essere considerati nocivi o dannosi. È il caso di alcuni scolitidi per le conifere, di curculionidi per i pioppi ibridi, di cerambicidi per il

---

**(1)** Si tende attualmente, anche a livello comunitario, a considerare in modo globale alcune di queste famiglie come saproxilici. È il caso degli Scolytidae, Buprestidae, Cerambycidae. Tale generico concetto non è condivisibile, poichè una buona percentuale di specie rappresentate da queste famiglie si nutre di piante vive, come ampiamente affermato dalla bibliografia citata e non solo. In aggiunta, per avvalorare l'inadeguatezza di questi inserimenti, si ricorda che numerose specie appartenenti ai gruppi tassonomici citati non possono neppure essere annoverate tra i lignivori *sensu lato*, poiché legate a piante erbacee (e quindi da considerare fillofaghe o poefaghe secondo i casi). Come esempio possiamo annoverare tra i buprestidi, limitatamente alla sola fauna italiana, i generi *Julodis, Cyphosoma, Sphenoptera, Meliboeus, Cylindromorphus, Paracylindromorphus, Aphanisticus, Trachys*, *Habroloma*, alcune specie dei generi *Acmaeodera, Acmaeoderella, Anthaxia, Coraebus, Agrilus*, (cfr. Curletti 1994), o i generi *Brachyta, Dorcadion, Agapanthia, Calamobius, Musaria, Opsilia, Phytoecia* tra i cerambicidi (Sama 1988). Di qui la necessità, per gli operatori forestali che intendono operare seriamente nel settore, di saper distinguere le specie saproxiliche anche nell'ambito di ogni singola famiglia, affidandosi, ove possibile, all'aiuto dei tassonomisti.

**(2)** Tutte le divisioni ecologiche proposte sono ovviamente molto schematiche e comprendono eccezioni e/o adattamenti che possono verificarsi in condizioni particolari. Tra i Curculionoidea succitati come defoliatori, sono note alcune specie con attitudini lignivore (il genere *Pissodes* ad esempio), tra gli Elateridae possiamo trovare specie lignivore o carnivore ecc. Risulta quindi ovvio che si tratta di divisioni di comodo, adottate per rendere il problema più facilmente comprensibile.

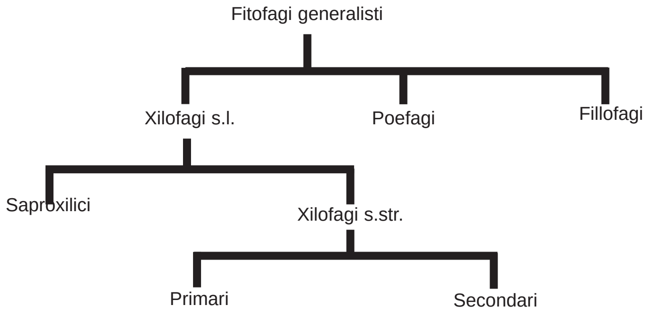


**Figura 1** - Origine degli invertebrati xilofagi.

**Foto 1** - Côte d'Ivoire: Adzopé. Trappole cromotropiche attivate (foto Curletti).

nocciolo, di alcuni buprestidi per le latifoglie. Tra questi ultimi, tanto per citarne alcuni, *Capnodis tenebrionis* (Linné, 1761) relativamente ai *Prunus* e alle Rosacee in generale (Del Guercio 1931; De Robertis 1954; De Lillo 1998), *Agrilus viridis* (Linné, 1758) per i *Salix* (Heering 1956; Gobbi 1968), e per il *Corylus avellana* L. (Ciampolini e Ugolini 1975), *Agrilus suvorovi* Obenberger, 1935 per i *Populus* (Arru 1962), *A. cuprescens* Ménétries, 1832 per i *Rubus* (Brussino e Scaramozzino 1982), *A. sinuatus* (Olivier, 1790) per le Pomacee (Lupo 1957), *Coraebus rubi* (Linné, 1767) per le rose coltivate (Cuscianna 1957), *C. florentinus* (Herbst, 1801) per *Quercus* (Zocchi 1953; Ambrosi 1964; Solinas 1971). È attuale (Curletti e Ranghino 2003) la segnalazione di massicci attacchi di *Palmar festiva* (Linné, 1767), specie considerata sempre molto rara, che hanno praticamente distrutto i vivai di *Thuja* nel Biellese in Piemonte. I fattori che scatenano queste infestazioni sono ben lontani dall'essere conosciuti a fondo, ma senza dubbio l'intervento antropico riveste un ruolo di grande importanza.

I rapporti tra xilofagi non detritivori e piante ospiti sono molto complessi, affinati da adattamenti evolutivi affermatisi nel corso di tempi geologici. Una specie troppo aggressiva finirebbe per estinguere la pianta ospite, portando in ultima analisi all'estinzione anche sé stessa. Questo ha determinato, nel tempo, un compromesso equilibrato e molto delicato, che permette la sopravvivenza di entrambi (Curletti 1987). Equilibrio che è influenzato anche da fattori fondamentali, che se squilibrati possono giocare a favore di uno dei due contendenti. Da un lato gli xilofagi non detritivori possono essere contenuti da funghi, batteri, artropodi parassiti, parassitoidi o predatori (acari, imenotteri quali betilidi, icneumonidi, calcididi, ditteri tachinidi, coleotteri cleridi ecc.), vertebrati come uccelli insettivori o piccoli mammiferi. Dall'altro condizioni ambientali possono contribuire all'indebolimento della pianta, rendendola più vulnerabile.

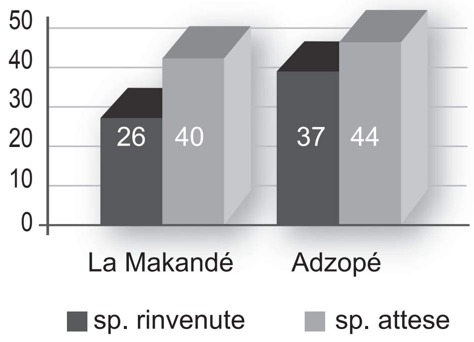


**Figura 2** - Differenze in valori assoluti tra le specie rinvenute e quelle attese sulla base dell'analisi Specrich, riguardanti le foreste di La Makandé in Gabon (foresta primaria ben conservata) e Adzopé in Côte d'Ivoire (foresta secondaria degradata). A fronte di un minor numero di specie e di esemplari rinvenuti a La Makandé, i conteggi statistici compiuti sulla totalità delle catture indicano che il numero di specie attese è pressoché uguale.

La competizione tra la pianta e l'insetto, in condizioni normali, vede l'aggressore per regola soccombere. La pianta è in grado di contrastare efficacemente l'attacco accentuando l'afflusso di linfa che annega la larva o con la produzione di calli che la isolano soffocandola. È pur vero che esiste una strategia di difesa della larva, che apre canali di drenaggio nella corteccia o che interrompe l'afflusso della linfa mediante incisioni che interrompono i vasi linfatici; in condizioni normali, tuttavia, tali operazioni sono per la quasi totalità dei casi poco efficaci. Ben diversa è la situazione in condizioni di rigoglio vegetativo parzialmente inibito. Tralasciando il processo naturale irreversibile provocato dalla senilità, che vede ovviamente gli ospiti primari come principali protagonisti della morte della pianta, altre cause possono contribuire all'indebolimento dell'ospite. Tra queste, molto importanti, sono le variazioni delle precipitazioni meteoriche e il conseguente inaridimento del suolo: è noto come periodi di prolungata siccità favoriscano gli xilofagi considerati primari, in quanto la pianta in condizioni di stress idrico non può reagire con l'afflusso di linfa. Altro fattore molto importante è l'inquinamento atmosferico (piogge acide) o squilibri naturali che favoriscono periodiche invasioni di insetti defoliatori, entrambi causa di riduzione della superficie fogliare. Anche l'inquinamento idrico e del suolo sono fattori di rilievo. Non

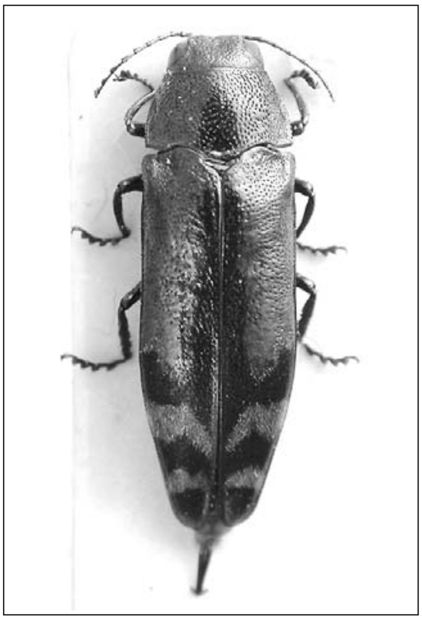


**Foto 2** - Habitus di *Coraebus florentinus* (foto Curletti).

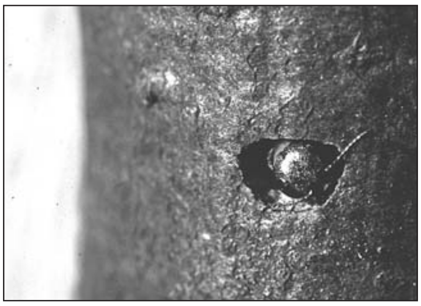


**Foto 3** - *Coraebus florentinus* in procinto di sfarfallare. Notare il foro di uscita dall'inconfondibile forma a "mezzaluna" (foto Boano).

ultimo, nel caso di politiche di afforestazione, è la scelta oculata delle specie arboree, che devono essere adatte al tipo di terreno e di clima prescelto. Altre cause di degrado ad opera di xilofagi primari sono da ricercarsi in gestioni non corrette del patrimonio forestale, o disboscamenti incontrollati. Studi recenti condotti in Costa d'Avorio e Gabon (Curletti 2002) hanno evidenziato come il degrado delle foreste causato dall'insediamento umano faccia aumentare in modo esponenziale le popolazioni degli xilofagi primari, pur impoverendo nel complesso la diversità biologica(3).

Tali presupposti portano a considerare gli xilofagi primari come un potenziale utile sistema di monitoraggio dello stato di salute delle foreste. Risulta chiaro che un aumento anomalo delle popolazioni di questi invertebrati è indice di sofferenza della foresta, e può essere di aiuto a scoprire le cause del fenomeno in tempi più brevi. Diventa quindi importante approfondire studi e metodologie che permettano di individuare poche specie indicatrici e la loro quantificazione attraverso parametri statistici standardizzati. La scelta di tali specie dovrà adattarsi alle latitudini e alla tipologia della foresta prescelta. Ad esempio, nel caso specifico dei Querco-Carpineti presenti nella pianura Padana, di cui il Bosco della Fontana (Marmirolo, provincia di Mantova) fa parte (Mason *et al.* 2002), la scelta potrebbe cadere sul monitoraggio costante del buprestide *Coraebus florentinus* (Foto 2, 3). Le attitudini biologiche di questa specie la rendono particolarmente adatta allo scopo. La larva matura, mediante incisione anulare, provoca la morte dei rami apicali delle querce, che risultano ben visibili l'anno successivo in quanto, alla ripresa vegetativa si evidenziano le foglie secche che contrastano con quelle verdi dei rami circostanti. In questo caso il monitoraggio degli attacchi risulta facilmente attuabile, sia mediante conteggio dei rami disseccati ancora presenti sugli alberi della zona campione, sia mediante conteggio dei rami caduti (facilmente riconoscibili per il foro di sfarfallamento e perché spezzati all'altezza dell'incisione anulare), in un transetto prefissato.

Approfondire le strette relazioni che intercorrono tra l'intensità degli attacchi degli xilofagi primari e le condizioni delle piante ospiti può aprire nuove strade a un'innovativa gestione per la salvaguardia delle foreste.

## Bibliografia

Ambrosi M., 1964 - **Una eccezionale infestazione di *Coroebus fasciatus* Villers sul Leccio (Coleoptera, Buprestidae)**. Rinascita Agricola, 224: 3-7.

Arru G., 1962 - ***Agrilus suvorovi populneus* Schaefer dannoso ai Pioppi nell'Italia settentrionale (Coleoptera, Buprestidae)**. Bollettino di Zoologia Agricoltura e Bachicoltura, 4 (1961-1962): 159-287.

Brussino G., Scaramozzino P., 1982 - **La presenza in Piemonte di *Agrilus aurichalceus* Redt. su Lampone (Coleoptera, Buprestidae)**. Informatore Fitopatologico, 32 (9-10): 55-58.

Burhnam K.P., Overton W.S., 1979 - **Robust estimation of population size when capture probabilities vary among animals**. Ecology, 60 (5): 927-936.

Ciampolini M., Ugolini A., 1975 - **Reperti sull'etologia dell'Agrilo del nocciolo e mezzi di difesa**. Informatore Fitopatologico, 25 (1): 21-27.

Curletti G., 1987 - **Xilofagi: gli insetti che si nutrono del legno**. Piemonte Parchi, 16 (2): 24-25.

Curletti G., 1994 - **I Buprestidae d'Italia. Catalogo Tassonomico, Sinonimico, Biologico, Geonemico**. Monografie di Natura Bresciana, Museo Civico di Scienze Naturali, Brescia, 19: 318 pp.

Curletti G., 2002 - **Contribution à la connaissance des Agrilini de Côte d'Ivoire (Coleoptera, Buprestidae)**. Lambillionea, 102 (1): 43-64.

Curletti G., Ranghino S., 2003 - **Su un'infestazione di *Palmar festiva* (L.) nel Biellese (Coleoptera, Buprestidae)**. Informatore Fitopatologico, 53 (4): 28-30.

Cuscianna N., 1957 - **Il *Coroebus rubi* L. insetto dannoso ai rosai nella Riviera Ligure di Ponente (Coleoptera, Buprestidae)**. Memorie Società entomologica italiana, 36: 24-30.

Del Guercio G., 1931 - **Bupreste nero del Susino, del Pesco, del Ciliegio e di altre specie fruttifere**. Redia, 19: 3-28.

De Lillo E., 1998 - **Andamento dell'ovoposizione di *Capnodis tenebrionis* (Coleoptera, Buprestidae)**. Entomologica, 32: 153-163.

De Robertis A., 1954 - **Osservazioni fisiopatologiche sul verde secco o moria del mandorlo e del *Capnodis tenebrionis* L.**. Atti e Relazioni Accademia Pugliese di Scienze, 12: 317-345.

Gobbi G., 1968 - **Osservazioni su alcuni *Agrilus* (Coleoptera, Buprestidae) dannosi ai Salici nei dintorni di Roma (studi sui Buprestidi italiani, II)**. Bollettino Associazione Romana di Entomologia, 23 (1): 2-4.

Heering H., 1956 - **Zur Biologie Ekologie und zum Massenwechsel des Buchenprachtkäfers (*Agrilus viridis*) (Coleoptera, Buprestidae)**. Ins. für angewandte Zoologie, 2 Teil: 249-287/76-114.

Lanza B., 1982 - **Dizionario del Regno Animale**. Ed. Mondadori, 705 pp.

Lupo V., 1957 - **Il Buprestide del Pero (*Agrilus sinuatus* Ol.)**. Tecniche Agricole, 9: 119-125.

Mason F., Cerretti P., Tagliapietra A., Speight M.C.D., Zapparoli M. (eds.), 2002 - **Invertebrati di una foresta della Pianura Padana, Bosco della Fontana.** Primo contributo. Conservazione Habitat Invertebrati 1. Gianluigi Arcari Editore, Mantova, pp. 176.

Sama G., 1988 - **Fauna d'Italia. XXVI. Coleoptera Cerambycidae. Catalogo topografico e sinonimico.** Ed. Calderini, XXXVI, 216 pp.

Solinas M., 1971 - **Considerazioni ecologiche sul preoccupante sviluppo di *Coroebus florentinus* (Herbst) nelle leccete del Gargano (Coleoptera, Buprestidae)**. Entomologica, 7: 115-121.

Zocchi R., 1953 - **Una eccezionale infestazione di *Coraebus fasciatus* Vill. in Toscana (Coleoptera, Buprestidae)**. Redia, 38: 163-168.

---

(3) Utilizzando gli stessi metodi basati sull'uso di trappole cromotropiche (Foto 1), si sono raccolti in 15 giorni 1.131 esemplari di *Agrilus* (Coleoptera, Buprestidae) in una foresta degradata della Costa d'Avorio e solamente 68 in due mesi di permanenza nella foresta ben conservata del Gabon. Il numero di specie tuttavia è risultato assai più confrontabile, rispettivamente 37 e 26. La distribuzione delle abbondanze rivela un gran numero di specie rare (rilevate con un solo individuo) nella foresta gabonese, a fronte di molte specie rappresentate da un gran numero di individui in Costa d'Avorio. Lo studio statistico di questa distribuzione con il metodo di Burhnam e Overton (1979) giunge addirittura a stimare un numero di specie praticamente identico 44 (+/- 6) in Costa d'Avorio e 41 (+/- 5) in Gabon (Figura 2). In pratica nelle foreste degradate si assiste ad un'esplosione del numero di individui di alcune specie a fronte di una probabile perdita di quelle più rare.

# EUPOTOSIA MIRIFICA, *JOYAU MENACÉ DU PATRIMOINE NATUREL EUROPÉEN (COLEOPTERA, CETONIIDAE)*

## EUPOTOSIA MIRIFICA, *GIOIELLO MINACCIATO DEL PATRIMONIO NATURALE EUROPEO (COLEOPTERA, CETONIIDAE)*

Henri-Pierre Aberlenc(1), Gianfranco Curletti(2), Moreno Dutto(3), Franco Tassi(4)

*(1) CIRAD TA 40/L Campus Baillarguet - CSIRO, F-34398 Montpellier Cedex 5, France. E-mail henri-pierre.aberlenc@cirad.fr*
*(2) Museo Civico di Storia Naturale, Casella Postale 89, I-10022 Carmagnola (TO), Italy. E-mail musnat@comune.carmagnola.it*
*(3) Via Papò, 4, I-12039, Verzuolo (CU), Italy. E-mail dutto.moreno@tiscali.it*
*(4) Podere Vallecupa, I-58042 Campagnatico (GR), Italy. E-mail piantaunalbero@libero.it*

**Summary:** ***Eupotosia mirifica*, threatened gem of Europe's Natural heritage (Coleoptera, Cetoniidae)**. Present state of knowledge and suggested research subjects about *E. mirifica*: taxonomy, geographical distribution, distinguishing features of the biotopes, biology, factors threatening the survival of the species. Proposals for its conservation: listed as a local and European protected species, preservation of its natural habitats, especially old oaks. A new synonymy is proposed: *E. mirifica* ssp. *mirifica* (Mulsant, 1842) = *E. mirifica* ssp. *koenigi* (Reitter, 1894) **n. syn**.

**Key words:** *Quercus, Eupotosia*, saproxylic invertebrates, heritage of humankind.

*Eupotosia mirifica* est la plus remarquable Cétoine de la faune ouest-européenne. C'est une très belle et grande espèce, spectaculaire, brillante, bleu foncé à nuances violettes (Photo 1). Elle ne vit que dans des biotopes assez petits, peu nombreux et éloignés les uns des autres. Sa survie est menacée presque partout, plus encore que celle d'*Osmoderma eremita* (Scopoli, 1763), qui est plus largement répandue et qui est protégee par la loi alors que *E. mirifica* ne l'est pas encore. Son destin sera lié à celui de ses habitats. Il faut mener de nouvelles recherches, il faut protéger cette espèce exceptionnelle et ses habitats, *E. mirifica* pouvant devenir "l'espèce-parapluie" de tout son riche écosystème. Ce ne sera possible que si les autorités prennent conscience de la nécessité et de l'urgence d'y consacrer les moyens nécessaires.

## MATÉRIEL ET MÉTHODES

### Sur le terrain

Les observations des adultes sont peu fréquentes, car ils fréquentent la canopée des grands Chênes d'où ils descendent rarement. La plupart des exemplaires connus ont été pris au piège (Allemand & Aberlenc 1991; Huerta *et al.* 1995).

Avec une canne télescopique, on suspend dans les Chênes des pièges (faits avec des bouteilles d'eau en plastique) appâtés avec un liquide (vin rouge, bière, jus de pêche) ou des fruits (bananes fermentées, pêches…).

**Photo 1** - *Eupotosia mirifica* (Mulsant, 1842): de Païolive (France).

### Au laboratoire

Il est facile d'élever des imagos prélevés dans la nature. Accouplements et pontes se déroulent en captivité pendant les mois d'été.

