COMPARING SIZE OF *OSMODERMA EREMITA* POPULATIONS AND HABITAT QUALITY IN DIFFERENT FRENCH LOCALITIES: CONSERVATION PERSPECTIVES

Vincent VIGNON[1]

RÉSUMÉ. — *Comparaison de la taille de populations et de la qualité de l'habitat d'Osmodera eremita dans diverses localités françaises: perspectives de conservation.* — Osmodera eremita est un coléoptère associé aux cavités dans les vieux arbres. Ses populations se rencontrent dans des habitats forestiers et des habitats de substitution comme les réseaux de haies et les vergers. Ces habitats de substitution recouvraient environ 10% du territoire français, notamment avant la fragmentation des réseaux de haies et des vergers causée par la modernisation de l'agriculture dans les 50 dernières années. Actuellement les habitats forestiers d'O. eremita, plus proches des habitats naturels, ne représentent que de très petites zones éloignées les unes des autres. Les distances entre ces sites sont bien supérieures à la capacité de dispersion de l'espèce. Ainsi, les métapopulations qui vivent dans ces zones sont isolées. La conservation de l'espèce apparaît mieux assurée dans les habitats forestiers relictuels tandis que le taux de disparition des vieux arbres avec cavités dans les haies des zones agricoles et les vergers s'accélère, ce qui réduit très vite le potentiel de conservation de métapopulations viables d'O. eremita.
Mots Clés: *Osmoderma eremita*, habitats, conservation

SUMMARY. — *Osmoderma eremita* is a beetle associated with old trees with cavities. Its populations are met in forest habitats and habitats of substitution like hedgerow networks and orchards. These habitats of substitution covered about 10% of the French territory, particularly prior the fragmentation of hedge networks and orchards caused by the modernization of agriculture in the past 50 years. Nowadays, forest habitats of *O. eremita*, which are closer to natural habitats, represent very small areas distant from each other. Distances between these sites are much higher than the species'dispersion capacity. Thus, metapopulations that live in these areas are isolated. The conservation of the species appears to be best guaranteed in relictual forest habitats, whereas the disappearance rate of old trees with cavities accelerates in hedged farmlands and orchards, which reduces very quickly the conservation potential of viable metapopulations of *O. eremita*.
Key Words: *Osmoderma eremita*, habitats, conservation

The Hermit beetle *Osmoderma eremita* (Coleoptera: Cetoniidae) is a specialist species of deciduous trees cavities with wood mould (Ranius *et al.*, 2005). It is an "umbrella species", being always accompanied by a diversified succession of species most of which are rare (Ranius, 2000). This beetle strongly regressed with the fragmentation of its habitats (Ranius *et al.*, 2005). In Western Europe, particularly in France, main habitats of *O. eremita* are found in the traditional rural landscapes structured by old trees (Vignon, 2005, 2006).

Populations of *O. eremita* occur in two very different contexts: traditional agrarian landscapes and forests.

---

[1] Office de Génie Ecologique (O.G.E.), 5, boulevard de Créteil. F-94100 Saint-Maur-des-Fossés. E-mail: v.vignon@oge.fr

The present paper compares habitat quality and metapopulations of *O. eremita* identified in these various landscapes studied in France. The main aim is to identify perspectives for population conservation in these different types of habitats.

AGROSYSTEMS: LARGE HABITATS OF SUBSTITUTION

In Western Europe, in the traditional agrosystems, trees were intended to produce fodder, fruits, or to establish limits between the agricultural properties.

Cavity development was accelerated by tree treatments: cutting of pollard trees, grafts and fruit trees. Successive cuts generate microhabitats of decaying wood and cavities at cut level. *O. eremita* generally colonizes the cavities of 70 to 120 years old pollard oaks (Vignon & Orabi, 2003), or at least 50 years old pollard willows (Vignon & Doaré, *pers. obs.*). Unpollarded oaks develop a favourable cavity for the Hermit beetle between 150 and 400 years of age (Ranius *et al.*, 2005). Thus cavities develop two to four times more quickly in pollarded than in unpollarded trees.

