UNIVERSITE DE FRANCHE-COMTE

U.F.R. Sciences et Techniques

Ecole Doctorale Environnement, Santé, Société

Doctorat en sciences de la vie et de l'environnement – sciences agronomiques

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Dynamique de la végétation et variations climatiques dans les Balkans au cours du dernier cycle climatique à partir des séquences polliniques des lacs Maliq et Ochrid (Albanie)

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Soutenue le 3 juin 2008

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Remerciements

Je tiens à remercier tout d’abord mes directeurs de thèse : Michel Magny, Odiel Peyron et Anne-Marie Lézine pour m’avoir permis de mener à bien cette thèse.

Je remercie les deux laboratoires qui m’ont accueilli pendant le déroulement de ma thèse : le laboratoire Chrono-Environnment à Besançon et la laboratoire des Sciences du Climat et de l’environnement (LSCE) à Gif-sur-Yvette, ainsi que leur équipe dirigeante : Hervé Richard, Laurent Turpin, Robert Vautard, Elsa Cortijo, Dominique Mazière et Pascale Delecluse, les membres des services administratifs, informatiques et les agents de la sécurité. Je remercie également le CEA (Commissariat à l’Energie Atomique) et le CNRS (Centre National de Recherche Scientifique). Au sein du LSCE, je tiens aussi à remercier Gilles Ramstein et Valérie Masson-Delmotte pour leur soutien et leur écoute.

Je remercie l’Ecole doctorale Environnement, Santé, Société ainsi que les membres administratifs de l’Université de Franche-Comté et de l’UFR Sciences et Techniques de Besançon.

Pour les missions de terrain, je tiens à remercier les memebres de l’Association archéologique franco-albanaise du bassin de Korçë et notamment : Gilles Touchais, Pétrika Léra, les albanais et les macédoniens qui nous ont accueilli chaleureusement et prêté main forte, Eric Fouache, Céline Coussot, Stéphane Desruelles, Christophe Grenier, Danièle Hureau-Mazaudier, Jean-Jacques Tiercelin et Ulrich von Grafenstein.

Je remercie également les programmes ECLIPSE (Environnement et CLImat du Passé : HiStoire et Evolution) du CNRS et IDEGLACE (Impact de Décharges d’Eau douce de la GLAce continentale sur le Climat Européen et méditerranéen) de l’ANR (Agence Nationale de la Recherche). Je tiens également à remercier Joël Guiot, Jacques-Louis de Beaulieu, Michèle Denèfle, Agnès Gauthier et Simon Brewer pour leur soutien et nos échanges scientifiques.

Un grand merci aux chercheurs, techniciens et thésards que j’ai rencontré pour les échanges scientifiques et les bons moments passés ensemble : Florence Aptel, Carole Bégeot, Soumaya Belmecheri, Benoît Caron, Jean-Pierre Cazet, Yannick Donnadieu, Isabelle Dormoy, Dominique Genty, Sarah Ivory, Isabelle Jouffroy, Dorothée Lewden, Florence Mazier, Nathalie Combourieu Nebout, Elena Ortu, Anne Vignot, Françoise Vimeux, Karine Wainer, Julie Watrin et les membres de l’équipe Hydrologie du LSCE.

Pour finir, je tiens à remercier ma famille et notamment mon mari pour son soutien quotidien.

Résumé

Au cours des derniers 150 000 ans, les enregistrements isotopiques des glaces et des océans ont révélé une succession de fluctuations climatiques rapides et de grande amplitude. Toutefois, les enregistrements continentaux témoignant d'une sensibilité suffisante pour cerner l'extension spatiale de ces changements climatiques sont très rares. Cette thèse a donc pour objectif d'analyser et de comparer les enregistrements polliniques des lacs Maliq et Ochrid situés en Albanie, afin d'obtenir une série climatique de référence pour l'Europe du Sud non méditerranéenne.

L'analyse palynologique de ces carottes a permis de :

- reconstituer, pour la première fois, l'histoire de la végétation à moyenne altitude dans le sud des Balkans au cours du dernier cycle climatique : la séquence prélevée dans le lac Ochrid montre que la dynamique de la végétation à Ochrid durant le dernier cycle climatique est très proche de celle des autres séquences continentales du sud de l'Europe, à savoir des ordres de succession d'écosystèmes très proches ; les différences que l'on observe concernent le « timing » de l'apparition d'une espèce à un endroit donné, l'importance qu'elle représente à l'intérieur de l'écosystème ainsi que la durée de sa présence dans ce même écosystème.
- quantifier les changements climatiques associés aux variations de la végétation : la séquence pollinique prélevée dans le lac Maliq, qui a montré l'histoire complexe des écosystèmes montagnards, a permis de quantifier les variations de température, de précipitation et de saisonnalité, pendant la dernière transition glaciaire-interglaciaire et l'Holocène, dans le sud des Balkans. La même méthode a été appliquée à la séquence d'Ochrid afin d'obtenir une reconstitution quantitative des paléoclimats dans les Balkans au cours du dernier cycle climatique.

Afin d'améliorer la qualité de ces reconstitutions environnementales et climatiques :

- les relations actuelles entre les assemblages polliniques, la végétation naturelle et les conditions climatiques passées, ont été préalablement analysées statistiquement, à partir d'échantillons de mousses prélevés en Albanie. Cette étude montre qu'il est possible de distinguer dans la sédimentation pollinique actuelle, les différents écosystèmes et étages de végétation, dans une région topographiquement très morcelée, et par conséquent, que les échantillons de surface correspondant peuvent être utilisés pour faire des fonctions de transfert.
- une nouvelle base de données polliniques actuelles, comprenant 2760 sites répartis en Europe, dans le bassin méditerranéen et en Eurasie, a été élaborée avec de nouveaux échantillons de surface afin d'améliorer la couverture spatiale du référentiel actuel qui est utilisé dans les méthodes de reconstitution quantitative des paléoclimats.

Abstract

Over the past 150 000 years, isotopic ice and ocean records have revealed a succession of rapid and high amplitude climate fluctuations. However, continental records showing sufficiently sensitive to determine the spatial extension of climate change are rare. This thesis therefore aims to analyze and compare the pollen records of Lakes Ohrid and Maliq in Albania, in order to obtain a climate reference record in the south-eastern Europe.

The analysis of these pollen records allowed to:

- Reconstitute, for the first time, the vegetation history at middle altitude in the southern Balkans during the last climatic cycle : the sequences of Lake Ohrid shows that the dynamics of vegetation during the last climatic cycle is very similar to that of other continental sequences of southern Europe, namely orders of succession of ecosystems very close ; the differences involve the « timing » of the appearance of a species, its importance within the ecosystem and the duration of its presence in the same ecosystem.
- Quantify climate changes associated with those in vegetation: the pollen sequence of Lake Maliq, which showed the complex historyof mountain ecosystems, has helped to quantify changes in temperature, precipitation and seasonality during the last glacial-interglacial transition and the Holocene in the southern Balkans. The same method has been applied to the sequence of Lake Ohrid to obtain a quantitative reconstruction in the Balkans during the last climatic cycle.

To improve the quality of these environmental and climate reconstructions:

- The modern relationships between pollen assemblages, vegetation and climate, which are the basis of past environmental and climate reconstructions, have been previously analyzed statistically, from moss samples collected in Albania, Greece and Republic of Macedonia. This study shows that it is possible to distinguish in modern pollen sedimentation the ecosystems and vegetation belts in a fragmented area, and therefore, that the corresponding surface samples can be used to transfer functions.
- A new modern pollen database, including 2760 sites in Europe, Mediterranean area and Eurasia, has been developed with new samples of surface to improve the spatial coverage of the modern dataset that is used in the methods of quantitative paleoclimate reconstruction.

Introduction générale

La compréhension des changements climatiques au cours du passé, en particulier lors du dernier cycle climatique est très importante pour la région méditerranéenne afin d'évaluer les conséquences socio-économiques et environnementales de tels changements dans le futur. L'étude des archives sédimentaires (chironomes, diatomées, foraminifères, glaces, ostracodes, pollen, …) permet de retracer les changements de l'environnement (climat, végétation…) au cours du temps.

Les enregistrements isotopiques des glaces et des océans (Bond et al., 1993; Dansgaard et al., 1993) ont mis en évidence au cours du dernier cycle climatique l'alternance de phases glaciaires et interglaciaires, avec une période comparable à notre interglaciaire actuel, l'Eemien, daté entre ~127 000 et 110 000 ans BP (fig. 1), ainsi qu'une succession de fluctuations climatiques rapides et de grande amplitude au cours de la dernière période glaciaire: les événements de Heinrich qui se traduisent par des arrivées soudaines et massives de sables et de débris grossiers transportés par des icebergs (Grousset, 2001, fig. 2) et les cycles de Dansgaard/Oeschger qui correspondent à des refroidissements rapides de 5 à 10°C en quelques siècles, suivis de réchauffements très rapides, en quelques décennies (Dansgaard et al., 1982 ; Oeschger et al., 1984, fig. 2).

La fin de la dernière période glaciaire est marquée par une phase de réchauffement climatique global, appelé Tardiglaciaire. Cette phase, datée entre ~18 000 et ~10 000 ans BP, est entrecoupée par un événement froid, le Dryas récent ou Younger Dryas daté entre 12 700 et 11 500 ans BP (Björck et al., 1998 ; Broecker, 1992, fig. 2) et par des oscillations mineures telles que le Dryas moyen ou Older Dryas daté entre 14 000 et 13 500 ans BP (Björck, 1984) et l'oscillation Gerzensee datée vers 13 200 ans BP (Eicher, 1980). Le Younger Dryas est précédé par l'interstade du Bølling/Allerød daté entre 14 700 et 12 700 ans BP et suivi par l'interglaciaire actuel, appelé Holocène, de 11 500 ans BP à l'actuel (fig. 2). L'Holocène est une phase relativement stable climatiquement, même si des oscillations mineures centenaires et millénaires, liées à des variations d'activité solaire (Bond et al., 2001) ont été enregistrées pendant cette période. Les oscillations climatiques holocènes les plus couramment rencontrées dans les enregistrements sédimentaires sont l'événement 8.2 ka (Alley et Agustsdottir, 2005; Alley et al., 1997; Johnsen et al., 2001; Mayewski et al., 2004; von Grafenstein et al., 1998, fig. 2) et l'oscillation Préboréal ou Youngest Dryas datée entre 11 400 et 11 100 ans BP (Behre, 1978 ; Björck et al., 1997).

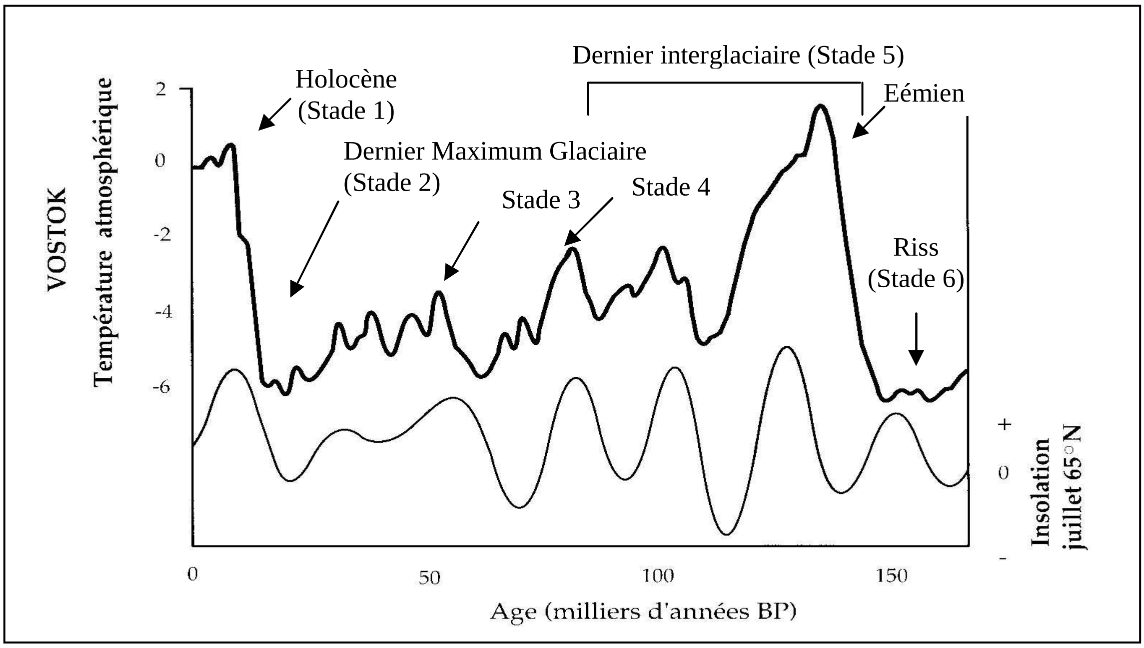

Figure 1: Les variations de l'insolation d'été à 65°N et des températures reconstituées à partir de l'étude de la carotte de glace de Vostok prélevée en Antarctique montrent une tendance parallèle au cours du dernier cycle climatique, c'est-à-dire que les températures augmentent en même temps que les valeurs d'insolation (d'après A. Berger, 1992 modifié). L'Holocène (ou stade isotopique 1, de –10 000 ans à aujourd'hui) et le dernier interglaciaire (ou stade isotopique 5, de –127 000 à –88 000 ans) sont deux périodes interglaciaires qui alternent avec deux périodes glaciaires: Riss (ou stade isotopique 6, de –200 000 à –127 000 ans) et Würm (ou stades isotopiques 2, 3 et 4, de –88 000 à –10 000 ans). Le «dernier maximum glaciaire», de -18000 à -21000 ans, correspond à la période la plus froide du dernier cycle climatique.

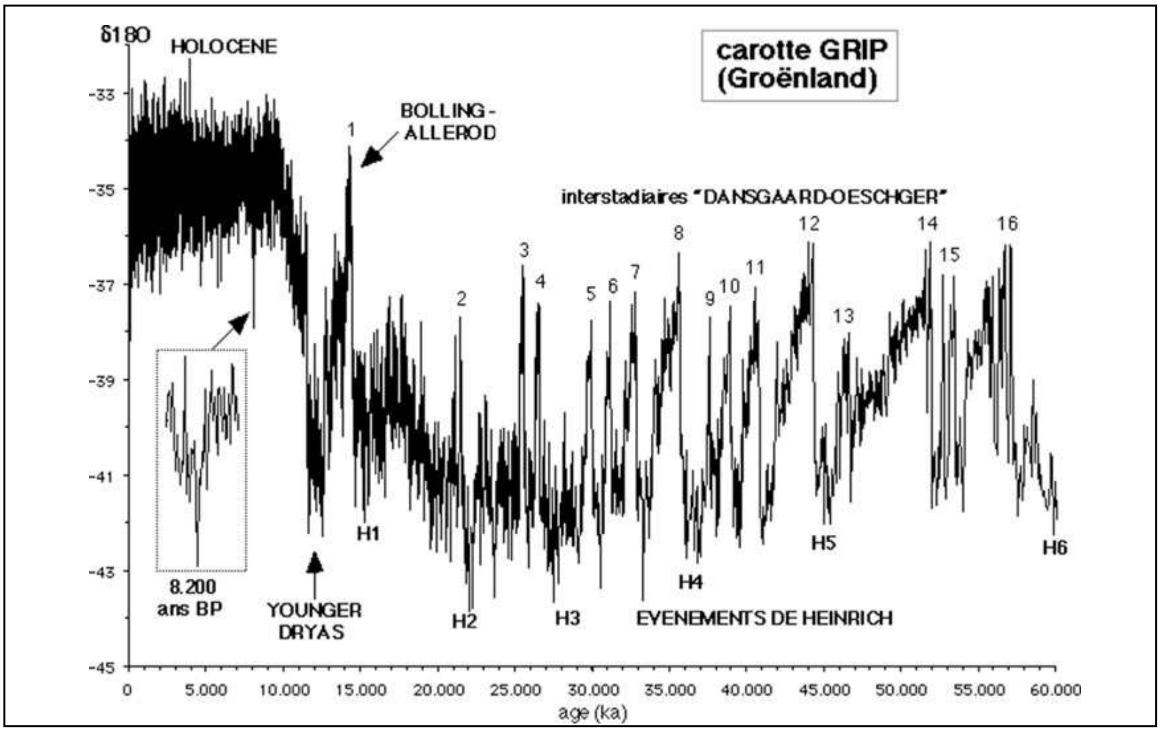

Figure 2: Succession des fluctuations climatiques rapides et de grande amplitude au cours du dernier cycle climatique: évènements de Dansgaard/Oeschger mis en évidence à partir du signal $\delta^{18}O$ mesuré sur la carotte de GRIP au Groenland (de Broecker and Hemming, 2002), évènements de Heinrich mis en évidence dans les sédiments marins de l'Atlantique Nord entre 40 et 60°N (Grousset, 2001), Bølling/Allerød (Yu et Eicher, 2001), Younger Dryas (Alley, 2000) et événement 8.2 ka (Alley et Agustsdottir, 2005; Alley et al., 1997; Johnsen et al., 2001; Mayewski et al., 2004; von Grafenstein et al., 1998).

Des études focalisées sur les carottes marines ont montré que certaines d'entre elles possédaient une résolution temporelle suffisante pour enregistrer parfaitement les évènements du dernier cycle climatique (événements de Heinrich et cycles de Dansgaard/Oeschger) (Bond, 1993; Bond et al., 1992; Cacho, 1999; Cayre et al., 1999; Combourieu-Nebout et al., 2002; Labeyrie, 2000; Sanchez-Goni et al., 2000; Shackleton et Hall, 2001; Turon et al., 2003; Vidal et al., 1997). A l'opposé, parmi les enregistrements continentaux européens qui couvrent le dernier cycle climatique (Bispingen, Bouchet, Castiglione, Echets, Furamoos, Grande Pile, Ioannina, Kopaïs, Lagaccione, Mondsee, Monticchio, Padul, Praclaux, Ribains et Tenaghi Philippon, fig. 3), peu d'entre eux fournissent la résolution temporelle nécessaire ou témoignent d'une sensibilité suffisante pour cerner l'extension spatiale de ces changements climatiques et leurs effets sur les continents (c.f. Guiot et al., 1993).

Figure 3: carte de localisation des longues séquences continentales du sud et du centre de l'Europe: Bispingen (53°5'N, 9°59'E, 100 m alt. – Müller, 1974), Furamoos (47°59'N, 9°53'E, 662 m alt. – Müller et al., 2003), Ioannina (I-284 – 39°45'N, 20°51'E, 470 m alt. – Tzedakis, 2000; Tzedakis et al., 2002; Ioannina II – Bottema, 1974), Kopais (K93 – 38°26'N, 23°03'E, 95 m alt. – Tzedakis, 1999, 2000; Tzedakis et al., 2002), Lagaccione (42°34'N, 11°51'E, 355 m alt. – Magri, 1999), Monticchio (40°56'N, 15°35'E, 656 m alt. – Allen et al., 1999, 2000, 2002; Brauer et al., 2000, 2007; Huntley et al., 1999; Watts et al., 1996a,b), La Grande Pile (47°44'N, 6°30'E, 330 m alt. – de Beaulieu et Reille, 1992; Field et al., 1994; Guiot et al., 1992; Kukla et al., 2002; Kühl et Litt, 2003; Rousseau et al., 2006; Seret et al., 1992; Woillard, 1978), Le Bouchet (44°55'N, 3°47'E, 1200 m alt. – de Beaulieu et al., 1995, 2001; Reille et de Beaulieu, 1988, 1990; Reille et al., 1998, 2000), Le Praclaux (44°49'N, 3°50'E, 1000 m alt. – Reille et de Beaulieu, 1995; Reille et al., 2000), Les Echets (45°54'N, 4°56'E, 267 m alt. – Andrieu et al., 2003; de Beaulieu et Reille, 1984, 1989; Gandouin et al., 2007; Guiter et al., 2005), Mondsee (47°49′N, 13°23′E, 540 m alt. – Klaus, 1975, 1987; Drescher-Schneider et Papesch, 1998; Müller, 2005), Padul (37°00'N, 3°40'W, 785 m alt. – Pons et Reille, 1988), Ribains (44°50'N, 6°09'E, 1080 m alt. – de Beaulieu et Reille, 1992; Kukla et al., 2002; Reille et al., 2000), (Tenaghi Philippon (TF-II – 41°10'N, 24°20'E, 40 m alt. - Wijmstra, 1969; Wijmstra et Smit, 1976; van der Hammen et al., 1971; Tzedakis, 2000; Tzedakis et al., 2006), Valle di Castiglione (41°53'N, 15°05'E, 44m alt. – Follieri et al., 1988, 1989, 1998), MD 95-2042 (37°484N, 10°10'W – Sánchez Goñi et al., 1999a, 2005; Shackleton et al. 2002, 2003), MD 95-2043 (36°8.6'N, 2°37.34W - Cacho et al., 2002) et OPD site 976 (36°12N, 4°18W – Combourieu et al., 1999).

Après les études pionnières de Iversen (1944), Szafer (1946) et Grichuk (1969, 1984), les données polliniques provenant de sédiments lacustres continentaux sont devenus un proxy fréquemment utilisé pour (1) étudier l'histoire de la végétation et (2) quantifier les changements climatiques quaternaires, à une échelle locale et régionale (c.f. Bartlein et al., 1986 ; Davis et al., 2003 ; Guiot, 1990 ; Lotter et al., 2000 ; Nakagawa et al., 2002 ; Peyron et al., 2005 ; Seppä et Birks, 2001, 2002 ; Seppä et al., 2005 ; Tarasov et al., 2005).

Les assemblages polliniques actuels ou fossiles donnent une image de la végétation régionale ou locale (Sugita, 1994). La distribution des écosystèmes végétaux dépend en grande partie des conditions climatiques. Whittaker (1975) a montré que les biomes – entité écologique d'échelle continentale, caractérisée par un type dominant de formation végétale, qui correspond à une aire bioclimatique – peuvent être répartis en fonction de la température et des précipitations annuelles (fig. 4).

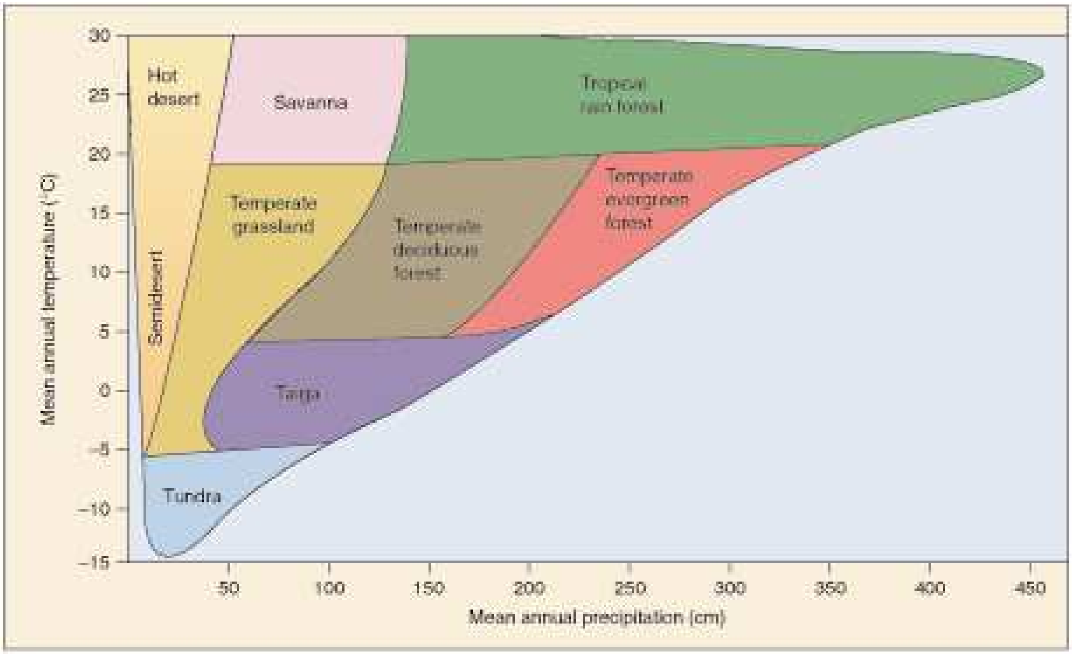

Figure 4: Répartition des biomes en fonction de la température moyenne annuelle et du montant annuel moyen des précipitations (d'après Whittaker, 1975).

Si les assemblages végétaux sont reliés au climat, les assemblages polliniques fossiles peuvent être utilisés pour reconstituer les variations climatiques passées qui ont conduit à ces changements de végétation (c.f. Guiot, 1990; Lotter et al., 2000; Davis et al., 2003; Peyron et al, 2005). Plusieurs études focalisées sur la pluie pollinique actuelle dans différentes régions du globe ont permis de tester et de valider cette hypothèse en analysant les relations végétation-pollen-climat (c.f. Brugiapaglia et al., 1998; Connor et al., 2004; Court-Picon et al., 2006; Finsinger et al., 2007; Seppä et al., 2004; Vermoere et al., 2001). Ces études ont mis en évidence le caractère régional de ces relations et semblent donc être un préalable indispensable à toute étude visant à quantifier les paléoclimats.

Des relations ont déjà été établies entre les oscillations climatiques Nord Atlantique et la réponse de la végétation en région méditerranéenne : au large du Portugal (Sanchez Goñi et al., 2000 ; Roucoux et al., 2001), en mer d'Alboran (Combourieu Nebout et al., 2002 ; Sanchez Goñi et al., 2002) et en Italie (Allen et al., 1999).

En Grèce, Tzedakis et ses collaborateurs (2004) ont montré (1) que les changements rapides de la végétation pendant la dernière période glaciaire étaient corrélés à des évènements de Heinrich et que les cycles de Dansgaard/Oeschger étaient moins bien ressentis qu'à l'Ouest de la région méditerranéenne, et (2) que les écosystèmes répondaient différemment à un même évènement climatique en fonction de leur localisation géographique et notamment de l'altitude. Par exemple, pendant l'évènement de Heinrich 4, les populations d'arbres ont disparu des sites de basse altitude (< 100 m) alors que les populations d'arbres tempérés n'ont fait que diminuer à moyenne altitude (Site de Ioannina, à ~ 500 m d'altitude, fig. 5). Denèfle et ses collaborateurs (2000) ont aussi montré que les éléments forestiers d'affinité tempérée étaient exceptionnellement bien représentés pendant les évènements glaciaires de la dernière déglaciation suggérant que les conditions climatiques devaient y être moins contrastées qu'à basse (Site de Gramousti, 285 m d'altitude, fig. 5) ou haute altitude (Site de Rezina, 1800 m d'altitude, fig. 5).

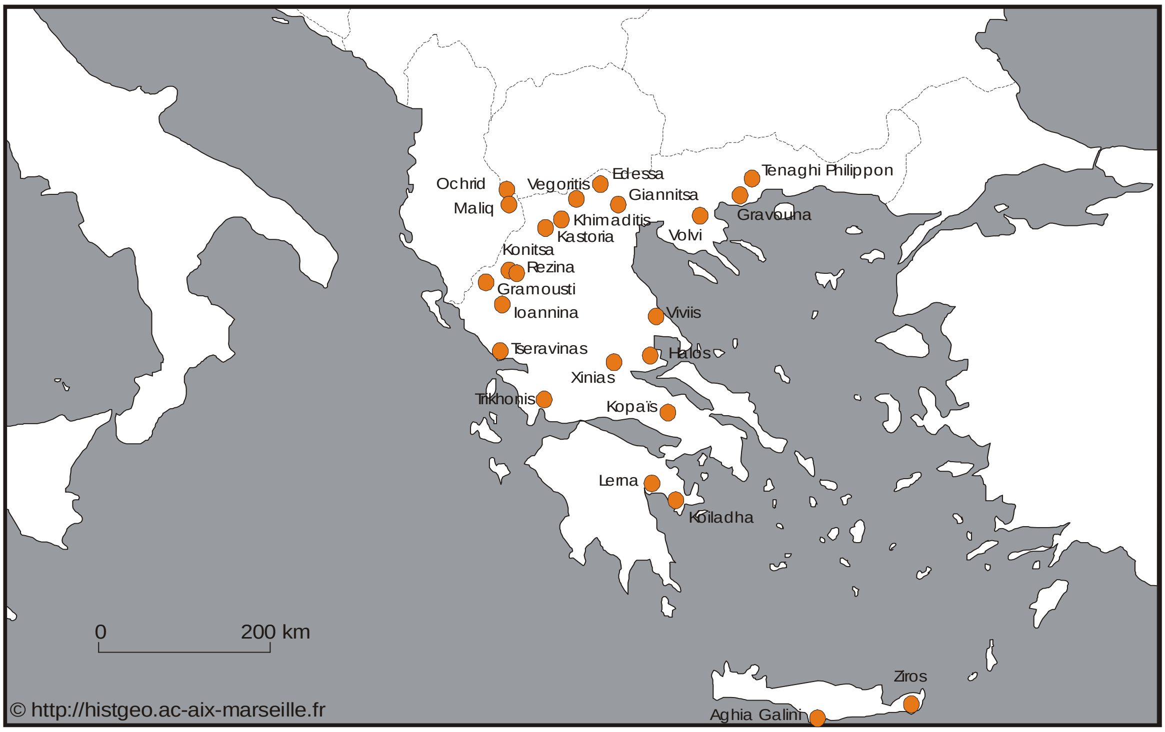

Figure 5: carte de localisation des sites polliniques fossiles du sud des Balkans : Aghia Galini (35°6'N, 24°41'E, 0 m – Bottema, 1980), Edessa (40°49'N, 21°57'E, 600 m – Bottema, 1974), Halos (39°10'N, 22°50'E, 0 m – Bottema, 1979), Giannitsa (40°40'N, 22°19'E, 20 m – Bottema, 1974), Gramousti (39°78'N, 20°35'E, 285 m – Willis, 1992a, 1994b), Gravouna (40°56'N, 24°41'E, 14 m – Greig et Turner, 1974; Turner et Greig, 1975), Ioannina (39°45'N, 20°51'E, 470 m – Bottema, 1974; Tzedakis, 1993), Kastoria (40°33'N, 21°19'E, 650 m – Bottema, 1974), Khimaditis (40°37'N, 21°35'E, 560 m – Bottema, 1974), Koiladha (37°33'N, 23°06'E, -10 m – Bottema, 1990), Kopaïs (38°26'N, 23°03'E, 95 m – Greig et al., 1974, Turner et Greig, 1975, Allen, 1986, 1990), Lerna (37°30'N, 22°35'E, 75 m – Jahns, 1993), Tenaghi Philippon (41°10'N, 24°20'E, 40 m – Wijmstra, 1969; Wijmstra et Smit, 1976; Greig et Turner, 1974; Turner et Greig, 1975), Trikonis (38°36'N, 21°30'E, 20 m – Bottema, 1982), Tseravinas (39°47'N, 20°21'E, 450 m – Turner et Sánchez Goñi, 1997), Vegoritis (40°45'N, 21°45'E, 570 m – Bottema, 1982), Viviis (39°35'N, 22°47'E, 50 m – Bottema, 1979), Volvi (40°45'N, 23°30'E, 100 m – Bottema, 1982), Xinias (39°03'N, 32°16'E, 480 m – Bottema, 1979), Ziros (39°17'N, 20°50'E, 50 m – Turner et Sánchez Goñi, 1997), ou haute altitude: Rezina (39°96'N, 20°49'E, 1800 m – Willis, 1992b, 1994b).
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Les variations climatiques pendant le dernier interglaciaire dans le sud des Balkans ont été estimées à partir des données isotopiques et palynologiques de la séquence de Ioannina (Frogley et al., 1999). Mais aucune étude n'apporte d'estimation quantifiée de ces changements climatiques afin de mieux comprendre ces différentes réponses de la végétation dans le sud des Balkans. La séquence pollinique la plus proche, qui fournit des estimations quantifiées des changements climatiques est celle du Lago Grande di Monticchio, en Italie (Allen et al., 2000). Dans le cadre de cette étude, les variations de trois paramètres climatiques ont été quantifiées : la température du mois le plus froid, le nombre de degrés jours supérieurs à 5°C et le rapport entre l'évapotranspiration réelle et l'évapotranspiration potentielle, depuis 100 000 ans, avec une résolution temporelle d'environ 200 ans. Cette étude montre, entre autres, le besoin d'étudier les changements de saisonnalité, notamment la saisonnalité des précipitations afin de mieux comprendre les mécanismes à l'origine des changements climatiques passés (Allen et al., 2002).

Les sites de Maliq et d’Ochrid, localisés à la frontière entre l’Albanie, la République de Macédoine et la Grèce, dans un couloir tectonique d’orientation Nord-Sud qui favorise les échanges floristiques entre la Méditerranée et l’Europe centrale, à moyenne altitude, sont très intéressants pour étudier l’impact des changements climatiques passés au cours du dernier cycle climatique sur les écosystèmes de moyenne altitude, à la limite entre les étages collinéen (dominé par la forêt mixte décidue caractérisée par *Acer monspessulanum, Carpinus orientalis, Fraxinus ornus, Ostrya carpinus orientalis, Quercus trojana, Q. frainetto* et *Q. cerris*) et montagnard (dominé par la forêt de hêtres caractérisée par *Fagus moesiaca* associé à *Pinus leucodermis*).

Ces sites doivent permettre (1) d’étudier la migration des plantes de la région phytogéographique dite «médio-européenne» à celle située au sud et dite «méditerranéenne» (Polunin, 1980), en réponse au changement climatique, (2) de compléter les données existantes sur l’histoire végétale du sud des Balkans jusqu’ici essentiellement documentée par les données polliniques en provenance des zones de basse altitude du secteur méditerranéen (fig. 5), et, (3) d’apporter pour la première fois des estimations quantifiées des changements climatiques ayant eu une influence sur la végétation dans l’Est de la région méditerranéenne, en prenant en compte les changements de saisonnalité des précipitations.

Cette thèse s’insère dans le cadre du projet du programme ECLIPSE (Environnement et CLImat du Passé : hiStoire et Evolution) du CNRS, intitulé : «Variations climatiques et Dynamique des écosystèmes au sud des Balkans au cours du dernier cycle climatique», 2002-2007, et, coordonné par E. Fouache et A.-M. Lézine. Ce projet a pour but d’établir un enregistrement multi-proxy des variations climatiques au Sud des Balkans au cours du dernier cycle climatique à partir des lacs Maliq et Orhid (Albanie). Pour cela, il vise à comparer l’enregistrement des variations de l’environnement et du climat de deux lacs très différents du Sud de l’Albanie: le lac Maliq qui a été récemment asséché et le lac Orhid qui est le plus profond et le plus ancien d’Europe. Il s’agit d’une étude multi-proxy regroupant à la fois l’étude des grains de pollen, des ostracodes, des téphras, de la géochimie isotopique des carbonates biogéniques, de la géochimie sédimentaire et de la sédimentologie.

Cette thèse s'intéresse plus particulièrement à l'analyse palynologique des carottes provenant des lacs Maliq et Ochrid afin (1) de retracer les variations du paléoenvironnement végétal dans les zones de moyenne altitude de la zone méridionale des Balkans, et, (2) de développer, à partir d'un référentiel actuel de données polliniques de surface (mousses…) des fonctions de transfert à appliquer aux données polliniques de Maliq et d'Ochrid dans le but de fournir les premières estimations quantifiées des changements climatiques lors du dernier cycle climatique dans les Balkans.

Le premier chapitre de cette thèse expose les résultats d'une étude sur la relation actuelle entre végétation, assemblages polliniques et paramètres climatiques dans la région des lacs Maliq et Ochrid, en Albanie. Ces données de surface issues de mousses vont également permettre d'étoffer le référentiel pollinique actuel utilisé dans les méthodes de reconstitution quantitative des paléoclimats.

Le deuxième chapitre présente ce référentiel, le travail réalisé pour améliorer notamment la couverture spatiale, et l'état actuel de celui-ci. En effet, le succès de la palynologie pour quantifier les changements climatiques passés dépend étroitement de la qualité du référentiel actuel utilisé pour établir la relation entre végétation, assemblages polliniques et paramètres climatiques (c.f. Birks, 2004). Ce référentiel doit être représentatif des différentes conditions environnementales rencontrées pendant la période passée étudiée.

Le troisième chapitre permet de tester la validité de ce référentiel actuel notamment en l'utilisant pour obtenir des reconstitutions climatiques quantifiées pour le Tardiglaciaire et l'Holocène à partir de la séquence du lac Maliq. La quantification des variations climatiques passées est nécessaire pour apporter des clés à la compréhension de ces mécanismes car elle est le seul moyen d'approcher la réalité des fluctuations climatiques. Les études visant à reconstituer quantitativement les variations de certains paramètres climatiques à partir des données polliniques ou d'autres indicateurs tels que les insectes ou les chironomes sont peu nombreuses et couvrent souvent les derniers 15 000 ans (c.f. Bordon et al., 2009; Davis et al., 2003; Heiri et al., 2008; Larocque et Finsinger, 2008; Ortu et al., 2006; Peyron et al., 1998, 2005). Les quantifications climatiques obtenues à partir de la séquence pollinique de Maliq ont été utilisées dans le cadre d'une étude prospective pour mettre en évidence de nouveaux sites archéologiques autour du bassin de Maliq (Fouache et al., soumis). Cette étude propose quatre reconstitutions du paléo-lac Maliq pendant le Tardiglaciaire (autour de 14 000 ans BP) et l'Holocène (autour de 9000 ans BP, 4500 ans BP et 2000 ans BP). Les reconstitutions climatiques doivent permettre de mieux comprendre le rôle de la variabilité climatique pour expliquer les fluctuations du niveau d'eau du paléo-lac Maliq, pendant le Tardiglaciaire et l'Holocène.

Le quatrième chapitre donne les résultats des analyses palynologiques et des quantifications climatiques effectuées sur la nouvelle carotte sédimentaire prélevée dans le lac Ochrid, pour le dernier cycle climatique. Pour cette période de temps, peu de quantifications climatiques existent en Europe: la Grande Pile (Guiot et al., 1989, 1992; Field et al., 1994; Cheddadi et al., 1998; Fauquette et al., 1999; Kühl & Litt, 2003; Rousseau et al., 2006), le Bouchet (Cheddadi et al., 1998; Fauquette et al., 1999), les Echets (Guiot et al., 1989; Cheddadi et al., 1998; Fauquette et al., 1999), Ribains (Cheddadi et al., 1998; Fauquette et al., 1999), Saint-Front (Cheddadi et al., 1998), Glowczyn (Cheddadi et al., 1998), Imbramowice (Cheddadi et al., 1998), Bispingen (Field et al., 1994; Kühl & Litt, 2003), Gröbern (Kühl & Litt, 2003) et Monticchio (Allen et al., 2000).

L'analyse palynologique de la séquence d'Ochrid offre une série climatique de référence pour l'Europe du Sud non méditerranéenne couvrant le dernier cycle climatique et elle permet d'aborder l'hypothèse des refuges forestiers glaciaires évoquée notamment par Tzedakis et ses collaborateurs (2002) à partir de la séquence du lac Ioannina en Grèce (Bottema, 1974; Tzedakis, 2000; Tzedakis et al., 2002), et de la discuter pour les zones de moyenne altitude des Balkans méridionaux.

Chapitre 1: Relations actuelles entre végétation, pollen et climat dans le sud des Balkans

Introduction

Ce premier chapitre porte sur l'étude de la représentativité des écosystèmes dans la sédimentation pollinique actuelle dans la région des lacs Maliq et Ochrid (en Albanie) et sur la détermination des paramètres climatiques qui discriminent chacun de ces écosystèmes.

Cette étude est un préalable nécessaire avant toute reconstitution de l'histoire de la végétation à partir de données polliniques fossiles (Birks, 1995). Elle permet de préciser les relations actuelles entre assemblage pollinique, végétation naturelle et conditions climatiques associées, qui sont à la base des reconstitutions environnementales et climatiques.

Le matériel nécessaire à cette étude a été prélevé au cours de trois missions de terrain, en 2002, 2003 et 2006, dans le cadre du projet ECLIPSE du CNRS intitulé: «Variations climatiques et Dynamique des écosystèmes au Sud des Balkans au cours du dernier cycle climatique», coordonné par Eric Fouache et Anne-Marie Lézine. En 2002, un premier échantillonnage (19 échantillons) a été réalisé autour du lac Maliq en Albanie et en Grèce. En 2003, 9 échantillons ont été collectés autour du lac Ochrid et dans les montagnes du Moravë et d'Ostrovicë autour du lac Maliq, en Albanie. La même année, deux échantillons prélevés par Enikö Huth, dans la région de Gna Gora en République de Macédoine ont pu être analysés (Huth, 2004). En 2006, la mission a eu comme objectif d'échantillonner dans les zones de montagne, pour mieux étudier la représentativité de *Abies* dans l'étage montagnard. Vingt-cinq échantillons ont été prélevés dans les montagnes de Baba, Valamarë et du Pinde en Albanie, Grèce et République de Macédoine, dont 6 échantillons ont pu être analysés. La même stratégie d'échantillonnage a été utilisée au cours des différentes missions. Des échantillons de mousse ont été prélevés à chaque site puis analysés au Laboratoire des Sciences du Climat et de l'Environnement (excepté les échantillons prélevés en 2006 qui ont subi les mêmes traitements physico-chimiques au Laboratoire de Chrono-Environnement de Besançon).

Ces échantillons permettent également d'étoffer la base de données polliniques actuelles, en particulier avec des spectres polliniques présentant des pourcentages élevés d'*Abies* et pouvant être considérés comme analogues pour le dernier interglaciaire à partir de la séquence du lac Orhid.

Ce premier chapitre fait l'objet d'un papier actuellement soumis à «Review of Palaeobotany and Palynology», intitulé: «Pollen-vegetation-climate relationships in mountainous areas of southern Balkans». Cet article a pour but d'étudier les relations actuelles entre la végétation, les assemblages polliniques et le climat, dans les régions montagneuses du sud des Balkans, afin de fournir des outils appropriés pour reconstruire quantitativement les variations climatiques à partir des données polliniques fossiles, nécessaires à l'étude de l'impact de ces changements sur la végétation dans une région à la frontière entre deux zones climatiques d'influence méditerranéenne au Sud et médio-européenne au Nord.

Trente six échantillons de mousse ont été récoltés le long d'un transect altitudinal entre 100 et 1900 m d'altitude en Albanie, Grèce et République de Macédoine. Des analyses statistiques ont été effectuées sur ces échantillons afin d'étudier la représentation des différents écosystèmes dans la pluie pollinique actuelle. Puis ces trente six échantillons ont été associés avec les échantillons polliniques actuels du Nord de la Grèce étudiés par Bottema (1974) pour analyser les relations entre pollen et climat, et, étudier comment la végétation est contrainte par le climat, du fait des influences méditerranéenne et médio-européenne. Pour chacun des sites de prélèvement de mousses, les données de six paramètres climatiques ont été interpolées à partir d'environ 60 stations météorologiques localisées en Albanie, en Grèce et en République de Macédoine, en utilisant la méthode d'interpolation linéaire. Ces six paramètres climatiques sont : la température moyenne pendant les mois de Juillet et de Décembre, l'évapotranspiration en Janvier et en Août, le nombre de degrés jours supérieurs à 0°C et l'indice d'aridité de De Martonne. Ces données ont également fait l'objet d'analyses statistiques.

Les résultats de ces analyses ont montré (1) que la sédimentation pollinique donne une bonne image de la complexité des écosystèmes montagnards dans la région des lacs Maliq et Ochrid, et, (2) que l'humidité relative et la saisonnalité des températures sont les deux facteurs qui contrôlent le plus la distribution des écosystèmes dans le sud des Balkans, à la frontière entre les zones d'influence méditerranéenne et médio-européenne.

Pollen-vegetation-climate relationships in mountainous areas of southern Balkans

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Abstract

This paper aims to study the modern pollen-vegetation-climate relationships in mountainous areas of the southern Balkans in order to provide appropriate tools for climate reconstructions using pollen data in this specific area at the confluence between Mediterranean and Medio-European influences.

Thirty-six moss samples collected along an altitudinal transect between 100 and 1900 m a.s.l. in Albania, Republic of Macedonia and northern Greece were analysed for pollen content to define modern pollen-vegetation relationships in Lake Maliq and Lake Ohrid area. These samples were then combined with the Mediterranean modern pollen samples studied by Bottema (1974), located some kilometres southwards in Greece, to analyse pollen and climate relationships and investigate how vegetation is constrained by the climate due to Mediterranean and Medio-European influences. Climatic data (mean temperature in July and December, potential evapo-transpiration in January and August, annual “growing” degree-day above 0°C, aridity index of De Martonne) for each moss sampling site were derived from ~60 meteorological stations in Albania, Republic of Macedonia and Greece, using the linear interpolation method.

Statistical analysis including ordination analyses were used to: (1) test the pollen-vegetation relationships in the complex mountain ecosystems and (2) reveal the climatic parameters that best reflect the main patterns of variation in the modern pollen rain.

The results indicate that (1) pollen sedimentation gives a good picture of the complexity of the mountain ecosystems, and, (2) the moisture availability and the seasonal temperature are the best climatic parameters controlling the variation of modern pollen rain at middle and high altitude in southern Balkans.

Keywords: pollen, surfaces samples, modern pollen-climate relationships, numerical analysis, mountainous areas, Mediterranean vegetation, climate, southern Balkans.

Introduction

Pollen data from late quaternary sediment deposits have widely been used as a source of quantitative reconstructions of past climates in Europe (Huntley and Birks 1983; Guiot 1990; Cheddadi, Lamb et al. 1998; Peyron, Guiot et al. 1998; Peyron, Begeot et al. 2005; Finsinger, Heiri et al. 2007; Bordon, Peyron et al. in press). These are mostly based on the use of a collection of modern pollen samples (e.g. (Davis, Brewer et al. 2003); Peyron et al., 1998, 2005; (Tarasov, Guiot et al. 1999)) and on the relation between modern pollen assemblages - or the occurrence and abundance of selected pollen types - and present-day environmental conditions in order to produce a pollen-climate calibration. In Europe, the potential of modern pollen-climate calibration sets derived from modern samples - including various environmental conditions from the Mediterranean borderlands to the South to Northern Siberia - for quantitative paleoclimate reconstructions has been highlighted (Fauquette, Guiot et al. 1998; Seppä, Birks et al. 2004).

The pioneer work of (Prentice, Guiot et al. 1996) has demonstrated the interest of surface pollen samples to reproduce the spatial distribution of biomes and their variations in the past. In Europe, the distribution of plants is well reproduced from modern pollen data analysed from lake surface sediments or moss polsters (Heim 1970; Huntley and Birks 1983). Lake surface sediments, moss polsters and soil samples, which are currently considered as a collecting and preserving medium of pollen deposition from the surrounding vegetation, are generally used as modern pollen analogues when the fossil record is obtained from lake or peat cores. And, their quality as a source for the modern pollen record is still being discussed (Räsänen, Hicks et al. 2004).

At the regional scale, in particular mountainous areas where the vegetation is particularly sensitive to climate changes (Beniston, Diaz et al. 1997; David 2001; David 2001; Houghton, Ding et al. 2001), specific problems occur related to important pollen transport. Long distance pollen transport from a vegetation type to another appears to be negligible at the continental scale. However, in mountainous areas, upwards transport by ascending winds has been observed (Brugiapaglia, de Beaulieu et al. 1998; Brugiapaglia, de Beaulieu et al. 1998; Muller, David et al. 2000; Court-Picon, Buttler et al. 2005; Ortu 2005; Court-Picon, Buttler et al. 2006; Ortu, Brewer et al. 2006). As a consequence, reconstruct variations of the tree line in the past from pollen data requires that special attention be made on the analysis of the pollen-climate-vegetation relationship in mountainous areas.

Here, we present new results from Southern Balkans, a region previously studied for modern pollen- plant relation, by (Bottema 1974; Gerasimidis, Panajiotidis et al. 2006) in northern Greece, and (Tonkov, Hicks et al. 2001) in Bulgaria. We focus our attention on Korçë-Ohrid Basin at the Albania-Macedonia border which underwent great amplitude variations of climate and vegetation in the past (Bordon et al., 2009; Denèfle et al., 2000).

The goal of our study is (1) to specify whether the surface pollen data allow all vegetation communities to be identified and to reproduce the complexity of mountain ecosystems in Lake Maliq and Ohrid area between 100 and 1900 m altitude, (2) to add new modern pollen samples required to transfer functions to reconstruct quantitatively past vegetation and climate since the last deglaciation from the Maliq pollen sequence (Denèfle, Lezine et al. 2000; Bordon, Peyron et al. in press) and during the last climatic cycle from the Ohrid pollen sequence (Bordon, Lotter et al. in preparation; Lézine, Bordon et al. in preparation), (3) to determine through statistical analysis if the pollen – climate relationship is significant in the southern Balkans and to discuss the climate significance of main pollen taxa. In this paper, pollen-vegetation relationship analysis have been done on thirty-six surface samples collected in Maliq and Ohrid areas. Then these samples are combined with 108 samples of Bottema (1974), located some kilometres southwards in Greece to study the pollen-climate relationships.

Modern setting

Topography

The area of study is located in the southern Balkans, between 39°38’ - 42°28’N and 20° – 22°E (fig. 1). The southern Balkans are characterized by a great variety of landscapes. Mountain ranges, oriented from north to south, reach as high as 2818 m a.s.l. (Mount Valamarë) and alternate with plains and tectonic basins (Aubouin and Ndojaj 1964). The orientation of the mountain ranges favours North-South exchanges of air masses and limits the Mediterranean influence from the Adriatic Sea to the east.

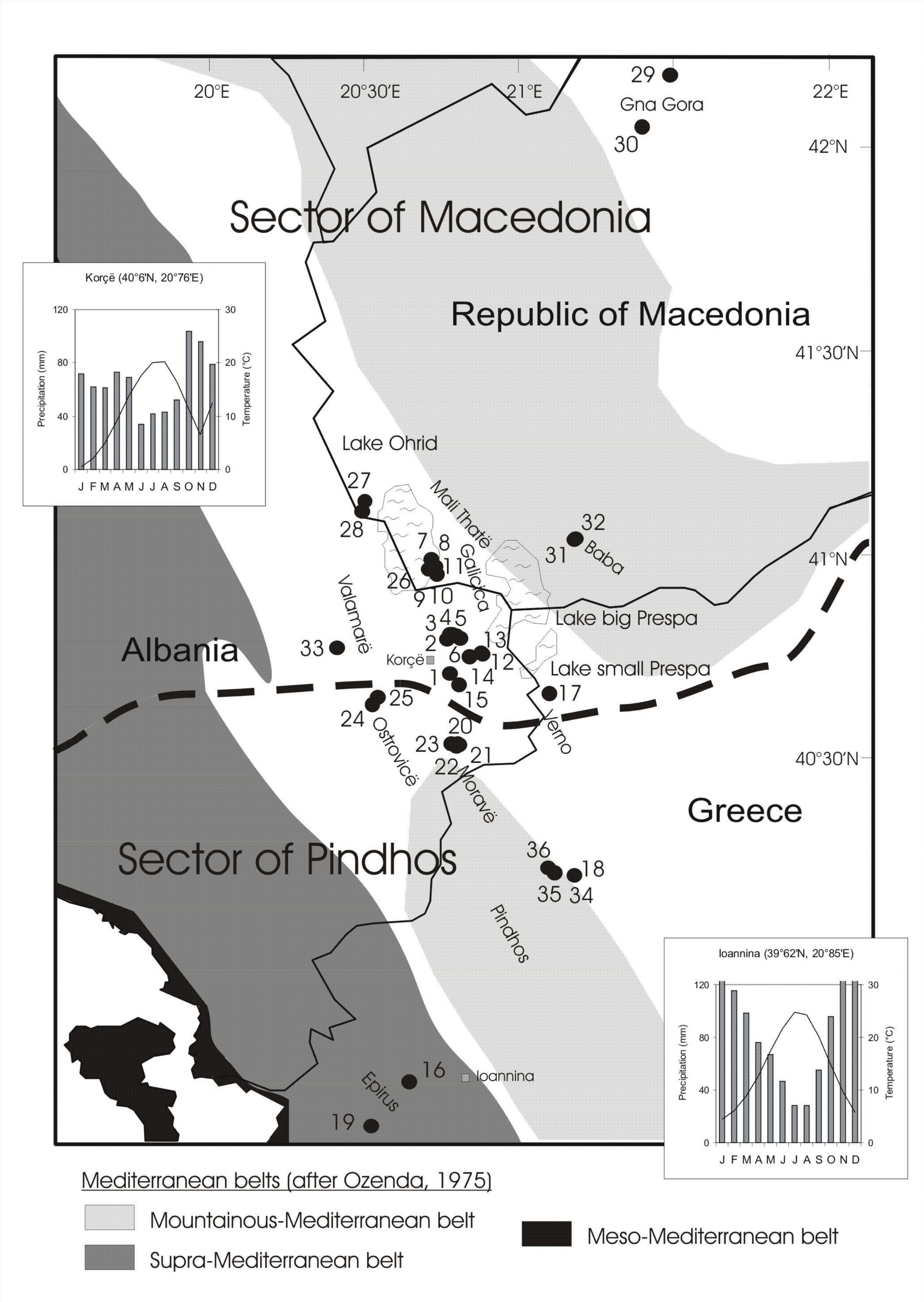

Figure 1: Location of the 36 surface pollen samples on the vegetation map of (Ozenda 1975) with ombrothermic diagrams of Ioannina and Korçë meteorological stations. The two phytogeographical sectors, Macedonia and Pindos, can be distinguished from South to North.

Vegetation

Various types of scrubs and forests are distributed in the area according to both altitudinal and latitudinal gradients (Polunin, 1980). The vegetation has been often altered or replaced by anthropogenic vegetation, except in some protected areas which we have chosen for our sampling. Given the complexity of ecosystems, vegetation is described below considering separately each geographical area.

The lowest altitudinal zones are present in the Epirus area of north-western Greece with Supra-Mediterranean belt, characterized by two vegetation associations: A*ndrachno-Quercetum ilicis* (Braun-Blanquet 1936) and *Ostryo-Carpinion* association (Barbero and Quézel 1976; Voliotis 1976; Raus 1979-1980; Raus 1979-1980; Raus 1979-1980). The first association is dominated by *Quercus ilex* and *Arbutus andrachne*, associated with *Quercus coccifera*, *Arbutus unedo*, *Phillyrea latifolia*, *Pistacia terebinthus* and *Pistacia lentiscus*. *Quercus ilex* and *Quercus coccifera* which support high temperatures and a dry atmosphere during the growing season, are also resistant to winter frosts (Huntley and Prentice 1993). *Phillyrea* and *Pistacia* tolerate dry summers but also high precipitation if evaporation is high (Bottema, 1974). The characteristic species of the second association are *Ostrya carpinifolia* and *Carpinus orientalis*. These taxa can be grouped with *Quercus pubescens*, *Fraxinus ornus* and *Acer* sp. *Ostrya carpinifolia* and *Carpinus orientalis* need hot summers and they are tolerant to a moderate drought. Their geographic distribution is limited by springtime temperatures and the amount of winter precipitation (Huntley and Birks, 1983).

Up to 1100 m alt., the lower mountain slopes are covered mixed deciduous woods of *Carpinus orientalis* with *Acer monspessulanum*, *Pistacia terebinthus*, *Fraxinus ornus* and *Phillyrea latifolia*, a distinctly transitional Mediterranean association represented only in Galicica National Park in Mali Thatë.

Between 1100 and 1900 m alt., the deciduous oak woods dominate, with *Quercus trojana*, *Q. frainetto* and *Q. cerris* in Galicica National Park, and *Q. cerris*, *Q. frainetto*, *Q. robur* and *Q. petraea*, associated with *Carpinus betulus*, *Fagus sylvatica*, *Acer campestre*, *A. tataricum*, *A. pseudoplatanus* and *Fraxinus excelsior*, in Gna Gora. Deciduous oaks are present in mild climate, even if at a large climatic amplitude. Pines forests are also found (1) with *Pinus leucodermis*, *Juniperus excelsa* and *J. foetidissima* in Galicica National Park, (2) with *Pinus nigra*, a species that tolerates dry summers and the presence of snow in winter, and *Pinus heldreichii* from 1500 to 1700 m, in the mountains of northern Pindos, in association with *Ostrya carpinifolia*, *Fagus sylvatica*, *Acer obtusatum* and *Fraxinus excelsior*, (3) with Pinus peuce, in the Baba mountain, in Perister National Park

Above 1900 m alt., beech woods dominate with *Fagus moesiaca* in Galicica National Park and *Abies borisii-regis* that accepts mean annual precipitation of more than 800 mm and a period of summer drought from 0 to 3 months (Quézel, 1998), in the mountains of northern Pindos. Though beeches can withstand drought, their presence implies that temperatures during coldest month must not fall below -2 to -4 ° C (Dahl 1980).
Above the timberline, a dense, low scrub covers the mountainside with dwarf shrubs of *Juniperus communis* subsp. *nana* and ericaceous plants such as *Bruckenthalia spiculifolia*, *Vaccinium myrtillus* and *V. uliginosus*. *Juniperus communis* subsp. *nana* is resistant to cold and drought conditions but needs sunny exposure.

Climate

The area lies within two distinct climate zones.
In the southern part, the Mediterranean climate zone is characterized by hot, dry summers, but rainy and mild winters. In northern Greece, the Mediterranean influence leads to warmer annual temperatures from 15°C at sea level (Thessaloniki, 40°13'N, 22°58'E) to 12°C at 634 m a.s.l. (Kozani, 40°17'N, 21°50'E) and minimum temperatures are between 1 and 5°C (Polunin, 1980). Mean annual precipitation varies from 400 mm in eastern and southern Greece to 1400 mm in the Pindhos mountains (Bottema, 1974) (fig. 1).
In the north of the Balkan Peninsula, the Central European climate is characterized by precipitation throughout the year with a maximum occurring in summer, and unusually cold winters for such southerly latitudes. In the Korçë basin in southern Albania (40°36' N, 20°46' E, 898 m a.s.l., fig. 1), the annual precipitation is 719 mm, with a maximum in May (99 mm) and in October-November (80-130 mm). Annual temperature averages 10.6°C with a maximum in July-August (20-22°C) and a minimum in January (0.5°C) (Gommes, Grieser et al. 2004). Lapse rates decrease from about 0.4°C par 100 m a.s.l. in January to about 0.7-0.8°C per 100 m a.s.l. in July (Furlan 1977).

Material and methods

Surface samples

Moss cushions were sampled in 2002, 2003, 2006, in Albania, Greece and Republic of Macedonia from different vegetation types along an altitudinal transect, from 100 to 1900 m a.s.l. (table 1). For each sample, about 5 sub-samples of moss polsters from one or different species were collected within a homogeneous wooded surface in protected areas and national parks.

Table 1: Metadata for each 36 pollen samples (longitude, latitude, altitude, location, vegetation type, date of sampling).

Site	Longitude (E)	Latitude (N)	Altitude (m)	Localisation	Vegetation type	Date of sampling
1	20°49' 21.30"	40°42' 11.64"	993	Mali Thatë - Albania	Degraded mixed deciduous forest of *Carpinus orientalis*	2002
2	20°49' 25.74"	40°47' 30.84"	1134	Mali Thatë - Albania	Degraded mixed deciduous forest of *Carpinus orientalis*	2002
3	20°50' 02.46"	40°48' 05.34"	1311	Mali Thatë - Albania	Degraded mixed deciduous forest of *Carpinus orientalis*	2002
4	20°50' 25.86"	40°48' 12.30"	1606	Mali Thatë - Albania	Degraded mixed deciduous forest of *Carpinus orientalis*	2002
5	20°51' 05.16"	40°48' 02.40"	1906	Mali Thatë - Albania	*Juniperus* scrub	2002
6	20°51' 49.02"	40°47' 35.94"	1648	Mali Thatë - Albania	Mixed oaks forest	2002
7	20°48' 01.08"	40°59' 30.78"	731	Ohrid lake - Macedonia	Mixed oaks forest	2002
8	20°48' 45.66"	40°58' 16.92"	1336	Mali Thatë - Macedonia	Mixed oaks forest	2002
9	20°48' 45.24"	40°57' 14.16"	1625	Mali Thatë - Albania	Mixed oaks forest	2002
10	20°48' 45.24"	40°57' 14.16"	1625	Mali Thatë - Albania	Mixed oaks forest	2002
11	20°48' 29.76"	40°58' 10.08"	1157	Mali Thatë - Macedonia	Mixed oaks forest	2002
12	20°55' 11.16"	40°45' 13.38"	966	Big Prespa lake - Albania	Degraded mixed deciduous forest of *Carpinus orientalis*	2002
13	20°55' 10.08"	40°45' 26.40"	926	Big Prespa lake - Albania	Degraded mixed deciduous forest of *Carpinus orientalis*	2002
14	20°53' 03.84"	40°44' 55.02"	1067	Big Prespa lake - Albania	Degraded mixed deciduous forest of *Carpinus orientalis*	2002
15	20°50' 45.11"	40°40' 39.12"	869	Small Prespa lake - Albania	Degraded mixed deciduous forest of *Carpinus orientalis*	2002
16	20°35' 41.76"	39°40' 52.20"	200	Epirus - Greece	*Ostryo-Carpinion* association	2002
17	21°06' 13.32"	40°39' 15.96"	1000	Verno - Greece	Mixed coniferous forest	2002
18	21°07' 07.74"	40°11' 51.30"	1200	Pindhos - Greece	Mixed coniferous forest	2002
19	20°28' 26.10"	39°34' 15.54"	100	Epirus - Greece	*Andrachno-Quercetum ilicis* association	2002
20	20°49' 29.94"	40°31' 37.80"	1367	Moravë - Albania	Mixed coniferous forest	2003
21	20°49' 36.84"	40°31' 27.18"	1300	Moravë - Albania	Mixed oaks forest	2003
22	20°49' 04.92"	40°31' 20.70"	1424	Moravë - Albania	Mixed coniferous forest	2003
23	20°48' 18.00"	40°31' 35.40"	1565	Moravë - Albania	Mixed coniferous forest	2003
24	20°35' 22.74"	40°37' 37.02"	1235	Ostrovicë - Albania	Pines forest	2003
25	20°36' 21.36"	40°38' 40.92"	1397	Ostrovicë - Albania	Pines forest	2003
26	20°47' 25.14"	40°58' 05.28"	786	Ohrid lake - Macedonia	Mixed oaks forest	2003
27	20°37' 41.40"	41°08' 22.62"	750	Ohrid lake - Macedonia	Mixed oaks forest	2003
28	20°37' 03.06"	41°06' 38.52"	956	Ohrid lake - Macedonia	Mixed oaks forest	2003
29	21°38' 07.00"	42°12' 33.00"	589	Gna Gora - Macedonia	Mixed oaks forest	2003
30	21°32' 27.00"	42°04' 48.00"	1200	Gna Gora - Macedonia	Pines forest	2003
31	21°13' 06.12"	41°02' 23.22"	1385	Baba - Macedonia	Mixed coniferous forest	2006
32	21°13' 19.80"	41°02' 34.44"	1240	Baba - Macedonia	Pines forest	2006
33	20°30' 19.74"	40°46' 07.56"	1300	Valamarë - Albania	Mixed coniferous forest	2006
34	21°07' 10.80"	40°11' 48.36"	1280	Pindhos - Greece	Pines forest	2006
35	21°03' 51.00"	40°12' 16.50"	1250	Pindhos - Greece	Pines forest	2006
36	21°02' 56.16"	40°13' 01.08"	1120	Pindhos - Greece	Mixed coniferous forest	2006

Pollen samples were processed using the classical method of (Faegri and Iversen 1989) without acetolysis after sieving with a 125 µm mesh. An additional sieving at 5 µm mesh was done at the end of the chemical treatment to improve reading. The pollen identification is based on regional pollen atlases (Reille 1992; Chester and Raine 2001) and the pollen reference collection at the Laboratory of Physical Geography of CNRS-Meudon. Pollen nomenclature follows the European Pollen Database guidelines (http://www.ngdc.noaa.gov/paleo/epd/epd_main.html).

In total, 74 pollen types were identified: 32 arboreal pollen (AP), 42 non arboreal pollen (NAP) and 3 fern spores. Other palynomorphs corresponding to algae, aquatic plants and amoeba were also found (table 2). Pollen percentages were calculated on the basis on the sum of trees, shrubs, herbs and ferns, whereas palynomorphs were excluded from the pollen sum (~ 600 terrestrial pollen grains).

Table 2: List of taxa identified in 36 modern pollen assemblages of this study.

Aceraceae	**Euphorbiaceae**	**Rhamnaceae** undiff
Acer	Euphorbia	**Rosaceae** undiff
Anacardiaceae	Mercurialis	Sanguisorba minor-type
Pistacia	**Fabaceae** undiff	**Rubiaceae** undiff
Rhus	**Fagaceae**	**Salicaceae**
Apiaceae undiff	Castanea sativa	Salix
Asteroideae undiff	Fagus	**Scrophulariaceae** undiff
Artemisia	Quercus coccifera-type	**Solanaceae** undiff
Centaurea	Quercus robur-type	**Tamaricaceae**
Betulaceae	**Gentianaceae** undiff	Tamarix
Alnus	**Guttiferae**	**Thymelaeaceae** undiff
Betula	Hypericum	**Tiliaceae**
Brassicaceae undiff	**Juglandaceae**	Tilia
Buxaceae	Juglans	**Ulmaceae**
Buxus	**Juncaceae**	Ulmus
Cannabaceae	**Labiatae** undiff	**Urticaceae** undiff
Humulus/Cannabis	**Linaceae**	**Verbenaceae** undiff
Caprifoliaceae	Linum	**Violaceae**
Sambucus	**Moraceae**	Viola
Viburnum	Morus	**Vitaceae**
Caryophyllaceae undiff	**Oleaceae** undiff	Vitis
Chenopodiaceae/Amaranthaceae undiff	Fraxinus excelsior-type	**Pteridophyta**
Cichorioideae undiff	Fraxinus ornus	Equisetum
Cistaceae undiff	Ligustrum vulgare-type	Polypodium
Helianthemum	Olea europaea	Dryopteris-type
Cornaceae	Phillyrea	Undifferentiated
Cornus	**Papaveraceae** undiff	**Aquatic plants**
Corylaceae	**Pinaceae**	Lotus-type
Carpinus betulus	Abies	Myriophyllum
Corylus	Pinus	Nymphoides peltata
Ostrya/Carpinus orientalis	**Plantaginaceae**	Potamogeton-type
Crassulaceae	Plantago	Typha latifolia-type
Sedum-type	**Platanaceae**	Sparganium-type
Cupressaceae	Platanus	**Algae**
Juniperus-type	**Poaceae** undiff	Pediastrum
Cyperaceae	Cerealia-type	Rivularia-type
Dipsacaceae undiff	**Polygonaceae**	**Amoeba**
Scabiosa	Polygonum	Arcella
Ephedraceae	Rumex/Oxyria	Assulina muscorum
Ephedra fragilis-type	**Ranunculaceae** undiff	Undifferentiated
Ericaceae-type undiff	Thalictrum	

In total, the modern pollen data set from Albania and Macedonia consists of 36 samples and 74 pollen taxa.

Environmental data

Geographical coordinates and elevations were obtained for each site (table 1). In order to estimate climatic variables at these sites, monthly mean and annual temperature (52 stations) as well as monthly mean and annual precipitation data (67 stations) covering the period 1961-1990 were used (Gommes et al., 2004). Temperatures and precipitations were interpolated to sea-level elevation using monthly lapse rates calculated from the nearest climate stations using linear regression.

Sixty-one climate parameters were considered. Six of them were described by (Woodward 1987) and (Prentice, Guiot et al. 1992) as the most important variables controlling the plant distribution: annual amount of precipitation (P_{ANN}, in mm), mean annual temperature (T_{ANN}, in °C), mean temperature of the warmest month (M_{TWA}, in °C) or coldest month (M_{TCO}, in °C), annual "growing" degree-day above 5°C (GDD5, in ° days) and the ratio of actual over potential evapotranspiration which serves as an index of moisture availability (AET/PET, in %). AET/PET is the ratio of the actual evapotranspiration (amount of water that really evaporates - AET) to the potential evapotranspiration (amount of water that would evaporate if the water reserves in the soil were endless - PET). Furthermore, to allow a more precise identification of climatic parameters governing the distribution of plants in our study area, we have also calculated at each site the mean monthly precipitation (P_{month}) and mean monthly temperature (T_{month}), annual "growing" degree-day above 0°C and 10°C (GDD0 and GDD10, in °C days), mean monthly potential evapotranspiration (PET_{month}, in mm), mean annual potential evapotranspiration (PET moy, in mm), length of the growing season or wet season if precipitation/PET >0.5 (D_{growth}, in number of months), the aridity index of De Martonne (Imartonne=P_{ANN}/(T_{ANN}moy+10) with T_{ANN}moy corresponding to mean monthly temperature, mm/°C) and monthly aridity index (I_{month}=(12xP_{month})/(T_{month}+10), mm/°C) (de Martonne 1926). The indices of aridity are added because they are key parameters that need to be taken into account in the Mediterranean region. GDDx, which serves as an index of plant growing-season requirements, is calculated by summing the mean daily temperature (less x°C) for those days when the mean temperature is higher than x°C (x equal to 0, 5 or 10).

The climatic space covered by the 144 samples vary from 18 to 24°C in T_{july}, from 1.5 to 9°C in $T_{december}$, from 9 to 15°C in T_{ANN}, and from 500 to 1500 mm in P_{ANN}. The potential evapotranspiration oscillates between 20 and 30 mm in January ($PET_{january}$) and between 145 and 165 mm in August (PET_{august}), with values of AET/PET between 50 and 100% and Imartonne between 16 and 90mm/°C. GDD0, GDD5 and GDD10 are between 120 and 1700, 60 and 930, 30 and 420 degree-day, respectively.

Numerical analyses of the pollen data

The 36 modern pollen samples acquired in this study around Lake Maliq and Lake Ohrid, were investigated using two multivariate analyses: a clustering analysis and an ordination analysis.