Nous avons analysé la littérature, examiné des collections et échangé des informations avec des collègues.

## RÉSULTATS

### Brève description - Systématique

- *Cetonia affinis* var. *mirifica* Mulsant, 1842: 549-550.
- *Potosia königi* Reitter, 1894: 127.

Longueur: 21,8 à 30 mm (de l'apex des élytres à la marge antérieure du clypéus, la tête levée à l'horizontale). Deux sous-espèces étaient reconnues jusqu'à présent, *E. mirifica mirifica* de l'Espagne aux Balkans et *E. mirifica koenigi* (Reitter, 1894) de Turquie et Syrie (Moretto & Baraud, 1982). La sous-espèce *koenigi* ne se distinguait de la sous-espèce *mirifica* par aucun caractère morphologique, mais seulement par sa coloration plus claire et plus rougeâtre-pourpré. C'est vrai pour les exemplaires biotés à la fin du XIXe siècle ou au début du XXe, mais la couleur des exemplaires récemment pris en Turquie et en Syrie ne diffère en rien de celle des exemplaires européens! Les vieux spécimens ont pâli avec le temps et la sous-espèce *koenigi* est basée sur un artéfact. Nous proposons donc la synonymie suivante: *Eupotosia mirifica* ssp. *mirifica* (Mulsant, 1842) = *Eupotosia mirifica* ssp. *koenigi* (Reitter, 1894) **n. syn**.

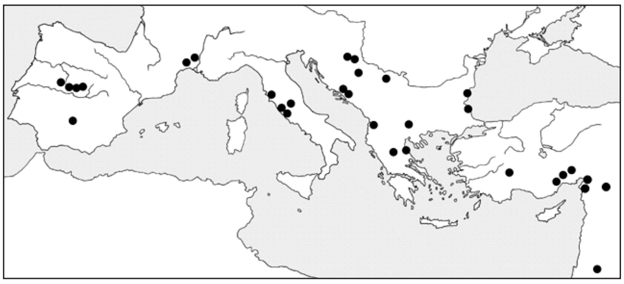


**Figure 1** - *Eupotosia mirifica* (Mulsant, 1842): carte de répartition.

## Biologie

### Larve et imago

*E. mirifica* est une espèce saproxylophage, c'est-à-dire qu'elle dépend du bois mort pendant une partie de son cycle (stade larvaire). La larve se développe dans les micro-cavités des troncs et des branches des Chênes caducifoliés et des recherches à Païolive (France) ont montré qu'elle vit aussi au sol, dans les accumulations de litière de *Quercus pubescens* Willd. et le terreau sous-jacent, dans les cavités du lapiaz, à même la roche-mère, ce qui est remarquable. L'imago vit dans la canopée des grands Chênes où on peut le voir voler. Il a été vu exceptionnellement sur des fleurs (à Païolive) et parfois sur des plaies de Chênes (Tassi 1966). En Europe, on ne rencontre les adultes dans la nature que de début juin à début août. En Turquie et en Syrie, l'imago se prend plutôt en juin. Le cycle vital dure deux ans principalement à cause des basses températures de la saison froide. Les accouplements et les pontes s'échelonnent de juin à septembre; grosses larves L3 dès septembre de l'année zéro; à l'automne de l'année + 1, la larve construit sa coque et se nymphose; les premiers adultes apparaissent vers octobre-novembre de l'année + 1; ils vont hiverner et n'être actifs que l'année suivante, pendant la belle saison de l'année + 2. Une partie de ces adultes seront encore vivants pendant la belle saison de l'année + 3, certaines femelles peuvent donc s'accoupler et pondre deux étés de suite.

## Une espèce bioindicatrice

*E. mirifica* est une remarquable espèce bioindicatrice des vieilles futaies chaudes et ensoleillées de grands Chênes caducifoliés (mêlés parfois localement à des Chênes sempervirents) sur le pourtour nord et oriental du Bassin Méditerranéen. Les recherches sur le terrain ont montré que dans les biotopes où elle est présente, on rencontre de très nombreuses espèces du cortège saproxylique (Aberlenc & Lentenois 2003). Le milieu *optimum* ne doit être ni trop fermé (grande forêt obscure et fraîche) ni trop ouvert (petits arbres isolés). On peut la rencontrer dans des bosquets de petits et moyens Chênes, mais c'est là où vivent de nombreux grands Chênes que les populations ont les effectifs les plus importants: un milieu devenu rare en zone méditerranéenne à cause de l'impact millénaire des activités humaines. *E. mirifica* vit en France sur *Quercus pubescens*, en Espagne sur *Q. pyrenaica* Willd., *Q. suber* L. et *Q. ilex* L. coexistent, en Italie elle vit sur d'autres Chênes caducifoliés parfois mêlés au *Q. suber*, en Grèce et en Turquie on la trouve sur divers Chênes caducifoliés.

## Répartition géographique **(Figure 1)**

### Liste des localités

Nous avons dressé cette liste à partir de la bibliographie, de nos recherches dans les collections, de nos propres captures et des données que des collègues nous ont aimablement communiquées (Box 1).

Les citations de Bosnie-Herzégovine, Serbie, Albanie et Bulgarie sont anciennes et doivent toutes être confirmées, car on ne sait dans quel état sont les biotopes aujourd'hui.

Selon Reitter (1894), l'holotype de *E. koenigi* proviendrait de Jérusalem. Le regretté Bytinski-Salz, de l'Université de Tel-Aviv, l'a vainement recherchée (com. pers.). L. Friedman, de l'Université de Tel-Aviv, nous confirme (com. pers.) qu'aucun coléoptériste israélien n'a pris *E. mirifica* en Israël. Pour Bytinski, de nombreux insectes collectés jadis au proche-Orient furent étiquetés par erreur "Palestine". Reitter était un marchand d'insectes associé à des chasseurs locaux et ses indications de provenance se rapportent parfois aux localités où ses correspondants étaient installés et non à celles où les insectes étaient capturés. Nous sommes d'accord avec nos collègues israéliens: "Jerusalem" est une erreur d'étiquette. L'holotype de Reitter venait sans doute de Syrie ou de Turquie.

De même, les exemplaires du XIX$^{e}$ siècle étiquetés "Akbès, Syrie" ne proviennent pas d'Alep en Syrie, comme on l'a long-

**Box 1 - Localités où la présence de *E. mirifica***

**Espagne**
Salamanca: Las Batuecas.
Avila: Sierra de Gredos (Candeleda et *Piedralaves)
Madrid: Escorial
Ciudad Real: Sierra Morena (Fuencaliente).
Cordoba: Sierra Morena (*Azuel)
**France**
Aude: localité non précisée
Hérault: Lac du Salagou; Brissac; Saint-Martin-de-Londres
Gard: Vers Saint-Hippolyte-du-Fort; *Courry.
Ardèche: *Bois de Païolive [population la plus nombreuse d'Europe occidentale] (Photo 2); Lagorce
**Italie**
Lazio: Tenuta Boccea près de Rome; *Cerveteri (Sasso); Rieti
Toscana: Grosseto
**Bosnie-Herzégovine**
Srbac (Motajica Planina); Bosanski Brod; Banovici; Klobuk (Ljubuski); Domanovici
**Serbie**
Petrovac
**Albanie**
Tirana
**Bulgarie**
Arcupino; Primorsko; Varna
**Grèce**
Katerini: Litohoro
Larissa: *Mont Ossa
Trikkala: *Météora; *Vlahava
Kilkis: *Kavalaris; *Mavroplagia
**Turquie**
*Isparta; *Mersin; *Gülek; *Karsenti
Région d'Erdemli: *Guzeloluk et *Aslandi
Monts Amanus: *Iskenderun; *Harbiye; *Akbès
**Syrie**
*30 km à l'est de Dar'a

* Localités où la présence actuelle de *E. mirifica* est confirmée.

temps cru, mais de l'ancien monastère d'Akbez au nord d'Antakya (Antioche) en Turquie.

**Photo 2** - Païolive (France): biotope d'*E. mirifica* (Mulsant, 1842).

### Biogéographie

*E. mirifica* n'est connue dans toute son aire de répartition que de 42 localités. Aucune observation récente ne confirme la présence de cette espèce dans 19 stations (et il est très probable que dans certains cas elle a disparu). On peut craindre que les populations italiennes de Grosseto, Rieti et Boccea ne soient éteintes. Il ne reste, de l'Espagne à la Syrie, que 20 localités où nous sommes certains qu'une population de *E. mirifica* est encore présente, dont 5 en Europe occidentale (Piedravales, Azuel, Courry, Païolive, Cerveteri) avec seulement 2 populations aux effectifs relativement nombreux (Piedravales et Païolive)!

Cette répartition sporadique et l'absence de confirmation de présence récente dans les localités anciennes est le symptôme que l'espèce est en voie d'extinction. Les populations d'*E. mirifica* sont en nette régression en France et en Italie et très probablement ailleurs, les biotopes sont menacés sur l'ensemble de l'aire de répartition, mais des prospections plus intenses sont nécessaires pour nuancer cette analyse cas par cas. L'espèce-sœur *E. affinis* (Andersch, 1797) est répandue de façon presque continue dans d'innombrables biotopes de la Péninsule ibérique à l'Iran (Tauzin 1991) et son avenir ne semble pas menacé, ses exigences écologiques étant moins étroites que celles de *E. mirifica*, qui est inféodée à des milieux très particuliers, ce qui la rend vulnérable. Certes, il reste des biotopes à découvrir en Espagne, dans les Balkans, en Turquie, en Syrie et peut-être au Liban (c'est moins probable en Italie et encore moins en France). Mais l'espèce est sporadique, extrêmement localisée, elle est absente de nombreux biotopes qui semblent pourtant a priori favorables: il est donc probable que le nombre maximal de populations restant à découvrir ou à confirmer ne dépassera pas quelques dizaines.

### Climat

L'exemple du Bois de Païolive: température moyenne 13 °C, moyenne en janvier 4 °C, moyenne de juillet 20 à 22 °C, pluviosité de 1.000 à 1.300 mm. Série inférieure du *Quercus pubescens*, étage collinéen subméditerranéen, (relativement) froid et humide l'hiver, chaud et sec l'été, terrain calcaire karstique secondaire avec grands rochers ruiniformes (qui sont des accumulateurs thermiques).

En Europe, *E. mirifica* vit en zone subméditerranéenne, dans ce qu'Ozenda (1990a, 1990b) appelle les formations caducifoliées xérothermes ou Biome némoral xérotherme (Précipitations entre 600 et 1.500 mm, température moyenne entre 8 et 13 °C). En Turquie, on rencontre *E. mirifica* dans ce que Garcia Lopez (2001) qualifie de phytoclimat méditerranéen et némoro-méditerranéen (précipitations entre 230 et 1.500 mm, température annelle moyenne entre 8 et 20 °C). En Syrie, la localité est en climat méditerranéen à influence subtropicale (brûlant et sec).

## DISCUSSION ET CONCLUSION

### Historique

Pendant la dernière glaciation, *E. mirifica* a pu survivre dans une ou plusieurs des quatre zones considérées traditionnellement comme refuge en région méditerranéenne: sud de l'Espagne, sud de l'Italie, Balkans et Proche-Orient. Quand le climat est redevenu clément, les *Quercus* ont progressivement recolonisé l'Europe occidentale à partir de trois refuges méridionaux (Kremer & Petit 2001). Une immense forêt de Chênes recouvrit peu à peu tout le continent. Il est probable qu'*E. mirifica* a suivi cette extension, en se cantonnant dans les régions les plus chaudes proches de la méditerranée. Son aire de distribution devait alors s'étendre sur un vaste territoire de la Péninsule ibérique au Levant. Depuis des millénaires, d'immenses surfaces ont été peu à peu déboisées en Europe. Les derniers témoins de cette immense chênaie primitive n'ont cessé de régresser en nombre et en étendue. *E. mirifica*, mal adaptée aux milieux ouverts par l'homme (contrairement à d'autres Cétoines), n'a pu survivre que dans quelques chênaies préservées (si petites et anthropisées soient-elles). Ces biotopes sont des oasis, des refuges préservés à travers le temps (dépendance de la continuité du milieu: cas exceptionnels de présence locale de grands Chênes depuis l'antiquité). Cette espèce est caractéristique d'un milieu en voie de disparition: la forêt climacique caducifoliée thermophile méditerranéenne.

### Menaces

La régression de l'espèce se poursuit et on observe son recul à une échelle de temps très courte: on n'en a revu qu'un exemplaire en Italie depuis 1969 et en France, dans la région de Montpellier, elle n'a plus été prise depuis 15 ans. Les expériences de capture-marquage-lâcher-recapture à Païolive suggèrent que l'effectif total des imagos ne doit pas dépasser quelques milliers d'individus: c'est extrèmement peu pour un insecte. Le trop faible effectif d'une population animale isolée la voue à l'extinction.

Les menaces anthropiques sur ces populations fragiles sont:

- principalement, la dégradation ou la banalisation des milieux: pollution, coupe des grands Chênes caducifoliés vieillissants ne laissant subsister que de jeunes sujets sans cavités. Le développement du réseau routier constitue aussi une grave menace. Par exemple, en France, si l'autoroute A 79 (de Valence à Narbonne) était construite, elle couperait le Bois de Païolive; de plus, les habitats de *E. mirifica* et d'*Osmoderma eremita* près de Saint-Martin-de-Londres, dans l'Hérault, sont eux aussi menacés par la même autoroute;
- secondairement, dans certaines localités, les prélèvements parfois excessifs des collectionneurs peuvent représenter un danger. Dans la majorité des cas, c'est seulement la destruction des habitats qui menace la survie des insectes, mais *E. mirifica* est menacée aussi par des prélèvements abusifs.

### Propositions pour la sauvegarde de l'espèce et des milieux

Un mémoire du Conseil de l'Europe (Good & Speight 1996) cite *Eupotosia mirifica* (sous son ancien nom, *E. koenigi*) dans la "Liste des espèces saproxyliques indicatrices pour identification des forêts importantes pour la protection à l'échelle européenne": "À chaque ajout d'espèces saproxyliques aux Annexes de la Convention de Berne, il convient d'admettre que l'objectif principal est de garantir la protection de l'habitat de ces espèces et non pas de faire interdire leur récolte. L'interdiction des récoltes n'est pas recommandée, car elle irait à l'encontre du but recherché, qui est d'obtenir des informations sur la situation des forêts." Protéger *E. mirifica*, c'est en faire une "espèce-parapluie" qui protègera de très riches communautés d'insectes saproxyliques. Cette espèce devrait être classée en catégorie 2 du code ZNIEFF: "espèce vulnérable, très localisée." Il est probable que dans quelques années, sans protection efficace de son habitat, elle aura disparu de la plupart des localités. Nous préconisons donc la protection légale de cette espèce et de ses habitats à l'échelle internationale. Les vieux Chênes à cavités doivent faire l'objet d'une protection renforcée, car ils constituent un patrimoine biologique en péril qui doit être sauvé.

Le Bois de Païolive doit être classé "Patrimoine de l'Humanité": ce site du réseau Natura 2000 abrite la population la plus riche d'Europe occidentale. Les autres biotopes, dans toute l'aire de répartition, devraient eux aussi être classés. La vente de cet insecte devrait être strictement interdite et sanctionnée.

### Recherches à venir

- Découvrir de nouvelles populations d'*E. mirifica* et confirmer la survie de celles anciennement citées;
- améliorer notre connaissance de la biologie et des exigences écologiques de *E. mirifica*;
- Etudier la génétique et la dynamique des populations d'*E. mirifica*.

## CONCLUSION

Sur le pourtour septentrional et oriental de la Méditerranée, les bois et bosquets de grands et vieux Chênes caducifoliés (mêlés parfois à *Quercus suber*) à cavités et les riches communautés d'organismes qui leur sont associées représentent un patrimoine vivant unique, irremplaçable, et gravement menacé de disparition. Leur survie dépend de l'investissement que nous saurons mobiliser pour préciser nos connaissances scientifiques, faire connaître l'intérêt de ces habitats uniques et les protéger efficacement. Il devient urgent pour l'Europe de proclamer une véritable politique de conservation des Invertébrés et de soutenir des actions de protection d'organismes emblématiques, tel qu'*Eupotosia mirifica*, qui permettront ainsi de préserver pour les générations futures les merveilles biologiques des vieilles chênaies caducifoliées méditerranéennes.

## Bibliographie

Aberlenc H.-P., Lentenois P., 2003. - **"Les insectes du bois de Païolive"**. 55-72. In: De Saint-Eugène en Païolive, Holthof J.F. & Schnetzler J. (eds.), La Fontaine de Siloé, Montmélian & Saint-Eugène en Païolive, les Vans: 320 p.

Allemand R., Aberlenc H.P., 1991 - **Une méthode efficace d'échantillonnage de l'entomofaune des frondaisons: le piège attractif aérien**. Bulletin de la Société entomologique suisse, 64: 293-305.

Garcia Lopez J.M., 2001 - **Mediterranean phytoclimates in Turkey. Phytoclimats méditerranéens en Turquie.** Ecologia mediterranea, 27: 15-32.

Good J.A., Speight M.C.D., 1996 - **Les invertébrés saproxyliques et leur protection à travers l'Europe**. Conseil de l'Europe, Strasbourg, 54 pp.

Huerta F., Crespo J.M., Huelves J.M., 1995 - **Sobre la presencia de *Eupotosia mirifica* Mulsant, 1842 y *Cetonischema aeruginosa* Drury, 1770 (Col., Cetoniidae, Cetoniini) en la Península Ibérica**. Zapateri Revta. aragon. ent., 5: 75-80.

Kremer A., Petit R., 2001 - **L'épopée des Chênes européens**. La Recherche, 342 (5): 40-43.

Moretto P., Baraud J., 1982 - **Les *Eupotosia* Miksic de France: nouveaux statuts (Col. Scarabaeoidea, Cetoniidae)**. Nouvelle Revue d'Entomologie, 12: 145-149.

Mulsant M.E., 1842 - **Histoire naturelle des Coléoptères de France. Lamellicornes**. Maison, Libraire Quai des Augustins, 29, Paris & Ch. Savy Jeune, Quai des Célestins, 48, Lyon, VIII + 623 pp.

Ozenda P., 1990a - **La zone némorale xérotherme sud-européenne**. Giornale Botanico Italiano, 124 : 759-780.

Ozenda P., 1990b - **Sur les divisions phytoécologiques de l'Europe**. Oecologia Mediterranea, 16: 299-315.

Reitter E., 1894 - **Zehnter Beitrag zur Coleopteren-Fauna des russischen Reiches. 12. *Potosia Königi* n. sp.** Wiener Entomologische Zeitung, 13: 127.

Tauzin P., 1991 - **Précision sur la répartition de quelques espèces de Cetoniinae Paléarctiques. Première note: les *Eupotosia* Miksic, 1954**. L'Entomologiste, 47: 293-305.

Tassi F., 1966 - **Una notevole conferma per la fauna italiana: *Potosia* (*Eupotosia*) *koenigi* Reitter (Coleoptera Scarabaeidae)**. Bollettino dell'Associazione Romana di Entomologia, 21 (2): 17-20.

### Remerciements

Nous remercions chaleureusement les organisateurs du Symposium de Mantova et les personnes qui nous ont aidés: Mesdames M. Aberlenc, F. Desangin, M. Martinelli-Tassi, Marquise M. Patrizi, V. Ponel-Andrieu; Messieurs R. Arpad, P. Audisio, J. Barret, C. Besuchet, A. Blanchet, S. Boirel, G. Carpaneto, J.-P. Chichery, C. Cocquempot, P. Dupont, C. Esposito, A. Foucart, S. Franchini, L. Friedman, M. Gigli, P. Gindre, N. Greff, T. Guilloux, J.-B. Huchet, B. Lasalle, P. Lentenois, G. Liskenne, J. Loriz, J.-M. Luce, J.-M. Maldès, P. Maltzeff, L. Marchetti, E. Migliaccio, E. Pacieri, L. Moretto, R. Paulian, Marquis P. Patrizi, D. Prunier, V. Restaino, O. Simonot, A. Tinelli, S. Veca, E.E. Vives, V. Vomero, et nous rendons hommage à nos collègues disparus: J. Balazuc, H. Bytinski-Salz, R. Roche, G. Ruter, J. Baraud, R. Miksic.