A second favourable factor is related to tree exposure to sun especially in hedgerow networks (Vignon, 2005). Trees with cavities are generally in hedges, or are disseminated in the field. Warm conditions are favourable to some saproxylic species (Lindhe *et al*., 2005).

A third factor is dependent on the continuity level, in both space and time, of networks with senescent trees and trees with cavities. Hedgerow networks and orchards are the landscape elements where trees with microhabitats of decaying wood and cavities are close to each other, frequently less than 20 m of distance.

In hedgerow networks densities of trees with cavities can reach values close to those of the sub-natural forests. For instance, a hedgerow network landscape and orchards in the Orne department have a density of 10 trees with cavities per hectare (Vignon *et al.*, 2005). This value is close to the densities of hollow trees in sub-natural forests (Vallauri *et al*., 2002).

This point is fundamental because some rare species associated with these habitats have a limited dispersion capacity. A weak capacity to disperse represents a threat for a species when its habitat is being fragmented. This question was particularly well studied in the Hermit beetle (Hedin, 2003; Hedin *et al.*, in press; Ranius, 2000; Ranius *et al.*, 2005). This species has a flight capacity of almost 200 meters, and only 15% of the individuals try to disperse, whereas the others reproduce in their birth cavity (Ranius, 2000).

METHODS OF SURVEY

Two survey methods were used. Figure 1 indicates the localization of the inventoried sites. Deciduous tree species likely to present cavities were located with the GPS, when surveying habitats in Les Bourines (site 6) in the Aveyron department (Brustel & Brin, 2003), Saint-Pée-sur-Nivelle (site 7) in the French Basque region (O.G.E., 2005c), and during the A28 motorway project in the Sarthe department (sites 5) (Oréade-Brèche & O.G.E., 2002a,b) and the Orne department (Site 1 (O.G.E., 2005a) and 2 (O.G.E., 2005b,c)). These trees were pollards and taken into account starting from a diameter of 20 cm (measured at 1.3 m from the ground). Large unpollarded trees develop cavities two to four times more slowly. We took them into account by fixing a minimum diameter threshold of 50 cm. Apple or pear trees (*Malus domestica*, *Pyrus* sp.) in orchards, which frequently develop cavities, were located. We systematically examined accessible cavities to check for the presence of *O. eremita.*

In the largest sites (more than one thousand hectares) of hedgerow networks of the Sarthe department (Sillé-le-Guillaume and Perseigne) (sites 3 and 4), we carried out a photographic atlas of the territory (O.G.E., 2005a,b). Using a plane, photos were taken at 150 - 300 m of altitude (in oblique), and along East-West directed lines, separated by 600 m. 1300 photos were taken through 20.000 ha of the territory. Then, we examined each photo and reported all pollard trees and orchards of apple trees on a Geographical Information System (GIS). We also evaluated in the field the reliability of the reported trees and checked the presence of *O. eremita*.

In the Sarthe department, we carried out a census of pollard trees in a radius of 300 m (calculations on GIS) around each large hedgerow network sites inventoried. In the hedgerow network of Gacé or that of Sée at Nonant-le-Pin, we made the same census around the trees with cavities, as surveyed with the GPS on the field (Vignon *et al*., 2007).

In the inventoried area between Mayet and Vaas (Sarthe department), we carried out a systematic search of *O. eremita* around three sites (O.G.E., 2007). These areas correspond to the surveyed sites within the framework of the mitigation measures of the A28 motorway assessment study (OGE, 2001). Each tree was controlled by looking for highest cavities (around 15 m height) to seek presence indices of the species. During 3 years (from 2004 to 2006), adults of *O. eremita* were captured using live traps checked every day (O.G.E., 2007).