Cluster analysis is an exploratory data analysis tool which aims at sorting the surface pollen samples into groups. Hierarchical agglomerative clustering was applied to identify discontinuities among the pollen dataset. Initially, each pollen sample is assigned to its own cluster and then the algorithm proceeds iteratively, at each stage joining the two most similar clusters, continuing until there is just a single cluster. Lance-Williams dissimilarity update formula (Batagelj 1988) was used to calculate dissimilarities (distances) between samples and complete linkage was applied, which means that the distances between clusters are determined by the greatest distance between any two objects in the different clusters (i.e., by the "furthest neighbours"). Results of the classification are represented in the form of a dendrogram (fig. 4). Number of clusters is determined using the DUNN index (Haldiki, Batistakis et al. 2002).

Ordination analysis was used to display gradients in the pollen data set, and Principal Components Analysis (PCA), was preferred since linear based methods were found suitable for our data. Pollen percentages were log-transformed to improve the normality of the response variables (species), and inter-samples distances were used to interpret relationships among samples (fig. 5).

Calculations for cluster and ordination analysis were performed on 36 pollen assemblages and 67 taxa. We have excluded the rare taxa (present only in one sample): *Mercurialis*, Papaveraceae, Rhamnaceae, *Scabiosa*, Thymelaceae, Verbenaceae and *Vitis*. Calculations were implemented with “hclust” and “cluster.stats” in R version 2.5.0 (Murtagh 1985) and CANOCO version 4.5 (ter Braak and Smilauer 2002), respectively. In order to present the results in a more comprehensive way, we kept only taxa with species fit range from 15 to 100%, in the ordination diagram.

Subsequently, numerical analysis was applied to the regional dataset, composed of 144 samples and 74 taxa (fig. 6) to determine whether the pollen-climate relationships are significant between the areas under the Mediterranean influence and those under the medio-European influence. This regional dataset is composed of our modern pollen samples combined with the modern dataset of Bottema (1974) which contains 108 pollen samples located several kilometres to the south in Greece, in the Pindos sector.

An ordination analysis was used to select the minimal subset of environmental variables that best explains, in a statistical sense, the pollen assemblages in the training set, and to estimate the relationships between these environmental variables and individual main pollen types. Redundancy Analysis (RDA) was preferred since linear based methods were found suitable for our data (fig. 6). This analysis was performed on 144 pollen assemblages, 74 taxa and 61 environmental variables. Pollen percentages were log-transformed and centered by species. We selected six environmental variables that explain more than 1% of the variance in the data pollen (lambda A): Tnovember, PETaugust, PETjanuary, Tjune, GDD10 and Imartonne. Tnovembre is the variable that explains most of the variance (8%). However, when the variables are tested independently, Tnovember and Tdecember are redundant and have the same value of lambda 1. To facilitate the comparison of our results with those obtained in previous studies, we kept Tdecember instead of Tnovember. In the same way, Tjune and GDD10 explain each 4% of the variance and are redundant with Tjuly and GDD0, respectively. Therefore, in the end we retained Tdecember as MTCO, PETaugust, PETjanuary, Tjuly as MTWA, GDD0 and Imartonne. In order to present the results in a more comprehensive way, we kept only taxa with species fit range from 15 to 100%, to which have been added: *Abies*, *Quercus* deciduous, *Juniperus*-type and Brassicaceae, the main taxa in Lake Maliq and Lake Ohrid area, as previoulsly shown by the Principal Components Analysis.

Results

Pollen diagram of 36 new surface samples

Figure 2 shows a synthetic pollen diagram of the our 36 surface samples with pollen percentages of the main taxa versus the altitudinal gradient.

The pollen diagram shows an altitudinal succession of taxa from lowland Mediterranean area to mountain areas. *Quercus* evergreen, *Phillyrea*, *Platanus* and *Pistacia* are associated together at low altitude (around 100 m a.s.l. – pollen zone 1). They represent respectively 48%, 9%, 6% and 4% of the pollen sum. Highest pollen percentages of *Phillyrea* and *Pistacia* are recorded at this altitude, in the Epirus area (sample 19). However *Phillyrea* is also present in samples 3, 12, 13, 15 and *Pistacia* in samples 13, 29 in low percentages (less than 2%), in association with *Pinus* (up to 30%), *Quercus* evergreen and *Q*. deciduous (up to 50%), *Juniperus*, *Ostrya*/*Carpinus orientalis* and Poaceae (up to 10%). Between 200 m and 800 m a.s.l., *Ostrya*/*Carpinus orientalis* pollen percentages dominate with percentages from 15 to 47% (pollen zone 2). *Quercus* deciduous and *Corylus* replace *Ostrya*/*Carpinus orientalis* progressively, with the highest pollen percentages of *Corylus* (from 1 to 24%) recorded between 900 and 1100 m a.s.l. (pollen zone 3). In this zone, the pollen percentages of *Quercus* deciduous vary from 5 to 50%. Above 1100 m a.s.l., the pollen zone 4 is characterized by *Abies* and *Pinus* whose percentages of these taxa vary respectively from 1 to 15% and from 5 to 90%. These taxa are associated with *Ostrya*/*Carpinus orientalis* which represents up to 26%. From 1300 m a.s.l., the pines are progressively replaced by *Fagus*. The pollen percentages of beeches vary between 1 and 16%, and are associated with those of *Abies* (up to 7%) (pollen zone 5). Above 1500 m a.s.l., *Juniperus*-type, associated with Poaceae and Brassicaceae, dominates the pollen assemblages (pollen zone 6).

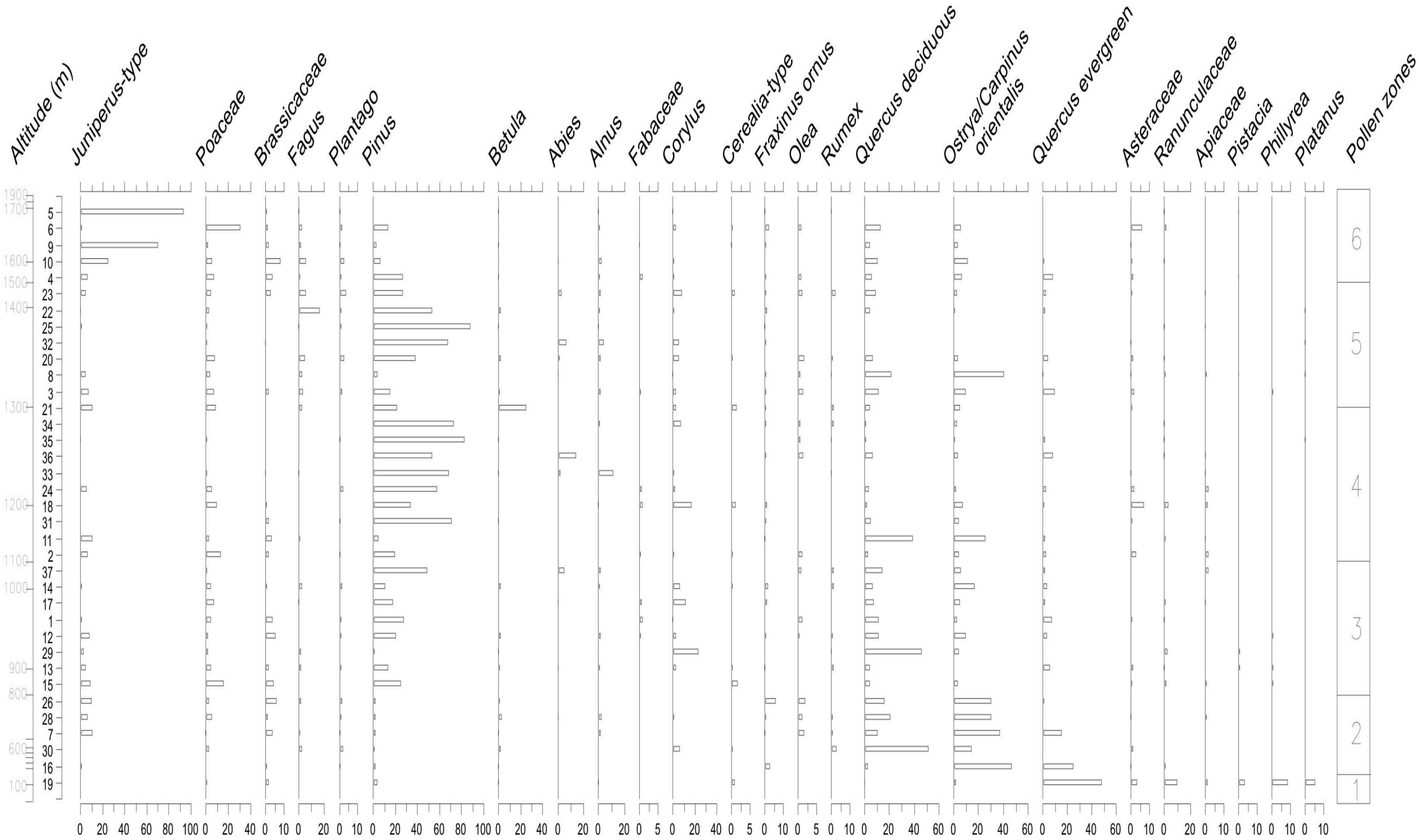

Figure 2: pollen percentages diagram of the thirty-seven modern pollen samples of this study from Albania, Republic of Macedonia and northern Greece versus the altitudinal gradient.

Cluster analysis

Cluster analysis of 36 pollen assemblages has been used to identify the site groups and understand how they correspond to the major vegetation zones (fig. 3).

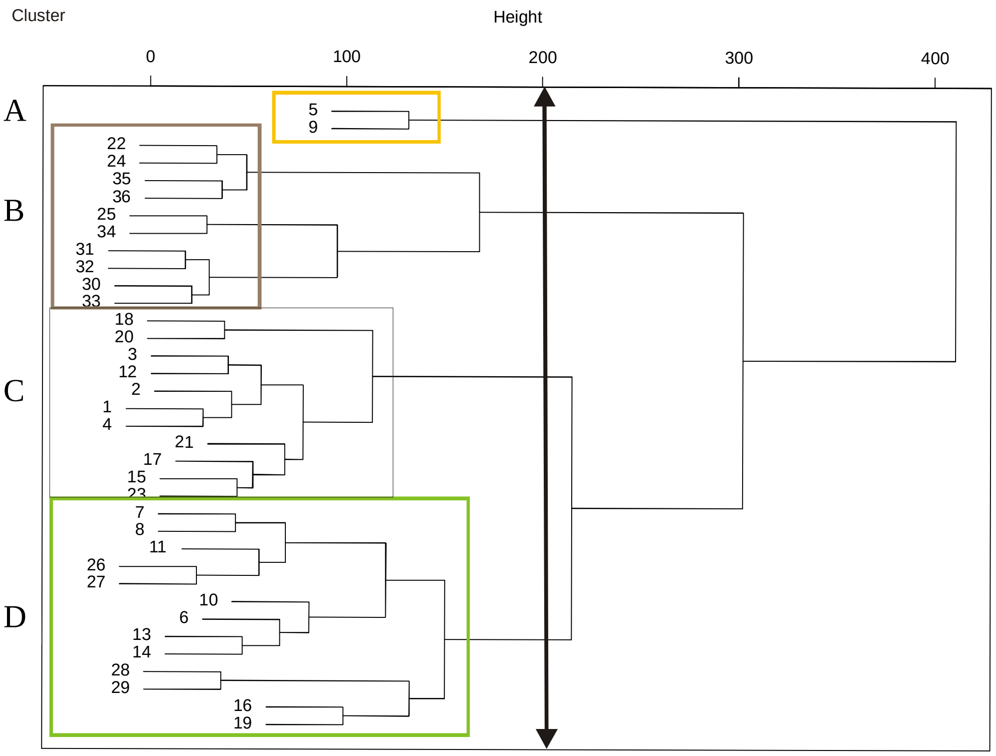

Figure 3: Dendrogram from Ward's method (Euclidean distance) cluster analysis of 36 new modern pollen samples in Albania, Republic of Macedonia and Greece. Height corresponds with the value of the criterion associated with the clustering method.

The classification of the 36 modern pollen samples results in 4 main clusters (fig. 3). The first cutting level of the dendrogram separates samples (cluster A) whose pollen assemblages are dominated by *Juniperus* (samples 5 and 9) from all other samples. The next cutting level of the dendrogram provides three main clusters. Cluster B is made up of 10 samples located between 1100 and 1400 m altitude. It includes samples taken in coniferous forest from Baba (samples 31 and 32), Pindhos (samples 34, 35, 36), Moravë, Ostrovicë (samples 22, 24 and 25) and Valamarë, Gna Gora (samples 33 and 30) mountains. Cluster C is made up 11 samples located in mixed deciduous and coniferous forests from Mali Thatë (samples 1, 2, 3, 4, 12), Moravë (samples 20, 21, 23), Pindhos (sample 18), Verno (sample 17) mountains and Small Lake Prespa (sample 15). Cluster D contains 13 samples taken in mixed oak and hornbeam forests mainly located around Lake Ohrid (samples 7, 8, 11, 26, 28 and 29), Gna Gora (sample 30) and Mali Thatë (samples 6, 10) mountains, the Epirus area in northern Greece (samples 16 and 19), and Great Lake Prespa (samples 13, 14).

Ordination analyses

The principal components analysis

The principal components analysis allows to interpret the clusters according to the pollen assemblages and to determine the characteristic taxa for each cluster. Figure 4 shows the ordination diagram against the two first axes of the ordination analysis that explains most of the variance in the pollen data (33.6%). The eigenvalues of the axis 1 and 2 are respectively 0.215 and 0.120.

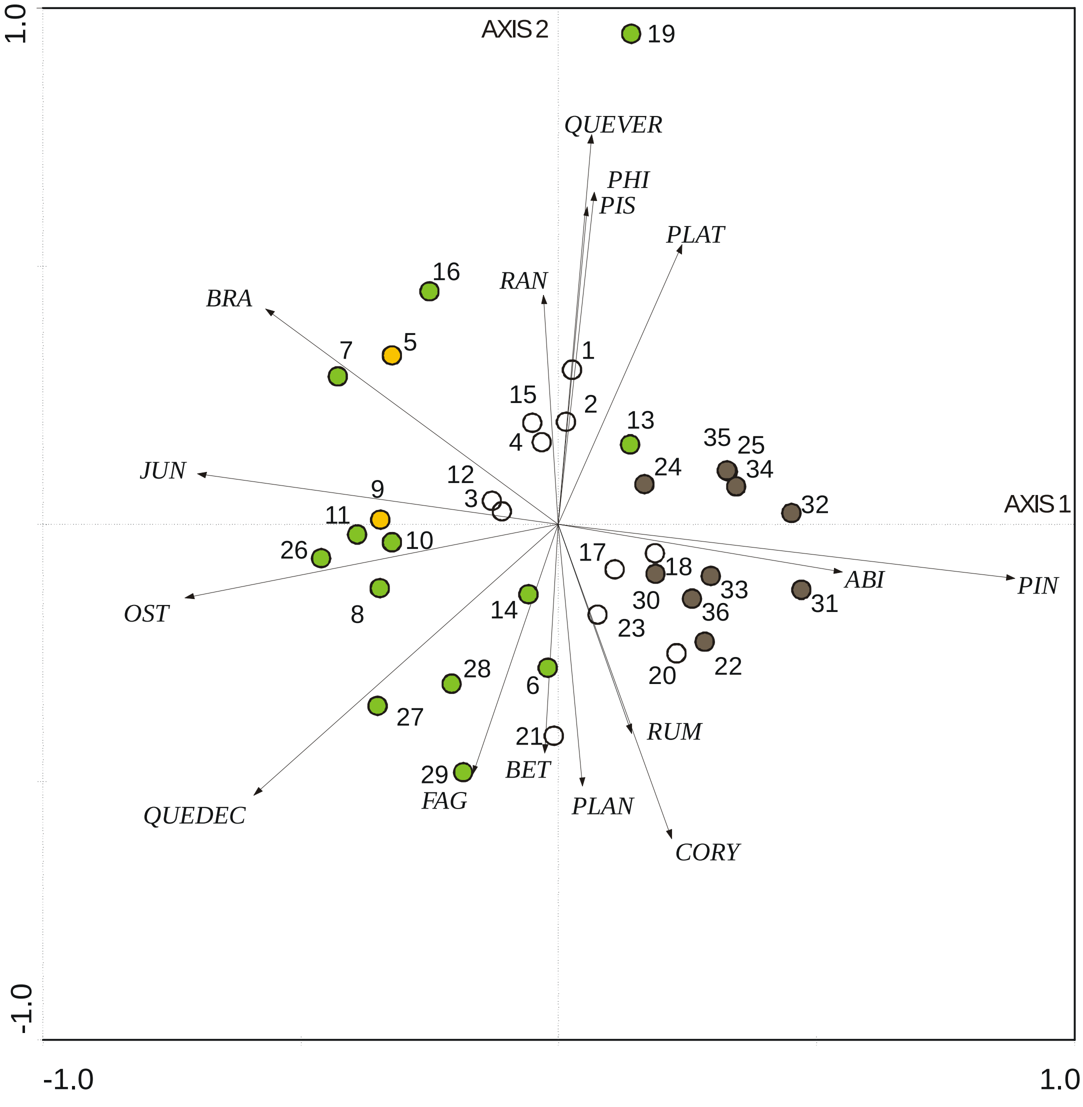

Figure 4: Ordination diagram against the first and second principal component axes of the principal component analysis for the 36 modern surface pollen samples. The distance between the sample points approximates the dissimilarity of their species composition, measured by their Euclidean distance. Each species arrow points in the direction of steepest increase of values for the corresponding species and the angles between arrows indicate correlations (or covariance) between the species. The sample symbols can be projected perpendicularly onto the line overlaying the arrow of particular species. These projections can be used to approximate the abundance of that species in individual samples. The sample points are in the order of predicted increase of abundance of the particular species. The predicted increase occurs in the direction indicated by the arrow. ABI: *Abies*, BET: *Betula*, BRA: Brassicaceae, CORY: *Corylus*, JUN: *Juniperus*-type, OST: *Ostrya*/*Carpinus orientalis*, PHI: *Phillyrea*, PIN: *Pinus*, PIS: *Pistacia*, PLAN: *Plantago*, PLAT: *Platanus*, QUEDEC: *Quercus* deciduous, RAN: Ranunculaceae, RUM: *Rumex*.

Samples of cluster B are distributed around the positive part of the axis 1. Conversely samples of clusters A and D are negatively correlated to the axis 1 and are located along the axis 2. Samples of cluster C are mainly centred in the diagram, between samples of cluster B and D.

The pollen assemblages of cluster A, which includes the two samples from the upper limit of trees in sub-alpine scrub are characterized by *Juniperus*-type and Brassicaceae. *Abies* and *Pinus* dominate in pollen samples of cluster B characterizing the mountain coniferous forests. Cluster D includes samples of low and middle altitude from mixed temperate or Mediterranean forests. Mixed temperate forest pollen assemblages are characterized by *Juniperus*-type, *Ostrya*/*Carpinus orientalis*, *Quercus* deciduous and *Fagus*, whereas pollen assemblages from the mixed Mediterranean forest are dominated by *Quercus* evergreen, *Phillyrea*, *Pistacia*, Ranunculaceae and *Platanus*. The pollen assemblages of cluster C, from degraded mixed deciduous forest of *Carpinus orientalis*, are positively correlated with axis 2 and characterized by: *Quercus* evergreen (samples 1, 2), Ranunculaceae (samples 4, 15), *Juniperus*-type (samples 3, 12). Others samples of cluster C are negatively correlated with axis 2 and characterized by *Betula* (sample 21), *Rumex* (samples 17, 20 and 23), *Corylus* and *Pinus* (sample 18), and *Plantago*.

The results show that the axis 1 of the ordination analysis allows differentiation between mountain conifer forest and deciduous forest of middle altitude. Axis 2 allows for distinguishing between Mediterranean and temperate ecosystems.

The regional pollen variation

The pollen diagram of 108 surface samples of Bottema (fig. 5)

The sampling method and the procedure of preparation of these surface samples are similar to ours. In total, 76 pollen types were identified: 27 arboreal pollen (AP), 45 non arboreal pollen (NAP) and 4 other taxa. The pollen sum (~ 500 terrestrial pollen grains) includes all pollen types and fern spores. The corresponding pollen diagram of 108 modern pollen assemblages is presented in figure 5.

In the Pindos sector (Bottema, 1974, fig. 5), the pollen assemblages are characterized by high pollen percentages of Mediterranean taxa, such as evergreen *Quercus* (up to 60%), *Phillyrea* (up to 20%) and *Pistacia* (up to 10%). Between 200 and 1100 m a.s.l., the pollen percentages of *Quercus* deciduous dominate (up to 60%), whereas *Ostrya*/*Carpinus orientalis* vary up to 20%. Above 1100 m a.s.l., *Fagus*, *Pinus* and *Abies* dominate the pollen assemblages in the Pindos sector with up to 75%, 70% and 7%, respectively.

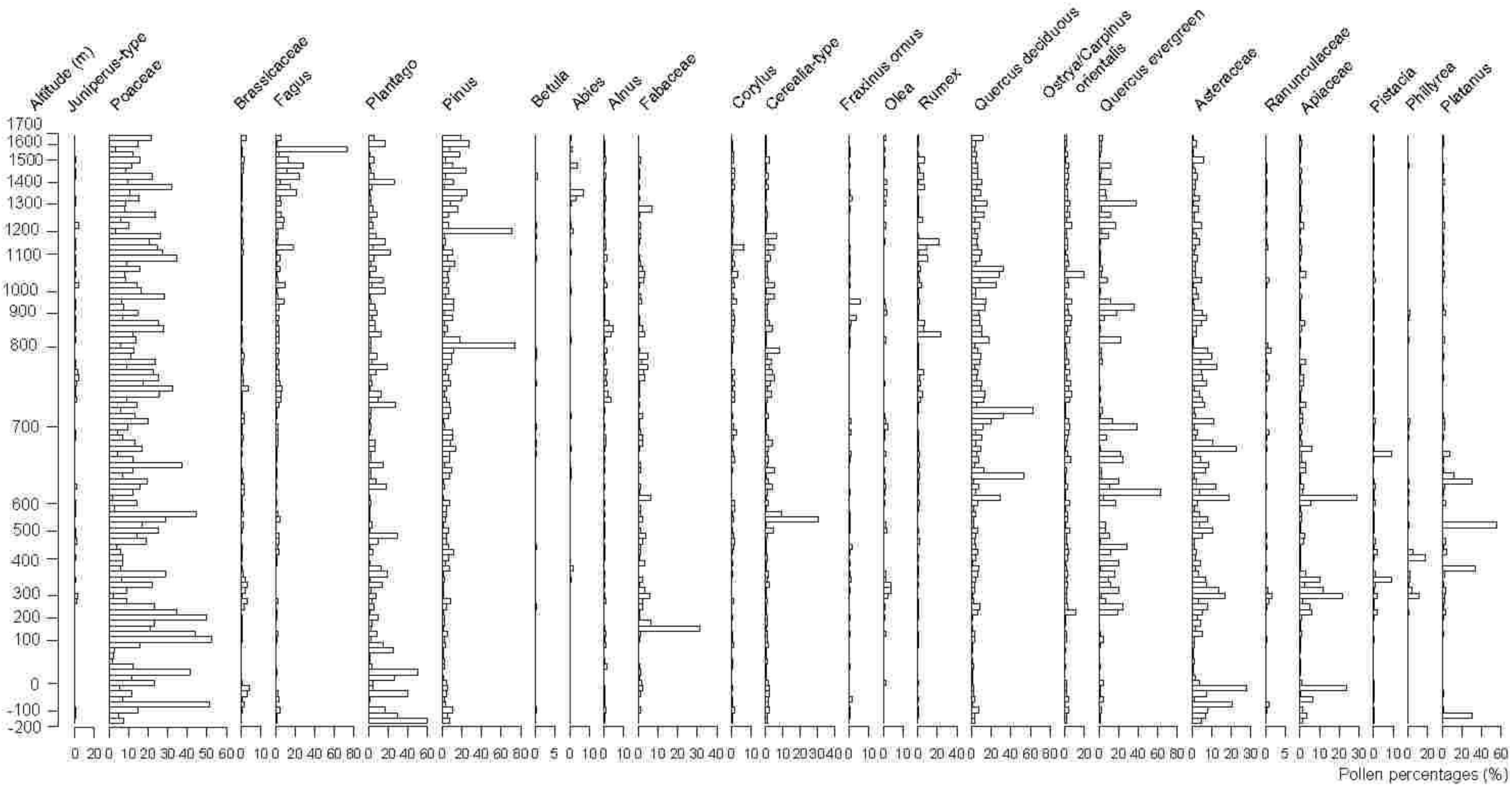

Figure 5: Pollen percentages diagram of the 108 modern pollen samples from northern Greece (Bottema, 1974) versus the altitudinal gradient.

The rendundancy analysis (RDA – figure 6)

The redundancy analysis has been applied to the regional modern pollen dataset to identify the climate variables that explain the most of the distribution of medio-European and Mediterranean ecosystems and the climate significance of main pollen taxa. The two first axes of the redundancy analysis explain most of the variation in the pollen data (62.6%) that depends on the six environmental variables previously selected. Nevertheless 37.4% of variation in the pollen data isn't accounted for by climate and it can probably be explained by other factors such as soil type, elevation and human activity.

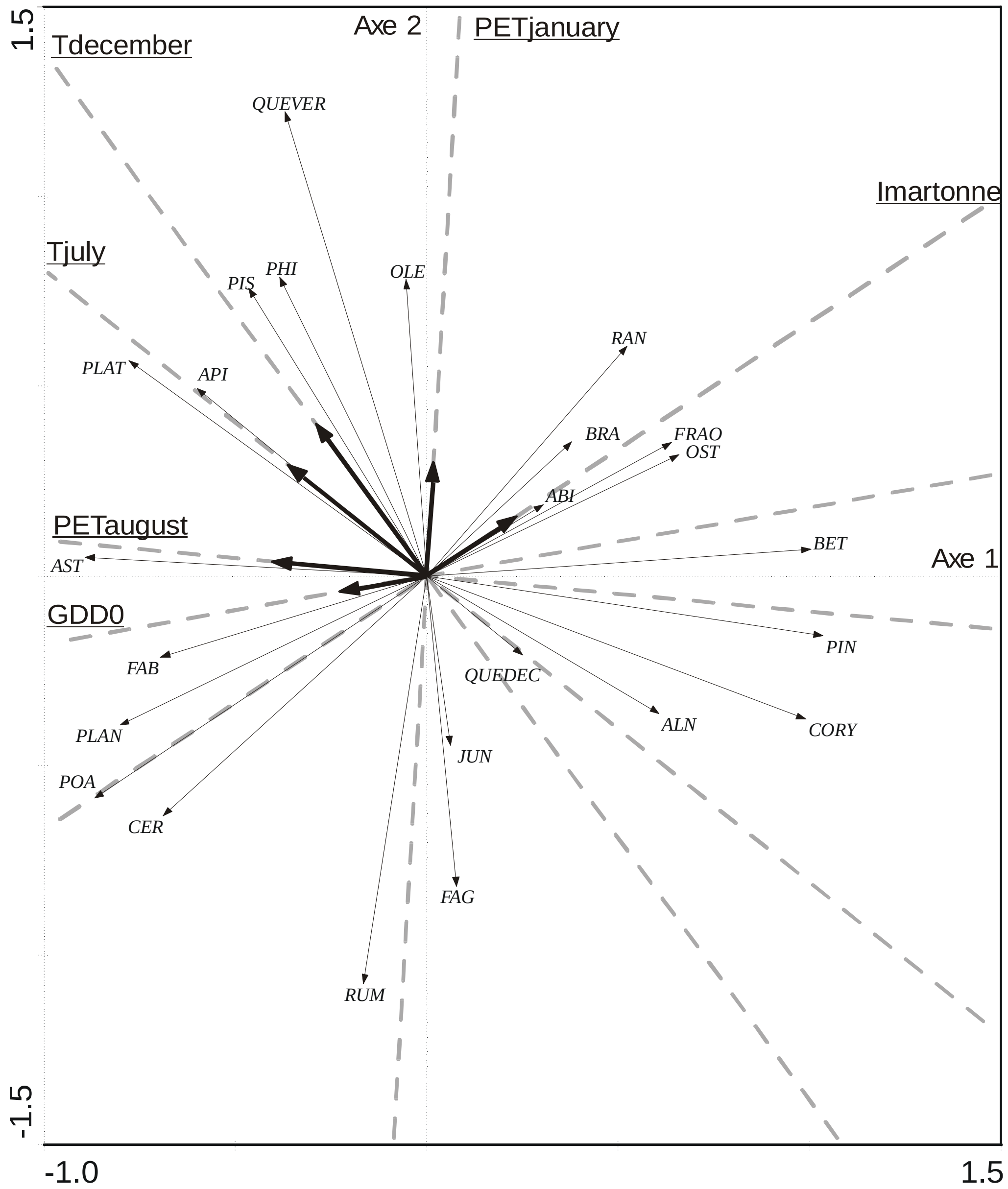

Figure 6: Ordination diagram against the first and second axes of the redundancy analysis for the 144 modern surface pollen samples from Albania, Republic of Macedonia and northern Greece. ABI: *Abies*, ALN: *Alnus*, API: Apiaceae, AST: Asteraceae, BET: *Betula*, BRA: Brassicaceae, CER: *Cerealia*-type, CORY: *Corylus*, FAB: Fabaceae, FAG: *Fagus*, FRAO: *Fraxinus ornus*, JUN: *Juniperus*-type, OLE: *Olea europaea*, OST: *Ostrya*/*Carpinus orientalis*, PHI: *Phillyrea*, PIN: *Pinus*, PIS: *Pistacia*, PLAN: *Plantago*, PLAT: *Platanus*, POA: Poaceae, QUEDEC: *Quercus* deciduous, QUEVER: *Quercus* evergreen, RAN: Ranunculaceae, RUM: *Rumex*.

Tree pollen types of the temperate forest (*Betula*, *Corylus* and *Pinus*) are located on positive end of axis 1, whereas herbaceous pollen types (Asteraceae), with high relative humidity in summer are located on the negative end of axis 1. Pollen types of Mediterranean forest (*Quercus* evergreen, *Olea*, *Phillyrea* and *Pistacia*), with high temperature and relative humidity in winter, are located on the positive end of axis 2, while those of temperate ecosystems (*Fagus* and *Rumex*) are found on the negative end of axis 2. Consequently, the moisture availability and winter and summer temperature seem to control the main variations of modern pollen data in southern Balkans.

Phillyrea, *Pistacia* and *Quercus* evergreen are linked to high temperature in winter (positive correlation with Tdecember), whereas *Alnus*, *Corylus* and *Quercus* deciduous are linked to low temperature in summer (negative correlation with Tjuly).

Abies, Brassicaceae, *Fraxinus ornus*, *Ostrya*/*Carpinus orientalis* and Ranunculaceae are linked with high moisture availability (positive correlation with Imartonne variable), whereas herbaceous taxa such as *Cerealia*-type, *Plantago* and Poaceae are correlated with low Imartonne values. *Olea europaea* and *Quercus* evergreen are correlated with high evapotranspiration in winter (positive correlation with high values of PETjanuary), in contrast with *Fagus*, *Juniperus*-type and *Rumex* (negative correlation with PETjanuary). *Pinus* is linked with low evapotranspiration in summer (negative correlation with PETaugust), whereas Asteraceae accepts high evapotranspiration in summer (positive correlation with PETaugust).

Discussion

The Mediterranean lowland

The RDA indicates that the presence of three main taxa, which characterize Mediterranean lowland vegetation: *Phillyrea*, *Pistacia* and *Quercus* evergreen, is related to high annual temperatures (Tjuly from 20 to 24°C, and Tdecember from 4 to 10°C).

Two under-represented pollen taxa: Phillyrea and Pistacia

Phillyrea taxa corresponds to two shrubs species: *Phillyrea latifolia* and *Phillyrea angustifolia*, characteristic of evergreen scrubs at low altitude, near the coast (Tutin, Heywood et al. 1972). Two species of *Pistacia* are encountered in our studied area: *Pistacia terebinthus*, a deciduous shrub or small tree, and, *Pistacia lentiscus*, a low evergreen shrub (Tutin, Heywood et al. 1972), characteristic of open and dry woodland. Maximum percentages of *Phillyrea* and *Pistacia* never exceed 10% and 5%, respectively in samples from the Epirus area, where these corresponding plants characterise the vegetation. This confirms previous observations from Bottema (1974) and (Wright, Mcandrew.Jh et al. 1967), in Greece and Iran respectively, who assert that these two plant types are under-represented in the pollen spectra.

An over-represented pollen taxon: Quercus evergreen:

This taxon includes two Mediterranean oak species whose pollen grains are morphologically similar: *Quercus ilex* and *Quercus coccifera*. *Quercus ilex* is mainly present on the Albanian coast, whereas *Quercus coccifera* is found in northern Greece.

In our study, the highest pollen percentages of evergreen *Quercus* (48%) are recorded in the Epirus area in northern Greece, where this taxon is an essential component of vegetation. This suggests that evergreen *Quercus* seems to be a good marker of the Mediterranean lowland, in agreement with the results of Bottema (1974).

In almost all samples, up to 1900 m, pollen grains of evergreen *Quercus* are identified, with percentages reaching 15%. Quézel and Médail, (2003) have shown that *Quercus ilex* and *Q. coccifera* are present today in the ecosystems of northern Greece up to 800 m a.s.l. Due to this distribution, the presence of *Quercus* evergreen pollen grains up to 1900 m would require high pollen transport by ascending winds. Moreover, the pollen percentages of *Quercus* evergreen above 800 m are less than 10% of the pollen sum. This value can be considered as a threshold below which one can assume that pollen percentages of evergreen oaks recorded in pollen samples are only linked to wind transport to high elevation sites. The presence of

Quercus coccifera at middle altitude in north of Mediterranean area around Lake Maliq and Lake Ohrid seems constrained by high winter evapotranspiration in sites where this taxa is present. This pattern seems also to be applied to another Mediterranean taxa: *Olea europaea*. Furthermore, the RDA diagram shows that *Quercus* evergreen is positively correlated with Tjuly and Tdecember (with values between 20 and 24°C, and 5 and 9°C, respectively) confirming that *Quercus ilex* and *Q. coccifera* support high temperature during the growing season, as proposed by Huntley and Prentice (1993).

The temperate ecosystems

The mixed deciduous forest

The mixed temperate deciduous forest is mainly characterized by three taxa: *Ostrya*/*Carpinus orientalis*, *Quercus* deciduous and *Juniperus*. The climate significance of each of these taxa differs, as shown by the RDA diagram. The distribution of *Ostrya*/*Carpinus orientalis* and *Juniperus* seems constrained by the moisture availability, whereas the deciduous *Quercus* distribution seems rather constrained by temperature.

1. *Ostrya carpinifolia/Carpinus orientalis*

This taxon groups pollen grains of two small trees: *Ostrya carpinifolia* and *Carpinus orientalis*.

In the southern Balkans, these species mainly occur in association with *Quercus pubescens, Q. frainetto* and *Fraxinus ornus* within the mid-altitude forest belt between 700 and 1200 m alt. (Polunin 1980). At these elevations, *Ostrya/Carpinus orientalis* pollen percentages vary from 10 to 40%, for example in the “Galicica” protected forest where *Ostrya carpinifolia* is one of the most remarkable species. In this area, *Ostrya*/*Carpinus orientalis* and *Fraxinus ornus* seem mainly to be characterized by high humidity (Imartonne between 40 and 60 and up to 90).

Ostrya carpinifolia and *Carpinus orientalis* may also extend downward to 400 m alt. in the sub-Mediterranean belt in association with *Quercus coccifera* (Bottema, 1974) where the highest pollen percentage (~50%) of the hornbeams is recorded.

Up to 1900 m alt., the identification of *Ostrya*/*Carpinus orientalis* pollen grains with pollen percentages less than 1% probably reflects efficient pollen transport of *Ostrya carpinifolia* and *Carpinus orientalis* pollen grains. This is in agreement with the Bottema study (1974) which indicates the presence of *Ostrya*/*Carpinus orientalis* in the pollen rain in northern Greece even in the treeless Plain of Macedonia.

2. *Quercus deciduous*

This taxon includes species mainly distributed at mid-altitude, between 400 and 1500 m alt. (*Quercus robur, Q. frainetto, Q. macrolepsis, Q. pubescens, Q. Polycarpa* and *Q. petraea*), except for *Q. cerris* (100-1200 m alt.) and *Q. trojana* (0-800 m alt.), which can be found in the lowlands.

In Albania, *Q. trojana* and *Q. pubescens* are commonly found in association with *Carpinus orientalis*, *Fraxinus ornus*, *Pistacia terebinthus* and *Juniperus oxycedrus*, *Q. cerris*, *Q. petraea*, *Q. frainetto* and *Carpinus betulus* (Vangjeli 1999). Our pollen assemblages clearly reflect this mixed oak forest with pollen percentages of *Quercus* deciduous up to 50-60%. So the pollen rain in moss samples gives a good representation of this association, as already shown by pollen traps in the Pieria mountains of northern Greece (Gerasimidis, Panajiotidis et al. 2006).

In the Pindos mountain forests, where Fagus, Abies and Pinus nigra dominate, Quercus deciduous are present with pollen percentages reaching 15%. This is in agreement with the Bottema study (1974).

In our sampling, the presence of pollen grains of *Quercus* deciduous in moss samples is correlated with low summer temperature (Tjuly around 20°C).

3. *Juniperus-type*

Three distinct populations of *Juniperus* sp. could explain the significantly abundant distribution of corresponding pollen grains all along our altitudinal transect.

Juniperus oxycedrus and *J. phoenica* grow under predominantly Mediterranean conditions along the coast and up to 1400 m alt. as a component of the evergreen forest. In this ecosystem, pollen percentages of *Juniperus* represent only a small quantity (less than 2%), as shown by sample n°16 and those of Bottema (1974) in eu-Mediterranean evergreen forest in north-western Greece.

Juniperus excelsa and *J. foetidissima* occur up to 2300 m alt. in association with *Abies* and *Pinus*. In the coniferous forest, *Juniperus* pollen reaches 10-40%, as shown in Mali Thatë and the Moravë Albanian mountains (this study) and in some samples in the Pindos mountain in northern Greece (Bottema, 1974).

Juniperus communis subsp. *nana* characterizes the uppermost vegetation belt above 1600 m alt. In this belt, our pollen assemblages consist exclusively of *Juniperus*, which constitutes the basic element of shrub vegetation, as recorded in the pollen traps in the Pieria mountains (Gerasimidis, Panajiotidis et al. 2006).

Climatically, the occurrence of *Juniperus* in the three populations presented above, is linked to low winter evapotranspiration (PETjanuary comprises between 20 and 25 mm).

The mountain forest

The pollen assemblages allow to clearly distinguishing the beech forests and the *Abies-Pinus* coniferous forests in mountain zones.

1. *Fagus*

Fagus sylvatica subsp. *orientalis* and *F. sylvatica* subsp. *taurica* (= *F. moesiaca*) grow at high elevation (between 1300 and 1900 m) in the mid-altitude forest belt, in association with *Abies borisii-regis.* In this altitudinal belt, the pollen percentages vary strongly. Samples between 1350 and 1400 m don't contain pollen grains of *Fagus* because they characterize areas oriented south, dominated by pines. *Fagus* pollen, despite its low values, lies in the Fagetalia vegetation zone. This is shown by the pollen samples taken in 2003 which have recorded pollen percentages higher than those of samples taken in 2002. This is probably related to the 3-year cycle of abundant fructification observed in Greek beech forests (Dafis 1974) and recorded with pollen traps in Greece (Gerasimidis, Panajiotidis et al. 2006) and Bulgaria (Tonkov, Hicks et al. 2001). The climate significance of *Fagus* and *Juniperus* seem constrained by low winter evapotranspiration (fig. 6). Dahl (1980), (Huntley, Bartlein et al. 1989) and (Prentice and Helmisaari 1991) have shown that the geographic range of *Fagus* is also limited by the winter temperature which must be above -3 or -4°C. Our study doesn't allow testing this hypothesis because the temperature isn't less than -1°C on average in our study area.

2. *Abies*

Abies alba and *A. borisii-regis* are found within our study area, between 1100 and 2000 m in mountain and sub-alpine or oro-mediterranean belts (Quézel 1998), in association with *Quercus* and locally with *Fagus sylvatica*, depending on the altitude (Quézel and Médail 2003).

In the pollen samples, the highest percentages of *Abies* are recorded when the fires are associated with oaks between 1100 and 1400 m. The *Fagus-Abies* association also appears clearly in the modern pollen rain with highest percentages reached between 1300 and 1600 m. In this forest type, *Fagus* shows higher percentages (up to 20%) than *Abies* (up to 3%), as shown by Bottema (1974) a few kilometres further south. Climatically, the development of fires seems be constrained by high moisture availability (Imartonne between 50 and 80).

3. *Pinus*

The dominance of *Pinus* pollen grains between 600 and 1700 m closely corresponds to the distribution of *P. nigra*, whose optimal development is observed between 500 and 1500 m in association with *Q. robur, Q. frainetto* or *Abies alba, Pinus peuce* and *P. heldreichii* (Llubani and Habili 1988). The modern distribution area of *P. nigra* is highly fragmented, which explains the strong variations of the corresponding percentages in the modern pollen samples (from 0.2 to 88% in Albania and 74% in Greece). Low *Pinus* pollen percentages recorded below 500 m a.s.l. in Albania (3%) and in Greece (4%) could be related to the presence of *P. halepensis*, *P. pinea* and *P. nigra* in Mediterranean coastal areas. It is of note that other species of *Pinus* found in the southern Balkans do not contribute significantly to the pollen deposition recorded in our samples given that these species can grow at higher elevation: *P. sylvestris* (900-2500 m), *P. mungo* (1400-2500 m), *P. peuce* (600-2200 m), and *P. heldreichii* (1800-1900 m).

The pollen-climate relationships for *Pinus* are complex due to the wide distribution of this taxon and the long distance pollen transport of these pollen grains. However, in the study area, the development of *Pinus* seems related to rather low summer evapotranspiration (PETaugust between 145 and 150 mm).

Representation of degraded communities

In our study area, different degraded communities can be encountered. The sites, where the natural forest has been destructed, can be recolonized by three trees taxa. For example, the forests close to the depression of Maliq have been degraded to cut firewood. The opening of forests which results has encouraged the expansion of pioneer such as *Betula* (site 21) or post-pioneer species such as the evergreen oaks (sites 1 and 2), or the junipers development in xeric brush (sites 3 and 12).

In sites from middle altitude (samples n° 1, 3, 12, 13, 15, 26, 29), the facies of the Ostryo-Carpinion association has been degraded and it is characterized by a “pseudomaquis” with a mixture of evergreen and deciduous bushes, including *Buxus sempervirens*, *Carpinus orientalis*, *Juniperus oxycedrus*, *J. excelsa*, *Ligustrum vulgare*, *Ostrya carpinifolia*, *Phillyrea media*, *Pistacia terebinthus*, *P. atlantica*, *Quercus coccifera*, *Q. trojana*, Rhamnaceae and Rosaceae (Devillers, Devillers-Terschuren et al. 2001).

Sample n°11, taken over 1200 m in a slight anthropogenic area, reflects the capacity of *Carpinus orientalis* to regenerated well after cutting and grazing (Turrill 1929), with pollen percentages of *Ostrya*/*Carpinus orientalis* above 10%.

The pollen rain in sites close to cultivated areas, as in the depression of Maliq (samples n°4 and 15), is characterized by the occurrence of Ranunculaceae comprising some grainland plants, and of *Cerealia*-type plants.

Conclusions

Our study is the first attempt to understand the complex relationships between climate, vegetation, and pollen taxa for mountainous areas of southern Europe and the Balkans, a boundary between two main eco-climatic regions (Mediterranean and Medio-European).

Two dominant climate parameters control the variations in the modern pollen rain, i.e. spatial distribution of modern complex ecosystems in the southern Balkans: the moisture availability and the temperature, especially the summer and winter temperature. Mediterranean lowlands are mainly characterized by three pollen taxa: *Phillyrea*, *Pistacia* and *Quercus* evergreen whose development is constrained by high temperature in winter. The mixed deciduous forest is characterized by three main pollen taxa whose climate significance differs: *Ostrya*/*Carpinus orientalis* and *Juniperus* seem constrained by moisture availability, whereas *Quercus* deciduous is rather constrained by temperature. The mountain ecosystems are characterized by the beech forests and the *Abies*-*Pinus* coniferous forests and these pollen taxa are climatically constrained by the moisture availability.

Our study shows that it is possible to distinguish in modern pollen sedimentation to distinguish the modern vegetation communities and the different vegetation belts in highly fragmented mountainous areas like the southern Balkans. Therefore, the corresponding surface samples can be used to transfer functions.

Acknowledgement

This work has been supported by the French CNRS in the frame of a Franco-Albanian cooperative project (ECLIPSE, Ecole Française d'Athènes). We wish to thank to Dr. E. Fouache (University Paris XII), G. Touchais (University Paris I), P. Lera (Archaeological Museum of Korçë, Albania), M. Magny (Laboratory of Chrono-Environment, University Franche-Comté) and J. Guiot (CEREGE, University Paul Cezanne) for support and fruitful discussions. S. Bottema is particularly acknowledged for giving access to his modern pollen dataset from Northern Greece.

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Chapitre 2: Elaboration d'une nouvelle base de données actuelles

Introduction

Les méthodes de reconstitution quantitative des paléoclimats à partir des données polliniques et les fonctions de transferts pollen-climat reposent sur un référentiel actuel composé d'échantillons de mousses, de sols ou de sommets de carottes lacustres ou continentales. Ce type de référentiel est également utilisé par certaines méthodes et modèles visant à retracer l'histoire de la végétation, telle que la technique de biomisation, qui consiste à attribuer un biome à un échantillon pollinique (Prentice et al., 1996). Les données du référentiel actuel doivent donc présenter une excellente hétérogénéité spatiale, être caractéristiques d'écosystèmes et de types de climat très différents, et avoir été prélevées dans des milieux peu ou pas anthropisés.

Historique et contributions

Grâce aux projets internationaux BIOME 6000 (Prentice et Webb, 1998), PMIP1 et PMIP2 (Paleoclimate Modelling Intercomparison Project 1-2), et QUEST (Quantifying and Understanding the Earth System), de nombreuses études visant à retracer les changements de végétation et de climat depuis les derniers 20 000 ans ont été menées ou sont en cours, et ce pour différentes régions du globe (eg Prentice et al., 2000). Dans le cadre de ces programmes, différents référentiels polliniques actuels ont été développés, à la fois pour l'Amérique du nord (Thompson et Anderson, 2000; Williams et al., 2000, 2004), l'Afrique (Jolly et al., 1998; Elenga et al., 2000; Peyron et al., 2006), la Chine et le Japon (Yu et al., 2000; Takahara et al., 2000), l'Europe et l'Eurasie (Prentice et al., 1996; Huntley et al., 1999; Peyron et al., 1998, 2005; Tarasov et al., 1998; 2000).

Pour l'Europe, certaines bases de données ont une valeur régionale car elles sont basées sur un nombre restreint de données polliniques/lacustres prélevées dans une région géographique précise (c.f. Bigler et al., 2002 ; Heikkilä et Seppä, 2003 ; Seppä et Birks, 2001 ; Seppä et al., 2004). Ces bases de données ont alors permis de calibrer des fonctions de transfert pouvant être utilisées pour quantifier les paléoclimats, par exemple dans les Alpes (Lotter et al., 2000; Ortu et al., sous presse) ou en Italie (Finsinger et al., 2007). D'autres bases de données polliniques possèdent une couverture spatiale étendue à l'échelle de l'Europe et sont basées sur un plus grand nombre de données polliniques (eg Guiot et al., 1990, 1993 ; Peyron et al., 1998). L'étude de Peyron et ses collaborateurs (1998) a permis de disposer (1) d'une base de données possédant 1328 sites, et, (2) d'un plus grand nombre de taxons herbacées. Puis, d'autres sites ont été ajoutés à cette base de données (Davis et al., 2003; Peyron et al., 2005; Wu et al., 2007).

Le rôle du référentiel actuel est déterminant dans les reconstitutions quantitatives des paléoenvironnements (Lotter et Peyron, en préparation). Il s'agit donc de s'appuyer sur des bases de données «de qualité», c'est-à-dire que (1) les données doivent être représentatives de tous les environnements passés, et, (2) la taxonomie, la nomenclature, la méthodologie d'échantillonnage, les procédures de traitement et les techniques de comptage doivent être cohérentes avec celle utilisée pour les données fossiles (Birks, 1995 ; Williams et al., 2001).

Cette thèse a donc pour but d'améliorer la couverture spatiale des données polliniques issues des études antérieures, en particulier de Peyron et ses collaborateurs (1998, 2005, fig. 1) et de mettre au point une base de données directement utilisable par toute la communauté des paléoenvironnementalistes. Dans ce cadre, une base de données gérées par Anne Vignot basée sur les compatges bruts des données polliniques est actuellement en cours d'élaboration au laboratoire Chrono-Environnement.

Dans le cadre de cette thèse, une nouvelle base de données regroupant 2760 échantillons polliniques actuels (table 1) a été élaborée pour reconstituer quantitativement les conditions climatiques (température et précipitation) passées. Elle comprend 397 échantillons polliniques issus de la base de données de (Peyron, Guiot et al. 1998) comprenant des données de l'European Pollen Database, des données polliniques publiées (Van Zeist, Woldring et al. 1975; Bottema 1979; Bottema and Bardoukah 1979; Bottema 1980; Atanassova and Bozilova 1994; Bottema, Woldring et al. 1995; Tarasov, Webb III et al. 1998) et des données non publiées et communiquées personnellement par les auteurs (A. Andreev, J. Belmonte, V. Andrieu-Ponel, B. Huntley, S. Leroy, F. Saadi). Cette nouvelle base de données comprend également 1872 données publiées (Bottema 1974; Tarasov, Webb III et al. 1998; Dambach 2000; Davis, Brewer et al. 2003) et 491 données non publiées (H.J.B. Birks, M. Court-Picon, Y. Miras, J.-P. Suc). Les sites sont répartis en Europe, dans le bassin méditerranéen et en Eurasie (fig. 3). Les nouveaux sites rééquilibrent la couverture spatiale et fournissent des données pour les écosystèmes du sud des Balkans, Espagne, Angleterre, Turquie, Finlande, Suède, Russie, Allemagne, Autriche, France, Norvège, Mongolie et Kazakhstan. Ces sites permettent de mieux caractériser les écosystèmes méditerranéens, les forêts tempérées et les écosystèmes de transition entre la forêt et la steppe.

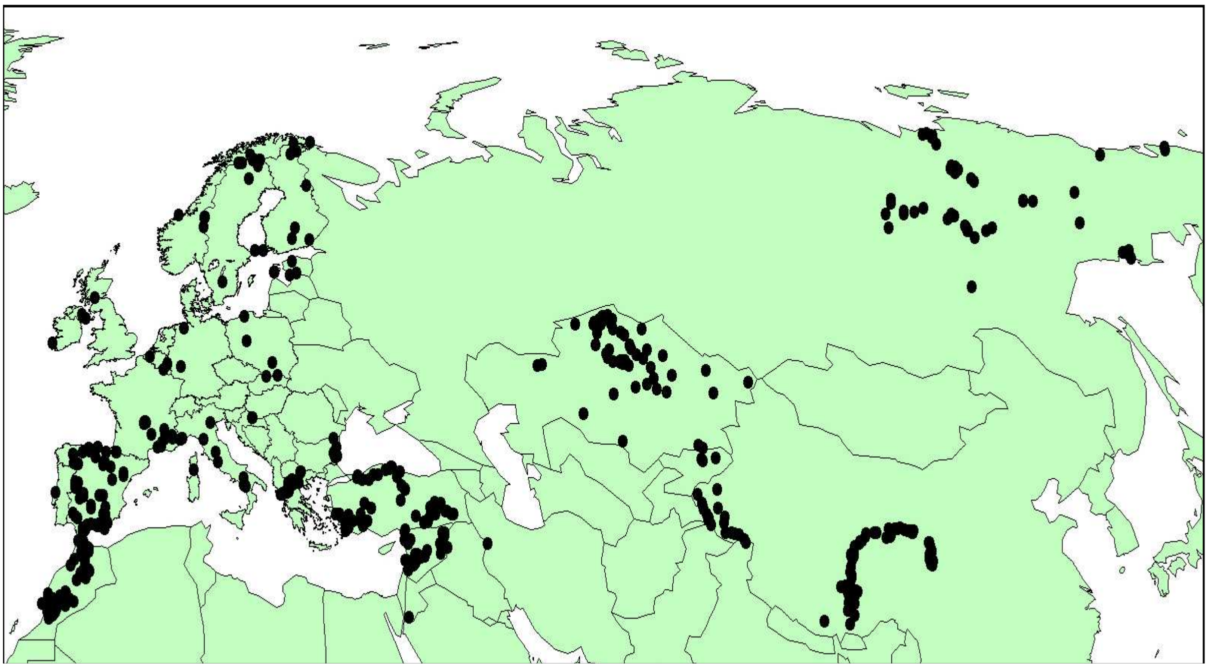


Figure 1: carte de répartition des échantillons de la base de données actuelles pollen-climat de Peyron et al. (1998, 2005).

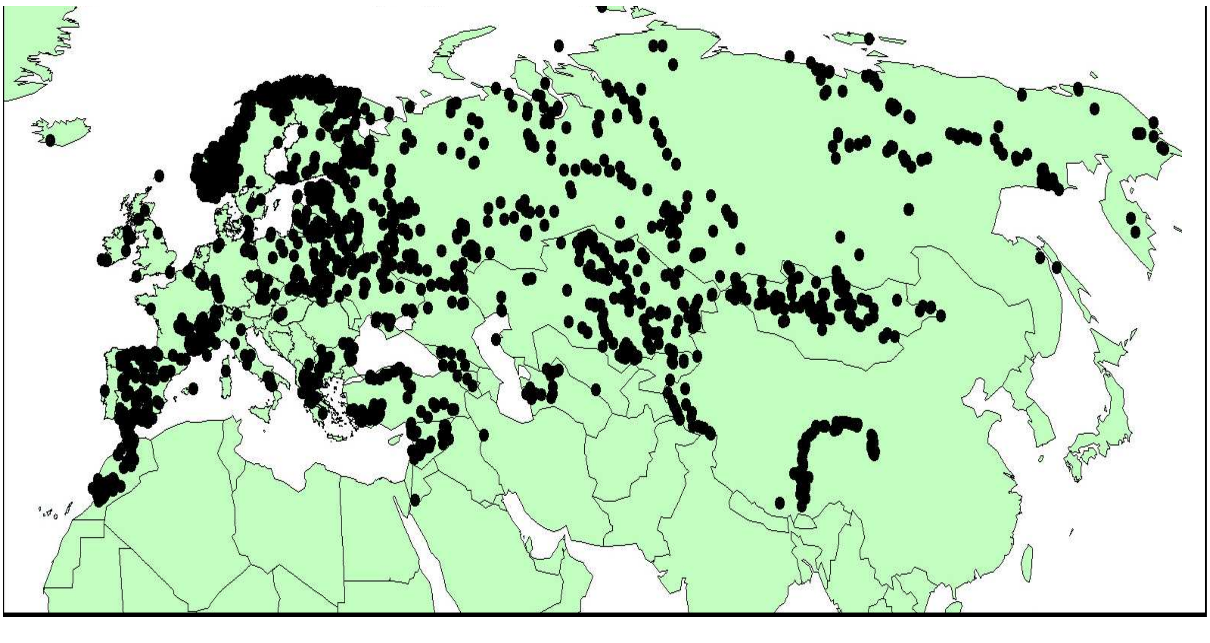


Figure 2: carte de répartition des 2760 échantillons de la base de données actuelles pollen-climat.

Les données

Pour chaque site de la base de données, plusieurs paramètres sont référencés: le type d'échantillon (mousse, échantillon de sol, sommet de carotte), la localisation géographique (la latitude et la longitude, exprimées en degrés décimaux, et l'altitude en mètre), les pourcentages polliniques, le biome associé et calculé selon la méthode de «biomisation» (Peyron et al., 1998; Prentice et al., 1996), et les valeurs climatiques interpolées à chaque site de prélevement.

Parmi tous les échantillons fournis par les auteurs, les sites doublons ont été identifiés sur la base de leurs coordonnées géographiques et des données polliniques, puis éliminés. Parmi les métadonnées fournies par chaque auteur, les différents paramètres cités ci-dessus ont été sélectionnés et leur nomenclature a été homogénéisée. Les données se présentent sous forme de fichiers Excel, compatibles entre autres avec l'utilisation du logiciel 3Pbase (Guiot & Goeury, 1995-1996), utilisé dans cette étude pour les reconstitutions climatiques.

Les données polliniques

La nomenclature des données polliniques a été homogénéisée selon celle de l'European Pollen Database (http://www.europeanpollendatabase.net). Pour les données polliniques, soit les comptages bruts, soit les pourcentages polliniques ont été fournis par les auteurs. Dans les deux cas, les pourcentages ont été recalculés en utilisant la somme des pourcentages des 97 taxons polliniques cités dans le tableau 2 comme somme pollinique totale. Les plantes aquatiques (excepté les Cyperaceae, une famille qui comprend à la fois des plantes terrestres et des plantes aquatiques sans distinction pollinique possible), les fougères, les spores et les algues n'ont pas été prises en compte. De même, les taxons présents sous la forme d'un seul grain de pollen n'ont pas été conservés.

Table 2: liste des 97 taxons polliniques pris en compte dans la base de données actuelles.

Famille	**Genre**	Fagaceae	*Castanea*
Aceraceae	*Acer*		*Fagus*
Adoxaceae	*Sambucus*		*Quercus robur-type*
Anacardiaceae	*Pistacia*		*Quercus ilex-type*
	Rhus	Gentianaceae	*sp.*
Apiaceae	*sp.*	Juglandaceae	*Juglans*
Aquifoliaceae	*Ilex*	Lamiaceae	*sp.*
Araliaceae	*Hedera*		*Rosmarinus*
Asteraceae	*sp.*		*Thymus*
	Artemisia	Myrtaceae	*sp.*
	Asteroideae	Oleaceae	*Fraxinus*
	Centaurea		*Olea*
	Cichorioideae		*Phillyrea*
Betulaceae	*Alnus*	Pinaceae	*Abies*
	Alnus fruticosa		*Cedrus*
	Betula		*Larix*
	Betula nana		*Picea*
	Carpinus		*Pinus*
	Corylus	Plantaginaceae	*Plantago*
	Ostrya		*Plantago lanceolata-type*
Boraginaceae	*sp.*	Platanaceae	*Platanus*
	Echium	Plumbaginaceae	*sp.*
Brassicaceae	*sp.*		*Armeria*
Buxaceae	*Buxus*	Poaceae	*sp.*
Campanulaceae	*sp.*		*Cerealia*
Cannabaceae	*Humulus*	Polygonaceae	*Polygonum*
Caprifoliaceae	*Lonicera*		*Rumex*
	Viburnum	Ranunculaceae	*Ranunculus*
Caryophyllaceae	*sp.*		*Thalictrum*
Chenopodiaceae	*sp.*	Rhamnaceae	*sp.*
Cistaceae	*Cistus*		*Frangula*
	Helianthemum		*Zizyphus*
Crassulaceae	*Crassula*	Rosaceae	*sp.*
Cupressaceae	*Juniperus-type*		*Dryas*
Cyperaceae	*sp.*		*Filipendula*
Dipsacaceae	*sp.*		*Sanguisorba*
Elaeagnaceae	*Hippophaë*	Rubiaceae	*sp.*
Ephedraceae	*Ephedra*		*Galium*
	Ephedra distachya-type	Salicaceae	*Populus*
	Ephedra fragilis-type		*Salix*
Ericaceae	*sp.*	Saxifragaceae	*sp.*
	Arbutus	Scrophulariaceae	*sp.*
	Calluna	Tamaricaceae	*Tamaris*
	Ericaceae froides?	Taxaceae	*Taxus*
Euphorbiaceae	*Euphorbia*	Tiliaceae	*Tilia*
	Mercurialis	Ulmaceae	*Ulmus*
Fabaceae	*sp.*	Urticaceae	*sp.*
	Acacia	Vitaceae	*Vitis*
	Ceratonia	Zygophyllaceae	*sp.*

Les données climatiques

Les données climatiques associées à chaque site ont été interpolées par Simon Brewer au C.E.R.E.G.E. (Centre Européen de Recherche et d'Enseignements des Géosciences de l'Environnement), en utilisant la base de données haute résolution de New et al (2002), qui possède des mesures climatiques effectuées entre 1961 et 1990 selon un point de grille de 1 minute de latitude/longitude. Différents paramètres climatiques ont été calculés.

Les valeurs mensuelles moyennes de température et de précipitation, correspondant aux moyennes pondérées calculées à partir des quatre points de grille les plus proches sont utilisées pour calculer:

- une série de variables climatiques annuelles: la température moyenne annuelle (TANN, °C) et le montant annuel des précipitations (PANN, mm), et de variables mensuelles: la température moyenne en hiver - décembre, janvier, février - (THIV, °C), en automne - septembre, octobre, novembre - (TAUTO, °C), en été - juin, juillet, août - (TETE, °C) et au printemps - mars, avril, mai - (TPRINT, °C),
- une série de variables «bioclimatiques» qui jouent un rôle fondamental sur la végétation en Europe (Prentice et al., 1992): la température moyenne du mois le plus chaud (MTWA, °C) et du mois le plus froid (MTCO, °C) , le «Growing-degree days» ou GDD, c'est-à-dire le nombre de degrés supérieurs à 0°C (GDD0, °jours) et 5°C (GDD5, °jours) sur une année, le rapport entre l'évapotranspiration réelle (AET ou flux de chaleur latent du bilan d'énergie calculé au-dessus d'un couvert végétal) et l'évapotranspiration potentielle (PET, calculée à partir de données météorologiques comme la vitesse du vent, l'hygrométrie et la température), qui est un indice de l'humidité relative, c'est-à-dire de l'eau disponible pour les plantes (AET/PET, %), la quantité annuelle d'eau reçue par les précipitations moins la quantité annuelle d'eau perdue par évapotranspiration (PPET, mm) et la quantité d'eau perdue annuellement par ruissellement (RUNOFF, mm).

La validité de l'interpolation de ces données climatiques a été vérifiée, en particulier pour les sites sélectionnés comme analogues pour les quantifications climatiques effectuées à partir des séquences de Maliq et d'Ochrid. Les valeurs interpolées ont été comparées aux valeurs mesurées aux stations météorologiques les plus proches, dans la base de données de New_LocClim (Gommes et al., 2004). Les valeurs ont été recalculées à partir des données des dix stations météorologiques lorsqu'elles étaient incohérentes avec les valeurs mesurées, excepté pour les sites localisés à très haute altitude dans les Alpes et dans les Pyrénées à cause de l'absence de données météorologiques pour vérification.

Les biomes

Le biome associé à chaque assemblage pollinique (fig. 4) a été déterminé en utilisant la méthode de (Prentice, Guiot et al. 1996). Cette méthode consiste à attribuer chaque taxon à un ou plusieurs types fonctionnels de plante (PFT), puis à définir chaque biome comme une combinaison de un ou plusieurs PFTs. Les types fonctionnels de plante correspondent à des classes de plantes définies par la taille de la plante (arbre, arbuste, etc.…), la forme des feuilles, la phénologie et les adaptations climatiques (Prentice et al., 1996). Les onze biomes définis par Prentice et al. (1996) ont été pris en compte dans cette étude: la végétation xérophytique («Xerophytic Woods/Scrub»), les déserts («Desert»), les steppes («Steppe»), la forêt mixte chaude («Broad-leaved evergreen/warm mixed forest»), la forêt tempérée décidue («Temperate Deciduous Forest»), la forêt mixte fraîche («Cool Mixed Forest»), la forêt mixte froide («Cold Mixed Forest»), la forêt de conifères («Cool Conifer Forest»), la forêt décidue froide («Cold Deciduous Forest»), la forêt boréale («Taïga») et la toundra («Tundra»). A ces biomes ont été ajoutés: la végétation pionnière, les écosystèmes anthropiques. Le biome «végétation pionnière» est défini par sept PFTs: «boreal evergreen conifer» (*Picea*), «cool grass/shrub» (*Hippophaë* et *Polygonum*), «eurythermic conifer» (*Pinus*), «heath» (*Calluna*, Ericaceae), «pioneer plant» (*Betula*), «temperate/boreal summergreen artic/alpine» (*Alnus*, *Salix*), «temperate/boreal summergreen» (*Populus*). Le biome «écosystème anthropique» est définit par quatre PFTs: «anthropic plant» (*Cerealia*, *Humulus*, *Plantago lanceolata*-type), «grass» (Poaceae), «sedge» (Cyperaceae), «steppe/desert forb/shrub» (*Artemisia*, Chenopodiaceae/Amaranthaceae). Les steppes et déserts des zones froides et chaudes ont été distingués, comme proposé par Tarasov et al. (1998) pour améliorer les reconstitutions climatiques pendant les phases steppiques.

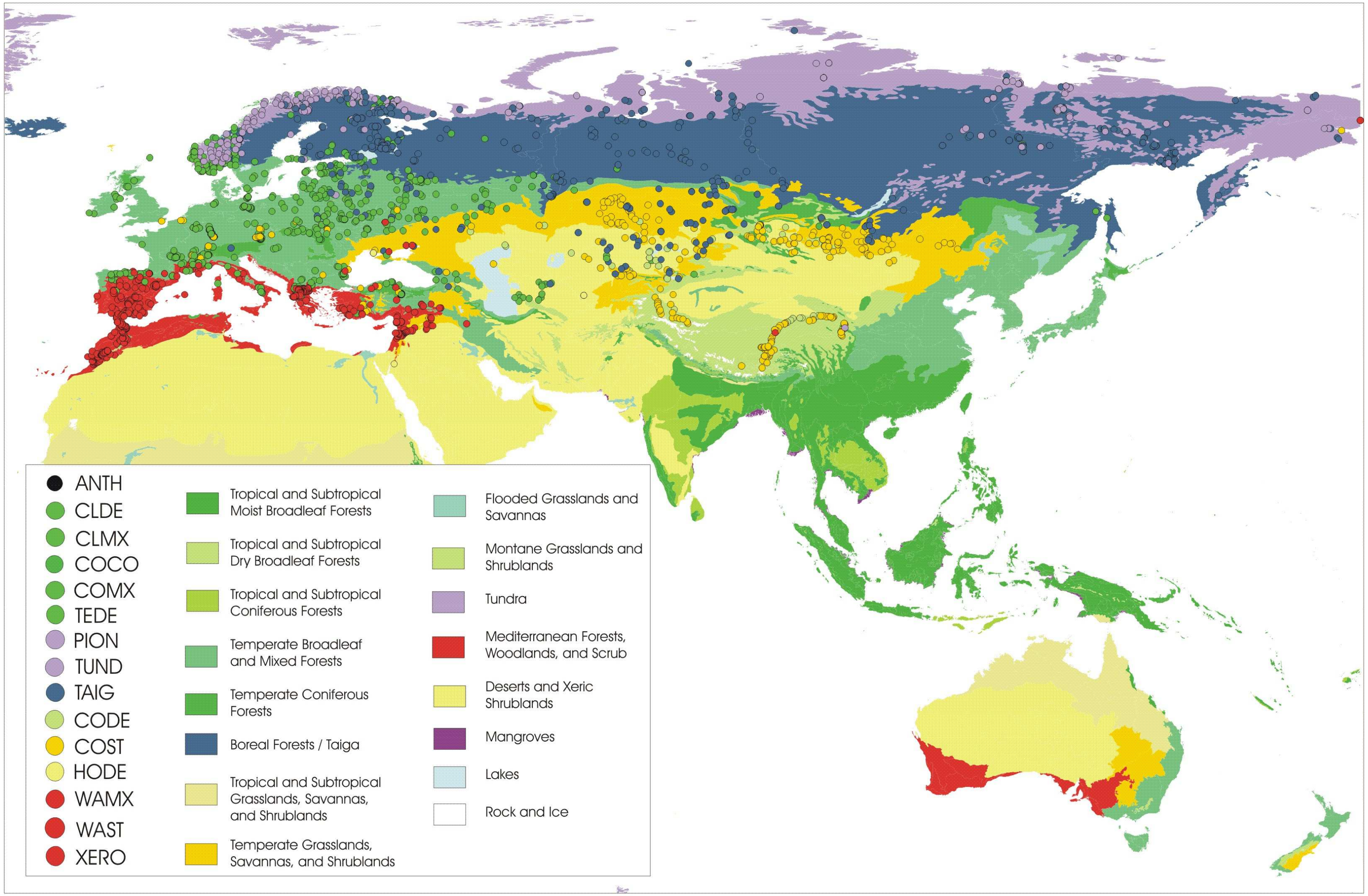


Figure 4: les biomes reconstitués à partir des données polliniques, pour chaque site de la base de données: végétation xérophytique (XERO), steppe chaude (WAST), forêt mixte chaude (WAMX), toundra (TUND), désert chaud (HODE), steppe froide (COST), forêt mixte froide (CLMX), taïga (TAIG), végétation anthropique (ANTH), désert froid (CODE), forêt de conifères (COCO), végétation pionnière (PION), forêt tempérée décidue (TEDE), forêt mixte fraîche (COMX), forêt décidue froide (CLDE). Le fond de carte représente les biomes définis à partir des écorégions ou régions écologiques correspondant à des zones géographiques assez larges se distinguant par le caractère unique de sa morphologie, de sa géologie, de son climat, de ses sols, de ses ressources en eau, de sa faune et de sa flore (Olson et al., 2004). Cent quarante deux écorégions terrestres sont répertoriées et classées en 14 biomes : forêts tropicales et subtropicales humides caducifoliées (forêts ombrophiles) ; forêts tropicales et subtropicales sèches caducifoliées (forêts tropophiles) ; forêts tropicales et subtropicales conifériennes ; forêts tempérées caducifoliées et mixtes ; prairies et savannes inondées ; prairies et broussailles de montagnes (forêts sclérophylles) ; déserts et broussailles xérophytes ; mangroves.

La figure 4 représente d'une part les différents biomes reconstitués à partir des 2760 données polliniques actuelles, et, d'autre part les biomes « potentiels » définis à partir des écorégions.