# DEVELOPMENT OF ECO-FRIENDLY FORESTRY PRACTICES IN EUROPE AND THE MAINTENANCE OF SAPROXYLIC BIODIVERSITY

## *SVILUPPO DI PRATICHE FORESTALI ECO-COMPATIBILI IN EUROPA E CONSERVAZIONE DELLA BIODIVERSITÀ DEGLI ORGANISMI SAPROXILICI*

Martin C.D.Speight[1], Jervis A. Good[2]

*(1) Research Branch, National Parks & Wildlife, 7 Ely Place, Dublin 2, Ireland. E-mail speightm@indigo.ie*
*(2) Terrascope Environmental Consultancy, Glinny, Riverstick, Co Cork, Ireland. E-mail terrasco@iol.ie*

**Summary:** It is demonstrated that maintenance of quantities of coarse woody debris (including dead trees) in European forests is largely irrelevant to the maintenance of biodiversity in saproxylic syrphids (Diptera: Syrphidae). In contrast to the saproxylics in some other taxonomic groups, such as European polypore fungi, most saproxylic syrphids depend upon microhabitats occurring almost exclusively in live (old, or senescent) trees. The need to design "ecologically-friendly" forest management measures expressly for saproxylics, that take account of the problems encountered in formulating analogous measures aimed at biodiversity maintenance in agriculture, is addressed. It is concluded that unless those problems are overcome, "ecologically-friendly" forestry measures could as easily damage saproxylic biodiversity as maintain it.

**Key words:** Syrphidae, saproxylics, biodiversity maintenance, forest management.

The great majority (600 out of ca. 800) of the European hoverfly (Diptera: Syrphidae) species have been coded into the files of the Syrph the Net (StN) database, making them available for use in rapid assessment of both local or European-level issues relating to habitat, microhabitat, etc. The larvae of 115 species of European syrphid can be regarded as saproxylic, from their biology and larval microhabitats (SPEIGHT 2003). These syrphids are not responsible for facilitating pest species in any way, they merely use microhabitats that are a normal component of ancient forest, developing there as trees senesce naturally. Among them, 92 species are coded into the StN database (SPEIGHT *et al*. 2003a). These 92 species are used here to compare the relevance of coarse woody debris (CWD) and overmature, living trees to the conservation of Europe's saproxylic syrphid fauna. The potential significance of these findings to attempts to provide for maintenance of saproxylic biodiversity in commercially-managed forests is then considered.

There appears to be some variation in the literature concerning application of the terms "coarse woody debris" (referred to here by its acronym CWD) and "dead wood". GROVE (2002) seems in some instances to include overmature, living trees within his concept of CWD, whilst at others confining it to dead, woody material. Since overmature living trees are by definition alive, not dead, overmature living trees are excluded from the concept of CWD applied here. In CAVALLI & MASON (2003) the term "dead wood" is used to embrace both dead wood carried by living trees and dead wood that is not attached to living trees. It is to this latter category that the term CWD is applied here, i.e. to coarse woody *debris* - dead woody material, including entire, dead trees, standing or fallen, occurring detached from trees that are alive. As to interpretation of "coarse", in the term "*coarse* woody debris", the same definition has been applied here as in CAVALLI & MASON (2003), namely that woody material of 10 cm or less in diameter is excluded.

## METHODS

Using the data coded into the Microsite features volume of the StN database (SPEIGHT *et al.* 2003a) the microhabitats of 92 saproxylic European syrphid species were grouped into two categories, as follows:

**1)** live-tree features: trunk cavities, rot-holes, insect workings, sap runs/lesions;
**2)** coarse woody debris (CWD) features: standing dead trees and trunks, fallen dead trees, trunks and major branches, stumps.

While a sap run may, on occasion, be found on a freshly cut stump, it does not persist there. By contrast, the trunk of an old, living tree may carry a functional sap run for many years, associating sap runs very firmly with living trees, rather than with CWD. Patches of dead wood may, of course, occur on living trees, providing microhabitat there for CWD-associated species. But the issue addressed here is the extent to which saproxylic species may occur away from living trees, so the CWD-associated species comprise a category contrasting strongly with those whose larvae are only found in association with microhabitats found almost exclusively on living trees, simply because CWD occurs dissociated from living trees.

Using these categories the 92 species were separated into three subsets:

- species associated only with live-tree features;
- species associated only with CWD features;

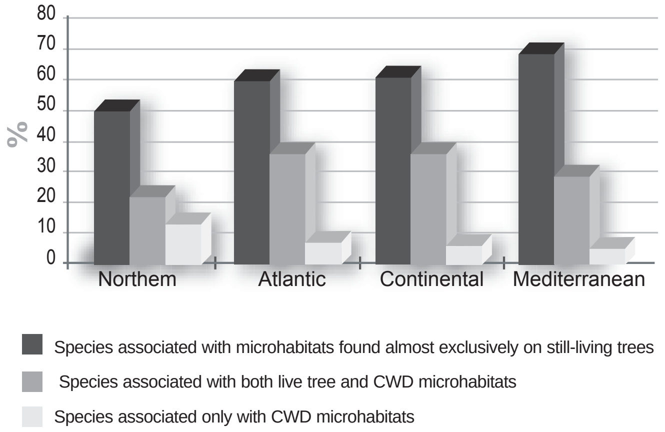


**Figure 1** - Proportion of the saproxylic syrphid fauna (n = 92) in different microhabitat groups, shown for various regions of Europe.

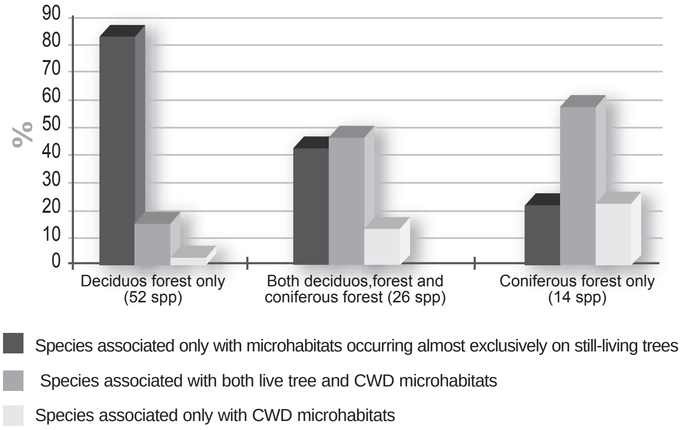


**Figure 2** - Proportion of saproxylic syrphid fauna associated with different groups of microhabitats, among the species using only deciduous forest, the species using only coniferous forest and the species using both deciduous and coniferous forest.

- species occurring in association with both live-tree and CWD features.

The third subset of species, those associated with both live-tree and CWD microhabitats does not comprise those species that may find CWD microhabitats on living trees, but species whose larvae can make use of both live-tree microhabitats and CWD microhabitats, for instance a species that can occur in association with both tree holes and tree stumps.

With these three subsets of the saproxylic species defined, the proportion they each represent in various groupings of the European Syrphidae was compared, once again using the information coded into the StN database. In this process, the following StN categories were used, from the Macrohabitats (SPEIGHT *et al*. 2003b) and Range and Status (SPEIGHT & CASTELLA 2003) files, respectively:

- macrohabitat categories: deciduous forest; coniferous forest;
- range categories: Europe; Atlantic Europe, Continental Europe, Northern Europe, Mediterranean Europe; Netherlands, Netherlands threatened species.

## RESULTS

Figure 1 shows that syrphids whose larvae are almost exclusively confined to microhabitats occurring only on live-trees predominate among the European saproxylic species, and that this predominance is maximal in the Mediterranean zone and minimal in Northern Europe. Figure 2 shows that this predominance is largely due to species associated with deciduous forest, that make up by far the greater part of Europe's saproxylic syrphid fauna. Figure 2 also demonstrates that the saproxylic syrphids of European deciduous forest are almost exclusively associated with live-tree microhabitats, whereas in coniferous forest the species associated both with live trees and CWD make up the greater part of the fauna. That a dependence upon overmature trees, rather than CWD, is not universal among European saproxylic organisms is demonstrated in Figure 3. Based upon the information provided by RYVARDEN & GILBERTSON (1993, 1994) Figure 3 shows that European saproxylic polypores (Basidiomycetes: Polyporaceae) contrast strongly with European saproxylic syrphids, in being largely dependent upon CWD, rather than on live-tree microhabitats.

Figure 4 shows that species whose larvae are almost exclusively confined to microhabitats occurring only on live-trees predominate among the saproxylic syrphids known from the Netherlands, and that they predominate also among the saproxylic syrphids regarded as threatened in the Netherlands. However, using data provided by REEMER *et al.* (2003), Figure 4 also shows that species whose larvae are almost exclusively confined to microhabitats occurring only on live-trees do *not* predominate among the species those authors suggest have benefited from introduction of eco-friendly forest management.

## DISCUSSION

The data presented here show that maintenance or enhancement of the quantities of CWD present in a forest is unlikely to contribute to the conservation of most European saproxylic syrphid species, since so many of them, especially in deciduous forests, are dependent upon live-tree microhabitats that are not provided by CWD. It is also demonstrated that the converse is true for most of Europe's saproxylic polypore fungi. Once the relevant data have been computerised it is relatively simple to gain this type of overview. But for most saproxylics computerised data sets are not available. This is particularly true for Coleoptera, which include many saproxylic species. ALEXANDER (2002) lists all of the saproxylic invertebrates known in Britain and Ireland and it was hoped to subject that list - or at least its Coleoptera - to a similar treatment as has been given here to European syrphids and polypores. However, although Alexander's list is annotated with information on each of the species there is, in many cases, no clear indication of whether the species are associated with live trees or CWD. It was thus not possible to use. Similar difficulties were encountered when attempting to use the data on Coleoptera provided by BRUSTEL (2002). It remains highly desirable that the data available on a significant proportion of Europe's saproxylic Coleoptera are analysed to gain an overview of their requirements. Without a clear understanding of the resource to be targeted by biodiversity maintenance measures it is difficult to see how such measures can be effective. The differences between the requirements of syrphids and polypores demonstrated here indicate the folly of formulating measures that would assume all saproxylics can be provided for in the same way.

That biodiversity is under threat in Europe is well recognised (STANNERS & BORDEAU

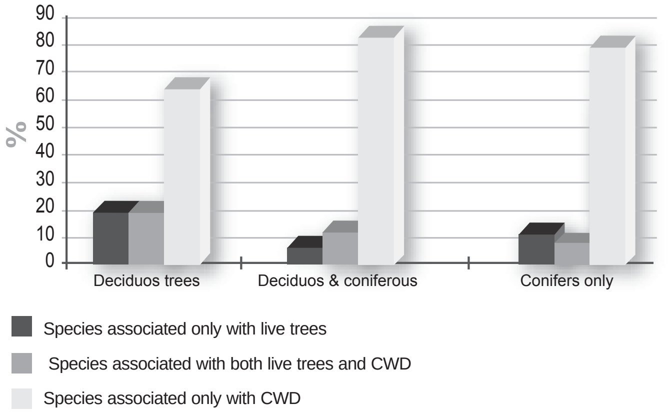


**Figure 3** - Proportion of saproxylic polypore species (n = 297) associated with different groups of microhabitats, among the species using only deciduous trees, the species using only coniferous trees and the species using both deciduous and coniferous trees (data from RYVARDEN & GILBERTSON 1993, 1994).

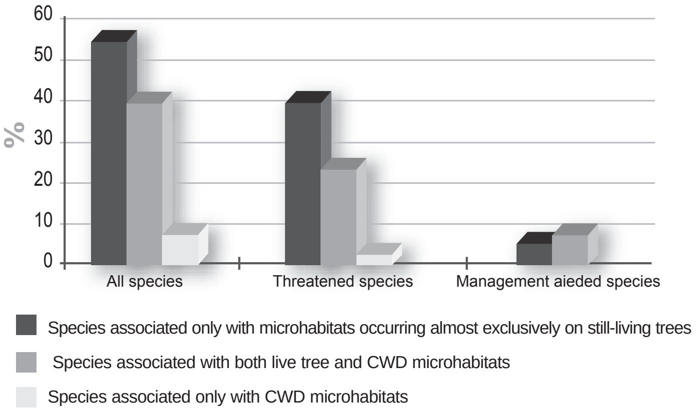


**Figure 4** - Proportion of the saproxylic syrphid fauna of the Netherlands (n = 56) in different microhabitat groups, shown for the entire fauna (all species), for the species threatened in the Netherlands (threatened species) and for the species apparently aided by eco-friendly forest management (management aided species: data from REEMER *et al*. 2003).

1995). In reviewing the progressive loss of saproxylic biodiversity through forest use and abuse GROVE (2002) refers to European forestry as "a 5000-year experiment in unsustainable management". Forest managers and forestry organisations are now searching for ways to make forest management more "ecologically-friendly", prompted within the EU by biodiversity maintenance requirements introduced at EU level. There are few European forests that are not subject to commercial exploitation. So it is inevitable that these requirements have to be met within a management framework designed to maximise commercial production and economic return, a situation which closely parallels attempts to maintain biodiversity within the farmed landscape, through so-called "eco-friendly farming" measures. Given that one target of "eco-friendly forestry" is increasingly maintenance of saproxylic biodiversity, and that there is a consequent focus upon design of measures to support this objective, it is pertinent to consider whether lessons can be learned from the formulation of their analogues in agriculture. It is already clear that existing eco-friendly farming measures are in some European states perceived as largely ineffectual (HICKIE *et al*. 1999; KLEIJN *et al*. 2001) in respect of biodiversity maintenance.

Figure 4 demonstrates that there are also signs that initial attempts at introducing eco-friendly forestry may be producing only the limited response from saproxylic syrphids that would be anticipated, from the data presented here. REEMER *et al.* (2003) attribute a significant increase in records for some Dutch saproxylic Syrphidae to changes in forest management that occurred during the period 1975-2000, saying "the tendency to remove all dead wood and ill trees gave way for the recent policy (since 1973) of leaving it in the forests". But, whereas species with larvae associated only with live-tree microhabitats are the dominant group among Dutch saproxylic syrphids and among the saproxylic syrphids threatened in the Netherlands, they would seem to be benefiting no more from eco-friendly forest management than are the species associated with CWD.

Standardised agri-environmental measures have been put together to operate in all types of farming and throughout a Member State's territory (CEC 1992). They tend to operate on the principle of requiring the same minimum standard to be achieved everywhere they are employed and finance is provided to support implementation. Although the detail of the measures varies from one Member State to another, ways in which their effectiveness is limited in respect of maintenance of invertebrate biodiversity can be identified:

- targeting only certain physical features of farms (e.g. hedges, field margins) but lacking mechanisms to deal with features they do not explicitly target;
- providing no reward for performance that exceeds the stipulated, minimum requirement and require the minimum, stipulated requirement to be met everywhere, regardless of utility;
- comprising a set of prohibitions to be complied with universally, but providing for little or no positive management;
- treating each farm as an independent management unit, without reference either to complementary or contradictory management occurring on adjacent land or to biodiversity maintenance at landscape level;
- there is no requirement for monitoring of the effectiveness of the measures;
- there is no built-in requirement for prior survey to establish which parts of a farm are most important to maintenance of invertebrate biodiversity.

Unfortunately, these measures, complete with equivalent limitations, already have their analogues among measures being developed with the objective of protecting biodiversity in forests. The attempt to standardise the quantity of dead wood (CWD) required to be left on the forest floor provides an example, within the context of maintenance of the biodiversity of saproxylic organisms. Considering such a measure in the light of the limitations listed above:

- targeting dead wood on the forest floor, without synchronously putting in place measures to protect overmature trees, would hasten the rate of disappearance of saproxylics dependent upon old trees, such as most saproxylic Syrphidae, because there would then be no *requirement* to maintain a stock of overmature trees;
- such a measure fails to recognise the "added value" of a forest, or part of a forest, containing both adequate supplies of fallen dead wood *and* overmature trees and provides no reward for maintaining these two resources together; it also requires the same quantities of dead wood to be maintained in forests where the presence of saproxylics would be expected, as in forests from which they are probably absent;

- the measure assumes the capacity of a forest to engender the required quantities of fallen, dead wood without either stipulating or prohibiting methods for artificially increasing dead wood availability;
- without prior survey to establish which saproxylics are present there would be no way of effectively monitoring the effects of the measure (and there is no mandatory requirement for monitoring). Similarly, the relative effectiveness of the measure in forests of different sizes could be impossible to ascertain, for the same reasons, even if it might be suspected that application of such a measure in forests below a certain size would be ineffectual.

Implementation of such a measure could even result in felling of old trees in a deciduous forest until those remaining provide for the minimum levels of dead wood required on the forest floor, with no reference to the greater value to biodiversity maintenance represented by the old trees themselves. Equally, it could result in biodiversity maintenance requirements being met by provision of quantities of fallen, dead wood in forests with virtually no associated saproxylic fauna. An example would be use of this compliance measure in commercial conifer plantations in parts of Europe lacking an indigenous conifer fauna (SPEIGHT 2000). Exploitation of Europe's forests by man since prehistory has greatly affected the distribution of saproxylics in the forests that remain, such that few have been identified where saproxylics are still well represented and many of the species exhibit relictual distribution patterns (SPEIGHT 1989; GROVE 2002). Forests that possess a saproxylic fauna thus require to be recognised, a process that can only be accomplished through survey. The results of comprehensive survey of the Bosco della Fontana forest (Italy) serve as a good example of what can be achieved (MASON *et al.* 2002) and demonstrate how many taxonomic groups could be used for survey in this context. That is not to suggest survey as comprehensive as that carried out in Bosco della Fontana is required. Survey of a small number of taxonomic groups like the Syrphidae, selected on the basis of the amount of information they can provide, or alternatively a series of species similarly selected to act as proxies for saproxylics in general, as advocated by BRUSTEL (2002), would be of more general application.

When a forest has been identified as important for its saproxylic biodiversity, if it not already protected within, for example, the Natura 2000 series of sites, there is need to ensure that measures introduced to support forest biodiversity can accommodate the "added value" represented by its known saproxylic fauna. No such system currently exists and, in particular, pro-active measures are lacking that would provide for introduction of dedicated forest management practices, like induction of premature senescence to a proportion of trees in a forest where the over-mature tree resource is inadequate (CAVALLI & MASON 2003). Both in farming and forestry, financial, legal and socio-cultural difficulties require attention in addressing this issue - it is currently much easier to require that an existing management practice detrimental to biodiversity maintenance is stopped or modified, than to require that a new practice genuinely beneficial to biodiversity maintenance is introduced and carried out. In the context of maintenance of saproxylic biodiversity it is not that relevant forest management techniques are unavailable. An effective review is provided by CAVALLI & MASON (2003). But if the lessons to be learned from attempts to introduce biodiversity maintenance measures to farming are ignored, the introduction of equivalent measures to forestry could even lead to extinction of major components of Europe's saproxylic flora and fauna as much as to the maintenance of others. And many saproxylics are already recognised as threatened with extinction in Europe (DAHLBERG & CRONEBORG 2003; GROVE 2002). Introduction of an inadequate or inappropriate set of biodiversity maintenance measures to forests could do little to arrest the disappearance of these organisms.

## CONCLUSIONS

Faced with the dual requirement to maintain both overmature trees for some saproxylics and CWD (in various forms - see, for example, JONSELL & WESLIEN 2003) for others, forest biodiversity maintenance measures require to address both issues explicitly. If such measures are not to be subject to the same limitations as "eco-friendly farming" measures, that have rendered the farming measures largely ineffectual in maintaining invertebrate biodiversity, the equivalent forest management measures require to be formulated such that they:

- relate to the full range of saproxylic microhabitats and requirements;
- vary in implementation according to requirements of forest type and geographical location;
- accomodate the "added value" of forests that exhibit potential for saproxylic maintenance above and beyond the minimum required standard;
- provide for pro-active management (i.e. the implementation of novel forest management practices introduced explicitly for biodiversity maintenance);
- provide for prior survey to identify forests of importance to maintenance of saproxylic biodiversity;
- provide for monitoring of the effectiveness of the management measures introduced, in at least a representative series of the forests in which the measures are applied.

One could be dismissed as naively optimistic in compiling this list. But protected forests comprise only a minuscule fraction of Europe's forest resource, the rest being commercially managed. The introduction of "eco-friendly forest management" measures throughout the EU represents the first, and only, comprehensive attempt to provide a standard for biodiversity maintenance in these commercially-managed forests. Perhaps saproxylic fungi adversely affected by management could re-establish themselves from spores remaining in the forest floor until conditions again became favourable for germination? Saproxylic invertebrates have no equivalent resting stage. The loss of a saproxylic invertebrate from a forest despite the introduction of biodiversity maintenance measures would be permanent, until and unless that species could re-colonise from elsewhere. But, if essentially the same biodiversity maintenance measures were introduced to the vast majority of European forests at the same time, the loss of species adversely affected by those measures could be equally universal, making re-establishment extremely unlikely, if not impossible. Introducing measures to maintain coarse woody debris in commercially-managed forests is an "easy option". But, if the more difficult issue of introducing measures to maintain overmature trees in these forests is not adequately addressed at the same time, extinctions among their saproxylic invertebrates are inevitable.