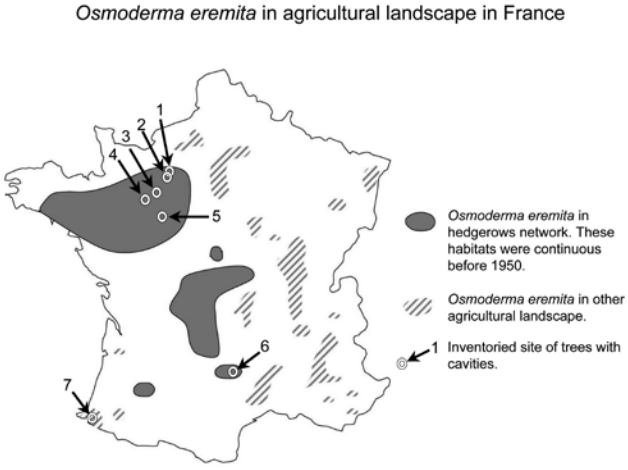

Figure 1: *Osmoderma eremita* in France agricultural landscapes

DIFFERENCES BETWEEN SOME HABITATS INVENTORIED IN FRANCE

Table I below presents data recorded in two groups:
— landscapes of hedgerow networks or orchards inventoried on large surfaces;
— groups of trees, each one constituting a core habitat.

TABLE I

Presence of Osmodera eremita in different French localities

N°	Site	Size of inventoried area (ha)	Number of trees	Number of trees with cavities	Density of trees/ha	Density of trees with cavities/ha	Percentage of trees harbouring *O. eremita*
	Landscape with pollarded trees in hedgerows network or trees of orchards						
1	Hedges network of Gacé (61) (O.G.E., 2003a)	2126	17881	10290	8.4	4.8	1%
2	Hedges network from Sée to Nonant-le-Pin (61) (O.G.E., 2003b and c)	2890	11158	5460	3.9	1.9	1%
3	Hedges network of Perseigne (72) (O.G.E., 2005b)	5815	16000		2.8		2%
4	Hedges network of Sillé-le Guillaume (72) (O.G.E., 2005a)	13440	64000		4.8		1%
5	Hedges network and chestnuts orchards from Mayet to Vaas (72) (Oréade-Brèche - O.G.E., 2002a and b)	8500	17577	9100	2.1	1.1	
	Landscape with dense habitat of trees with cavities						
6	Pollarded tress of Les Bourines (12) (Brustel and Brin, 2003)	112	129		1.2		about 20 %
7	Polladed trees of Saint-Pée (64) (O.G.E., 2005c)	29	402		13.9		about 75 %

RESULTS AND DISCUSSION

The five landscapes of more than 2000 ha in which trees were inventoried, have densities varying from 2 to 8 trees/ha. These trees constitute the potential habitat of *O. eremita*. These are pollard trees, orchards of apple trees and grafted chestnuts (*Castanea sativa*), also planted as orchards.

Inside these areas, density of trees with cavities is variable. Thus, core habitats are present in different places inside hedgerow networks.

In the hedgerow networks of Sillé-le-Guillaume and Perseigne (Sarthe department), we evaluated the occupancy rate of the species in pollard trees. These rates are low: about 1 to 2% of the trees with presence indices of *O. eremita*. In dense core habitats, we counted the number of trees present around each tree, in a radius of 300 m. Thus, each tree with cavity is potentially surrounded by one or two populations of *O. eremita* (O.G.E., 2005a,b). This appears weak to ensure the viability of the Hermit beetle populations in this kind of landscape.

In the hedgerow networks inventoried with GPS, between Sée and Gacé (Orne department), the occupancy rate of *O. eremita* is also low: about 1% of pollard trees (Vignon *et al.*, 2005).

In the hedgerow networks of Gacé, we recorded a high level of heterogeneity in the population distribution pattern of *O. eremita*. Populations are present either in hedges of pollard oaks, or in orchards of apple trees (Vignon *et al.*, 2005). Dubois (2006) confirmed an aggregative spatial organization of the populations.

Inventories of trees with cavities do not sufficiently document the wood mould volume present in the cavities. Local populations can remain in small volumes of only about 10 l, but populations are more robust as soon as this volume exceeds 20 l (Vignon *et al.*, 2005). A hedgerow network constitutes a landscape characterized in particular by the continuity of the hedges. In fact, some hedges do not include, or not sufficiently enough, vast cavities to receive *O. eremita*. This is a pattern of fragmentation of *O. eremita* habitat within the hedges.