Cette figure montre qu'il y a quelques sites où les biomes reconstitués à partir des assemblages polliniques et les biomes déterminés à partir de la végétation ne sont pas cohérents, et, donc pour lesquels il faudra contrôler l'attribution du biome :

- Le biome « steppe chaude » est reconstitué pour 20 sites localisés dans la toundra et dans la steppe tibétaine,
- Le biome « toundra » est reconstitué pour 21 sites localisés dans la taïga,
- Le biome « forêt tempérée décidue » est reconstitué pour 4 sites localisés dans le désert du centre de l'Asie,
- Le biome « taïga » est reconstitué pour 99 sites localisés dans la toundra, les steppes d'Asie centrale et du Kazakhstan, le désert et la forêt mixte d'Europe centrale,
- Le biome « steppe froide » est reconstitué pour 12 sites localisés dans la toundra ou la taïga,
- Le biome « désert froid » est reconstitué pour 1 site localisé dans la taïga,
- Le biome « forêt mixte fraîche » est reconstitué pour 2 sites localisés dans la taïga,
- Le biome « forêt mixte froide » est reconstitué pour 9 sites localisés dans la steppe et le désert,
- Le biome « forêt décidue froide » est reconstitué pour 2 sites localisés dans la taïga.

L'attribution des biomes est correcte pour la majorité des sites (environ 2000 sites), ce qui montre la fiabilité de la méthode, même si les résultats de la figure 4 mettent en évidence quelques problèmes de définition des biomes : « taïga », « toundra » et « steppes chaude et froide », alors que les biomes forestiers semblent assez bien reconstitués.

L'état actuel et la validation de la base de données

Pour évaluer la fiabilité des reconstitutions climatiques à partir de cette base de données, deux tests de validation ont été menés, en appliquant la technique des meilleurs analogues sans puis avec la contrainte des biomes: (1) à tous les échantillons de la base de données, (2) à 1406 échantillons sélectionnés au hasard dans la base de données (table 5). Les coefficients de corrélation et l'erreur quadratique moyenne (RMSE) ont été calculés pour différents paramètres climatiques.

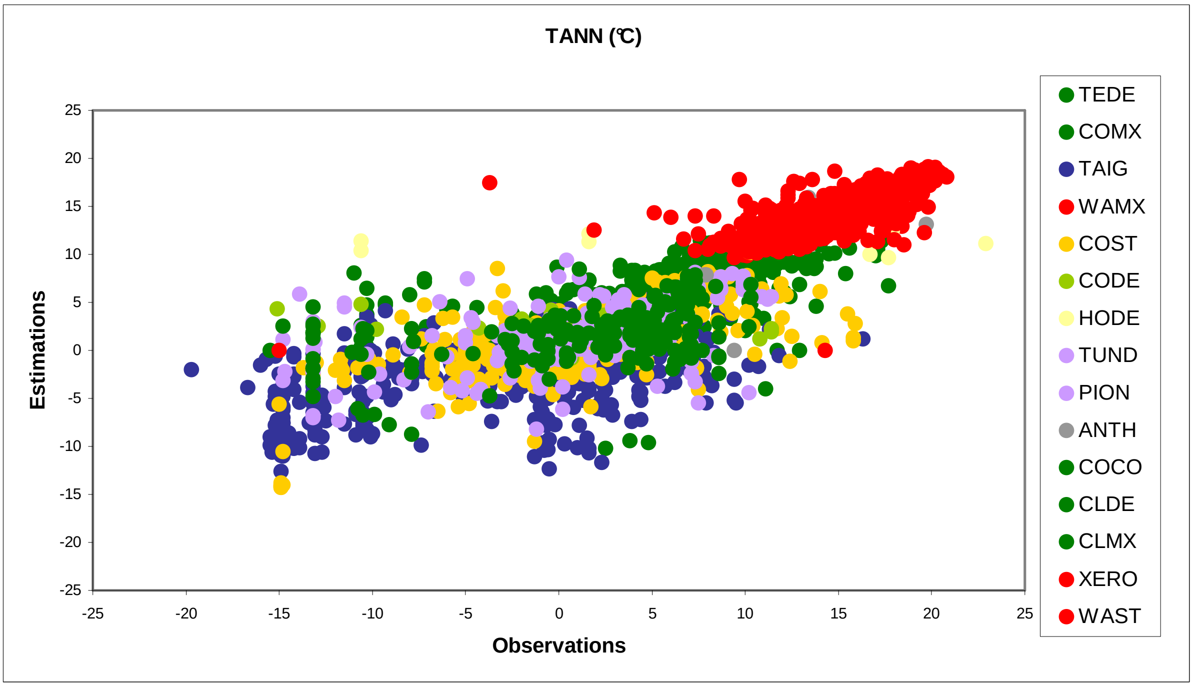
Table 5: coefficients de corrélation entre les valeurs observées et reconstituées et erreur quadratique moyenne (RMSE) calculés pour chaque paramètre de précipitation et de température, obtenus en appliquant la technique des meilleurs analogues sans puis avec la contrainte par les biomes: (1) à tous les échantillons de la base de données, (2) à 1406 échantillons sélectionnés au hasard parmi les 2760 échantillons de la base de données actuelles.

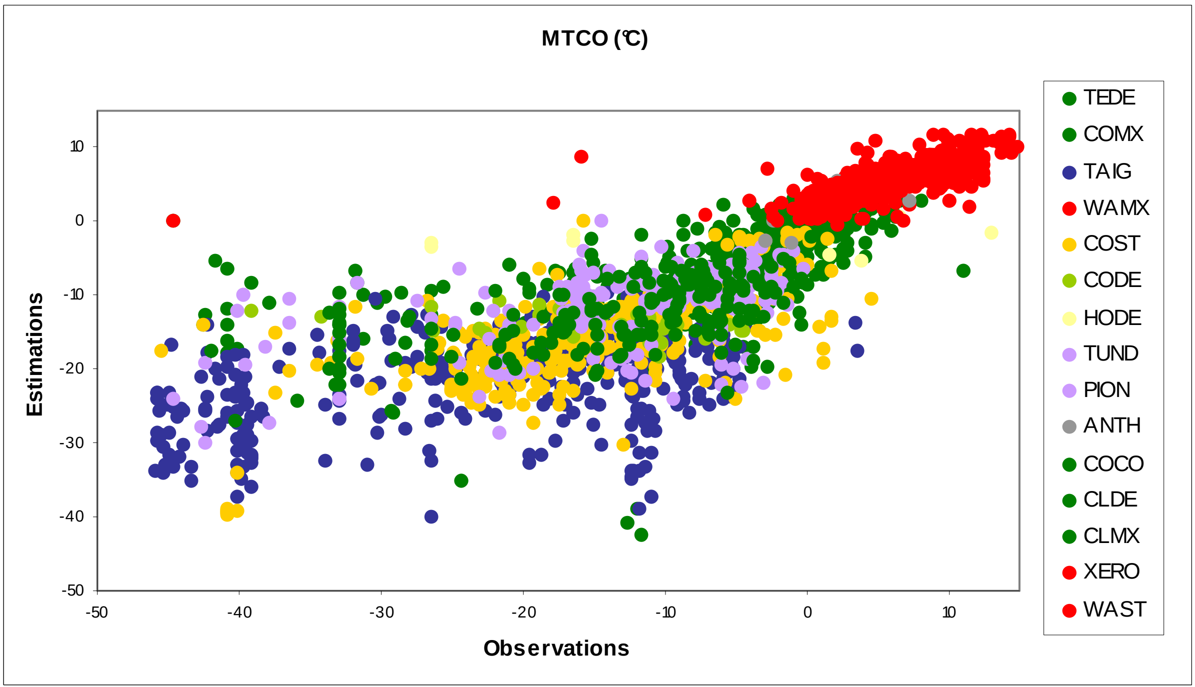
Précipitations								
	Les 1406 échantillons sélectionnés				Les 2760 échantillons			
	MAT sans contrainte par les biomes		MAT avec contrainte par les biomes		MAT sans contrainte par les biomes		MAT avec contrainte par les biomes	
Paramètres	R^2	RMSE	R^2	RMSE	R^2	RMSE	R^2	RMSE
PJAN	0.81	16.06	**0.76**	17.40	0.49	48.62	**0.80**	23.10
PFEB	0.84	12.69	**0.80**	13.92	0.47	46.51	**0.84**	18.15
PMAR	0.81	11.96	**0.77**	13.07	0.41	46.11	**0.81**	17.36
PAPR	0.84	9.14	**0.79**	10.17	0.37	44.96	**0.82**	13.50
PMAY	0.83	9.78	**0.77**	11.11	0.38	45.42	**0.80**	14.79
PJUN	0.83	10.96	**0.77**	12.45	0.41	46.81	**0.81**	16.82
PJUL	0.85	12.31	**0.76**	14.72	0.45	48.00	**0.83**	18.21
PAUG	0.84	12.22	**0.78**	14.06	0.45	47.73	**0.83**	18.42
PSEP	0.74	15.95	**0.69**	16.97	0.39	49.30	**0.73**	23.81
POCT	0.74	17.24	**0.69**	18.58	0.42	49.80	**0.72**	25.44
PNOV	0.80	17.50	**0.75**	19.18	0.49	49.93	**0.79**	25.48
PDEC	0.80	18.59	**0.76**	19.92	0.52	50.57	**0.79**	26.79
PANN	0.76	138.78	**0.73**	147.20	0.73	210.97	**0.74**	206.18
PET	0.88	86.98	**0.80**	111.81	0.85	139.93	**0.88**	121.83
PPET	0.81	168.12	**0.75**	186.57	0.80	240.55	**0.80**	241.92
AET	0.76	75.51	**0.72**	80.74	0.69	121.52	**0.74**	108.73
RUNOFF	0.73	116.83	**0.70**	122.52	0.72	173.54	**0.73**	171.19
AETPET	0.63	15.77	**0.55**	16.88	0.31	49.29	**0.65**	21.61

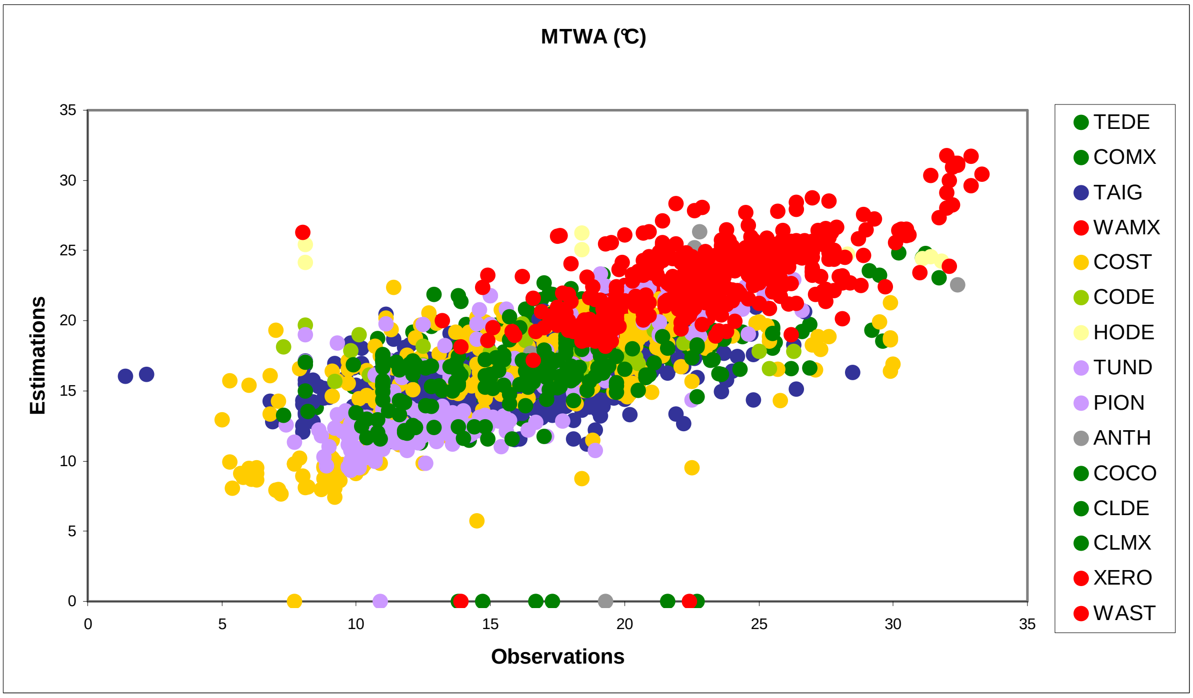
Températures								
	Les 1406 échantillons sélectionnés				Les 2760 échantillons			
	MAT sans contrainte par les biomes		MAT avec contrainte par les biomes		MAT sans contrainte par les biomes		MAT avec contrainte par les biomes	
Paramètres	R^2	RMSE	R^2	RMSE	R^2	RMSE	R^2	RMSE
TJAN	0.83	4.70	**0.75**	5.71	0.84	6.61	**0.84**	6.65
TFEB	0.84	4.40	**0.75**	5.48	0.85	6.18	**0.85**	6.21
TMAR	0.83	3.83	**0.73**	4.74	0.83	5.36	**0.83**	5.38
TAPR	0.76	3.45	**0.65**	4.09	0.77	4.83	**0.77**	4.83
TMAY	0.71	2.97	**0.59**	3.45	0.72	4.15	**0.73**	4.12
TJUN	0.73	2.38	**0.59**	2.80	0.73	3.34	**0.74**	3.30
TJUL	0.79	2.08	**0.67**	2.51	0.79	2.94	**0.80**	2.90
TAUG	0.82	2.06	**0.71**	2.52	0.83	2.90	**0.83**	2.86
TSEP	0.86	2.11	**0.75**	2.70	0.86	2.97	**0.86**	2.95
TOCT	0.84	2.95	**0.74**	3.66	0.84	4.12	**0.84**	4.13
TNOV	0.80	4.38	**0.71**	5.18	0.81	6.16	**0.81**	6.19
TDEC	0.81	4.69	**0.73**	5.55	0.82	6.60	**0.82**	6.64
THIV	0.83	4.59	**0.75**	5.57	0.84	6.45	**0.84**	6.48
TAUTO	0.83	3.04	**0.74**	3.74	0.84	4.27	**0.84**	4.27
TETE	0.78	2.15	**0.66**	2.58	0.79	3.02	**0.79**	2.98
TPRINT	0.78	3.30	**0.67**	3.96	0.79	4.61	**0.79**	4.61
MTCO	0.83	4.70	**0.75**	5.71	0.84	6.61	**0.84**	6.65
MTWA	0.79	2.08	**0.67**	2.51	0.79	2.93	**0.80**	2.89
TANN	0.82	3.04	**0.72**	3.73	0.83	4.25	**0.83**	4.25
GDD0	0.86	573.93	**0.73**	758.39	0.86	813.00	**0.87**	792.19
GDD5	0.85	440.95	**0.72**	571.91	0.85	621.85	**0.85**	607.27

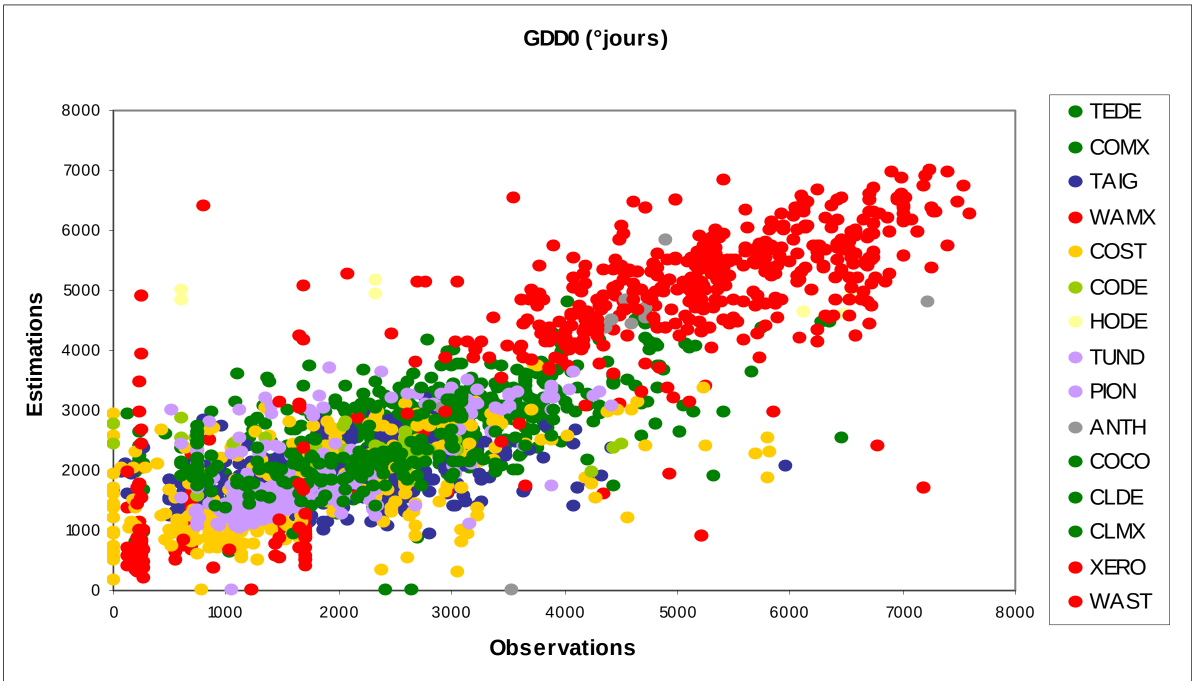
Les résultats montrent que les coefficients de corrélation et les RMSE calculés pour les températures et les précipitations sont élevés quelque soit le paramètre climatique considéré (table 5). Pour les précipitations, la corrélation entre les observations et les estimations est meilleure (R^2 compris entre 0.65 et 0.88) et les RMSE sont plus faibles donc les reconstitutions sont plus fiables, lorsque la technique des meilleurs analogues est appliquée avec la contrainte des biomes à tous les 2760 échantillons de la base de données. Les estimations de AET/PET sont variables et dépendent des échantillons, ce qui peut expliquer que les corrélations soient meilleurs sur l'ensemble des 2760 échantillons de la base de données (R^2 est égal à 0.65) que sur les 1406 échantillons (R^2 égal 0.55).

La figure 5 représente, pour sept paramètres climatiques : température moyenne annuelle (TANN), température moyenne du mois le plus froid (MTCO) et du mois le plus chaud (MTWA), le nombre de degrés jours supérieurs à 0°C (GDD0) et 5°C (GDD5), le montant annuel des précipitations (PANN) et le rapport entre l'évapotranspiration réelle et l'évapotranspiration potentielle (AET/PET), en abscisse les valeurs climatiques observées et en ordonnée les valeurs climatiques estimées, en appliquant la méthode des meilleurs analogues contrainte par les biomes sur l'ensemble des 2760 échantillons.






MTWA (°C)
Estimations
Observations
0
5
10
15
20
25
30
35
TEDE
COMX
TAIG
WAMX
COST
CODE
HODE
TUND
PION
ANTH
COCO
CLDE
CLMX
XERO
WAST


GDD0 (°jours)
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Observations
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6000
7000
8000
TEDE
COMX
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WAMX
COST
CODE
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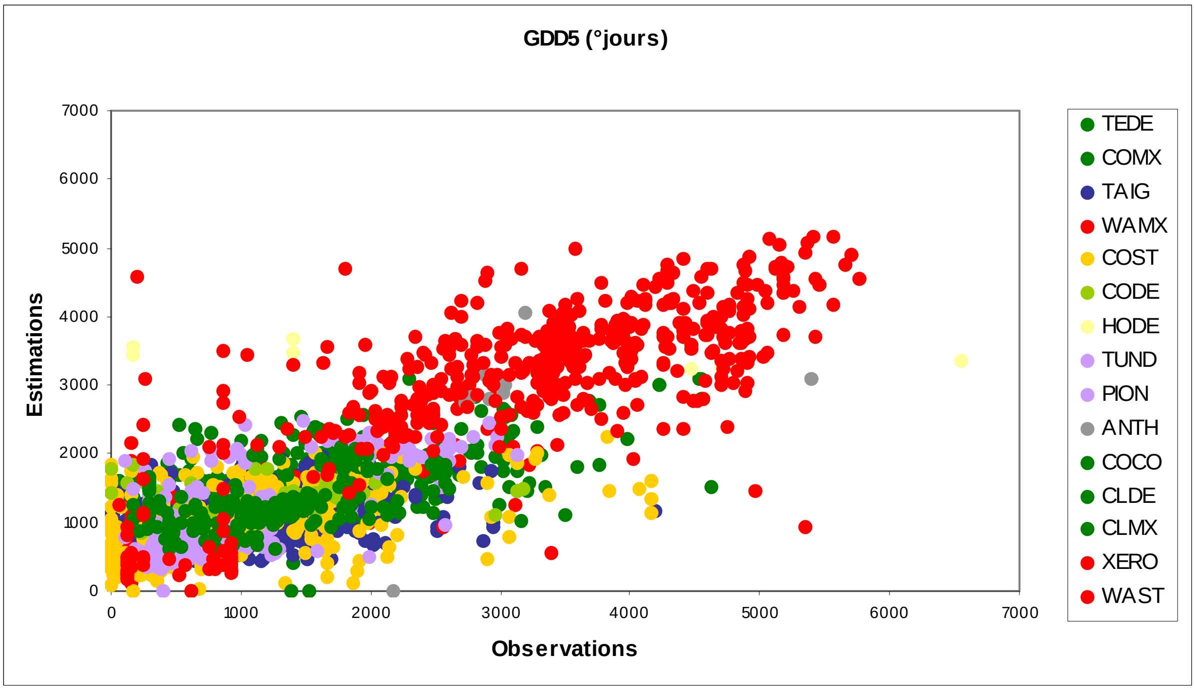
TUND
PION
ANTH
COCO
CLDE
CLMX
XERO
WAST


GDD5 (°jours)
Estimations
Observations
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4000
5000
6000
7000
TEDE
COMX
TAIG
WAMX
COST
CODE
HODE
TUND
PION
ANTH
COCO
CLDE
CLMX
XERO
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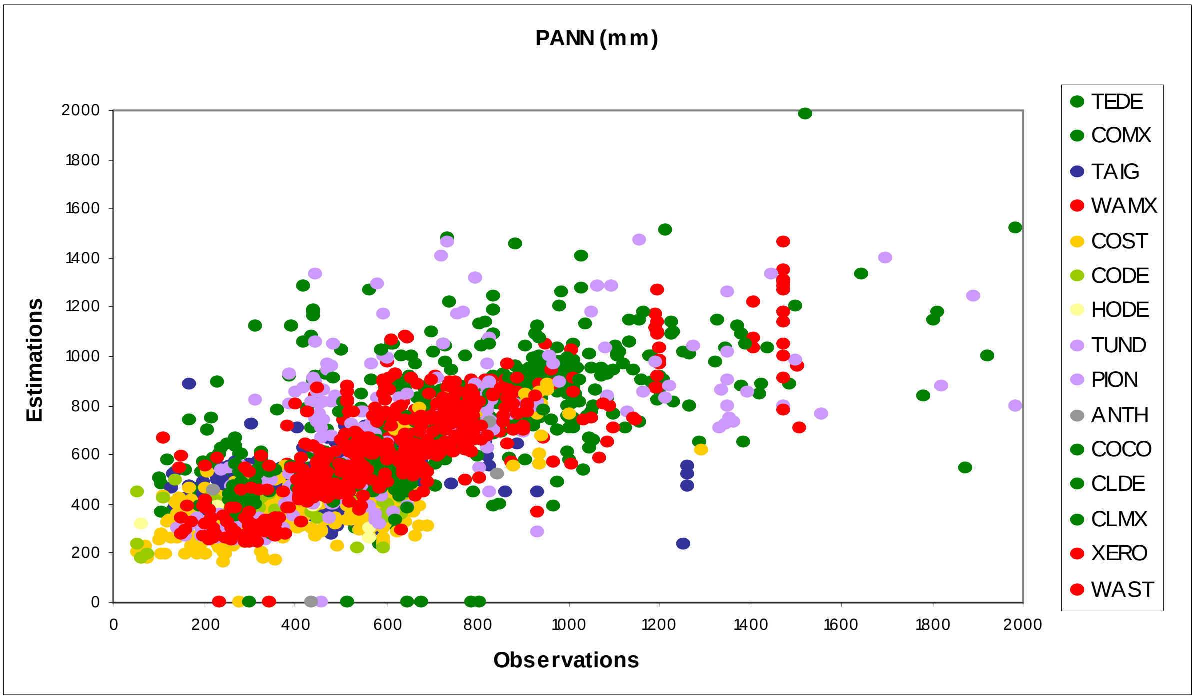
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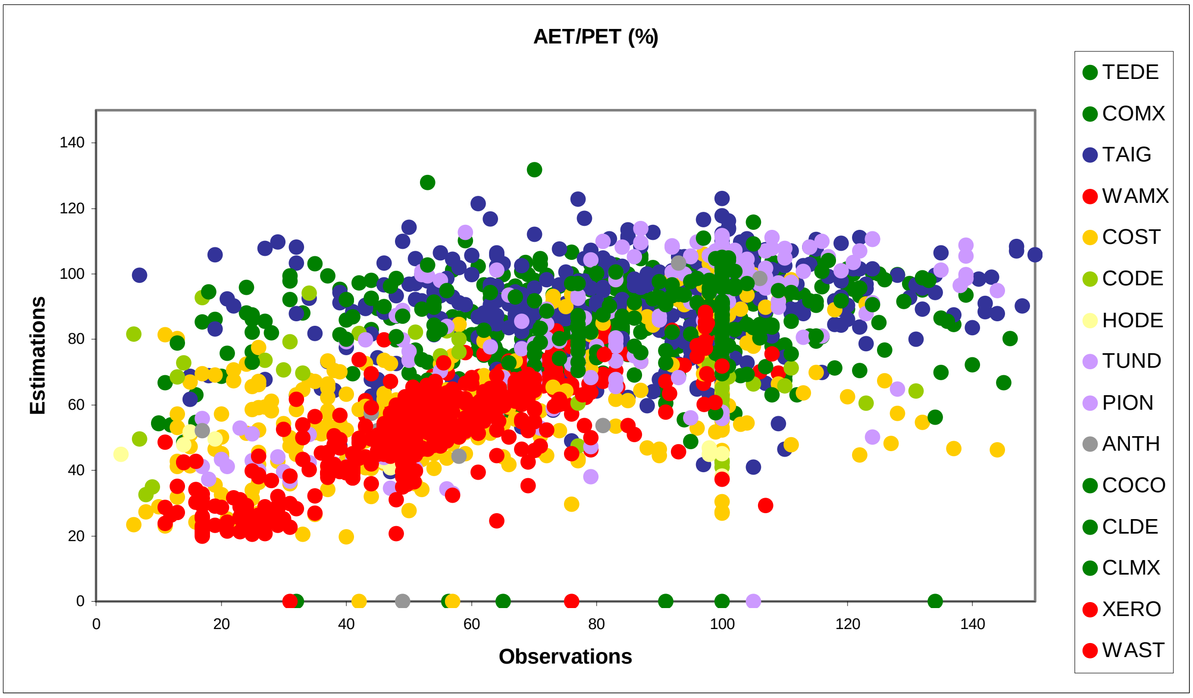

Figure 5: Graphiques représentant en abscisse les valeurs observées et en ordonnée les valeurs estimées de sept paramètres climatiques: température moyenne annuelle (TANN, °C), température moyenne du mois le plus froid (MTCO, °C) et du mois le plus chaud (MTWA, °C), le nombre de degrés jours supérieurs à 0°C (GDD0, °jours) et à 5°C (GDD5, ° jours), le montant annuel des précipitations (PANN, mm) et l'humidité relative (AET/PET, %), en appliquant la MAT contrainte par les biomes sur l'ensemble des 2760 échantillons de la base de données.

La figure 5 montre une répartition cohérente de la plupart des sites le long de chaque gradient climatique, en fonction du biome qui lui est associé. Les graphiques (fig. 5) indiquent aussi des corrélations proches de 1 entre les estimations et les observations pour les paramètres climatiques liés à la température (TANN, MTCO, MTWA, GDD0, GDD5), qui sont meilleures que celles des paramètres liés aux précipitations (PANN, AET/PET). Des vérifications/corrections ont déjà été faites, pour certains sites, sur les valeurs des paramètres liés aux précipitations et à l'évapotranspiration, mais la figure 5 montre qu'il reste encore des sites où les valeurs interpolées sont différentes des estimations et doivent donc être vérifiées à partir de données de stations météorologiques les plus proches de chaque site. Les valeurs observées d'AET/PET sont parfois supérieures à 100%, et, pour les sites associés au biome COST, les valeurs d'AET/PET sont souvent incorrectes car elles ne devraient pas être supérieures à 65%. Dans ce cas, les valeurs de PET et AET interpolées doivent être vérifiées pour chaque site concerné. Des corrections ont déjà été faites pour certains sites et les problèmes étaient liés à des valeurs de PET interpolées différentes des valeurs fournies à partir des stations météorologiques les plus proches de chaque site. Les graphiques de la figure 5 montrent qu'il y a aussi des sites où aucun analogue n'a pu être identifié et donc où les valeurs climatiques estimées sont égales à zéro.

Pour les sites présentant des incohérences, (1) soit le biome attribué n'est pas cohérent avec la carte des biomes établie à partir de données de végétation (fig. 4) et l'attribution du biome doit être vérifiée, (2) soit les valeurs climatiques interpolées ne sont pas correctes et doivent être modifiées à partir des données de stations météorologiques. La figure 5 montre donc l'état actuel de la base de données avec ces points positifs et le travail qu'il reste encore à effectuer pour la valider entièrement.

Conclusion

Cette nouvelle base de données semble prometteuse pour la reconstitution quantitative des climats du passé à partir de données polliniques fossiles, puisque les tests de corrélation indiquent des valeurs correctes de R^2, mais des analyses statistiques plus approfondies semblent encore nécessaires. Grâce aux nouveaux échantillons qui ont été ajoutés, les environnements type «végétation méditerranéenne, forêt tempérée ou végétation de transition entre la forêt et la steppe» sont mieux représentés dans la base de données. L'ajout des valeurs mensuelles des paramètres de température, de précipitation et d'évapotranspiration potentielle associées à chaque site permet de faire des reconstitutions quantitatives mensuelles du climat et donc de mieux comprendre les changements passés de la saisonnalité.

Du travail reste encore à effectuer pour valider entièrement cette nouvelle base de données. Pour certains sites, les données climatiques interpolées et/ou le biome doivent être vérifiés et corrigés.

L'ensemble des 2760 sites permet aujourd'hui de couvrir la majorité des écosystèmes présents actuellement en Europe et en Eurasie. Mais, il serait intéressant d'apporter de nouveaux échantillons pour améliorer la couverture spatiale notamment dans le Nord de la France, en Allemagne, au Nord des Balkans et sur les îles britanniques, et, ainsi limiter les situations de non analogie lors des reconstitutions climatiques à partir de la méthode des meilleurs analogues appliquée à des données polliniques fossiles. Ces nouveaux sites pourraient correspondre: (1) à des zones géographiques qui ne sont pas encore couvertes par les 2760 échantillons de la base de données (par exemple le nord de la péninsule balkanique), (2) à des zones altitudinales non caractérisées dans les régions montagneuses. Par exemple, les 2760 échantillons de la base de données ne permettent pas actuellement une bonne représentation des sites correspondant à la steppe alpine. Or ces sites pourraient donner de bons analogues pour étudier les phases glaciaires.

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Chapitre 3: Le climat depuis la dernière déglaciation dans la région de Maliq

Introduction

Une première application de la base de données actuelles a été réalisée sur la séquence pollinique K6 prélevée dans le lac Maliq (Denèfle et al., 2000) pour reconstituer les variations mensuelles de température et de précipitation dans la région de Maliq au cours de la dernière déglaciation et de l'Holocène. Les reconstitutions climatiques ont été obtenues en appliquant la technique des « meilleurs analogues » avec le nouveau référentiel actuel (chapitre 2) sur les données polliniques fossiles du lac Maliq. Les résultats font l'objet d'un article accepté à Quaternary International (Bordon et al., sous presse). Ils montrent deux phases froides dans la région de Maliq, correspondant aux périodes du Dryas ancien et du Dryas moyen, et, à un évènement froid autour de 8200 ans cal BP. Ces résultats suggèrent que les forçages climatiques enregistrés en Atlantique Nord depuis la dernière période glaciaire ont influencé le climat jusque dans l'Est de la région méditerranéenne. Le Dryas ancien et le Dryas moyen sont caractérisés dans la région du lac Maliq par un climat aride et un changement de saisonnalité des précipitations : les précipitations estivales pendant les phases glaciaires apparaissent plus élevées que les précipitatioons qui tombent en été pendant les phases tempérées. Le climat à l'Holocène est relativement stable avec des valeurs pour chaque paramètre climatique qui sont proches des valeurs actuelles. Des petites oscillations sont enregistrées par exemple autour de 8300-8100 ans cal BP.

Les données climatiques obtenues à Maliq ont ensuite été utilisées pour discuter les variations du niveau lacustre du paléo-lac de Maliq dont les résultats ont été soumis à la revue Geoarcheology (Fouache et al., soumis).

Pollen-inferred Late-Glacial and Holocene climate in southern Balkans (Lake Maliq)

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Abstract

High-temporal resolution analysis of pollen records from Lake Maliq (Albania) provides quantitative estimates of monthly temperature and precipitation changes since the last deglaciation. The climate parameters were estimated using the best modern analogue technique with an updated modern pollen-climate database composed of 2748 surface samples. The record shows two main cooling phases in the Maliq area (the Oldest and Younger Dryas) and a cooling event around 8200 years which suggests that the forcing factors driving climate variations in the North Atlantic area since the last glacial period also extended their influence into the Mediterranean area. The Oldest and Younger Dryas are also characterized by an arid climate and a change in the seasonality of precipitation: the summer precipitation tends to be greater during the cooling phases than during the temperate periods. The Holocene climate is relatively stable and the values of each parameter reach their modern levels, except for an arid event between 8300 and 8100 cal years BP.

Keywords: Climate, Pollen, Late-Glacial, Holocene, Southern Balkans, Mediterranean area

Introduction

Due to present-day global change, a considerable effort has been made over the last few decades to provide reliable estimates of paleoclimate changes, particularly for the last 15 000 years BP. Quantitative climate reconstructions are needed (1) to better understand the mechanisms that drive climate changes, (2) to study the possible relationships between climate and human societies and (3) to validate GCM simulations, that incorporate climate forcing that differs from forcing experienced today. The development of regional pollen databases, collections of several hundreds of well-dated sequences (e.g. European Pollen Database) and the development of various statistical techniques for climate reconstructions (Guiot 1990; Birks 1995; Peyron, Guiot et al. 1998; Kühl, Gebhardt et al. 2002) offer exceptional opportunities to investigate temperature and rainfall distributions and their variations through time and space in Europe during the last deglaciation and early Holocene. Several continental paleoclimatic reconstructions have been published for this period, however, they differ significantly, particularly regarding the Mediterranean area (Huntley and Prentice 1988; Cheddadi, Yu et al. 1997; Masson, Cheddadi et al. 1999; Roberts, Reed et al. 2001; Sadori and Narcisi 2001; Antonioli, Cremona et al. 2002; Marchal, Cacho et al. 2002). This is mainly due to (1) the lack of quantitative estimates of climate parameters in southern Europe and the Mediterranean area, where only two pollen sequences have been analysed: at Lago Grande di Monticchio in Italy (Allen, Watts et al. 2002) and at Tigalmamine in Morocco (Cheddadi, Lamb et al. 1998) and (2) the scarcity of high resolution sequences covering the last deglaciation and the Holocene, particularly in southern Balkans (Bottema 1979; Willis 1994a; Bottema 1995; Denèfle, Lezine et al. 2000). Especially, the Younger Dryas event has not been clearly recorded so far (Bottema 1995), with the exception of a single low altitude site: Tenaghi Philippon, in Greece (Wijmstra 1969).

In this study, we use the K6 pollen sequence recovered in Lake Maliq (40°21’N, 20°25’E) (Denèfle, Lezine et al. 2000) to infer past climate changes which occurred at mid-altitude in the southern Balkans during the last deglaciation and the Holocene. We use the modern analogue technique (MAT), developed by Guiot (1990) which is a commonly used and accepted method for the reconstruction of the oscillations of the Lateglacial and Holocene climate from continental sequences (Huntley and Prentice 1988; Guiot and Couteaux 1992; Guiot, de Beaulieu et al. 1993; Cheddadi, Yu et al. 1997; Huntley, Watts et al. 1999; Magny 2001; Muller, Pross et al. 2003; Peyron, Begeot et al. 2005; Ortu, Brewer et al. 2006). Our study is based on a set of 2748 modern pollen samples (Peyron and Bordon, unpublished data).

This article aims to (1) discuss the timing of the deglaciation in southern Balkans and (2) accurately reconstruct the climate parameters responsible for the high amplitude environmental change which occurred at middle altitudes. We will discuss the role of the seasonal distribution of temperature and rainfall, previously shown at lower altitudes by Prentice et al. (1992) for the last glacial period.

Regional setting

Lake Maliq lies in the north-western part of the Korçë basin (Fig. 1) in southern Albania. It is mainly fed by the Devollit and the Dunacevit rivers. Lake Maliq belongs to a complex hydrological system formed by four lacustrine basins: Korçë in Albania, Great and Small Prespa on the boundary between Albania, Greece and Macedonia to the east, and Ohrid on the boundary between Albania and Macedonia to the north. These basins have been isolated since the end of the Pliocene. The Korçë basin has an altitude of the 818 m a.s.l. and is surrounded by highlands which reach 2028 m (Mali Thatë) in height. Lake Maliq has recently been drained for agricultural purposes. During the Holocene, however, its surface varied between a minimum of 40 km^2 during periods of low level to a maximum of 80 km^2.

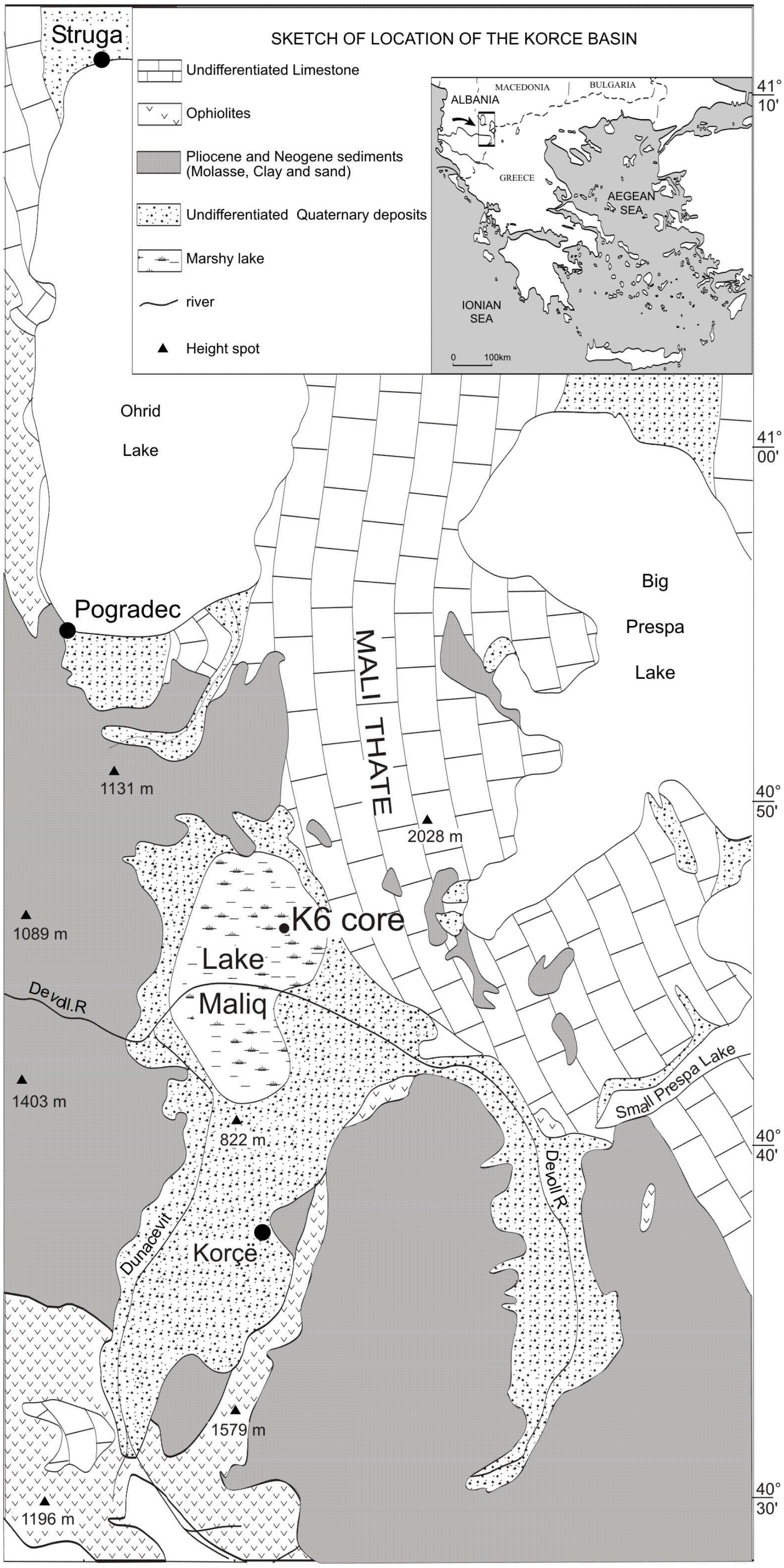

Figure 1: Location and geomorphologic context of Lake Maliq (Albania), and location of the core K6 (40°21' N, 20°25' E; alt. 818 m).

Due to the proximity of the Adriatic Sea and the surrounding mountains, the climate in the area of Maliq has both Mediterranean and continental influences, as illustrated in figure 2. The regional climate is characterized by low temperatures in winter (around 0°C) and mild temperatures in summer (from 16°C to 20°C) with a mean annual temperature of 11.2°C. Annual rainfall is 790 mm with its peak in October (105 mm). In summer, the rainfall is around 45 mm per month, in winter around 65 mm per month.

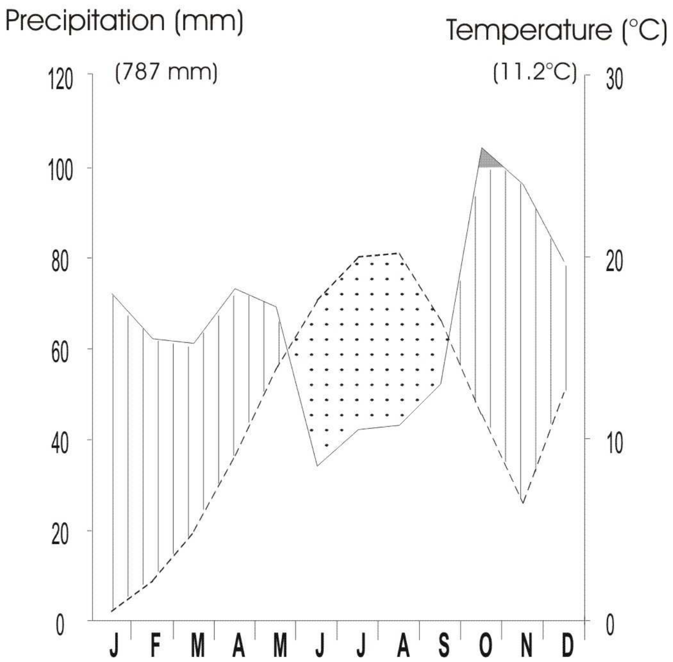

Figure 2: Ombrothermic diagram based on the climate records from 1961 to 1990 at Maliq climate station (Watzin, Puka et al. 2002). The periods of maximum precipitation are hatched and black, the latter representing precipitation exceeding 100 mm. The arid periods are dotted.

The present-day vegetation at Lake Maliq is sub-Mediterranean with an altitudinal distribution of plant communities (Polunin et al., 1980). The lower mountain slopes, up to about 1200 m a.s.l., are dominated by mixed deciduous woods with *Carpinus orientalis*, *Acer monspessulanum*, *Pistacia terebinthus*, *Fraxinus ornus* and *Phillyrea latifolia*. The upper slopes are covered by oak forests with *Quercus trojana*, *Q. frainetto*, *Q. cerris* that may be locally associated with *Pinus leucodermis*, *Juniperus excelsa*, *J. foetidissima* and *Aesculus hippocastanum*. Beech woods, with *Fagus moesiaca*, *Abies alba* and *Abies borisii-regis*, are found above the oak forests, up to 1800 m a.s.l. Sub-alpine moors and grasslands are present above the tree-line (~ 1800 m).

Material and methods

The Lake Maliq sedimentary sequence

The Lateglacial and Holocene vegetation and climate history are based on the pollen analysis of the K6 core (40°21'N, 20°25'E), collected in the central part of Lake Maliq. The sedimentary sequence is composed of a grey clay unit at the base, overlain by an organic-rich deposit.

To improve the chronology, eight new AMS ^{14}C measurements on total organic matter, have here been added to the eight dates available in Denèfle et al. (2000) allowing a precise chronology of the last deglaciation in southern Balkans (Table 1). Two slight inversions, not exceeding 150 years, are observed between 281-220 cm and 645-620 cm of depth. Fourteen ^{14}C measurements have been retained and converted into calendar ages (cal yr BP) using calibration from (Bard, Arnold et al. 1998) and (Reimer, Baillie et al. 2004). A time scale was then obtained by linear interpolation to the profile of calendar ages against depth (Fig. 3).

Table 1: Age control for core Korçë 6 based on eight new AMS radiocarbon measurements and eight ^{14}C measurements based on the study of Denèfle et al. (2000). Calibration was performed with the radiocarbon calibration program Calib Rev 5.0.2 with one-standard deviation error bars.

Depth (cm)	Age 14C (years BP)	Age calibrated (1 sigma) (cal B.P.)	Laboratory	Material
220-225	2560+/-55	2646+/-107	Lyon-502 (OxA)	Organic matter
277-281	2415+/-45	2512+/-158	Lyon-828 (OxA)	Organic matter
300	3730+/-30	4070+/-76	SacA 5298	Organic matter
320-328	4245+/-90	4747+/-132	Ly-8143	Organic matter
410-415	4420+/-70	5043+/-172	Lyon-503 (OxA)	Organic matter
440	5405+/-30	6236+/-41	SacA 5299	Organic matter
515	6155+/-30	7078+/-78	SacA 5300	Organic matter
560-565	7210+/-90	8057+/-102	Lyon-504 (OxA)	Organic matter
620	8415+/-35	9458+/-28	SacA 5301	Organic matter
640-645	8350+/-70	9379+/-84	Lyon-671 (Oxa)	Organic matter
665	9310+/-40	10506+/-70	SacA 5302	Organic matter
690	9995+/-45	11466+/-137	SacA 5303	Organic matter
700-710	10065+/-100	11604+/-212	Lyon-505 (OxA)	Organic matter
785	10715+/-40	12789+/-36	SacA 5304	Organic matter
845-850	11475+/-100	13326+/-89	Lyon-670 (OxA)	Organic matter
925	13560+/-50	16127+/-191	SacA 5305	Organic matter

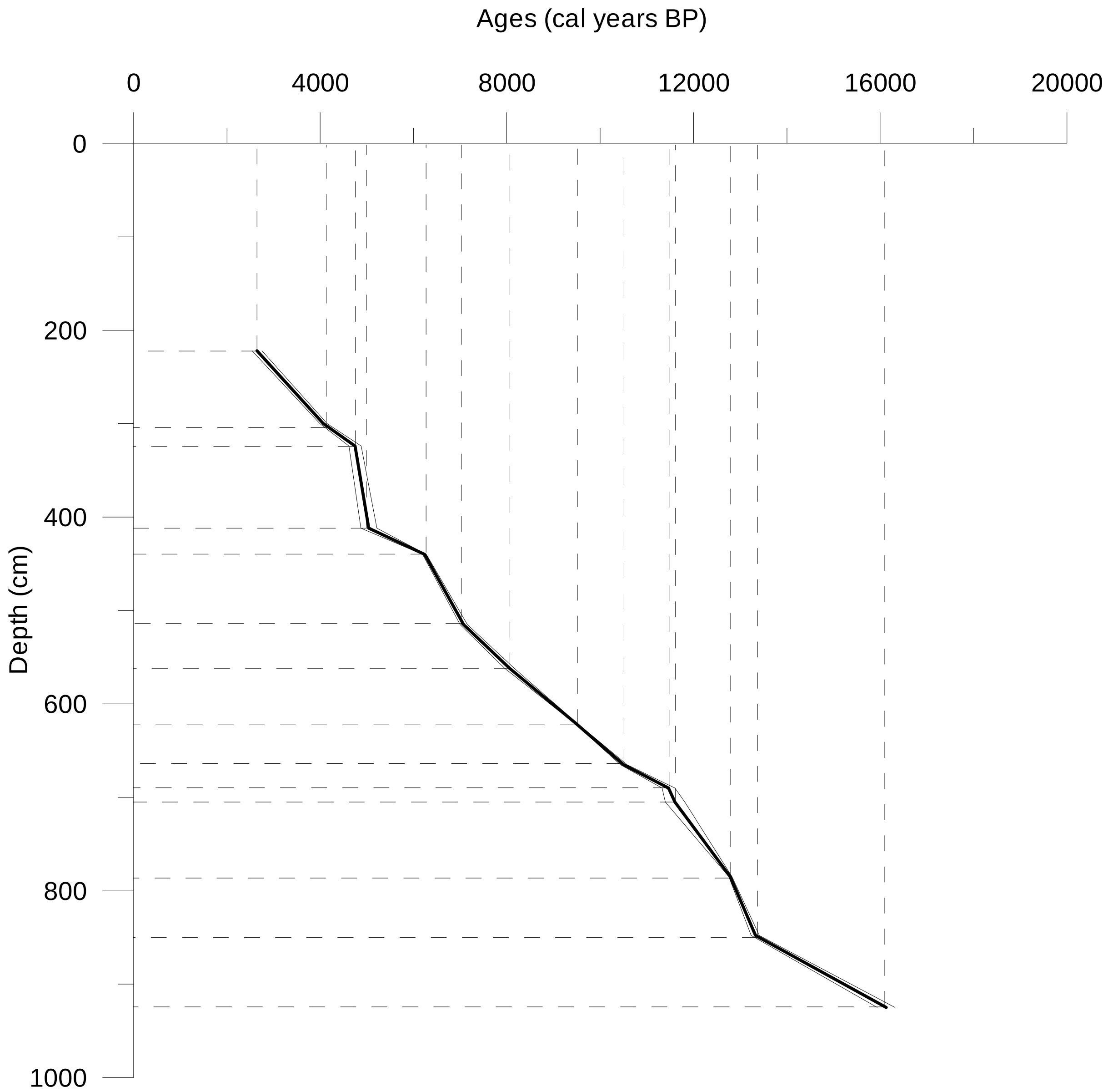

Figure 3: Age-depth model developed for the K6 core (thick line) with error bars (light lines).

Modern analogue technique (MAT)

The modern analogue technique, firstly developed by Overpeck et al. (1985) and extended by Guiot (1990) to reconstruct climate parameters from fossil assemblages for past key periods, was applied to the Lake Maliq pollen sequence. The principle of this technique is (1) to compare the fossil pollen assemblage with modern pollen assemblages using a dissimilarity index, (2) and to select, for each fossil assemblage, between five to eight of the closest modern pollen assemblages (or best modern analogues). The climate parameters of these selected best analogues are then averaged to provide the climatic estimates of the fossil assemblage. The climate parameters considered are: the mean temperature of the coldest month (MTCO) and the annual accumulated temperature over 5°C (GDD5), as these are main climate parameters controlling plant distribution, after Prentice et al. (1992). In addition, we have reconstructed the mean temperature of the warmest month (MTWA), the mean annual temperature (TANN) and the annual precipitations (PANN) to allow comparisons with previous studies, and, the mean monthly precipitation in summer (Psummer) and winter (Pwinter) to study the changes of seasonal distribution of precipitation.

A new modern pollen dataset

The MAT, like most of the approaches that aim to quantitatively reconstruct the past climate from fossil assemblages, is based on the present-day environment, and therefore requires high-quality, taxonomically consistent modern datasets. In this study, the method is based on a new modern pollen-climate dataset which comprises 2748 sets of pollen data (Fig. 5) sampled from a wide variety of biomes (Peyron and Bordon, unpublished data).

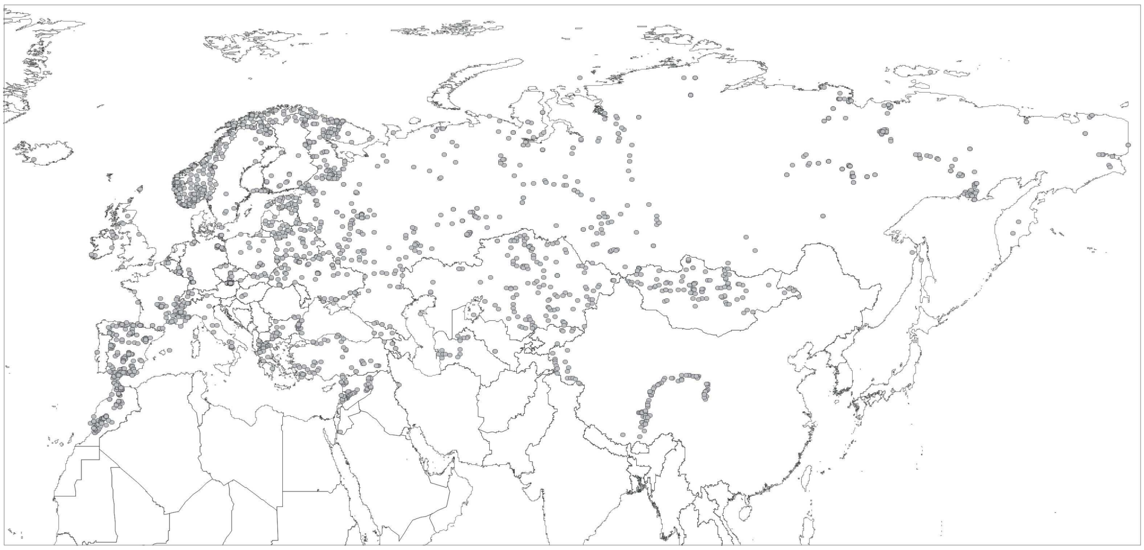

Figure 5: The distribution of pollen sites from the modern pollen-climate database used in this study.

This dataset is a compilation of information from a previous modern pollen dataset (Peyron, Guiot et al. 1998) to which we have added 763 new samples already published (Bottema 1974; Tarasov, Webb III et al. 1998; Dambach 2000; Davis, Brewer et al. 2003) and 1319 other new samples (H.J.B. Birks, M. Court-Picon, Y. Miras, J.-P. Suc, unpublished data). For each sample, several parameters are available: the geographical location, the pollen percentages, the associated biome and the monthly climate variables interpolated at each site. Modern pollen data are taken from moss samples, soil or core samples. The pollen percentages are calculated using the sum of the percentages of a set of 104 taxa as total pollen sum. Climatic values are assigned to each of the modern pollen samples using the high-resolution database of climatic means (New et al., 2002). For each site, mean monthly values of temperature, precipitation and cloud cover were assigned as a weighted average from the closest four grid points, then adjusted for differences in elevation between the site and the climatic grid. The monthly values were then used to calculate a set of bioclimatic variables, considered to be more closely linked to the pollen assemblages (Prentice, Guiot et al. 1992). These variables include: MTCO, MTWA and GDD5 which is calculated by summing the mean daily temperature (less 5°C), for all days when the mean temperature is higher than 5°C. Biomes were determined using the "biomization" method (Prentice, Guiot et al. 1996). This method consists of classifying each taxon as one or more plant functional type (PFT), and then defining each biome as a potential combination of one or more PFT. Sixteen biomes are considered: cold deciduous forest, taïga, pioneer vegetation, cool mixed forest, cool conifer forest, temperate deciduous forest, cold mixed forest, warm mixed forest, xerophytic woods/scrub, tundra, cold steppe, warm steppe, cold desert, hot desert, aquatic vegetation, and anthropic vegetation.

Selection of the modern analogues

The selection of the best modern analogues is based on the calculation of a chord distance measured between each fossil and modern pollen assemblage (Overpeck, Webb et al. 1985; Guiot 1990). A subset of analogues is selected with a distance less than a threshold defined by a Monte Carlo test. From this, the eight modern analogues closest to the fossil assemblage are selected and considered as the best modern analogues. The climatic values of the fossil assemblage are obtained as a weighted average of the climate parameters of the eight analogues. This procedure is then repeated for all fossil assemblages. To give an indication of the homogeneity of the analogues and thus of the quality of the reconstitution, a confidence interval is also defined (Guiot 1990).

Furthermore, to reduce uncertainties caused by human influence on the modern vegetation or the occurrence of no-analogue situations that can affect climate reconstructions, particularly during the Glacial and Lateglacial periods (Guiot, Harrison et al. 1993; Peyron, Guiot et al. 1998; Peyron, Begeot et al. 2005), we have carried out a second reconstruction using the MAT approach with a "biome" constraint, as defined by Guiot et al. (1993). The principle of the constraint consists in comparing the biome attributed to the eight analogues with the biome attributed to the fossil assemblage. Only the analogues with consistent biomes are retained for the analogue selection and for the climate reconstruction.

Results

Reliability of the reconstructions

To evaluate the reliability of the paleoclimate reconstructions, two validation tests have been set up by applying the MAT and the MAT with "biome" constraints (1) to all the samples of the modern pollen dataset; and (2) to eight independent surface samples from Albania, the Republic of Macedonia and northern Greece which had been collected along an altitudinal transect in each vegetation belt (two samples were randomly selected per vegetation belt). The correlation coefficient and the root mean squared error (RMSE) indicate the accuracy of the method (Table 2). Results show that the correlation coefficients of the precipitation and temperature parameters are good when the "biome" constraint method is applied to all samples in the modern pollen dataset (R^2 between 0.71 and 0.85), and to the eight modern samples (R^2 between 0.80 and 0.88). Also, the correlation between observations and reconstructions is better with the "biome" constraint modern analogue technique than the modern analogue technique without biome constraint.

Table 2: Correlation coefficients between observed and reconstructed values of climate parameters obtained from application of Modern Analogues Technique approach to (1) all the samples of the modern pollen dataset, and (2) eight modern pollen samples of Albania, the Republic of Macedonia and northern Greece.

Temperatures						
	Modern pollen database			**Modern samples from Albania**		
	Correlation coefficient		RMSE	Correlation coefficient		RMSE
Climate parameter	MAT with no biome constraint	MAT with biome constraint	MAT with biome constraint	MAT with no biome constraint	MAT with biome constraint	MAT with biome constraint
MTCO	0.84	**0.84**	**6.9**	0.73	**0.84**	**2.5**
MTWA	0.77	**0.77**	**3.2**	0.51	**0.80**	**2.5**
TANN	0.82	**0.82**	**4.5**	0.65	**0.81**	**2.5**
GDD5	0.85	**0.85**	**620**	0.48	**0.84**	**599**

Precipitations						
	Modern pollen database			**Modern samples from Albania**		
	Correlation coefficient		RMSE	Correlation coefficient		RMSE
Climate parameter	MAT with no biome constraint	MAT with biome constraint	MAT with biome constraint	MAT with no biome constraint	MAT with biome constraint	MAT with biome constraint
PANN	0.75	**0.71**	**219**	-0.04	**0.83**	**110**
Psummer	0.81	**0.80**	**19**	0.47	**0.88**	**5**
Pwinter	0.80	**0.77**	**20**	0.21	**0.80**	**14**

The biome and climate reconstructions at Lake Maliq

From 16 000 cal years BP to the end of the Holocene, four distinct “climatic” periods can be described at Lake Maliq (Fig. 6a, b).

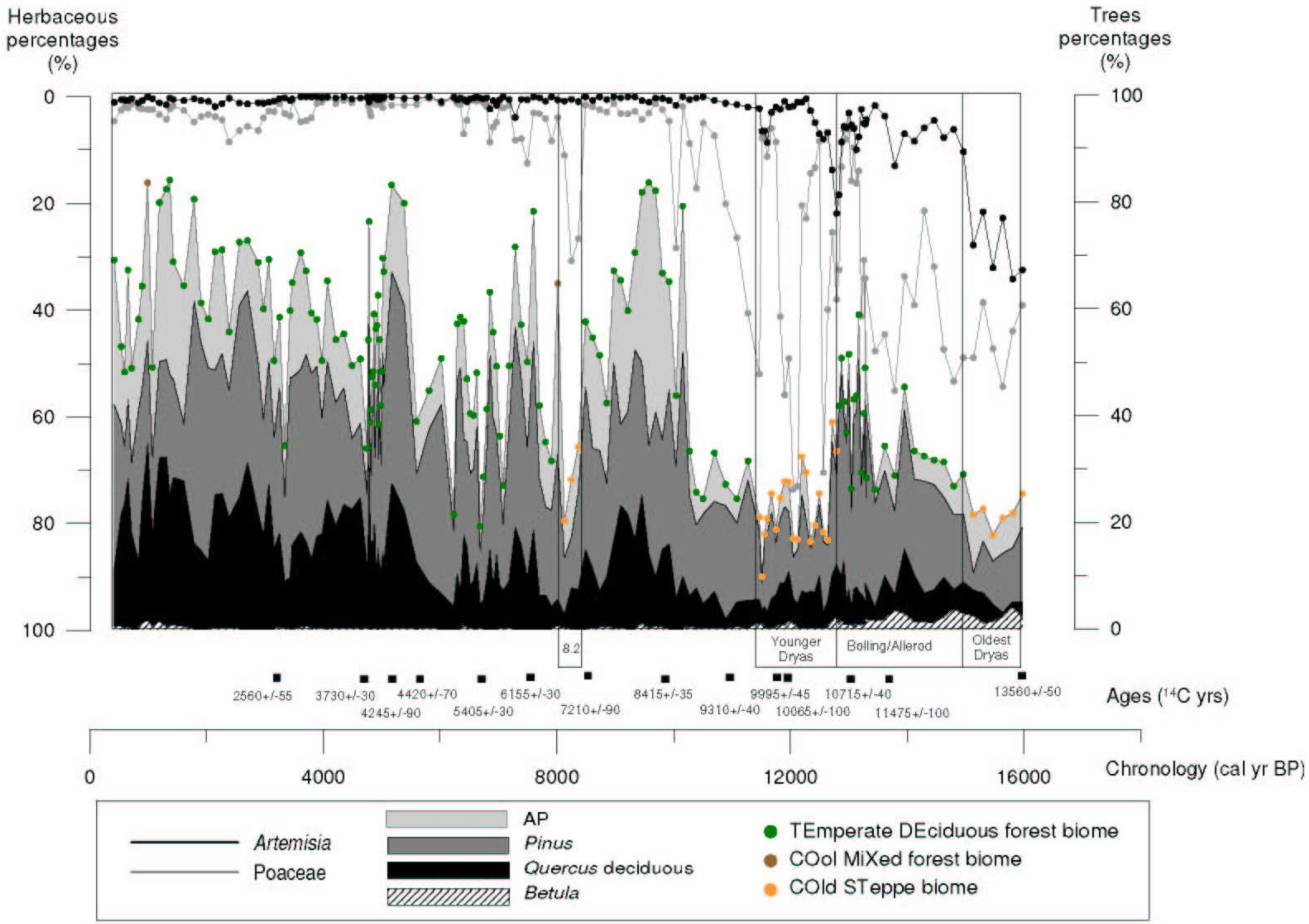

Figure 4: Simplified pollen diagram of Lake Maliq core K6. The biome attribution is based on Prentice et al (1996) and Peyron et al. (1998). The biome abbreviation (TEDE: temperate deciduous forest; COMX: cool mixed forest; COST: cold steppe) is indicated above the arboreal pollen (AP) curve.

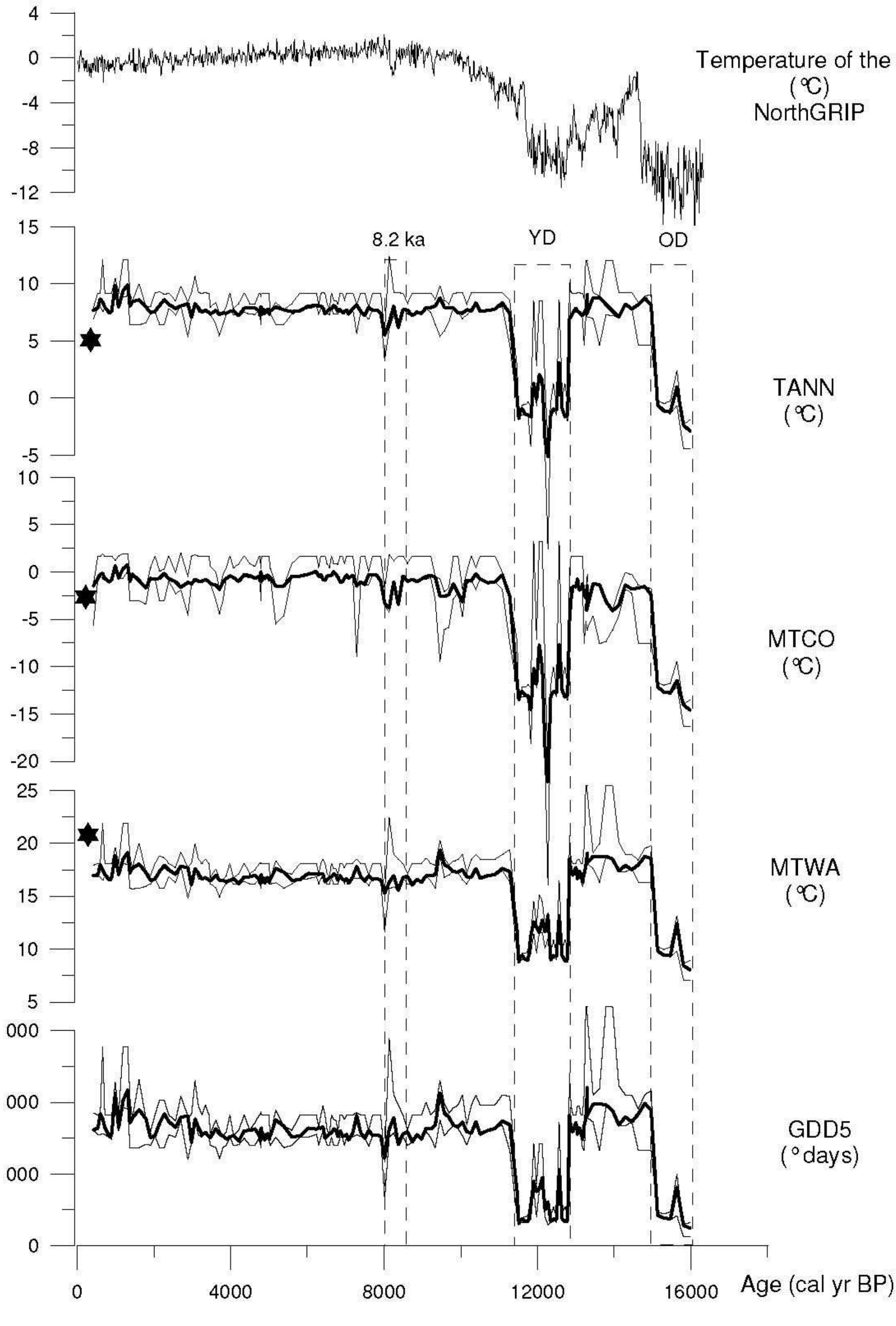

Figure 6a: Quantitative climate reconstruction at Lake Maliq pollen using MAT with biome constraint: (1) pollen-inferred temperature parameters: mean annual temperature (TANN), mean temperature of the coldest month (MTCO), and the warmest month (MTWA), annual growing degree days above 5°C (GDD5). Mean values are plotted (line) together with the error bars, which are plotted in grey. The major Holocene and Lateglacial events (8.2 ka, Younger Dryas, Oldest Dryas) are indicated. The modern climate values are indicated

with a black star. Values of air temperature estimated at NorthGRIP from delta ^{18}O measurements (Johnsen et al., 2001) are given at the top of the figure.