## References

ALEXANDER K.N.A., 2002 - **The invertebra-**

**tes of living and decaying timber in Britain and Ireland - a provisional, annotated checklist**. English Nature Research Reports, No 467, 142 pp.

Brustel H., 2002 - **Coléoptères saproxyliques et valeur biologique des forêts Françaises**. Doctoral thesis 1828, Institut National Polytechnique de Toulouse, 327 pp.

Cavalli R., Mason F. (eds.), 2003 - **Tecniche di ripristino del legno morto per la conservazione delle faune saproxiliche. Il progetto LIFE Natura NAT/IT/99/6245 di "Bosco della Fontana" (Mantova, Italia) - *Techniques for re-establishment of dead wood for saproxylic fauna conservation. LIFE Nature project NAT/IT/99/6245 "Bosco della Fontana" (Mantova, Italy).*** Rapporti scientifici, *Scientific Reports*, 2. Centro Nazionale per lo Studio e la Conservazione della Biodiversità Forestale di Verona - Bosco della Fontana. Gianluigi Arcari Editore, Mantova, 112 pp.

CEC, 1992 - **Council Regulation (EC) 2078/92 of 30 June 1992 on agricultural production methods compatible with the requirements of the protection of the environment and maintenance of the countryside**. Offic. J. L 215, 30 July 1992.

Dahlberg A., Croneborg H., 2003 - **Thirty-three threatened fungi in Europe: complementary and revised information on candidates for listing in Appendix 1 of the Bern Convention**. T-PVS (2001) 34, rev 2, 82 pp. Council of Europe, Strasbourg.

Grove S.J., 2002 - **Saproxylic insect ecology and the sustainable management of forests**. Annu. Rev. Ecol. Syst., 33: 1-23.

Hickie D., Smyth E., Bohnsack U., Scott S., Baldock D., 1999 - **A report of the impact of agriculture schemes and payments on aspects of Ireland's Heritage**.Heritage Council, Kilkenny, 211 pp.

Jonsell M., Weslien J., 2003 - **Felled or standing retained timber - it makes a difference for saproxylic beetles**. Forest Ecology and Management, 175: 425-435.

Kleijn D., Berendse F., Smit. R., Gillssen N., 2001 - **Agri-environmental schemes do not effectively protect biodiversity in Dutch agricultural landscapes**. Nature, 413: 723-725.

Mason F., Cerretti P., Tagliapietra A., Speight M.C.D., Zapparoli M. (eds.), 2002 - **Invertebrati di una foresta della Pianura Padana, Bosco della Fontana**. Primo contributo. Conservazione Habitat Invertebrati 1. Gianluigi Arcari Editore, Mantova, 176 pp.

Reemer M., Smit J.T., van Steenis W., 2003 - **Changes in ranges of hoverflies in the Netherlands in the 20th century (Diptera: Syrphidae)**. Proc. 12th International colloquium European Invertebrate Survey. EIS Netherlands, Leiden, 53-60.

Ryvarden L., Gilbertson R.L., 1993 - **European Polypores. Pt.1. *Abortiporus* to *Lindtneria***. 1-387. Synopsis Fungorum, 6. Fungiflora, Oslo.

Ryvarden L., Gilbertson R.L., 1994 - **European Polypores. Pt 2. *Meripilus* to *Tyromyces***. 394-743. Synopsis Fungorum, 7. Fungiflora, Oslo.

Speight M.C.D., 1989 - **Saproxylic invertebrates and their conservation**. Nature & Environment Series, 42: 1-81. Council of Europe, Strasbourg.

Speight M.C.D., 2000 - **Some thoughts on corridors and invertebrates: the hoverfly (Diptera: Syrphidae) fauna of *Abies/Picea* forests in temperate west/central Europe.** Proc. Workshop on ecological corridors for invertebrates: strategies for dispersal and recolonisation in today's agricultural and forestry landscapes. Neuchatel, May 2000. Environmental Encounters, 45: 129-135. Council of Europe, Strasbourg.

Speight M.C.D., 2003 - **Species accounts of European Syrphidae (Diptera): special commemorative issue, Second International Workshop on the Syrphidae, Alicante, June 2003**, 229-230. In: Speight M.C.D., Castella E., Obrdlik P. & Ball S. (eds.), Syrph the Net, the database of European Syrphidae 38. Syrph the Net publications, Dublin.

Speight M.C.D., Castella E., Obrdlik P., 2003a - **Microsite features used by European Syrphidae (Diptera), 2002**. 1-162. In: Speight M.C.D., Castella E., Obrdlik P. & Ball S. (eds.), Syrph the Net, the database of European Syrphidae. 34. Syrph the Net publications, Dublin.

Speight M.C.D., Castella E., Obrdlik P., 2003b - **Macrohabitat preferences of European Syrphidae (Diptera), 2002**. 1-478. In: Speight M.C.D., Castella E., Obrdlik P. & Ball S. (eds.), Syrph the Net, the database of European Syrphidae, 33. Syrph the Net publications, Dublin.

Speight M.C.D., Castella E., 2003 - **Range and Status data for European Syrphidae (Diptera), 2002**. 1-203. In: Speight, M.C.D., Castella, E., Obrdlik, P. & Ball S. (eds.), Syrph the Net, the database of European Syrphidae, 36. Syrph the Net publications, Dublin.

Stanners D., Bordeau P., 1995 - **Europe's Environment: The Dobrís Assessment**. European Environment Agency, Copenhagen, 676 pp.

## Acknowledgements

We are grateful to Emmanuel Castella (Geneva) and Jean-Pierre Sarthou (Toulouse) for their helpful comments on an earlier draft of this text.

# WINDTHROW STIMULATES ARTHROPOD BIODIVERSITY IN FORESTS

## *GLI SCHIANTI FORESTALI INCENTIVANO LA BIODIVERSITÀ DEGLI ARTROPODI*

Beat Wermelinger, Peter Duelli, Martin K. Obrist

*WSL Swiss Federal Research Institute, Zürcherstrasse 111, CH-8903 Birmensdorf, Switzerland.*
*E-mail beat.wermelinger@wsl.ch ; peter.duelli@wsl.ch ; martin.obrist@wsl.ch .*

**Summary:** After the severe windthrows caused by the storm "Vivian" in 1990 the arthropod fauna was assessed for up to ten years after the storm in three regions in the Eastern Swiss Alps. A total of 1.683 arthropod species were identified. Windthrow areas yielded 35-69% more species than the intact forest plot. Species composition but not species numbers differed between cleared and uncleared windthrow areas. Saproxylic beetles were more abundant on uncleared areas. Extrapolation of rarefaction functions revealed that a combination of cleared and uncleared areas enhances biodiversity significantly by 22% as compared to a single treatment.

**Key words:** Biodiversity, windthrow, succession, woody debris, saproxylic insects.

Windthrow is a natural driving force in the dynamics of forest ecosystems. It constitutes a sudden change in a habitat by affecting structures, resources and microclimate. One of the obvious effects is the ample supply of dead wood. This substrate is an indispensable prerequisite for many species of beetles, bees, wasps, ants, flies, mosquitoes and other invertebrates (SPEIGHT 1989; IRMLER *et al.* 1996; ØKLAND *et al.* 1996; SCHIEGG 2000). The newly growing vegetation in the windthrow areas is an emerging resource for a wide range of herbivorous insects. What may appear as a disaster to a single organism or to human economics, can be a chance for the survival of numerous species.

The storm Vivian in early 1990 triggered intensive research on the development of windthrow areas in Central Europe (SCHÖNENBERGER *et al.* 1995; FISCHER 1998; SCHÖNENBERGER 2002). Apart from investigations on the development of vegetation, special emphasis was put on the dynamics of invertebrates (FUNKE *et al.* 1995; KENTER *et al.* 1996; DUELLI *et al.* 2002; WERMELINGER *et al.* 2002). Between 1991 and 2000 the insect fauna was monitored in three windthrow areas in Swiss mountain spruce forests. The objectives of the investigation were to study the long-term development of the arthropod assemblages and to compare them between different clearing treatments and with the intact forest. A comprehensive overview of this study was published in more detail by DUELLI *et al.* (2002).

## MATERIALS AND METHODS

### Experimental setup

Three alpine regions in Eastern Switzerland were chosen, each with areas of 1-2 ha of uncleared and cleared windthrows in spruce forests. The three sites were Schwanden (Glarus, 900-1.100 m a.s.l.), Pfäfers (1.400-1.500 m), and Disentis (Grisons, 1.400-1.550 m). At the Schwanden site, there was a control plot in an adjacent intact forest in addition to the two clearing treatments.

Arthropods were collected with three types of traps: in each sampling plot three window traps (flight interception traps, 50x80 cm glass: DUELLI *et al.* 1999) were installed at a distance of at least 20 m to each other (WERMELINGER *et al.* 2002). In addition, five pitfall traps (funnel traps with 15 cm diameter: OBRIST & DUELLI 1996), and five yellow water pans (20 cm diameter: DUELLI *et al.* 1999) were placed per sampling plot. The traps were emptied weekly from May (depending on snow cover and accessibility) to September in the years 1991-1994, 1996 and 2000. Diurnal butterflies were recorded in 1992 and 1993 with standardized transects. The catches were sorted and subsequently identified by specialists to the species level.

### Data analysis

Identification data were read into a large Oracle database (Oracle Corporation, Redwood Shores, CA), which allowed for any combined query on the data in space and time.

As site accessibility varied between years due to different snow thawing times, we confined our data set to weeks 20 to 37 for any time-critical analysis. Summary analyses (e.g. total species lists) comprise the full data set.

Statistical data analysis was performed with DataDesk statistical software (Data Description, Inc. Ithaca, NY). Each trap represented a replicate. If not stated explicitly, an error probability of $p \leq 0{,}05$ applies to all statements about statistical significance.

## RESULTS

### Clearing treatments

A total of 214.066 individuals in 1.683 arthropod species were collected in the six years of sampling (Table 1). In general, there was no statistical difference between the species numbers in cleared and uncleared plots. Only the butterflies (Lepidoptera, Rhopalocera) were more diverse in cleared plots than in the uncleared plots. Likewise, the percentage of threatened species did not differ between either treatment. However, species abun-

| Group | Uncleared | Cleared | Total |
|---|---|---|---|
| Araneae | 132 | 130 | 168 |
| Opiliones | 9 | 8 | 10 |
| Pseudoscorpiones | 3 | 2 | 3 |
| Isopoda | 3 | 1 | 3 |
| Diplopoda | 13 | 14 | 15 |
| Heteroptera | 120 | 131 | 167 |
| Coleoptera | 630 | 635 | 814 |
| Hymenoptera: Aculeata | 287 | 305 | 361 |
| Diptera: Syrphidae | 115 | 114 | 142 |
| Lepidoptera: Rhopalocera | 44 | 53 | 62 |
| Total | 1.312 | 1.340 | 1.683 |
| Number of individuals | 117.413 | 96.653 | 214.066 |

**Table 1** - Number of arthropod species caught in three windthrow areas with cleared and uncleared plots. Species numbers of the different groups do not base on equal numbers of years.

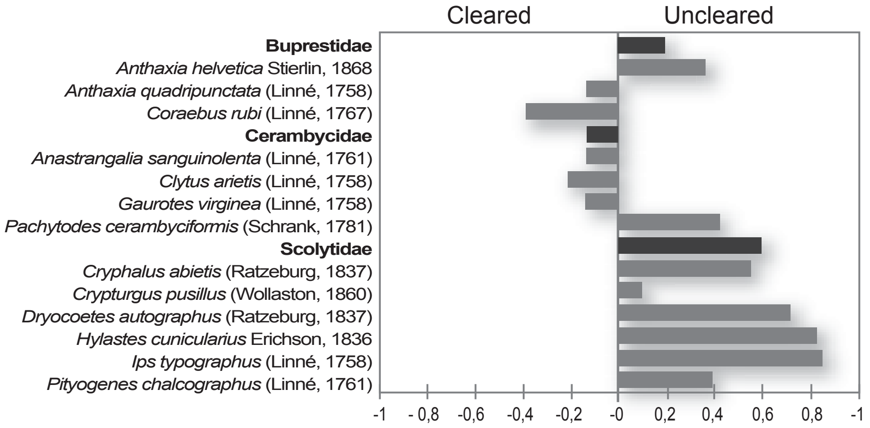


**Figure 1** - Relative abundance of saproxylic beetles in cleared and uncleared windthrow areas; all sites and years combined. The value 0 represents equal abundance on both habitats, 1 means occurrence on only one habitat (see text).

| Group | Cleared | Uncleared | Forest | Total |
|---|---|---|---|---|
| Scolytidae | 15,5 % | 54,7 % | 29,8 % | 21.846 |
| Cerambycidae | 52,7 % | 45,6 % | 1,7 % | 3.473 |
| Buprestidae | 50,3 % | 49,6 % | 0,1 % | 4.907 |
| Total | 25,4 % | 52,8 % | 21,7% | 30.226 |

**Table 2** - Relative abundance of three saproxylic beetle families at the three habitats: cleared windthrow, uncleared windthrow, and intact forest at the Schwanden site; data from six years.

dance was higher in uncleared areas. This is largely due to bark beetles: in Figure 1 the preference of the most abundant saproxylic insect species for clearing treatments is depicted as index i= ($n_{ucl}$ - $n_{cl}$)/N, where $n_{ucl}$ is the number of individuals in uncleared areas, ncl the number in cleared areas, and N the total number. Scolytid beetles preferred the uncleared areas, most pronouncedly *Ips typographus* (Linné, 1758). In contrast, cerambycid beetles were generally more abundant in the cleared plots with the exception of *Pachytodes cerambyciformis* (Schrank, 1781) which was the most abundant cerambycid species. Its larvae develop in roots of a number of tree species. Within the buprestids the two *Anthaxia* Eschscholtz, 1829 species showed an opposite preference, *A. quadripunctata* (Linné, 1758) for cleared and *A. helvetica* Stierlin, 1868 for uncleared plots.

The three saproxylic groups also differed in their abundance in the intact forest at Schwanden (Table 2). Buprestid and cerambycid abundance and total species numbers were significantly higher (ANOVA $p<0,01$) in the two windthrow treatments than in the intact forest, but equally represented in both clearing treatments. The buprestid species were virtually absent in the forest (5 specimens out of 4.900 Buprestidae!). Scolytid abundance and species numbers did not differ statistically between treatments. However, they tended to reach higher numbers in the forest than in the cleared windthrow treatment. In the forest, the species richness of Cerambycidae and Buprestidae was only 20-50% of that in the uncleared areas. In total, 59 species were found in windthrow areas, whereas in the forest we caught only 32 species.

## Temporal development

The temporal pattern of catches in the windthrow areas was quite differential among the saproxylic beetles (Figure 2). The scolytid fauna showed a distinct peak in the third year (1992) after the storm but declined to very low levels four years later. This pattern was mainly due to captures of *Pityogenes chalcographus* (Linné, 1791) and *I. typographus* (cf. WERMELINGER *et al.* 1999). The population build-up of species from the two other saproxylic families was delayed. Buprestid beetles reached a maximum in 1994 and thereafter decreased only slowly. Cerambycid numbers approached a maximum at the end of the observation period. The number of cerambycid and scolytid species peaked in the second year after the storm while the low number of buprestid species did not markedly change throughout the whole period under study. More results on the saproxylics may be found in WERMELINGER *et al.* (2002).

The development of arthropod species numbers was compared between treatments and with the intact forest at Schwanden (Table 3). There was a trend for an increase in species numbers within 10 years, amounting to 17% in both the cleared and the uncleared site. The increase is mainly due to the Heteroptera (true bugs) and carabid beetles, while the species numbers of spiders, syrphids, and some saproxylic beetles remained fairly constant. The bark beetles (Scolytidae), on the other hand, showed a marked decrease with time.

In the forest control plot, the increase between 1991 and 2000 was merely 5%. This site was close to windthrow areas, so

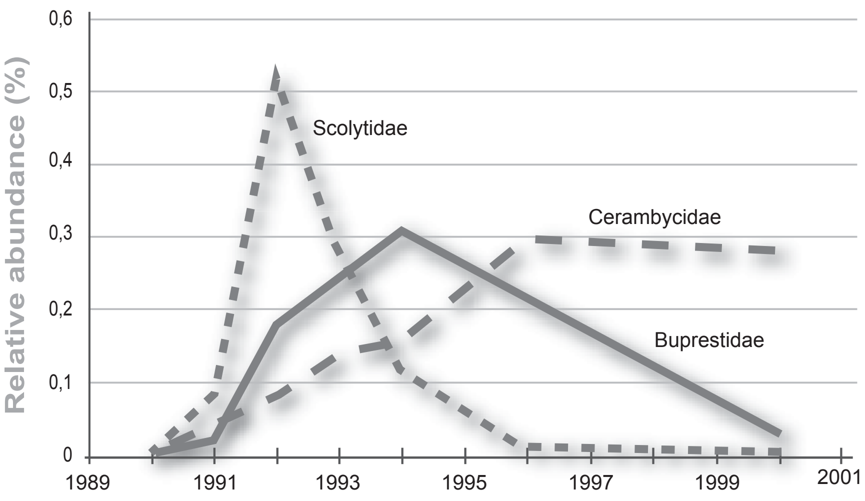


**Figure 2** - Relative dynamics of three saproxylic groups of Coleoptera; all sites combined.

the increased species numbers of carabids and Heteroptera are most likely the result of immigration from surrounding windthrow sites.

### Estimated species gain with treatment combinations

Although the overall species numbers collected in cleared and uncleared sites were similar, the species composition differed between the two treatments. To estimate the potential gain of a combination of both treatments and intact forest in a region we estimated the total numbers of species per plot by means of extrapolating rarefaction functions which corrects for unequal sample sizes (Duelli *et al.* 2002). Extrapolating the functions to 500.000 individuals, we calculated 967 species in the cleared and 1.017 species in the uncleared treatment (Table 4). The forest achieved only 653 species. Combining both treatments significantly increased species numbers by 22%. This is also confirmed by the other study sites. A further increase is achieved by combining both treatments and the intact forest, which exactly doubled the species richness (100% increase).

## DISCUSSION AND CONCLUSIONS

Windthrows caused an overall increase in biodiversity compared to the intact forest. Apart from bark beetles and arthropod groups depending on high humidity such as Isopoda, Opiliones, and Diplopoda, all identified groups showed an increase in species richness after the storm. The highest gains were observed in aculeate Hymenoptera and buprestid beetles. In the course of the ten-year-investigation, the species numbers increased in the windthrows by 17%, while the species gain in the forest control plot was insignificant and presumably due to immigration from nearby windthrows. Investigations in Germany on windthrows of the same storm “Vivian” also found a higher species richness in windthrows than in the intact forest (e.g. Kenter & Funke 1995; Kenter *et al.* 1997).

Arthropod abundance was consistently higher in the uncleared plots. However, uncleared windthrows did not harbor a higher species diversity or more endangered species than cleared ones. Though the species number was similar the assemblages of the two treatments differed from each other. While many saproxylic species were more numerous in uncleared than in cleared areas insects such as bees, wasps, bugs and syrphid flies preferred the cleared areas where amount and diversity of flowering plants growing on the disturbed surface was higher (Wohlgemuth *et al.* 2002). In addition, various adult cerambycids and buprestids feed on pollen or leaves and thus prefer the cleared areas while their developing larvae depend on dead wood supplied in uncleared areas.

Among the saproxylic beetles, scolytids as typical exploiters of short-lived substrates responded rapidly to the favorable conditions: their population dynamics peaked in the third year after the storm. Many buprestid and cerambycid species have longer larval development times or may also colonize older substrates. Therefore, the emergence of species in these families was delayed by several years. A short-term increase in not only the insect numbers but also the species richness of saproxylics has been found also in other windthrow studies (e.g. Otte 1989), while in clearcuts their abundance decreased (Werner 2002).