One of the problems in the analysis of the network of trees with cavities in hedgerow areas consists in delimiting contours of the core habitats favourable to *O. eremita*. For this purpose, it is necessary to find the maximum distance between the trees with cavities being able to be covered by *O. eremita* (Ranius, 2000). We fixed this distance at 300 m according to a dispersion of about some hundreds of meters. Analysis of the metapopulations viability of *O. eremita* should be carried out in these limits. Occupancy rate of the trees constitutes one of the indicators of this viability.

In Mayet (Sarthe department), the traditional agricultural landscape is characterized by orchards of grafted chestnuts. These orchards were intensively managed in the middle of the 19th century (Blandin *et al.*, 1999). Nowadays, more than half of these trees have disappeared. Grafting accelerated the development of cavities. The majority of the large chestnuts have important volumes of wood mould favourable to *O. eremita*, often more than 50 l. In the remaining core habitats, we can find up to 250 chestnuts with cavities.

In spite of the abundance of these habitats, the occupancy rates of trees are relatively low, 10% at the most. We observed occupancy rates still lower (< 4%), in some orchards which include, however, more than 50 large grafted chestnut trees.

Population inventories carried out in three sites (O.G.E., 2007), allowed us to discover a site with a metapopulation of *O. eremita* (site of "Montabon", Fig. 2) and two sites with some isolated populations (site of "Taille-Pied", Fig. 3, and site of "Les Blottes", Fig. 4). In these two last sites, trees with indices of presence of *O. eremita* are distant of more than 300 m, even though large trees with cavities are present between the trees harbouring *O. eremita*. Even if this specie can possibly disperse at distances higher than 300 m, its current scarcity seems to be a consequence of a regression of its populations.

Most of these abandoned orchards are overgrown with a chestnut coppice which reaches the top of the old trees with cavities. Thus, conditions are less favourable to *O. eremita*, in particular when the shade generates colder conditions. Furthermore, some orchards are currently surrounded by chestnut coppices**,** which were exploited as firewood until the 1970s. During the

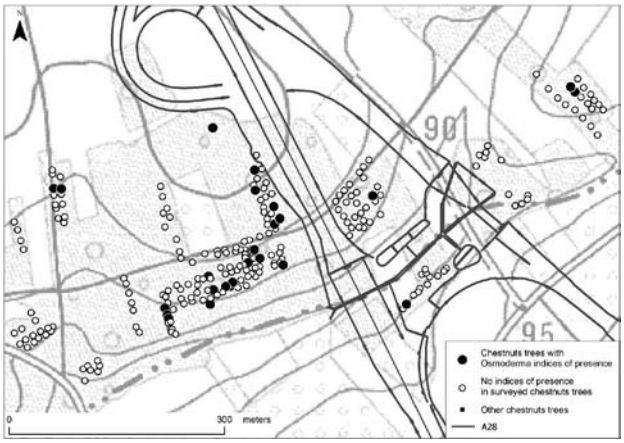

Figure 2: Presence of *Osmoderma eremita* indices in the site of "Montabon"

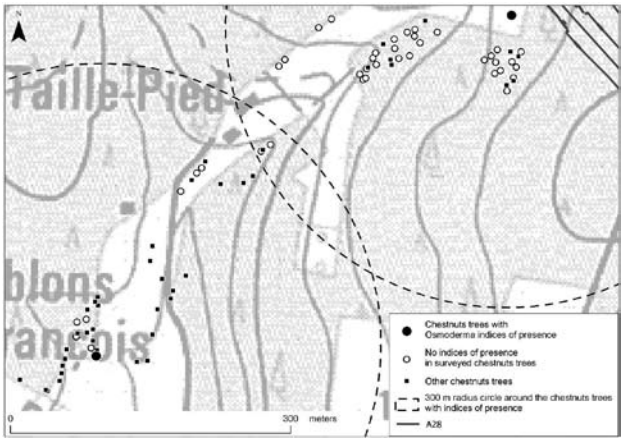

Figure 3: Presence of *Osmoderma eremita* indices in the site of "Taille-Pied"