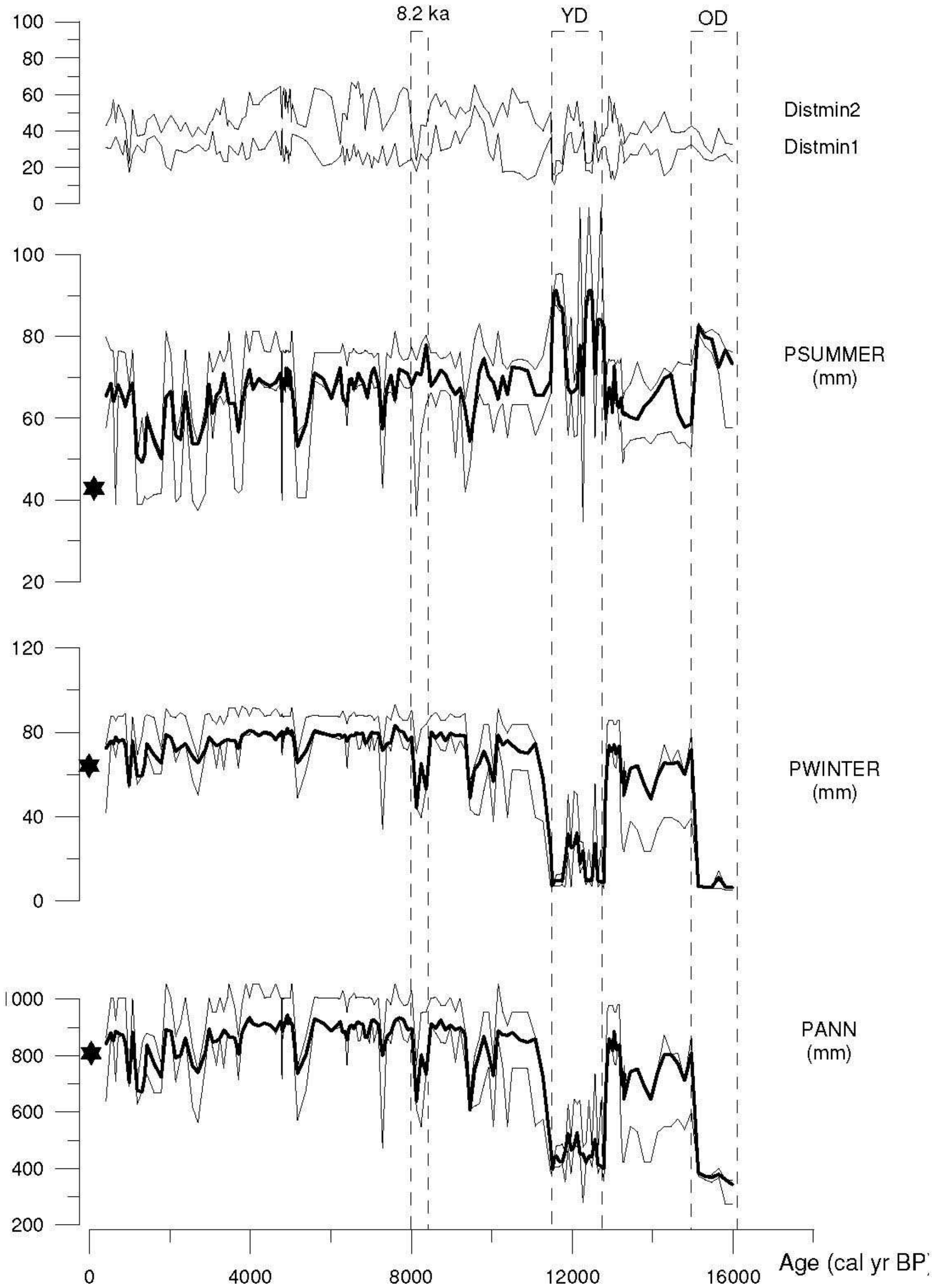

Figure 6b: Pollen-inferred quantitative climate reconstruction at Lake Maliq using MAT with biome constraint: (2) hydrological parameters: summer precipitations (Psummer) calculated as the mean of the precipitations during June, July, August and September; winter precipitations (Pwinter) calculated as the mean of the precipitations during October, November, December, January, February, March, April, May, annual precipitation (PANN). The Euclidian distances calculated between the eight modern pollen assemblages considered as the best analogues and the fossil assemblage (nearest and furthest) are indicated at the top of the figure as Distmin 1 and Distmin 2.

From 16 000 to 15 100 cal. yr. BP: a cold and dry event (Oldest Dryas)

Between 16 000 ± 200 and 15 100 ± 200 cal years BP, the reconstructed biome is a cold steppe dominated by *Artemisia* and Poaceae (Fig. 4). It is characterized by low temperatures in both summer and winter (-3° to 1°C for TANN, 8° to 12°C for MTWA,–14.5° to –12°C for MTCO, 240 and 800 degree days for GDD5) and annual precipitation lower than 400 mm (Fig. 6a, b). Our results also show increased summer precipitation (i.e. +30 mm more than today) and lower precipitation in winter (i.e. –55 mm) (Fig. 6b). The Euclidean distance measured between the fossil assemblages and the best analogues is particularly low (Fig 6b), indicating that the modern samples selected provide close analogues for the fossil samples and the reconstructions for the Oldest Dryas at Lake Maliq are not affected by "no-analogues" situations that often occur in Lateglacial climate reconstructions.

From 15 100 to 12 800 cal. yr. BP: a temperate period (Bølling/Allerød)

Between 15 100 ± 200 and 12 800 ± 50 cal years BP, the main biome is "temperate deciduous forest" (Fig. 4). This is consistent with the occurrence of temperate forest elements, mainly *Betula*, *Pinus* and deciduous *Quercus* associated with low percentages of steppe elements (Fig. 4). However, despite the occurrence of these species, some pollen samples are wrongly classified as "cold steppe" biome rather than a wooded steppe, following the biomization scheme of (Prentice, Guiot et al. 1996) and (Peyron, Guiot et al. 1998). Therefore we have classified these samples as "temperate deciduous forest" biome, as modern pollen assemblages that correspond to wooded steppes are defined as temperate deciduous forest in the modern database. The presence of temperate deciduous forest indicates that the climate becomes abruptly warmer and wetter (Fig. 6 a,b). These result here show an abrupt warming (i.e. +10°C for TANN, MTWA and MTCO, +1350 degree days for GDD5) coupled with wetter winter conditions (i.e. +400 mm for PANN, +65 mm for Pwinter, -25 mm for Psummer). The reconstructed–values are very close to modern values for all the climate parameters. The climate reconstruction for this period is characterized by low values of the Euclidean distance, with the exception of two peaks corresponding to the two wooded steppe samples.

From 12 800 to 11 300 cal. yr. BP: a cold and dry event (Younger Dryas)

From 12 800 ± 50 to 11 300 ± 150 cal years BP, the biome reconstructed at Lake Maliq is "cold steppe" (Fig. 4) which corresponds to a major rise in the herbaceous pollen taxa (e.g. *Artemisia* and Poaceae). The results show that the Allerød/Younger Dryas transition is abrupt (Fig. 6 a,b), and that the Younger Dryas was characterized by three major climatic phases. Cold and dry conditions are reconstructed from 12 800 ± 50 to 12 200 ± 200 and from 11 900 ± 200 to 11 300 ± 150 cal years BP with a drop of around -10°C in temperature (i.e. -9° for TANN, -11° for MTCO, -8°C for MTWA, -1300 degree days for GDD5) (Fig. 6a) and generally reduced precipitation. Summer precipitation is, however, higher than present summer precipitation as observed during the Oldest Dryas (i.e. -400 mm for PANN, -55 mm for Pwinter, +40 mm for Psummer) (Fig. 6b). This is followed by a short-lived climate event between 12 200 to 11 900 cal years BP, associated with warmer (i.e. +3° for TANN, +5° for MTCO, +4°C for MTWA, +550 degree days for GDD5) and slightly wetter (+100 mm for PANN, +20 mm for Pwinter, -20 mm for Psummer) winter conditions (Fig. 6a,b).
The reconstructions show quite large variations in the Euclidean distance calculated between fossil and modern pollen spectra during the Younger Dryas (Fig. 6b): the analogues are particularly good for the two cold steppe phases, but less accurate during the warm climate event.

From 11 300 cal. yr. BP to the present: a temperate period (Holocene)

From 11 300 ± 150 to 420 ± 100 cal yr. BP, the results show remarkably stable climatic conditions with vegetation dominated by the "temperate deciduous forest" biome (Fig. 4). The climate values become similar to modern values; however, two short-lived events can be observed during this period. The first event occurs rapidly between 8300 and 8100 cal. yr. BP with an increase in steppic conditions (Fig. 4), and is mainly due to an increase of Poaceae pollen percentages. This event is marked by a return to more arid conditions (i.e. -250 mm for PANN, -35 mm for Pwinter) and low temperatures (i.e. -2° for TANN, -3° for MTCO, -1°C for MTWA, -200 degree days for GDD5). From 1000 years cal BP to the present, our climate reconstructions show large variability and major oscillations both in temperature and precipitation that coincide with the development of cultivated taxa such as *Cerealia*-type and *Olea* sp.

Discussion

The timing of the deglaciation in southern Balkans

The Lateglacial and early Holocene climatic oscillations widely recorded throughout northern Europe, such as the Younger Dryas (Alley 2000) and the “8.2 ka event” (Alley, Mayewski et al. 1997; von Grafenstein, Erlenkeuser et al. 1998; Alley and Agustsdottir 2005), have not been clearly recorded in the individual behaviour of plant types in existing pollen diagrams from southern Balkans (Bottema 1974; Willis 1992a; Willis 1992c; Willis 1994a; Denèfle, Lezine et al. 2000).

Based on an extensive dataset of modern analogues, our biome reconstruction shows a succession of well differentiated vegetation associations in the Maliq basin during the last deglaciation with two main biomes: cold steppe and temperate deciduous forest. The “steppe” vegetation dominated at Lake Maliq from 16 000 to 15 400, from 12 700 to 10 900, and from 8500 to 8300 cal years BP, during the periods corresponding to the Oldest and Younger Dryas and the 8.2 ka event respectively. The “steppe” ecosystems were rapidly established. However, the re-colonization of temperate trees at the Oldest Dryas/Bølling transition and at the Younger Dryas/Holocene transition occurred more progressively with the maximum extension of trees occurring respectively 1100 and 2600 years after the onset of forest rise in the immediate surroundings of Lake Maliq. This probably reflects an ecological succession from a pioneer to a mature forest stage.

The timing of these successive phases of the last deglaciation at Maliq is consistent with that proposed elsewhere in Europe from well dated continental sequences and the Greenland ice cores (Björck, Walker et al. 1998; Huntley, Watts et al. 1999; Magny, de Beaulieu et al. 2006). Despite the global resemblance with the Greenland records, our pollen record at Lake Maliq display marked differences with the ice core records: (1) the Bølling/Allerød transition is rather gradual, as recorded in speleothems records from caves from southern France to northern Tunisia (Genty et al., 2006), and (2) the temperature during the Allerød is equivalent to this during the Bølling.

The paleoclimatic reconstructions in southern Balkans

The steppic phases of the last deglaciation (Oldest and Younger Dryas)

Low temperatures

Our data show that the periods corresponding to the Oldest and Younger Dryas were characterized by low temperature in both winter and summer. The winter temperature ranged from –15° to –12°C (Oldest Dryas) and from –12° to –8°C (Younger Dryas), while the summer temperatures ranged from 8° to 12°C (Oldest Dryas) and from 9° to 13°C (Younger Dryas). In Italy, fossil pollen assemblages at Lago Grande di Monticchio provide quantitative estimates of paleo-temperatures of the coldest month ranging from –20° to –15°C (Oldest Dryas) and around –7°C (Younger Dryas) (Huntley, Watts et al. 1999). (Renssen and Isarin 2001) have reconstructed the January air temperature in Europe from a variety of paleo-botanical data. They estimated a January temperature of around –15°C (Oldest Dryas) and around 0°C (Younger Dryas) at sea-level in southern Balkans. During the Oldest and Younger Dryas, the marine records also show an abrupt decrease of surface water temperature. In the Adriatic Sea, this is shown by high amounts of dinoflagellate *Spiniferites elongates* during the Oldest Dryas, a species that currently characterizes arctic and sub-arctic areas (Zonneveld 1996), and from the peak of *Neogloboquadrina pachyderma* foraminifera in the CM9243 core during the Younger Dryas (Asioli, Trincardi et al. 2001). At Maliq, our reconstructions show colder climate conditions during the Younger Dryas than elsewhere in Europe (Renssen and Isarin, 2001). However, the reconstructed temperature values of the warmest month at Lake Maliq are similar to those recorded in Central Europe from pollen, chironomid assemblage based-reconstructions at Lake Lautrey in France (Peyron, Begeot et al. 2005) and pollen and cladoceran assemblage based-reconstructions at Lake Gerzensee in Switzerland (Lotter, Birks et al. 2000).

Seasonality of precipitation

Our reconstruction shows increased seasonality of precipitation during the Oldest and Younger Dryas at Lake Maliq, with arid conditions in winter and wetter conditions in summer. The REMO model (Renssen, Isarin et al. 2001) simulates a negative anomaly for the winter precipitation (December, January, February), but also for the summer precipitation (June, July, August), of around –30 mm per month in Eastern Europe. However, in Western Europe, the REMO model simulates a positive anomaly for the winter precipitation, which is consistent with the high lake-levels recorded in the Alps and the Jura (Magny 2001) and in north-central Italy from Lake Accesa (Magny, de Beaulieu et al. 2006). These results suggest that (1) there is a E-W gradient for changes in the seasonality of precipitation in Europe during the Lateglacial periods, (2) seasonality of precipitation is a crucial climate parameter to consider in paleo-climate reconstructions in the Mediterranean area.

At Lake Maliq, the increase of aquatic indicators (*Myriophyllum*, *Pediastrum*) during the Younger Dryas indicates that climate conditions were dry in summer and moist in winter (Denèfle et al., 2000), as previously described for southern Europe (Willis 1994a; Watts, Allen et al. 1996a; Watts, Allen et al. 1996b). Our reconstructions suggest higher summer precipitation and winter drought during the Oldest and Younger Dryas. Such a reconstruction can be explained by the climate features of the closest modern analogues for the *Artemisia*-dominated pollen spectra. They come from Asian steppes, from the Tibet and Kazakhstan areas, characterized by low annual precipitation and a spring or summer precipitation maximum. Attempts to model the paleo-environment at Ioannina for the last glacial maximum have shown that this area can appear wetter or drier in winter, depending on the extent to which the anticyclone over the North European ice sheet penetrates the Mediterranean area (Prentice et al., 1992). It is therefore possible that changes in the position of the anticyclone during the Late-glacial period had a different effect on the climate in southern Balkans compared to other Mediterranean areas, with the maximum precipitation falling in summer, favouring the development of *Myriophyllum* and *Pediastrum*. However, our results should be interpreted with caution, and more data is required to better explain this seasonality pattern.

The Holocene

Stable climatic conditions

Our paleoclimate reconstructions suggest a warming at the beginning of the Holocene, in contrast to the cooling reconstructed in southern Europe during the same period by (Davis, Brewer et al. 2003). This difference can be explained by the location of the series used for their study. South-east Europe, as defined by Davis et al. (2003) includes the southern Balkans and the steppe areas of southern Turkey and Iran. However these steppe areas respond differently to southern Balkans, as suggested by (Bottema 1995). This author has shown that Younger Dryas pollen records from the southern Balkans differ from those of the Eastern Mediterranean area but are comparable to those of central and north-western Europe. Our reconstructions show that the modern values for each climate parameter are reached in the early Holocene and remain very stable throughout. It does not show cooler and moister conditions, recorded elsewhere in the Mediterranean area (Huntley and Prentice 1988; Cheddadi, Yu et al. 1997; Masson, Cheddadi et al. 1999; Roberts, Reed et al. 2001; Sadori and Narcisi 2001).

The 8.2 ka event

The Holocene is relatively stable at Lake Maliq, with the exception of a short-lived cooling event, dated at 8300 to 8100 cal. yr. BP. This event is coeval with the “8.2 ka event”, widely recorded in ice cores and marine and terrestrial archives in the northern-hemisphere (Johnsen, Dahl-Jensen et al. 2001; Mayewski, Rohling et al. 2004; Alley and Agustsdottir 2005). Our reconstructions suggest cold and dry conditions especially in wintertime and are consistent with previous observations in the northern-hemisphere (Alley and Agustsdottir 2005). (Magny, Begeot et al. 2003) show that drier conditions occurred in both northern and southern Europe in response to the 8.2 ka cooling, whereas the climate of central Europe was wetter. The precipitation reconstruction at Lake Maliq supports this result. The cooling recorded at Lake Maliq (-2°C for TANN) is similar with the cooling of –2°C in central Europe from the Ammersee $^{18}0$ record (von Grafenstein, Erlenkeuser et al. 1999) and a simulated cooling of between –1° and 0°C in the Balkans from ECBilt-CLIO model results (Wiersma and Renssen 2006). The difference between the cooling in Greenland (-4°C) (Johnsen, Dahl-Jensen et al. 2001) and at Lake Maliq (-2°C) could be explained by the polar amplification of climate change (Masson-Delmotte, Kageyama et al. 2006). This suggests that the forcing factors driving the observed changes over the North Atlantic area also extended their influence into the Mediterranean area during the Holocene.

Conclusions

(1) The mid-altitude Lake Maliq pollen record provides, for the first time, high-resolution quantitative estimates of rainfall, temperature and seasonality variations, during the last glacial-interglacial transition and early Holocene in southern Balkans. This study provides a clearer understanding of the vegetation and climate dynamics of the last deglaciation in an area where only the Mediterranean lowlands have extensively been studied for both vegetation dynamics and related climate changes.

(2) Reconstructed temperatures record high amplitude changes, between –5°C and 10°C, probably enhanced by the topography of the Maliq basin. There is a difference in the annual distribution of rainfall between warm and cold phases with a maximum in summer during the cold phases (Oldest and Younger Dryas, 8.2 ka event) and a minimum during the temperate phases (Bølling, Allerød, Holocene). The seasonality of precipitation thus appears to be a crucial climate parameter to consider in the Mediterranean paleo-climate reconstructions.

(3) The timing of the last deglaciation in southern Balkans is consistent with that recorded elsewhere in Europe and Greenland, within the dating uncertainties of the radiocarbon method. The terrestrial sediment sequence of Maliq confirms the conclusions from marine cores in the central Mediterranean and Alboran Seas, that, since the Last Glacial period, forcing factors of climate variations in the North Atlantic area have extended their influence into the Mediterranean area.

(4) The MAT with “biome” constraint gives better results than without constraint. However, the reconstruction obtained during the phases of vegetation and climate transitions should be interpreted carefully due to a lack of good analogue.

Acknowledgments

Many thanks to Michèle Denèfle, Michel Magny and Sarah Ivory for fruitful scientific discussion. We also wish to thank the French CNRS through the ECLIPSE project coordinated by A.-M. Lézine and E. Fouache, entitled «Variations climatiques et Dynamique des écosystèmes au Sud des Balkans au cours du dernier cycle climatique», for financial support, the members of the Franco-Albanian cooperative project, the French Archaeological School of Athens (Greece), the Archaeological Museum of Korçë (Albania) and ARTEMIS AMS facilities in Saclay (France). Authors express their sincere thanks to each pollen contributor to the modern pollen database: A. Andreev, V. Andrieu-Ponel, J. Atanassova, C. Bégeot, J. Belmonte, H.J.B. Birks, S. Bottema, E. Bozilova, E. Brugiapaglia, M. Court-Picon, K. Dambach, B.A.S. Davis, D. Galop, B. Huntley, S. Leroy, Y. Miras, M. Reille, V. Ruiz-Sanchez, F. Saadi, M.-F. Sanchez Goni, J.-P. Suc, P.E. Tarasov, Vergne, G. Yu, W. van Zeist, for their contribution.

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DEM and GIS as tools for Holocene palaeogeographical reconstructions of Lake Maliq (Korça Basin, Albania)

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Abstract

Since the early 90s, excavations of a protohistoric lakeside settlement in the Korça basin carried out by a French-Albanian team have induced geomorphological and palynological studies about the sedimentary records of Lake Maliq. In order to prepare a survey around the now dried up lake, which started during the summer of 2007, we made a 3D model of the Holocene deposit from the lake using geomorphological mapping, excavation data, numerous core logs and AMS radiocarbon datings. SRTM DEM data, after DGPS control, was connected to a GIS including all geological and archaeological information. We obtained 4 reconstructions of the Maliq palaeo-lake during the late glacial times (around 14000 BP), the Early Neolithic (around 9000 BP), the Middle Bronze Age (around 4500 BP) and the Iron Age (2300 BP), as well as a map of the thickness of the sediments above potential archaeological layers. The role of Holocene climatic variability to account for fluctuations in the palaeo-levels of lake Maliq will be discussed.

Keywords: SRTM DEM, GIS, geoarchaeology, geomorphology, Holocene, Albania.

Introduction

The archaeological excavations which started in 1988 (Lera 1990) and were carried out systematically from 1993 onwards (Lera *et al.* 1996, Touchais *et al.* 2005, Lafe 2005) in the Korça basin in Albania, and especially in Sovjan, confirm that this basin was a place where people settled and agriculture and cattle breeding appeared as early as the early Neolithic with the Podgorie culture around 9000 BP (Prendi 1990, Korkuti 1995) to the early Iron Age, according to a relative chronology based on ceramics and radiocarbon measurements. The lowest area of the basin was occupied by Lake Maliq until drainage works began in 1950. Its surface varied between a minimum of 40 km^2 during periods of low level to a maximum of 80 km^2. From the Early Neolithic to the Early Iron Age, and especially during the Middle Bronze Age (around 4500 BP), the nearby lake shore was occupied by numerous settlements (Fig. 1) like Maliq (Prendi 1966) or Sovjan. Since Quaternary times, the waters of Lake Maliq, which has always been a shallow marshy lake, have been evacuated towards the Adriatic Sea by the Devoll River. Two rivers join the lake, the Devoll River on the east side and the Dunavec River on the south. During the Last Glacial Maximum (LGM) the sedimentation was mainly detritic (sand) and since 11300 cal. yr. BP, organic deposit (mainly peat) is dominant. The lake is limited by alluvial fans to the south-east from the river Devoll and to the south from the river Dunavec, as well as by a series of smaller coalescent alluvial fans on its western edge. The maximum thickness of Holocene sediments deposited in the lake is 10 meters. To reconstruct the extension of the lake at different periods need numerous and systematic sedimentological information. Unpublished data from the Geological Service in Korça, 101 logs obtained in 1974 by core-drilling, at a moment when the Albanian state had the project to burn peat in a power station, allowed us to draw a 3D perspective of the sediments. Complementary data, with paleoenvironmental analyses (sedimentology, palynology), were obtained from cores in the frame of the excavation of Sovjan, or for the need of environmental studies.

In order to prepare a survey around the now dried up lake, that started during summer 2007, we made a 3D model of the Holocene deposit from the lake using geomorphological mapping, excavation data, numerous core logs and AMS radiocarbon datings. SRTM DEM data, after DGPS control, was connected to a GIS including all geological and archaeological informations. We obtain 4 reconstructions of the Maliq palaeo- lake during the late glacial times (around 14000 BP), the Early Neolithic (around 9000 BP), the Middle Bronze Age (around 4500 BP) and during Roman times (around 2000 BP), as well as a map of the thickness of sediments above potential archaeological layers.

Regional setting

Geology

Lake Maliq is located in the north-western part of the Korça basin. Surrounding mountains culminate to the east with Mount Mali Thatë (2028m). The average altitude of the bottom of the palaeo-lake is 812m (Fig. 1). The Korça basin is a graben valley. Throughout the Pliocene, the grabens of Ochrid and Korça belonged to the same lake-river system. Tectonic activity during the Quaternary and still active today (Tagari *et al.* 1993) isolated the Korça graben within its present geological borders. The Korça basin is asymmetric in shape with a much higher scarp to the east (Fig. 2). The neotectonic subsidence is more significant in the northern centre of the plain. The pace of this subsidence - between 0.15 and 0.2 mm/y (Dufaure *et al.* 1999) - cannot alone account for the substantial variations in the level of the lake. The lake is drained by the river Devoll, down to the Adriatic Sea. Combined with a massive progradation of the huge sandy/silty fan built up by the Devoll river, this subsidence accounts for the location of the shallow Maliq lake and its extensive marsh. This more strongly subsiding area continues to be a permanent obstacle to drainage, especially during winter flooding. The waters are evacuated with some difficulty by the Devoll as it leaves the plain.

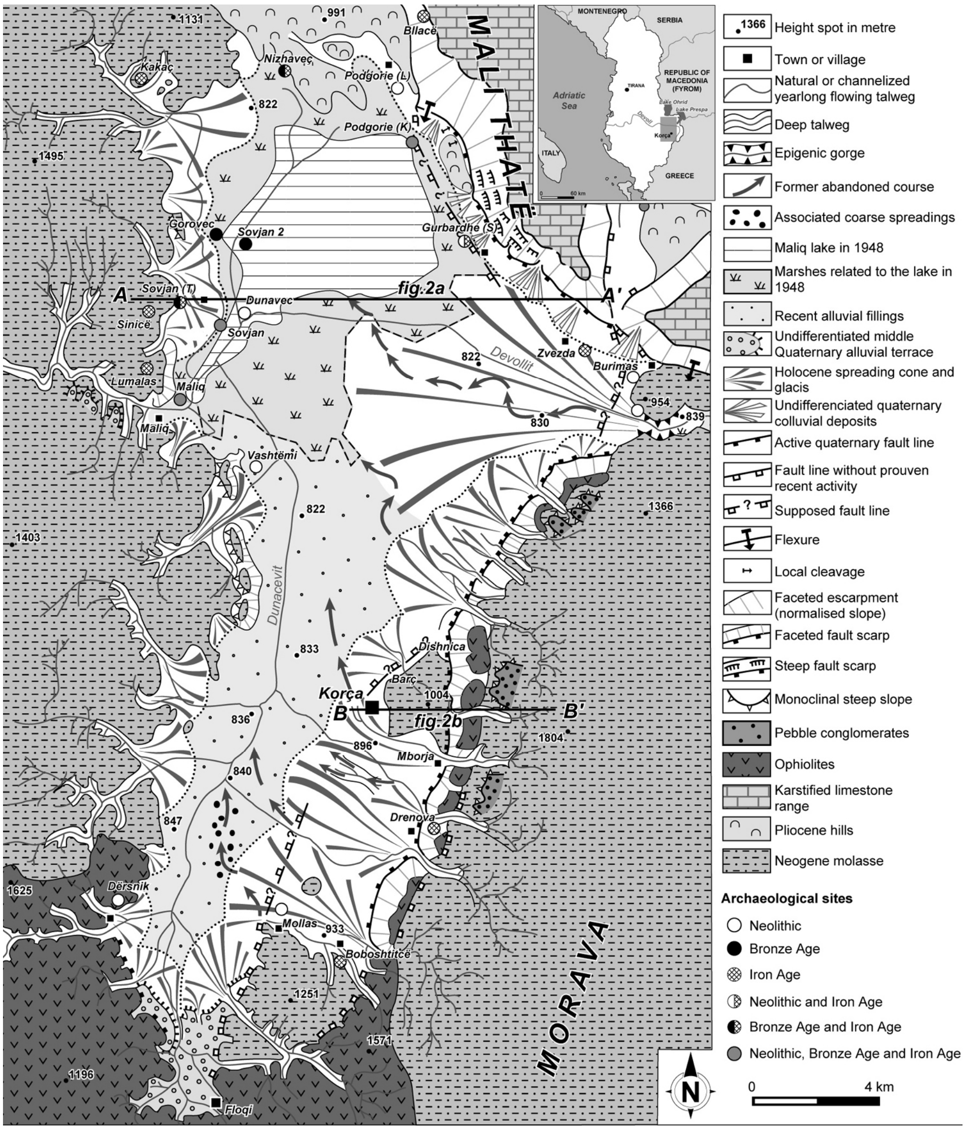

Figure 1: Location area and geomorphological map of the Basin of Korça.

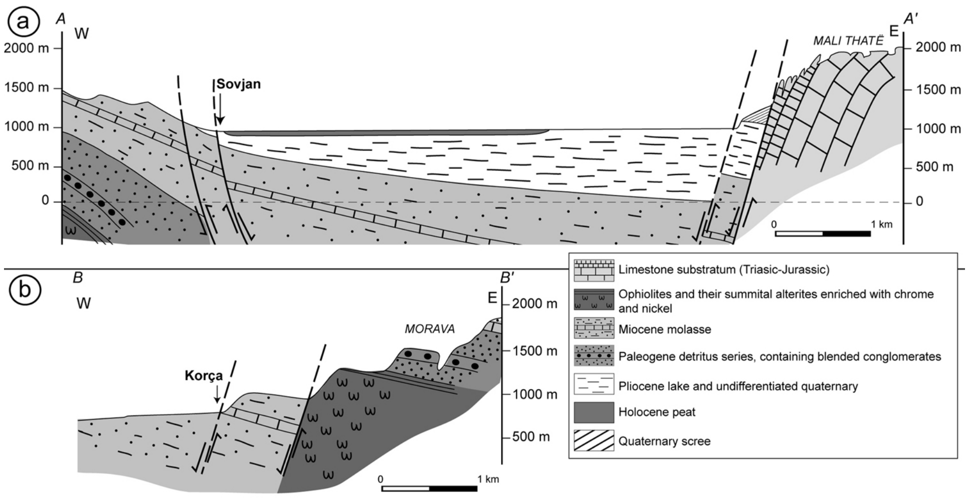

Figure 2: Geological cross section of the Korça graben.

The climate

The regional climate is characterized by an average annual rainfall of 800-1000 mm. Precipitation occurs mainly in December (75-100 mm). Temperatures average 23°C to 25°C in July and 2°C to 5°C in January. The present-day vegetation at Korça Basin is sub-Mediterranean with an altitudinal distribution of the plant communities. The lower mountain slopes, up to about 1200 m a.s.l., are dominated by mixed deciduous woods with *Carpinus orientalis*, *Acer monspessulanum*, *Pistacia terebinthus*, *Fraxinus ornus* and *Phillyrea latifolia*. The upper slopes are covered by oak forests where *Quercus trojana, Q. frainetto, Q. cerris* may be locally associated with *Pinus leucodermis*, *Juniperus excelsa*, *J. foetidissima* and *Aesculus hippocastanum*. Beech woods, with *Fagus moesiaca*, *Abies alba* and *Abies borisii-regis*, are found above the oak forests, up to 1800 m a.s.l. Sub-alpine moors and grasslands are present above the tree-line (~ 1800 m).

Holocene climatic variability

Bordon's high-temporal resolution analysis (Bordon *et al.*, 2009) of pollen record from Lake Maliq provides for the first time in the Balkans quantitative estimates of monthly temperature and precipitation changes since the last deglaciation (16,000 cal years BP). Her paleoclimate reconstructions (Fig. 3) suggest a warming at the beginning of the Holocene, in contrast with the cooling reconstructed in southern Europe during the same period by (Davis, Brewer et al. 2003). This has been shown by (Bottema 1995), who considered that Younger Dryas pollen records from the southern Balkans differ from those of the Eastern Mediterranean area but are similar to those of central and north-western Europe. The modern values for each climatic parameter are reached in the early Holocene and remain very stable throughout the Holocene. Our reconstruction does not show cooler and moister conditions, recorded elsewhere in the Mediterranean area (Huntley and Prentice 1988; Cheddadi, Yu et al. 1997; Masson, Cheddadi et al. 1999; Roberts, Reed et al. 2001; Sadori and Narcisi 2001). Reconstructed temperatures record high amplitude changes, between –5°C and 10°C, probably enhanced by the topography of the Korça basin. There is a clear difference in the annual distribution of rainfall between warm and cold phases with a maximum in summer during the cold phases (Older and Younger Dryas, 8.2 ka event) and a minimum during the temperate phases (Bølling, Allerød, Holocene). The seasonality of precipitation thus appears to be a crucial climatic parameter to consider in the Mediterranean palaeo-climate reconstructions.

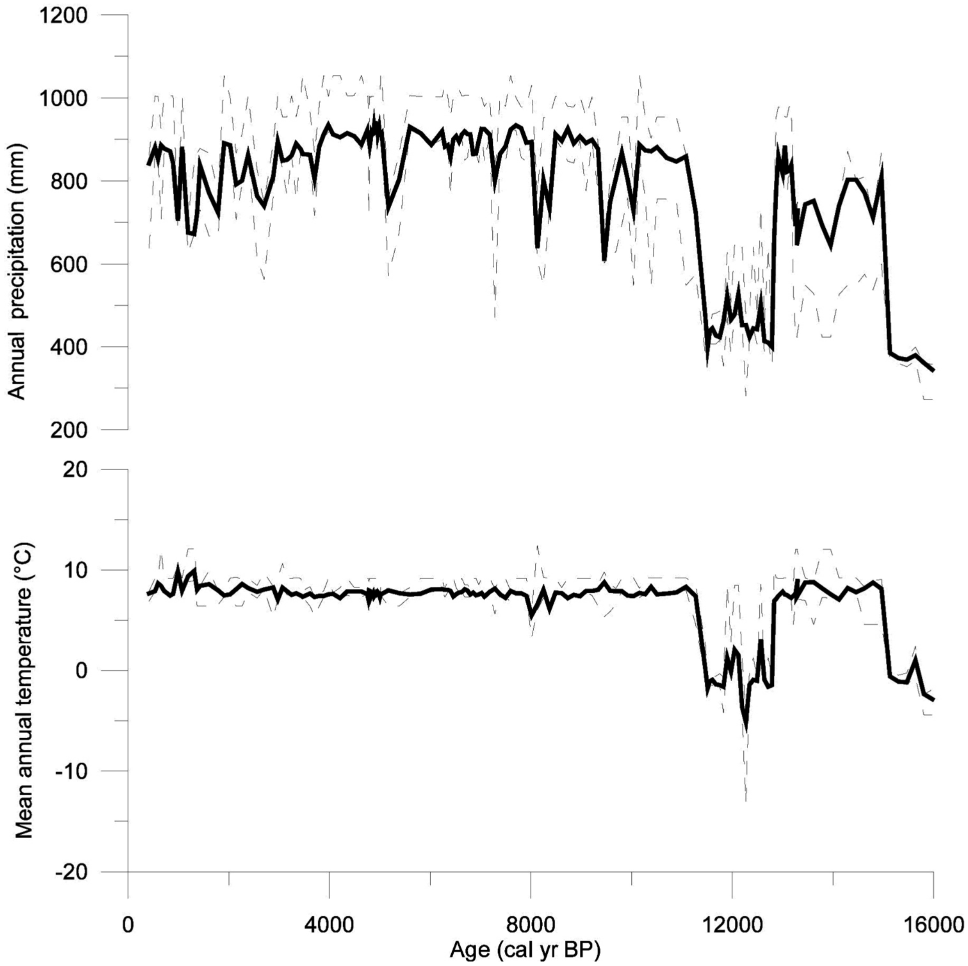

Figure 3: Pollen-inferred quantitative reconstruction of the annual precipitation (PANN) and mean annual temperature (TANN) in the basin of Korça (from 16000 cal yr BP), using modern analogue technique with biome constraint. The error bars are plotted by dotted lines.

Methods

Contrary to the American-Albanian survey carried out since 2005 in the southern part of the Korça basin (KOBAS project), the PALM French-Albanian project (Archaeological Prospection of Lake Maliq), started in 2007, is inspired by a palaeoenvironmental interrogation about the variations of the lake level and their impact on human occupancy. This interrogation is met by a very diverse sample of data issued from geomorphology, sedimentology, palynology, etc. The aim of the project is not so much to complete the archaeological map of the Korça basin as to understand the phenomena that may have had an impact on human settlement in the area, from the Neolithic down to the modern era, which requires a combined study of natural and cultural dynamics (Touchais & Fouache 2007). In order to integrate the archaeological, geological and topographic data, we had to create a DEM and a GIS.

* DEM creation using SRTM data.

The topographic data used for the study of the Korça Basin come from NASA SRTM3 data (Shuttle Radar Topography Mission). In spite of the spatial resolution (approximately 30 m by 30 m) of the map derived from the data (Farr *et al.* 2007), SRTM data were preferred to topographic information provided by the Albanian charts: in our study area, the most precise maps (1:25 000 scale), published in 1982, have contour lines at 5 m intervals in plain. Such a precision is insufficient (Fig. 4), because it does not allow discriminating the topography of the centre of the palaeo-lake. The quality of SRTM data was controlled by statements with the DGPS measurements on two transects (E/W and N/S) crossing the plain of the Korça Basin. These two types of topographic data are based on the WGS84 projection system associated with the EGM96 geoïd. On average, the heights of the cartography resulting from SRTM data are 1.8 m higher than the altitudes provided by the dGPS. This difference seems to be in conformity with that usually observed in flat regions (<2m – Rodriguez *et al.*, 2005).

SRTM data were added in the GIS of the Korça Basin, created with the "ESRI ArcMap 9.1" software. DEM and contour lines were created with the "SpatialAnalyst" extension.

* Geological and palaeoenvironnemental data integration into the GIS to reconstruct the palaeo-topography of the Korça basin.

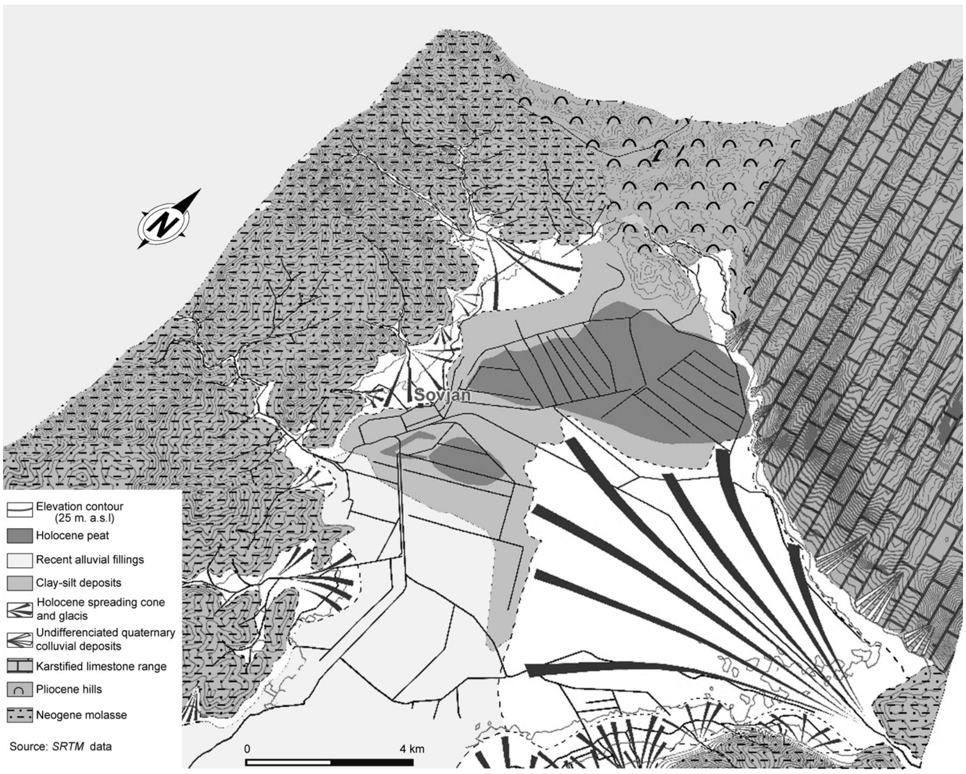

Figure 4: SRTM DEM of the basin of Korça.

Unpublished data (Fig. 5) from the Geological Institute in Korça (101 logs obtained in 1974 by core-drilling, E/W and N/S profiles) allowed to reconstruct the geometry of the palaeo-lake, and in particular the bottom of the lake before its filling by peat. This reconstruction was necessary because the elevation of the low lake-levels is lower than the current minimal height of the Korça basin. Heights of the palaeo-topography of the plain of the Korca Basin, interpreted using the geological data, were integrated into the GIS. The extension "spatialAnalyst" was then used to model in 3D palaeo-topography.

* Palaeoenvironnemental analyses on cores to establish chrono-stratigraphy of the Maliq palaeo-lake.

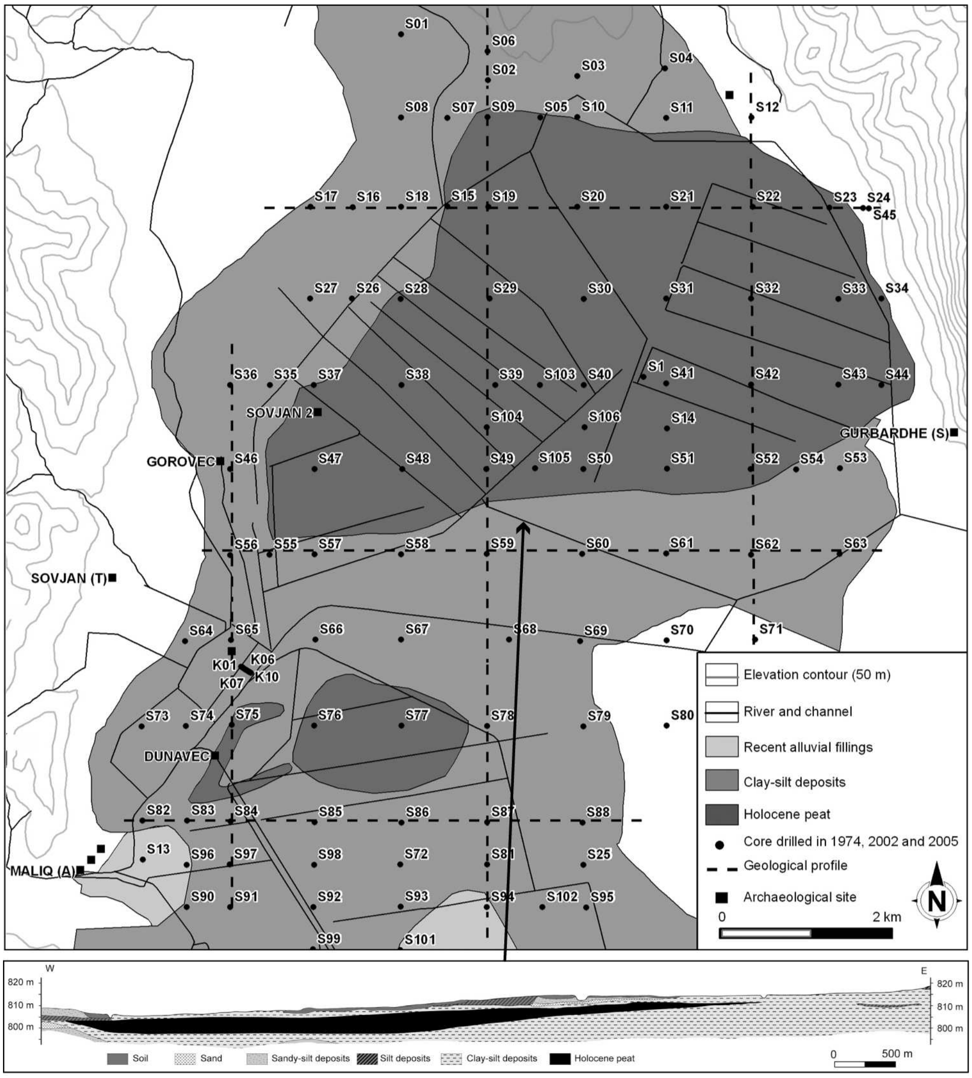

Figure 5: Albanian geological data base from 1974.

Past water-level fluctuations of Lake Maliq were reconstructed using changes in the lithology (Digerfeldt, 1986; Magny, 2007) observed along a 150 m-long core transect from the tell to the lake basin (Fig. A and B). Organic deposits (peat, anmoor) characterise overgrowing processes and littoral mires, while silt and silty-clay deposits correspond to sedimentation in open water (deeper water). The core transect provides a comprehensive stratigraphic section of the littoral sediment sequence, so that the geometry of the layers and the lateral variability of the lithological facies can be highlighted. The ages of the lake-level changes identified from the sediment sequence have been inferred from radiocarbon and archaeological dating.

Results

The sediment sequence of Lake Maliq (Fig. 6) allows distinguishing a series of centennial-scale high and low lake-level events which punctuated the Holocene period as follows:

-The radiocarbon dates obtained in core K5 and K1 indicate that the first formation of peat in the southwestern shore area of Lake Maliq occurred at ca 8600 / 7100-7000 BC. This peat deposition may reflect an overgrowing process or a lake-level lowering, or have resulted from a combination of both phenomena (lake-level at ca 810-811.5 m).

-In core K1, a deposition of a clayish layer interbedded between peat layers occurred to 6208-5987 BC and marks a higher lake level (water table at ca 812-812.5 m).

-The upper part of the peat deposits which accumulated before the formation of layer 7 and include many wood pieces, indicates that the lake level was at ca 812-812.5 between ca 4000 and 2300 BC.

-The deposition of clayish layer 7 observed in cores K1, K2, K3 and K5 coincided with a highstand of the water table which may have reached 814.5-815 m at ca 2300-2050 BC.

-The development of the tell between 2000 and 800-700 BC (cores K1, K2 and K3) was synchronous with an accumulation of peat in cores K4 and K5. The water table probably stood below 814 m.

-The abandonment of the tell around 800-700 BC was followed by the deposition of a clayish layer which overlaid the highest parts of the tell and marks a high lake level. The water table may have reached 816.5-817 m.

-During the Roman period, the lake level returned to a lower stand (less than 814-814.5 m) as indicated by the deposition of peat dated to ca 50 BC-70 AD.

-Finally, this lowstand was followed by higher lake-level conditions which resulted in the deposition of a thick silty layer (water tabel above 815.5-816 m).

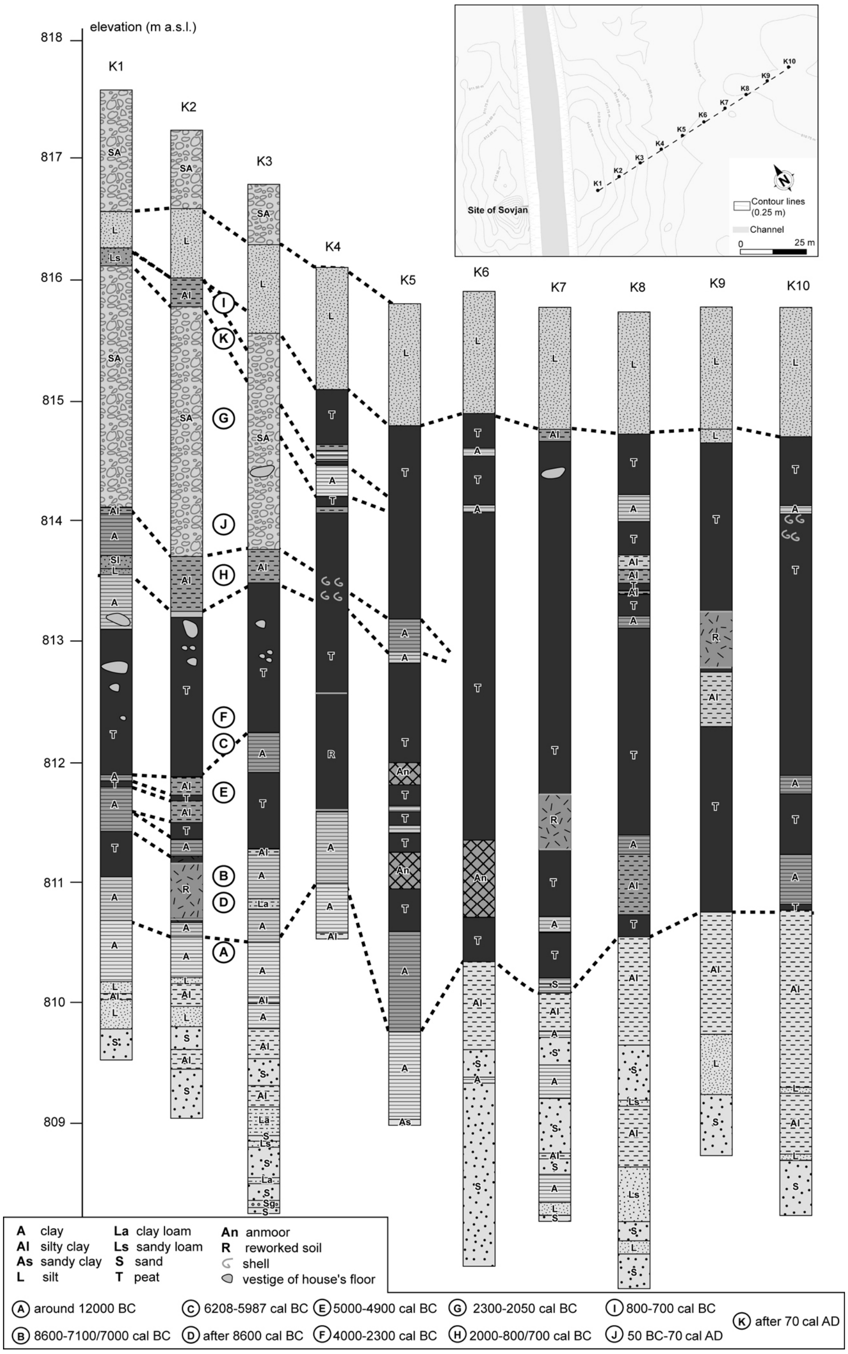

Figure 6: Chronostratigraphy from K1 to K5 (Sovjan Archaeological site).

Those results, integrated to the DEM and the GIS, allow us to propose four palaeogeographic reconstitutions of the extension of Lake Maliq.

Discussion

The Sovjan sediment sequence gives evidence of three distinct centennial-scale high lake-level events which occurred at around 6200-6000, 2300-2050, and 800-700 BC. These successive rise events may have been coeval with climate reversals dated to 8200, 4200 and 2700 cal BP (Alley *et al*., 1997; Marchant and Hooghiemstra, 2004; Drysdale *et al*., 2006; van Geel *et al*., 1996; Bordon *et al*., 2009), but it is too early to assert with certainty from our preliminary results.

In addition, the Sovjan sediment sequence also gives evidence of a millennial-scale trend of lake level rise. The accumulation of peaty deposits, the thickness of which exceeds 4.5 m, suggests that the water table of Lake Maliq was characterised by a progressive rise since the mid-Holocene. The subsidence which affects the Korça basin has been assessed to be ca 0.2 mm/yr (Dufaure *et al*., 1999) and can only partially explain such an important accumulation of peat. The rising millinial-scale trend observed for the second half of the Holocene at Lake Maliq (latitude 40°21'N, altitude 818 m) contrasts with that reconstructed for the same period at Lake Xinias (latitude 39°45'N, altitude 500 m a.s.l.; Digerfeldt *et al*., 2007), but it is in agreement with that established at Lake Accesa in Tuscany (latitude 43°N, altitude 157 m a.s.l.; Magny *et al*., 2007).

Our results do not permit to conclude that the rise in the lake level is responsible for the abandonment of the site of Sovjan during the Iron Age, however we may suggest as a hypothesis that it did play a part in it. Our reconstitutions focus on high lake levels, but the latter are obviously separated by periods of regression. Those high levels, together with the knowledge of the thickness of the sediment allowed us to design a predictive map of the potential archaeological layers for the Neolithic and the Bronze Age. The preliminary results of the prospection carried out in August 2007, yet unpublished, show a reliable coincidence between the location of the sites dating back to these periods and our reconstitutions over the periods in question. However, they also show that the medieval sites dating back to the 8th & 9th centuries AD are all located slightly inward with regard to the lowest lake level we reconstituted. This proves that a very low level did exist at that time and that our palaeoenvironmental reconstitutions need to be extended over the past 2000 years.

Conclusion

The regional study carried out around Lake Maliq demonstrates that in order to assess correctly the surface archaeological potential as well as that of the Holocene sedimentary layers, it is necessary to take in to account the variability of lake levels and of the associated sediments. The integration of the geological and geomorphological data from these Holocene layers into a GIS and a DEM permits a 3D modelling of the field, a regular update of this model that easily integrates the new data, and provides synthetic maps of use to archaeologists and developers alike. In the long run, these maps also enable precise palaeo-geographic reconstitutions to be carried out. Our research will continue towards relating high lake levels to precise climatic events, towards comparing lakes Prespa and Ohrid on a regional scale but also making a palaeogeographic atlas of the areas around the lake from the Ancient Neolithic to the present day.

Acknowledgements

Many thanks are addressed for financial support to the French CNRS Eclipse and Artemis programmes, to the French Ministery of Foreign Affairs and to the French School of Archaeology in Athens.

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Chapitre 4: le dernier cycle climatique dans le sud des Balkans à partir de la séquence du lac Ochrid: analyse palynologique et quantification paléoclimatique

Introduction

Le lac Ochrid (41°N, 20-21°E), localisé à la frontière entre l'Albanie et la République de Macédoine est un site exceptionnel et nouveau pour étudier les fluctuations climatiques glaciaires/interglaciaires et leur impact sur les écosystèmes de moyenne et haute altitude, dans une région clé à la frontière entre les influences méditerranéenne et medio-européenne.

Le lac Ochrid est un des lacs les plus anciens d'Europe (Meybeck, 1995). Il se serait formé au Pliocène, entre 2 et 5 millions d'années (Stankovic, 1960).
Ce lac s'est installé dans un fossé d'effondrement de moyenne altitude, bordé par de hautes chaînes de montagne orientées nord-sud et culminant autour de 2000 m alt.: les monts Galicica à l'est (2250 m), Mali Thatë au sud (2028 m) et Jablanica à l'ouest (1945 m).
Le lac accueille plus de 200 espèces endémiques, principalement des algues et des invertébrés (cf. Jerkovic, 1972; Kenk, 1978; Decraemer et Coomans, 1994; Michel, 1994) et les écosystèmes environnants présentent une grande diversité floristique (Stankovic, 1961).
Ces caractéristiques font du lac Ochrid un site unique en Europe où les conditions environnementales ont dû rester relativement stables sur une longue période de temps pour favoriser le maintien de ces nombreuses espèces.

Wagner et al. (2007) viennent de publier une étude qui démontre le potentiel sédimentaire du lac Ochrid pour établir des reconstitutions paléo-environnementales.
Dans le cadre du projet Eclipse du CNRS, coordonné par Anne-Marie Lézine et Eric Fouache, intitulé «Variations climatiques et Dynamique des écosystèmes au Sud des Balkans au cours du dernier cycle climatique», la séquence JO 2004 (40°55.000N, 20°40.297E, 705 m d'altitude, 144 m de profondeur moyenne) a été prélevée dans le lac Ochrid par Ulrich von Grafenstein, Jean-Jacques Tiercelin et Jean-Pierre Cazet (Lézine et al., soumis), afin de fournir le premier enregistrement multi-proxy (pollen, ostracodes, sédimentologie, minéralogie, téphras, susceptibilité magnétique) de moyenne altitude pour le dernier cycle climatique (depuis environ 150 000 ans à aujourd'hui).

Cet enregistrement serait directement comparable aux longues séquences continentales situées en Europe du Sud à basse altitude: Tenaghi Philippon (41°10’N, 24°20’E, 40 m - Wijmstra, 1969; Wijmstra et Smit, 1976; van der Hammen et al., 1971; Tzedakis, 2000; Tzedakis et al., 2006), Ioannina (39°45’N, 20°51’E, 470 m – Bottema, 1974; Tzedakis, 2000; Tzedakis et al., 2002), Kopais (38°26’N, 23°03’E, 95 m – Tzedakis, 1999, 2000; Tzedakis et al., 2002), et, aux longues séquences continentales du centre de l’Europe (tableau 1, figure 1).

Tableau 1: Liste des sites du sud et du centre de l’Europe, fournissant de longues séquences continentales.

Nom du site	**Latitude**	**Longitude**	**Altitude**	**Références**
Bispingen	53°5’N	9°59’E	100 m	Müller, 1974
Furamoos	47°59’N	9°53’E	662 m	Müller et al., 2003
Lagaccione	42°34’N	11°51’E	355 m	Magri, 1999
Lago Grande di Monticchio	40°56’N	15°35’E	656 m	Allen et al., 1999, 2000, 2002; Brauer et al., 2000, 2007; Huntley et al., 1999; Watts et al., 1996a, b
La Grande Pile	47°44’N	6°30’E	330 m	de Beaulieu et Reille, 1992; Field et al., 1994; Guiot et al., 1992; Kukla et al., 2002; Kühl et Litt, 2003; Rousseau et al., 2006; Seret et al., 1992; Woillard, 1978
Le Bouchet	44°55’N	3°47’E	1200 m	de Beaulieu et al., 1995, 2001; Reille et de Beaulieu, 1988, 1990; Reille et al., 1998, 2000
Le Praclaux	44°49’N	3°50’E	1000 m	Reille et de Beaulieu, 1995; Reille et al., 2000
Les Echets	45°54’N	4°56’E	267 m	Andrieu et al., 2003; de Beaulieu et Reille, 1984, 1989; Gandouin et al., 2007; Guiter et al., 2005
Mondsee	47°49′N	13°23′E	540 m	Klaus, 1975, 1987; Drescher-Schneider et Papesch, 1998; Müller, 2005
Padul	37°00’N	3°40’W	785 m	Pons et Reille, 1988
Ribains	44°50’N	6°09’E	1080 m	de Beaulieu et Reille, 1992; Kukla et al., 2002; Reille et al., 2000
Valle di Castiglione	41°53’N	15°05’E	44 m	Follieri et al., 1988, 1989, 1998

Figure 1: Carte de localisation des longues séquences continentales du sud et du centre de l'Europe.

Le chapitre 4 s'attache à montrer les principaux résultats obtenus à partir de l'analyse pollinique de la séquence d'Ochrid et des quantifications climatiques, après une description du système hydrologique, du climat et de la végétation autour du lac Ochrid.

Les aspects stratigraphiques de la séquence du lac Ochrid sont présentés dans l'article ci-joint (Lézine et al., soumis).

Les données acquises à partir de la séquence JO 2004 offrent l'opportunité : (1) de discuter de la dynamique de la végétation sur un cycle climatique, dans une zone de moyenne altitude du sud des Balkans, à la frontière entre les influences méditerranéenne et medio-européenne, (2) d'apporter de nouvelles données pour étudier la présence de refuges forestiers glaciaires, à moyenne altitude, dans le sud des Balkans (Bordacs et al., 2002; Brewer et al., 2002; Petit et al., 2002; Tzedakis et al., 2002; Willis et al., 2000), et (3) de fournir pour la première fois des données quantifiées des variations climatiques qui ont eu lieu dans la région du lac Ochrid, au cours du dernier cycle climatique.

Ailleurs en Europe, peu de séquences permettent d'étudier l'histoire de la végétation et du climat sur l'ensemble du dernier cycle climatique.

En Europe occidentale, trois séquences polliniques, celles de la Grande Pile, des Echets et du Bouchet (France) ont permis d'obtenir des informations sur les changements paléoclimatiques au cours de la totalité ou d'une partie du dernier cycle climatique. (c.f. Guiot et al., 1989, 1990; Cheddadi et al., 1998; Klozt et al, 2004; Rousseau et al, 2006) mais aucune séquence ne fournit de reconstitutions quantifiées des variations climatiques, alors que la quantification apparaît comme un excellent moyen d'approcher la réalité des fluctuations climatiques.

Pour l'Europe méridionale, seule la séquence de Monticchio en Italie (Allen et al., 1999, 2000, 2002; Brauer et al., 2000, 2007; Huntley et al., 1999; Watts et al., 1996a, b) a fourni à ce jour une étude suffisamment documentée pour permettre de quantifier les brefs événements climatiques du dernier cycle climatique.

Présentation du site d'étude (figure 2)

Figure 2: Localisation du lac Ochrid et topographie dans la région des lacs Ochrid et Prespa (modifié à partir d'une image du satellite Landsat 7 de la NASA du 17 septembre 2006).

Un système hydrologique complexe

Le réseau d'alimentation en eau du lac Ochrid est complexe du fait de ces connections souterraines avec le lac Grand Prespa (Watzin et al., 2002). Le lac Prespa se situe au sud-est du lac Ochrid, 150 m plus haut en altitude (Amataj et al., 2007; Anovski et al., 1991; Gvijic, 1906; Watzin et al., 2002). Environ 50% de l'eau qui sort des sources du Saint Naum et de Tushemisht sur la côte sud-est du lac Ochrid provient du lac Prespa (Cvilic, 1911). Les montagnes karstiques du Mali Thatë en Albanie et de Galicica en République de Macédoine sont très poreuses et facilitent le transport de l'eau du lac Prespa vers le lac Ochrid. La présence d'une paléo-vallée sur le Mali Thatë témoigne de l'existence d'une connexion directe entre les deux lacs, dans le passé (Amataj et al., 2007). Le lac Ochrid est alimenté à 50% par les eaux des rivières Cherava, Sateska et Koselska, et, à 50% par des sources karstiques dont l'eau provient du lac Prespa et des précipitations (figure 3). Les principales sources du lac Ochrid se déversent au sud-est du lac. L'exutoire du lac se situe au nord. L'eau s'écoule via la rivière Crn Drim jusque dans la mer Adriatique.

Figure 3: Bassin versant des lacs Prespa et Ochrid.

Le climat actuel

Le climat actuel dans la région du lac Ochrid est tempéré, du fait: (1) de la présence de montagnes autour du lac qui facilitent entre autre la pénétration des masses d'air chaudes de la Méditerranée, et (2) de la proximité de la mer Adriatique.

Le diagramme ombrothermique de la station météorologique de Pogradec (20°66'N, 40°90'E, 707 m d'altitude), une ville localisée au sud du lac Ochrid (figure 4), nous donne une image de la répartition mensuelle des précipitations et des variations mensuelles de température au cours d'une année. Les données climatiques correspondent à la moyenne des valeurs enregistrées entre 1961 et 1990 et compilées par la FAO (Gommes et al., 2004). Les températures sont indiquées par une ligne rouge, alors que les précipitations sont représentées par des colonnes bleues.

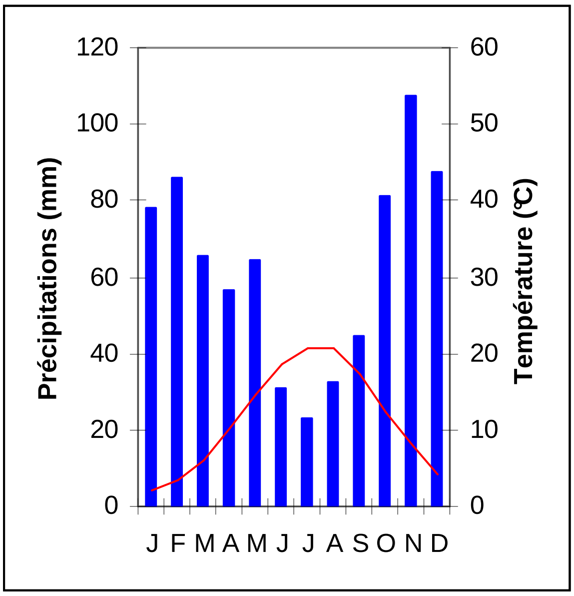

Figure 4: Diagramme ombrothermique de la station météorologique de Pogradec (20°66'N, 40°90'E, 707 m alt).

Entre les mois de septembre et de mai, la courbe des précipitations se situe au-dessus de celle de la température, donc pendant cette période le climat est humide. Le temps est sec entre les mois de juin et d'août, la courbe de la température étant supérieure à celle des précipitations. La température moyenne annuelle est de 11.5°C. Le mois le plus froid est le mois de janvier et les mois les plus chauds sont juillet et août.

Le régime pluviométrique est de type méditerranéen. Il est caractérisé par un maximum de précipitations l'hiver en novembre et décembre (environ 100 mm), avec un second pic au printemps pendant le mois de mai. Les mois de juin, juillet et août sont les plus secs. La quantité annuelle de précipitations oscille autour de 700 mm.

Le régime des vents est caractérisé par des vents d'orientation nord-sud, liés à la circulation atmosphérique, et, par des vents locaux liés à la présence du lac. A l'automne et pendant l'hiver, les vents viennent principalement du nord alors que pendant le printemps et l'été, ils viennent du sud et du sud-est.

Une végétation de type sub-méditerranéen

La végétation autour du lac Ochrid est de type sub-méditerranéen Quézel (1998). En-dessous de 1200 m d'altitude, la forêt mixte décidue domine, caractérisée par l'association d'espèces tempérées: *Carpinus orientalis*, *Acer monspessulanum*, *Fraxinus ornus* et d'espèces méditerranéennes: *Pistacia terebinthus* et *Phillyrea latifolia*. Entre 1200 et 1900 m d'altitude, les chênes forment soit des chênaies pures, soit des chênaies mixtes. Les principales espèces de chênes rencontrées sont: *Quercus trojana*, *Q. frainetto* et *Q. cerris*. Au-dessus de 1900 m d'altitude, la forêt de hêtres à *Fagus moesiaca* domine. D'autres arbres sont aussi présents en association avec les hêtres: *Pinus leucodermis*, *Juniperus excelsa*, *J. foetidissima* et *Aesculus hippocastanum*. Au-dessus de la limite des arbres se développent des zones arbustives à genévriers nains puis des pelouses alpines dominées par les Poaceae.

A l'ouest du lac Ochrid, la végétation est dégradée à cause de la déforestation. En revanche, la végétation à l'est du lac Ochrid est protégée grâce à la création du parc national de Galicica, avec des mesures particulières pour la protection des zones forestières (figure 5).

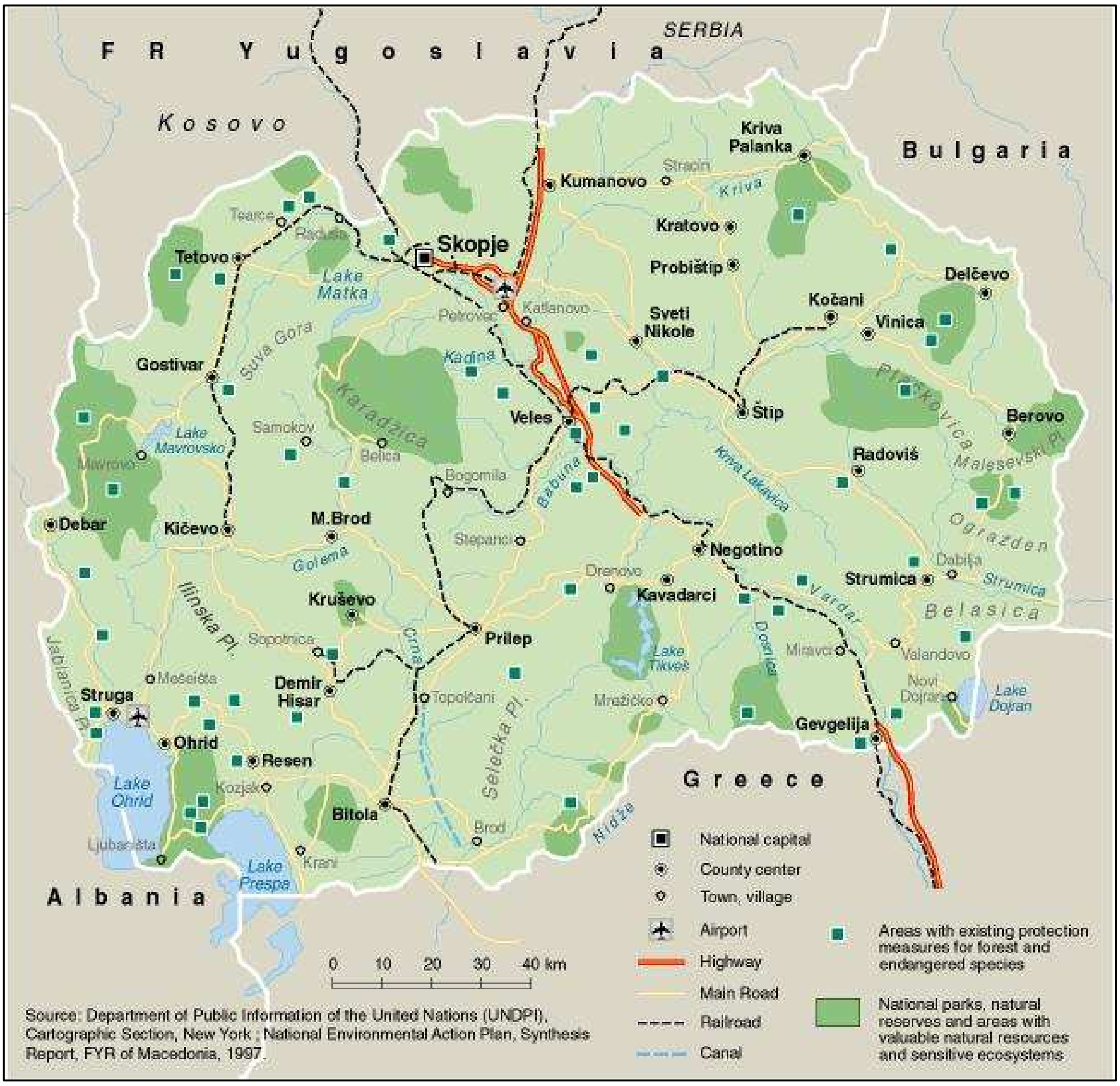

Figure 5: Carte de la République de Macédoine montrant dans la région des lacs Ochrid et Prespa, les zones protégées par des parcs naturels nationaux.

Histoire de la végétation et du climat à Ochrid lors du dernier cycle climatique

Matériel et méthodes

Echantillonnage

L'échantillonnage a été réalisé tous les 10 cm sur les quatre tronçons JO-2004-1, puis tous les 5 cm entre 5 et 15 cm, entre 65 cm et la base du tronçon JO-2004-1A, entre le sommet et 135 cm sur le tronçon JO-2004-1B, entre le sommet et 245 cm sur le tronçon JO-2004-1D. L'échantillonnage a ensuite été resserré tous les 1 cm entre 84 et 88 cm, entre 124 et 127 cm, entre 140 et 142 cm, entre 155 et 157 cm sur le tronçon JO-2004-1A, autour de pics pouvant correspondre à des évènements steppiques rapides de la dernière déglaciation.

Méthode de traitement physico-chimique

Les 155 échantillons sédimentaires prélevés ont été traités au laboratoire de palynologie du Laboratoire des Sciences du Climat et de l'Environnement, à Gif-sur-Yvette, en France. Ils ont subi d'abord un traitement physique par tamisage pour éliminer la fraction supérieure à 125µm, puis plusieurs traitements chimiques (HCl, HF, KOH) comme décrits par Faegri et Iversen (1977) pour éliminer au maximum la fraction minérale. Les résidus ont ensuite été filtrés à 5µm pour éliminer tous les éléments fins inférieurs à 5µm puis rincés à l'eau glycérinée phénolée 30% pour faciliter la conservation du résidu pollinique.

Afin de pouvoir mesurer les concentrations polliniques – quantité de grains de pollen et de spores dans 1 cm^3 de sédiment – le volume du sédiment avant traitement a été mesuré, et, une quantité connue de grains de pollen «éxotiques» - des spores de *Lycopodium* – a été ajoutée au sédiment avant les traitements chimiques.

Détermination pollinique

Le comptage des grains de pollen a été réalisé sous microscope optique au grossissement x500 et la détermination pollinique au grossissement x1000. Les ouvrages de morphologie pollinique de Reille (1992), de Faegri et Iversen (1977) et de Chester et Raine (2001) ont été utilisés pour identifier le nom de la plante ayant disséminé chaque grain de pollen observé.

En moyenne 500 grains de pollen ont été comptés par échantillon. Cette somme pollinique varie légèrement d'un échantillon à l'autre car elle dépend de la concentration totale en grains de pollen, de la présence d'un taxon dominant et de l'état de conservation des grains de pollen. Le comptage a été considéré comme valide lorsque le nombre de taxons identifiés par ligne de comptage atteignait un plateau et lorsqu'il y avait plus de 100 grains de pollen déterminés en dehors de la masse dominante.

Cent-dix taxons polliniques ont été identifiés dont 46 taxons d'arbres et 64 taxons herbacés, plus 5 types de spores de Ptéridophytes et 6 types d'algues (tableau 2). La nomenclature utilisée pour l'identification des taxons est celle de la banque européenne de données polliniques (EPD: European Pollen Database, http://www.europeanpollendatabase.net).