Many saproxylic species are endangered. Disturbances like windthrow provide new resources for them and many other arthropod groups and thus increase biodiversity. Storms stimulate population dynamics and allow weak populations to strengthen in a suitable, but ephemeral environment.

| | | Cleared | | Uncleared | | Forest | |
|---|---|---|---|---|---|---|---|
| **Order** | **Family** | **1991** | **2000** | **1991** | **2000** | **1991** | **2000** |
| Araneae | | 52 | 56 | 48 | 52 | 40 | 28 |
| Coleoptera | Buprestidae | 5 | 3 | 6 | 7 | 2 | 0 |
| " | Carabidae | 19 | 26 | 19 | 25 | 14 | 21 |
| " | Cerambycidae | 19 | 17 | 19 | 19 | 12 | 9 |
| " | Scolytidae | 12 | 7 | 17 | 6 | 12 | 13 |
| Diptera | Syrphidae | 21 | 30 | 38 | 37 | 21 | 17 |
| Heteroptera | | 19 | 33 | 16 | 45 | 8 | 25 |
| Total | | 147 | 172 | 163 | 191 | 109 | 113 |
| Total in comparison to forest | | | + 35 % | + 52 % | | + 50 % | + 69 % |

**Table 3** - Species numbers of the years 1991 and 2000 in the cleared and uncleared windthrow areas at Schwanden and comparison with the intact forest.

| Treatment | Species at 500.000 individuals | Increase in species numbers (%) |
|---|---|---|
| Uncleared | 1.017 | |
| Cleared | 967 | |
| Both treatments | 1.209 | 22% |
| Forest | 653 | |
| Both treatments and forest | 1.307 | 100% |

**Table 4** - Estimated number of species in single and combined habitat types (clearing treatments and forest) at Schwanden.

Within a forest with storm-caused gaps creating a mosaic of cleared and uncleared windthrow areas can best enhance faunal biodiversity.

## References

Duelli P., Obrist M.K., Schmatz D.R., 1999 - **Biodiversity evaluation in agricultural landscapes: above-ground insects**. Agric. Ecosyst. Environ., 74: 33-64.

Duelli P., Obrist M.K., Wermelinger B., 2002 - **Windthrow-induced changes in faunistic biodiversity in alpine spruce forests**. For. Snow Landsc. Res., 77: 117-131.

Fischer A., 1998 - **Die Entwicklung von Wald-Biozönosen nach Sturmwurf**. Ecomed, Landsberg, 427 pp.

Funke W., Kenter B., Baumann K., Schwarz E., Bellmann H., Kraus J., Werth H., 1995 - **Sukzession der Lebensgemeinschaften von Windwurfflächen (bei Langenau, Bad Waldsee und Bebenhausen) - Untersuchungen an Arthropodenzönosen**. Veröff. PAÖ, 12: 24-25.

Irmler U., Heller K., Warning J., 1996 - **Age and tree species as factors influencing the populations of insects living in dead wood (Coleoptera, Diptera: Sciaridae, Mycetophilidae)**. Pedobiologia, 40: 134-148.

Kenter B., Baumann K., Bellmann H., Werth H., Funke W., 1996 - **Tiergesellschaften auf Windwurfflächen in Süddeutschland - Untersuchungen an Arthropoden- und Avizönosen**. Veröff. PAÖ, 16: 357-366.

Kenter B., Funke W., 1995 - **Sukzession von Tiergesellschaften auf Windwurfflächen - Untersuchungen an Raubarthropoden**. Mitt. deutsch. Ges. allg. ang. Entomol., 10: 95-98.

Kenter B., Kopf A., Spelda J., Werth S., Wilhelm P., Bellmann H., Funke W., 1997 - **Sukzessionsforschung auf Windwurfflächen - Untersuchungen an Wirbellosen und Wirbeltieren**. Veröff. PAÖ, 22: 163-174.

Obrist M.K., Duelli P., 1996 - **Trapping efficiency of funne l- and cup-traps for epigeal arthropods**. Mitt. Schweiz. Entomol. Ges., 69: 361-369.

Økland B., Bakke A., Hågvar S., Kvamme T., 1996 - **What factors influence the diversity of saproxylic beetles? A multiscaled study from a spruce forest in southern Norway.** Biodivers. Conserv., 5: 75-100.

Otte J., 1989 - **Ökologische Untersuchungen zur Bedeutung von Windwurfflächen für die Insektenfauna (Teil I)**. Waldhygiene, 17: 193-247.

Schiegg K., 2000 - **Effects of dead wood volume and connectivity on saproxylic insect species diversity**. Ecosci., 7: 290-298.

Schönenberger W., 2002 - **Windthrow research after the 1990 storm Vivian in Switzerland: objectives, study sites, and projects**. For. Snow Landsc. Res., 77: 9-16.

Schönenberger W., Kuhn N., Lässig R., 1995 - **Forschungsziele und -projekte auf Windwurfflächen in der Schweiz**. Schweiz. Z. Forstwes., 146: 859-862.

Speight M.C.D., 1989 - **Saproxylic invertebrates and their conservation**. Council of Europe, Strasbourg, 82 pp.

Wermelinger B., Duelli P., Obrist M.K., 2002 - **Dynamics of saproxylic beetles (Coleoptera) in windthrow areas in alpine spruce forests**. For. Snow Landsc. Res., 77: 133-148.

Wermelinger B., Obrist M.K., Duelli P., Forster B., 1999 - **Development of the bark beetle (Scolytidae) fauna in windthrow areas in Switzerland**. Mitt. Schweiz. Entomol. Ges., 72: 209-220.

Werner R.A., 2002 - **Effect of ecosystem disturbance on diversity of bark and wood-boring beetles (Coleoptera: Scolytidae, Buprestidae, Cerambycidae) in white spruce (*Picea glauca* (Moench) Voss) ecosystems of Alaska**. USDA For. Serv. PNW-RP, 546: 1-15.

Wohlgemuth T., Kull P., Wüthrich H., 2002 - **Disturbance of microsites and early tree regeneration after windthrow in Swiss mountain forests due to the winter storm Vivian 1990**. For. Snow Landsc. Res., 77: 17-47.

## Acknowledgements

There are too many people involved in field work, sample processing, and insect identifications to be listed here. However, they are all warmly thanked for their valuable collaboration. The support by the Swiss Agency for the Environment, Forests and Landscape (BUWAL) is gratefully acknowledged.

# SAPROXYLIC BEETLES IN BOREAL FORESTS: TEMPORAL VARIABILITY AND REPRESENTATIVENESS OF SAMPLES IN BEETLE INVENTORIES

## *COLEOTTERI SAPROXILICI NELLE FORESTE BOREALI: VARIABILITÀ TEMPORALE E RAPPRESENTATIVITÀ DEI CAMPIONI NEGLI INVENTARI*

Petri Martikainen

*Faculty of Forest Sciences, University of Joensuu, PO Box 111, FIN-80101 Joensuu, Finland. E-mail petri.martikainen@joensuu.fi*

**Summary:** Saproxylic beetles are one of the most species-rich groups of organisms living in dead wood. Many of the species are now threatened in Europe because of the reduction of dead wood in managed forests. Saproxylic beetles can be surveyed with many kinds of traps, but rare and threatened species - the ones that often are of great interest - are especially difficult to catch. Results from Finnish studies indicate that the occurrence of rare and threatened species in trap samples is much more unpredictable than the occurrence of common species. If the aim is to find threatened species living in a certain forest area, samples have to be large and collected with suitable methods. The most efficient methods for catching rare saproxylic beetles are obviously trunk window traps attached to dead trees and direct searching of beetles by experts.

**Key words:** Boreal forest, sampling methodology, saproxylic Coleoptera, species inventories, threatened species.

Forest beetles, particularly those living in dead or dying trees, have received a lot of attention from entomologists in the Nordic Countries for more than hundred years. Thanks to the long tradition, the beetles in the boreal forests of Fennoscandia are well known. Collections and publications of the early coleopterists (e.g. Saalas 1917, 1923; Palm 1951, 1959) have also helped us to track down changes that have taken place in our forest beetle faunas due to intensive forest management.

Although Finland is located far in the north, surprisingly many species of beetles can be found in Finnish forests. Some 2.000 of the 3.650 beetle species recorded from Finland live in the forests, and ca. 800 of them are saproxylic (dependent on dead wood) (Siitonen 2001). Beetles are in fact one of the most species-rich groups of organisms that are dependent on dead wood, constituting as much as 20% of all the 4.000-5.000 saproxylic species that have been found in Finland (Siitonen 2001). Furthermore, the share of beetles of all the 564 threatened forests species in Finland is even greater, 29%, i.e. 165 species (Rassi *et al.* 2001). Most of the threatened forest beetle species are suffering from the lack of decaying wood in the managed forest landscape (Rassi *et al.* 2001). Seventeen beetle species have already disappeared from Finnish forests, many of them (e.g. *Cucujus haematodes* Erichson, 1845, *Rhizophagus puncticollis* C. R. Sahlberg, 1837 and *Hylochares cruentatus* Gyllenhal, 1808) (Photo 1) already long time ago in the 1800's or early 1900's (Rassi *et al.* 2001). Some of these species can still be found in Russian Karelia, only a few hundred kilometres from Finland, where the forests are not as intensively managed as they are in Finland (Siitonen & Martikainen 1994).

Quantitative sampling of forest beetles using standard methods such as window or pitfall traps began a couple of decades ago in Fennoscandia and has become more and more popular since then. Studies based on quantitative methods have substantially increased our knowledge about forest beetles, their habitat requirements and responses to forest management. These studies have for example demonstrated that saproxylic beetles are far more sensitive to forest management than other groups of beetles, and that the number of saproxylic species increases curvilinearly when the amount of dead wood increases (Martikainen 2000; Martikainen *et al.* 2000) (Figure 1). Diversity, continuity and sun exposure of dead wood also play important roles in determining the species richness and composition of forest beetle assemblages (e.g. Martikainen 2001; Jonsell & Nordlander 2002; Similä *et al.* 2003).

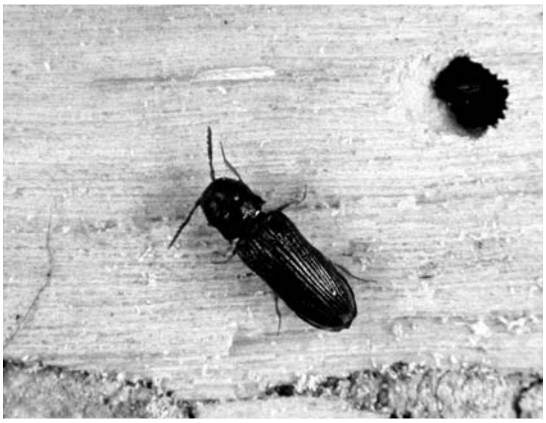


**Photo 1** - An example of a beetle species that went extinct in Finland already in the beginning of 1900's, a false click beetle *Hylochares cruentatus* (family Eucnemidae). This species inhabits large, dead aspen trees and can still be found in Russian Karelia.

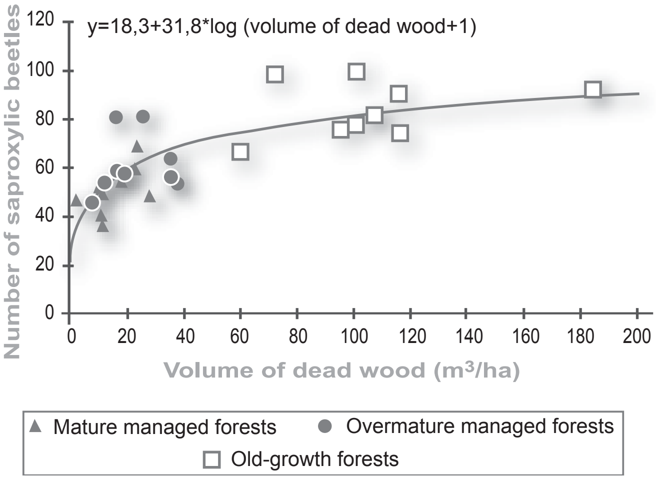


**Figure 1** - Relationship between the volume of dead wood and the number of saproxylic beetle species caught in window traps in old spruce-dominated forests in Finland (modified from Martikainen *et al.* 2000).

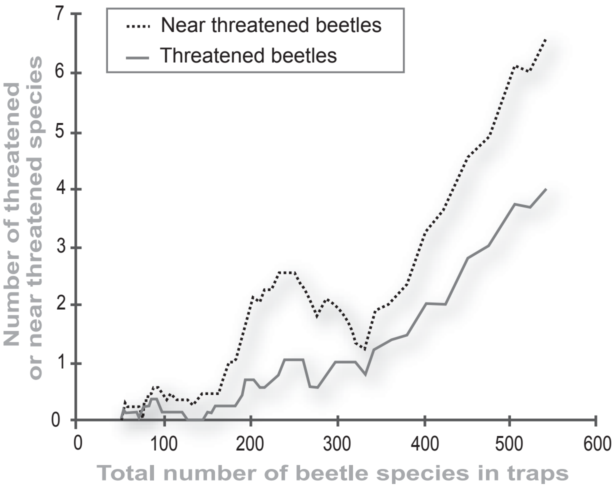


**Figure 2** - Relationship between the number of near threatened or threatened species and the total number of species caught using traps in 68 forests in Finland (modified from Martikainen & Kouki 2003).

Although quantitative trapping methods are nowadays widespread, many important aspects related to these methods have remained poorly investigated. For example, we do not know much about how beetle samples vary from year to year, how rare species accumulate in the samples, how useful different sampling methods are for catching threatened species, and what is an adequate sample size for finding threatened species. These questions have been addressed in two studies recently carried out in Finland.

## SAMPLES FROM TEN YEARS

Martikainen & Kaila (unpublished manuscript) collected saproxylic beetles in two forests in southern Finland during the entire 1990's. Ten trunk-window traps (Kaila 1993) were placed on dead birch (*Betula* spp.) trees close to the fruiting bodies of wood-rotting fungi *Fomes fomentarius* (L.: Fr.) Fr. (Polyporaceae) in both forests every summer between 1990 and 1999. Beetles belonging to 32 families were identified every year. The number of saproxylic species belonging to these families were 99 and 116 in the two forests during the ten-year period, and the number of individuals was 29.889.

According to the results, the abundance of saproxylic beetles in traps can vary substantially from year to year: the largest sample was ca. twice as large as the smallest sample during the ten years in both forests. However, the number of species varied much less and remained rather constant. In the case of rare species both the number of species and individuals varied a lot between years. For example, the annual number of rare saproxylic species in the ten traps varied between 2 and 10 in one forest and between 4 and 12 in the other forest during the ten years. Also, the similarities between years of rare species in the samples were much lower than those of more abundant species.

Accumulation of species in the samples during ten years showed that common species (i.e. species that have lot of occurrences in Finland, see Rassi 1993) are caught relatively soon in the traps: most of the common species that were found in the entire ten-year period were detected already during the first two or three years. The corresponding proportion was much smaller for rare and threatened species and threatened species especially accumulated very slowly in the samples.

These results show that it is rather easy to get a general overview of the species that live in a certain forest stand. A large proportion of the abundant species can be detected quite easily with a reasonable sampling effort. Rare and threatened species are much more difficult to sample adequately. New threatened (or near threatened) species were found even in the last year of the ten-year monitoring period in both forests. Also the variation between years is much greater in rare than in common species, which may complicate comparisons of rare species between forests. For example, in some years the samples did not contain any threatened species although such species are in fact numerous in both forests.

## BEETLES FROM 68 FORESTS

What are the best methods for catching threatened forest beetles, and how large samples are adequate? These questions were addressed in a study which put together data from 17 published beetle inventories carried out in Finland recently (Martikainen & Kouki 2003). These inventories included beetle materials from 68 different forest areas. Most of the threatened and near threatened species found in these studies were saproxylic.

The results demonstrated that samples containing less than 200 beetle species or 2.000 individuals contain threatened species only accidentally. The probability of finding threatened species increased considerably when the number of species in a sample exceeded 400 (Figure 2).

Window traps attached directly to or close to dead trees (= trunk window traps) were much more effective in catching threatened forest beetles than the other trap types used in the inventories. These included, for example, randomly located freely hanging window traps, pitfall traps and car net. Direct searching of beetles by coleopterists (i.e. peeling of bark, sieving, hand picking from polypores etc.) gave even better results than the use of trunk window traps, pointing out the value of experienced entomologists in beetle surveys.

## CONCLUSIONS

In many beetle surveys the aim is to get a comprehensive picture of the species that are present in the forests studied. Occurrences of rare and threatened species are often of particular interest, because these are the ones that may need special attention e.g. from the conservation point of view. However, it may be problematic to identify habitats where such species still occur, because beetle samples collected from the forests mainly consist of abundant and common species. As these results show, samples have to be large in order to reveal the rare members of the beetle assemblages. And even if the samples are really large - tens of thousands of individuals - some species will still be missed.

Although challenging, the study of rare and threatened saproxylic beetles is nevertheless interesting and important. Not only are saproxylic beetles one of the largest groups of species living in dead wood in the forests, but they are also the ones that have been particularly severely affected by the reduction of dead wood in the managed forests in Europe. To be able to maintain the species diversity in our forests, we have to increase our knowledge about saproxylic beetles and their habitat requirements.

## References

JONSELL M., NORDLANDER G., 2002 - **Insects in polypore fungi as indicator species: a comparison between forest sites differing in amounts and continuity of dead wood.** Forest Ecology and Management, 157: 101-118.

KAILA L., 1993 - **A new method for collecting quantitative samples of insects associated with decaying wood or wood fungi**. Entomologica Fennica, 4: 21-23.

MARTIKAINEN P., 2000 - **Effects of forest management on beetle diversity, with implications for species conservation and forest protection**. PhD thesis. University of Joensuu, Joensuu, 26 pp.

MARTIKAINEN P., 2001 - **Conservation of threatened saproxylic beetles: significance of retained aspen *Populus tremula* on clearcut areas**. Ecological Bulletins, 49: 205-218.

MARTIKAINEN P., KOUKI J., 2003 - **Sampling the rarest: threatened beetles in boreal forest biodiversity inventories**. Biodiversity and Conservation, 12: 1815-1831.

MARTIKAINEN P., SIITONEN J., PUNTTILA P., KAILA L., RAUH J., 2000 - **Species richness of Coleoptera in mature managed and old-growth boreal forests in southern Finland**. Biological Conservation, 94: 199-209.

PALM T., 1951 - **Die Holz- und Rinden-Käfer der nordschwedischen Laubbäume**. Meddelanden från Statens Skogsforskningsinstitut, 40: 1-242.

PALM T., 1959 - **Die Holz- und Rinden-Käfer der süd- und mittelschwedischen Laubbäume**. Opuscula Entomologica Supplementum, 16: 1-374.

RASSI P. (ed.), 1993 - **Frequency score of Coleoptera in Finland 1.1.1960-1.1.1990**. WWF Finland, Helsinki, 136 pp.

RASSI P., ALANEN A., KANERVA T., MANNERKOSKI I. (eds.), 2001 - **Suomen lajien uhanalaisuus 2000** [Threatened species in Finland in 2000 (in Finnish)]. Ympäristöministeriö & Suomen Ympäristökeskus, Helsinki, 432 pp.

SAALAS U., 1917 - **Die Fichtenkäfer Finnlands I**. Annales Academiae Scientiarum Fennicae Ser. A, 8: 1-547.

SAALAS U., 1923 - **Die Fichtenkäfer Finnlands II**. Annales Academiae Scientiarum Fennicae Ser. A, 22: 1-746.

SIITONEN J., 2001 - **Forest management, coarse woody debris and saproxylic organisms: Fennoscandian boreal forests as an example**. Ecological Bulletins, 49: 11-41.

SIITONEN J., MARTIKAINEN P., 1994 - **Occurrence of Rare and Threatened Insects Living on Decaying *Populus tremula*: A Comparison Between Finnish and Russian Karelia**. Scand. J. For. Res., 9: 185-191.

SIMILÄ M., KOUKI J., MARTIKAINEN P., 2003 - **Saproxylic beetles in managed and semi-natural Scots pine forests: quality of dead wood matters**. Forest Ecology and Management, 174: 365-381.

# COMMUNITY DYNAMICS AND CONSERVATION OF BOREAL WOOD-DECAYING FUNGI

## DINAMICHE DELLA COMUNITÀ E CONSERVAZIONE DEI FUNGHI BOREALI DECOMPOSITORI DEL LEGNO

Pertti Renvall

*Kuopio Natural History Museum, Myhkyrinkatu 22, FIN-70100 Kuopio, Finland. Email pertti.renvall@kuopio.fi*

**Summary:** This paper is a brief summary on some major principles of the dynamics of wood-decaying Basidiomycetes (Fungi) on decomposing tree trunks in boreal old-growth forests. Species of wood-inhabiting fungi succeed each other during the decomposition of a trunk. Details of the species' compositions and successional pathways vary strongly from tree to tree. Many species depend on old-growth forests and are now threatened.