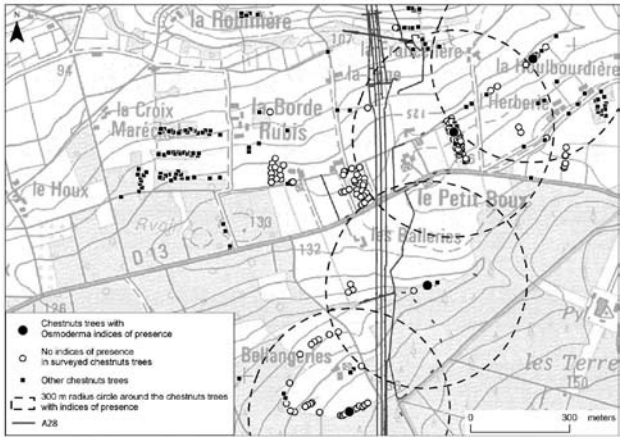

Figure 4: Presence of Osmoderma eremita indices in the site of "Les Blottes"

monitoring of an adult Hermit beetle by radio-tracking, we noticed that this landscape structure constituted a very strong constraint regarding the flight capacity of the insect (Dubois & Vignon, 2008).

In dense habitats of pollard oaks in grasslands in the Aveyron department (Brustel & Brin, 2003) and dense habitat of pollard oak orchards in Saint-Pée in Pyrénées-Atlantiques department (Van Meer, *pers. comm.*), occupancy rates were respectively 20% and 80% of pollard trees. Almost all the trees with numerous large and close cavities were occupied in Saint-Pée.

In hedgerow networks, defining core habitats should constitute an operational framework to improve the conservation of *O. eremita*. However, delimitation of a core area in hedge networks is not easy due to the heterogeneity of the hollow trees distribution.

In the studied agrosystems, long-term conservation perspectives of *O. eremita* seem very weak. Networks of trees were considerably fragmented, and almost no renewal ensures the habitat continuity in the future. However, in France, agrosystems still currently constitute the largest habitats suitable for *O. eremita* with approximately 10% of the French territory in the middle of the 20th century (Vignon, 2005). Moreover, traditional practices like tree cutting or grafting ensured a fast development of the cavities. Thus, it is urgent to preserve *O. eremita* habitat networks by identifying the most remarkable metapopulations in these agricultural landscapes. Most of them are in traditional orchards (apple trees, oaks, etc.).

Today, forest habitats of *O. eremita*, closer to the natural habitats, are insignificant areas. Forest parcels containing *O. eremita* are often less than 50 ha, and distant from each other by tens to more than 100 km. However, these relictual habitats present a potentially high temporal stability, but only if we preserve them for the future. It is in these small forest patches, very distant from each other, that the conservation of the species seems the most ensured, while the disappearance rate of old trees with cavities in hedgerow network and orchards is increasing.

Traditional agricultural activities have generated habitats of substitution for *O. eremita* which ensured the conservation of the species in approximately 10% of the French territory. A conservation action regarding traditional agricultural landscapes could be to preserve, in priority, orchards which present important metapopulations of *O. eremita*. The proximity of favourable trees in an orchard seems similar to the distribution of trees with cavities found in forest stands. It is upon these relictual traditional habitats of orchards and forest patches that a policy of reconstitution of ecological continuities could be elaborated to reconnect habitats step by step.

ACKNOWLEDGEMENTS

I would like to thank the O.G.E. team, especially Adil Baghli for his comments and the translation of the manuscript, Coralie Le Châtreux and Lionel Picard for their cartographic help, Glenn Dubois (PhD student, Rennes 1 University), Cédric Doaré and Olivier Martin for their valuable assistance in the field.

RÉFÉRENCES

BLANDIN, P., LUCE, J.M. & VIGNON, V. (1999). — L'impact de l'autoroute A28 sur les populations sarthoises de trois espèces de coléoptères protégées au titre de la Directive «Habitats» (Osmoderma eremita, Lucanus cervus et Cerambyx cerdo). Diagnostic et préconisations, Rapport final. Muséum National d'Histoire Naturelle pour Cofiroute.