Les pourcentages polliniques ont été calculés sur la somme des grains de pollen d'arbres, d'herbacés, des grains de pollen indéterminés et des spores de fougères. Les indéterminables, les spores de Bryophytes, les taxons de plantes aquatiques et les algues n'ont pas été pris en compte pour le calcul de cette somme.

Tableau 2 : Liste des taxons polliniques arborés, herbacés, de spores de fougères et de types d'algues, identifiés dans les sédiments de la séquence JO-2004 prélevée dans le lac Ochrid.

Arbres et arbustes		Fagaceae	*Castanea sativa*
Aceraceae	*Acer campestre*-type		*Fagus*
Adoxaceae	*Sambucus nigra*-type		*Quercus ilex*-type
Anacardiaceae	*Pistacia*		*Quercus robur*-type
Aquifoliaceae	*Ilex*	Juglandaceae	*Juglans*
Araliaceae	*Hedera*	Malvaceae	*Tilia*
Betulaceae	*Alnus glutinosa*-type	Oleaceae	sp.
	Alnus viridis-type		*Fraxinus excelsior*-type
	Betula		*Fraxinus ornus*
	Betula nana-type		*Olea europaea*
	Carpinus betulus		*Phillyrea*
	Corylus	Pinaceae	*Abies*
	Ostrya/*Carpinus orientalis*		*Cedrus*
Buxaceae	*Buxus*		*Picea*
Celastraceae	*Euonymus*		*Pinus*
Cornaceae	*Cornus*		*Tsuga*
	Cornus sanguinea-type	Platanaceae	*Platanus*
Cupressaceae	sp.	Rhamnaceae	sp.
	Juniperus-type	Salicaceae	*Salix*
Elaeagnaceae	*Hippophaë rhamnoides*	Tamaricaceae	*Myricaria*
Ephedraceae	*Ephedra*	Ulmaceae	*Ulmus*/*Zelkova*
	Ephedra distachya-type	Vitaceae	*Vitis*
	Ephedra fragilis-type		
Ericaceae	sp.		
	Arbutus		

Plantes herbacées			
Asteraceae	*Ambrosia*-type	Monocotylédone	sp.
	Artemisia	Moraceae	Morus
	Asteroideae	Orobanchaceae	Euphrasia
	Carduus		Pedicularis palustris-type
	Centaurea nigra-type		Rhinanthus-type
	Cichorioideae	Plantaginaceae	Plantago
	Echinops		Plantago coronopus-type
	Serratula-type		Plantago lanceolata-type
Apiaceae	sp.		Plantago major/media-type
Asphodelaceae	*Asphodelus*		Veronica-type
Boraginaceae	sp.	Plumbaginaceae	sp.
	Myosotis	Poaceae	sp.
Brassicaceae	sp.		Cerealia-type
	Hornungia-type		Secale cereale
Cannabaceae	*Humulus lupulus*	Polygonaceae	Oxyria digyna
Caryophyllaceae	sp.		Polygonum
	Cerastium fontanum-type		Rumex/Oxyria
Chenopodiaceae/ Amaranthaceae	sp.	Ranunculaceae	sp.
Cistaceae	*Helianthemum*		Helleborus
Clusiaceae	*Hypericum*		Ranunculus acris-type
Cyperaceae	sp.		Thalictrum
Dipsacaceae	*Dipsacus*	Rosaceae	sp.
Euphorbiaceae	*Euphorbia*		Sanguisorba minor-type
Fabaceae	sp.		Sanguisorba officinalis
	Hedysarum	Rubiaceae	sp.
Gentianaceae	*Gentiana pneumonanthe*-type	Urticaceae	sp.
	Gentianella campestris-type		Parietaria
Juncaceae	sp.		Urtica dioica-type
Labiateae	sp.	Saxifragaceae	Saxifraga
	Stachys sylvatica-type	Scrophulariaceae	sp.
Liliaceae	sp.	Smilacaceae	Smilax
	Allium-type	Valerianaceae	Valeriana

Pteridophyta	sp.
Aspleniaceae	*Cheilanthes*
Botrychiaceae	*Botrychium*
Dryopteridaceae	*Dryopteris*-type
Equisetaceae	*Equisetum*
Hypolepidaceae	*Pteridium aquilinum*

Algae	
Chlorellaceae	*Chlorella*
Desmidiaceae	*Cosmarium*
	Euastrum
	Staurastrum
Dictyosphaeriaceae	*Botryococcus*
Hydrodictyaceae	*Pediastrum*

L'histoire de la végétation à Ochrid

Les courbes des pourcentages polliniques des arbres et des éléments steppiques (figure 6) donnent une première indication des grands changements de végétation à Ochrid. La séquence pollinique JO 2004 montre l'alternance de deux phases glaciaires dominées par les taxons steppiques (entre 990 et 875 cm MCD et entre 460 et 110 cm MCD) avec deux phases interglaciaires dominées par les éléments forestiers (entre 875 et 460 cm MCD et entre 110 cm MCD et le sommet de la carotte).

Le diagramme pollinique synthétique de la séquence du lac Ochrid (figure 7) montre la chronostratigraphie associée à ces différentes phases, en se basant sur sept grands groupes de plantes : les plantes pionnières (*Betula*), les pins et les genévriers (*Pinus* et *Juniperus*), les conifères (*Abies* et *Picea*), les arbres mésoïques (*Acer*, *Alnus*, *Arbutus*, *Buxus*, *Carpinus betulus*, *Castanea*, *Cedrus*, *Cornus*, *Corylus*, Cupressaceae, *Ephedra* sp., Ericaceae, *Euonymus*, *Fagus*, *Fraxinus* sp., *Hedera*, *Hippophaë*, *Ilex*, *Juglans*, *Ostrya*/*Carpinus orientalis*, *Platanus*, *Quercus* décidu, Rhamnaceae, *Salix*, *Sambucus*, *Tilia*, *Tsuga*, *Ulmus* et *Vitis*), les arbres/arbustes méditerranéens (*Olea*, Oleaceae, *Phillyrea*, *Pistacia* et *Quercus ilex*-type), les Poaceae et les autres plantes herbacées. Les phases glaciaires (Riss et Würm) et les évènements froids (Mélisey 1 et 2) sont dominés par les Poaceae et les autres herbacées. Les phases interglaciaires (Eemien, Saint-Germain 1 et 2, Holocène) sont dominées par *Pinus*, *Juniperus*, *Abies*, *Picea* et les arbres mésoïques. Les arbres/arbustes méditerranéens sont présents seulement à l'Eemien et à l'Holocène. *Pinus*, *Juniperus* et les arbres masoïques sont présents tout le long de la séquence du lac Ochrid, même pendant les phases glaciaires et les évènements froids.

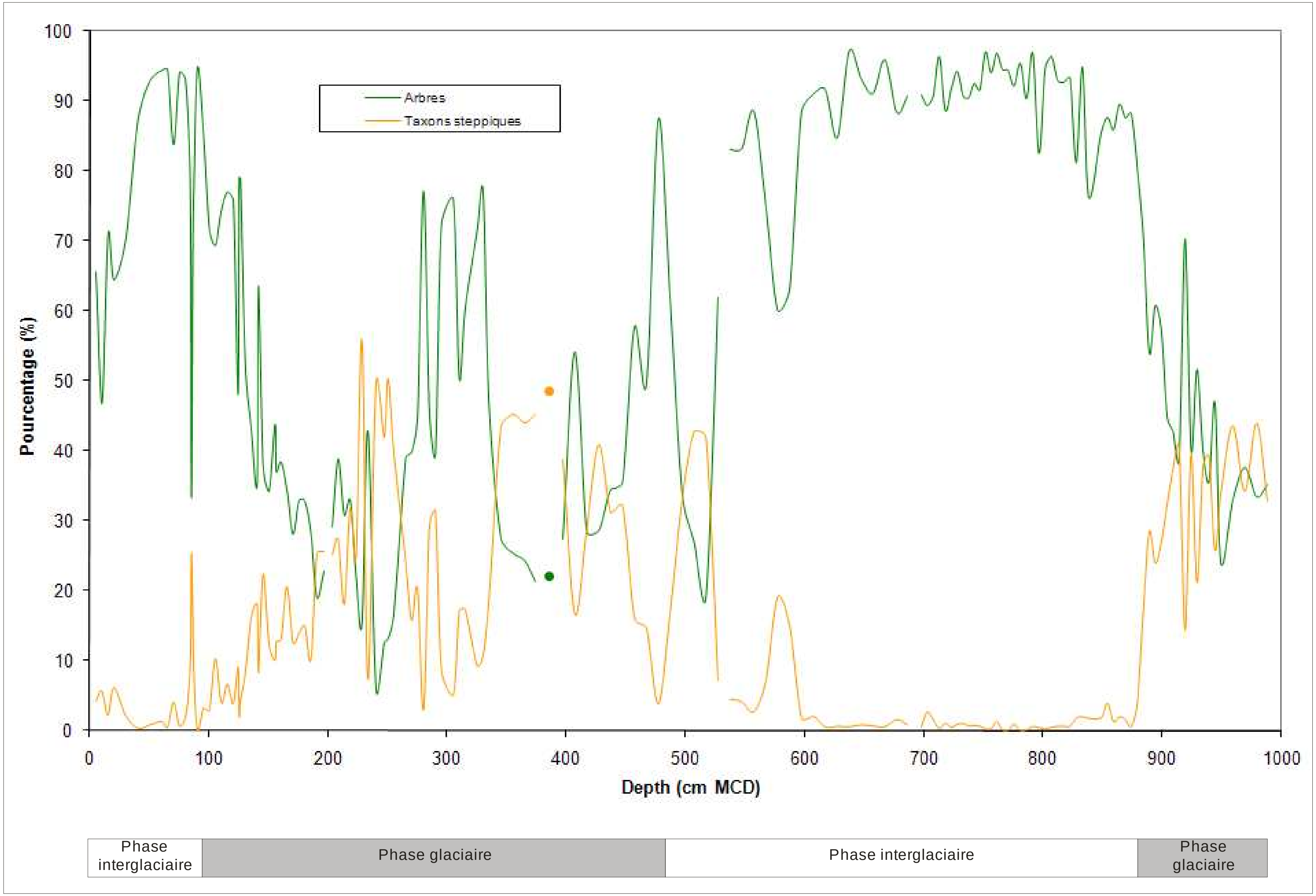

Figure 6: Pourcentages d'arbres (courbe verte) et de taxons steppiques: *Artemisia* et Chenopodiaceae/Amaranthaceae (courbe orange), pour chaque tronçon de la carotte JO-2004-1 d'Ochrid, sont représentés en fonction de la profondeur MCD. Les points orange et vert correspondent aux pourcentages mesurés sur un échantillon de la carotte parallèle (tronçon JO-2004-1a-B).

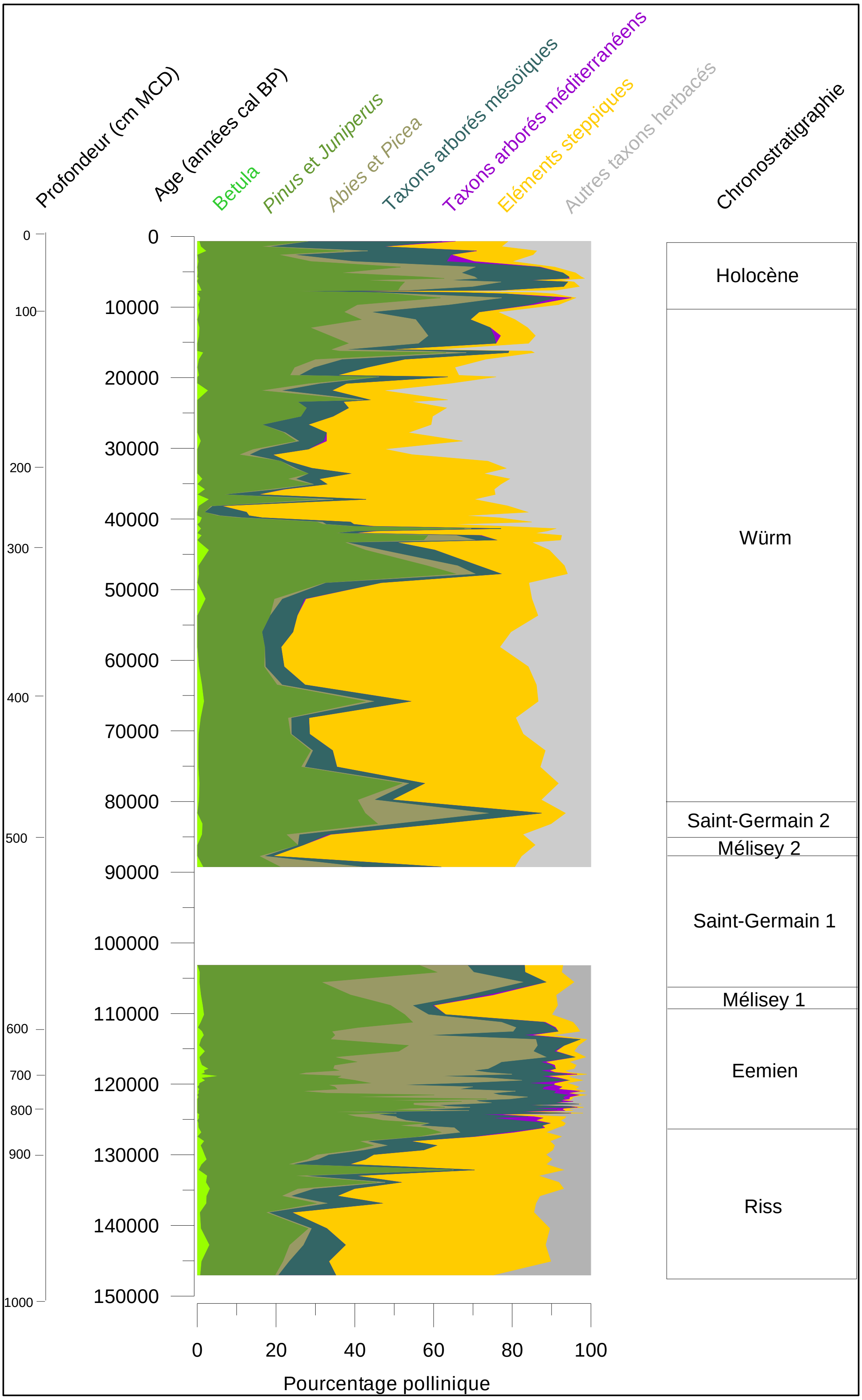

Figure 7 : Diagramme pollinique synthétique de la séquence JO 2004 du lac Ochrid, représentant en fonction de la profondeur exprimée en cm MCD et de la chronologie exprimée en années cal BP, les pourcentages polliniques de *Betula*, de *Pinus* et *Juniperus*, d'*Abies* et *Picea*, des arbres mésoïques, des arbres et arbustes méditerranéens, des Poaceae et des autres herbacées, et, la chronologie.

Le diagramme pollinique simplifié permet d'identifier huit zones polliniques (tableau 3, figure 8).

Tableau 3 : Description synthétique des zones polliniques de la séquence JO 2004 et de la chronostratigraphie associée.

Zone pollinique	**Signature pollinique**	**Chronostratigraphie**
8b	Développement de *Fagus* (6%), *Castanea* (5%), associés à *Juglans* et *Cerealia*-type (2%)	Holocène (110-0 cm MCD)
8a	Développement de *Quercus robur*-type (5-20%) et *Ostrya*/*Carpinus orientalis* (jusqu'à 5%)	
7d	Développement de *Abies* (5-30%), *Pinus* (30-60%), associés à *Quercus robur*-type (jusqu'à 10%)	Transition Würm/Holocène 130-110 cm MCD)
7c	Cichorioïdeae (jusqu'à 25%) associé à *Hippophaë rhamnoïdes* (jusqu'à 10%)	Würm (460-130 cm MCD)
7b	Augmentation de *Pinus* (de 20 à 60%) et diminution des éléments steppiques : *Artemisia* (<25%), Chenopodiaceae/Amaranthaceae (<5%)	
7a	Développement des éléments steppiques: *Artemisia* (10-40%), Poaceae (15% en moyenne), Chenopodiaceae/Amaranthaceae (jusqu'à 15%)	
6	Développement des conifères : *Abies* (10% en moyenne) et *Pinus* (20-45%), au dépend des éléments steppiques (<30%)	Saint Germain 2 (500-460 cm MCD)
5	Développement des éléments steppiques: *Artemisia* (30%), Poaceae (15-20%), Chenopodiaceae/Amaranthaceae (10-15%), associés à *Pinus* (15-25%)	Mélisey 2 (520-500 cm MCD)
4	Développement des conifères : *Abies* (10-50%) et *Pinus* (20-60%), au dépend des éléments steppiques (<7%)	Saint-Germain 1 (570-520 cm MCD)
3	Développement des éléments steppiques : *Artemisia* (10-15%), Poaceae (jusqu'à 15%), Chenopodiaceae/Amaranthaceae (5%)	Mélisey 1 (590-570 cm MCD)
2c	Développement de la forêt à *Picea* (jusqu'à 15%) et *Abies* (30% en moyenne), associés à *Pinus* (30-55%)	Eemien (875-590 cm MCD)
2b	Développement de la forêt mixte de montagne : *Abies* (30% en moyenne), *Carpinus betulus* (jusqu'à 15%), *Pinus* (25-75%), *Quercus robur*-type (<15%)	
2a	Développement des éléments mésoïques: *Pinus* (30-70%), *Quercus robur*-type (10-40%), *Abies* (jusqu'à 20%), *Tilia* (<10%), associés à des taxons méditerranéens : *Quercus ilex*-type et *Olea* (<10%)	
1b	Eléments steppiques diminuent et *Pinus* augmente (20-60%)	Transition Riss/Eemien (940-875 cm MCD)
1a	Eléments steppiques dominent: *Artemisia* (20-40%), Poaceae (10-30%), Chenopodiaceae/Amaranthaceae (5-10%), associés à des éléments tempérés: *Pinus* (<30%) et *Quercus robur*-type (<15%)	Riss (990-940 cm MCD)

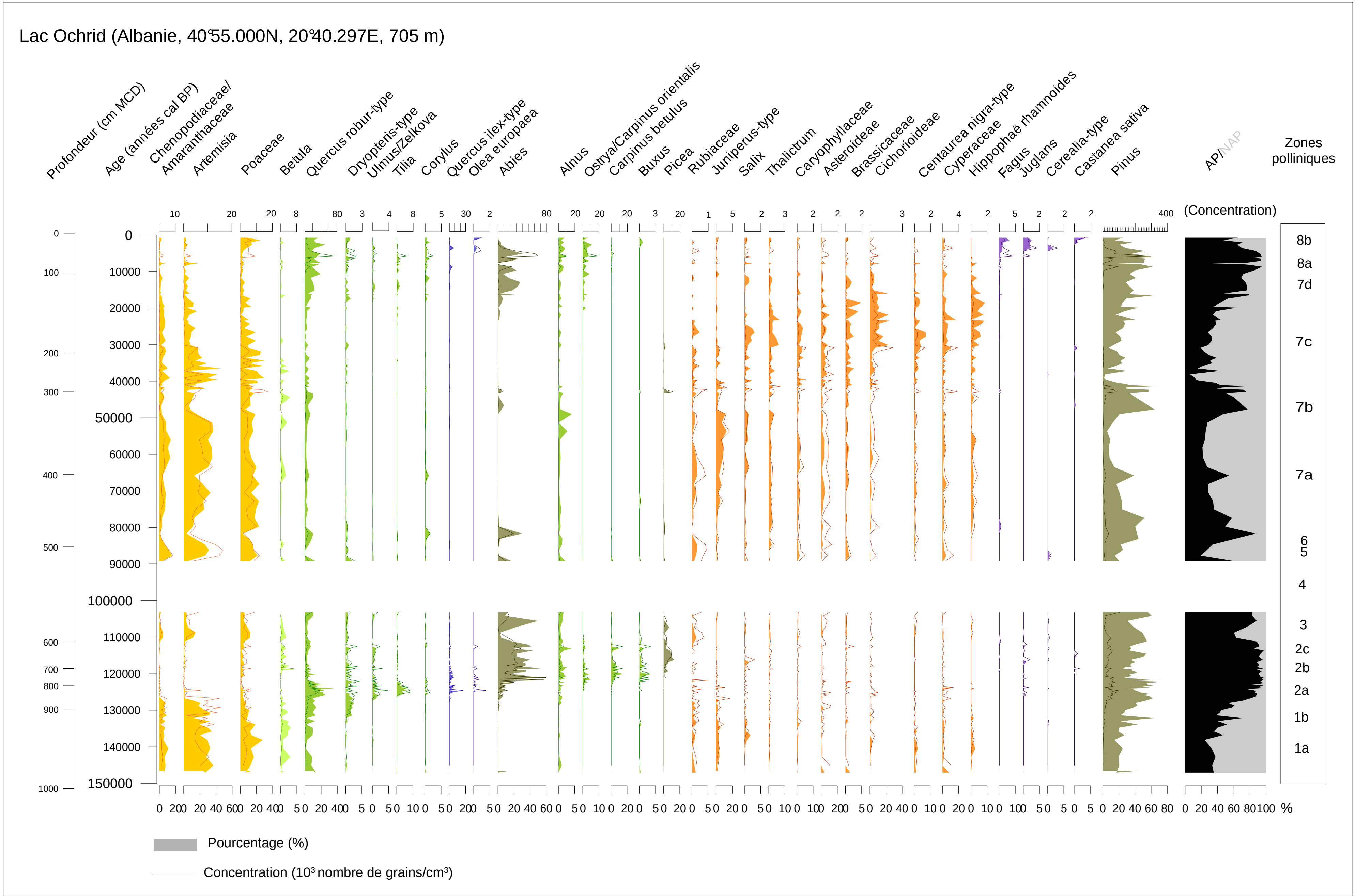

Figure 8: Diagramme pollinique simplifié avec les taxons marqueurs des zones polliniques: pourcentages et concentrations polliniques en fonction de la profondeur exprimée versus la chronologie (en années cal BP).

Reconstitution des biomes (figure 12)

La reconstitution des biomes montre également les principaux changements de végétation à Ochrid.

Le biome « steppe froide » présente les scores les plus élevés entre 990 et 905 cm MCD (entre 147 000 et 130 000 ans cal BP), entre 520 et 490 cm MCD (entre 89 000 et 84 000 ans cal BP), et, entre 470 et 130 cm MCD (entre 80 000 et 17 000 ans cal BP). Ces trois phases steppiques semblent correspondre, respectivement : (1) à la glaciation du Riss ou au stade isotopique MIS 6 identifié dans les sédiments marins (Shackleton 1969; Shackleton, Sanchez Goni et al. 2003), (2) au Mélisey 2 (Woillard 1978), et, (3) à la glaciation würmienne (A. Penck et E.Brückner, 1901-1909) ou stades isotopiques MIS 2, 3, 4.

Ces phases steppiques alternent avec deux phases dominées par les biomes « forêt tempérée décidue » ou « forêt mixte froide ».

La forêt tempérée décidue domine entre 905 et 735 cm MCD (entre 130 000 et 120 000 ans cal BP) pendant la première phase de l'Eemien (Bosch et al., 2000) ou stade isotopique MIS 5e, puis entre 130 et 5 cm MCD (entre 17 000 et 700 ans cal BP) pendant l'Holocène ou stade isotopique MIS 1.

La forêt mixte froide domine entre 735 et 520 cm MCD (entre 120 000 et 89 000 ans cal BP), entre 490 et 470 cm MCD (entre 84 000 et 80 000 ans cal BP), puis entre 330 et 310 cm MCD, entre 305 et 290 cm MCD et vers 280 cm MCD (entre 48 000 et 41 000 ans cal BP). Ces trois phases forestières semblent correspondre, respectivement : (1) aux phases 2 et 3 de l'Eemien, (2) au Saint-Germain 2 (Woillard 1978), puis (3) à la zone arborée de la glaciation du Würm. Le Saint-Germain 1 (Woillard 1978) à Ochrid est marqué par un hiatus dans l'enregistrement sédimentaire. Le Mélisey 1 (Woillard 1978) est caractérisé par le biome « forêt mixte froide » même si les éléments steppiques se développent car les arbres persistent autour du lac Ochrid. A la transition entre le Riss et l'Eemien, la recolonisation forestière présente trois phases successives alors qu'à la transition entre le Würm et l'Holocène, les arbres se développent simultanément. En revanche, pendant les phases de transition glaciaire – interglaciaire (Riss/Eemien et Würm/Holocène), le maximum d'extension des arbres dans le bassin versant du lac Ochrid est toujours atteint environ 6 000 ans après le début de l'augmentation des arbres.

Le timing de ces phases successives du dernier cycle climatique à Ochrid est cohérent avec ce qui est proposé ailleurs en Europe, à partir de séquences continentales bien datées (c.f. Bispingen en Allemagne – (Müller 1974) et Monticchio en Italie - (Brauer, Allen et al. 2007)). De plus, la date de la transition entre le Riss et l'Eemien à Ochrid est cohérente avec la datation de la transition glaciaire (MIS 6) - interglaciaire (MIS 5) en Atlantique Nord à partir d'enregistrements marins et de carottes de glace, proposée par Waelbroeck et al. en 2008. En revanche, la fin de l'Eemien semble arriver plus tardivement à Ochrid où les populations d'arbres se maintiennent jusqu'à 110 000 ans cal BP, alors que dans le nord de l'Europe, la forêt disparaît dès 115 000 ans cal BP (Tzedakis, 2003).

Le Riss

La fin du Riss correspond à la zone pollinique 1a (figure 8), caractérisée par des sédiments d'argile grise sableuse, qui comprennent de forts pourcentages de taxons steppiques : *Artemisia*, Poaceae et Chenopodiaceae/Amaranthaceae (tableau 3), associés à (1) quelques taxons arboréens : *Pinus* et *Quercus robur*-type, caractéristiques de la forêt mixte de moyenne altitude, présente actuellement dans les montagnes du Pinde au nord de la Grèce (Bottema 1974; Bordon, Peyron et al. in press) et (2) à deux taxons pionniers : *Juniperus*-type et *Betula*, qui se développent dans des conditions froides et sèches dans des zones ouvertes car ce sont des plantes héliophiles (Da Lage and Métailié 2000).

Pendant cette période, le bassin versant du lac Ochrid est donc recouvert par la steppe à armoises, parsemée de genévriers et de bouleaux. La steppe est aussi associée à des populations forestières de pins et de chênes. Ce même type de végétation a été enregistré dans le Nord de la Grèce, dans la région de Khimaditis (Bottema 1974), dans un site localisé 4.5 km au nord-est du lac Khimaditis (40°38'30''N, 21°37'11''E, 560 m d'altitude).

La transition entre le Riss et l'Eemien (zone pollinique 1b – figure 8, tableau 3) est marquée par la diminution des éléments steppiques au profit du développement de la forêt de pins dans le bassin versant du lac Ochrid.

L'Eemien

La zone pollinique 2 (figure 8) montre trois intervalles caractérisant les phases successives de la recolonisation forestière à l'Eemien : la forêt mixte tempérée (zone pollinique 2a), la forêt mixte froide (zone pollinique 2b) puis la forêt de conifères (zone pollinique 2c).

Les arbres mésophiles, prinicipalement les chênes décidus, qui ne tolèrent ni la sécheresse ni l'humidité excessive (Da Lage and Métailié 2000), sont les premiers à se développer (zone pollinique 2a – tableau 3) autour du lac Ochrid. Ils sont associés à des taxons montagnards : *Pinus* et *Abies* dont les populations doivent être restreintes aux zones de hautre altitude sur les montagnes environnantes, et, à des taxons méditerranéens : *Olea europaea* et *Quercus ilex*-type dont le développement est probablement lié à une forte évapotranspiration en hiver (Bordon et al., en préparation). Comme cela a été montré en Italie à partir des séquences polliniques de Monticchio (Brauer, Allen et al. 2007) et de Castiglione (Follieri, Magri et al. 1988; Magri and Tzedakis 2000), le développement des éléments méditerranéens au début de l'Eemien à Ochrid semble aussi corrélé à un maximum d'insolation estivale (figure 9).

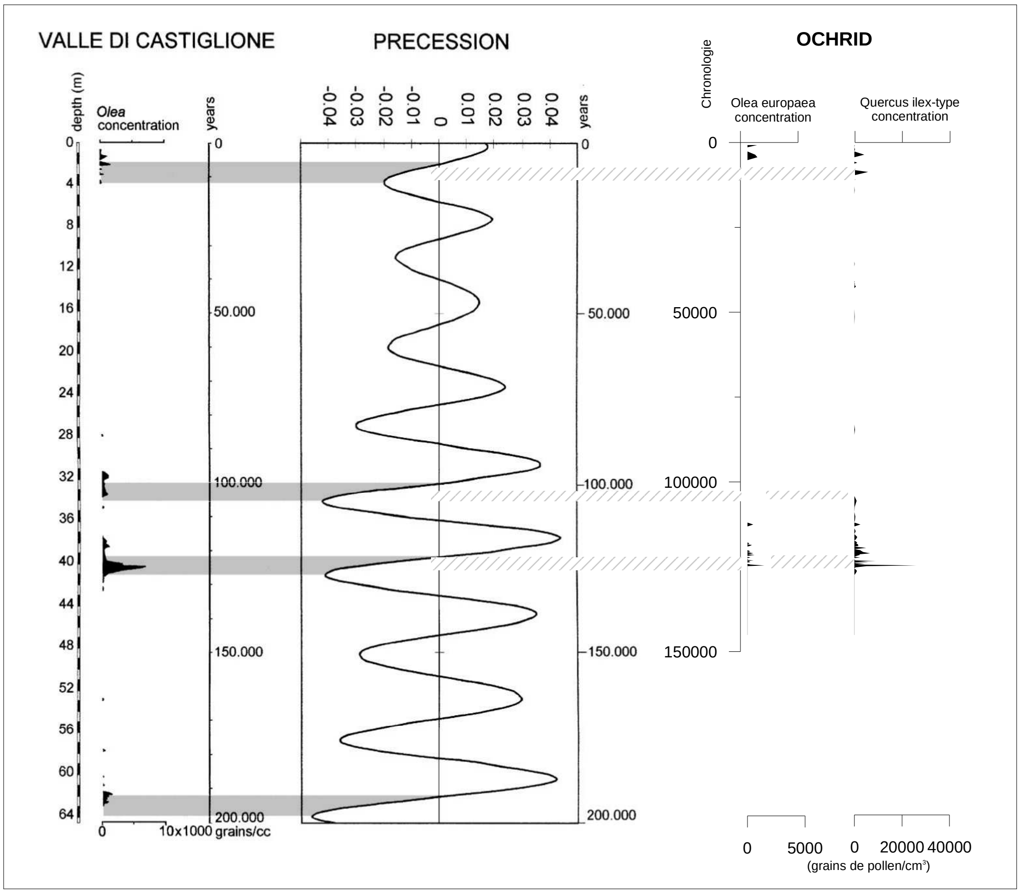

Figure 9 : Concentrations polliniques de *Olea europaea* et *Quercus ilex*-type dans la séquence JO 2004 prélevée dans le lac Ochrid (Albanie) et variations de la précession (Berger 1992). Les bandes grisées indiquent les périodes où la Terre est au périhélie – moment de l'année où la Terre est la plus proche du Soleil – en été, c'est-à-dire quand l'insolation estivale est la plus forte.

En Grèce, la forêt mixte décidue domine également au début du dernier interglaciaire, mais l'importance relative d'*Ostrya*/*Carpinus orientalis* et de *Quercus* décidu est différente. Les charmes sont plus abondants au nord de la Grèce (Khimaditis IV, Ioannina II - (Bottema 1974)) alors qu'autour du lac Ochrid ce sont les chênes décidus qui dominent. D'après l'étude des relations actuelles entre la pluis pollinique et les conditions climatiques dans le sud des Balkans (Bordon et al., soumis – chapitre 1), les chênes décidus tolèrent des températures estivales plus basses que *Ostrya carpinifolia* et *Carpinus orientalis*. Actuellement, les températures estivales à Ochrid sont inférieures à celles enregistrées dans le nord de la Grèce. Il semble donc que cette différence climatique actuelle entre les deux régions était déjà présente à l'Eemien.

Vers 122 000 ans cal BP, une forêt mixte froide dominée par les sapins associés aux charmes, principalement Carpinus betulus, se met progressivement en place autour du lac Ochrid (zone pollinique 2b, tableau 3). En Grèce, à Ioannina (Tzedakis 2000; Tzedakis, Frogley et al. 2002), le même type de végétation se développe, mais ce sont les charmes qui dominent. Cette différence est probablement liée à des effets d'altitude, le lac Ochrid se situant environ 200 m plus haut en altitude que le lac Ioannina.

Vers 118 000 ans cal BP, la forêt de conifères (zone pollinique 2c, tableau 3) succède à la forêt mixte, avec le développement des épicéas. En revanche, à Ioannina (Tzedakis 2000; Tzedakis, Frogley et al. 2002), la forêt mixte persiste et ce sont les hêtres qui se développent. A Ochrid, les températures hivernales basses ne permettent probablement pas le maintien des hêtres, qui ne tolèrent pas des températures inférieures à -3°C (Huntley, Bartlein et al. 1989; Prentice and Helmisaari 1991). En revanche, les épicéas, qui ont besoin de températures hivernales inférieures à -3°C pour se développer (Zagwijn 1996) et qui sont présents au début de l'Eemien en Bosnie Herzégovine, Serbie et Bulgarie (figure 10 - (Ravazzi 2002)) ont pu migrer depuis ces régions vers le sud et coloniser le bassin versant du lac Ochrid.

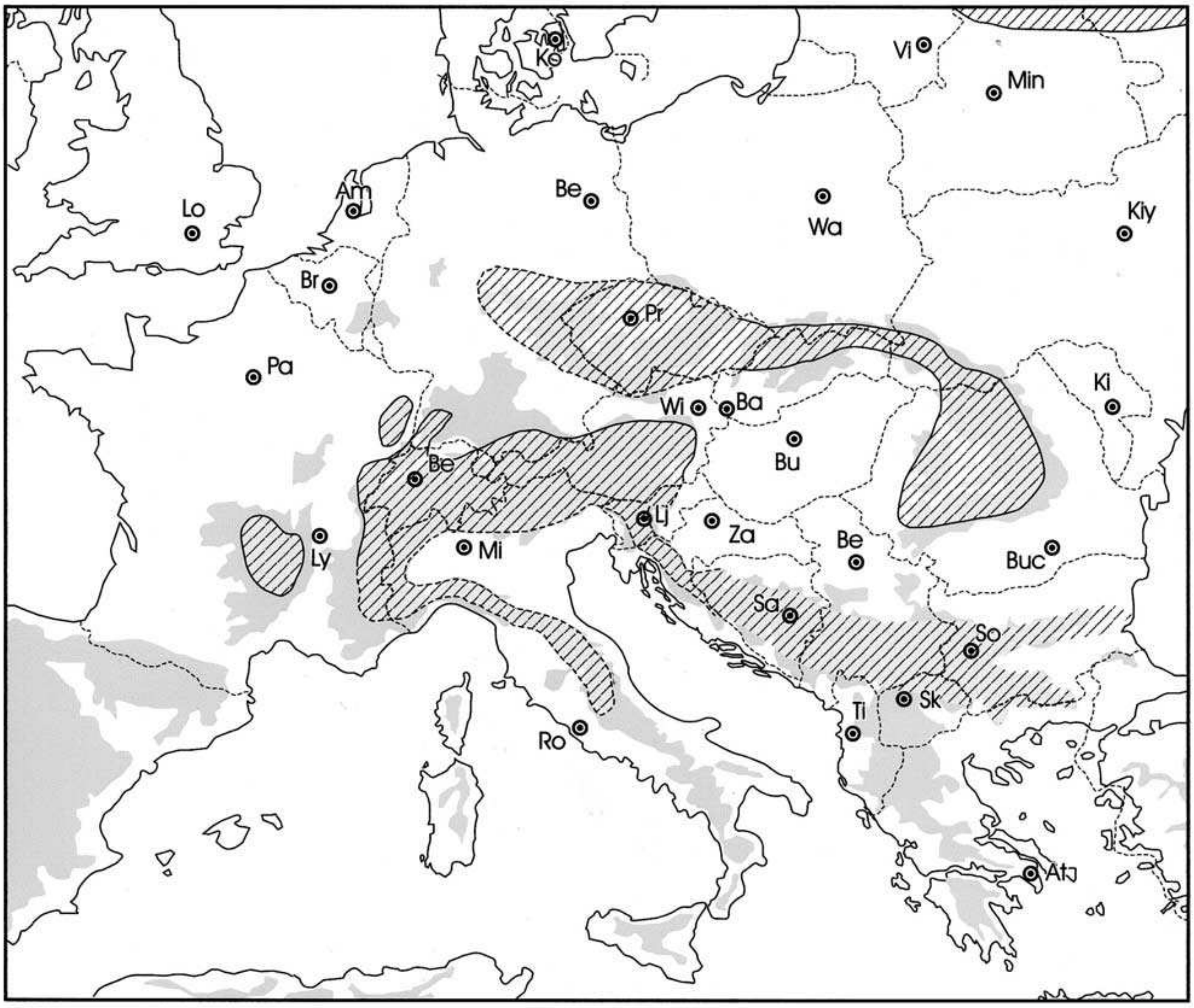

Figure 10 : Carte de distribution des épicéas (*Picea abies* et *Picea omoricoides*) dans le centre et le sud de l'Europe durant la première partie de l'Eemien (zone E3/IV, d'après Turner, 2000). Les sites qui ont servi à l'élaboration de cette carte sont ceux cités dans Zagwijn (1989, 1996). La carte est tirée de Ravazzi (2002).

Le Mélisey 1

Le Mélisey 1 (zone pollinique 3, figure 8) est marqué (1) par le développement des éléments steppiques, même si les grains de pollen d'*Artemisia* et de Chenopodiaceae/Amaranthaceae ne dépassent pas 20% de la somme pollinique totale, et, (2) le maintien de populations de *Abies*, de *Pinus* et de *Picea* sur les versants montagneux entourant le lac Ochrid. Deux cent mètres plus bas en altitude, le site de Ioannina (Tzedakis, Frogley et al. 2002), localisé quelques kilomètres au sud du lac Ochrid, montre qu'à environ 400 m d'altitude les arbres qui étaient présents à l'Eemien, soit des chênes décidus associés à des pins, se maintiennent aussi pendant le Mélisey 1.

Le Saint-Germain 1

A Ochrid, le Saint-Germain 1 semble dominé par la forêt à *Picea* et *Abies* (zone pollinique 4, figure 8), même si l'enregistrement n'est pas complet car la séquence sédimentaire présente un hiatus pour cette période. Ce type de végétation forestière caractérise aussi les sites à plus basse altitude du nord de la Grèce tels que : Tenaghi Philippon (Tzedakis and al. 2006) et Ioannina (Bottema 1974). Ailleurs en Europe du sud et en Europe centrale, les sites montrent plutôt le développement de la chênaie mixte (de Beaulieu and Reille 1992a; Huntley, Watts et al. 1999).

Le Mélisey 2

Pendant le Mélisey 2 (zone pollinique 5, figure 8), l'abondance de grains de pollen d'*Artemisia*, de Poaceae et de Chenopodiaceae/Amaranthaceae indique le développement d'une végétation à caractère steppique dans le bassin versant du lac Ochrid. Ce type de végétation est également enregistré pour la même période en Europe du sud, à : Padul (Pons and Reille 1988), Monticchio (Huntley, Watts et al. 1999), Castiglione (Follieri, Magri et al. 1988; Follieri, Magri et al. 1989; Follieri, Giardini et al. 1998) et Tenaghi Philippon (Tzedakis and al. 2006), et, en Europe centrale : aux Echets (Guiter, Triganon et al. 2005) et à la Grande Pile (de Beaulieu and Reille 1992a). Les montagnes environnantes du lac Ochrid sont colonisées par des forêts de pins et de sapins, associés à quelques populations de chênes décidus. La séquence du lac du Bouchet montre également la présence de grains de pollen de *Picea* et de *Fagus* et donc le maintien d'une forêt de montagne dans le massif central au début du Mélisey 2 (Reille and de Beaulieu 1990). La présence de *Betula* marque la transition vers l'interstade suivant, le Saint-Germain 2.

Le Saint-Germain 2

Autour du lac Ochrid, les forêts éparses de pins et de sapins présentes pendant le Mélisey 2 se développent pendant le Saint-Germain 2 (zone pollinique 6, figure 8). *Pinus* et *Abies* forment des zones boisées ouvertes car des grains de pollen d'*Artemisia*, de Poaceae et de Chenopodiaceae/Amaranthaceae sont également enregistrés dans la séquence du lac Ochrid. En Europe centrale et en Europe du sud, les sites de basse et moyenne altitudes tels que : Ioannina (Bottema 1974), les Echets (Guiter, Triganon et al. 2005), la Grane Pile (de Beaulieu and Reille 1992a), Padul (Pons and Reille 1988) et Tenghi Philippon (Tzedakis and al. 2006), sont colonisés par des forêts mixtes décidues dominées par les chênes. En revanche, à haute altitude, au site du lac du Bouchet (Reille and de Beaulieu 1990), c'est la forêt mixte avec des taxons décidus associés à des conifères qui domine pendant le Saint-Germain 2. Le site de Castoglione (Follieri, Magri et al. 1988; Follieri, Magri et al. 1989; Follieri, Giardini et al. 1998), localisé à basse altitude, apparaît comme une exception car il enregistre une forte proportion de grains de pollen de conifères : *Pinus* et *Abies*, associés à *Carpinus betulus, Ulmus* et *Quercus* décidu.

Le Würm

Pendant la glaciation würmienne (zone pollinique 7, figure 8), des steppes s'étendaient autour du lac Ochrid, ainsi qu'à Ioannina, quelques kilomètres plus au sud, au nord de la Grèce (Bottema 1974) et dans le sud de l'Europe comme à Tenaghi Philippon en Grèce (Tzedakis and al. 2006) et à Monticchio en Italie (Huntley, Watts et al. 1999). Les pourcentages d'*Artemisia* atteignent leur valeur maximale à Ochrid pendant cette période. Les grains de pollen d'armoises sont associés à de grandes quantités de grains de pollen de Chenopodiaceae/Amaranthaceae et de Poaceae (tableau 3), indiquant la présence de vastes steppes autour du lac Ochrid. Dans ces steppes, d'autres taxons herbacés se développent tels que : Asteroideae, Brassicaceae, Caryophyllaceae, *Centaurea nigra*-type, Cichorioideae, Rubiaceae, *Thalictrum* ainsi que quelques individus arborés héliophiles ou pionniers tels que : *Hippophaë rhamnoïdes*, *Juniperus*-type, *Pinus* et *Salix* (tableau 3).

Pendant le Würm, entre 50 000 et 41 000 ans cal BP, le bassin versant du lac Ochrid est caractérisé par le développement de la forêt, avec des concentrations élevées de *Pinus*, associé à *Juniperus*-type, *Artemisia* et Chenopodiaceae/Amaranthaceae (tableau 3). Plusieurs corrélations chronologiques sont envisageables pour cette phase : (1) à Villars, dans le sud de la France, un évènement similaire daté autour de 45 000 ans cal BP est enregistré par les spéléothèmes (Genty, Combourieu Nebout et al. 2005), (2) en Italie (Laggacione, Monticchio, Valle di Castiglione), une phase forestière dominée par *Quercus* et *Fagus*, associés à *Corylus*, *Tilia* et *Ulmus*, et, datée à Monticchio autour de 50 000 ans cal BP (Brauer, Allen et al. 2007), (3) à Ioannina en Grèce, une phase forestière datée autour de 50 000 – 60 000 ans cal BP (Tzedakis, Frogley et al. 2002), (4) à Kopaïs en Grèce, une phase forestière dominée par la chênaie mais non datée (Okuda et al., 2001), et, (5) à Tenaghi Philippon en Grèce, une phase forestière caractérisée par une forêt ouverte dominée par *Pinus*, *Picea* et *Juniperus* associés à *Ephedra* et datée autour de 32 000 ans ^{14}C BP (Wijmstra 1969).

La dernière déglaciation

La dernière déglaciation (zone pollinique 7d, figure 8) entre 16 000 et 12 000 ans cal BP à Ochrid, est caractérisée par le développement des sapins et des pins, associés à des chênes décidus. Les pourcentages polliniques d'*Abies* atteignent des valeurs élevées dès environ 14 500 ans cal BP, alors qu'à Maliq (Denèfle, Lezine et al. 2000), les pourcentages maximum de sapins sont atteints vers 10 000 ans cal BP. Comme les grains de pollen de sapins sont peu transportés, leur présence dans la sédimentation pollinique indique la présence locale des individus ayant produits ces grains de pollen (Huntley and Birks 1983). La comparaison des séquences polliniques d'Ochrid et de Maliq semblent donc indiquer que les sapins colonisent d'abord le bassin versant du lac Ochrid à la fin du Würm puis s'étendent autour du lac Maliq au début de l'Holocène.

L'Holocène

L'Holocène (zone pollinique 8, figure 8) est marqué par le développement de la forêt mixte telle qu'on la retrouve actuellement autour du lac Ochrid. Les mécanismes de recolonisation du territoire par les arbres forestiers autour du lac Ochrid pendant l'Holocène sont similaires à ceux enregistrés par la séquence toute proche du lac Maliq (Denèfle, Lezine et al. 2000), ce qui montre que les deux séquences enregistrent un signal régional. Les pourcentages polliniques des conifères (Pinus et Abies) sont plus importants à Ochrid qu'à Maliq (Denèfle, Lezine et al. 2000). Cette différence est peut-être dûe à la position des carottages dans les deux bassins de Maliq et d'Ochrid. Le carottage dans le lac Ochrid est plus proche des montagnes environnantes colonisées par les conifères que le carottage dans le lac Maliq.

Dans la région des lacs Ochrid et Maliq, les plus anciens sites archéologiques découverts datent de l'âge du Néolithique récent, soit 7 000 ans avnt J.C. (Touchais, Lera et al. 2005). Au Bronze moyen (2 000 ans avant J.C.), l'étude des restes végétaux sur le site archéologique de Savjan indique (1) de possibles défrichements, et (2) que les habitants cultivaient au moins 4 espèces de céréales (l'engrain, le blé amidonnier, l'orge et le millet), ce qui pourrait expliquer l'apparition des taxons anthropiques dans le diagramme pollinique (*Fagus, Castanea*, *Juglans* et *Cerealia*-type), datée autour de environ 5 000 ans cal BP dans la séquence pollinique du lac Ochrid (zone pollinique 8b, figure 8).

Cette phase d'anthropisation est beaucoup plus détaillée dans la séquence pollinique issue d'un carottage dans la partie macédonienne du lac Ochrid (Lotter, A., communication personnelle, figure 11). Cette s équence montre deux phases d'anthropisation : (1) une phase dominée par *Cerealia*-type, *Secale*, *Plantago lanceolata*-type, *Juglans*, *Olea* et *Sporomiella* (un champignon associé au fumier des herbivores domestiques, marquant le début de l'élevage des herbivores - Davis, 1987), (2) puis une phase marquée par la présence de *Zea mays* et *Castanea*.

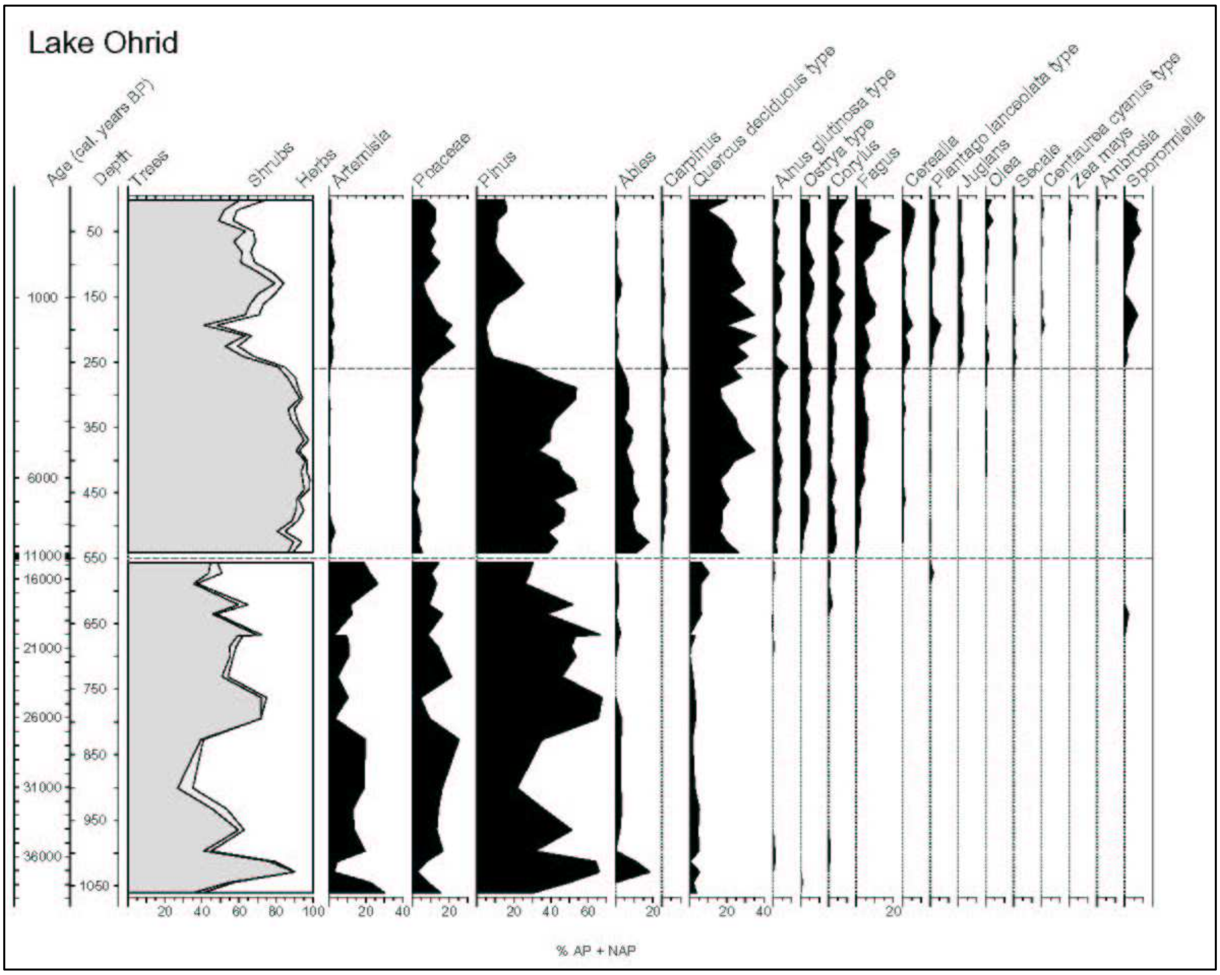

Figure 11 : Diagramme pollinique simplifié de la séquence macédonienne du lac Ochrid (Wagner et al., 2007, Lotter, A., communication personnelle).

Les « refuges forestiers glaciaires »

Lors de la dernière déglaciation et l'Holocène, la séquence pollinique de Maliq a mis en évidence la présence continue de taxons mésoïques (principalement des chênes décidus) dans les Balkans (Denèfle, Lezine et al. 2000). La séquence du lac Ochrid permet d'aborder cette question des « refuges forestiers glaciaires » pour la totalité du dernier cycle climatique dans les Balkans. La présence continue de *Quercus* décidu et de *Pinus* à Ochrid confirme l'hypothèse de la présence de zones de refuges pour les arbres tempérés (Tzedakis, Frogley et al. 2002) entre 700 et 800 m d'altitude dans le sud des Balkans. Le maintien de ces arbres peut être lié à des conditions climatiques locales particulières favorisées par la présence du lac et des montagnes environnantes.

La question des zones de « refuge forestier glaciaire » reste au cœur de l’actualité (Willis and Whittaker 2000). Des charbons de bois (>0.2 cm de diamètre) ont été analysés pour déterminer si les arbres tempérés présents dans la pluie pollinique de 31 séquences localisées en Hongrie sont des indicateurs de la présence de zones refuges ou si les grains de pollen proviennent de zones plus au sud et donc auraient été transportés sur de très grandes distances (Willis, Rudner et al. 2000). De plus, Willis et van Andel (2004) remettent en cause l’hypothèse que les zones de refuges forestiers glaciaires soient restreintes au sud de l’Europe pendant la dernière période glaciaire entre 37 000 et 16 000 ans. Le facteur qui limiterait la croissance des arbres pendant les épisodes glaciaires serait probablement l’aridité. D’ailleurs, pendant la dernière période glaciaire, la présence d’arbres tempérés est détectée à moyenne ou haute altitude où il y avait plus de précipitations orographiques. Il existe des séquences prélevées dans des zones de basse altitude qui enregistrent la présence d’arbres mésophiles et thermophiles pendant les épisodes glaciaires. Pour tester la présence d’arbres pendant la dernière période glaciaire, Willis et van Andel ont étudiés les restes de bois macrofossiles (fragments > 2 mm de diamètre). L’Europe de l’Est, l’Autriche, la République tchèque, la Croatie, la Hongrie, la Moldavie, la Pologne et la Roumanie sont des régions traditionnellement décrites comme des zones possibles de refuges forestiers glaciaires. Les résultats ont montré qu’en Autriche, *Picea* et *Pinus cembra* étaient présents pendant les épisodes froids de la dernière période glaciaire. En République tchèque, la dernière période glaciaire est probablement caractérisée par la présence d’une steppe forestière froide dominée par les conifères avec quelques populations d’arbres décidus tels que *Quercus*, *Fraxinus, Fagus* et *Taxus*. En Croatie, des microrefuges sont occupés entre 28 000 et 24 000 ans par *Pinus*, *Abies*, *Sorbus*, *Fagus sylvatica*, *Ulmus*, *Populus* et *Rhamnus cathartica*. En Hongrie, la dernière période glaciaire et le dernier maximum glaciaire sont probablement caractérisés par une steppe forestière, se rapprochant de la forêt ouverte de type boréale. En Albanie, à Ochrid, les périodes glaciaires du Riss et du Würm sont caractérisées par une steppe forestière dominée par *Pinus* et *Quercus* décidu.

Les quantifications paléo-climatiques à Ochrid

La technique des « meilleurs analogues » contrainte par les biomes a été appliquée à la séquence pollinique du lac Ochrid avec la base des 2760 données actuelles (chapitre 2) afin de quantifier les variations paléoclimatiques au cours du dernier cycle climatique. Six paramètres ont été reconstruits : le montant annuel des précipitations (PANN), le rapport entre l'évapotranspiration réelle et l'évapotranspiration potentielle (AET/PET), la température moyenne annuelle (TANN), la température moyenne du mois le plus froid (MTCO) et du mois le plus chaud (MTWA), et, le nombre de degrés jours cumulés supérieurs à 0°C pendant une année (GDD0). Les résultats de la reconstitution quantitative de chacun de ces paramètres climatiques, basée sur les données polliniques de la séquence du lac Ochrid, sont montrés sur la figure 12.

Les distances de Chord mesurées entre les échantillons fossiles et les analogues actuels sélectionnés pour chacun des échantillons sont faibles, notamment pendant les périodes du Riss, les phases 1 et 3 de l'Eemien (zones polliniques 2a et 2c), la première phase du Würm (zone pollinique 7a) et pendant l'Holocène (zone pollinique 8) où elles sont comprises entre 10 et 55 (figure 12). Donc, les reconstitutions climatiques peuvent être considérées comme fiables pour ces périodes. Pendant la phase 2 de l'Eemien (zone pollinique 2b), les distances sont en moyenne plus élevées et atteignent au maximum la valeur 65, car il existe peu d'échantillons dans la base des 2760 données actuelles avec des pourcentages d'*Abies* compris entre 20 et 60%. La phase qui suit la période arborée du Würm présente aussi des distances élevées atteignant des valeurs proches de 60, car il existe peu d'analogues dans la base des 2760 données actuelles pour caractériser l'association de pourcentages élevés d'*Hippophaë* et de Cichorioideae.

Huit analogues ont été sélectionnés pour tous les échantillons, excepté : pour les échantillons à 765 et 750 cm MCD présentant entre 45 et 55% d'*Abies*, et, pour les échantillons à 185, 175, 156, 150, 124 et 85 cm MCD caractérisés par environ 5 à 10% d'*Hippophaë* associé à environ 15 à 25% de Cichorioideae.

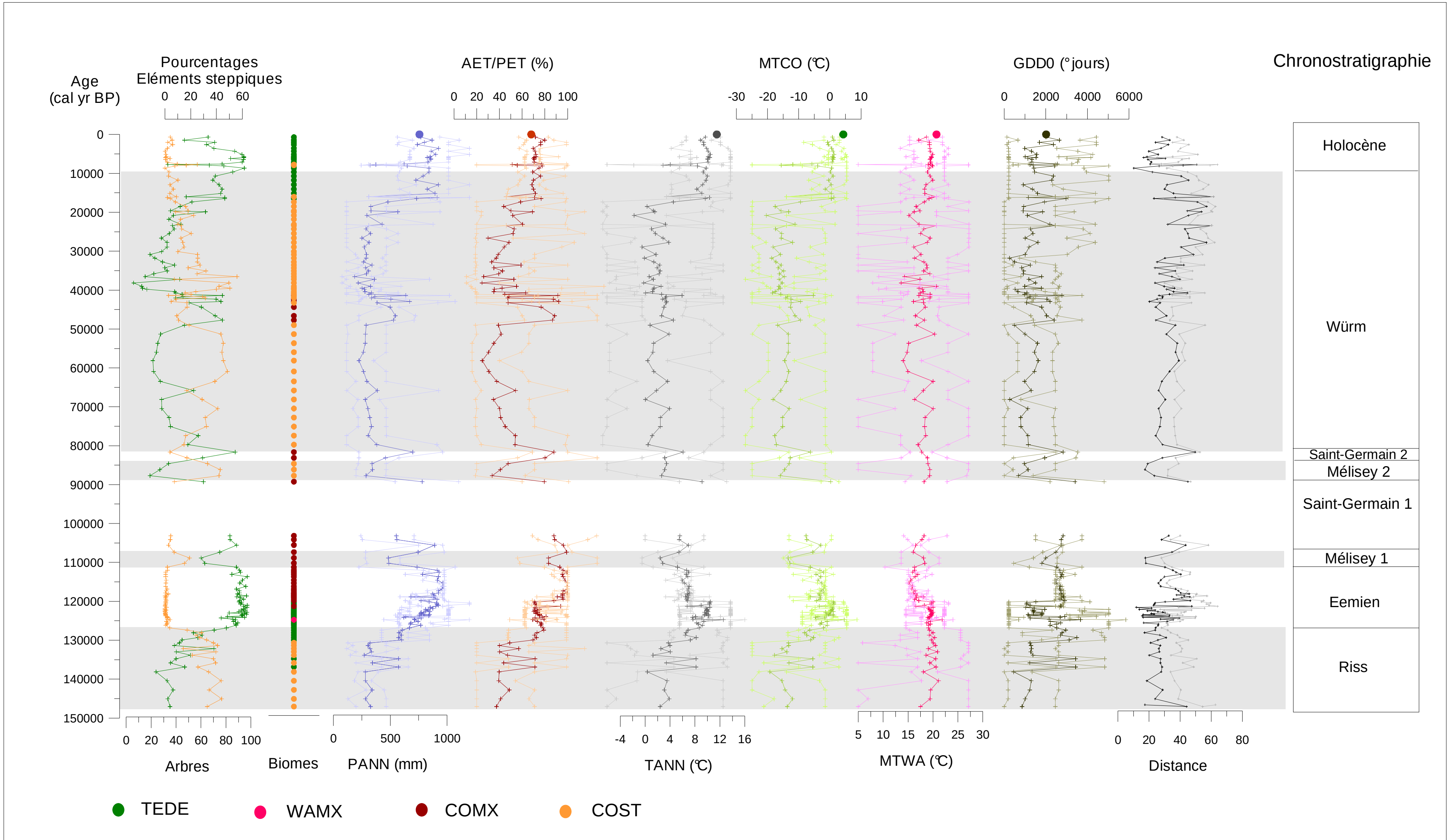

Figure 12: Reconstitutions climatiques quantitatives obtenues en utilisant la méthode des « meilleurs analogues », appliquée avec la contrainte des biomes, sur les données polliniques de la séquence JO 2004 prélevée dans le lac Ochrid: précipitations annuelles (PANN), rapport entre l'évapotranspiration réelle et l'évapotranspiration potentielle (AET/PET), température moyenne annuelle (TANN), température moyenne du mois le plus froid (MTCO) et du mois le plus chaud (MTWA), nombre de degrés jours cumulés supérieurs à 0°C (GDD0). A gauche sont indiquées les courbes des pourcentages polliniques de tous les arbres (en vert) et des éléments steppiques (*Artemisia* et Chenopodiaceae/Amaranthaceae, en orange), et, les biomes reconstitués pour chaque spectre fossile de la séquence: forêt tempérée décidue (TEDE), forêt mixte froide (COMX), forêt mixte chaude (WAMX) et steppe froide (COST). Les valeurs des paramètres climatiques sont indiquées en fonction de la chronologie en années cal BP. La chronostratigraphie est indiquée à droite (Lézine et al., soumis).

Entre 147 000 et 126 000 ans cal BP: phase froide et sèche (Riss) suivie d'une phase de transition climatique

Entre 147 000 et 136 000 ans cal BP, le biome steppe froide est reconstitué (figure 12). Ce type de végétation est présent sous un climat froid et sec, caractérisé par des températures basses en hiver comme en été (de 0 à 4 °C pour TANN, de -19 à -12 °C pour MTCO, de 17 à 21 °C pour MTWA, de 500 à 1200 degrés jours pour GDD0), des précipitations annuelles autour de 300 mm et AET/PET égal à environ 40% (figure 12). La figure 13 montre que la majorité des précipitations sont réparties entre les mois de mai et de septembre contrairement à la courbe de distribution des précipitations actuelles qui sont réparties entre les mois d'octobre et de février. Les reconstitutions montrent également une augmentation de la quantité mensuelle des précipitations qui tombe en été (+30 à +40 mm en juillet) et une diminution des précipitations en hiver (-70 mm en décembre) par rapport aux valeurs actuelles, probablement à cause de la baisse des températures hivernales.

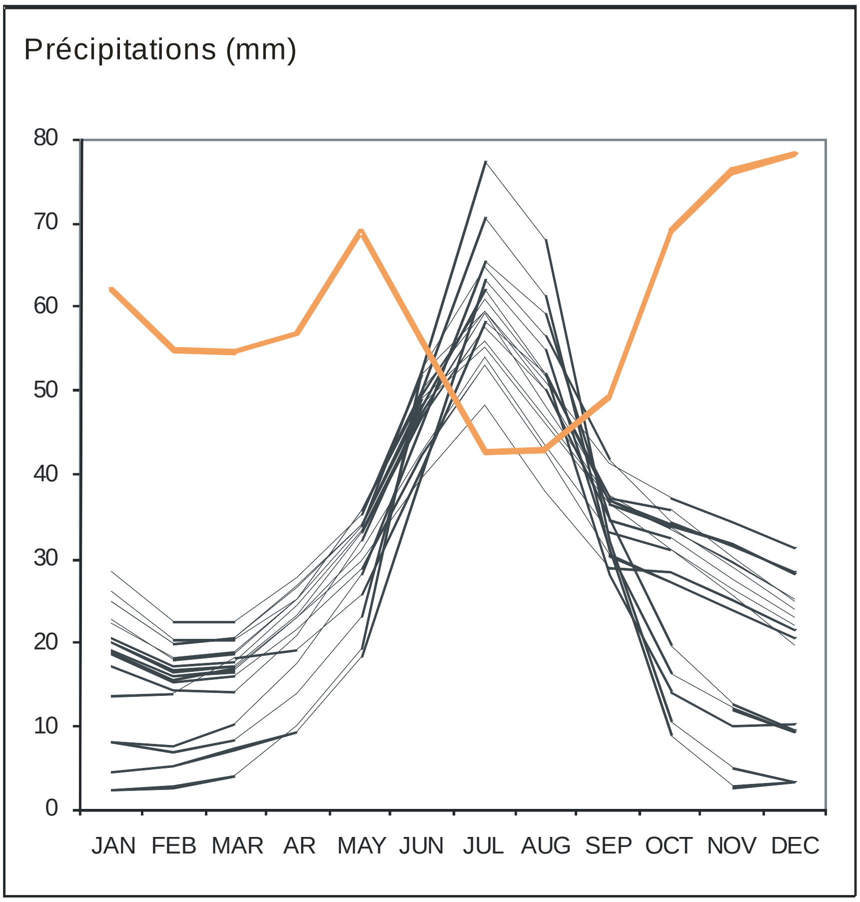

Figure 13: Distribution annuelle des précipitations pendant le Riss à Ochrid (en grisé) et à l'actuel (en orange). Les différentes courbes représentent les valeurs reconstituées pour chaque échantillon disponible pour la période considérée.

A Monticchio, le Riss est associé à un climat caractérisé par une sécheresse saisonnière (Brauer, Allen et al. 2007). A Ochrid, les conditions climatiques estimées pendant le Riss semblent proches de celles reconstituées pendant la glaciation du Würm, avec toutefois des températures légèrement plus élevées en été pendant le Riss (la valeur minimum de MTWA est égale à 17 °C, figure 12) que pendant le Würm (la valeur minimum de MTWA est égale à 14 °C, figure 12). Donc le climat du Riss semble moins extrême que celui du Würm à Ochrid, comme cela avait été proposé par Bottema (1974) d'après l'analyse de la séquence de Khimaditis, en Grèce.

Le développement des arbres lors de la transition entre le Riss et l'Eemien (de 136 000 à 126 000 ans cal BP) à Ochrid est lié à un réchauffement climatique, excepté en été (+ 6 °C pour TANN, + 11 °C pour MTCO, figure 12), ainsi qu'à une augmentation des précipitations (+ 400 mm pour PANN, figure 12) et un doublement des valeurs de AET/PET (de 40 à 80%, figure 12).

Entre 126 000 et 110 000 ans cal BP: phase tempérée et humide (Eemien)

Le développement de la forêt mixte tempérée à chaude à Ochrid, entre 126 000 et 122 000 ans cal BP, est associé à des conditions climatiques plus chaudes notamment en hiver (de – 4 à + 1 °C pour MTCO, environ 10 °C pour TANN, figure 12) et plus humides (de 700 à 800 mm pour PANN, environ 70 à 80% pour AET/PET, figure 12). Le développement de la forêt mixte puis de la forêt de conifères, entre 122 000 et 110 000 ans cal BP, est lié à la fois à une augmentation de AET/PET qui atteint jusqu'à 95%, et, à une baisse des températures (de 10 à 6 °C pour TANN, de 0 à -3 °C pour MTCO, de 19 à 17 °C pour MTWA, de 1000 à 3000 degrés jours pour GDD0). Les valeurs de précipitations annuelles oscillent autour de 800 mm.

Les reconstitutions climatiques obtenues à partir de la séquence du lac Ochrid confirment l'hypothèse d'une phase qui ne serait pas uniformément chaude et humide à l'Eemien, comme cela a été montré en Europe de l'Ouest à partir de séquences continentales (Guiot, de Beaulieu et al. 1993; Thouveny, de Beaulieu et al. 1994; Klotz, Muller et al. 2004; Rousseau, Hatte et al. 2006), même si l'hypothèse inverse d'une phase climatiquement stable a été soutenue par Kukla et ses collaborateurs en 1997.

En Europe, il semble que l’on enregistre un gradient négatif des températures estivales (valeurs de MTWA - tableau 4) des sites de basse altitude pour lesquels les valeurs de MTWA oscillent entre 23 et 26 °C (site de la Grande Pile, en France (330 m) – Rousseau et al., 2006) vers les sites de moyenne altitude pour lesquels les valeurs de MTWA oscillent autour de 20 °C (site d’Ochrid, en Albanie (705 m) – cette étude) et de haute altitude pour lesquels les valeurs de MTWA sont comprises entre 16 et 17 °C (site de Ribains, en France (1080 m) – Tarasov et al., 2007). Ces différences liées à la position altitudinale des sites sont probablement à l’origine des différences d’abondance d’un même taxon arboré enregistrées pour ces sites pendant la première phase de l’Eemien.

Le refroidissement enregistré vers 120 000 ans cal BP à Ochrid peut être corrélé à celui enregistré à la même date au Groenland à partir de la séquence de NorthGRIP (NorthGRIP Members, 2004).

Tableau 4 : Comparaison des valeurs reconstituées de température et de précipitation en Europe pour la période du Riss au Saint-Germain 2. En fonction des auteurs et des sites, différentes méthodes ont été utilisées (MAT : technique des « meilleurs analogues », MCR : « mutual climatic range », …).