**Key words:** Boreal forest, Basiodiomycetes, dead wood, threatened species.

Decomposing wood is the key element in maintaining a high diversity of ecological niches in the boreal forest ecosystem. Decaying snags and fallen tree trunks, in particular, maintain the major part of the species richness in boreal forests. They make up an indispensable resource for thousands of forest-dwelling species: invertebrates, fungi, bryophytes and lichens, even to some birds and mammals (summarized by SIITONEN 2001). This paper is a brief summary on some major principles of the dynamics of wood-rotting polypores and corticioid fungi (Basidiomycetes) on decomposing logs in boreal old-growth forests as indicated by the data based on distribution and abundance of fruit bodies.

During the last 15 years significant progress has been made in research on the biology of boreal wood-inhabiting fungi. Many important *species novae* have just recently been discovered in old-growth forests of northwestern Europe (e.g. RENVALL & NIEMELÄ 1992; NIEMELÄ 1994, 1998; BERGLUND & RYVARDEN 2000; JOHANNESSON *et al.* 2000; NIEMELÄ *et al.* 2001). This has essentially improved our chances to interprete, e.g. the ecological demands of some difficult key species' groups. Quantitative data, though mostly based on distribution and abundance of fruit bodies only, are now available on the species' compositions and general structures of fungal communities at a single tree trunk level as well as on a landscape scale (RENVALL 1995; HØILAND & BENDIKSEN 1997; LINDBLAD 1998; LINDGREN 2001). The effects of forestry on polypores and other aphyllophoroid Basidiomycetes are now much better known and understood, and are known to be severe (e.g. BADER *et al.* 1995; LINDBLAD 1998; SIPPOLA & RENVALL 1999; RASSI *et al.* 2001; SIPPOLA *et al.* 2001). Contributions dealing with the true mycelial distribution and activity (e.g. BODDY 1992, 2001; NIEMELÄ *et al.* 1995; HOLMER 1996; JOHANNESSON & STENLID 1999) have helped us to shed light on the secrets of interspecific interactions between mycelia taking place inside, e.g. a single fallen log. Studies on the genetics and population biology of wood-decaying fungi (e.g. HALLENBERG 1995; NORDÉN 1997; HÖGBERG 1998; KAUSERUD 2001) have given us totally new tools for understanding the population dynamics, sexuality and dispersal biology of wood-decaying fungi.

## DYNAMICS AT LOG LEVEL

The species of wood-rotting fungi are known to have specific preferences for certain stages of wood decomposition (BADER *et al.* 1995; RENVALL 1995). Species replace one another in a characteristic sequence during the decomposition of wood, altering the physical structure, moisture, acidity and nutrient contents of the wood. The distinct successional orders of species that develop on decaying trunks show that lignicolous Basidiomycetes differ greatly from each other in their substratum requirements and in their competitive abilities at different stages of decomposition.

Properties of the host-tree species and the microclimate of the growth site govern the basic community development of wood-decaying fungi. However, the first stages in tree trunk decomposition strongly depend on the way the tree died. Pioneer decayers alter the structure and chemistry of wood, and in this way indirectly modify the fungal communities at later stages of succession (RENVALL 1995).

If the almost completely decayed trunks are excluded, the number of species occurring on decomposing conifer trunks increases with the stage of decomposition (RENVALL 1995; NIEMELÄ *et al.* 1995). On the other hand, each stage of decomposition has a characteristic species' composition, which means that logs at each stage of decay harbour species which are not found at other stages of decay. The trunks at late and intermediary stages of decay maintain exceptionally diverse species' combinations and therefore are crucial for the conservation of lignicolous fungi.

The species' composition of wood-rotting fungi inhabiting a single conifer trunk is most closely attached to the stage of decomposition. However, many other log characteristics contribute to the structure and dynamics of fungal communities. The history of fungal infections preceding the tree fall has a strong impact as do the base diameter and the type of stem breakage (Renvall 1995; Niemelä *et al.* 1995). Bark affects the microclimate inside wood by reducing evaporation, and thus is a factor that balances the moisture variability in fallen trunks.

Many white-rot-causing fungi seem to be restricted to a certain stage of decay, while many brown-rot-causing species stand out as dominant decomposers during several successive stages of decay (Renvall 1995). Brown-rotters are clearly the dominant decomposers in dry habitats, in particular on pine (Gilbertson 1981), while white-rot fungi often predominate, e.g. on logs of deciduous tree species and on spruce, particularly in permanently wet localities. Many strong primary pioneer decayers of spruce (*Picea abies* (L.) H. Karst) are white-rot fungi. They play a special role in the dynamics of lignicolous fungi by opening different successional pathways of decomposition.

At least three major strategies can be distinguished among the species inhabiting the final stages of decomposition. Many species of corticioid fungi and some polypores are ephemeral and appear quickly on suitable pieces of wood. Others seem to be very slowly-establishing species, and evidently survive only in circumstances which remain stable for decades. Many of these final-stage decayers seem to be independent, appearing and disappearing without any evident correlation to preceding decayers or other similar species. They may grow side by side, but the co-occurrences seem to take place in more or less random combinations. However, there is a special group of wood-rotting fungi that inhabit only trees which were previously decayed by certain other species (Niemelä *et al.* 1995). The biology of these fungi is still insufficiently known. Although these successor species are strong competitors in laboratory (Holmer *et al.* 1997), they seem to be rare in nature and sensitive to the impacts of logging. Many of them have been classified as threatened, e.g. in Finland (Rassi *et al.* 2001).

## DECAYING LOGS AS A RESOURCE FOR LIGNICOLOUS FUNGI

During decomposition, logs undergo structural and chemical changes. They become decorticated and collapse to the ground. The wood becomes softened and cracked, and its density decreases. Logs become more or less covered with bryophytes and lichens, which increase the water-holding capacity of the wood and reduce evaporation. The moisture content of wood in fallen trunks increases during decomposition (e.g. Dix 1985; Renvall 1995). The nutrient contents of wood differ with the stage of decay (Grier 1978; Lambert *et al.* 1980). The amount of gaseous carbon dioxide increases inside decaying wood, until fragmentation of the wood enhances ventilation (Hintikka & Korhonen 1970). Accordingly both chemical and physical conditions of wood are closely linked to the stage of decomposition. Forest fires create new kinds of substrates for fungi to invade. Through changing the quality of wood, burning totally changes the pathway of decomposition (Renvall 1995; Penttilä & Kotiranta 1996). To conclude, varying with tree species, microclimate of the site, stage of decomposition, size of the tree unit, history of fungal infections, type of stem breakage and amount of bark, decomposing logs offer a whole variety of ecological niches for lignicolous fungi. A fallen log should be understood as a changing, heterogeneous and spatially discontinuous resource unit. It is a substrate, which finally will be eradicated by its own inhabitants. All this makes it very difficult and extremely challenging to succeed in restoration and in other conservation measures in managed forests.

## CONSERVATION OF WOOD-DECAYING FUNGI

Recent studies on lignicolous fungi in northwestern Europe have shown that the species' richness is much lower in managed forests than in old-growth forests. It has been estimated in Finland that depending on the intensity of logging up to 80% of the species of wood-inhabiting fungi may disappear locally because of forest management. The lack of suitable substrates in managed forests is the main reason for the low diversity. Forestry mostly leaves just thin freshly cut trunks, stumps and twigs in the managed areas. Such woody material supports only a small part of the total mycoflora found in natural conditions. Therefore many wood-decaying fungi, in particular species that prefer large-diameter logs and many late-successional saprotrophs, are now threatened (Rassi *et al.* 2001).

Species of lignicolous fungi prefer either thick or thin tree trunks and they are adapted to decompose certain parts of the trunks. Many species which are able to colonise thin trunks, crowns, branches or twigs are frequently found in managed forests as well, while almost all the species that are adapted to utilise thick parts of trunks are rare outside old-growth forests. Large trunks are therefore one of the most important substrates for maintaining the species richness of boreal lignicolous fungi.

## References

Bader P., Jansson S., Jonsson B.G., 1995 - **Wood-inhabiting fungi and substratum decline in selectively logged boreal spruce forests**. Biol. Conserv. 72: 355-362.

Berglund H., Ryvarden L., 2000 - ***Oligoporus norrlandicus* nov. sp.**. Cryptogamie Mycol. 21 : 145-146.

Boddy L., 1992 - **Development and function of fungal communities in decomposing wood**. 749-782. In: Wicklow D.T. & Carroll C.G. (eds.), The fungal community. Its organization and role in the ecosystem. Marcel Dekker, New York.

Boddy L., 2001 - **Fungal community ecology and wood decomposition process in angiosperms: from standing tree to complete decay of coarse woody debris**. Ecol. Bull., 49: 43-56.

Dix N.J., 1985 - **Changes in relationship between water content and water potential after decay and its significance for fungal successions**. Trans. British Mycol. Soc., 85: 649-653.

Gilbertson R.L., 1981 - **North American wood-rotting fungi that cause brown rots**. Mycotaxon, 12: 372-416.

Grier C.C., 1978 - **A *Tsuga heterophylla* - *Picea sitchensis* ecosystem of coastal Oregon: decomposition and nutrient balances of fallen logs**. Canadian J. Forest Res., 8:198-206.

Hallenberg N., 1995 - **Dispersal abilities and distributional patterns in Aphyllophorales, with emphasis in corticioid fungi**. Acta Univ. Ups. Symb. Bot. Ups., 30: 95-100.

Hintikka V., Korhonen K., 1970 - **Effects of carbon dioxide on the growth of lignicolous and soil-inhabiting Hymenomycetes.** Comm. Inst. Forest. Fenniae, 69: 1-28.

Högberg N., 1998 - **Population biology of common and rare wood-decay fungi**. Acta Univ. Agricult. Suec., Silvestria 53 (Doctoral dissertation).

Høiland K., Bendiksen E., 1997 - **Biodiversity of wood-inahbiting fungi in a boreal coniferous forest in Sør-Trøndelag County, Central Norway**. Nordic J. Bot., 16: 643-659.

Holmer L., 1996 - **Interspecific interactions between wood-inhabiting basidiomycetes in boreal forests**. Doctoral dissertation. Swedish University of Agricultural Sciences, Uppsala.

Holmer L., Renvall P., Stenlid J., 1997 -

**Selective replacement between species of wood-rotting basidiomycetes, a laboratory study**. Mycol. Res., 101: 714-720.

JOHANNESSON H., RENVALL P., STENLID J., 2000 - **Taxonomy of the genus *Antrodiella* (Basidiomycetes) inferred from morphological and molecular data**. Mycol. Research, 104: 92-99.

JOHANNESSON H., STENLID J., 1999 - **Molecular identification of wood-inhabiting fungi in an unmanaged *Picea abies* forest in Sweden**. Forest Ecol. Manage., 115: 203-211.

KAUSERUD H., 2001 - **Population genetics and sexuality in wood-decaying polypores (Basidiomycota)**. Doctoral dissertation, University of Oslo, Oslo.

LAMBERT R.L., LANG G.E., REINERS W.A., 1980 - **Loss of mass and chemical change in decaying boles of a subalpine balsam fir forest**. Ecology, 61: 1460-1473.

LINDBLAD I., 1998 - **Wood-inhabiting fungi on fallen logs of Norway spruce: relations to forest management and substrate quality**. Nord. J. Bot., 18: 243-255.

LINDGREN M., 2001 - **Polypore species richness and community structure in natural boreal forests of NW Russian Karelia and adjacent areas in Finland**. Acta Bot. Fennica, 170: 1-41.

NIEMELÄ T., 1994 - **Five species of *Anomoporia*, rare polypores of old forests**. Ann. Bot. Fennici, 31: 93-115.

NIEMELÄ T., 1998 - **The *Skeletocutis subincarnata* complex (Basidiomycetes), a revision**. Acta Bot. Fennica, 161: 1-35.

NIEMELÄ T., KINNUNEN J., LINDGREN M., MANNINEN O., MIETTINEN O., PENTTILÄ R., TURUNEN O., 2001 - **Novelties and records of poroid Basidiomycetes in Finland and adjacent Russia**. Karstenia, 41: 1-21.

NIEMELÄ T., RENVALL P., PENTILLÄ R., 1995 - **Interactions of fungi at late stages of wood decomposition.** Ann. Bot. Fennici, 32: 141-152.

NORDÉN B., 1997 - **Genetic variation with and among populations of *Fomitopsis pinicola* (Basidiomycetes)**. Nordic J. Bot., 17: 319-329.

PENTTILÄ R., KOTIRANTA H., 1996 - **Short-term effects of prescribed burning on wood-rotting fungi**. Silva Fennica, 30: 399-419.

RASSI P., ALANEN A., KANERVA T., MANNERKOSKI I. (eds.), 2001 - **The 2000 red list of Finnish species**. Ministry of the Environment & Finnish Environment Institute, Helsinki.

RENVALL P., 1995 - **Community structure and dynamics of wood-rotting Basidiomycetes on decomposing conifer trunks in northern Finland**. Karstenia, 35: 1-51.

RENVALL P., NIEMELÄ T., 1992 - **Basidiomycetes at the timberline in Finland 3. Two new boreal polypores with intricate hyphal systems**. Karstenia, 32: 29-42.

SIITONEN J., 2001 - **Forest management, coarse woody debris and saproxylic organisms: Fennoscandian boreal forest as an example**. Ecol. Bull., 49: 11-41.

SIPPOLA A.-L., LEHESVIRTA T., RENVALL P., 2001 - **Effects of selective logging on coarse woody debris and diversity of wood-decaying polypores in eastern Finland**. Ecol. Bull., 49: 243-254.

SIPPOLA A.-L., RENVALL P., 1999 - **Wood-decomposing fungi and seed-tree cutting: a 40-year perspective**. Forest Ecol. Manage, 15: 183-201.

# THE SUCCESSION OF SAPROXYLIC INSECTS IN DEAD WOOD: A NEW RESEARCH METHOD

## *SUCCESSIONI DEGLI INSETTI SAPROXILICI NEL LEGNO MORTO: UN NUOVO METODO DI RICERCA*

Daniele Birtele

*MiPAF - National Forest Service. National Centre for the Study and Conservation of Forest Biodiversity of Verona - Bosco della Fontana. Laboratories. Strada Mantova 29, I-46045 Marmirolo (MN), Italy. E-mail entomolabcfs@tin.it*

**Summary:** In forests, dead wood hosts assemblages of insect species the find, in dead wood microhabitats, ideal conditions for their development and that change according to the wood's state of decay. In order to better understand the evolution in time of these saproxylic faunas, a study has been undertaken since March 2002 in the *Querco-Carpinetum* forest of Bosco della Fontana (Province of Mantova), which is situated in the heart of the Padana Plain (northern Italy). This study is based on wooden boxes filled with *Quercus robur* L. shavings. Twelve of these boxes have been positioned in groups of three at four separate sites inside the forest, all near *Q. robur* trees in damp areas. Each year one box is removed from every site and then placed within an emergence trap, which allows collection of all the saproxylic insects that have developed inside the box. The project will last a total of three years. The aims of the study are: a) to provide information on the insect succession that occurs during the early stages of decomposition of dead wood in this forest; b) to establish whether such a method can be applied as an instrument for testing the efficiency of forest management actions aimed at maintaining and enhancing biodiversity in forests, through increasing the quantities of dead wood on the forest floor.

**Key words:** Succession, saproxylic insects, dead wood, *Quercus robur,* Syrphidae.

This study is part of a larger conservation project (LIFE Nature project NAT/IT/99/6245 Bosco della Fontana) aimed at the improvement of the environmental condition of a mature forest through the maximization of patchiness (diversification of habitats) (Cavalli & Mason 2003). Forests, even those with senescent trees, often lack microhabitats appropriate for saproxylic communities (Birtele, unpublished data) that require particular ecological conditions. Such microhabitats of many different types (Speight 1989; Siitonen 2001), are generally characterized by a high stability of the main physical parameters (temperature, humidity, light) and a relatively good availability of space and food resources.

Dead wood hosts various saproxylic insect species that find in dead wood microhabitats conditions ideal for their development. This saproxylic fauna changes according to the wood's state of decay. The removal of old trees and dead wood causes, as a first disastrous consequence, the extinction of species, and successively an impoverishment of the soil's organic substances, so fundamental for the natural evolution of the forest humus (Speight 1989). The importance of saproxylic species has also been acknowledged at a European level (Council of Europe 1988).

Re-establishment of dead wood in forests not only diminishes the probability of extinction of the species that occupy such a specialized ecological niche, but also aids in maintenance of biodiversity necessary for other forest species.

Thorough studies on the ecology of saproxylic species are necessary to define forest management techniques that relate more directly to environmental problems, than to the mere exploitation of wood as a resource. It is in this context that the methodology described here is being developed, to enable the use of "artificial microenvironments" in surveying and understanding the succession of saproxylic faunas in dead wood. A second project, involving artificially producing facsimiles of saproxylic microhabitats, has also been established at Bosco della Fontana, based on cutting out cavities (basal slits) in the trunks of trees (Cavalli & Donini 2002).

**Photo 1** – Rearing boxes.

## STUDY AREA

The study is being carried out in the 239 ha Nature Reserve of Bosco della Fontana, located in the municipality of Marmirolo, in the Province of Mantova, Italy. It is one of the last *Querco-Carpinetum* forests still existing in the Padana Plain, and is the subject of various publications which can be consulted for further information (cfr. Cavalli & Mason 2002; Mason *et al*. 2002).

## MATERIAL AND METHODS

In March 2002 a study on the suc-

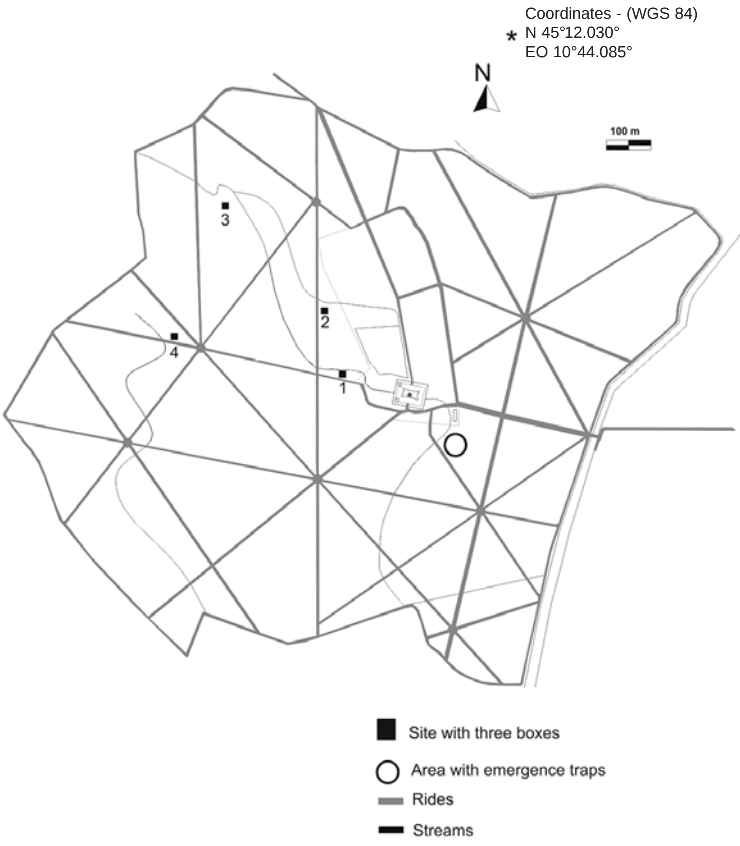


**Figure 1** - Location of the rearing boxes and the emergence traps at Bosco della Fontana.

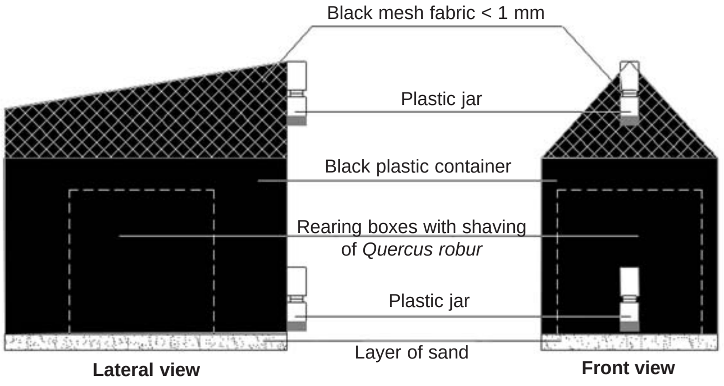


**Figure 2** - Emergence trap.

cession of saproxylic insects was initiated inside the Reserve, using rearing boxes (Photo 1). These boxes are 50 cm a side and 4 cm thick, built with *Quercus robur* L. timber, and filled with small *Q. robur* shavings from a live tree. They are open at the top and covered with a 1 cm mesh galvanized wire grating, in order to avoid all interference by small mammals, and stop any large insects such as Lucanidae and Cerambycidae (Coleoptera) from entering. This last factor will be taken into consideration during the final analysis of the collected data. The boxes were placed on bricks at a height of 20 cm off the ground, so as to avoid contact with soil arthropods. These rearing devices have been planned in such a way as to reproduce the right conditions for the development of various saproxylic insects.