BRUSTEL, H. & BRIN, A. (2003). — Cortèges faunistiques associés à Osmoderma eremita en Aveyron (Coleoptera). Purpan pour la DIREN Midi-Pyrénées.

DUBOIS, G. (2006). — Étude de la répartition et caractérisation de l'habitat d'Osmoderma eremita (Coleoptera:Cetoniidae) dans un agrosystème bocager. Mémoire de stage, Université de Rennes 1.

DUBOIS, G. & VIGNON, V. (2008). — First results on radio-tracking of Hermit beetle, Osmoderma eremita (Coleoptera: Cetoniidae) in chestnut orchards of the northwest of France. Proc. 4th Symposium and Workshop on the Conservation of Saproxylic Beetles, held in Vivoin, France, June 27th to 29th, 2006. Rev. Ecol. (Terre Vie), 63: xxx-xxx.

HEDIN, J. (2003). — Metapopulation ecology of Osmoderma eremita – dispersal, habitat quality and habitat history. Thesis, Department of Zoology, Lund University, Sweden.

HEDIN, J., RANIUS, T., NILSSON, G. & SMITH, G., (in press). — Restricted dispersal in a flying beetle assessed by telemetry. Biodiv. Cons.

LINDHE, A., LINDELOW, A. & ASENBLAD, N. (2005). — Saproxylic beetles in standing dead wood density in relation to substrate sun-exposure and diameter. Biodiv. Cons., 14: 3033–3053.

O.G.E. (2001). — Complément d'évaluation de l'impact de l'autoroute A28 sur les populations d'Osmoderma eremita d'Ecommoy à la Vallée du Loir. Office de génie écologique pour le Ministère de l'Équipement des Transports et du Logement.

O.G.E. (2003a). — Autoroute A28, Rouen – Alençon. Prise en compte du Pique-prune (Osmoderma eremita) et du Grand Capricorne du chêne (Cerambyx cerdo) dans le cadre de l'opération d'aménagement foncier sur les communes de Gacé, Croisilles et Coulmer. Office de génie écologique pour Alis et le CG 61.

O.G.E. (2003b). — Autoroute A28, Rouen – Alençon. Prise en compte du Pique-prune (Osmoderma eremita) et du Grand Capricorne du chêne (Cerambyx cerdo) dans le cadre de l'opération d'aménagement foncier sur les communes de Saint-Germain-de-Clairefeuille, Godisson, Nonant-le-Pin et le Merlerault. Office de génie écologique pour Alis et le CG 61.

O.G.E. (2003c). — Autoroute A28, Rouen – Alençon. Prise en compte du Pique-prune (Osmoderma eremita) et du Grand Capricorne du chêne (Cerambyx cerdo) dans le cadre de l'opération d'aménagement foncier sur les communes de Chailloué et Neuville près Sées. Office de génie écologique pour Alis et le CG 61.

O.G.E. (2005a). — Document d'objectifs du site Natura 2000 FR5202003: Bocage à Osmoderma eremita entre Sillé-le-Guillaume et Grande-Charnie (Sarthe). Office de génie écologique pour la Direction Régionale de l'Environnement des Pays de la Loire.

O.G.E. (2005b). — Document d'objectifs du site Natura 2000 FR5202004: Bocage à Osmoderma eremita au nord de la forêt de Perseigne (Sarthe). Office de génie écologique pour la Direction Régionale de l'Environnement des Pays de la Loire.

O.G.E. (2005c). — Étude d'incidences du projet de barrage écrêteur de crue de Lurberria sur le Pique-prune (Osmoderma eremita), le Grand Capricorne du chêne (Cerambyx cerdo), le Lucane cerf-volant (Lucanus cervus) et leur habitat, Saint-Pée-sur-Nivelle (64). Office de génie écologique pour le Syndicat du Bassin de la Nivelle.

O.G.E. (2007). — Autoroute A28, section Ecommoy – Montabon. Transfert des populations d'Osmoderma eremita. Bilan de la 3ème année de suivi (2006). Office de génie écologique pour Cofiroute.