Pays	Site	Référence	Méthode	Late Riss	Transition 6/5e	Eemien - phase 1	Eemien - phase 2	Eemien - phase 3	Fin de l'Eemien	Transition 5/4
Allemagne	Glowczyn	Cheddadi et al. 1998	MAT	Tjan: -16°C; PANN: 4 00 mm	Tjan: +20°C	Tjan: 4°C; PANN: 800 mm	PANN: 700-10 00 mm	TANN: -2 à -6°C; PANN: 200-300 mm	Tjan: 2-3°C; PANN: 200-300 mm	
	Imbramowice	Cheddadi et al. 1998	MAT	Tjan: -16°C; PANN : 400 mm	Tjan: +20°C	Tjan: 4°C; PANN: 800 mm	PANN: 700 -1000 mm	TANN: -2 à -6°C; PANN: 200-300 mm	Tjan: 2-3°C; PANN: 200-300 mm	
	Bispingen	Field et al. 1994	Surfaces de réponse			MTCO: 5°C	MTCO: 5°C - augmentation de l'humidité (AET/PET: 95%)	Baisse de la température	Fluctuations climatiques	
	Bispingen	Kühl & Litt 2003	pdf (fonction de densité de probabilité)	Tjan: -13°C	Tjan: +15°C	Tjan: 2°C	Tjan: -3 à -4°C; Climat continental		Climat océanique	Tjan: -8 à -10°C; Tjul: -5°C
	Gröbern	Kühl & Litt 2003	pdf (fonction de densité de probabilité)	Tjan: -11°C	Tjan: +11°C	Tjan: 0°C	Tjan: -2 à -3°C; Climat continental		Climat océanique	Tjan: -8 à -10°C; Tjul: -5°C
France	La Grande Pile	Guiot et al., 1989	MAT	TANN: 3.5°C; PAN N: 400 mm	TANN: +6.5°C; PANN: +500mm	TANN: 10°C; PANN: 900 mm	TANN: 10°C; PANN: 900 mm	TANN: 10°C; PANN: 900 mm	TANN: 8.5°C; PANN: 1000 mm	
	La Grande Pile	Guiot et al. 1992	MAT							
	La Grande Pile	Field et al. 1994	Surfaces de réponse							
	La Grande Pile	Cheddadi et al. 1998	MAT	Tjan: -16°C; PANN: 400 mm	Tjan: +20°C	Tjan: 4°C; PANN: 800 mm	PANN: 700-1000 mm	TANN: -2 à -6°C; PANN: 200-300 mm	Tjan: 2-3°C; PANN: 200-300 mm	
	La Grande Pile	Fauquette et al. 1999	Espaces climatiques			Optimum: TANN: 9-12°C				
	La Grande Pile	Kühl & Litt 2003	pdf (fonction de densité de probabilité)	Tjan: -7°C	Tjan: +7°C	Tjan: 0°C			Climat océanique	Tjan: -8 à -10°C; Tjul: -5°C
	La Grande Pile	Rousseau et al. 2006	Modélisation inverse & ¯C	PANN: 300-500 mm; TANN: 1+-2°C; MTWA: 14.5 à 20.5°C; MTCO: -23.5 à -18.5°C		PANN: 900-1100 mm (valeur actuelle); TANN: 10-15°C, MTCO: 5 à 4 °C, MTWA: 23-26°C	?	?		
	Les Echets	Guiot et al., 1989	MAT	TANN: -1°C; PANN: 30 0 mm	TANN: +13°C; PANN: +550mm	TANN: 12°C; PANN: 850 mm	TANN: 12°C; PANN: 700 mm	TANN: 8°C; PANN: 700 mm	TANN: 2°C; PANN: 900 mm	
	Les Echets	Cheddadi et al. 1998	MAT	Tjan: -16°C; PANN: 400 mm	Tjan: +20°C	Tjan: 4°C; PANN: 800 mm	PANN: 700- 1000 mm	TANN: -2 à -6°C; PANN: 200-300 mm	Tjan: 2-3°C; PANN: 200-300 mm	
	Les Echets	Fauquette et al. 1999	Espaces climatiques			Optimum: TANN: 8-12°C				
	Bouchet	Cheddadi et al. 1998	MAT	Tjan: -16°C; PANN: 40 0 mm	Tjan: +20°C	Tjan: 4°C; PANN: 800 mm	PANN: 700-100 0 mm	TANN: -2 à -6°C; PANN: 200-300 mm	Tjan: 2-3°C; PANN: 200-300 mm	
	Bouchet	Fauquette et al. 1999	Espaces climatiques			Optimum: TANN: 10-13°C				
	Ribains	Cheddadi et al. 1998	MAT	Tjan: -16°C; PANN: 40 0 mm	Tjan: +20°C	Tjan: 4°C; PANN: 800 mm	PANN: 700-100 0 mm	TANN: -2 à -6°C; PANN: 200-300 mm	Tjan: 2-3°C; PANN: 200-300 mm	
	Ribains	Fauquette et al. 1999	Espaces climatiques							
	Saint-Front	Cheddadi et al. 1998	MAT	Tjan: -16°C; PANN : 400 mm	Tjan: +20°C	Tjan: 4°C; PANN: 800 mm	PANN: 700 -1000 mm	TANN: -2 à -6°C; PANN: 200-300 mm	Tjan: 2-3°C; PANN: 200-300 mm	
Russie	Baikal	Tarasov et al. 2007	MAT biome							
Europe centrale et Europe de l'Ouest		Zagwijn, 1996	Espèces indicatrices			Tjul: 19°C, Tjan>-2°C; PANN: 700 mm; Climat maritime	Tjan: 3°C; augmentation des précipitations; Climat continental	Tjan proche de valeur actuelle	Tjul chute de -10 à -11°C; Tjan<0°C	
	Maille: 15-22°E, 39.3-44.4°N	Braconnot, communication personnelle	Simulation IPSL			Tann: 12°C, Pann: 650-700 mm, MTCO: 1-2°C, MTWA: 24-27°C	Tann: 10.5°C, Pann: 700 mm, MTCO: 0.5°C, MTWA: 20°C			

Entre 110 000 et 106 000 ans cal BP: phase froide et humide (Mélisey 1)

Entre 110 000 et 106 000 ans cal BP, le développement des éléments steppiques est associé à une dégradation des conditions climatiques à Ochrid. D'après nos reconstitutions, le climat devient plus froid (de 2 à 5 °C pour TANN, de 16 à 18 °C pour MTWA, MTCO ~13 °C et GDD0 ~2000 degrés jours) et plus sec (PANN ~500 mm et AET/PET ~80%). Mais les conditions climatiques restent plus favorables que pendant les phases glaciaires du Riss et du Würm, ce qui permet le maintien de la forêt mixte autour du lac Ochrid.

Le tableau 4 montre un gradient négatif altitudinal des températures du mois le plus froid comme pendant la première phase de l'Eemien, des sites de basse altitude (MTCO ~2 °C au site des Echets (267 m) – Klotz et al., 2004) vers les sites de moyenne altitude (MTCO ~7 °C aux sites de Jammertal (578 m), de Samerberg (660 m) et de Füramoos (662 m) – Klotz et al., 2004, et, au site d'Ochrid (705 m) – cette étude). Ce gradient peut probablement expliquer les différences enregistrées à Ochrid en termes de végétation où les conifères plus résistants au froid se maintiennent, et, à Ioannina où ce sont les chênes décidus, sensibles à une baisse des températures estivales (Bordon et al., soumis) qui se maintiennent.

Entre 106 000 et 89 000 ans cal BP: phase de réchauffement climatique (Saint Germain 1)

Entre 106 000 et 89 000 ans cal BP, le maintien de la forêt mixte autour du lac Ochrid est associé à une amélioration des conditions climatiques (de 6 à 9 °C pour TANN, de 17 à 18 °C pour MTWA, de -7 à 0 °C pour MTCO, GDD0 ~3000 degrés jours, de 600 à 800 mm pour PANN et de 80 à 90% pour AET/PET). Nos estimations de la température du mois le plus froid sont cohérentes avec celles proposées par Huntley et ses collaborateurs en 1995 à partir de la séquence pollinique de Padul en Espagne (Pons and Reille 1988), puisqu'ils considèrent que la température hivernale doit être inférieure à -3 °C. En revanche, les reconstitutions climatiques obtenues à partir de sites localisés au nord de la Méditerranée, en Europe centrale (sites des Echets, de Füramoos, de Jammertal et de Samerberg – Klotz et al., 2004) montrent des températures hivernales plus froides (MTCO ~ -17 °C) qu'à Ochrid (MTCO ~-7 à 0 °C). Ce résultat montre un gradient latitudinal avec un climat plus froid en Europe centrale qu'en Méditerranée pendant le Saint-Germain 1.

Entre 89 000 et 85 000 ans cal BP: phase froide et sèche, en hiver (Mélisey 2)

Entre 89 000 et 85 000 ans cal BP, le développement de la steppe à armoises à Ochrid est associée à une dégradation des conditions climatiques caractérisée par une chute des précipitations et de l'humidité (PANN ~300 mm et AET/PET ~30 à 40%) et une baisse des températures hivernales (MTCO ~ -15 °C et TANN ~3 °C). Allen et Huntley (2000) associent le développement de la steppe pendant le Mélisey 2, en Europe du sud, à la mise en place d'une aridité saisonnière. Nos reconstitutions climatiques à Ochrid montrent en effet que les conditions ne semblent arides que pendant l'hiver et le printemps (figure 14). En été, les valeurs reconstituées des précipitations moyennes mensuelles (entre 50 et 60 mm, figure 14) sont supérieures à celles enregistrées actuellement (~20 mm).

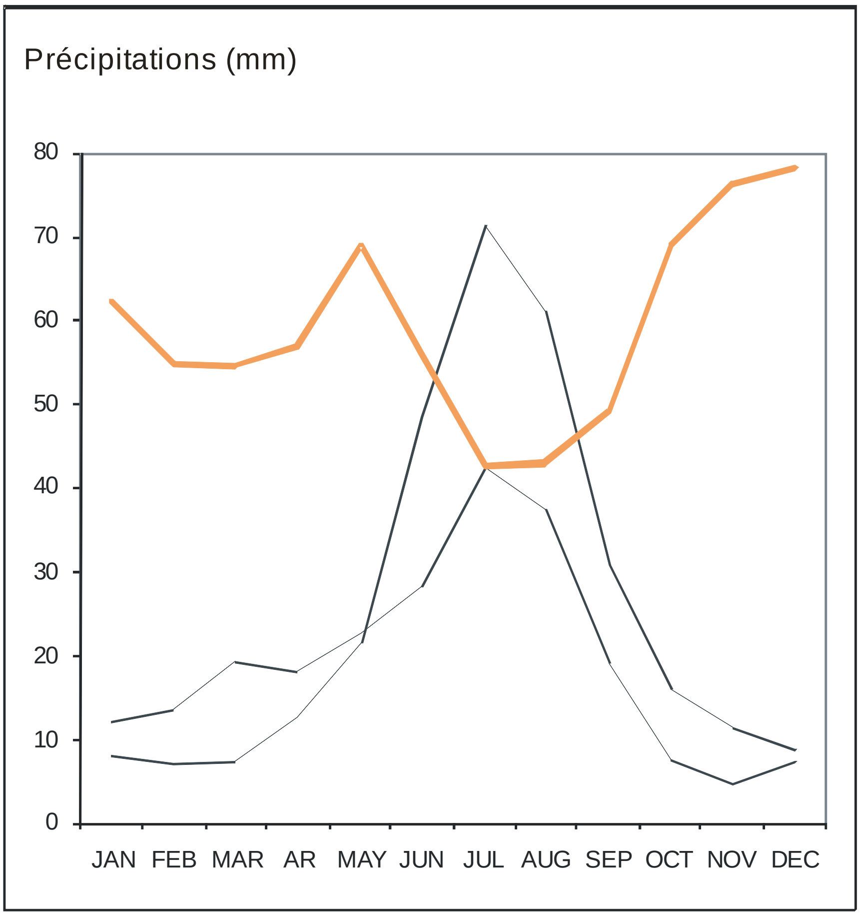

Figure 14 : Distribution annuelle des précipitations pendant le Mélisey 2 (en grisé) et à l'actuel (en orange) à Ochrid. Les courbes représentent les valeurs reconstituées à partir des deux échantillons polliniques disponibles pour cette période de temps avec la technique des « meilleurs analogues » contrainte par les biomes.

En Europe centrale, les reconstitutions climatiques obtenues à partir des sites des Echets, de Füramoos, de Jammertal et de Samerberg (Klotz, Muller et al. 2004) indiquent un climat plus chaud en hiver (MTCO ~ -5 à 3 °C) et plus humide (PANN ~700 mm) qu'en Europe du sud. Donc contrairement au Saint-Germain 1, les conditions climatiques seraient plus favorables en Europe centrale qu'en Europe du sud pendant le Mélisey 2.

Entre 85 000 et 78 000 ans cal BP: phase tempérée et humide (Saint Germain 2)

Entre 85 000 et 78 000 ans cal BP, les conditions climatiques s'améliorent avec une légère augmentation des températures (de 3 à 6 °C pour TANN, de 17 à 19 °C pour MTWA, de -17 à -6 °C pour MTCO et de 1000 à 3000 degrés jours pour GDD0) et des précipitations (PANN ~400 mm et AET/PET ~50 à 80%), ce qui permet le maintien de la forêt mixte dans le bassin versant du lac Ochrid (figure 12).

Lors de la transition entre le Saint-Germain 2 et la glaciation würmienne, les conditions climatiques se dégradent rapidement.

Entre 78 000 et 16 000 ans cal BP: phase froide et sèche (Würm)

Entre 78 000 et 16 000 ans cal BP, le remplacement de la forêt mixte par la steppe à armoises (figure 12) est associé à une chute brutale des températures, en particulier des températures hivernales (de -1 à 3 °C pour TANN, de 14 à 20 °C pour MTWA, de -18 à -13 °C pour MTCO et de 500 à 1500 degrés jours pour GDD0) ainsi qu'à une baisse des précipitations (PANN ~300 mm et AET/PET ~30 à 60%).

La phase arborée pendant le Würm, entre 50 000 et 41 000 ans cal BP à Ochrid, est associée à une amélioration des conditions climatiques qui se traduit principalement par une augmentation des précipitations (de 300 à 700 mm pour PANN et de 50 à 90% pour AET/PET) et une légère augmentation des températures (de 2 à 6 °C pour TANN, de 16 à 19 °C pour MTWA, de -14 à -5 °C pour MTCO et de 1000 à 3000 degrés jours pour GDD0).

Entre 16 000 et le sommet de la carotte: phase tempérée et humide (Tardiglaciaire et Holocène)

La dernière déglaciation est caractérisée par une augmentation des températures (TANN ~9 °C, MTWA ~19 °C, MTCO ~ -1 à +1 °C et GDD0 ~1500 degrés jours), des précipitations et de l'humidité (PANN ~800 à 900 mm et AET/PET ~70%) qui favorisent le développement des essences forestières tempérées dans le bassin versant du lac Ochrid, comme à Maliq (Bordon et al., sous presse). Un évènement rapide, froid et sec, est enregistré vers 125 cm MCD (TANN ~3 °C, MTCO ~ -14 °C, PANN ~300 mm et AET/PET ~50%). Cet évènement pourrait correspondre à l'évènement steppique du Younger Dryas.

Pendant l'Holocène, le climat reste relativement stable (TANN ~9 à 10 °C, MTWA ~19 °C, MTCO ~ 0 à 1 °C, GDD0 ~1500 à 2500 degrés jours, PANN ~600 à 800 mm et AET/PET ~70 à 80%) et les valeurs de chaque paramètre climatique, atteintes vers 700 ans cal BP, sont proches des valeurs actuelles (figure 12), comme cela a été décrit à Maliq (Bordon et al., sous presse).

Conclusions

Cette étude présente la dynamique de la végétation et les changements climatiques lors du dernier cycle climatique dans les Balkans à partir de l'enregistrement pollinique du lac Ochrid (Albanie). Les reconstitutions quantitatives de six paramètres climatiques et des biomes à partir des données polliniques contribuent à mieux comprendre la dynamique des écosystèmes en relation avec le climat dans une région clé de moyenne altitude à la frontière entre la zone médio-européenne et la zone méditerranéenne.

La dynamique de la végétation à Ochrid durant le dernier cycle climatique est très proche de celle des autres séquences continentales du sud de l'Europe, à savoir des ordres de succession d'écosystèmes très proches. Les différences que l'on observe concernent généralement le "timing" de l'apparition d'une espèce à un endroit donné, l'importance qu'elle représente à l'intérieur de l'écosystème ainsi que la durée de sa présence dans ce même écosystème. Par exemple, penda&nt la deuxième phase de l'Eemien, les sapins et les charmes dominent à Ochrid et à Ioannina mais les sapins sont beaucoup plus abondants à Ochrid qu'à Ioannina. Durant les phases glaciaires et pendant les évènements froids des phases interglaciaires, la végétation régionale est dominée par les taxons herbacés, et principalement des éléments steppiques tels que : *Artemisia*, Poaceae et Chenopodiaceae/Amaranthaceae. Les arbres mésoïques dominent pendant l'Eemien, les Saint-Germain 1 et 2 et l'Holocène, et se maintiennent avec quelques populations autour du lac Ochrid pendant les glaciations du Riss et du Würm. Les taxons méditerranéens qui tolèrent bien la sécheresse estivale mais qui ne tolèrent pas des conditions hivernales froides, sont majoritairement présents au début de l'Eemien et à l'Holocène.

La séquence du lac Ochrid donne pour la première fois des estimations quantifiées des variations climatiques qui ont eu lieu au cours du dernier cycle climatique à moyenne altitude, entre 600 et 1000 m d'altitude. Ces quantifications climatiques montrent entre autres la mise en place d'une aridité saisonnière touchant principalement la saison hivernale pendant les phases et les évènements glaciaires dans le sud de l'Europe et un gradient climatique nord-sud présent à la fin du dernier interglaciaire.

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Conclusion générale

Ce travail de thèse a permis de compléter, le long d'un transect altitudinal, les données polliniques actuelles disponibles dans le sud des Balkans, afin de mieux comprendre l'histoire des écosystèmes de moyenne altitude et d'apporter de nouvelles clés pour comprendre l'impact des changements climatiques sur les écosystèmes dans une zone de transition entre les zones «médio-européenne» au nord et «méditerranéenne» au sud.

L'étude des relations actuelles entre la végétation, les assemblages polliniques et le climat dans la région des lacs Maliq et Ochrid a permis de valider l'utilisation des données polliniques fossiles pour reconstituer l'histoire de la végétation dans cette région. Pour cela, trente six nouvelles données polliniques actuelles, caractérisant les écosystèmes non méditerranéens du sud des Balkans, entre 400 et 1900 m d'altitude, ont été acquises. Des analyses statistiques sur ces échantillons ont permis de déterminer les paramètres climatiques qui discriminent le mieux les différents écosystèmes présents dans le sud des Balkans.

Une nouvelle base de données actuelles polliniques et climatiques plus complète que les précédentes a été mise au point. Elle a permis (1) d'augmenter la couverture spatiale, (2) d'obtenir une meilleure représentation des écosystèmes méditerranéens, de la forêt tempérée et des écosystèmes de transition entre la forêt et la steppe, et (3) de quantifier les variations d'une plus grande variété de paramètres climatiques et notamment des données mensuelles de température et de précipitation afin d'étudier les variations de saisonnalité. En effet, ce paramètre semble nécessaire à étudier afin de mieux comprendre les mécanismes mis en cause lors des évènements climatiques. L'application de cette base de données à plusieurs sites en Europe montre le caractère global de cette base de données et l'intérêt de ce travail pour la communauté scientifique. En collaboration avec une équipe informatique spécialisée du laboratoire de Chrono-Environnement (Besançon), la base de données devrait être prochainement accessible sur le web, afin de faciliter l'utilisation des données par la communauté scientifique.

Cette thèse présente de nouvelles données paléoenvironnementales de la séquence JO 2004 du lac Ochrid qui apparaît comme une nouvelle longue séquence de référence, pour le dernier cycle climatique en Europe du sud non méditerranéenne.

La dynamique de la végétation à Ochrid durant le dernier cycle climatique est très proche de celle des autres séquences continentales du sud de l'Europe, à savoir des ordres de succession d'écosystèmes très proches. Les différences que l'on observe concernent généralement le « timing » de l'apparition d'une espèce à un endroit donné, l'importance qu'elle représente à l'intérieur de l'écosystème ainsi que la durée de sa présence dans ce même écosystème. Les quantifications climatiques montrent entre autres la mise en place d'une aridité saisonnière touchant principalement la saison hivernale pendant les phases et les évènements glaciaires dans le sud de l'Europe et un gradient climatique nord-sud présent à la fin du dernier interglaciaire.

Cette étude a permis aussi d'obtenir des estimations quantifiées à haute résolution des changements climatiques depuis la dernière déglaciation dans la région des Balkans. La séquence de Maliq montre deux phases froides, correspondant au Dryas ancien et au Dryas moyen, et, un évènement froid autour de 8200 ans cal BP. Ces résultats suggèrent que les forçages climatiques en Atlantique Nord depuis la dernière période glaciaire ont influencé le climat jusque dans le sud des Balkans, dans l'Est de la région méditerranéenne. Le Dryas ancien et le DRyas moyen sont caractérisés dans la région de Maliq par un climat aride et un changement de saisonnalité des précipitations : les précipitations estivales pendant les phases glaciaires apparaissent plus élevées que les précipitations qui tombent en été pendant les phases tempérées. Le climat à l'Holocène est relativement stable et les valeurs de chaque paramètre climatique sont proches des valeurs actuelles, excepté lors de l'évènement froid autour de 8300-8100 ans cal BP.

Enfin, ce travail de quantification basé sur des séquences polliniques bien datées et à haute résolution semble indispensable pour valider les simulations des modèles climatiques pour le dernier cycle climatique et ses événements clés.

Perspectives

Il faudrait améliorer la résolution temporelle de la séquence d'Ochrid, notamment pendant la dernière période glaciaire et lors des phases de transition entre les phases glaciaires et les phases interglaciaires (entre le dernier interglaciaire et le Würm, et entre le Würm et l'Holocène), afin de mieux comprendre les mécanismes à l'origine des évènements climatiques.

Un nouveau carottage d'environ 30 m de profondeur a été effectué dans le lac Maliq dans le cadre du projet ECLIPSE «Variations climatiques et Dynamique des écosystèmes au sud des Balkans au cours du dernier cycle climatique». Vu les premières datations ^{14}C qui ont été obtenues sur cette séquèence, ce carottage devrait permettre d'étudier à haute résolution les changements environnementaux et climatiques pendant la dernière période glaciaire et lors de la dernière transition glaciaire/interglaciaire, afin de mieux comprendre les mécanismes intervenant lors des évènements de Heinrich et de Dansgaard-Oeschger.

Cette thèse a montré l'intérêt de la nouvelle base de données actuelles élaborée dans le cadre de ce travail puisqu'elle peut-être utilisée à une échelle régionale en Méditerranée, dans les Alpes et dans bien d'autres régions, et ce à partir de séquences continentales ou marines. Mais elle montre aussi le travail qu'il reste à faire pour valider l'application de cette base de données. Des analyses statistiques et de nouveaux tests pour valider la base de données doivent être effectués. L'attribution de certains biomes, notamment les biomes steppiques et les biomes de transition (taïga, toundra, …) doit être retravaillée, et de nouveaux échantillons, principalement prélevés dans les steppes alpines doivent être intégrés pour tenter d'améliorer les reconstitutions pendant les phases glaciaires.

Cette thèse a démontré également la fiabilité de la technique des « meilleurs analogues » à fournir des estimations quantifiées des changements climatiques sur le dernier cycle climatique. Ces estimations sont en effet comparables aux estimations obtenues avec d'autres méthodes (modélisation inverse, densité de probabilité, …). Mais il serait intéressant de comparer les résultats des quantifications obtenues dans le cadre de cette thèse avec ceux que l'on obtiendrait avec d'autres méthodes, comme la modélisation inverse (Guiot, Torre et al. 2000) et la modélisation Bayesienne (Vasko, Toivonen et al. 2000), appliquée avec la même base de données actuelles sur les données polliniques d'Ochrid et de Maliq, pour tester la validité des reconstitutions notamment pendant les phases et les évènements glaciaires pour lesquelles le climat reconstitué apparaît peut-être trop froid.

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Annexe 1

Table 1: liste des 2760 échantillons disponibles dans la base de données. Pour chaque échantillon est indiqué son nom de code, le nom du site où le prélèvement a été fait, le pays, les coordonnées géographiques (latitude, longitude et altitude), le biome associé, le nom de l'auteur des analyses polliniques, le nom du contact qui a fourni la donnée et la référence si les données ont été publiées.

Nom	Site	Pays	Longitude	Latitude	Altitude	Nature du prélèvement	Biome	Auteur	Source	Référence
AL0201	Mali Thatë	Albanie	20.822583	40.703233	993	Mousses	Forêt mixte chaude	Bordon, A.	Bordon, A.	Bordon et al., submitted
AL0202	Mali Thatë	Albanie	20.823817	40.7919	1134	Mousses	Steppe chaude	Bordon, A.	Bordon, A.	Bordon et al., submitted
AL0203	Mali Thatë	Albanie	20.834017	40.801483	1311	Mousses	Forêt mixte chaude	Bordon, A.	Bordon, A.	Bordon et al., submitted
AL0204	Mali Thatë	Albanie	20.840517	40.803417	1606	Mousses	Forêt mixte chaude	Bordon, A.	Bordon, A.	Bordon et al., submitted
AL0205	Mali Thatë	Albanie	20.851433	40.800667	1906	Mousses	Forêt mixte chaude	Bordon, A.	Bordon, A.	Bordon et al., submitted
AL0206	Mali Thatë	Albanie	20.863817	40.793317	1648	Mousses	Forêt tempérée décidue	Bordon, A.	Bordon, A.	Bordon et al., submitted
AL0207	Lac Ochrid	République de Macédoine	20.8003	40.991883	731	Mousses	Forêt mixte chaude	Bordon, A.	Bordon, A.	Bordon et al., submitted
AL0208	Mali Thatë	République de Macédoine	20.812683	40.971367	1336	Mousses	Forêt tempérée décidue	Bordon, A.	Bordon, A.	Bordon et al., submitted
AL0209	Mali Thatë	Albanie	20.812567	40.953933	1625	Mousses	Forêt tempérée décidue	Bordon, A.	Bordon, A.	Bordon et al., submitted
AL0210	Mali Thatë	Albanie	20.812567	40.953933	1625	Mousses	Forêt mixte chaude	Bordon, A.	Bordon, A.	Bordon et al., submitted
AL0211	Mali Thatë	République de Macédoine	20.808267	40.969467	1157	Mousses	Forêt mixte chaude	Bordon, A.	Bordon, A.	Bordon et al., submitted
AL0212	Lac Grand Prespa	Albanie	20.919767	40.753717	966	Mousses	Forêt mixte chaude	Bordon, A.	Bordon, A.	Bordon et al., submitted
AL0213	Lac Grand Prespa	Albanie	20.919467	40.757333	926	Mousses	Forêt mixte chaude	Bordon, A.	Bordon, A.	Bordon et al., submitted
AL0214	Lac Grand Prespa	Albanie	20.8844	40.748617	1067	Mousses	Forêt mixte chaude	Bordon, A.	Bordon, A.	Bordon et al., submitted
AL0215	Lac Petit Prespa	Albanie	20.845864	40.677533	869	Mousses	Forêt mixte chaude	Bordon, A.	Bordon, A.	Bordon et al., submitted
AL0216	Epirus	Grèce	20.594933	39.681167	200	Mousses	Forêt mixte chaude	Bordon, A.	Bordon, A.	Bordon et al., submitted
AL0217	Verno	Grèce	21.1037	40.654433	1000	Mousses	Forêt mixte chaude	Bordon, A.	Bordon, A.	Bordon et al., submitted
AL0218	Pindhos	Grèce	21.118817	40.197583	1200	Mousses	Forêt mixte chaude	Bordon, A.	Bordon, A.	Bordon et al., submitted
AL0219	Epirus	Grèce	20.473917	39.570983	100	Mousses	Végétation xérophytique	Bordon, A.	Bordon, A.	Bordon et al., submitted
AL0301	Moravë	Albanie	20.824983	40.527167	1367	Mousses	Forêt tempérée décidue	Bordon, A.	Bordon, A.	Bordon et al., submitted
AL0302	Moravë	Albanie	20.8269	40.524217	1300	Mousses	Forêt tempérée décidue	Bordon, A.	Bordon, A.	Bordon et al., submitted
AL0303	Moravë	Albanie	20.818033	40.522417	1424	Mousses	Forêt tempérée décidue	Bordon, A.	Bordon, A.	Bordon et al., submitted
AL0304	Moravë	Albanie	20.805	40.5265	1565	Mousses	Forêt mixte chaude	Bordon, A.	Bordon, A.	Bordon et al., submitted
AL0305	Ostrovicë	Albanie	20.58965	40.62695	1235	Mousses	Forêt mixte chaude	Bordon, A.	Bordon, A.	Bordon et al., submitted
AL0306	Ostrovicë	Albanie	20.605933	40.6447	1397	Mousses	Forêt mixte chaude	Bordon, A.	Bordon, A.	Bordon et al., submitted
AL0307	Lac Ochrid	République de Macédoine	20.790317	40.968133	786	Mousses	Forêt tempérée décidue	Bordon, A.	Bordon, A.	Bordon et al., submitted
AL0309	Lac Ochrid	République de Macédoine	20.628167	41.139617	750	Mousses	Forêt tempérée décidue	Bordon, A.	Bordon, A.	Bordon et al., submitted
AL0310	Lac Ochrid	République de Macédoine	20.617517	41.1107	956	Mousses	Forêt mixte chaude	Bordon, A.	Bordon, A.	Bordon et al., submitted
ALG1	Algecir	Espagne	-4.880000	36.970000	450	Mousses	Végétation xérophytique	Belmonte, J.	J Guiot/Peyron, O.	Peyron et al., 1998
ALG2	Algecir	Espagne	-5.070000	36.830000	1051	Mousses	Végétation xérophytique	Belmonte, J.	J Guiot/Peyron, O.	Peyron et al., 1998
ALG3	Algecir	Espagne	-5.350000	36.520000	750	Mousses	Végétation xérophytique	Belmonte, J.	J Guiot/Peyron, O.	Peyron et al., 1998
ALG4	Algecir	Espagne	-5.380000	36.470000	100	Mousses	Végétation xérophytique	Belmonte, J.	J Guiot/Peyron, O.	Peyron et al., 1998
ALG5	Algecir	Espagne	-5.420000	36.330000	100	Mousses	Végétation xérophytique	Belmonte, J.	J Guiot/Peyron, O.	Peyron et al., 1998
ALL8	Muntes-Osnabruck	Allemagne	7.800000	50.100000	100		Forêt mixte fraîche			Peyron et al., 1998
ALP1	Alpujar	Espagne	-3.620000	37.030000	965	Mousses	Végétation xérophytique	Belmonte, J.	J Guiot/Peyron, O.	Peyron et al., 1998
ALP2	Alpujar	Espagne	-3.520000	36.920000	660	Mousses	Végétation xérophytique	Belmonte, J.	J Guiot/Peyron, O.	Peyron et al., 1998

Nom	Site	Pays	Longitude	Latitude	Altitude	Nature du prélèvement	Biome	Auteur	Source	Référence
ALP3	Alpujar	Espagne	-3.350000	36.950000	1590	Mousses	Forêt mixte chaude	Belmonte, J.	J Guiot/Peyron, O.	Peyron et al., 1998
ALP5	Alpujar	Espagne	-3.280000	36.950000	1280	Mousses	Végétation xérophytique	Belmonte, J.	J Guiot/Peyron, O.	Peyron et al., 1998
ALP6	Alpujar	Espagne	-3.230000	36.950000	1430	Mousses	Forêt mixte chaude	Belmonte, J.	J Guiot/Peyron, O.	Peyron et al., 1998
ALP7	Alpujar	Espagne	-3.020000	37.030000	1430	Mousses	Forêt mixte chaude	Belmonte, J.	J Guiot/Peyron, O.	Peyron et al., 1998
ALPB	Alpujar	Espagne	-2.920000	37.170000	1280	Mousses	Steppe chaude	Belmonte, J.	J Guiot/Peyron, O.	Peyron et al., 1998
ALPC	Alpujar	Espagne	-3.120000	37.180000	1320	Mousses	Végétation xérophytique	Belmonte, J.	J Guiot/Peyron, O.	Peyron et al., 1998
ARA1	Aracena	Espagne	-6.150000	37.630000	200	Mousses	Végétation xérophytique	Belmonte, J.	J Guiot/Peyron, O.	Peyron et al., 1998
ARA2	Aracena	Espagne	-6.380000	37.770000	550	Mousses	Forêt mixte chaude	Belmonte, J.	J Guiot/Peyron, O.	Peyron et al., 1998
ARA4	Aracena	Espagne	-6.730000	38.030000	580	Mousses	Végétation xérophytique	Belmonte, J.	J Guiot/Peyron, O.	Peyron et al., 1998
BEL1	Recogne	Belgique	5.400000	49.900000	550	Mousses	Forêt mixte fraîche		Peyron, O.	Peyron et al., 1998
BEL2	Recogne	Belgique	5.400000	49.900000	550	Mousses	Forêt mixte fraîche		Peyron, O.	Peyron et al., 1998
BEL3	Recogne	Belgique	5.400000	49.900000	550	Mousses	Forêt mixte fraîche		Peyron, O.	Peyron et al., 1998
BEL4	Recogne	Belgique	5.400000	49.900000	550	Mousses	Forêt mixte fraîche		Peyron, O.	Peyron et al., 1998
BEL5	Vallee 3 Ponts	Belgique	5.900000	50.300000	300	Mousses	Forêt mixte fraîche		Peyron, O.	Peyron et al., 1998
BEL6	Salin Château	Belgique	5.900000	50.300000	300	Mousses	Forêt mixte fraîche		Peyron, O.	Peyron et al., 1998
BEL7	Bonage Sleppe	Belgique	5.900000	50.400000	300	Mousses	Forêt mixte fraîche		Peyron, O.	Peyron et al., 1998
BU01	Bulgarian shelf	Bulgarie	27.850000	42.630000	0	Mousses	Forêt mixte fraîche		Peyron, O.	Peyron et al., 1998
BU03	Bulgarian shelf	Bulgarie	27.870000	42.650000	0	Mousses	Forêt tempérée décidue		Peyron, O.	Peyron et al., 1998
BU04	Bulgarian shelf	Bulgarie	27.870000	42.630000	0	Mousses	Forêt tempérée décidue		Peyron, O.	Peyron et al., 1998
BU05	Bulgarian shelf	Bulgarie	27.890000	42.650000	0	Mousses	Forêt tempérée décidue		Peyron, O.	Peyron et al., 1998
BU06	Bulgarian shelf	Bulgarie	28.170000	42.670000	0	Mousses	Forêt mixte fraîche		Peyron, O.	Peyron et al., 1998
BU20	Bulgarian shelf	Bulgarie	28.120000	43.420000	0	Mousses	Steppe chaude		Peyron, O.	Peyron et al., 1998
BU22	Bulgarian shelf	Bulgarie	27.970000	43.250000	0	Mousses	Forêt tempérée décidue		Peyron, O.	Peyron et al., 1998
BU23	Bulgarian shelf	Bulgarie	27.990000	43.280000	0	Mousses	Forêt tempérée décidue		Peyron, O.	Peyron et al., 1998
BU24	Bulgarian shelf	Bulgarie	27.840000	42.920000	0	Mousses	Forêt tempérée décidue		Peyron, O.	Peyron et al., 1998
BU25	Bulgarian shelf	Bulgarie	27.840000	42.920000	0	Mousses	Forêt tempérée décidue		Peyron, O.	Peyron et al., 1998
BU26	Bulgarian shelf	Bulgarie	27.630000	42.970000	60	Mousses	Forêt tempérée décidue		Peyron, O.	Peyron et al., 1998
BU27	Bulgarian shelf	Bulgarie	27.800000	42.990000	14	Mousses	Forêt tempérée décidue		Peyron, O.	Peyron et al., 1998
BU28	Bulgarian shelf	Bulgarie	27.890000	43.030000	0	Mousses	Forêt tempérée décidue		Peyron, O.	Peyron et al., 1998
BU30	Bulgarian shelf	Bulgarie	27.890000	43.030000	0	Mousses	Forêt tempérée décidue		Peyron, O.	Peyron et al., 1998
BU45	Bulgarian shelf	Bulgarie	27.900000	44.120000	200	Mousses	Forêt tempérée décidue		Peyron, O.	Peyron et al., 1998
BU56	Bulgarian shelf	Bulgarie	23.100000	41.350000	500	Mousses	Forêt tempérée décidue		Peyron, O.	Peyron et al., 1998
BU57	Bulgarian shelf	Bulgarie	23.120000	41.350000	500	Mousses	Forêt tempérée décidue		Peyron, O.	Peyron et al., 1998
BUR2	Burgos	Espagne	-3.870000	42.630000	990	Mousses	Forêt tempérée décidue	Belmonte, J.	J Guiot/Peyron, O.	Peyron et al., 1998
BX02	Bazax	Espagne	-2.700000	37.620000	842	Mousses	Steppe chaude	Belmonte, J.	J Guiot/Peyron, O.	Peyron et al., 1998
BX08	Bazax	Espagne	-2.550000	37.920000	1300	Mousses	Végétation xérophytique	Belmonte, J.	J Guiot/Peyron, O.	Peyron et al., 1998
BX10	Bazax	Espagne	-2.570000	37.820000	1190	Mousses	Steppe chaude	Belmonte, J.	J Guiot/Peyron, O.	Peyron et al., 1998
BX11	Bazax	Espagne	-2.480000	37.520000	1250	Mousses	Végétation xérophytique	Belmonte, J.	J Guiot/Peyron, O.	Peyron et al., 1998
BX12	Bazax	Espagne	-2.450000	37.500000	1320	Mousses	Végétation xérophytique	Belmonte, J.	J Guiot/Peyron, O.	Peyron et al., 1998
C001	Laguna Sarinena	Espagne	-3.173600	41.800000	380	Sommet de carotte	Steppe chaude	EPD	Davis, B.A.S.	Davis et al., 2003
C002	Salina del Cameron	Espagne	-0.283300	41.408000	328	Sommet de carotte	Végétation xérophytique	EPD	Davis, B.A.S.	Davis et al., 2003

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C003	Salina del Rebellon	Espagne	-0.312500	41.383000	319	Sommet de carotte	Végétation xérophytique	EPD	Davis, B.A.S.	Davis et al., 2003
C004	Salina de Pinol	Espagne	-0.250000	41.428000	338	Sommet de carotte	Végétation xérophytique	EPD	Davis, B.A.S.	Davis et al., 2003
C005	Salina de la Muerte	Espagne	-0.255600	41.403000	335	Sommet de carotte	Végétation xérophytique	EPD	Davis, B.A.S.	Davis et al., 2003
C006	Laguna del Pez	Espagne	-0.266700	41.383000	330	Sommet de carotte	Végétation xérophytique	EPD	Davis, B.A.S.	Davis et al., 2003
C007	Hoya de los Berzas	Espagne	-0.215300	41.400000	334	Sommet de carotte	Végétation xérophytique	EPD	Davis, B.A.S.	Davis et al., 2003
C008	Laguna Guallar	Espagne	-0.233300	41.415000	336	Sommet de carotte	Végétation xérophytique	EPD	Davis, B.A.S.	Davis et al., 2003
C009	Hoya del Vinagrero II	Espagne	-0.215300	41.397000	337	Sommet de carotte	Désert chaud	EPD	Davis, B.A.S.	Davis et al., 2003
C010	Hoya del Vinagrero I	Espagne	-0.231900	41.397000	339	Sommet de carotte	Végétation xérophytique	EPD	Davis, B.A.S.	Davis et al., 2003
C011	Hoya de Valdcarreta	Espagne	-0.222200	41.392000	340	Sommet de carotte	Désert chaud	EPD	Davis, B.A.S.	Davis et al., 2003
C012	Hoya de Rafelez	Espagne	-0.225000	41.381000	321	Sommet de carotte	Végétation xérophytique	EPD	Davis, B.A.S.	Davis et al., 2003
C013	Hoya de los Aljeces	Espagne	-0.233300	41.372000	325	Sommet de carotte	Végétation xérophytique	EPD	Davis, B.A.S.	Davis et al., 2003
C014	Laguna de Pito	Espagne	-0.036100	41.415000	323	Sommet de carotte	Végétation xérophytique	EPD	Davis, B.A.S.	Davis et al., 2003
C015	Laguna de la Playa	Espagne	-0.186700	41.420000	326	Sommet de carotte	Végétation xérophytique	EPD	Davis, B.A.S.	Davis et al., 2003
C016	Hoyo de Botones	Espagne	-0.136100	41.456000	340	Sommet de carotte	Désert chaud	EPD	Davis, B.A.S.	Davis et al., 2003
C017	Las Alforjetas	Espagne	-0.125000	41.403000	352	Sommet de carotte	Végétation xérophytique	EPD	Davis, B.A.S.	Davis et al., 2003
C018	Clota Yesera I	Espagne	-0.115300	41.404000	354	Sommet de carotte	Désert chaud	EPD	Davis, B.A.S.	Davis et al., 2003
C019	Clota Yesera II	Espagne	-0.115300	41.404000	351	Sommet de carotte	Désert chaud	EPD	Davis, B.A.S.	Davis et al., 2003
C020	Venta del Carrero (West)	Espagne	-0.122200	41.394000	360	Sommet de carotte	Désert chaud	EPD	Davis, B.A.S.	Davis et al., 2003
C021	Venta del Carrero (East)	Espagne	-0.111100	41.397000	360	Sommet de carotte	Végétation xérophytique	EPD	Davis, B.A.S.	Davis et al., 2003
C022	Hoya del Castillo	Espagne	-0.513900	41.260000	250	Sommet de carotte	Végétation xérophytique	EPD	Davis, B.A.S.	Davis et al., 2003
C023	Laguna Salada de Chiprana	Espagne	-0.180600	41.239000	150	Sommet de carotte	Végétation xérophytique	EPD	Davis, B.A.S.	Davis et al., 2003
C024	Laguna de la Estanca	Espagne	-0.140300	41.233000	130	Sommet de carotte	Végétation xérophytique	EPD	Davis, B.A.S.	Davis et al., 2003
C025	La Estanca	Espagne	-0.188900	41.060000	337	Sommet de carotte	Végétation xérophytique	EPD	Davis, B.A.S.	Davis et al., 2003
C026	Salada Pequena	Espagne	-0.219400	41.044000	370	Sommet de carotte	Végétation xérophytique	EPD	Davis, B.A.S.	Davis et al., 2003
C027	Salada Grande	Espagne	-0.200000	41.042000	370	Sommet de carotte	Végétation xérophytique	EPD	Davis, B.A.S.	Davis et al., 2003
C028	Laguna Gallocanta	Espagne	-2.183300	40.833000	995	Sommet de carotte	Végétation xérophytique	EPD	Davis, B.A.S.	Davis et al., 2003
C029	Laguna Rodrigo	Espagne	-4.458300	40.982000	900	Sommet de carotte	Forêt mixte chaude	EPD	Davis, B.A.S.	Davis et al., 2003
C030	Laguna Iglesia	Espagne	-4.591700	41.204000	770	Sommet de carotte	Forêt mixte chaude	EPD	Davis, B.A.S.	Davis et al., 2003
C031	Laguna Eras	Espagne	-4.591700	41.204000	790	Sommet de carotte	Forêt mixte chaude	EPD	Davis, B.A.S.	Davis et al., 2003
C032	Laguna Salinas (Villarin)	Espagne	-5.629200	41.797000	670	Sommet de carotte	Steppe chaude	EPD	Davis, B.A.S.	Davis et al., 2003
C033	Laguna Salina Grande (Villafafila)	Espagne	-5.606900	41.833000	671	Sommet de carotte	Steppe chaude	EPD	Davis, B.A.S.	Davis et al., 2003
C034	Laguna Barrillos	Espagne	-5.598600	41.256000	670	Sommet de carotte	Steppe chaude	EPD	Davis, B.A.S.	Davis et al., 2003
C035	Laguna Villarin de Camp	Espagne	-5.644400	41.804000	680	Sommet de carotte	Forêt mixte chaude	EPD	Davis, B.A.S.	Davis et al., 2003
C036	Laguna Amarga	Espagne	-4.694400	37.484000	370	Sommet de carotte	Végétation xérophytique	EPD	Davis, B.A.S.	Davis et al., 2003
C037	Laguna Amarga	Espagne	-4.694400	37.484000	370	Sommet de carotte	Végétation xérophytique	EPD	Davis, B.A.S.	Davis et al., 2003
C038	Laguna Amarga	Espagne	-4.694400	37.484000	370	Sommet de carotte	Végétation xérophytique	EPD	Davis, B.A.S.	Davis et al., 2003

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C039	Laguna Salobral	Espagne	-4.200000	37.588000	410	Sommet de carotte	Végétation xérophytique	EPD	Davis, B.A.S.	Davis et al., 2003
C040	Laguna Rincon	Espagne	-4.625600	37.457000	310	Sommet de carotte	Végétation xérophytique	EPD	Davis, B.A.S.	Davis et al., 2003
C041	Laguna Rincon	Espagne	-4.625600	37.457000	310	Sommet de carotte	Végétation xérophytique	EPD	Davis, B.A.S.	Davis et al., 2003
C042	Laguna Rincon	Espagne	-4.625600	37.457000	310	Sommet de carotte	Végétation xérophytique	EPD	Davis, B.A.S.	Davis et al., 2003
C043	Laguna Zonar	Espagne	-4.694400	37.484000	290	Sommet de carotte	Végétation xérophytique	EPD	Davis, B.A.S.	Davis et al., 2003
C044	Laguna Zonar	Espagne	-4.694400	37.484000	290	Sommet de carotte	Végétation xérophytique	EPD	Davis, B.A.S.	Davis et al., 2003
C045	Laguna Zonar	Espagne	-4.694400	37.484000	290	Sommet de carotte	Végétation xérophytique	EPD	Davis, B.A.S.	Davis et al., 2003
C046	Laguna Tiscar	Espagne	-4.818300	37.431000	170	Sommet de carotte	Végétation xérophytique	EPD	Davis, B.A.S.	Davis et al., 2003
C047	Laguna Fuente de Piedra	Espagne	-4.746700	37.108000	410	Sommet de carotte	Végétation xérophytique	EPD	Davis, B.A.S.	Davis et al., 2003
C048	Laguna Ratosa	Espagne	-4.700000	37.180000	450	Sommet de carotte	Végétation xérophytique	EPD	Davis, B.A.S.	Davis et al., 2003
C049	Laguna Dulce	Espagne	-4.833300	37.053000	460	Sommet de carotte	Végétation xérophytique	EPD	Davis, B.A.S.	Davis et al., 2003
C050	Laguna Chica	Espagne	-4.309700	37.099000	790	Sommet de carotte	Végétation xérophytique	EPD	Davis, B.A.S.	Davis et al., 2003
C051	Laguna Grande	Espagne	-4.302800	37.108000	790	Sommet de carotte	Végétation xérophytique	EPD	Davis, B.A.S.	Davis et al., 2003
C052	Laguna Grande	Espagne	-4.302800	37.108000	790	Sommet de carotte	Végétation xérophytique	EPD	Davis, B.A.S.	Davis et al., 2003
C053	Laguna Grande	Espagne	-4.302800	37.108000	790	Sommet de carotte	Végétation xérophytique	EPD	Davis, B.A.S.	Davis et al., 2003
C054	Laguna Taraje	Espagne	-5.906700	36.917000	50	Sommet de carotte	Végétation xérophytique	EPD	Davis, B.A.S.	Davis et al., 2003
C055	Laguna Arjona	Espagne	-5.816900	37.037000	30	Sommet de carotte	Steppe chaude	EPD	Davis, B.A.S.	Davis et al., 2003
C056	Laguna Alcaparrosa	Espagne	-5.808300	37.050000	30	Sommet de carotte	Steppe chaude	EPD	Davis, B.A.S.	Davis et al., 2003
C057	Laguna Gosque	Espagne	-4.941700	37.128000	430	Sommet de carotte	Végétation xérophytique	EPD	Davis, B.A.S.	Davis et al., 2003
C058	Laguna Pilon	Espagne	-5.895800	36.906000	70	Sommet de carotte	Steppe chaude	EPD	Davis, B.A.S.	Davis et al., 2003
C059	Laguna Campano	Espagne	-6.105600	36.353000	10	Sommet de carotte	Steppe chaude	EPD	Davis, B.A.S.	Davis et al., 2003
C060	Laguna Medina	Espagne	-6.046700	36.622000	20	Sommet de carotte	Steppe chaude	EPD	Davis, B.A.S.	Davis et al., 2003
C061	Laguna Tollos	Espagne	-6.016700	36.845000	60	Sommet de carotte	Forêt tempérée décidue	EPD	Davis, B.A.S.	Davis et al., 2003
C062	Laguna Comisario	Espagne	-6.016700	36.525000	70	Sommet de carotte	Végétation xérophytique	EPD	Davis, B.A.S.	Davis et al., 2003
C063	Laguna Tarage	Espagne	-6.058300	36.546000	70	Sommet de carotte	Steppe chaude	EPD	Davis, B.A.S.	Davis et al., 2003
C064	Laguna Honda	Espagne	-4.130000	37.597000	450	Sommet de carotte	Végétation xérophytique	EPD	Davis, B.A.S.	Davis et al., 2003
C065	Laguna Almodovar	Espagne	-4.166700	38.703000	670	Sommet de carotte	Végétation xérophytique	EPD	Davis, B.A.S.	Davis et al., 2003
C066	Laguna Carrizosa	Espagne	-4.244400	38.842000	690	Sommet de carotte	Steppe chaude	EPD	Davis, B.A.S.	Davis et al., 2003
C067	Laguna Caracuel	Espagne	-4.069400	38.825000	670	Sommet de carotte	Végétation xérophytique	EPD	Davis, B.A.S.	Davis et al., 2003
C068	Laguna Michos	Espagne	-4.358300	38.964000	680	Sommet de carotte	Steppe chaude	EPD	Davis, B.A.S.	Davis et al., 2003
C069	Laguna Lomillos	Espagne	-3.941700	38.744000	760	Sommet de carotte	Steppe chaude	EPD	Davis, B.A.S.	Davis et al., 2003
C070	Laguna Nava Grande	Espagne	-3.941700	39.180000	620	Sommet de carotte	Steppe chaude	EPD	Davis, B.A.S.	Davis et al., 2003
C071	Laguna Alcahozo	Espagne	-2.875000	39.395000	670	Sommet de carotte	Végétation xérophytique	EPD	Davis, B.A.S.	Davis et al., 2003
C072	Laguna Cerro Mesado	Espagne	-3.272200	39.325000	620	Sommet de carotte	Steppe chaude	EPD	Davis, B.A.S.	Davis et al., 2003
C073	Laguna Prado	Espagne	-3.833300	38.915000	620	Sommet de carotte	Végétation xérophytique	EPD	Davis, B.A.S.	Davis et al., 2003
C074	La Laguna	Espagne	-4.090300	38.753000	670	Sommet de carotte	Steppe chaude	EPD	Davis, B.A.S.	Davis et al., 2003
C075	Laguna Yeguas	Espagne	-3.286100	39.422000	620	Sommet de carotte	Végétation xérophytique	EPD	Davis, B.A.S.	Davis et al., 2003
C076	Laguna Carboneras	Espagne	-3.955600	38.756000	780	Sommet de carotte	Steppe chaude	EPD	Davis, B.A.S.	Davis et al., 2003
C077	Laguna Camino de Villafranca	Espagne	-3.258300	39.417000	620	Sommet de carotte	Végétation xérophytique	EPD	Davis, B.A.S.	Davis et al., 2003
C078	Laguna Fuentilejo	Espagne	-4.055000	38.940000	690	Sommet de carotte	Végétation xérophytique	EPD	Davis, B.A.S.	Davis et al., 2003

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C079	Laguna Albardiosa	Espagne	-3.291700	39.656000	660	Sommet de carotte	Végétation xérophytique	EPD	Davis, B.A.S.	Davis et al., 2003
C080	Laguna Altillo	Espagne	-3.296700	39.692000	700	Sommet de carotte	Végétation xérophytique	EPD	Davis, B.A.S.	Davis et al., 2003
C081	Laguna Tirez	Espagne	-3.360000	39.537000	650	Sommet de carotte	Végétation xérophytique	EPD	Davis, B.A.S.	Davis et al., 2003
C082	Laguna Peña Hueca	Espagne	-3.341700	39.513000	650	Sommet de carotte	Végétation xérophytique	EPD	Davis, B.A.S.	Davis et al., 2003
C083	Laguna Chica de Villafranca	Espagne	-3.341700	39.458000	950	Sommet de carotte	Forêt mixte chaude	EPD	Davis, B.A.S.	Davis et al., 2003
C084	Laguna Manjavacas	Espagne	-2.861700	39.420000	670	Sommet de carotte	Forêt mixte chaude	EPD	Davis, B.A.S.	Davis et al., 2003
C085	Laguna Malgarejo	Espagne	-2.825000	39.397000	670	Sommet de carotte	Végétation xérophytique	EPD	Davis, B.A.S.	Davis et al., 2003
C087	Laguna Sanchez Gomez	Espagne	-2.833300	39.439000	660	Sommet de carotte	Steppe chaude	EPD	Davis, B.A.S.	Davis et al., 2003
C088	Laguna Grande	Espagne	-2.716700	39.425000	690	Sommet de carotte	Végétation xérophytique	EPD	Davis, B.A.S.	Davis et al., 2003
C089	Laguna Taray las Pedroñeras	Espagne	-2.758300	39.408000	690	Sommet de carotte	Forêt mixte chaude	EPD	Davis, B.A.S.	Davis et al., 2003
C090	Laguna Ontalafia	Espagne	-1.263900	38.714000	840	Sommet de carotte	Végétation xérophytique	EPD	Davis, B.A.S.	Davis et al., 2003
C091	Laguna de la Salinas	Espagne	-0.891700	38.500000	480	Sommet de carotte	Végétation xérophytique	EPD	Davis, B.A.S.	Davis et al., 2003
C092	La Laguna	Espagne	-3.994400	37.092000	2260	Sommet de carotte	Steppe chaude	EPD	Davis, B.A.S.	Davis et al., 2003
C093	Laguna Marchalicho 1	Espagne	-1.876400	37.133000	700	Sommet de carotte	Steppe chaude	EPD	Davis, B.A.S.	Davis et al., 2003
C094	Laguna Grande	Espagne	-3.252800	40.886000	950	Sommet de carotte	Steppe chaude	EPD	Davis, B.A.S.	Davis et al., 2003
C095	Laguna Carralogroño	Espagne	-2.566700	42.540000	560	Sommet de carotte	Steppe chaude	EPD	Davis, B.A.S.	Davis et al., 2003
C096	Laguna Carravalseca	Espagne	-2.566700	42.532000	560	Sommet de carotte	Végétation xérophytique	EPD	Davis, B.A.S.	Davis et al., 2003
C097	Laguna Cucharas	Espagne	-4.147200	38.750000	640	Sommet de carotte	Steppe chaude	EPD	Davis, B.A.S.	Davis et al., 2003
C098	Laguna Rollico	Espagne	-0.300000	41.392000	323	Sommet de carotte	Végétation xérophytique	EPD	Davis, B.A.S.	Davis et al., 2003
C099	Laguna Salicor	Espagne	-3.173300	39.468000	680	Sommet de carotte	Végétation xérophytique	EPD	Davis, B.A.S.	Davis et al., 2003
C100	Laguna Mediana	Espagne	0.730600	41.503000	340	Sommet de carotte	Végétation xérophytique	EPD	Davis, B.A.S.	Davis et al., 2003
C101	Morrone Birkwoods	Angleterre	-3.433333	57.000000	425	Sommet de carotte	Forêt mixte froide	EPD	Davis, B.A.S.	Davis et al., 2003
C102	Rukatunturi	Finlande	29.150000	66.166667	462	Sommet de carotte	Végétation pionnière	EPD	Davis, B.A.S.	Davis et al., 2003
C104	Chabada Lake	Russie	129.366667	61.983333	290	Sommet de carotte	Forêt boréale	EPD	Davis, B.A.S.	Davis et al., 2003
C105	Dolgoe	Biélorussie	28.183333	55.233333	173	Sommet de carotte	Forêt boréale	EPD	Davis, B.A.S.	Davis et al., 2003
C106	Fjällnas	Suède	12.166667	62.550000	780	Sommet de carotte	Végétation pionnière	EPD	Davis, B.A.S.	Davis et al., 2003
C107	Krageholmssjön	Suède	13.733333	55.500000	43	Sommet de carotte	Forêt mixte fraîche	EPD	Davis, B.A.S.	Davis et al., 2003
C109	Amsoldingersee	Suisse	7.575000	46.725000	641	Sommet de carotte	Forêt de conifères	EPD	Davis, B.A.S.	Davis et al., 2003
C110	Sluggan Moss	Irlande	-6.300000	54.933333	52	Sommet de carotte	Forêt tempérée décidue	EPD	Davis, B.A.S.	Davis et al., 2003
C112	Grande Brière	France	-2.250000	47.366667	80	Sommet de carotte	Forêt tempérée décidue	EPD	Davis, B.A.S.	Davis et al., 2003
C114	Mabo Moss	Suède	16.066667	58.016667	117	Sommet de carotte	Forêt mixte fraîche	EPD	Davis, B.A.S.	Davis et al., 2003
C116	Loch Lomond Ross Dubh	Angleterre	-4.583333	56.086389	8	Sommet de carotte	Forêt tempérée décidue	EPD	Davis, B.A.S.	Davis et al., 2003
C117	Lac Saint Léger	France	6.336389	44.420000	1308	Sommet de carotte	Steppe froide	EPD	Davis, B.A.S.	Davis et al., 2003
C118	Long Lough	Irlande	-5.866667	54.416667	25	Sommet de carotte	Forêt tempérée décidue	EPD	Davis, B.A.S.	Davis et al., 2003
C119	Lough Henney	Irlande	-5.900000	54.433333	25	Sommet de carotte	Forêt tempérée décidue	EPD	Davis, B.A.S.	Davis et al., 2003
C120	Dry Lake II (Rila)	Bulgarie	23.533333	42.050000	1900	Sommet de carotte	Forêt mixte fraîche	EPD	Davis, B.A.S.	Davis et al., 2003
C121	Kanjerjoki	Finlande	29.000000	66.116667	288	Sommet de carotte	Forêt de conifères	EPD	Davis, B.A.S.	Davis et al., 2003
C122	Ilmen Lake	Russie	31.233333	58.300000	18	Sommet de carotte	Forêt de conifères	EPD	Davis, B.A.S.	Davis et al., 2003
C123	Edessa	Grèce	21.952500	40.818056	350	Sommet de carotte	Forêt mixte chaude	EPD	Davis, B.A.S.	Davis et al., 2003

Nom	Site	Pays	Longitude	Latitude	Altitude	Nature du prélèvement	Biome	Auteur	Source	Référence
C124	Vegoritis 8	Grèce	21.750000	40.750000	570	Sommet de carotte	Forêt mixte chaude	EPD	Davis, B.A.S.	Davis et al., 2003
C125	Kastoria	Grèce	21.322222	40.551944	650	Sommet de carotte	Forêt tempérée décidue	EPD	Davis, B.A.S.	Davis et al., 2003
C126	Lake Xinias	Grèce	22.266667	39.050000	500	Sommet de carotte	Forêt mixte chaude	EPD	Davis, B.A.S.	Davis et al., 2003
C127	Trikhonis 5	Grèce	21.500000	38.600000	20	Sommet de carotte	Forêt mixte chaude	EPD	Davis, B.A.S.	Davis et al., 2003
C128	Koiladha	Grèce	23.100000	37.550000	-10	Sommet de carotte	Végétation xérophytique	EPD	Davis, B.A.S.	Davis et al., 2003
C129	Beysehir Gölü I	Turquie	31.500000	37.541667	1120	Sommet de carotte	Ecosystèmes anthropisés	EPD	Davis, B.A.S.	Davis et al., 2003
C130	Hoyran Gölü	Turquie	30.875000	38.275000	920	Sommet de carotte	Ecosystèmes anthropisés	EPD	Davis, B.A.S.	Davis et al., 2003
C131	Kararmik Batakligi	Turquie	30.800000	38.425000	1000	Sommet de carotte	Ecosystèmes anthropisés	EPD	Davis, B.A.S.	Davis et al., 2003
C133	Sögüt Gölü	Turquie	29.883333	37.050000	1400	Sommet de carotte	Forêt tempérée décidue	EPD	Davis, B.A.S.	Davis et al., 2003
C134	Ageröds Mosse	Suisse	13.416667	55.833333	58	Sommet de carotte	Forêt mixte fraîche	EPD	Davis, B.A.S.	Davis et al., 2003
C135	Komorany	Tchékoslovaquie	13.500000	50.500000	231	Sommet de carotte	Forêt mixte fraîche	EPD	Davis, B.A.S.	Davis et al., 2003
C136	Särkikangas	Finlande	29.200000	65.916667	265	Sommet de carotte	Forêt boréale	EPD	Davis, B.A.S.	Davis et al., 2003
C137	Kittilä	Finlande	24.683333	65.025000	8	Sommet de carotte	Forêt boréale	EPD	Davis, B.A.S.	Davis et al., 2003
C138	Sipola (Oulu)	Finlande	24.791667	65.050000	7	Sommet de carotte	Forêt boréale	EPD	Davis, B.A.S.	Davis et al., 2003
C139	Landruchie Mire	Russie	39.000000	61.000000	120	Sommet de carotte	Forêt boréale	EPD	Davis, B.A.S.	Davis et al., 2003
C140	Malcin	Tchékoslovaquie	15.416667	49.666667	520	Sommet de carotte	Forêt mixte fraîche	EPD	Davis, B.A.S.	Davis et al., 2003
C141	Kansjon	Suisse	14.533333	57.633333	308	Sommet de carotte	Forêt mixte fraîche	EPD	Davis, B.A.S.	Davis et al., 2003
C142	Cueto de la Avellanosa	Espagne	-4.364167	43.116667	1320	Sommet de carotte	Forêt tempérée décidue	EPD	Davis, B.A.S.	Davis et al., 2003
C143	Pico del Sertal	Espagne	-4.436111	43.215556	940	Sommet de carotte	Forêt tempérée décidue	EPD	Davis, B.A.S.	Davis et al., 2003
C144	Alsa	Espagne	-4.016667	43.117778	820	Sommet de carotte	Forêt tempérée décidue	EPD	Davis, B.A.S.	Davis et al., 2003
C145	Puerto de las Estaces de Trueba	Espagne	-3.700556	43.121389	1160	Sommet de carotte	Forêt mixte froide	EPD	Davis, B.A.S.	Davis et al., 2003
C147	Lilla Gloppsjön	Suisse	14.627778	59.804444	198	Sommet de carotte	Forêt de conifères	EPD	Davis, B.A.S.	Davis et al., 2003
C148	Kassjön	Suède	20.016667	63.916667	84	Sommet de carotte	Végétation pionnière	EPD	Davis, B.A.S.	Davis et al., 2003
C149	Krontjärnen	Suède	20.950000	66.233333	58	Sommet de carotte	Forêt boréale	EPD	Davis, B.A.S.	Davis et al., 2003
C150	Kluki	Pologne	17.284722	54.706944	1	Sommet de carotte	Forêt tempérée décidue	EPD	Davis, B.A.S.	Davis et al., 2003
C151	Reisdorf	Luxembourg	6.301667	49.851667	369	Sommet de carotte	Forêt tempérée décidue	EPD	Davis, B.A.S.	Davis et al., 2003
C152	Reisdorf	Luxembourg	6.301667	49.851667	369	Sommet de carotte	Forêt mixte fraîche	EPD	Davis, B.A.S.	Davis et al., 2003
C153	Reisdorf	Luxembourg	6.301667	49.851667	369	Sommet de carotte	Forêt mixte fraîche	EPD	Davis, B.A.S.	Davis et al., 2003
C154	Michurinskoe Lake	Russie	29.983333	60.516667	94	Sommet de carotte	Forêt boréale	EPD	Davis, B.A.S.	Davis et al., 2003
C155	Lake Nuochaga	Russie	129.550000	61.300000	260	Sommet de carotte	Forêt boréale	EPD	Davis, B.A.S.	Davis et al., 2003
C156	Onego Lake	Russie	34.916667	61.716667	33	Sommet de carotte	Forêt boréale	EPD	Davis, B.A.S.	Davis et al., 2003
C157	Derput	Russie	124.116667	57.033333	700	Sommet de carotte	Forêt boréale	EPD	Davis, B.A.S.	Davis et al., 2003
C158	Pannel Bridge	Angleterre	0.683333	50.900000	3	Sommet de carotte	Steppe froide	EPD	Davis, B.A.S.	Davis et al., 2003
C159	Onego Lake	Russie	34.916667	61.716667	33	Sommet de carotte	Forêt boréale	EPD	Davis, B.A.S.	Davis et al., 2003
C160	Osvea	Biélorussie	56.083333	56.050000	132	Sommet de carotte	Forêt de conifères	EPD	Davis, B.A.S.	Davis et al., 2003
C161	Arts Lough	Irlande	-6.433333	52.950000	490	Sommet de carotte	Forêt tempérée décidue	EPD	Davis, B.A.S.	Davis et al., 2003
C162	Palasiny	Tchékoslovaquie	15.483333	49.688889	520	Sommet de carotte	Steppe froide	EPD	Davis, B.A.S.	Davis et al., 2003
C164	Peschanoe	Biélorussie	25.483333	51.983333	139	Sommet de carotte	Forêt mixte fraîche	EPD	Davis, B.A.S.	Davis et al., 2003
C165	Lago de Ajo	Espagne	-6.150000	43.050000	1570	Sommet de carotte	Forêt tempérée décidue	EPD	Davis, B.A.S.	Davis et al., 2003
C166	Le Mont	France	6.548889	45.551389	1995	Sommet de carotte	Forêt mixte fraîche	EPD	Davis, B.A.S.	Davis et al., 2003

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C167	Monticchio	Italie	15.180556	40.944444	1326	Sommet de carotte	Forêt tempérée décidue	EPD	Davis, B.A.S.	Davis et al., 2003
C168	Rasna pond	Slovaquie	15.370833	49.230556	680	Sommet de carotte	Forêt de conifères	EPD	Davis, B.A.S.	Davis et al., 2003
C169	Rudushskoe Lake	Lettonie	27.550000	56.500000	150	Sommet de carotte	Forêt boréale	EPD	Davis, B.A.S.	Davis et al., 2003
C171	Svatoborice-Mistrin	Tchékoslovaquie	17.166667	48.833333	175	Sommet de carotte	Steppe froide	EPD	Davis, B.A.S.	Davis et al., 2003
C173	Flögeln	Allemagne	8.763889	53.666667	2	Sommet de carotte	Forêt mixte fraîche	EPD	Davis, B.A.S.	Davis et al., 2003
C174	Flögeln	Allemagne	8.763889	53.666667	2	Sommet de carotte	Forêt tempérée décidue	EPD	Davis, B.A.S.	Davis et al., 2003
C175	Flögeln	Allemagne	8.763889	53.666667	2	Sommet de carotte	Forêt tempérée décidue	EPD	Davis, B.A.S.	Davis et al., 2003
C177	Mire Saviku	Estonie	27.233333	58.400000	30	Sommet de carotte	Forêt mixte fraîche	EPD	Davis, B.A.S.	Davis et al., 2003
C178	Mire Pelisoo	Estonie	22.383333	58.466667	33	Sommet de carotte	Forêt mixte fraîche	EPD	Davis, B.A.S.	Davis et al., 2003
C179	Selle di Carnino	Italie	7.694444	44.150000	1905	Sommet de carotte	Forêt mixte fraîche	EPD	Davis, B.A.S.	Davis et al., 2003
C180	Moussous	France	3.991111	44.636111	1300	Sommet de carotte	Forêt tempérée décidue	EPD	Davis, B.A.S.	Davis et al., 2003
C181	Picherande	France	2.800000	45.533333	1208	Sommet de carotte	Forêt tempérée décidue	EPD	Davis, B.A.S.	Davis et al., 2003
C182	Puy de Pailleret	France	2.816667	45.516667	1590	Sommet de carotte	Forêt tempérée décidue	EPD	Davis, B.A.S.	Davis et al., 2003
C183	Bois de la Masse	France	2.733333	45.500000	1140	Sommet de carotte	Forêt tempérée décidue	EPD	Davis, B.A.S.	Davis et al., 2003
C184	Lac Saint Léger	France	6.336389	44.420000	1308	Sommet de carotte	Forêt tempérée décidue	EPD	Davis, B.A.S.	Davis et al., 2003
C185	Puerto de Los Tornos	Espagne	-3.433333	43.150000	920	Sommet de carotte	Steppe chaude	EPD	Davis, B.A.S.	Davis et al., 2003
C186	Uitbergen	Belgique	3.944722	51.017778	4	Sommet de carotte	Steppe froide	EPD	Davis, B.A.S.	Davis et al., 2003
C187	Saldropo	Espagne	-2.716667	43.050000	625	Sommet de carotte	Forêt tempérée décidue	EPD	Davis, B.A.S.	Davis et al., 2003
C188	Atxuri	Espagne	-1.550000	43.250000	500	Sommet de carotte	Forêt tempérée décidue	EPD	Davis, B.A.S.	Davis et al., 2003
C189	Bois de Buchelbush	Belgique	5.829722	49.713889	375	Sommet de carotte	Forêt tempérée décidue	EPD	Davis, B.A.S.	Davis et al., 2003
C190	Maleshevska Mts	Bulgarie	23.033333	41.700000	1720	Sommet de carotte	Forêt tempérée décidue	EPD	Davis, B.A.S.	Davis et al., 2003
C191	Saint Sixte	France	5.625000	45.425000	650	Sommet de carotte	Forêt mixte fraîche	EPD	Davis, B.A.S.	Davis et al., 2003
C193	Le Grand Lemps	France	5.416667	45.473333	500	Sommet de carotte	Forêt mixte fraîche	EPD	Davis, B.A.S.	Davis et al., 2003
C194	Hières sur Amby	France	5.283333	45.790833	410	Sommet de carotte	Steppe froide	EPD	Davis, B.A.S.	Davis et al., 2003
C195	Lake Duranunlak	Bulgarie	28.550000	43.666667	4	Sommet de carotte	Ecosystèmes anthropisés	EPD	Davis, B.A.S.	Davis et al., 2003
C196	Lake Duranunlak	Bulgarie	28.550000	43.666667	4	Sommet de carotte	Ecosystèmes anthropisés	EPD	Davis, B.A.S.	Davis et al., 2003
C197	Vernerovice	Tchékoslovaquie	16.250000	50.100000	450	Sommet de carotte	Forêt mixte fraîche	EPD	Davis, B.A.S.	Davis et al., 2003
C198	Vishnevskoe Lake	Russie	29.516944	60.502222	15	Sommet de carotte	Forêt boréale	EPD	Davis, B.A.S.	Davis et al., 2003
C199	Puerto de Belate	Espagne	-2.050000	43.033333	847	Sommet de carotte	Forêt tempérée décidue	EPD	Davis, B.A.S.	Davis et al., 2003
C200	Quintanar de la Sierra	Espagne	-3.016667	42.033333	1470	Sommet de carotte	Forêt mixte chaude	EPD	Davis, B.A.S.	Davis et al., 2003
C201	Nigula	Estonie	24.666667	58.000000	55	Sommet de carotte	Forêt tempérée décidue	EPD	Davis, B.A.S.	Davis et al., 2003
C202	Mukkavaara	Finlande	21.000000	68.916667	535	Sommet de carotte	Végétation pionnière	EPD	Davis, B.A.S.	Davis et al., 2003
C203	Ylimysneva	Finlande	22.866667	62.133333	172	Sommet de carotte	Forêt boréale	EPD	Davis, B.A.S.	Davis et al., 2003
C204	Kupena	Bulgarie	24.333333	41.983333	1300	Sommet de carotte	Forêt mixte fraîche	EPD	Davis, B.A.S.	Davis et al., 2003
C205	Mayralampi	Finlande	26.233333	62.333333	118	Sommet de carotte	Forêt mixte fraîche	EPD	Davis, B.A.S.	Davis et al., 2003
C206	Maanselänsuo	Finlande	29.600000	65.616667	248	Sommet de carotte	Forêt boréale	EPD	Davis, B.A.S.	Davis et al., 2003
C207	Lake Kolmilaträsk	Finlande	20.150000	60.283333	12	Sommet de carotte	Forêt mixte fraîche	EPD	Davis, B.A.S.	Davis et al., 2003
C208	Kaartlamminsuo	Finlande	24.216667	60.733333	115	Sommet de carotte	Forêt boréale	EPD	Davis, B.A.S.	Davis et al., 2003
C209	Kaarkotinlampi	Finlande	25.866667	61.416667	104	Sommet de carotte	Forêt de conifères	EPD	Davis, B.A.S.	Davis et al., 2003
C210	Kirkkosaari	Finlande	24.500000	60.866667	84	Sommet de carotte	Forêt boréale	EPD	Davis, B.A.S.	Davis et al., 2003
C211	Siikasuo	Finlande	22.066667	61.300000	35	Sommet de carotte	Forêt boréale	EPD	Davis, B.A.S.	Davis et al., 2003