Twelve boxes have been positioned in groups of three at the four chosen sites, all situated near *Q. robur* trees of from 60 to 90 cm in trunk diameter (Figure 1).

During the three-year study period, one box will be removed every year from each site, and placed for a period of two years inside a modified “emergence trap” (Figure 2) (cf. Sutherland 1996; New 1998). Adult insects emerging from the wood shavings will be caught within the box. In order to avoid vandalism or interferences of any kind, these emergence traps have been installed in an area of the Reserve that is closed to the public.

The “emergence trap” consists of a black plastic container 80 x 60 x 60 cm in size, with a 5 cm layer of sand on the bottom, which allows larvae to pupate. The container is closed with a black 0,1 mm mesh fabric netting, positioned in such a way as to convey the insects into a plastic jar containing 70° alcohol. Another jar is placed at the base of the container in order to catch the arthropods that crawl out of the sand. The jars are emptied every fortnight, and the collected insects then sorted to family level in the laboratory, preserved in test-tubes filled with 70° alcohol, and subsequently sent to specialist taxonomists for their identification.

## PRELIMINARY RESULTS AND CONCLUSIONS

This new method for studying saproxylic fauna exhibits some advantages: firstly it does not involve any direct collecting by an entomologist, which can often cause damage to microhabitats, and secondly it allows a standardised approach, providing information on the succession of saproxylic communities and on the synecology of the species. It is inevitably time consuming, given the characteristically slow development of saproxylic organisms. Three years would usually be a normal period of time to carry out such a study, even when only the passive rearing of xylophagous insects is involved (cf. Zàngheri 1951; Marozzini & Gobbi 1974; Cooter 1991).

Creating an artificial dead wood microhabitat may seem risky. However, even though the emergence traps have as yet been in place for less than one year they have collected a range of species, demonstrating that the rearing boxes work. The material collected so far, obtained from boxes that were left for one year inside the forest, includes representatives of several taxonomic groups (Box 1).

This is both encouraging and stimulating, especially considering the fact that the biology of many saproxylic species, and their

### Box 1 - Taxonomic groups

**Araneae; Pseudoscorpionida;**
**Isopoda; Diplopoda**
**Coleoptera**
Carabidae, Histeridae, Pselaphidae,
Staphylinidae, Cetoniidae, Cantharidae,
Anobiidae, Nitidulidae, Cucujidae,
Tenebrionidae, Curculionidae, Scolytidae
**Diptera**
Limoniidae, Tipulidae, Psychodidae,
Mycetophilidae, Sciaridae,
Dolichopodidae, Rhagionidae,
Empididae, Syrphidae, Phoridae,
Lonchaeidae, Muscidae, Tachinidae
**Lepidoptera**
Noctuidae
**Hymenoptera**
Tenthredinidae, Cynipidae, Formicidae

inter-relationships, are still poorly known.

A limited amount of the material collected from the emergence traps has so far been identified to species level. The identified specimens belong to the families Syrphidae and Tachinidae (Diptera): *Myathropa florea* (Linné, 1758), *Chalcosyrphus nemorum* (Fabricius, 1805) and *Xylota sylvarum* (Linné, 1758) among Syrphidae; *Compsilura concinnata* (Meigen, 1824) and *Aphantorhaphopsis samarensis* (Villeneuve, 1921) among Tachinidae. These tachinids are both parasitoids of Lepidoptera (cf. Cerretti & Tschorsnig 2002), whereas the syrphids collected are all saproxylics, and one of them, *Xylota sylvarum*, was not previously known from Bosco della Fontana (Birtele *et al.* 2002); it is an Asiatic-European species (Birtele *et al.* 2003), found in Italy from north to south (cf. Belcari *et al.* 1995), whose larvae live in rotting trunks and stumps of mature *Abies*, *Fagus* and *Quercus* forests (Rotheray 1994; Speight 2000). Among the saproxylic Syrphidae recorded from Bosco della Fontana (Birtele *et al.* 2002) there are only six species that would be expected to occur in dead wood on the forest floor, so half of them have already been hatched from the rearing boxes after only the first year of this project.

## References

Belcari A., Daccordi M., Kozànek M., Munari L., Raspi A. & Rivosecchi L., 1995 - **Diptera Platypezoidea, Syrphoidea.** In: Minelli A., Ruffo S. & La Posta S. (eds.), Checklist delle specie della fauna italiana, 70. Calderini, Bologna, 36 pp.

Birtele D., Sommaggio D., Speight M.C.D., Tisato M., 2002 - **Syrphidae**. 115-118. In: Mason F., Cerretti P., Tagliapietra A., Speight M.C.D. & Zapparoli M. (eds.), Invertebrati di una foresta della Pianura Padana, Bosco della Fontana, Primo contributo. Conservazione Habitat Invertebrati 1. Gianluigi Arcari Editore, Mantova.

Birtele D., Sommaggio D., Speight M.C.D., 2003 - **Syrphidae**. 154-163. In: Cerretti P., Tagliapietra A., Tisato M., Vanin S., Mason F. & Zapparoli M. (eds.), Artropodi dell'orizzonte del faggio nell'Appennino Settentrionale, Primo contributo. Conservazione Habitat Invertebrati 2. Gianluigi Arcari Editore, Mantova, 256 pp.

Cavalli R., Donini F., 2003 - **Interventi attuabili per incrementare le quantità di legno morto e marcescente Possible management actions to increase the amount of dead and marcescent wood**. 31-56. In: Cavalli R. & Mason F. (eds.), Tecniche di ripristino del legno morto per la conservazione delle faune saproxiliche. Il progetto LIFE Natura NAT/IT/99/6245 di "Bosco della Fontana" (Mantova, Italia) *Techniques for re-establishment of dead wood for saproxylic fauna conservation. LIFE Nature project NAT/IT/99/6245 "Bosco della Fontana" (Mantova, Italy)*. Rapporti scientifici, *Scientific Reports, 2*. Centro Nazionale per lo Studio e la Conservazione della Biodiversità Forestale di Verona - Bosco della Fontana. Gianluigi Arcari Editore, Mantova.

Cavalli R., Mason F. (eds.), 2003 - **Tecniche di ripristino del legno morto per la conservazione delle faune saproxiliche. Il progetto LIFE Natura NAT/IT/99/6245 di "Bosco della Fontana" (Mantova, Italia).** ***Techniques for re-establishment of dead wood for saproxylic fauna conservation. LIFE Nature project NAT/IT/99/6245 "Bosco della Fontana" (Mantova, Italy)***. **Rapporti scientifici, *Scientific Reports, 2***. Centro Nazionale per lo Studio e la Conservazione della Biodiversità Forestale di Verona - Bosco della Fontana. Gianluigi Arcari Editore, Mantova, 112 pp.

Cerretti P., Tschorsnig H.-P., 2002 - **Tachinidae**. 132-137. In: Mason F., Cerretti P., Tagliapietra A., Speight M.C.D. & Zapparoli M. (eds.), Invertebrati di una foresta della Pianura Padana, Bosco della Fontana, Primo contributo. Conservazione Habitat Invertebrati 1. Gianluigi Arcari Editore, Mantova.

Consiglio d'Europa, 1988 - **Raccomandazione (88) 10**. Del Comitato dei Ministri agli Stati Membri. Per la Conservazione degli organismi saproxilici e dei loro biotopi.

Cooter J. (ed.), 1991 - **A Coleopterist's Handbook (3rd Edition)**. General editor Cribb P.W., Amateur Entomolosist's Society, VIII + 294 pp.

Marozzini F., Gobbi G., 1974 - **L'allevamento degli Insetti xilofagi**. L'Informatore del Giovane Entomologo, 15 (72): 9-12; 15 (73): 13-15.

Mason F., Cerretti P., Tagliapietra A., Speight M.C.D., Zapparoli M. (eds.), 2002 - **Invertebrati di una foresta della Pianura Padana, Bosco della Fontana, Primo contributo.** Conservazione Habitat Invertebrati 1. Gianluigi Arcari Editore, Mantova, 176 pp.

New T.R., 1998 - **Invertebrate Surveys for Conservation**. Oxford University Press, 54-55, 240 pp.

Rotheray G.E., 1994 - **Colour Guide to Hoverfly larvae (Diptera, Syrphidae) in Britain and Europe**. Dipterists Digest, 9 (1993): 156 pp.

Siitonen J., 2001 - **Forest management, coarse woody debris and saproxilic organisms: Fennoscandian boreal forests as an example**. Ecological Bulletins, 49: 11-41.

Speight M.C.D., 1989 - **Les invertébrés saproxyliques et leur protection**. Collection Sauvegarde de la nature, Council of Europe, Strasbourg, 42: 77 pp.

Speight M.C.D., 2000 - **Species accounts of European Syrphidae (Diptera): species of the Atlantic, Continental and Nothern Regions**. 229-230. In: Speight M.C.D., Castella E., Obrdlik P. & Ball S. (eds.), Syrph the Net, the database of European Syrphidae, vol. 20, Syrph the Net publications, Dublin.

Sutherland W.J., 1996 - **Ecological Census Techniques: a Handbook**. Cambridge University Press, 156, 336 pp.

Zàngheri P., 1951 - **Il Naturalista esploratore raccoglitore preparatore imbalsamatore: guida pratica elementare per la raccolta, preparazione, conservazione di tutti gli oggetti di storia naturale**. Hoepli Milano, 503 pp.

## Acknowledgements

I thank M.C.D. Speight, Research Branch National Parks & Wildlife (Dublin) for all his advice, my colleagues from the National Centre for the Study and Conservation of Forest Biodiversity and the State Forestry Board Office of Verona.

# PRIMI DATI SUI CHIROTTERI DELLA RISERVA NATURALE STATALE BOSCO DELLA FONTANA

## *FIRST DATA ON THE BATS OF THE NATURAL RESERVE BOSCO DELLA FONTANA*

Dino Scaravelli(1), Massimo Bertozzi(2)

*(1) Fondazione Chiroptera Italica, Via Veclezio 10a, I-47100 Forlì, Italy. E-mail dinosc@tin.it;*
*(2) ST.E.R.N.A., Via Pedriali 12, I-47100 Forlì, Italy.*

La notevole pressione antropica subita nell'ultimo secolo dalla Pianura Padana ne ha fortemente compromesso le caratteristiche paesaggistico-naturalistiche. L'intensivo sfruttamento agricolo è stato responsabile della forte riduzione di elementi naturali caratteristici dell'area quali i boschi planiziali. Solo poche aree di pianura hanno saputo mantenere fino ad oggi un buon grado di naturalità, fra queste spicca certamente il Bosco della Fontana (Mantova), sia per estensione che per continuità storica. Quest'area boscata di 230 ettari di superficie, che presenta al suo interno un buon numero di radure ed è attraversata da una complessa rete idrica, si dimostra particolarmente vocata quale area di rifugio e foraggiamento per un elevato numero di specie di chirotteri non solo strettamente forestali. Con questa indagine si è inteso reperire le prime informazioni sulle presenze di chirotteri nel Bosco.

### AREA DI STUDIO

Il Bosco della Fontana è situato nel Comune di Marmirolo a nord di Mantova. É il relitto di ben più vaste aree boscate possedute dai Gonzaga, signori di Mantova, già dal XII secolo.

Attualmente la superficie di 230 ettari è tutelata quale "Riserva Naturale Orientata dello Stato" in gestione al Corpo Forestale dello Stato. La quota media è 25 m s.l.m. ed il suolo pianeggiante è di origine alluvionale quaternaria con ghiaia e ciottoli prevalenti anche se con *facies* meridionali umide per la presenza di depositi argillosi. La temperatura media annua è di 13,6 °C e la piovosità raggiunge i 700 mm annui. Caratterizzato da una flora particolarmente ricca (Persico 1990), la vegetazione è riconducibile al *Querco-Carpinetum boreoitalicum* (Agostini 1964; Hofmann 1980), sebbene siano evidenziabili componenti spiccatamente igrofile in alcune aree (Persico 1990). Oltre al bosco propriamente detto sono presenti radure, fabbricati, (Palazzina di caccia gonzaghesca, ex-stalle, ecc.) viali e una rete idrica superficiale complessa, con fonti, rogge e canali, di cui il rio Begotta rappresenta l'asse portante.

### MATERIALI E METODI

Su segnalazione del gruppo di studio sulla biodiversità forestale impegnati nell'attività di ricerca all'interno dell'Area, gli autori hanno compiuto una breve indagine il 22/07/2002 (Tabella 1). Gli unici dati precedentemente conosciuti per l'area sono costituiti da un esemplare di Pipistrello albolimbato (*Pipistrellus kuhli*) trovato morto nei pressi della Palazzina di caccia nel giugno 1984 (cfr. Nadali 2001). Nel luglio si è ispezionata una delle cavità nido per uccelli ricavata all'interno di un platano ad una altezza da terra di circa sei metri (Longo 2003). Sono stati anche controllati gli edifici presenti all'interno del Bosco, le ex-stalle e la Palazzina di caccia, della quale sono stati ispezionati il sottotetto e i sotterranei. Alla sera è stata posizionata una rete (*mist-net*) sul rio Begotta e sono stati effettuati punti di ascolto, in eterodinico, e registrazioni, in divisione di frequenza, con *bat detector* Pettersonn D940 in diversi punti del Bosco.

### RISULTATI

Nella cavità nido artificiale ispezionata sono stati rilevati cinque esemplari di Nottola comune *Nyctalus noctula*, quattro dei quali sono stati catturati. Gli esemplari catturati, una femmina giovane e tre maschi adulti, sono stati misurati e poi inanellati prima di essere rilasciati. I maschi presentavano epididimi particolarmente gonfi, segno del loro già avviato stato di attività riproduttiva. Ciò fa supporre che la specie utilizzi il bosco quale sito di accoppiamento, nel quale cioè i maschi costruiscano il proprio harem di femmine nel tardo periodo estivo.

Il controllo degli edifici presenti ha evidenziato alcune, seppur non particolarmente significative, tracce di presenza di chirotteri. In particolare è parso molto adatto quale *roost* per chirotteri il sottotetto con travi in legno della secentesca Palazzina di caccia, sottoposta, al momento del rilievo, a lavori di restauro.

L'attività di rilievo tramite *mist-net* ha permesso la cattura di due esemplari di Vespertilio di Daubenton (*Myotis daubentoni*) intenti in attività di caccia sul corso del rio Begotta.

Tramite *bat detector* sono state contattati Pipistrello albolimbato (*Pipistrellus kuhli*),

| Specie | N. esemplari | Attività | Metodo rilievo |
|---|---|---|---|
| *Eptesicus serotinus* (Schreber, 1774) | 3-5 | Caccia | Bat detector |
| *Myotis daubentoni* (Leisler in Kuhl, 1819) | 2 | Caccia | Mist-net |
| *Myotis daubentoni* (Leisler in Kuhl, 1819) | 3 | Caccia | Bat detector |
| *Nyctalus noctula* (Schreber, 1774) | 5 | Riposo | Cattura |
| *Pipistrellus kuhli* (Natterer in Kuhl, 1819) | 3-9 | Caccia | Bat detector |
| *Pipistrellus savii* Bonaparte, 1837 | 2-6 | Caccia | Bat detector |

**Tabella 1** - Rilievi del 22/07/2002.

Pipistrello di Savi (*P. savii*), alcuni esemplari sia nell'area della Palazzina di caccia sia in più punti del bosco, Serotino comune (*Eptesicus serotinus*), un esemplare nel bosco, e tre esemplari di Vespertilio di Daubenton in caccia su un corso d'acqua. Il confronto con le attuali conoscenze per la regione (cfr. Prigioni *et al.* 2001) sottolineano come *P. kuhli* e *P. savii* siano specie ubiquitarie e ben distribuite ma come *E. serotinus* e *M. daubentoni* siano specie localizzate e ancora in gran parte sotto rilevate. Si tratta in questo caso delle prime segnalazioni per la provincia di Mantova. Ancora più di rilevo il caso di *N. noctula* che costituisce l'unico dato di *roost* regionale.

Le presenze riscontrate oltre a confermare l'indubbio valore conservazionistico del Bosco della Fontana inducono a sperare che la comunità chirotterologica sia ancora più complessa e a sottolineare la necessità di studi di settore.

## Bibliografia

Agostini R., 1964 - **Il Bosco della Fontana a Mantova: considerazioni geobotaniche e selvocolturali**. L'Italia Forestale e Montana, 20: 123-137.

Hofmanm A., 1980 - **Ecologia degli ambienti golenali e il querceto planiziario "Bosco Fontana"**. Not. Fitosoc., 17: 1-9.

Longo L., 2003 - **Gli alberi habitat: prescrizioni per la realizzazione e il monitoraggio delle cavità di nidificazione** ***Habitats tree: instructions for creating and monitoring nest holes***. 63-68. In: Cavalli R. & Mason F. (eds.), Tecniche di ripristino del legno morto per la conservazione delle faune saproxiliche. Il progetto LIFE Natura NAT/IT/99/6245 di "Bosco della Fontana" (Mantova, Italia) *Techniques for re-establishment of dead wood for saproxylic fauna conservation. LIFE Nature project NAT/IT/99/6245 "Bosco della Fontana" (Mantova, Italy)*. Rapporti scientifici, 2-2003. Centro Nazionale per lo Studio e la Conservazione della Biodiversità Forestale di Verona - Bosco della Fontana. Gianluigi Arcari Editore, Mantova.

Nadali A., 2001 - **Mammiferi**. 75-88. In: Longo L. & Nadali A. (eds.), Vertebrati di un bosco planiziario padano. Quaderni Conservazione Habitat, 1. Corpo Forestale dello Stato, Centro Nazionale per lo Studio e la Conservazione della Biodiversità di Bosco della Fontana. Gianluca Arcani Editore.

Persico G., 1990 - **La flora della Riserva Naturale Orientata dello Stato di Bosco della Fontana**. Quaderni naturalistici di Bosco della Fontana, Botanica 1, M.A.F., Verona.

Prigioni C., Cantini M., Zilio A. (eds.), 2001 - **Atlante dei mammiferi della Lombardia**. Regione Lombardia e Univ. di Pavia. 324 pp.

## Ringraziamenti

Un sentito ringraziamento a Franco Mason e a Luca Longo per il sostegno morale e materiale.

# *GASTEROCERCUS DEPRESSIROSTRIS* IN RELICT WOODS IN NORTH-EASTERN ITALY: NEW RECORDS OF A RARE "PRIMARY FOREST" SPECIES (COLEOPTERA, CURCULIONIDAE)

## GASTEROCERCUS DEPRESSIROSTRIS *IN FORESTE RELITTE DELL'ITALIA NORD-ORIENTALE: NUOVE SEGNALAZIONI DI UNA SPECIE RARA DELLE "FORESTE PRIMARIE" (COLEOPTERA, CURCULIONIDAE)*

Iris Bernardinelli, Fabio Stergulc, Filippo Michele Buian, Pietro Zandigiacomo

*Dipartimento di Biologia Applicata alla Difesa delle Piante - Università degli Studi di Udine, Via delle Scienze 208, I-33100 Udine, Italy.*
*E-mail iris.bernardinelli@uniud.it*

In the summer 2001, *Gasterocercus depressiostris* (Fabricius, 1792) was found in Palude Moretto, a wetland in the municipality of Castions di Strada (Udine, Friuli-Venezia Giulia; north-eastern Italy). In 2002 and 2003 further investigations to assess the occcurrence of *G. depressirostris* were carried out in the main lowland ancient woods of north-eastern Italy.