ORÉADE-BRÈCHE & O.G.E. (2002a). — Étude complémentaire aux études d'impact de remembrement sur Lavernat – Montabon – Vaas. Schéma directeur pour la protection d'habitats à Osmoderma eremita, Cerambyx cerdo et Lucanus cervus. Etude réalisée pour le Conseil Général de la Sarthe.

ORÉADE-BRÈCHE & O.G.E. (2002b). — Etude complémentaire aux études d'impact de remembrement sur Mayet – Verneil le Chétif. Schéma directeur pour la protection d'habitats à Osmoderma eremita, Cerambyx cerdo et Lucanus cervus. Etude réalisée pour le Conseil Général de la Sarthe.

POINTEREAU, P. (2002). — Les haies, évolution du linéaire en France depuis quarante ans. Courr. Environn. INRA, 46: 69-73.

RANIUS, T. (2000). — Population biology and conservation of beetles and pseudoscorpions associated with hollow oaks. Thesis, Department of Zoology. Lund University, Sweden.

RANIUS, T. (2006). — Measuring the dispersal of saproxylic insects: a key characteristic for their conservation. Population Ecol., 48: 177-188.

RANIUS, T., AGUADO, L.O., ANTONSSON, K., AUDISIO, P., BALLERIO, A., GIUSEPPE, M.C., CHOBOT, K., GJURAŠIN, B., HANSSEN, O., HUIJBREGTS, H., LAKATOS, F., MARTIN, O., NECULISEANU, Z., NIKITSKY, N.B., PAILL, W., PIRNAT, A., RIZUN, V., RUICĂNESCU, A., STEGNER, J., SÜDA, I., SZWAŁKO, P., TAMUTIS, V., TELNOV, D., TSINKEVICH, V., VERSTEIRT, V., VIGNON, V., VÖGELI, M. & ZACH, P. (2005). — Osmoderma eremita (Coleoptera: Scarabaeidae: Cetoniinae) in Europe. Anim. Biodiv. Cons., 28: 1-44.

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 scientifique du WWF, Paris.

VIGNON, V. (2005). – Le rôle des habitats de substitution (bocage, parcs, arbres d'alignement) pour la survie des espèces cavicoles et saproxyliques – Implications et synergie avec la conservation en milieu forestier. Pp 293-300 in: D. Vallauri, J. André, B. Dodelin, R. Eymard-Machet & D. Rambaud (eds.). Bois mort et à cavités: une clé pour des forêts vivantes. Lavoisier Tec et Doc, Paris.

VIGNON, V. (2006). — Le pique-prune, histoire d'une sauvegarde. Catiche production, Nohanent, O.G.E. – Cofiroute Ed.

VIGNON, V., ASMODÉ, J.F. & RAPAPORT, P. (2005). — Heterogeneity of the spatial distribution of Osmoderma eremita populations in a hedgerows network (France, Normandy). In M.V.L.Barclay & D. Telnov (eds), Proceedings of the 3rd Symposium and Workshop on the Conservation of Saproxylic Beetles, Riga / Latvia, 07th-11th July, 2004. Latvijas entomologs, Suppl. VI: 109-115.

VIGNON, V., ASMODÉ, J.F. & RAPAPORT, P. (2007). — Inventaire des arbres à cavités du bocage pour la conservation du Pique-prune (Osmoderma eremita) et de la faune associée (entre Sées et Gacé, dans le département de l'Orne). Actes du colloque «Les vieux arbres et la conservation de la biodiversité. Du scientifique au gestionnaire», Office pour les insectes et leur environnement Languedoc-Roussillon. Prades (Pyrénées Orientales), 16-17 octobre 2003: 79-90.

VIGNON, V. & ORABI, P. (2003). — Exploring the hedgerows network in the west of France for the conservation of saproxylic beetles (Osmoderma eremita, Gnorimus variabilis, Lucanus cervus, Cerambyx cerdo). Pp 36-38 In: C.P. Bowen (ed.) Proceedings of the second pan-European conference on Saproxylic Beetles. People's Trust for Endangered Species, London.