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C212	Isokärret	Finlande	22.133333	60.216667	16	Sommet de carotte	Végétation pionnière	EPD	Davis, B.A.S.	Davis et al., 2003
C213	Tullerinsuo	Finlande	21.950000	61.333333	29	Sommet de carotte	Forêt boréale	EPD	Davis, B.A.S.	Davis et al., 2003
C214	Lalaxkärret	Finlande	21.866667	60.150000	20	Sommet de carotte	Forêt de conifères	EPD	Davis, B.A.S.	Davis et al., 2003
C215	Mossen	Finlande	21.600000	60.116667	17	Sommet de carotte	Forêt boréale	EPD	Davis, B.A.S.	Davis et al., 2003
C216	Syrjälänsuo	Finlande	28.116667	61.216667	83	Sommet de carotte	Forêt de conifères	EPD	Davis, B.A.S.	Davis et al., 2003
C217	Vasikkasuo	Finlande	27.866667	64.666667	270	Sommet de carotte	Végétation pionnière	EPD	Davis, B.A.S.	Davis et al., 2003
C218	Burgmoos	Suisse	7.674444	47.172222	465	Sommet de carotte	Forêt mixte fraîche	EPD	Davis, B.A.S.	Davis et al., 2003
C219	Burgmoos	Suisse	7.674444	47.172222	465	Sommet de carotte	Forêt mixte fraîche	EPD	Davis, B.A.S.	Davis et al., 2003
C222	Burgmoos	Suisse	7.674444	47.172222	465	Sommet de carotte	Steppe froide	EPD	Davis, B.A.S.	Davis et al., 2003
C223	Burgmoos	Suisse	7.674444	47.172222	465	Sommet de carotte	Forêt mixte fraîche	EPD	Davis, B.A.S.	Davis et al., 2003
C224	Khimaditis III	Grèce	21.586111	40.612500	560	Sommet de carotte	Forêt mixte chaude	EPD	Davis, B.A.S.	Davis et al., 2003
C225	Khimaditis Ib	Grèce	21.583333	40.616667	560	Sommet de carotte	Steppe froide	EPD	Davis, B.A.S.	Davis et al., 2003
C226	Tontelange Heideknapp	Belgique	5.820000	49.719444	325	Sommet de carotte	Forêt mixte fraîche	EPD	Davis, B.A.S.	Davis et al., 2003
C227	Arsenala-Varna lake	Bulgarie	27.833333	43.200000	0	Sommet de carotte	Ecosystèmes anthropisés	EPD	Davis, B.A.S.	Davis et al., 2003
C228	Bois de Buchelbush	Belgique	5.829722	49.713889	375	Sommet de carotte	Forêt mixte fraîche	EPD	Davis, B.A.S.	Davis et al., 2003
C229	Plan Dechaud	France	6.830833	45.567222	2175	Sommet de carotte	Forêt mixte fraîche	EPD	Davis, B.A.S.	Davis et al., 2003
C230	Cairn	France	6.556667	45.331389	2315	Sommet de carotte	Steppe froide	EPD	Davis, B.A.S.	Davis et al., 2003
C231	Plan du Clou	France	6.539167	45.699722	1700	Sommet de carotte	Forêt mixte fraîche	EPD	Davis, B.A.S.	Davis et al., 2003
C232	Lac Couvert	France	6.534722	45.696389	1805	Sommet de carotte	Forêt mixte fraîche	EPD	Davis, B.A.S.	Davis et al., 2003
C233	Plan du Jeu	France	6.532222	45.607222	2010	Sommet de carotte	Forêt mixte fraîche	EPD	Davis, B.A.S.	Davis et al., 2003
C235	Mikolajki lake	Pologne	21.418056	53.768056	116	Sommet de carotte	Forêt mixte fraîche	EPD	Davis, B.A.S.	Davis et al., 2003
C236	Puscizna Rekowianska	Pologne	19.816667	49.483333	656	Sommet de carotte	Forêt mixte fraîche	EPD	Davis, B.A.S.	Davis et al., 2003
C237	Tarnawa Wyzna	Pologne	22.833333	49.100000	670	Sommet de carotte	Forêt mixte fraîche	EPD	Davis, B.A.S.	Davis et al., 2003
C238	Beaufort Birkenbach	Luxembourg	6.125833	49.847222	360	Sommet de carotte	Steppe froide	EPD	Davis, B.A.S.	Davis et al., 2003
C239	Slopiec	Pologne	20.783333	50.783333	248	Sommet de carotte	Forêt mixte fraîche	EPD	Davis, B.A.S.	Davis et al., 2003
C240	Slopiec	Pologne	20.783333	50.783333	248	Sommet de carotte	Forêt mixte fraîche	EPD	Davis, B.A.S.	Davis et al., 2003
C241	Tarnowiec	Pologne	21.616667	49.700000	220	Sommet de carotte	Forêt mixte fraîche	EPD	Davis, B.A.S.	Davis et al., 2003
C242	Steklin	Pologne	18.983333	52.933333	73	Sommet de carotte	Forêt tempérée décidue	EPD	Davis, B.A.S.	Davis et al., 2003
C243	Jasiel	Pologne	21.886944	49.372778	680	Sommet de carotte	Forêt mixte fraîche	EPD	Davis, B.A.S.	Davis et al., 2003
C244	Fletnowo	Pologne	18.650000	53.533333	31	Sommet de carotte	Forêt mixte fraîche	EPD	Davis, B.A.S.	Davis et al., 2003
C245	Bledowo lake	Pologne	20.666667	52.550000	78	Sommet de carotte	Forêt tempérée décidue	EPD	Davis, B.A.S.	Davis et al., 2003
C246	Kalsa mire	Estonie	27.450000	58.166667	38	Sommet de carotte	Forêt boréale	EPD	Davis, B.A.S.	Davis et al., 2003
C249	Chranboz	Tchékoslovaquie	15.361111	49.758333	480	Sommet de carotte	Forêt mixte fraîche	EPD	Davis, B.A.S.	Davis et al., 2003
C250	Hroznotin	Tchékoslovaquie	15.355556	49.752778	485	Sommet de carotte	Steppe froide	EPD	Davis, B.A.S.	Davis et al., 2003
C251	Jestrebske blato	Tchékoslovaquie	14.591667	50.602778	259	Sommet de carotte	Forêt mixte fraîche	EPD	Davis, B.A.S.	Davis et al., 2003
C252	Palasiny	Tchékoslovaquie	15.483333	49.688889	520	Sommet de carotte	Forêt mixte fraîche	EPD	Davis, B.A.S.	Davis et al., 2003
C253	Spisska Bela	Slovénie	20.450000	49.184722	625	Sommet de carotte	Forêt de conifères	EPD	Davis, B.A.S.	Davis et al., 2003
C255	Karas'e Lake	Kazakhstan	70.220000	53.030000	435	Sommet de carotte	Forêt boréale	EPD	Davis, B.A.S.	Davis et al., 2003
C256	Kotyrkol' Peat Bog	Kazakhstan	70.416667	52.966667	439	Sommet de carotte	Forêt boréale	EPD	Davis, B.A.S.	Davis et al., 2003
C257	Pashennoe	Kazakhstan	75.400000	49.370000	871	Sommet de carotte	Steppe froide	EPD	Davis, B.A.S.	Davis et al., 2003
C258	Punso	Estonie	27.250000	57.683333	183	Sommet de carotte	Forêt mixte fraîche	EPD	Davis, B.A.S.	Davis et al., 2003

Nom	Site	Pays	Longitude	Latitude	Altitude	Nature du prélèvement	Biome	Auteur	Source	Référence
C259	Zaboinoe Lake	Russie	62.366667	55.533333	275	Sommet de carotte	Forêt mixte fraîche	EPD	Davis, B.A.S.	Davis et al., 2003
C260	Zirbenwaldmoor	Autriche	11.025000	46.858333	2150	Sommet de carotte	Forêt boréale	EPD	Davis, B.A.S.	Davis et al., 2003
C261	Mire Petrolivo	Russie	31.983333	56.000000	175	Sommet de carotte	Forêt mixte fraîche	EPD	Davis, B.A.S.	Davis et al., 2003
C262	Mire Sosvyatskoe	Russie	32.000000	56.200000	175	Sommet de carotte	Forêt boréale	EPD	Davis, B.A.S.	Davis et al., 2003
C263	Butter mountain	Irlande	-6.033333	54.166667	458	Sommet de carotte	Forêt tempérée décidue	EPD	Davis, B.A.S.	Davis et al., 2003
C264	Blato (Zispachy)	Tchékoslovaquie	15.191667	49.041667	645	Sommet de carotte	Forêt mixte fraîche	EPD	Davis, B.A.S.	Davis et al., 2003
C265	Loucky	Tchékoslovaquie	15.502778	49.325000	560	Sommet de carotte	Forêt de conifères	EPD	Davis, B.A.S.	Davis et al., 2003
C266	Sredna Gora mountains	Bulgarie	24.833333	42.833333	1300	Sommet de carotte	Steppe froide	EPD	Davis, B.A.S.	Davis et al., 2003
C268	Derrycunihy	Irlande	-9.416667	52.016667	60	Sommet de carotte	Forêt tempérée décidue	EPD	Davis, B.A.S.	Davis et al., 2003
C269	Lake Nero	Russie	39.451389	57.183333	95	Sommet de carotte	Forêt mixte fraîche	EPD	Davis, B.A.S.	Davis et al., 2003
C270	Stupino	Russie	39.833333	52.250000	95	Sommet de carotte	Forêt de conifères	EPD	Davis, B.A.S.	Davis et al., 2003
C271	Starniki	Ukraine	26.016667	50.266667	198	Sommet de carotte	Forêt mixte fraîche	EPD	Davis, B.A.S.	Davis et al., 2003
C272	Ivano-Frankovskoye	Ukraine	23.766667	49.916667	300	Sommet de carotte	Forêt mixte fraîche	EPD	Davis, B.A.S.	Davis et al., 2003
C273	Pecheniya	Ukraine	23.933333	49.666667	225	Sommet de carotte	Forêt mixte fraîche	EPD	Davis, B.A.S.	Davis et al., 2003
C274	Stoyanov-2	Ukraine	24.633333	50.383333	198	Sommet de carotte	Forêt mixte fraîche	EPD	Davis, B.A.S.	Davis et al., 2003
C275	Zalozhtsy-2	Ukraine	25.450000	49.750000	320	Sommet de carotte	Forêt mixte fraîche	EPD	Davis, B.A.S.	Davis et al., 2003
C277	Bezdonnoe	Russie	32.766667	62.033333	121	Sommet de carotte	Forêt boréale	EPD	Davis, B.A.S.	Davis et al., 2003
C278	Dlinnoe	Russie	33.850000	62.316667	66	Sommet de carotte	Forêt boréale	EPD	Davis, B.A.S.	Davis et al., 2003
C279	Glubokoe	Russie	36.050000	61.066667	50	Sommet de carotte	Forêt boréale	EPD	Davis, B.A.S.	Davis et al., 2003
C280	Gotnavolok	Russie	33.800000	62.200000	110	Sommet de carotte	Forêt boréale	EPD	Davis, B.A.S.	Davis et al., 2003
C281	Kepskoe	Russie	32.166667	65.083333	124	Sommet de carotte	Forêt boréale	EPD	Davis, B.A.S.	Davis et al., 2003
C282	Koppalosuo	Russie	33.650000	62.283333	117	Sommet de carotte	Forêt boréale	EPD	Davis, B.A.S.	Davis et al., 2003
C283	Landshaftnoe	Russie	30.533333	64.566667	207	Sommet de carotte	Forêt boréale	EPD	Davis, B.A.S.	Davis et al., 2003
C284	Mezhgornoe	Russie	30.700000	66.366667	190	Sommet de carotte	Forêt boréale	EPD	Davis, B.A.S.	Davis et al., 2003
C285	Nenazvannoe	Russie	33.483333	61.805556	100	Sommet de carotte	Forêt boréale	EPD	Davis, B.A.S.	Davis et al., 2003
C286	Nosuo	Russie	30.833333	64.566667	163	Sommet de carotte	Forêt boréale	EPD	Davis, B.A.S.	Davis et al., 2003
C287	Ptichje	Russie	30.566667	66.350000	120	Sommet de carotte	Forêt boréale	EPD	Davis, B.A.S.	Davis et al., 2003
C288	Punozerka	Russie	33.577778	62.816667	157	Sommet de carotte	Forêt boréale	EPD	Davis, B.A.S.	Davis et al., 2003
C289	Rugozero	Russie	32.633333	64.083333	140	Sommet de carotte	Forêt boréale	EPD	Davis, B.A.S.	Davis et al., 2003
C290	Shombashuo	Russie	32.633333	65.116667	100	Sommet de carotte	Forêt boréale	EPD	Davis, B.A.S.	Davis et al., 2003
C291	Solnechnoe	Russie	34.333333	65.833333	10	Sommet de carotte	Forêt boréale	EPD	Davis, B.A.S.	Davis et al., 2003
C292	Zaruckoe	Russie	36.250000	63.900000	20	Sommet de carotte	Forêt boréale	EPD	Davis, B.A.S.	Davis et al., 2003
C293	Zapovednoe	Russie	32.633333	65.116667	110	Sommet de carotte	Forêt boréale	EPD	Davis, B.A.S.	Davis et al., 2003
C295	Mire Garvan	Bulgarie	26.950000	44.126667	20	Sommet de carotte	Forêt mixte fraîche	EPD	Davis, B.A.S.	Davis et al., 2003
C296	Mutorog	Bulgarie	23.616667	43.516667	1700	Sommet de carotte	Forêt mixte fraîche	EPD	Davis, B.A.S.	Davis et al., 2003
C297	Lake Srebarna	Bulgarie	27.116667	44.083300	20	Sommet de carotte	Forêt tempérée décidue	EPD	Davis, B.A.S.	Davis et al., 2003
C298	Laguna de la Roya	Espagne	-6.766667	42.216667	1608	Sommet de carotte	Forêt tempérée décidue	EPD	Davis, B.A.S.	Davis et al., 2003
C300	Vevilov ice cap	Russie	95.350000	79.450000	665	Sommet de carotte	Forêt boréale	EPD	Davis, B.A.S.	Davis et al., 2003
C301	Lake Balaton SW	Hongrie	17.735000	46.818333	104	Sommet de carotte	Forêt tempérée décidue	EPD	Davis, B.A.S.	Davis et al., 2003
C302	Lake Balaton centre	Hongrie	17.400833	46.744444	104	Sommet de carotte	Forêt mixte fraîche	EPD	Davis, B.A.S.	Davis et al., 2003
C303	Lake Balaton NE	Hongrie	18.104167	47.001667	104	Sommet de carotte	Forêt mixte fraîche	EPD	Davis, B.A.S.	Davis et al., 2003
C305	Lake Glubelka	Biélorussie	26.416667	54.950000	166	Sommet de carotte	Forêt mixte fraîche	EPD	Davis, B.A.S.	Davis et al., 2003

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C306	Naroch	Biélorussie	26.750000	54.816667	165	Sommet de carotte	Végétation pionnière	EPD	Davis, B.A.S.	Davis et al., 2003
C308	Maloe	Biélorussie	28.200000	54.183333	164	Sommet de carotte	Forêt mixte fraîche	EPD	Davis, B.A.S.	Davis et al., 2003
C309	Svitjaz	Russie	25.916667	53.433333	242	Sommet de carotte	Forêt mixte fraîche	EPD	Davis, B.A.S.	Davis et al., 2003
C310	Regetovka	Slovaquie	21.716667	49.716667	515	Sommet de carotte	Forêt mixte fraîche	EPD	Davis, B.A.S.	Davis et al., 2003
C311	Karasieozerskoe	Russie	60.750000	56.766667	230	Sommet de carotte	Forêt boréale	EPD	Davis, B.A.S.	Davis et al., 2003
C312	Maksimkin Yar	Russie	88.166667	58.333333	150	Sommet de carotte	Forêt boréale	EPD	Davis, B.A.S.	Davis et al., 2003
C313	Ovrazhnoe	Russie	85.166667	56.250000	110	Sommet de carotte	Forêt boréale	EPD	Davis, B.A.S.	Davis et al., 2003
C314	Ust'Mashevskoe	Russie	57.883333	56.316667	220	Sommet de carotte	Forêt boréale	EPD	Davis, B.A.S.	Davis et al., 2003
C315	Zuratkul'	Russie	59.266667	54.900000	720	Sommet de carotte	Forêt boréale	EPD	Davis, B.A.S.	Davis et al., 2003
C316	Rotsee	Suisse	8.325556	47.075556	419	Sommet de carotte	Forêt mixte fraîche	EPD	Davis, B.A.S.	Davis et al., 2003
C317	Rotsee	Suisse	8.325556	47.075556	419	Sommet de carotte	Forêt mixte fraîche	EPD	Davis, B.A.S.	Davis et al., 2003
C319	Chernoe lake	Russie	106.633333	50.950000	500	Sommet de carotte	Forêt boréale	EPD	Davis, B.A.S.	Davis et al., 2003
C320	Bol'shoe Eravnoe Lake	Russie	111.666667	52.583333	947	Sommet de carotte	Forêt boréale	EPD	Davis, B.A.S.	Davis et al., 2003
C321	Monticchio	Italie	15.180556	40.944444	1326	Sommet de carotte	Forêt tempérée décidue	EPD	Davis, B.A.S.	Davis et al., 2003
C322	Colfiorito	Italie	12.916667	43.025000	752	Sommet de carotte	Forêt mixte chaude	EPD	Davis, B.A.S.	Davis et al., 2003
C324	Hort Timoner	Espagne	4.126389	39.875000	40	Sommet de carotte	Steppe chaude	EPD	Davis, B.A.S.	Davis et al., 2003
C326	Dallican water	Shetland	-1.100000	60.391667	56	Sommet de carotte	Forêt mixte froide	EPD	Davis, B.A.S.	Davis et al., 2003
C327	Czajkow	Pologne	21.283333	50.783333	206	Sommet de carotte	Forêt tempérée décidue	EPD	Davis, B.A.S.	Davis et al., 2003
C328	Czajkow	Pologne	21.283333	50.783333	206	Sommet de carotte	Forêt mixte fraîche	EPD	Davis, B.A.S.	Davis et al., 2003
C329	Czajkow	Pologne	21.283333	50.783333	206	Sommet de carotte	Steppe froide	EPD	Davis, B.A.S.	Davis et al., 2003
C330	Gorno	Italie	20.833333	50.850000	240	Sommet de carotte	Steppe froide	EPD	Davis, B.A.S.	Davis et al., 2003
C331	Suchedniow	Pologne	20.850000	51.050000	255	Sommet de carotte	Forêt tempérée décidue	EPD	Davis, B.A.S.	Davis et al., 2003
C332	Babozero	Russie	37.516667	66.375000	138	Sommet de carotte	Toundra	EPD	Davis, B.A.S.	Davis et al., 2003
C333	Kunyok	Russie	33.666667	67.833333	220	Sommet de carotte	Forêt boréale	EPD	Davis, B.A.S.	Davis et al., 2003
C335	Lake Crivoe	Biélorussie	29.133333	55.133333	130	Sommet de carotte	Forêt boréale	EPD	Davis, B.A.S.	Davis et al., 2003
C336	Oltush Lake	Biélorussie	23.956667	51.696667	158	Sommet de carotte	Forêt boréale	EPD	Davis, B.A.S.	Davis et al., 2003
C337	El Acebron	Espagne	-6.500000	37.116667	25	Sommet de carotte	Steppe chaude	EPD	Davis, B.A.S.	Davis et al., 2003
C338	Hoya del Castillo	Espagne	-0.493611	41.253333	260	Sommet de carotte	Végétation xérophytique	EPD	Davis, B.A.S.	Davis et al., 2003
C339	Laguna Salada Chiprana	Espagne	-0.258889	41.157778	160	Sommet de carotte	Végétation xérophytique	EPD	Davis, B.A.S.	Davis et al., 2003
C340	Laguna Guallar	Espagne	-0.233333	41.415278	336	Sommet de carotte	Végétation xérophytique	EPD	Davis, B.A.S.	Davis et al., 2003
C341	Laguna de las Madres II	Espagne	-6.833333	37.150000	3	Sommet de carotte	Steppe chaude	EPD	Davis, B.A.S.	Davis et al., 2003
C342	Salada Pequena	Espagne	-0.219444	41.044444	370	Sommet de carotte	Végétation xérophytique	EPD	Davis, B.A.S.	Davis et al., 2003
C343	Las Salinas	Espagne	-0.891667	38.500000	470	Sommet de carotte	Végétation xérophytique	EPD	Davis, B.A.S.	Davis et al., 2003
C344	Laguna Zarracatin	Espagne	-5.800000	37.033333	20	Sommet de carotte	Végétation xérophytique	EPD	Davis, B.A.S.	Davis et al., 2003
C345	Kardashinski Swamp	Ukraine	32.616667	46.516667	4	Sommet de carotte	Steppe froide	EPD	Davis, B.A.S.	Davis et al., 2003
COV1	Covadon	Espagne	-4.830000	43.320000	240	Mousses	Forêt tempérée décidue	Belmonte, J.	J Guiot/Peyron, O.	Peyron et al., 1998
D001	Nordschwarzwald	Allemagne	8.456800	48.524400	735		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D002	Nordschwarzwald	Allemagne	8.456800	48.524400	735		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D003	Nordschwarzwald	Allemagne	8.456800	48.524400	735		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D004	Nordschwarzwald	Allemagne	8.456800	48.524400	735		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D005	Nordschwarzwald	Allemagne	8.456800	48.524400	735		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000

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D006	Nordschwarzwald	Allemagne	8.456800	48.524400	735		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D007	Nordschwarzwald	Allemagne	8.454900	48.524700	735		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D008	Nordschwarzwald	Allemagne	8.454900	48.524700	735		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D009	Nordschwarzwald	Allemagne	8.454900	48.524700	735		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D010	Nordschwarzwald	Allemagne	8.454900	48.524700	735		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D011	Nordschwarzwald	Allemagne	8.454900	48.524700	735		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D012	Nordschwarzwald	Allemagne	8.491900	48.542800	730		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D013	Nordschwarzwald	Allemagne	8.491900	48.542800	730		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D014	Nordschwarzwald	Allemagne	8.491900	48.542800	730		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D015	Nordschwarzwald	Allemagne	8.491900	48.542800	730		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D016	Nordschwarzwald	Allemagne	8.491900	48.542800	730		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D017	Nordschwarzwald	Allemagne	8.498800	48.548600	710		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D018	Nordschwarzwald	Allemagne	8.498800	48.548600	710		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D019	Nordschwarzwald	Allemagne	8.498800	48.548600	710		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D020	Nordschwarzwald	Allemagne	8.498800	48.548600	710		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D021	Nordschwarzwald	Allemagne	8.498800	48.548600	710		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D022	Nordschwarzwald	Allemagne	8.363200	48.545400	820		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D023	Nordschwarzwald	Allemagne	8.363200	48.545400	820		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D024	Nordschwarzwald	Allemagne	8.363200	48.545400	820		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D025	Nordschwarzwald	Allemagne	8.363200	48.545400	820		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D026	Nordschwarzwald	Allemagne	8.363200	48.545400	820		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D027	Nordschwarzwald	Allemagne	8.385200	48.529400	760		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D028	Nordschwarzwald	Allemagne	8.385200	48.529400	760		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D029	Nordschwarzwald	Allemagne	8.385200	48.529400	760		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D030	Nordschwarzwald	Allemagne	8.385200	48.529400	760		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D031	Nordschwarzwald	Allemagne	8.385200	48.529400	760		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D032	Nordschwarzwald	Allemagne	8.355500	48.560600	900		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D033	Nordschwarzwald	Allemagne	8.355500	48.560600	900		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D034	Nordschwarzwald	Allemagne	8.355500	48.560600	900		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D035	Nordschwarzwald	Allemagne	8.355500	48.560600	900		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D036	Nordschwarzwald	Allemagne	8.355500	48.560600	900		Forêt de conifères	Dambach, K.	Pangaea	Dambach, 2000
D037	Nordschwarzwald	Allemagne	8.377700	48.560700	865		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D038	Nordschwarzwald	Allemagne	8.377700	48.560700	865		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D039	Nordschwarzwald	Allemagne	8.377700	48.560700	865		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D040	Nordschwarzwald	Allemagne	8.377700	48.560700	865		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D041	Nordschwarzwald	Allemagne	8.377700	48.560700	865		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D042	Nordschwarzwald	Allemagne	8.377700	48.560700	865		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D043	Nordschwarzwald	Allemagne	8.349100	48.570400	900		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D044	Nordschwarzwald	Allemagne	8.349100	48.570400	900		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D045	Nordschwarzwald	Allemagne	8.349100	48.570400	900		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D046	Nordschwarzwald	Allemagne	8.349100	48.570400	900		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D047	Nordschwarzwald	Allemagne	8.349100	48.570400	900		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000

Nom	Site	Pays	Longitude	Latitude	Altitude	Nature du prélèvement	Biome	Auteur	Source	Référence
D048	Nordschwarzwald	Allemagne	8.348300	48.571300	900		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D049	Nordschwarzwald	Allemagne	8.348300	48.571300	900		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D050	Nordschwarzwald	Allemagne	8.348300	48.571300	900		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D051	Nordschwarzwald	Allemagne	8.348300	48.571300	900		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D052	Nordschwarzwald	Allemagne	8.348300	48.571300	900		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D053	Nordschwarzwald	Allemagne	8.347800	48.569200	900		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D054	Nordschwarzwald	Allemagne	8.347800	48.569200	900		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D055	Nordschwarzwald	Allemagne	8.347800	48.569200	900		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D056	Nordschwarzwald	Allemagne	8.347800	48.569200	900		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D057	Nordschwarzwald	Allemagne	8.347800	48.569200	900		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D075	Nordschwarzwald	Allemagne	8.491400	48.503400	660		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D076	Nordschwarzwald	Allemagne	8.491400	48.503400	660		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D077	Nordschwarzwald	Allemagne	8.491400	48.503400	660		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D078	Nordschwarzwald	Allemagne	8.491400	48.503400	660		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D079	Nordschwarzwald	Allemagne	8.491400	48.503400	660		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D080	Nordschwarzwald	Allemagne	8.491400	48.503400	660		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D081	Nordschwarzwald	Allemagne	8.482200	48.504600	700		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D086	Nordschwarzwald	Allemagne	8.481700	48.516000	700		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D087	Nordschwarzwald	Allemagne	8.481700	48.516000	700		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D088	Nordschwarzwald	Allemagne	8.481700	48.516000	700		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D089	Nordschwarzwald	Allemagne	8.481700	48.516000	700		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D090	Nordschwarzwald	Allemagne	8.481700	48.516000	700		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D091	Nordschwarzwald	Allemagne	8.481700	48.516000	700		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D092	Nordschwarzwald	Allemagne	8.481700	48.516000	700		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D093	Nordschwarzwald	Allemagne	8.481700	48.516000	700		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D094	Nordschwarzwald	Allemagne	8.483300	48.514700	690		Steppe froide	Dambach, K.	Pangaea	Dambach, 2000
D096	Nordschwarzwald	Allemagne	8.483300	48.514700	690		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D097	Nordschwarzwald	Allemagne	8.483300	48.514700	690		Steppe froide	Dambach, K.	Pangaea	Dambach, 2000
D098	Nordschwarzwald	Allemagne	8.483300	48.514700	690		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D099	Nordschwarzwald	Allemagne	8.483300	48.514700	690		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D100	Nordschwarzwald	Allemagne	8.483300	48.514700	690		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D101	Nordschwarzwald	Allemagne	8.482900	48.513800	690		Steppe froide	Dambach, K.	Pangaea	Dambach, 2000
D103	Nordschwarzwald	Allemagne	8.482900	48.513800	690		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D104	Nordschwarzwald	Allemagne	8.482900	48.513800	690		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D105	Waldviertel	Autriche	15.033300	48.450000	970		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D106	Waldviertel	Autriche	15.033300	48.450000	970		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D107	Waldviertel	Autriche	15.033300	48.450000	970		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D108	Waldviertel	Autriche	15.033300	48.450000	970		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D109	Waldviertel	Autriche	15.033300	48.450000	940		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D110	Waldviertel	Autriche	15.033300	48.450000	940		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D113	Waldviertel	Autriche	15.033300	48.450000	940		Steppe froide	Dambach, K.	Pangaea	Dambach, 2000
D116	Waldviertel	Autriche	15.033300	48.450000	950		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000

Nom	Site	Pays	Longitude	Latitude	Altitude	Nature du prélèvement	Biome	Auteur	Source	Référence
D117	Waldviertel	Autriche	15.033300	48.450000	950		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D118	Waldviertel	Autriche	15.033300	48.450000	950		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D119	Waldviertel	Autriche	15.033300	48.450000	950		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D120	Waldviertel	Autriche	15.033300	48.450000	1000		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D121	Waldviertel	Autriche	15.033300	48.450000	1000		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D122	Waldviertel	Autriche	15.033300	48.450000	1000		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D123	Waldviertel	Autriche	15.033300	48.450000	1000		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D124	Waldviertel	Autriche	15.033300	48.450000	1000		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D125	Waldviertel	Autriche	14.783300	48.450000	840		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D126	Waldviertel	Autriche	14.783300	48.450000	840		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D129	Waldviertel	Autriche	14.783300	48.450000	850		Forêt de conifères	Dambach, K.	Pangaea	Dambach, 2000
D130	Waldviertel	Autriche	14.783300	48.450000	850		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D131	Waldviertel	Autriche	14.783300	48.450000	850		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D132	Waldviertel	Autriche	14.783300	48.450000	850		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D133	Waldviertel	Autriche	14.783300	48.450000	860		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D134	Waldviertel	Autriche	14.783300	48.450000	860		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D135	Waldviertel	Autriche	14.783300	48.450000	860		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D136	Waldviertel	Autriche	14.783300	48.450000	860		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D137	Waldviertel	Autriche	14.783300	48.450000	860		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D138	Waldviertel	Autriche	14.783300	48.450000	850		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D139	Waldviertel	Autriche	14.783300	48.450000	850		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D140	Waldviertel	Autriche	14.783300	48.450000	850		Steppe froide	Dambach, K.	Pangaea	Dambach, 2000
D141	Waldviertel	Autriche	14.783300	48.450000	850		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D142	Waldviertel	Autriche	14.816700	48.450000	900		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D143	Waldviertel	Autriche	14.816700	48.450000	900		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D144	Waldviertel	Autriche	14.816700	48.450000	900		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D145	Waldviertel	Autriche	14.816700	48.450000	900		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D146	Waldviertel	Autriche	14.816700	48.450000	890		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D147	Waldviertel	Autriche	14.816700	48.450000	890		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D150	Waldviertel	Autriche	15.166700	48.450000	816		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D151	Waldviertel	Autriche	15.166700	48.450000	816		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D152	Waldviertel	Autriche	15.166700	48.450000	816		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D153	Waldviertel	Autriche	15.166700	48.450000	816		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D154	Waldviertel	Autriche	15.166700	48.533300	710		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D155	Waldviertel	Autriche	15.166700	48.533300	710		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D156	Waldviertel	Autriche	15.166700	48.533300	710		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D157	Waldviertel	Autriche	15.166700	48.533300	710		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D158	Waldviertel	Autriche	15.166700	48.533300	710		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D159	Waldviertel	Autriche	15.166700	48.566700	670		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D161	Waldviertel	Autriche	15.166700	48.566700	670		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D162	Waldviertel	Autriche	15.166700	48.566700	670		Steppe froide	Dambach, K.	Pangaea	Dambach, 2000
D163	Waldviertel	Autriche	15.150000	48.566700	700		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000

Nom	Site	Pays	Longitude	Latitude	Altitude	Nature du prélèvement	Biome	Auteur	Source	Référence
D164	Waldviertel	Autriche	15.150000	48.566700	700		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D165	Waldviertel	Autriche	15.150000	48.566700	700		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D166	Waldviertel	Autriche	15.150000	48.566700	700		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D167	Waldviertel	Autriche	15.200000	48.550000	650		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D168	Waldviertel	Autriche	15.200000	48.550000	650		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D169	Waldviertel	Autriche	15.200000	48.550000	650		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D170	Waldviertel	Autriche	15.200000	48.550000	650		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D171	Waldviertel	Autriche	15.200000	48.550000	650		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D172	Waldviertel	Autriche	15.200000	48.583300	650		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D173	Waldviertel	Autriche	15.200000	48.583300	650		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D174	Waldviertel	Autriche	15.200000	48.583300	650		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D175	Waldviertel	Autriche	15.200000	48.583300	650		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D176	Waldviertel	Autriche	15.366700	48.566700	590		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D177	Waldviertel	Autriche	15.366700	48.566700	590		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D178	Waldviertel	Autriche	15.366700	48.566700	590		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D179	Waldviertel	Autriche	15.366700	48.566700	590		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D180	Waldviertel	Autriche	15.366700	48.566700	590		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D181	Waldviertel	Autriche	15.383300	48.566700	540		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D182	Waldviertel	Autriche	15.383300	48.566700	540		Steppe froide	Dambach, K.	Pangaea	Dambach, 2000
D185	Waldviertel	Autriche	15.416700	48.566700	610		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D186	Waldviertel	Autriche	15.416700	48.566700	610		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D187	Waldviertel	Autriche	15.416700	48.566700	610		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D188	Waldviertel	Autriche	15.416700	48.566700	610		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D189	Waldviertel	Autriche	15.516700	48.566700	620		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D190	Waldviertel	Autriche	15.516700	48.566700	620		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D191	Waldviertel	Autriche	15.516700	48.566700	620		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D192	Waldviertel	Autriche	15.516700	48.566700	620		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D193	Waldviertel	Autriche	15.516700	48.566700	620		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D194	Waldviertel	Autriche	15.516700	48.550000	580		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D195	Waldviertel	Autriche	15.516700	48.550000	580		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D197	Waldviertel	Autriche	15.516700	48.550000	580		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D198	Waldviertel	Autriche	15.516700	48.550000	600		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D199	Waldviertel	Autriche	15.516700	48.550000	600		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D200	Waldviertel	Autriche	15.516700	48.550000	600		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D201	Waldviertel	Autriche	15.516700	48.550000	600		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D202	Waldviertel	Autriche	15.650000	48.383300	190		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D203	Waldviertel	Autriche	15.650000	48.383300	190		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D204	Waldviertel	Autriche	15.650000	48.383300	190		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D205	Waldviertel	Autriche	15.650000	48.383300	190		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D206	Waldviertel	Autriche	15.650000	48.383300	190		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D207	Waldviertel	Autriche	15.650000	48.383300	190		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D208	Waldviertel	Autriche	15.650000	48.383300	190		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000

Nom	Site	Pays	Longitude	Latitude	Altitude	Nature du prélèvement	Biome	Auteur	Source	Référence
D209	Waldviertel	Autriche	15.650000	48.383300	190		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D210	Waldviertel	Autriche	15.650000	48.383300	190		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D211	Waldviertel	Autriche	15.450000	48.316700	500		Ecosystèmes anthropisés	Dambach, K.	Pangaea	Dambach, 2000
D212	Waldviertel	Autriche	15.450000	48.316700	500		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D213	Waldviertel	Autriche	15.450000	48.316700	500		Ecosystèmes anthropisés	Dambach, K.	Pangaea	Dambach, 2000
D214	Waldviertel	Autriche	15.450000	48.316700	520		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D215	Waldviertel	Autriche	15.450000	48.316700	520		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D216	Waldviertel	Autriche	15.450000	48.316700	520		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D217	Waldviertel	Autriche	15.450000	48.316700	520		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D218	Waldviertel	Autriche	15.450000	48.316700	511		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D219	Waldviertel	Autriche	15.450000	48.316700	511		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D220	Waldviertel	Autriche	15.450000	48.316700	511		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D221	Waldviertel	Autriche	15.450000	48.316700	511		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D222	Waldviertel	Autriche	15.450000	48.316700	511		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D223	Waldviertel	Autriche	15.450000	48.316700	790		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D224	Waldviertel	Autriche	15.450000	48.316700	790		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D225	Waldviertel	Autriche	15.450000	48.316700	790		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D226	Waldviertel	Autriche	15.450000	48.316700	790		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D227	Waldviertel	Autriche	15.383300	48.383300	790		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D228	Waldviertel	Autriche	15.383300	48.383300	790		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D229	Waldviertel	Autriche	15.383300	48.383300	790		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D232	Waldviertel	Autriche	15.383300	48.383300	790		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D233	Waldviertel	Autriche	15.383300	48.383300	790		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D234	Waldviertel	Autriche	15.383300	48.383300	790		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D235	Waldviertel	Autriche	15.383300	48.383300	790		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D236	Waldviertel	Autriche	15.383300	48.383300	790		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D237	Waldviertel	Autriche	15.383300	48.383300	790		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D238	Waldviertel	Autriche	15.383300	48.383300	790		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D239	Waldviertel	Autriche	15.383300	48.383300	790		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D240	Waldviertel	Autriche	15.383300	48.383300	790		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D241	Waldviertel	Autriche	15.166700	48.450000	770		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D242	Waldviertel	Autriche	15.166700	48.450000	770		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D243	Waldviertel	Autriche	15.166700	48.450000	770		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D244	Waldviertel	Autriche	15.166700	48.450000	770		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D245	Waldviertel	Autriche	15.166700	48.450000	770		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D246	Waldviertel	Autriche	15.166700	48.450000	770		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D247	Waldviertel	Autriche	15.166700	48.450000	770		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D249	Waldviertel	Autriche	15.166700	48.450000	770		Forêt de conifères	Dambach, K.	Pangaea	Dambach, 2000
D251	Donnersberg	Allemagne	7.954000	49.659000	440		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D252	Donnersberg	Allemagne	7.954000	49.659000	440		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D253	Donnersberg	Allemagne	7.954000	49.659000	440		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D254	Donnersberg	Allemagne	7.954000	49.659000	440		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000

Nom	Site	Pays	Longitude	Latitude	Altitude	Nature du prélèvement	Biome	Auteur	Source	Référence
D255	Donnersberg	Allemagne	7.954700	49.659600	435		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D256	Donnersberg	Allemagne	7.954700	49.659600	435		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D257	Donnersberg	Allemagne	7.954700	49.659600	435		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D258	Donnersberg	Allemagne	7.954700	49.659600	435		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D259	Donnersberg	Allemagne	7.954700	49.659600	435		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D260	Donnersberg	Allemagne	7.954700	49.659600	435		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D261	Donnersberg	Allemagne	7.935200	49.661300	415		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D265	Donnersberg	Allemagne	7.930800	49.664600	430		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D266	Donnersberg	Allemagne	7.930800	49.664600	430		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D267	Donnersberg	Allemagne	7.930800	49.664600	430		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D268	Donnersberg	Allemagne	7.930800	49.664600	430		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D269	Donnersberg	Allemagne	7.882200	49.653100	420		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D270	Donnersberg	Allemagne	7.882200	49.653100	420		Forêt tempérée décidue	Dambach, K.	Pangaea	Dambach, 2000
D271	Donnersberg	Allemagne	7.882200	49.653100	420		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D272	Donnersberg	Allemagne	7.882200	49.653100	420		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D277	Donnersberg	Allemagne	7.879900	49.648100	440		Steppe froide	Dambach, K.	Pangaea	Dambach, 2000
D278	Donnersberg	Allemagne	7.879900	49.648100	440		Steppe froide	Dambach, K.	Pangaea	Dambach, 2000
D279	Donnersberg	Allemagne	7.873100	49.650000	370		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D280	Donnersberg	Allemagne	7.873100	49.650000	370		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D281	Donnersberg	Allemagne	7.873100	49.650000	370		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D282	Donnersberg	Allemagne	7.873100	49.650000	370		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D283	Donnersberg	Allemagne	7.881000	49.646900	370		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D284	Donnersberg	Allemagne	7.906700	49.606400	460		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D285	Donnersberg	Allemagne	7.906700	49.606400	460		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D286	Donnersberg	Allemagne	7.906700	49.606400	460		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D287	Donnersberg	Allemagne	7.906700	49.606400	460		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D288	Donnersberg	Allemagne	7.901800	49.606300	520		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D289	Donnersberg	Allemagne	7.901800	49.606300	520		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D290	Donnersberg	Allemagne	7.901800	49.606300	520		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D291	Donnersberg	Allemagne	7.901800	49.606300	520		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D292	Donnersberg	Allemagne	7.925900	49.614400	486		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D293	Donnersberg	Allemagne	7.925900	49.614400	486		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D294	Donnersberg	Allemagne	7.925900	49.614400	486		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D295	Donnersberg	Allemagne	7.925900	49.614400	486		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D296	Donnersberg	Allemagne	7.925400	49.613600	460		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D297	Donnersberg	Allemagne	7.925400	49.613600	460		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D298	Donnersberg	Allemagne	7.925400	49.613600	460		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D299	Donnersberg	Allemagne	7.925400	49.613600	460		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D300	Donnersberg	Allemagne	7.923300	49.615100	450		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D301	Donnersberg	Allemagne	7.923300	49.615100	450		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D302	Donnersberg	Allemagne	7.923300	49.615100	450		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D303	Donnersberg	Allemagne	7.923300	49.615100	450		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000

Nom	Site	Pays	Longitude	Latitude	Altitude	Nature du prélèvement	Biome	Auteur	Source	Référence
D304	Donnersberg	Allemagne	7.926500	49.612000	420		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D305	Donnersberg	Allemagne	7.926500	49.612000	420		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D306	Donnersberg	Allemagne	7.926500	49.612000	420		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D307	Donnersberg	Allemagne	7.926500	49.612000	420		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D308	Donnersberg	Allemagne	7.932500	49.611600	370		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D309	Donnersberg	Allemagne	7.932500	49.611600	370		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D310	Donnersberg	Allemagne	7.932500	49.611600	370		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D311	Donnersberg	Allemagne	7.932500	49.611600	370		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D312	Donnersberg	Allemagne	7.911100	49.621200	620		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D313	Donnersberg	Allemagne	7.911100	49.621200	620		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D314	Donnersberg	Allemagne	7.911100	49.621200	620		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D315	Donnersberg	Allemagne	7.911100	49.621200	620		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D316	Donnersberg	Allemagne	7.911600	49.622300	605		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D317	Donnersberg	Allemagne	7.911600	49.622300	605		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D318	Donnersberg	Allemagne	7.911600	49.622300	605		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D319	Donnersberg	Allemagne	7.911600	49.622300	605		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D320	Donnersberg	Allemagne	7.911600	49.622300	605		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D321	Donnersberg	Allemagne	7.904400	49.607500	500		Ecosystèmes anthropisés	Dambach, K.	Pangaea	Dambach, 2000
D322	Donnersberg	Allemagne	7.904400	49.607500	500		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D323	Donnersberg	Allemagne	7.904400	49.607500	500		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D327	Donnersberg	Allemagne	8.206200	49.057700	120		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D331	Bienwald	Allemagne	8.198300	49.054700	121		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D332	Bienwald	Allemagne	8.198300	49.054700	121		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D333	Bienwald	Allemagne	8.198300	49.054700	121		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D334	Bienwald	Allemagne	8.198300	49.054700	121		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D335	Bienwald	Allemagne	8.173200	49.022100	130		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D337	Bienwald	Allemagne	8.176400	49.021100	130		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D339	Bienwald	Allemagne	8.171700	49.009000	124		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D340	Bienwald	Allemagne	8.171700	49.009000	124		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D341	Bienwald	Allemagne	8.171700	49.009000	124		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D342	Bienwald	Allemagne	8.171700	49.009000	124		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D343	Bienwald	Allemagne	8.160000	49.027400	132		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D344	Bienwald	Allemagne	8.160000	49.027400	132		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D345	Bienwald	Allemagne	8.160000	49.027400	132		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D346	Bienwald	Allemagne	8.160000	49.027400	132		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D350	Bienwald	Allemagne	8.162800	49.026500	140		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D351	Bienwald	Allemagne	8.147200	49.040300	128		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D352	Bienwald	Allemagne	8.147200	49.040300	128		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D353	Bienwald	Allemagne	8.147200	49.040300	128		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D354	Bienwald	Allemagne	8.142700	49.040000	139		Forêt tempérée décidue	Dambach, K.	Pangaea	Dambach, 2000
D355	Bienwald	Allemagne	8.142700	49.040000	139		Forêt tempérée décidue	Dambach, K.	Pangaea	Dambach, 2000
D356	Bienwald	Allemagne	8.142700	49.040000	139		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000

Nom	Site	Pays	Longitude	Latitude	Altitude	Nature du prélèvement	Biome	Auteur	Source	Référence
D357	Bienwald	Allemagne	8.142700	49.040000	139		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D358	Bienwald	Allemagne	8.059300	49.011100	135		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D359	Bienwald	Allemagne	8.059300	49.011100	135		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D360	Bienwald	Allemagne	8.059300	49.011100	135		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D361	Bienwald	Allemagne	8.059800	49.011500	135		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D362	Bienwald	Allemagne	8.059800	49.011500	135		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D363	Bienwald	Allemagne	8.059800	49.011500	135		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D364	Bienwald	Allemagne	8.059800	49.011500	135		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D368	Bienwald	Allemagne	8.040600	49.020700	139		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D369	Bienwald	Allemagne	8.040600	49.020700	139		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D370	Bienwald	Allemagne	8.040600	49.020700	139		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D371	Bienwald	Allemagne	8.041300	49.021700	144		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D372	Bienwald	Allemagne	8.041300	49.021700	144		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D373	Bienwald	Allemagne	8.041300	49.021700	144		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D374	Bienwald	Allemagne	8.041300	49.021700	144		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D375	Vilm	Allemagne	13.516700	54.333300	5		Forêt tempérée décidue	Dambach, K.	Pangaea	Dambach, 2000
D376	Bienwald	Allemagne	13.980200	52.757900	160		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D377	Eberswalder Urstromtal	Allemagne	13.980200	52.757900	160		Forêt tempérée décidue	Dambach, K.	Pangaea	Dambach, 2000
D378	Eberswalder Urstromtal	Allemagne	13.984100	52.753700	160		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D379	Eberswalder Urstromtal	Allemagne	14.011400	52.754800	150		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D380	Eberswalder Urstromtal	Allemagne	13.998100	52.727700	140		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D381	Eberswalder Urstromtal	Allemagne	14.055400	52.734400	120		Forêt tempérée décidue	Dambach, K.	Pangaea	Dambach, 2000
D382	Eberswalder Urstromtal	Allemagne	14.055400	52.734400	120		Forêt tempérée décidue	Dambach, K.	Pangaea	Dambach, 2000
D383	Eberswalder Urstromtal	Allemagne	14.012500	52.915600	90		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D384	Eberswalder Urstromtal	Allemagne	14.016400	52.912900	90		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D386	Eberswalder Urstromtal	Allemagne	14.026900	52.907800	95		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D387	Eberswalder Urstromtal	Allemagne	14.023700	52.899600	90		Forêt tempérée décidue	Dambach, K.	Pangaea	Dambach, 2000
D388	Eberswalder Urstromtal	Allemagne	14.023700	52.899600	90		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D390	Eberswalder Urstromtal	Allemagne	13.918200	52.891100	100		Forêt tempérée décidue	Dambach, K.	Pangaea	Dambach, 2000
D391	Eberswalder Urstromtal	Allemagne	13.925500	52.909000	100		Forêt tempérée décidue	Dambach, K.	Pangaea	Dambach, 2000
D392	Eberswalder Urstromtal	Allemagne	13.651500	52.923000	70		Forêt tempérée décidue	Dambach, K.	Pangaea	Dambach, 2000
D393	Eberswalder Urstromtal	Allemagne	13.651800	52.929500	70		Forêt tempérée décidue	Dambach, K.	Pangaea	Dambach, 2000
D394	Eberswalder Urstromtal	Allemagne	13.655800	52.939200	80		Forêt tempérée décidue	Dambach, K.	Pangaea	Dambach, 2000
D395	Eberswalder Urstromtal	Allemagne	13.653800	52.946100	80		Forêt tempérée décidue	Dambach, K.	Pangaea	Dambach, 2000
D396	Eberswalder Urstromtal	Allemagne	13.653900	52.951800	80		Forêt tempérée décidue	Dambach, K.	Pangaea	Dambach, 2000
D397	Eberswalder Urstromtal	Allemagne	13.644500	52.967500	75		Forêt tempérée décidue	Dambach, K.	Pangaea	Dambach, 2000
D399	Rheinsberg	Allemagne	12.891500	52.989400	50		Forêt tempérée décidue	Dambach, K.	Pangaea	Dambach, 2000
D400	Rheinsberg	Allemagne	12.854000	52.972200	50		Forêt tempérée décidue	Dambach, K.	Pangaea	Dambach, 2000
D403	Rheinsberg	Allemagne	12.843900	53.002500	65		Forêt tempérée décidue	Dambach, K.	Pangaea	Dambach, 2000
D404	Rheinsberg	Allemagne	13.100000	53.150000	90		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D405	Rheinsberg	Allemagne	13.100000	53.150000	90		Forêt tempérée décidue	Dambach, K.	Pangaea	Dambach, 2000
D406	Rheinsberg	Allemagne	13.100000	53.150000	90		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000

Nom	Site	Pays	Longitude	Latitude	Altitude	Nature du prélèvement	Biome	Auteur	Source	Référence
D407	Rheinsberg	Allemagne	13.100000	53.150000	90		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D408	Rheinsberg	Allemagne	13.083300	53.116700	80		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D409	Rheinsberg	Allemagne	13.000000	53.150000	65		Forêt tempérée décidue	Dambach, K.	Pangaea	Dambach, 2000
D410	Rheinsberg	Allemagne	13.016700	53.133300	65		Forêt mixte froide	Dambach, K.	Pangaea	Dambach, 2000
D411	Rheinsberg	Allemagne	13.016700	53.133300	66		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D412	Rheinsberg	Allemagne	13.083300	53.150000	70		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D413	Rheinsberg	Allemagne	13.083300	53.150000	70		Forêt tempérée décidue	Dambach, K.	Pangaea	Dambach, 2000
D414	Rheinsberg	Allemagne	13.083300	53.150000	70		Forêt tempérée décidue	Dambach, K.	Pangaea	Dambach, 2000
D415	Rheinsberg	Allemagne	13.083300	53.166700	50		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D416	Rheinsberg	Allemagne	13.083300	53.166700	50		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D417	Rheinsberg	Allemagne	13.083300	53.166700	50		Forêt tempérée décidue	Dambach, K.	Pangaea	Dambach, 2000
D418	Rheinsberg	Allemagne	13.083300	53.150000	70		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D419	Rheinsberg	Allemagne	13.083300	53.150000	70		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D420	Rheinsberg	Allemagne	13.100000	53.150000	90		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D421	Vilm	Allemagne	13.516700	54.333300	5		Forêt tempérée décidue	Dambach, K.	Pangaea	Dambach, 2000
D422	Vilm	Allemagne	13.516700	54.333300	5		Forêt tempérée décidue	Dambach, K.	Pangaea	Dambach, 2000
D423	Vilm	Allemagne	13.516700	54.333300	5		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D424	Vilm	Allemagne	13.516700	54.333300	5		Forêt tempérée décidue	Dambach, K.	Pangaea	Dambach, 2000
D425	Vilm	Allemagne	13.516700	54.316700	7		Forêt tempérée décidue	Dambach, K.	Pangaea	Dambach, 2000
D426	Vilm	Allemagne	13.516700	54.316700	7		Forêt tempérée décidue	Dambach, K.	Pangaea	Dambach, 2000
D427	Vilm	Allemagne	13.533300	54.333300	20		Forêt tempérée décidue	Dambach, K.	Pangaea	Dambach, 2000
D429	Vilm	Allemagne	13.533300	54.333300	10		Forêt tempérée décidue	Dambach, K.	Pangaea	Dambach, 2000
D430	Vilm	Allemagne	13.533300	54.333300	10		Forêt tempérée décidue	Dambach, K.	Pangaea	Dambach, 2000
D431	Vilm	Allemagne	13.533300	54.333300	30		Forêt tempérée décidue	Dambach, K.	Pangaea	Dambach, 2000
D432	Vilm	Allemagne	13.533300	54.333300	20		Forêt tempérée décidue	Dambach, K.	Pangaea	Dambach, 2000
D433	Rügen	Allemagne	13.434100	54.385100	50		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D434	Rügen	Allemagne	13.443800	54.380000	50		Forêt tempérée décidue	Dambach, K.	Pangaea	Dambach, 2000
D435	Rügen	Allemagne	13.445200	54.380700	50		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D436	Rügen	Allemagne	13.437400	54.374100	50		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D438	Rügen	Allemagne	13.560200	54.477100	5		Forêt tempérée décidue	Dambach, K.	Pangaea	Dambach, 2000
D440	Rügen	Allemagne	13.563600	54.477100	5		Forêt tempérée décidue	Dambach, K.	Pangaea	Dambach, 2000
D441	Rügen	Allemagne	13.632600	54.567900	150		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D442	Rügen	Allemagne	13.649600	54.568100	140		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D443	Rügen	Allemagne	13.658900	54.568100	100		Forêt tempérée décidue	Dambach, K.	Pangaea	Dambach, 2000
D444	Rügen	Allemagne	13.668300	54.569200	100		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D445	Eberswalder Urstromtal	Allemagne	13.967100	52.887000	10		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D446	Eberswalder Urstromtal	Allemagne	13.653900	52.951800	80		Forêt mixte fraîche	Dambach, K.	Pangaea	Dambach, 2000
D447	Rügen	Allemagne	13.668300	54.569200	100		Forêt tempérée décidue	Dambach, K.	Pangaea	Dambach, 2000
E017		Norvège	12.100000	62.330000	780	Sommet de carotte	Végétation pionnière	EPD	Peyron, O.	Peyron et al., 1998
E032		Irlande	-6.180000	54.560000	52	Sommet de carotte	Forêt tempérée décidue	EPD	Peyron, O.	Peyron et al., 1998
E042		France	6.110000	44.312000	975	Sommet de carotte	Steppe froide	EPD	Peyron, O.	Peyron et al., 1998
E060		Angleterre	-4.350000	56.051100	8	Sommet de carotte	Forêt tempérée décidue	EPD	Peyron, O.	Peyron et al., 1998

Nom	Site	Pays	Longitude	Latitude	Altitude	Nature du prélèvement	Biome	Auteur	Source	Référence
E063		France	6.201100	44.251200	1308	Sommet de carotte	Forêt tempérée décidue	EPD	Peyron, O.	Peyron et al., 1998
E066		Irlande	-5.540000	54.260000	25	Sommet de carotte	Forêt tempérée décidue	EPD	Peyron, O.	Peyron et al., 1998
E070		Finlande	29.000000	66.070000	288	Sommet de carotte	Forêt de conifères	EPD	Peyron, O.	Peyron et al., 1998
E106		Turquie	31.300000	37.323000	1120	Sommet de carotte	Ecosystèmes anthropisés	EPD	Peyron, O.	Peyron et al., 1998
E155		Suède	14.320000	57.380000	308	Sommet de carotte	Forêt mixte fraîche	EPD	Peyron, O.	Peyron et al., 1998
E169		Pologne	17.170500	54.422500	1	Sommet de carotte	Forêt tempérée décidue	EPD	Peyron, O.	Peyron et al., 1998
E194		Russie	121.370000	63.490000	120	Sommet de carotte	Forêt boréale	EPD	Peyron, O.	Peyron et al., 1998
E195		Russie	120.580000	64.500000	160	Sommet de carotte	Toundra	EPD	Peyron, O.	Peyron et al., 1998
E197		Russie	124.070000	57.020000	700	Sommet de carotte	Forêt boréale	EPD	Peyron, O.	Peyron et al., 1998
E202		Irlande	-10.183000	52.120000	84	Sommet de carotte	Forêt tempérée décidue	EPD	Peyron, O.	Peyron et al., 1998
E216		Norvège	8.420000	63.420000	45	Sommet de carotte	Forêt de conifères	EPD	Peyron, O.	Peyron et al., 1998
E281		Estonie	25.380000	58.160000	506	Sommet de carotte	Forêt mixte fraîche	EPD	Peyron, O.	Peyron et al., 1998
E296		Allemagne	8.455000	53.400000	2	Sommet de carotte	Forêt tempérée décidue	EPD	Peyron, O.	Peyron et al., 1998
E297		Allemagne	8.455000	53.400000	2	Sommet de carotte	Forêt tempérée décidue	EPD	Peyron, O.	Peyron et al., 1998
E298		Allemagne	8.440000	53.420000	2	Sommet de carotte	Forêt tempérée décidue	EPD	Peyron, O.	Peyron et al., 1998
E302		Estonie	22.120000	58.230000	32	Sommet de carotte	Forêt mixte fraîche	EPD	Peyron, O.	Peyron et al., 1998
E303		Estonie	25.000000	59.260000	32	Sommet de carotte	Forêt de conifères	EPD	Peyron, O.	Peyron et al., 1998
E307		Estonie	22.230000	58.280000	33	Sommet de carotte	Forêt mixte fraîche	EPD	Peyron, O.	Peyron et al., 1998
E335		Belgique	3.564100	51.010400	4	Sommet de carotte	Steppe froide	EPD	Peyron, O.	Peyron et al., 1998
E339	Saldropo	Espagne	-2.430000	43.030000	625	Sommet de carotte	Forêt tempérée décidue	EPD	Peyron, O.	Peyron et al., 1998
E348		France	6.201100	44.251200	1308	Sommet de carotte	Steppe chaude	EPD	Peyron, O.	Peyron et al., 1998
E401		Lettonie	24.400000	58.000000	55	Sommet de carotte	Forêt tempérée décidue	EPD	Peyron, O.	Peyron et al., 1998
E404		Pologne	17.213800	52.330000	109	Sommet de carotte	Forêt tempérée décidue	EPD	Peyron, O.	Peyron et al., 1998
E405		Finlande	28.500000	69.350000	104	Sommet de carotte	Forêt boréale	EPD	Peyron, O.	Peyron et al., 1998
E406		Norvège	28.250000	70.110000	119	Sommet de carotte	Forêt boréale	EPD	Peyron, O.	Peyron et al., 1998
E407		Norvège	31.020000	70.190000	120	Sommet de carotte	Forêt boréale	EPD	Peyron, O.	Peyron et al., 1998
E408		Suède	21.000000	68.550000	535	Sommet de carotte	Végétation pionnière	EPD	Peyron, O.	Peyron et al., 1998
E416		Finlande	26.140000	62.200000	118	Sommet de carotte	Forêt mixte fraîche	EPD	Peyron, O.	Peyron et al., 1998
E418		Finlande	20.900000	60.170000	12	Sommet de carotte	Forêt mixte fraîche	EPD	Peyron, O.	Peyron et al., 1998
E421		Finlande	27.410000	69.073000	170	Sommet de carotte	Forêt boréale	EPD	Peyron, O.	Peyron et al., 1998
E424		Finlande	25.520000	61.250000	104	Sommet de carotte	Forêt de conifères	EPD	Peyron, O.	Peyron et al., 1998
E434		Finlande	28.070000	61.130000	83	Sommet de carotte	Forêt de conifères	EPD	Peyron, O.	Peyron et al., 1998
E435		Finlande	19.590000	60.210000	14	Sommet de carotte	Forêt mixte fraîche	EPD	Peyron, O.	Peyron et al., 1998
E528		Slovaquie	19.490000	49.290000	656	Sommet de carotte	Forêt mixte fraîche	EPD	Peyron, O.	Peyron et al., 1998
E532		Slovaquie	21.060000	49.380000	465	Sommet de carotte	Forêt mixte fraîche	EPD	Peyron, O.	Peyron et al., 1998
E537		Pologne	20.470000	50.470000	248	Sommet de carotte	Forêt mixte fraîche	EPD	Peyron, O.	Peyron et al., 1998
ES02	Valle de Lago	Espagne	-6.130000	42.020000	1500	Mousses	Forêt tempérée décidue	Huntley, B.	EPD	Huntley, 1991
ES09	Moncalvo 1	Espagne	-6.780000	42.130000	1600	Mousses	Forêt tempérée décidue	Huntley, B.	EPD	Huntley, 1991
ES12	Lagoa de Pataias	Espagne	-9.000000	39.670000	100	Mousses	Steppe chaude	Huntley, B.	EPD	Huntley, 1991
ES20	Laguna de la Dehesillo	Espagne	-2.830000	39.420000	700	Mousses	Forêt mixte chaude	Huntley, B.	EPD	Huntley, 1991
ES24	Laguna Salada	Espagne	-4.810000	37.030000	460	Mousses	Végétation xérophytique	Huntley, B.	EPD	Huntley, 1991
ES25	Laguna Grande	Espagne	-4.300000	37.100000	800	Mousses	Végétation xérophytique	Huntley, B.	EPD	Huntley, 1991

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ES26	La Laguna (Setiles)	Espagne	-1.600000	40.720000	1400	Mousses	Forêt mixte chaude	Huntley, B.	EPD	Huntley, 1991
ES27	Balsa Salada	Espagne	-0.170000	41.030000	400	Mousses	Végétation xérophytique	Huntley, B.	EPD	Huntley, 1991
ES30	Laguna Negra de Urbion	Espagne	-2.870000	42.000000	1700	Mousses	Forêt tempérée décidue	Huntley, B.	EPD	Huntley, 1991
ES31	Laguna Negra de Urbion	Espagne	-2.870000	42.000000	1700	Mousses	Forêt tempérée décidue	Huntley, B.	EPD	Huntley, 1991
ES36	Laguna de Valdeazores	Espagne	-2.800000	37.950000	1250	Mousses	Végétation xérophytique	Huntley, B.	EPD	Huntley, 1991
ES37	Laguna Helada	Espagne	-2.850000	41.990000	2000	Mousses	Forêt tempérée décidue	Huntley, B.	EPD	Huntley, 1991
ES38	Sierra de Alcaraz (S)	Espagne	-2.520000	38.500000	1000	Mousses	Steppe chaude	Huntley, B.	EPD	Huntley, 1991
ES40	Laguna de la Roya	Espagne	-6.790000	42.130000	1643	Mousses	Forêt tempérée décidue	Huntley, B.	EPD	Huntley, 1991
ES41	Laguna Grande, Villafranca de los Caballeros	Espagne	-3.350000	39.450000	700	Mousses	Forêt mixte chaude	Huntley, B.	EPD	Huntley, 1991
ES43	Laguna Chica, Villafranca de los Caballeros	Espagne	-3.350000	39.450000	700	Mousses	Forêt mixte chaude	Huntley, B.	EPD	Huntley, 1991
ES44	Estanca Alcanoz	Espagne	-0.170000	41.050000	330	Mousses	Végétation xérophytique	Huntley, B.	EPD	Huntley, 1991
ES45	Laguna Salada, Caspe	Espagne	-0.150000	41.230000	150	Mousses	Forêt mixte chaude	Huntley, B.	EPD	Huntley, 1991
ES46	Estanca Chiprana	Espagne	-0.130000	41.270000	177	Mousses	Végétation xérophytique	Huntley, B.	EPD	Huntley, 1991
ES47	Puerto de Santa Inés	Espagne	-2.830000	42.000000	2050	Mousses	Forêt tempérée décidue	Sanchez-Goni, M.F.	Sanchez-Goni, M.F.	Sanchez-Goni et al., 1999
ES48	Puerto de Santa Inés	Espagne	-2.830000	42.010000	2000	Mousses	Forêt tempérée décidue	Sanchez-Goni, M.F.	Sanchez-Goni, M.F.	Sanchez-Goni et al., 1999
ES49	Puerto de Santa Inés	Espagne	-2.820000	42.010000	1950	Mousses	Forêt tempérée décidue	Sanchez-Goni, M.F.	Sanchez-Goni, M.F.	Sanchez-Goni et al., 1999
ES50	Puerto de Santa Inés	Espagne	-2.810000	42.020000	1900	Mousses	Forêt tempérée décidue	Sanchez-Goni, M.F.	Sanchez-Goni, M.F.	Sanchez-Goni et al., 1999
ES51	Puerto de Santa Inés	Espagne	-2.800000	42.020000	1850	Mousses	Forêt tempérée décidue	Sanchez-Goni, M.F.	Sanchez-Goni, M.F.	Sanchez-Goni et al., 1999
ES52	Puerto de Santa Inés	Espagne	-2.790000	42.030000	1800	Mousses	Forêt tempérée décidue	Sanchez-Goni, M.F.	Sanchez-Goni, M.F.	Sanchez-Goni et al., 1999
ES53	Puerto de Santa Inés	Espagne	-2.780000	42.030000	1750	Mousses	Forêt tempérée décidue	Sanchez-Goni, M.F.	Sanchez-Goni, M.F.	Sanchez-Goni et al., 1999
ES54	Puerto de Santa Inés	Espagne	-2.780000	42.040000	1700	Mousses	Forêt tempérée décidue	Sanchez-Goni, M.F.	Sanchez-Goni, M.F.	Sanchez-Goni et al., 1999
ES55	Puerto de Santa Inés	Espagne	-2.770000	42.040000	1650	Mousses	Forêt tempérée décidue	Sanchez-Goni, M.F.	Sanchez-Goni, M.F.	Sanchez-Goni et al., 1999
ES56	Puerto de Santa Inés	Espagne	-2.760000	42.050000	1600	Mousses	Forêt tempérée décidue	Sanchez-Goni, M.F.	Sanchez-Goni, M.F.	Sanchez-Goni et al., 1999
ES57	Puerto de Santa Inés	Espagne	-2.760000	42.060000	1400	Mousses	Forêt mixte chaude	Sanchez-Goni, M.F.	Sanchez-Goni, M.F.	Sanchez-Goni et al., 1999
ES58	Puerto de Santa Inés	Espagne	-2.750000	42.070000	1300	Mousses	Steppe chaude	Sanchez-Goni, M.F.	Sanchez-Goni, M.F.	Sanchez-Goni et al., 1999
ES59	Puerto de Santa Inés	Espagne	-2.750000	42.080000	1200	Mousses	Steppe chaude	Sanchez-Goni, M.F.	Sanchez-Goni, M.F.	Sanchez-Goni et al., 1999
ES60	Puerto de Santa Inés	Espagne	-2.720000	42.080000	1150	Mousses	Forêt tempérée décidue	Sanchez-Goni, M.F.	Sanchez-Goni, M.F.	Sanchez-Goni et al., 1999
ES61	Puerto de Santa Inés	Espagne	-2.700000	42.090000	1100	Mousses	Forêt mixte chaude	Sanchez-Goni, M.F.	Sanchez-Goni, M.F.	Sanchez-Goni et al., 1999
ES62	Puerto de Santa Inés	Espagne	-2.670000	42.100000	1000	Mousses	Forêt mixte chaude	Sanchez-Goni, M.F.	Sanchez-Goni, M.F.	Sanchez-Goni et al., 1999
ES63	Puerto de Santa Inés	Espagne	-2.650000	42.170000	900	Mousses	Forêt mixte chaude	Sanchez-Goni, M.F.	Sanchez-Goni, M.F.	Sanchez-Goni et al., 1999
ES64	Puerto de Santa Inés	Espagne	-2.620000	42.250000	800	Mousses	Forêt mixte chaude	Sanchez-Goni, M.F.	Sanchez-Goni, M.F.	Sanchez-Goni et al., 1999
EUR6	Europa	Espagne	-4.680000	43.170000	460	Mousses	Forêt mixte chaude	Belmonte, J.	J Guiot/Peyron, O	Peyron et al., 1998
EURB	Europa	Espagne	-4.700000	43.100000	1190	Mousses	Forêt tempérée décidue	Belmonte, J.	J Guiot/Peyron, O	Peyron et al., 1998
EURE	Europa	Espagne	-4.580000	43.230000	130	Mousses	Forêt mixte chaude	Belmonte, J.	J Guiot/Peyron, O	Peyron et al., 1998
EXT1	Extrema	Espagne	-5.850000	39.180000	410	Mousses	Steppe chaude	Belmonte, J.	J Guiot/Peyron, O	Peyron et al., 1998
EXT2	Extrema	Espagne	-5.380000	39.370000	570	Mousses	Végétation xérophytique	Belmonte, J.	J Guiot/Peyron, O	Peyron et al., 1998
EXT3	Extrema	Espagne	-5.330000	39.380000	830	Mousses	Végétation xérophytique	Belmonte, J.	J Guiot/Peyron, O	Peyron et al., 1998
EXT8	Extrema	Espagne	-5.420000	39.600000	850	Mousses	Végétation xérophytique	Belmonte, J.	J Guiot/Peyron, O	Peyron et al., 1998