*G. depressirostris* (Photo 1) is the only European species of the genus *Gasterocercus* Laporte & Brullé, 1828 (Hoffmann 1958) and it belongs to the subfamily Cryptorhynchinae, that includes many species which live on dead wood or in dying trees.

### Habitat and distribution

*G. depressirostris* lives in trunks and large branches of dying *Quercus robur* L. or *Fagus sylvatica* L. (Hoffmann 1958).

The species is known to live in "primary forests" (*Querco-Carpinetum*) (Hoffmann 1958), which are found scattered over Europe, including Italy.

The weevil is distributed in some areas of France, Germany, Romania (Hoffmann 1958), Ukraina (Kudela 1974), Moravia, Slovakia (Strejcek 1993), Hungary (Csoka & Kovaks 1999) and Austria (Franz 1994).

This insect was first found in Italy in 1993 (Basilicata - southern Italy). Up to then it was not known to be part of the Italian fauna (Caldara & Angelini 1997).

### Life history

*G. depressirostris* overwinter as larvae in tree trunk and pupate in May-June (Hoffmann 1958; Kudela 1974).

In France adults emerge from June to September (Hoffmann 1958) and they have dusky habits (Hofmann 1958; Caldara & Angelini 1997). During the day they can hardly be seen on oak trunks because of their camouflaged tegument (Photo 2). Their emergence holes are 3-4 mm large (Photo 2) and are grouped in lines 3-10 cm apart.

### Our findings

We found this species mostly in lowland forests with an area of more than 100 hectars in Friuli-Venezia Giulia (Table 1 and Figure 1). In woods of this type the old dying oaks are never completely cleared out, so some dead or dying trees are always available and *G. depressirostris* can

**Photo 1** - Adult of *Gasterocercus depressirostris*.

**Figure 1** - Map of the occurrence of *Gasterocercus depressirostris* in north-eastern Italy.

| Number on the map | Woodland name | Locality (province) | Area (ha) | Management | Gasterocercus findings |
|---|---|---|---|---|---|
| 1 | Bosco Pradiziolo | Cervignano del Friuli (UD) | 20 | high forest | - |
| 2 | Bosco Ronchi di Sass | S. Giorgio di Nogaro (UD) | 21 | coppice with standards | - |
| 3 | Bosco Boscat | Castions di Strada (UD) | 52 | coppice with standards + high forest | - |
| 4 | Palude Moretto | Castions di Strada (UD) | - | wetland + coppice with standards | + |
| 5 | Bosco dei Larghi | Carlino (UD) | 29 | coppice with standards | + |
| 6 | Bosco Sacile | Carlino (UD) | 141 | coppice with standards + high forest | + |
| 7 | Bosco Sgobitta | Porpetto (UD) | 10 | high forest | - |
| 8 | Bosco Coda di Manin | Muzzana del Turgnano (UD) | 150 | coppice with standards | + |
| 9 | Selva di Arvonchi | Muzzana del Turgnano (UD) | 163 | coppice with standards + high forest | + |
| 10 | Bosco Torrate | S. Vito al Tagliamento (PN) | 9 | high forest | - |
| 11 | Bosco Marzinis | Fiume Veneto (PN) | 8 | high forest | - |
| 12 | Bosco Olmè | Cessalto (TV) | 27 | coppice with standards + high forest | - |
| 13 | Bosco Cavalier | Gorgo al Monticano (TV) | 11 | high forest | - |

**Table 1** - Wood management and occurrence of *Gasterocercus depressirostris* in north-eastern Italy ( + = presence; - = absence).

survive in this habitat.

## IMPORTANCE AND ECOLOGICAL VALUE

*G. depressirostris* is rare because its habitat is being destroyed in Europe. Actually in some countries (Austria and Germany) it is included in the Red list (Binot *et al.* 1998; Franz 1994).

The occurrence of *G. depressirostris* in some forests of the Friulian plain highlights the fact that its habitat needs to be protected, and forest practices updated to conserve dead wood more effective.

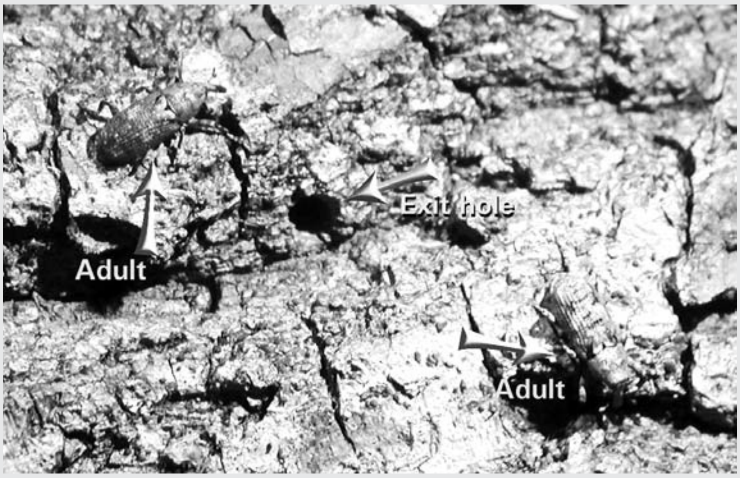


**Photo 2** - Tegument camouflage of *Gasterocercus depressirostris* adults and exit hole.

## References

Binot M., Bless R., Gruttke H., Pretscher P., 1998 - **Rote Liste gefährdeter Tiere Deutschlands**. Schriftenreihe für Landschaftspflege und Naturschutz, Heft 55, 434 pp.

Caldara R., Angelini F., 1997 - **Su alcuni Curculionidea nuovi per l'Italia e per varie regioni italiane**. Boll. Soc. entom. ital. 129(3), 241-249.

Csoka G., Kovaks T., 1999 - **Xylophagus insects**. Forest Research Institute AGROINFORM Budapest, 190 pp.

Franz H., 1994 - **Curculionidae, Russelkäfer**. 185; 188-199. In: Jäch M.A. (red.), Rote Liste der gefährdeter Käfer Österreichs (Coleoptera). In: Gepp J. (ed.), Rote Listen gefährdeter Tiere Österreichs, Band 2. Bundesministerium für Unwelt, Junged und Familie, Graz.

Hoffmann A., 1958 - **Faune de France 62. Coléptères Curculionides** (Troisième partie). Librairie de la Faculté des Sciences, Paris: 1208-1839.

Kudela M., 1974 - **Gatt.-Gruppe Cryptorrhynchini**, 298. In: Schwenke W., (ed.), Die Forsschadlinge Europas. Bd. 2, P. Parey Verl., Hamburg u. Berlin.

Strejcek J., 1993 - **Curculionidae**. 135-152. In: Jelínek J. (ed.), Checklist of Czechoslovak Insect IV (Coleoptera) Seznam ceskolovenskych brouku. Folia Heyrovskyana Suppl. 1.

# CONTENUTO DI LIGNINA E CELLULOSA DI QUERCIA ROSSA E FARNIA A DIVERSI STADI DI MARCESCENZA

## *THE CONTENT OF LIGNIN AND CELLULOSE IN RED OAK AND PEDUNCULATE OAK DURING DIFFERENT STAGES OF DECOMPOSITION*

Pierandrea Conigliaro, Carla Fabro, Stefano Filacorda

*Dipartimento di Scienze della Produzione Animale - Università degli Studi di Udine. E-mail stefano.filacorda@dspa.uniud.it*

Nell'ambito del progetto Life "Azioni integrate a salvaguardia di due Siti Natura 2000 del Tarvisiano" (NAT/IT/005112) sono state sviluppate diverse attività di networking, alcune delle quali sono state svolte in collaborazione con il Corpo Forestale dello Stato della Riserva Naturale "Bosco della Fontana" (Mantova). In questa Riserva è in atto il progetto Life Natura "Azioni urgenti conservazione habitat relitto" (NAT/IT/006245) che si occupa dello studio della fauna che vive sul legno morto (saproxilica e saproxilobia) (Cavalli e Mason 2003). Le analisi relative alla degradazione chimico-fisica del legno morto sono state effettuate nei laboratori del Dipartimento di Scienze della Produzione Animale (Università degli Studi di Udine). Le analisi hanno lo scopo di verificare la possibile relazione tra la degradazione visiva del legno morto e quella delle sue componenti. Nel nostro caso le componenti esaminate sono state la lignina e la cellulosa. L'obiettivo è quindi quello di determinare se al deterioramento visivo della componente vegetale, corrisponde un'alterazione del contenuto di lignina e di cellulosa delle piante. La classificazione visiva del tasso di decadimento del legno morto viene espressa con una numerazione progressiva chiamata RDW (Rate of Decay of Dead Wood), che parte da tronchi appena tagliati con legno duro (RDW=1), fino a residui di corteccia di alberi morti (RDW=9). A questo codice ne viene abbinato un altro chiamato DWP (Dead Wood Position) che, con una numerazione progressiva da 3 a 9, indica la posizione fisica in cui si trova la pianta sottoposta a prelievo.

### PRELIEVI

I prelievi sono stati effettuati nel luglio 2001 presso la Riserva Naturale "Bosco della Fontana" situata nel comune di Marmirolo (Mantova). Le specie di piante prese in considerazione sono due: Farnia (*Quercus robur* L.) e Quercia rossa (*Quercus rubra* L.). Ogni prelievo è stato effettuato due volte sulla stessa pianta, e in totale i campioni prelevati sono state 265.

### ANALISI STATISTICA

Il contenuto in termini di lignina e cellulosa espresso come percentuale di sostanza secca è stato sottoposto ad analisi della varianza (proc Glm, lsmeans/pdiff) (SAS 1988) al fine di valutare l'effetto dello stadio di marcescenza (piante vive e con RDW da 1 a 3) della specie e dell'interazione tra specie e stadio, nel caso di piante vive e con DWP=8. Sugli stessi dati è stata effettuata un'analisi di correlazione (proc Corr) (SAS 1988) tra RDW (piante vive definite arbitrariamente come stadio 0) e contenuto di lignina e di cellulosa. Sullo stadio RDW =1 della quercia rossa è stato studiato l'effetto del tipo di intervento (cercinatura, snag, sradicatumento, volis e taglio) (Cavalli e Mason 2003) sul contenuto di lignina e cellulosa (proc Glm, lsmeans/pdiff) (SAS 1988).

### METODI E STRUMENTI

#### Prelievo

Per la raccolta dei campioni è stato usato un "succhiello" forestale, un attrezzo manuale che permette di compiere un carotaggio sul fusto della pianta. Al fine di rendere maggiormente omogenea l'analisi, la profondità del prelievo è stata di circa 10 cm. Dopo l'estrazione dalla pianta il campione è stato conservato in appositi sacchetti di plastica numerati, e posto in congelatore.

#### Analisi di laboratorio

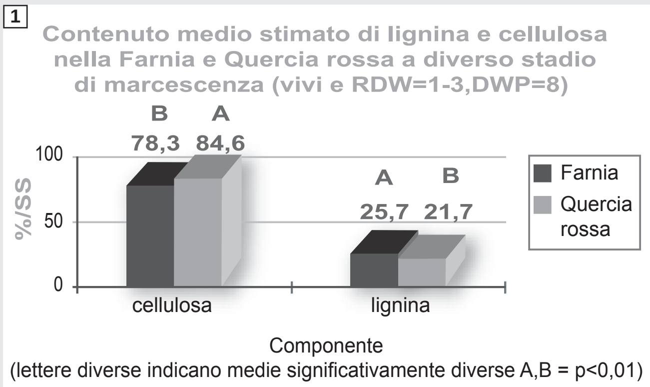
Per effettuare le analisi di laboratorio(1) i passaggi sono stati i seguenti:

1 - ritiro del sacchetto (contenente ciascuno due prelievi) corrispettivo ad ogni classe di RDW;
2 - collocazione dei campioni all'interno di vaschette di alluminio precedentemente pesate, corrispondenti ad ogni pianta;
3 - pesatura dei campioni nelle vaschette con una bilancia elettronica;
4 - collocazione delle vaschette in una stufa ad aria per due notti a 60°C;
5 - ulteriore pesatura, dopo un appropriato raffreddamento, per ricavare il peso secco;
6 - macinatura dei campioni secchi per ottenere un prodotto ridotto in polvere, maggiormente attaccabile dai successivi trattamenti chimici;
7 - prelievo da ogni vaschetta di 0,50 g di prodotto e loro collocazione in sacchettini filtranti ANCOM di cellulosa (precedentemente pesati), ideali per questo tipo di analisi;
8 - termosaldatura dei sacchettini di cellulosa;
9 - preparazione di una soluzione per l'analisi della fibra acido detersa (ADF);
10 - immersione dei sacchettini nella soluzione, all'interno di un apposita apparecchiatura per 60 minuti;
11 - tre risciacqui in acqua bollente dei sacchettini; successivo lavaggio con acetone per compiere un'adeguata disidratazione;
12 - collocazione dei sacchettini in una stufa per 12 ore a 105°C;
13 - raffreddamento dei sacchettini in essiccatore e pesata su bilancia elettronica per la determinazione dell'ADF;
14 - immersione per tre ore dei sacchettini in un recipiente contenente acido solforico 72% per determinare il contenuto della sola lignina (ADL);
15 - collocazione dei sacchettini risciacquati e tamponati in stufa per 12 ore;
16 - raffreddamento in essiccatore e pesata

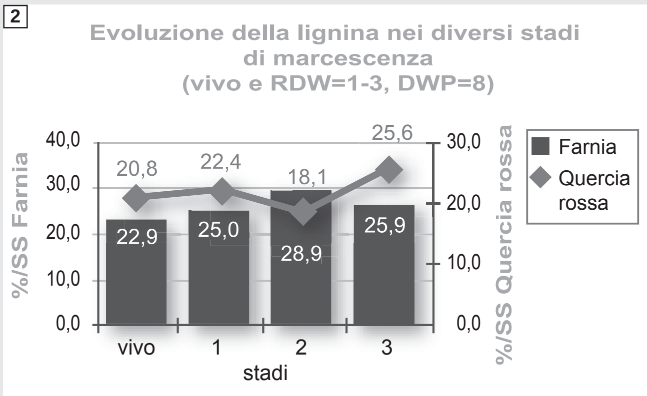
---

**(1)** Per le metodologie e la bibliografia relativa si fa riferimento al: Progetto MURST Cofin '98: "Ottimizzazione delle razioni per ruminanti: risposte produttive e ricadute ambientali". Istituto di zootecnica - Facoltà di Agraria, U.C.S.C. – Piacenza. Coordinatore: Prof. Giuseppe Bretoni.

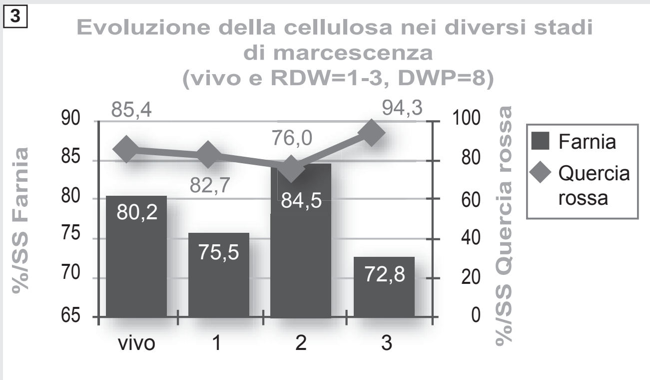
1



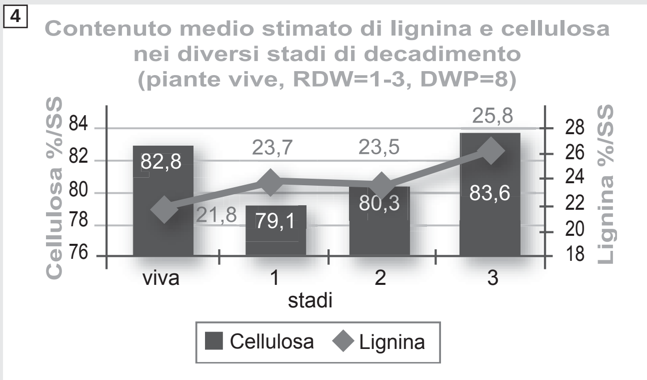
2



3



4



I prelievi dello stadio 4 di RDW non consentono stime attendibili del contenuto di cellulosa e lignina. L'effetto delle specie appare (Figura 1) statisticamente significativo sia per la cellulosa (p=0,0058) che per la lignina (p=0,0085) al contrario dello stadio di marcescenza che non sembra influenzare il contenuto di queste due componenti se non interagendo con la specie, Figura 2 e 3 (cellulosa, p=0,002; lignina p=0,069). Valutando i parametri di stima del modello lineare ed il Figura 4 si può osservare una crescita media del valore di lignina dalle piante vive allo stadio 3. La matrice di correlazione non evidenzia alcuna relazione significativa tra RDW, lignina e cellulosa. Nel caso dello stadio RDW=1 della quercia rossa non vi sono effetti significativi del tipo di intervento.

su bilancia elettronica, quindi determinazione dell'ADL;

17 - collocazione dei sacchettini ripiegati all'interno di crogioli di ceramica (precedentemente pesati), in una muffola a 500°C per provvedere all'incenerimento e quindi alla determinazione del contenuto in ceneri;

18 - estrazione dei crogioli dalla muffola; loro pesatura, dopo il raffreddamento, con una bilancia elettronica; calcolo del contenuto in ceneri per sottrazione della tara.

## CARATTERI QUALITATIVI DEL LEGNO MORTO (DWP+RDW)

### Posizione del legno morto (*Dead Wood Position, DWP*)

Per gli alberi morti la posizione della pianta è espressa secondo i codici seguenti:

- *snags*: monconi di tronco morto spezzati ancora in piedi che danno origine ai volis (3)
- *saw logs*: tronchi e pezzi di tronco segati dall'uomo (4)
- *volis*: tronchi e grosse branche spezzate a terra originate dagli snags (5)
- *bending trees*: alberi pendenti morti (spezzati o sradicati ma non ancora al suolo) (6)
- *standing trees*: alberi morti o ceppi diritti in piedi (7)
- *fallen trees*: alberi morti giacenti sul suolo forestale (8)
- *stumps*: ceppaie di alberi tagliati dall'uomo (9).

### Tasso di decadimento del legno morto (*Rate of Decay of Dead Wood*)

I numeri di codice che esprimono il tasso di decadimento del legno morto sono i seguenti:

- ceppaie tagliate di fresco, tronchi o branche, legno duro, corteccia intatta, tronco rotondo in sezione trasversale (1)
- il legno può essere schiacciato superficialmente (al di sopra di 1 cm), corteccia staccata e in parte caduta, fusto rotondo in sezione trasversale (2)
- legno morbido, la maggior parte del fusto può essere schiacciata per diversi centimetri, corteccia caduta , fusto rotondo in sezione trasversale (3)
- legno soffice completamente decomposto, fusto ovale in sezione trasversale, fusto con grandi aperture, il legno perde la sua consistenza e si disintegra quando viene toccato (4)
- i residui della pianta possono esser riconosciuti nello strato di lettiera o sono evidenziati dalla diversa vegetazione (5)
- cortecce di alberi morti naturalmente o di alberi sradicati che sono stati rimossi successivamente dall'uomo (9)
- alberi o tronchi che sono scomparsi prima dell'osservazione (0). La causa della loro scomparsa può essere la decomposizione da funghi, il trasporto (in foreste sommerse) o l'utilizzazione dell'uomo.

## Bibliografia

CAVALLI R., MASON F. (eds.), 2003 - **Tecniche di ripristino del legno morto per la conservazione delle faune saproxiliche. Il progetto LIFE Natura NAT/IT/99/6245 di "Bosco della Fontana" (Mantova, Italia)** ***Techniques for re-establishment of dead wood for saproxylic fauna conservation. LIFE Nature project NAT/IT/99/6245 "Bosco della Fontana" (Mantova, Italy)***. Rapporti scientifici, 2-2003. Centro Nazionale per lo Studio e la Conservazione della Biodiversità Forestale di Verona - Bosco della Fontana. Gianluigi Arcari Editore, Mantova, 112 pp.

S.A.S., 1988 - **User's Guide, S.A.S**. Institute, Cary, NY (USA).

## Ringraziamenti

La ricerca è stata effettuata nell'ambito dei Progetti Comunitari Life "Azioni integrate a salvaguardia di due Siti Natura 2000 del Tarvisiano" - (B4 - 3200/98/487) e "Azioni urgenti conservazione habitat relitto" (NAT/IT/006245) con i loro qualificati personali.

Bosco della Fontana 30th May 2003
Marmirolo, Mantova (Italy)

ISBN 88-901223-0-7