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F27	Ars	France	2.017000	45.598000	811	Mousses	Forêt mixte fraîche	Miras, Y.	Miras, Y.	Miras et al., 2004
F28	Puy du Bois	France	2.031000	45.643000	814	Mousses	Forêt mixte fraîche	Miras, Y.	Miras, Y.	Miras et al., 2004
F29	Lissac	France	2.056000	45.681000	900	Mousses	Forêt mixte fraîche	Miras, Y.	Miras, Y.	Miras et al., 2004
F30	Marcy n°4	France	2.030000	45.650000	812	Mousses	Forêt mixte fraîche	Miras, Y.	Miras, Y.	Miras et al., 2004
F31	Marcy n°12	France	2.037000	45.734000	814	Mousses	Forêt mixte fraîche	Miras, Y.	Miras, Y.	Miras et al., 2004
F32	Faux la Montagne	France	1.923000	45.753000	700	Mousses	Forêt mixte fraîche	Miras, Y.	Miras, Y.	Miras et al., 2004
FR01	Cabane Artxilondo	France	1.133333	43.033333	500	Mousses	Forêt tempérée décidue	Suc, J-P.	Suc, J-P.	données non publiées
FR02	Cerin	France	5.533333	45.766667	787	Mousses	Forêt tempérée décidue	Suc, J-P.	Suc, J-P.	données non publiées
FR03	Chamonix-col des Montets	France	6.916667	45.966667	1461	Mousses	Forêt mixte fraîche	Suc, J-P.	Suc, J-P.	données non publiées
FR04	Clairvaux les lacs	France	5.750000	46.566667	606	Mousses	Forêt mixte fraîche	Suc, J-P.	Suc, J-P.	données non publiées
FR05	Col de Jau	France	2.250000	42.683333	1506	Mousses	Forêt tempérée décidue	Suc, J-P.	Suc, J-P.	données non publiées
FR06	Florentia	France	5.400000	46.366667	352	Mousses	Forêt mixte fraîche	Suc, J-P.	Suc, J-P.	données non publiées
FR07	Lac de Séguret	France	6.733333	44.416667	1030	Mousses	Forêt tempérée décidue	Suc, J-P.	Suc, J-P.	données non publiées
FR08	Le Monestier	France	3.633333	45.533333	1090	Mousses	Forêt mixte fraîche	Suc, J-P.	Suc, J-P.	données non publiées
FR09	Montpellier	France	3.900000	43.600000	18	Mousses	Forêt mixte chaude	Suc, J-P.	Suc, J-P.	données non publiées
FR10	Mosset	France	2.316667	42.683333	900	Mousses	Forêt tempérée décidue	Suc, J-P.	Suc, J-P.	données non publiées
FR12	Nyons	France	5.083333	44.366667	300	Mousses	Forêt mixte chaude	Suc, J-P.	Suc, J-P.	données non publiées
FR13	Oraate	France	1.116667	43.050000	420	Mousses	Steppe chaude	Suc, J-P.	Suc, J-P.	données non publiées
FR14	Pardon	France	3.016667	45.766667	825	Mousses	Forêt mixte fraîche	Suc, J-P.	Suc, J-P.	données non publiées
FR15	Porquerolles	France	6.216667	43.000000	0	Mousses	Forêt mixte chaude	Suc, J-P.	Suc, J-P.	données non publiées
FR17	Saint Léger	France	6.400000	44.400000	2000	Mousses	Forêt mixte fraîche	Suc, J-P.	Suc, J-P.	données non publiées
FR18	Saint Nazaire	France	3.000000	42.666667	0	Mousses	Steppe chaude	Suc, J-P.	Suc, J-P.	données non publiées
FR19	Saint Restitut	France	4.750000	44.333333	310	Mousses	Forêt mixte chaude	Suc, J-P.	Suc, J-P.	données non publiées
FR20	Silvacane	France	5.283333	43.716667	190	Mousses	Forêt mixte chaude	Suc, J-P.	Suc, J-P.	données non publiées
FR21	Sisteron	France	5.950000	44.183333	540	Mousses	Forêt mixte fraîche	Suc, J-P.	Suc, J-P.	données non publiées
FR24	Vallon en Sully	France	2.550000	46.500000	177	Mousses	Forêt tempérée décidue	Suc, J-P.	Suc, J-P.	données non publiées
FR26	Villette d'Anthon	France	5.100000	45.800000	214	Mousses	Forêt mixte fraîche	Suc, J-P.	Suc, J-P.	données non publiées
FR27	Le Clos et de la Fauvie	France	2.017000	45.598000	811	Mousses	Forêt tempérée décidue	Court-Picon, M.	Court-Picon, M.	Court-Picon et al., 2005
FR28	Les Richards	France	6.100200	44.684700	1305	Mousses	Forêt mixte fraîche	Court-Picon, M.	Court-Picon, M.	Court-Picon et al., 2005
FR29	Sagnes de Canne	France	6.100200	44.617900	1270	Mousses	Forêt mixte fraîche	Court-Picon, M.	Court-Picon, M.	Court-Picon et al., 2005
FR30	Coste Longue	France	6.200400	44.634600	1392	Mousses	Forêt mixte fraîche	Court-Picon, M.	Court-Picon, M.	Court-Picon et al., 2005
FR31	Les Champs	France	6.116900	44.684700	1432	Mousses	Forêt mixte fraîche	Court-Picon, M.	Court-Picon, M.	Court-Picon et al., 2005
FR32	Le Belvédère des trois croix	France	6.835000	44.701400	1271	Mousses	Forêt tempérée décidue	Court-Picon, M.	Court-Picon, M.	Court-Picon et al., 2005
FR33	Lac de Barbeyroux	France	6.116900	44.684700	1500	Mousses	Steppe froide	Court-Picon, M.	Court-Picon, M.	Court-Picon et al., 2005
FR34	Lac de Faudon	France	6.200400	44.601200	1577	Mousses	Forêt tempérée décidue	Court-Picon, M.	Court-Picon, M.	Court-Picon et al., 2005
FR35	Libouse	France	6.217100	44.634600	1455	Mousses	Steppe froide	Court-Picon, M.	Court-Picon, M.	Court-Picon et al., 2005
FR36	Libouse	France	6.217100	44.634600	1455	Mousses	Forêt mixte fraîche	Court-Picon, M.	Court-Picon, M.	Court-Picon et al., 2005
FR37	Libouse	France	6.217100	44.634600	1455	Mousses	Steppe froide	Court-Picon, M.	Court-Picon, M.	Court-Picon et al., 2005
FRA1	Francia	Espagne	-6.480000	40.570000	700	Mousses	Forêt mixte chaude	Belmonte, J.	J Guiot/Peyron, O	Peyron et al., 1998

Nom	Site	Pays	Longitude	Latitude	Altitude	Nature du prélèvement	Biome	Auteur	Source	Référence
FRA4	Francia	Espagne	-6.200000	40.520000	1400	Mousses	Forêt tempérée décidue	Belmonte, J.	J Guiot/Peyron, O	Peyron et al., 1998
FRA5	Francia	Espagne	-6.170000	40.520000	1400	Mousses	Forêt tempérée décidue	Belmonte, J.	J Guiot/Peyron, O	Peyron et al., 1998
FRA6	Francia	Espagne	-6.130000	40.520000	1100	Mousses	Forêt tempérée décidue	Belmonte, J.	J Guiot/Peyron, O	Peyron et al., 1998
FRA7	Francia	Espagne	-6.120000	40.470000	1230	Mousses	Forêt tempérée décidue	Belmonte, J.	J Guiot/Peyron, O	Peyron et al., 1998
FX01	Filabrx	Espagne	-2.220000	37.210000	1050	Mousses	Végétation xérophytique	Belmonte, J.	J Guiot/Peyron, O	Peyron et al., 1998
FX03	Filabrx	Espagne	-2.200000	37.190000	885	Mousses	Steppe chaude	Belmonte, J.	J Guiot/Peyron, O	Peyron et al., 1998
G001		Grèce	22.7200	40.4600	0	Mousses	Steppe chaude	Bottema, S.	J Guiot/Peyron, O	Bottema, 1974
G002		Grèce	22.7000	40.4600	0	Mousses	Steppe chaude	Bottema, S.	J Guiot/Peyron, O	Bottema, 1974
G005		Grèce	22.7300	40.4900	0	Mousses	Steppe chaude	Bottema, S.	J Guiot/Peyron, O	Bottema, 1974
G006		Grèce	22.7200	40.5100	0	Mousses	Steppe chaude	Bottema, S.	J Guiot/Peyron, O	Bottema, 1974
G008		Grèce	22.6500	40.6800	0	Mousses	Steppe chaude	Bottema, S.	J Guiot/Peyron, O	Bottema, 1974
G009		Grèce	22.5400	40.7000	-100	Mousses	Steppe chaude	Bottema, S.	J Guiot/Peyron, O	Bottema, 1974
G010		Grèce	22.4700	40.7200	-100	Mousses	Steppe chaude	Bottema, S.	J Guiot/Peyron, O	Bottema, 1974
G011		Grèce	22.4000	40.7200	-100	Mousses	Steppe chaude	Bottema, S.	J Guiot/Peyron, O	Bottema, 1974
G012		Grèce	22.3100	40.6500	-100	Mousses	Steppe chaude	Bottema, S.	J Guiot/Peyron, O	Bottema, 1974
G013		Grèce	22.6100	40.8800	100	Mousses	Steppe chaude	Bottema, S.	J Guiot/Peyron, O	Bottema, 1974
G014		Grèce	22.6200	40.8700	100	Mousses	Steppe chaude	Bottema, S.	J Guiot/Peyron, O	Bottema, 1974
G015		Grèce	22.6300	40.8600	100	Mousses	Steppe chaude	Bottema, S.	J Guiot/Peyron, O	Bottema, 1974
G016		Grèce	22.6300	40.8600	100	Mousses	Steppe chaude	Bottema, S.	J Guiot/Peyron, O	Bottema, 1974
G017		Grèce	22.1000	40.6000	200	Mousses	Steppe chaude	Bottema, S.	J Guiot/Peyron, O	Bottema, 1974
G018		Grèce	22.0700	40.6000	400	Mousses	Forêt mixte chaude	Bottema, S.	J Guiot/Peyron, O	Bottema, 1974
G019		Grèce	22.0600	40.5900	500	Mousses	Forêt mixte chaude	Bottema, S.	J Guiot/Peyron, O	Bottema, 1974
G020		Grèce	22.0500	40.5700	650	Mousses	Forêt tempérée décidue	Bottema, S.	J Guiot/Peyron, O	Bottema, 1974
G021		Grèce	22.0400	40.5600	1000	Mousses	Forêt mixte chaude	Bottema, S.	J Guiot/Peyron, O	Bottema, 1974
G022		Grèce	22.0400	40.5500	1200	Mousses	Forêt mixte chaude	Bottema, S.	J Guiot/Peyron, O	Bottema, 1974
G023		Grèce	22.0500	40.5400	1400	Mousses	Forêt mixte chaude	Bottema, S.	J Guiot/Peyron, O	Bottema, 1974
G024		Grèce	22.0500	40.5300	1500	Mousses	Forêt mixte chaude	Bottema, S.	J Guiot/Peyron, O	Bottema, 1974
G025		Grèce	22.0100	40.5100	1600	Mousses	Forêt mixte chaude	Bottema, S.	J Guiot/Peyron, O	Bottema, 1974
G026		Grèce	22.1500	40.5200	400	Mousses	Forêt mixte chaude	Bottema, S.	J Guiot/Peyron, O	Bottema, 1974
G027		Grèce	22.1300	40.5200	600	Mousses	Forêt mixte chaude	Bottema, S.	J Guiot/Peyron, O	Bottema, 1974
G028		Grèce	22.1700	40.5200	300	Mousses	Forêt mixte chaude	Bottema, S.	J Guiot/Peyron, O	Bottema, 1974
G029		Grèce	22.2000	40.5000	250	Mousses	Steppe chaude	Bottema, S.	J Guiot/Peyron, O	Bottema, 1974
G030		Grèce	22.2900	40.3900	1000	Mousses	Steppe chaude	Bottema, S.	J Guiot/Peyron, O	Bottema, 1974
G031		Grèce	22.2700	40.4000	1000	Mousses	Forêt mixte chaude	Bottema, S.	J Guiot/Peyron, O	Bottema, 1974
G032		Grèce	22.2500	40.4000	800	Mousses	Forêt mixte chaude	Bottema, S.	J Guiot/Peyron, O	Bottema, 1974
G033		Grèce	22.2400	40.4100	650	Mousses	Forêt mixte chaude	Bottema, S.	J Guiot/Peyron, O	Bottema, 1974
G034		Grèce	22.2700	40.4200	400	Mousses	Forêt mixte chaude	Bottema, S.	J Guiot/Peyron, O	Bottema, 1974
G035		Grèce	21.7300	40.7700	900	Mousses	Steppe chaude	Bottema, S.	J Guiot/Peyron, O	Bottema, 1974
G036		Grèce	21.7800	40.7900	650	Mousses	Steppe chaude	Bottema, S.	J Guiot/Peyron, O	Bottema, 1974
G037		Grèce	21.9000	40.7300	500	Mousses	Steppe chaude	Bottema, S.	J Guiot/Peyron, O	Bottema, 1974
G038		Grèce	21.9200	40.7500	500	Mousses	Steppe chaude	Bottema, S.	J Guiot/Peyron, O	Bottema, 1974

Nom	Site	Pays	Longitude	Latitude	Altitude	Nature du prélèvement	Biome	Auteur	Source	Référence
G039		Grèce	21.9700	40.7700	400	Mousses	Forêt mixte chaude	Bottema, S.	J Guiot/Peyron, O	Bottema, 1974
G040		Grèce	22.1500	40.5800	-200	Mousses	Steppe chaude	Bottema, S.	J Guiot/Peyron, O	Bottema, 1974
G041		Grèce	22.2000	40.5900	-200	Mousses	Steppe chaude	Bottema, S.	J Guiot/Peyron, O	Bottema, 1974
G042		Grèce	22.2500	40.6200	-100	Mousses	Steppe chaude	Bottema, S.	J Guiot/Peyron, O	Bottema, 1974
G043		Grèce	22.1700	40.4500	450	Mousses	Steppe chaude	Bottema, S.	J Guiot/Peyron, O	Bottema, 1974
G044		Grèce	22.1500	40.4100	600	Mousses	Forêt mixte chaude	Bottema, S.	J Guiot/Peyron, O	Bottema, 1974
G045		Grèce	22.1200	40.3800	900	Mousses	Forêt mixte chaude	Bottema, S.	J Guiot/Peyron, O	Bottema, 1974
G046		Grèce	22.0700	40.3700	1200	Mousses	Forêt mixte chaude	Bottema, S.	J Guiot/Peyron, O	Bottema, 1974
G047		Grèce	22.0500	40.3300	1000	Mousses	Forêt mixte chaude	Bottema, S.	J Guiot/Peyron, O	Bottema, 1974
G048		Grèce	22.1000	40.3100	1100	Mousses	Steppe chaude	Bottema, S.	J Guiot/Peyron, O	Bottema, 1974
G049		Grèce	21.9600	40.3400	700	Mousses	Steppe chaude	Bottema, S.	J Guiot/Peyron, O	Bottema, 1974
G050		Grèce	21.8600	40.3400	700	Mousses	Steppe chaude	Bottema, S.	J Guiot/Peyron, O	Bottema, 1974
G052		Grèce	21.5700	40.2100	700	Mousses	Steppe chaude	Bottema, S.	J Guiot/Peyron, O	Bottema, 1974
G053		Grèce	21.4800	40.2700	600	Mousses	Steppe chaude	Bottema, S.	J Guiot/Peyron, O	Bottema, 1974
G054		Grèce	21.4100	40.3400	700	Mousses	Steppe chaude	Bottema, S.	J Guiot/Peyron, O	Bottema, 1974
G056		Grèce	21.5500	40.6500	800	Mousses	Steppe chaude	Bottema, S.	J Guiot/Peyron, O	Bottema, 1974
G057		Grèce	21.5000	40.5800	800	Mousses	Steppe chaude	Bottema, S.	J Guiot/Peyron, O	Bottema, 1974
G058		Grèce	21.5000	40.5400	1050	Mousses	Steppe chaude	Bottema, S.	J Guiot/Peyron, O	Bottema, 1974
G059		Grèce	21.4700	40.5300	1100	Mousses	Steppe chaude	Bottema, S.	J Guiot/Peyron, O	Bottema, 1974
G060		Grèce	21.4100	40.5300	700	Mousses	Steppe chaude	Bottema, S.	J Guiot/Peyron, O	Bottema, 1974
G061		Grèce	21.3700	40.4800	700	Mousses	Steppe chaude	Bottema, S.	J Guiot/Peyron, O	Bottema, 1974
G062		Grèce	21.3500	40.4600	700	Mousses	Steppe chaude	Bottema, S.	J Guiot/Peyron, O	Bottema, 1974
G063		Grèce	21.3200	40.4900	700	Mousses	Steppe chaude	Bottema, S.	J Guiot/Peyron, O	Bottema, 1974
G064		Grèce	21.2700	40.7600	1500	Mousses	Steppe chaude	Bottema, S.	J Guiot/Peyron, O	Bottema, 1974
G065		Grèce	21.2600	40.7700	1400	Mousses	Forêt mixte chaude	Bottema, S.	J Guiot/Peyron, O	Bottema, 1974
G066		Grèce	21.2200	40.8000	1350	Mousses	Steppe chaude	Bottema, S.	J Guiot/Peyron, O	Bottema, 1974
G067		Grèce	21.2000	40.7600	1200	Mousses	Steppe chaude	Bottema, S.	J Guiot/Peyron, O	Bottema, 1974
G069		Grèce	21.1700	40.6900	1000	Mousses	Forêt mixte chaude	Bottema, S.	J Guiot/Peyron, O	Bottema, 1974
G071		Grèce	21.1700	40.6200	700	Mousses	Steppe chaude	Bottema, S.	J Guiot/Peyron, O	Bottema, 1974
G072		Grèce	21.1900	40.5600	700	Mousses	Steppe chaude	Bottema, S.	J Guiot/Peyron, O	Bottema, 1974
G073		Grèce	21.4300	40.2200	650	Mousses	Steppe chaude	Bottema, S.	J Guiot/Peyron, O	Bottema, 1974
G074		Grèce	21.4600	40.1000	600	Mousses	Steppe chaude	Bottema, S.	J Guiot/Peyron, O	Bottema, 1974
G075		Grèce	21.4800	39.9600	700	Mousses	Steppe chaude	Bottema, S.	J Guiot/Peyron, O	Bottema, 1974
G076		Grèce	21.5000	39.9200	700	Mousses	Forêt mixte chaude	Bottema, S.	J Guiot/Peyron, O	Bottema, 1974
G077		Grèce	21.5300	39.8900	700	Mousses	Forêt tempérée décidue	Bottema, S.	J Guiot/Peyron, O	Bottema, 1974
G078		Grèce	21.5600	39.8400	600	Mousses	Forêt mixte chaude	Bottema, S.	J Guiot/Peyron, O	Bottema, 1974
G079		Grèce	21.2100	39.7100	1350	Mousses	Forêt tempérée décidue	Bottema, S.	J Guiot/Peyron, O	Bottema, 1974
G080		Grèce	21.2200	39.6700	1550	Mousses	Forêt mixte chaude	Bottema, S.	J Guiot/Peyron, O	Bottema, 1974
G081		Grèce	21.2000	39.7000	1450	Mousses	Forêt mixte chaude	Bottema, S.	J Guiot/Peyron, O	Bottema, 1974
G082		Grèce	21.1800	39.7000	1300	Mousses	Forêt mixte chaude	Bottema, S.	J Guiot/Peyron, O	Bottema, 1974
G083		Grèce	21.1700	39.7100	1200	Mousses	Forêt mixte chaude	Bottema, S.	J Guiot/Peyron, O	Bottema, 1974
G084		Grèce	21.0200	39.7000	800	Mousses	Forêt mixte chaude	Bottema, S.	J Guiot/Peyron, O	Bottema, 1974

Nom	Site	Pays	Longitude	Latitude	Altitude	Nature du prélèvement	Biome	Auteur	Source	Référence
G085		Grèce	21.1200	39.7200	900	Mousses	Forêt mixte chaude	Bottema, S.	J Guiot/Peyron, O	Bottema, 1974
G086		Grèce	21.1500	39.7300	1300	Mousses	Forêt mixte chaude	Bottema, S.	J Guiot/Peyron, O	Bottema, 1974
G087		Grèce	21.1600	39.7600	1400	Mousses	Forêt mixte chaude	Bottema, S.	J Guiot/Peyron, O	Bottema, 1974
G088		Grèce	21.2100	39.7500	1650	Mousses	Forêt mixte chaude	Bottema, S.	J Guiot/Peyron, O	Bottema, 1974
G089		Grèce	21.2800	39.7600	1200	Mousses	Forêt mixte chaude	Bottema, S.	J Guiot/Peyron, O	Bottema, 1974
G090		Grèce	21.3200	39.7500	800	Mousses	Forêt mixte chaude	Bottema, S.	J Guiot/Peyron, O	Bottema, 1974
G091		Grèce	21.4300	39.7400	1100	Mousses	Steppe chaude	Bottema, S.	J Guiot/Peyron, O	Bottema, 1974
G092		Grèce	21.4600	39.7300	1000	Mousses	Forêt tempérée décidue	Bottema, S.	J Guiot/Peyron, O	Bottema, 1974
G093		Grèce	21.5500	39.7000	300	Mousses	Forêt tempérée décidue	Bottema, S.	J Guiot/Peyron, O	Bottema, 1974
G094		Grèce	20.8400	39.4800	600	Mousses	Forêt mixte chaude	Bottema, S.	J Guiot/Peyron, O	Bottema, 1974
G095		Grèce	20.8600	39.4500	500	Mousses	Forêt mixte chaude	Bottema, S.	J Guiot/Peyron, O	Bottema, 1974
G096		Grèce	20.7800	39.6700	600	Mousses	Steppe chaude	Bottema, S.	J Guiot/Peyron, O	Bottema, 1974
G097		Grèce	20.6500	39.6800	600	Mousses	Forêt mixte chaude	Bottema, S.	J Guiot/Peyron, O	Bottema, 1974
G098		Grèce	20.5900	39.6900	250	Mousses	Steppe chaude	Bottema, S.	J Guiot/Peyron, O	Bottema, 1974
G099		Grèce	20.5700	39.6400	250	Mousses	Forêt mixte chaude	Bottema, S.	J Guiot/Peyron, O	Bottema, 1974
G100		Grèce	20.5200	39.6000	300	Mousses	Steppe chaude	Bottema, S.	J Guiot/Peyron, O	Bottema, 1974
G101		Grèce	20.5200	39.5900	600	Mousses	Steppe chaude	Bottema, S.	J Guiot/Peyron, O	Bottema, 1974
G102		Grèce	20.5000	39.5600	700	Mousses	Steppe chaude	Bottema, S.	J Guiot/Peyron, O	Bottema, 1974
G103		Grèce	20.4500	39.5400	300	Mousses	Steppe chaude	Bottema, S.	J Guiot/Peyron, O	Bottema, 1974
G104		Grèce	20.3200	39.5200	300	Mousses	Steppe chaude	Bottema, S.	J Guiot/Peyron, O	Bottema, 1974
G105		Grèce	20.4000	39.5000	300	Mousses	Steppe chaude	Bottema, S.	J Guiot/Peyron, O	Bottema, 1974
G106		Grèce	20.4500	39.5200	300	Mousses	Steppe chaude	Bottema, S.	J Guiot/Peyron, O	Bottema, 1974
G107		Grèce	20.9900	39.6800	700	Mousses	Forêt mixte chaude	Bottema, S.	J Guiot/Peyron, O	Bottema, 1974
G108		Grèce	20.9600	39.6600	600	Mousses	Forêt mixte chaude	Bottema, S.	J Guiot/Peyron, O	Bottema, 1974
G109		Grèce	20.9500	39.6400	900	Mousses	Forêt mixte chaude	Bottema, S.	J Guiot/Peyron, O	Bottema, 1974
G110		Grèce	20.7800	39.7000	500	Mousses	Steppe chaude	Bottema, S.	J Guiot/Peyron, O	Bottema, 1974
GAT1	Gata	Espagne	-6.370000	40.100000	600	Mousses	Végétation xérophytique	Belmonte, J.	J Guiot/Peyron, O	Peyron et al., 1998
GAT3	Gata	Espagne	-6.500000	40.130000	510	Mousses	Végétation xérophytique	Belmonte, J.	J Guiot/Peyron, O	Peyron et al., 1998
GAT4	Gata	Espagne	-6.500000	40.280000	580	Mousses	Forêt mixte chaude	Belmonte, J.	J Guiot/Peyron, O	Peyron et al., 1998
GAT6	Gata	Espagne	-6.450000	40.350000	1100	Mousses	Forêt mixte chaude	Belmonte, J.	J Guiot/Peyron, O	Peyron et al., 1998
GAT7	Gata	Espagne	-6.470000	40.370000	1100	Mousses	Forêt tempérée décidue	Belmonte, J.	J Guiot/Peyron, O	Peyron et al., 1998
GAT9	Gata	Espagne	-6.480000	40.470000	800	Mousses	Végétation xérophytique	Belmonte, J.	J Guiot/Peyron, O	Peyron et al., 1998
HA05	Harpea	France	-1.170000	43.030000	880	Mousses	Forêt mixte chaude	Galop, D.	Peyron, O.	données non publiées
HA08	Harpea	France	-1.170000	43.020000	867	Mousses	Forêt tempérée décidue	Galop, D.	Peyron, O.	données non publiées
HA12	Harpea	France	-1.170000	43.020000	861	Mousses	Forêt tempérée décidue	Galop, D.	Peyron, O.	données non publiées
HARM	Harpea	France	-1.170000	43.030000	876	Mousses	Steppe chaude	Galop, D.	Peyron, O.	données non publiées
HJB10		Norvège	30.755600	69.599200	261	Mousses	Végétation pionnière	Birks HJB, Seppä H	Birks, H.J.B.	Seppa and Birks 2001
HJB100		Norvège	29.180000	69.170200	120	Mousses	Forêt de conifères	Birks HJB, Seppä H	Birks, H.J.B.	Seppa and Birks 2001
HJB101		Norvège	29.165500	69.303200	148	Mousses	Végétation pionnière	Birks HJB, Seppä H	Birks, H.J.B.	Seppa and Birks 2001
HJB102		Norvège	27.250800	69.507500	88	Mousses	Végétation pionnière	Birks HJB, Seppä H	Birks, H.J.B.	Seppa and Birks 2001
HJB103		Norvège	29.951300	69.559100	85	Mousses	Végétation pionnière	Birks HJB, Seppä H	Birks, H.J.B.	Seppa and Birks 2001

Nom	Site	Pays	Longitude	Latitude	Altitude	Nature du prélèvement	Biome	Auteur	Source	Référence
HJB104		Norvège	29.441300	69.634200	90	Mousses	Végétation pionnière	Birks HJB, Seppä H	Birks, H.J.B.	Seppa and Birks 2001
HJB105		Norvège	4.997200	60.382400	48	Mousses	Forêt mixte froide	Birks HJB, Seppä H	Birks, H.J.B.	Seppa and Birks 2001
HJB107		Norvège	5.366200	60.199800	51	Mousses	Forêt tempérée décidue	Birks HJB, Seppä H	Birks, H.J.B.	Seppa and Birks 2001
HJB108		Norvège	6.526600	58.412600	424	Mousses	Forêt mixte fraîche	Birks HJB, Seppä H	Birks, H.J.B.	Seppa and Birks 2001
HJB109		Norvège	6.669600	58.399200	296	Mousses	Forêt tempérée décidue	Birks HJB, Seppä H	Birks, H.J.B.	Seppa and Birks 2001
HJB11		Norvège	19.279100	69.772800	69	Mousses	Végétation pionnière	Birks HJB, Seppä H	Birks, H.J.B.	Seppa and Birks 2001
HJB112		Norvège	8.019000	58.301600	172	Mousses	Forêt mixte fraîche	Birks HJB, Seppä H	Birks, H.J.B.	Seppa and Birks 2001
HJB113		Norvège	8.581300	58.790600	218	Mousses	Forêt mixte fraîche	Birks HJB, Seppä H	Birks, H.J.B.	Seppa and Birks 2001
HJB115		Norvège	10.708500	60.691200	429	Mousses	Forêt mixte fraîche	Birks HJB, Seppä H	Birks, H.J.B.	Seppa and Birks 2001
HJB116		Norvège	5.883900	61.414300	356	Mousses	Forêt mixte froide	Birks HJB, Seppä H	Birks, H.J.B.	Seppa and Birks 2001
HJB117		Norvège	5.493700	61.349000	302	Mousses	Forêt tempérée décidue	Birks HJB, Seppä H	Birks, H.J.B.	Seppa and Birks 2001
HJB118		Norvège	5.359500	61.199900	212	Mousses	Forêt tempérée décidue	Birks HJB, Seppä H	Birks, H.J.B.	Seppa and Birks 2001
HJB119		Norvège	5.572100	60.837000	302	Mousses	Forêt tempérée décidue	Birks HJB, Seppä H	Birks, H.J.B.	Seppa and Birks 2001
HJB12		Norvège	21.064900	69.815300	210	Mousses	Forêt de conifères	Birks HJB, Seppä H	Birks, H.J.B.	Seppa and Birks 2001
HJB120		Norvège	5.573200	60.722900	222	Mousses	Forêt tempérée décidue	Birks HJB, Seppä H	Birks, H.J.B.	Seppa and Birks 2001
HJB121		Norvège	6.127900	60.797100	480	Mousses	Forêt de conifères	Birks HJB, Seppä H	Birks, H.J.B.	Seppa and Birks 2001
HJB122		Norvège	6.210400	60.610100	609	Mousses	Végétation pionnière	Birks HJB, Seppä H	Birks, H.J.B.	Seppa and Birks 2001
HJB123		Norvège	6.075100	60.530000	590	Mousses	Forêt mixte froide	Birks HJB, Seppä H	Birks, H.J.B.	Seppa and Birks 2001
HJB124		Norvège	6.062800	60.343700	356	Mousses	Forêt mixte fraîche	Birks HJB, Seppä H	Birks, H.J.B.	Seppa and Birks 2001
HJB126		Norvège	5.564500	61.249300	170	Mousses	Forêt tempérée décidue	Birks HJB, Seppä H	Birks, H.J.B.	Seppa and Birks 2001
HJB127		Norvège	7.878200	58.437000	250	Mousses	Forêt mixte fraîche	Birks HJB, Seppä H	Birks, H.J.B.	Seppa and Birks 2001
HJB128		Norvège	7.975600	58.383900	255	Mousses	Forêt mixte fraîche	Birks HJB, Seppä H	Birks, H.J.B.	Seppa and Birks 2001
HJB129		Norvège	8.024400	58.599900	480	Mousses	Forêt mixte fraîche	Birks HJB, Seppä H	Birks, H.J.B.	Seppa and Birks 2001
HJB13		Norvège	22.332900	69.949300	88	Mousses	Végétation pionnière	Birks HJB, Seppä H	Birks, H.J.B.	Seppa and Birks 2001
HJB130		Norvège	7.734000	58.541600	191	Mousses	Forêt mixte fraîche	Birks HJB, Seppä H	Birks, H.J.B.	Seppa and Birks 2001
HJB131		Norvège	7.749300	58.303800	290	Mousses	Forêt mixte fraîche	Birks HJB, Seppä H	Birks, H.J.B.	Seppa and Birks 2001
HJB132		Norvège	7.936000	59.074300	635	Mousses	Forêt de conifères	Birks HJB, Seppä H	Birks, H.J.B.	Seppa and Birks 2001
HJB133		Norvège	8.748100	58.934700	173	Mousses	Forêt mixte fraîche	Birks HJB, Seppä H	Birks, H.J.B.	Seppa and Birks 2001
HJB134		Norvège	8.587300	59.015100	265	Mousses	Forêt mixte fraîche	Birks HJB, Seppä H	Birks, H.J.B.	Seppa and Birks 2001
HJB135		Norvège	8.827500	59.028200	361	Mousses	Forêt mixte fraîche	Birks HJB, Seppä H	Birks, H.J.B.	Seppa and Birks 2001
HJB136		Norvège	8.804000	59.182700	135	Mousses	Forêt mixte fraîche	Birks HJB, Seppä H	Birks, H.J.B.	Seppa and Birks 2001
HJB137		Norvège	9.663900	59.578000	322	Mousses	Forêt mixte fraîche	Birks HJB, Seppä H	Birks, H.J.B.	Seppa and Birks 2001
HJB138		Norvège	10.011700	59.724900	285	Mousses	Forêt mixte fraîche	Birks HJB, Seppä H	Birks, H.J.B.	Seppa and Birks 2001
HJB139		Norvège	9.717100	59.666700	212	Mousses	Végétation pionnière	Birks HJB, Seppä H	Birks, H.J.B.	Seppa and Birks 2001
HJB14		Norvège	25.058600	69.886300	209	Mousses	Végétation pionnière	Birks HJB, Seppä H	Birks, H.J.B.	Seppa and Birks 2001
HJB140		Norvège	10.186100	59.626400	143	Mousses	Forêt mixte fraîche	Birks HJB, Seppä H	Birks, H.J.B.	Seppa and Birks 2001
HJB141		Norvège	9.155100	60.579000	513	Mousses	Végétation pionnière	Birks HJB, Seppä H	Birks, H.J.B.	Seppa and Birks 2001
HJB142		Norvège	9.622300	60.679100	640	Mousses	Végétation pionnière	Birks HJB, Seppä H	Birks, H.J.B.	Seppa and Birks 2001
HJB144		Norvège	9.913500	60.358700	480	Mousses	Végétation pionnière	Birks HJB, Seppä H	Birks, H.J.B.	Seppa and Birks 2001
HJB145		Norvège	10.143000	59.975300	632	Mousses	Forêt mixte fraîche	Birks HJB, Seppä H	Birks, H.J.B.	Seppa and Birks 2001
HJB146		Norvège	10.623400	60.273800	485	Mousses	Forêt mixte fraîche	Birks HJB, Seppä H	Birks, H.J.B.	Seppa and Birks 2001
HJB147		Norvège	8.711400	59.785000	630	Mousses	Forêt de conifères	Birks HJB, Seppä H	Birks, H.J.B.	Seppa and Birks 2001

Nom	Site	Pays	Longitude	Latitude	Altitude	Nature du prélèvement	Biome	Auteur	Source	Référence
HJB148		Norvège	8.589800	59.823300	830	Mousses	Végétation pionnière	Birks HJB, Seppä H	Birks, H.J.B.	Seppa and Birks 2001
HJB149		Norvège	9.913500	60.358700	730	Mousses	Forêt mixte fraîche	Birks HJB, Seppä H	Birks, H.J.B.	Seppa and Birks 2001
HJB15		Norvège	25.881600	69.603700	328	Mousses	Végétation pionnière	Birks HJB, Seppä H	Birks, H.J.B.	Seppa and Birks 2001
HJB150		Norvège	9.160100	59.744000	329	Mousses	Forêt mixte fraîche	Birks HJB, Seppä H	Birks, H.J.B.	Seppa and Birks 2001
HJB151		Norvège	9.197900	60.414600	402	Mousses	Forêt mixte fraîche	Birks HJB, Seppä H	Birks, H.J.B.	Seppa and Birks 2001
HJB152		Norvège	8.711400	59.785000	693	Mousses	Végétation pionnière	Birks HJB, Seppä H	Birks, H.J.B.	Seppa and Birks 2001
HJB155		Norvège	6.712700	58.447500	423	Mousses	Forêt mixte fraîche	Birks HJB, Seppä H	Birks, H.J.B.	Seppa and Birks 2001
HJB156		Norvège	6.487100	58.438800	407	Mousses	Forêt tempérée décidue	Birks HJB, Seppä H	Birks, H.J.B.	Seppa and Birks 2001
HJB157		Norvège	6.767700	58.417100	156	Mousses	Forêt mixte fraîche	Birks HJB, Seppä H	Birks, H.J.B.	Seppa and Birks 2001
HJB158		Norvège	6.813300	58.400800	208	Mousses	Forêt tempérée décidue	Birks HJB, Seppä H	Birks, H.J.B.	Seppa and Birks 2001
HJB159		Norvège	8.533200	58.899100	167	Mousses	Forêt mixte fraîche	Birks HJB, Seppä H	Birks, H.J.B.	Seppa and Birks 2001
HJB160		Norvège	7.835100	58.340500	295	Mousses	Forêt mixte fraîche	Birks HJB, Seppä H	Birks, H.J.B.	Seppa and Birks 2001
HJB161		Norvège	6.798700	58.468800	485	Mousses	Forêt tempérée décidue	Birks HJB, Seppä H	Birks, H.J.B.	Seppa and Birks 2001
HJB162		Norvège	10.518600	60.313600	391	Mousses	Végétation pionnière	Birks HJB, Seppä H	Birks, H.J.B.	Seppa and Birks 2001
HJB163		Norvège	5.564500	61.249300	221	Mousses	Forêt tempérée décidue	Birks HJB, Seppä H	Birks, H.J.B.	Seppa and Birks 2001
HJB165		Norvège	20.933333	68.850000	487	Mousses	Végétation pionnière	Birks HJB, Seppä H	Birks, H.J.B.	Seppa and Birks 2001
HJB166		Norvège	21.083333	68.466667	554	Mousses	Végétation pionnière	Birks HJB, Seppä H	Birks, H.J.B.	Seppa and Birks 2001
HJB167		Norvège	21.033333	68.366667	523	Mousses	Végétation pionnière	Birks HJB, Seppä H	Birks, H.J.B.	Seppa and Birks 2001
HJB168		Norvège	21.250000	68.350000	483	Mousses	Végétation pionnière	Birks HJB, Seppä H	Birks, H.J.B.	Seppa and Birks 2001
HJB169		Norvège	22.016667	68.266667	354	Mousses	Végétation pionnière	Birks HJB, Seppä H	Birks, H.J.B.	Seppa and Birks 2001
HJB17		Norvège	18.205700	69.457500	111	Mousses	Végétation pionnière	Birks HJB, Seppä H	Birks, H.J.B.	Seppa and Birks 2001
HJB170		Norvège	21.800000	68.183333	386	Mousses	Végétation pionnière	Birks HJB, Seppä H	Birks, H.J.B.	Seppa and Birks 2001
HJB171		Norvège	19.716667	68.233333	363	Mousses	Végétation pionnière	Birks HJB, Seppä H	Birks, H.J.B.	Seppa and Birks 2001
HJB172		Norvège	19.416667	68.266667	407	Mousses	Végétation pionnière	Birks HJB, Seppä H	Birks, H.J.B.	Seppa and Birks 2001
HJB173		Norvège	19.166667	68.333333	375	Mousses	Végétation pionnière	Birks HJB, Seppä H	Birks, H.J.B.	Seppa and Birks 2001
HJB174		Norvège	19.133333	68.350000	348	Mousses	Végétation pionnière	Birks HJB, Seppä H	Birks, H.J.B.	Seppa and Birks 2001
HJB175		Norvège	22.700000	67.750000	288	Mousses	Végétation pionnière	Birks HJB, Seppä H	Birks, H.J.B.	Seppa and Birks 2001
HJB176		Norvège	22.650000	67.483333	223	Mousses	Végétation pionnière	Birks HJB, Seppä H	Birks, H.J.B.	Seppa and Birks 2001
HJB177		Norvège	22.550000	67.416667	208	Mousses	Végétation pionnière	Birks HJB, Seppä H	Birks, H.J.B.	Seppa and Birks 2001
HJB178		Norvège	22.516667	67.383333	213	Mousses	Végétation pionnière	Birks HJB, Seppä H	Birks, H.J.B.	Seppa and Birks 2001
HJB179		Norvège	21.700000	67.433333	354	Mousses	Végétation pionnière	Birks HJB, Seppä H	Birks, H.J.B.	Seppa and Birks 2001
HJB18		Norvège	19.188000	69.292000	346	Mousses	Végétation pionnière	Birks HJB, Seppä H	Birks, H.J.B.	Seppa and Birks 2001
HJB180		Norvège	22.200000	67.716667	318	Mousses	Végétation pionnière	Birks HJB, Seppä H	Birks, H.J.B.	Seppa and Birks 2001
HJB181		Norvège	22.433333	67.716667	316	Mousses	Végétation pionnière	Birks HJB, Seppä H	Birks, H.J.B.	Seppa and Birks 2001
HJB182		Norvège	22.616667	67.616667	278	Mousses	Végétation pionnière	Birks HJB, Seppä H	Birks, H.J.B.	Seppa and Birks 2001
HJB183		Norvège	22.633333	67.550000	262	Mousses	Végétation pionnière	Birks HJB, Seppä H	Birks, H.J.B.	Seppa and Birks 2001
HJB184		Norvège	22.033333	67.366667	295	Mousses	Végétation pionnière	Birks HJB, Seppä H	Birks, H.J.B.	Seppa and Birks 2001
HJB185		Norvège	19.716667	68.233333	363	Mousses	Végétation pionnière	Birks HJB, Seppä H	Birks, H.J.B.	Seppa and Birks 2001
HJB186		Norvège	19.700000	68.233333	357	Mousses	Végétation pionnière	Birks HJB, Seppä H	Birks, H.J.B.	Seppa and Birks 2001
HJB187		Norvège	19.383333	68.266667	407	Mousses	Végétation pionnière	Birks HJB, Seppä H	Birks, H.J.B.	Seppa and Birks 2001
HJB188		Norvège	19.150000	68.333333	390	Mousses	Végétation pionnière	Birks HJB, Seppä H	Birks, H.J.B.	Seppa and Birks 2001
HJB189		Norvège	20.633333	67.750000	439	Mousses	Végétation pionnière	Birks HJB, Seppä H	Birks, H.J.B.	Seppa and Birks 2001

Nom	Site	Pays	Longitude	Latitude	Altitude	Nature du prélèvement	Biome	Auteur	Source	Référence
HJB19		Norvège	21.503600	69.480100	70	Mousses	Végétation pionnière	Birks HJB, Seppä H	Birks, H.J.B.	Seppa and Birks 2001
HJB190		Norvège	20.766667	67.750000	360	Mousses	Forêt boréale	Birks HJB, Seppä H	Birks, H.J.B.	Seppa and Birks 2001
HJB2		Norvège	27.064600	70.553200	174	Mousses	Végétation pionnière	Birks HJB, Seppä H	Birks, H.J.B.	Seppa and Birks 2001
HJB20		Norvège	22.610900	69.212300	446	Mousses	Végétation pionnière	Birks HJB, Seppä H	Birks, H.J.B.	Seppa and Birks 2001
HJB21		Norvège	23.746300	69.202500	349	Mousses	Végétation pionnière	Birks HJB, Seppä H	Birks, H.J.B.	Seppa and Birks 2001
HJB22		Norvège	25.549800	69.150100	280	Mousses	Végétation pionnière	Birks HJB, Seppä H	Birks, H.J.B.	Seppa and Birks 2001
HJB23		Norvège	16.130300	68.808100	261	Mousses	Végétation pionnière	Birks HJB, Seppä H	Birks, H.J.B.	Seppa and Birks 2001
HJB24		Norvège	17.949600	68.893900	255	Mousses	Végétation pionnière	Birks HJB, Seppä H	Birks, H.J.B.	Seppa and Birks 2001
HJB25		Norvège	19.453400	68.983300	162	Mousses	Végétation pionnière	Birks HJB, Seppä H	Birks, H.J.B.	Seppa and Birks 2001
HJB26		Norvège	22.968600	68.979000	358	Mousses	Végétation pionnière	Birks HJB, Seppä H	Birks, H.J.B.	Seppa and Birks 2001
HJB28		Norvège	15.933200	68.423600	292	Mousses	Végétation pionnière	Birks HJB, Seppä H	Birks, H.J.B.	Seppa and Birks 2001
HJB29		Norvège	17.778200	68.579900	290	Mousses	Végétation pionnière	Birks HJB, Seppä H	Birks, H.J.B.	Seppa and Birks 2001
HJB31		Norvège	14.628200	67.316300	70	Mousses	Végétation pionnière	Birks HJB, Seppä H	Birks, H.J.B.	Seppa and Birks 2001
HJB32		Norvège	15.723700	67.427200	253	Mousses	Végétation pionnière	Birks HJB, Seppä H	Birks, H.J.B.	Seppa and Birks 2001
HJB34		Norvège	15.673600	66.809300	349	Mousses	Végétation pionnière	Birks HJB, Seppä H	Birks, H.J.B.	Seppa and Birks 2001
HJB35		Norvège	13.475800	66.176200	308	Mousses	Végétation pionnière	Birks HJB, Seppä H	Birks, H.J.B.	Seppa and Birks 2001
HJB36		Norvège	14.498900	66.159600	529	Mousses	Végétation pionnière	Birks HJB, Seppä H	Birks, H.J.B.	Seppa and Birks 2001
HJB37		Norvège	13.355100	65.537800	290	Mousses	Végétation pionnière	Birks HJB, Seppä H	Birks, H.J.B.	Seppa and Birks 2001
HJB38		Norvège	14.503700	65.802500	533	Mousses	Végétation pionnière	Birks HJB, Seppä H	Birks, H.J.B.	Seppa and Birks 2001
HJB39		Norvège	11.566500	64.935200	74	Mousses	Forêt mixte fraîche	Birks HJB, Seppä H	Birks, H.J.B.	Seppa and Birks 2001
HJB4		Norvège	30.070100	70.560200	102	Mousses	Végétation pionnière	Birks HJB, Seppä H	Birks, H.J.B.	Seppa and Birks 2001
HJB40		Norvège	13.083900	64.866000	421	Mousses	Végétation pionnière	Birks HJB, Seppä H	Birks, H.J.B.	Seppa and Birks 2001
HJB41		Norvège	13.651200	64.917100	605	Mousses	Végétation pionnière	Birks HJB, Seppä H	Birks, H.J.B.	Seppa and Birks 2001
HJB42		Norvège	11.547100	64.439900	160	Mousses	Forêt de conifères	Birks HJB, Seppä H	Birks, H.J.B.	Seppa and Birks 2001
HJB43		Norvège	12.749400	64.473500	333	Mousses	Forêt de conifères	Birks HJB, Seppä H	Birks, H.J.B.	Seppa and Birks 2001
HJB44		Norvège	13.944500	64.500400	390	Mousses	Végétation pionnière	Birks HJB, Seppä H	Birks, H.J.B.	Seppa and Birks 2001
HJB45		Norvège	10.393600	63.943800	188	Mousses	Végétation pionnière	Birks HJB, Seppä H	Birks, H.J.B.	Seppa and Birks 2001
HJB46		Norvège	11.632200	62.935200	153	Mousses	Végétation pionnière	Birks HJB, Seppä H	Birks, H.J.B.	Seppa and Birks 2001
HJB47		Norvège	12.738100	64.182400	540	Mousses	Végétation pionnière	Birks HJB, Seppä H	Birks, H.J.B.	Seppa and Birks 2001
HJB48		Norvège	8.806300	63.327500	226	Mousses	Forêt de conifères	Birks HJB, Seppä H	Birks, H.J.B.	Seppa and Birks 2001
HJB49		Norvège	10.608200	63.341900	217	Mousses	Forêt mixte froide	Birks HJB, Seppä H	Birks, H.J.B.	Seppa and Birks 2001
HJB5		Norvège	23.606900	70.395500	110	Mousses	Végétation pionnière	Birks HJB, Seppä H	Birks, H.J.B.	Seppa and Birks 2001
HJB50		Norvège	11.630200	63.439000	190	Mousses	Forêt de conifères	Birks HJB, Seppä H	Birks, H.J.B.	Seppa and Birks 2001
HJB52		Norvège	7.539600	62.712500	185	Mousses	Forêt mixte froide	Birks HJB, Seppä H	Birks, H.J.B.	Seppa and Birks 2001
HJB53		Norvège	9.516600	62.738000	650	Mousses	Végétation pionnière	Birks HJB, Seppä H	Birks, H.J.B.	Seppa and Birks 2001
HJB54		Norvège	10.507800	62.835900	609	Mousses	Végétation pionnière	Birks HJB, Seppä H	Birks, H.J.B.	Seppa and Birks 2001
HJB55		Norvège	11.847900	62.883400	790	Mousses	Forêt de conifères	Birks HJB, Seppä H	Birks, H.J.B.	Seppa and Birks 2001
HJB56		Norvège	5.614300	62.134700	357	Mousses	Forêt mixte froide	Birks HJB, Seppä H	Birks, H.J.B.	Seppa and Birks 2001
HJB57		Norvège	6.491800	61.243600	423	Mousses	Végétation pionnière	Birks HJB, Seppä H	Birks, H.J.B.	Seppa and Birks 2001
HJB58		Norvège	8.162200	62.267000	625	Mousses	Végétation pionnière	Birks HJB, Seppä H	Birks, H.J.B.	Seppa and Birks 2001
HJB59		Norvège	9.076700	62.148300	1047	Mousses	Forêt de conifères	Birks HJB, Seppä H	Birks, H.J.B.	Seppa and Birks 2001
HJB6		Norvège	25.091300	70.301100	60	Mousses	Végétation pionnière	Birks HJB, Seppä H	Birks, H.J.B.	Seppa and Birks 2001

Nom	Site	Pays	Longitude	Latitude	Altitude	Nature du prélèvement	Biome	Auteur	Source	Référence
HJB60		Norvège	10.521000	62.329400	861	Mousses	Végétation pionnière	Birks HJB, Seppä H	Birks, H.J.B.	Seppa and Birks 2001
HJB61		Norvège	11.492700	62.220200	800	Mousses	Forêt de conifères	Birks HJB, Seppä H	Birks, H.J.B.	Seppa and Birks 2001
HJB64		Norvège	8.015600	61.563100	1402	Mousses	Végétation pionnière	Birks HJB, Seppä H	Birks, H.J.B.	Seppa and Birks 2001
HJB65		Norvège	9.356300	61.607500	988	Mousses	Végétation pionnière	Birks HJB, Seppä H	Birks, H.J.B.	Seppa and Birks 2001
HJB67		Norvège	11.751400	61.679000	553	Mousses	Végétation pionnière	Birks HJB, Seppä H	Birks, H.J.B.	Seppa and Birks 2001
HJB68		Norvège	5.768100	61.010800	689	Mousses	Forêt mixte fraîche	Birks HJB, Seppä H	Birks, H.J.B.	Seppa and Birks 2001
HJB7		Norvège	26.688000	70.366500	150	Mousses	Végétation pionnière	Birks HJB, Seppä H	Birks, H.J.B.	Seppa and Birks 2001
HJB70		Norvège	8.078000	61.108300	1283	Mousses	Végétation pionnière	Birks HJB, Seppä H	Birks, H.J.B.	Seppa and Birks 2001
HJB71		Norvège	9.262600	61.009800	800	Mousses	Végétation pionnière	Birks HJB, Seppä H	Birks, H.J.B.	Seppa and Birks 2001
HJB72		Norvège	10.520700	61.094800	461	Mousses	Végétation pionnière	Birks HJB, Seppä H	Birks, H.J.B.	Seppa and Birks 2001
HJB73		Norvège	11.621400	61.080700	284	Mousses	Forêt mixte fraîche	Birks HJB, Seppä H	Birks, H.J.B.	Seppa and Birks 2001
HJB74		Norvège	12.628700	61.059200	331	Mousses	Végétation pionnière	Birks HJB, Seppä H	Birks, H.J.B.	Seppa and Birks 2001
HJB76		Norvège	6.892700	60.542700	508	Mousses	Forêt mixte froide	Birks HJB, Seppä H	Birks, H.J.B.	Seppa and Birks 2001
HJB77		Norvège	8.211800	60.500400	1048	Mousses	Végétation pionnière	Birks HJB, Seppä H	Birks, H.J.B.	Seppa and Birks 2001
HJB78		Norvège	9.252000	60.604000	861	Mousses	Forêt mixte fraîche	Birks HJB, Seppä H	Birks, H.J.B.	Seppa and Birks 2001
HJB79		Norvège	10.315900	60.494500	483	Mousses	Végétation pionnière	Birks HJB, Seppä H	Birks, H.J.B.	Seppa and Birks 2001
HJB8		Norvège	28.581600	70.092600	70	Mousses	Végétation pionnière	Birks HJB, Seppä H	Birks, H.J.B.	Seppa and Birks 2001
HJB80		Norvège	11.777900	60.516100	481	Mousses	Forêt de conifères	Birks HJB, Seppä H	Birks, H.J.B.	Seppa and Birks 2001
HJB81		Norvège	5.957900	59.833700	290	Mousses	Forêt tempérée décidue	Birks HJB, Seppä H	Birks, H.J.B.	Seppa and Birks 2001
HJB82		Norvège	6.992300	59.845500	1144	Mousses	Toundra	Birks HJB, Seppä H	Birks, H.J.B.	Seppa and Birks 2001
HJB83		Norvège	8.223400	59.784900	969	Mousses	Forêt de conifères	Birks HJB, Seppä H	Birks, H.J.B.	Seppa and Birks 2001
HJB84		Norvège	9.503600	59.869700	382	Mousses	Forêt mixte fraîche	Birks HJB, Seppä H	Birks, H.J.B.	Seppa and Birks 2001
HJB85		Norvège	10.569000	60.004100	330	Mousses	Forêt mixte fraîche	Birks HJB, Seppä H	Birks, H.J.B.	Seppa and Birks 2001
HJB86		Norvège	11.727200	59.954700	308	Mousses	Forêt de conifères	Birks HJB, Seppä H	Birks, H.J.B.	Seppa and Birks 2001
HJB87		Norvège	6.168800	59.346000	378	Mousses	Forêt tempérée décidue	Birks HJB, Seppä H	Birks, H.J.B.	Seppa and Birks 2001
HJB88		Norvège	7.304500	59.355000	633	Mousses	Forêt tempérée décidue	Birks HJB, Seppä H	Birks, H.J.B.	Seppa and Birks 2001
HJB89		Norvège	8.331200	59.379600	719	Mousses	Forêt mixte fraîche	Birks HJB, Seppä H	Birks, H.J.B.	Seppa and Birks 2001
HJB9		Norvège	29.555200	69.725000	126	Mousses	Végétation pionnière	Birks HJB, Seppä H	Birks, H.J.B.	Seppa and Birks 2001
HJB90		Norvège	9.479800	59.330100	276	Mousses	Forêt mixte fraîche	Birks HJB, Seppä H	Birks, H.J.B.	Seppa and Birks 2001
HJB91		Norvège	10.984500	59.365300	136	Mousses	Forêt mixte fraîche	Birks HJB, Seppä H	Birks, H.J.B.	Seppa and Birks 2001
HJB92		Norvège	11.705900	59.296600	130	Mousses	Forêt mixte fraîche	Birks HJB, Seppä H	Birks, H.J.B.	Seppa and Birks 2001
HJB93		Norvège	6.167600	58.703500	210	Mousses	Forêt tempérée décidue	Birks HJB, Seppä H	Birks, H.J.B.	Seppa and Birks 2001
HJB94		Norvège	7.388800	58.762300	610	Mousses	Forêt mixte fraîche	Birks HJB, Seppä H	Birks, H.J.B.	Seppa and Birks 2001
HJB95		Norvège	8.449000	58.846700	564	Mousses	Forêt mixte fraîche	Birks HJB, Seppä H	Birks, H.J.B.	Seppa and Birks 2001
HJB96		Norvège	9.413300	58.922600	50	Mousses	Forêt mixte fraîche	Birks HJB, Seppä H	Birks, H.J.B.	Seppa and Birks 2001
HJB98		Norvège	8.474200	58.207300	50	Mousses	Forêt mixte fraîche	Birks HJB, Seppä H	Birks, H.J.B.	Seppa and Birks 2001
HJB99		Norvège	29.019200	69.067200	96	Mousses	Végétation pionnière	Birks HJB, Seppä H	Birks, H.J.B.	Seppa and Birks 2001
IR26		Iran	46.330000	35.530000	1450	Mousses	Steppe chaude	Mc Andrews, S.	Peyron, O.	Peyron et al., 1998
IT01	Lago di Fimon	Italie	11.530000	45.450000	330	Mousses	Forêt tempérée décidue	Huntley, B.	EPD	Huntley, 1990
IT07	Lago Santo by Abetone	Italie	10.530000	44.100000	1501	Mousses	Forêt mixte fraîche	Huntley, B.	EPD	Huntley, 1990
IT10	Lago Laudemio	Italie	15.810000	40.150000	1500	Mousses	Forêt tempérée décidue	Huntley, B.	EPD	Huntley, 1990
IT11	Lago di Chiusi	Italie	12.020000	43.050000	250	Mousses	Forêt tempérée décidue	Huntley, B.	EPD	Huntley, 1993

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IT16	Lago Piccolo di Monticchio	Italie	15.580000	40.920000	656	Mousses	Forêt tempérée décidue	Huntley, B.	EPD	Huntley, 1988
IT19	Lago di Monterosi	Italie	12.300000	42.220000	239	Mousses	Forêt mixte chaude	Huntley, B.	EPD	Huntley, 1988
IT40		Italie	15.700000	40.280000	710	Mousses	Forêt tempérée décidue		Peyron, O.	Peyron et al., 1998
IT44		Italie	15.670000	40.250000	510	Mousses	Forêt tempérée décidue		Peyron, O.	Peyron et al., 1998
IT45		Italie	15.650000	40.250000	550	Mousses	Forêt mixte chaude		Peyron, O.	Peyron et al., 1998
IT49		Italie	15.550000	40.320000	640	Mousses	Forêt mixte chaude		Peyron, O.	Peyron et al., 1998
IT50		Italie	15.550000	40.320000	640	Mousses	Forêt tempérée décidue		Peyron, O.	Peyron et al., 1998
IT51		Italie	15.550000	40.320000	640	Mousses	Forêt mixte chaude		Peyron, O.	Peyron et al., 1998
IT54	Pian di Verra inferiore	Italie	7.733333	45.870000	2050	Mousses	Forêt mixte fraîche	Brugiapaglia, E.	Peyron, O.	Brugiapaglia, E.,1996
IT59	Champlong	Italie	7.650000	45.890000	2100	Mousses	Forêt mixte fraîche	Brugiapaglia, E.	Peyron, O.	Brugiapaglia, E.,1996
IT60	Tourbière de Chanleve	Italie	7.650000	45.870000	1841	Mousses	Forêt mixte fraîche	Brugiapaglia, E.	Peyron, O.	Brugiapaglia, E.,1996
IT61	Tourbière de lo Cret	Italie	7.616667	45.900000	1869	Mousses	Forêt mixte fraîche	Brugiapaglia, E.	Peyron, O.	Brugiapaglia, E.,1996
IT62	Localité Fioc	Italie	7.616667	45.820000	1800	Mousses	Forêt mixte fraîche	Brugiapaglia, E.	Peyron, O.	Brugiapaglia, E.,1996
IT63	Tourbière de Pilaz	Italie	7.616667	45.820000	1900	Mousses	Forêt mixte fraîche	Brugiapaglia, E.	Peyron, O.	Brugiapaglia, E.,1996
IT66		Italie	7.680000	44.150000	1905	Mousses	Forêt mixte fraîche	Brugiapaglia, E.	Peyron, O.	Brugiapaglia, E.,1996
JO02	Wadi Rum	Jordanie	35.500000	29.500000	350	Mousses	Désert chaud	Huntley, B.	EPD	Huntley, 1989
KA52		Kazakhstan	57.200000	50.250000	250	Mousses	Steppe froide	Tarasov, P.E.	Peyron, O.	Peyron et al., 1998
KA87		Kazakhstan	75.400000	49.370000	883	Mousses	Forêt boréale	Tarasov, P.E.	Peyron, O.	Peyron et al., 1998
LX16	Littox	Espagne	-2.620000	36.700000	70	Mousses	Végétation xérophytique	Belmonte, J.	Peyron, O.	Peyron et al., 1998
M001		Maroc	-9.480000	29.400000	700	Mousses	Steppe chaude	Saadi, F.	J Guiot/Peyron, O.	Peyron et al., 1998
M002		Maroc	-9.480000	29.400000	700	Mousses	Steppe chaude	Saadi, F.	J Guiot/Peyron, O.	Peyron et al., 1998
M003		Maroc	-9.480000	29.420000	750	Mousses	Steppe chaude	Saadi, F.	J Guiot/Peyron, O.	Peyron et al., 1998
M004		Maroc	-9.350000	29.580000	1300	Mousses	Steppe chaude	Saadi, F.	J Guiot/Peyron, O.	Peyron et al., 1998
M005		Maroc	-9.020000	29.680000	1100	Mousses	Steppe chaude	Saadi, F.	J Guiot/Peyron, O.	Peyron et al., 1998
M006		Maroc	-9.020000	29.680000	1100	Mousses	Steppe chaude	Saadi, F.	J Guiot/Peyron, O.	Peyron et al., 1998
M007		Maroc	-8.850000	29.780000	1000	Mousses	Steppe chaude	Saadi, F.	J Guiot/Peyron, O.	Peyron et al., 1998
M008		Maroc	-9.250000	29.850000	1600	Mousses	Steppe chaude	Saadi, F.	J Guiot/Peyron, O.	Peyron et al., 1998
M009		Maroc	-8.640000	29.950000	1600	Mousses	Steppe chaude	Saadi, F.	J Guiot/Peyron, O.	Peyron et al., 1998
M010		Maroc	-9.500000	29.880000	1500	Mousses	Steppe chaude	Saadi, F.	J Guiot/Peyron, O.	Peyron et al., 1998
M011		Maroc	-9.440000	29.860000	175	Mousses	Steppe chaude	Saadi, F.	J Guiot/Peyron, O.	Peyron et al., 1998
M012		Maroc	-9.520000	29.860000	200	Mousses	Steppe chaude	Saadi, F.	J Guiot/Peyron, O.	Peyron et al., 1998
M013		Maroc	-9.600000	29.950000	50	Mousses	Steppe chaude	Saadi, F.	J Guiot/Peyron, O.	Peyron et al., 1998
M014		Maroc	-9.650000	29.950000	125	Mousses	Steppe chaude	Saadi, F.	J Guiot/Peyron, O.	Peyron et al., 1998
M015		Maroc	-9.700000	29.950000	150	Mousses	Steppe chaude	Saadi, F.	J Guiot/Peyron, O.	Peyron et al., 1998
M019		Maroc	-9.350000	30.520000	500	Mousses	Steppe chaude	Saadi, F.	J Guiot/Peyron, O.	Peyron et al., 1998
M020		Maroc	-9.350000	30.520000	500	Mousses	Steppe chaude	Saadi, F.	J Guiot/Peyron, O.	Peyron et al., 1998
M022		Maroc	-9.300000	30.550000	900	Mousses	Steppe chaude	Saadi, F.	J Guiot/Peyron, O.	Peyron et al., 1998
M025		Maroc	-9.250000	30.620000	900	Mousses	Steppe chaude	Saadi, F.	J Guiot/Peyron, O.	Peyron et al., 1998
M026		Maroc	-9.160000	30.680000	900	Mousses	Steppe chaude	Saadi, F.	J Guiot/Peyron, O.	Peyron et al., 1998
M027		Maroc	-9.140000	30.720000	900	Mousses	Steppe chaude	Saadi, F.	J Guiot/Peyron, O.	Peyron et al., 1998
M028		Maroc	-9.820000	30.620000	120	Mousses	Steppe chaude	Saadi, F.	J Guiot/Peyron, O.	Peyron et al., 1998

Nom	Site	Pays	Longitude	Latitude	Altitude	Nature du prélèvement	Biome	Auteur	Source	Référence
M029		Maroc	-10.380000	30.580000	240	Mousses	Steppe chaude	Saadi, F.	J Guiot/Peyron, O.	Peyron et al., 1998
M030		Maroc	-9.780000	30.800000	280	Mousses	Steppe chaude	Saadi, F.	J Guiot/Peyron, O.	Peyron et al., 1998
M031		Maroc	-9.780000	30.820000	200	Mousses	Steppe chaude	Saadi, F.	J Guiot/Peyron, O.	Peyron et al., 1998
M032		Maroc	-9.780000	30.820000	220	Mousses	Steppe chaude	Saadi, F.	J Guiot/Peyron, O.	Peyron et al., 1998
M035		Maroc	-9.700000	31.440000	350	Mousses	Steppe chaude	Saadi, F.	J Guiot/Peyron, O.	Peyron et al., 1998
M040		Maroc	-8.950000	31.020000	1150	Mousses	Végétation xérophytique	Saadi, F.	J Guiot/Peyron, O.	Peyron et al., 1998
M041		Maroc	-8.360000	30.720000	600	Mousses	Steppe chaude	Saadi, F.	J Guiot/Peyron, O.	Peyron et al., 1998
M042		Maroc	-8.360000	30.720000	600	Mousses	Steppe chaude	Saadi, F.	J Guiot/Peyron, O.	Peyron et al., 1998
M043		Maroc	-8.500000	30.280000	1000	Mousses	Steppe chaude	Saadi, F.	J Guiot/Peyron, O.	Peyron et al., 1998
M044		Maroc	-8.780000	30.500000	700	Mousses	Steppe chaude	Saadi, F.	J Guiot/Peyron, O.	Peyron et al., 1998
M045		Maroc	-6.400000	30.780000	1000	Mousses	Steppe chaude	Saadi, F.	J Guiot/Peyron, O.	Peyron et al., 1998
M049		Maroc	-8.350000	30.800000	1900	Mousses	Végétation xérophytique	Saadi, F.	J Guiot/Peyron, O.	Peyron et al., 1998
M050		Maroc	-8.350000	30.840000	2000	Mousses	Végétation xérophytique	Saadi, F.	J Guiot/Peyron, O.	Peyron et al., 1998
M051		Maroc	-8.340000	30.880000	1700	Mousses	Végétation xérophytique	Saadi, F.	J Guiot/Peyron, O.	Peyron et al., 1998
M052		Maroc	-8.320000	30.860000	1700	Mousses	Végétation xérophytique	Saadi, F.	J Guiot/Peyron, O.	Peyron et al., 1998
M053		Maroc	-8.300000	30.900000	1200	Mousses	Végétation xérophytique	Saadi, F.	J Guiot/Peyron, O.	Peyron et al., 1998
M054		Maroc	-8.220000	30.900000	1800	Mousses	Végétation xérophytique	Saadi, F.	J Guiot/Peyron, O.	Peyron et al., 1998
M055		Maroc	-8.200000	30.920000	1650	Mousses	Végétation xérophytique	Saadi, F.	J Guiot/Peyron, O.	Peyron et al., 1998
M056		Maroc	-8.180000	30.660000	700	Mousses	Steppe chaude	Saadi, F.	J Guiot/Peyron, O.	Peyron et al., 1998
M057		Maroc	-7.480000	30.420000	1800	Mousses	Steppe chaude	Saadi, F.	J Guiot/Peyron, O.	Peyron et al., 1998
M059		Maroc	-7.030000	30.980000	1200	Mousses	Steppe chaude	Saadi, F.	J Guiot/Peyron, O.	Peyron et al., 1998
M060		Maroc	-8.180000	31.240000	700	Mousses	Steppe chaude	Saadi, F.	J Guiot/Peyron, O.	Peyron et al., 1998
M061		Maroc	-8.180000	31.240000	700	Mousses	Steppe chaude	Saadi, F.	J Guiot/Peyron, O.	Peyron et al., 1998
M062		Maroc	-8.180000	31.240000	750	Mousses	Steppe chaude	Saadi, F.	J Guiot/Peyron, O.	Peyron et al., 1998
M063		Maroc	-8.180000	31.240000	650	Mousses	Steppe chaude	Saadi, F.	J Guiot/Peyron, O.	Peyron et al., 1998
M064		Maroc	-8.180000	31.240000	700	Mousses	Steppe chaude	Saadi, F.	J Guiot/Peyron, O.	Peyron et al., 1998
M065		Maroc	-8.180000	31.240000	700	Mousses	Steppe chaude	Saadi, F.	J Guiot/Peyron, O.	Peyron et al., 1998
M066		Maroc	-8.060000	31.150000	1000	Mousses	Végétation xérophytique	Saadi, F.	J Guiot/Peyron, O.	Peyron et al., 1998
M068		Maroc	-7.950000	31.220000	1400	Mousses	Végétation xérophytique	Saadi, F.	J Guiot/Peyron, O.	Peyron et al., 1998
M069		Maroc	-7.950000	31.220000	1400	Mousses	Végétation xérophytique	Saadi, F.	J Guiot/Peyron, O.	Peyron et al., 1998
M071		Maroc	-7.740000	31.350000	1150	Mousses	Végétation xérophytique	Saadi, F.	J Guiot/Peyron, O.	Peyron et al., 1998
M073		Maroc	-7.750000	31.320000	1200	Mousses	Végétation xérophytique	Saadi, F.	J Guiot/Peyron, O.	Peyron et al., 1998
M074		Maroc	-7.800000	31.220000	800	Mousses	Steppe chaude	Saadi, F.	J Guiot/Peyron, O.	Peyron et al., 1998
M075		Maroc	-7.800000	31.220000	750	Mousses	Steppe chaude	Saadi, F.	J Guiot/Peyron, O.	Peyron et al., 1998
M078		Maroc	-7.720000	31.250000	1100	Mousses	Végétation xérophytique	Saadi, F.	J Guiot/Peyron, O.	Peyron et al., 1998
M086		Maroc	-7.400000	31.410000	1500	Mousses	Végétation xérophytique	Saadi, F.	J Guiot/Peyron, O.	Peyron et al., 1998
M087		Maroc	-7.400000	31.410000	1850	Mousses	Végétation xérophytique	Saadi, F.	J Guiot/Peyron, O.	Peyron et al., 1998
M088		Maroc	-7.400000	31.410000	1750	Mousses	Végétation xérophytique	Saadi, F.	J Guiot/Peyron, O.	Peyron et al., 1998
M090		Maroc	-7.400000	31.410000	1550	Mousses	Végétation xérophytique	Saadi, F.	J Guiot/Peyron, O.	Peyron et al., 1998
M091		Maroc	-7.400000	31.410000	1550	Mousses	Végétation xérophytique	Saadi, F.	J Guiot/Peyron, O.	Peyron et al., 1998
M092		Maroc	-7.400000	31.410000	1450	Mousses	Végétation xérophytique	Saadi, F.	J Guiot/Peyron, O.	Peyron et al., 1998
M093		Maroc	-7.380000	31.460000	1200	Mousses	Végétation xérophytique	Saadi, F.	J Guiot/Peyron, O.	Peyron et al., 1998

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M094		Maroc	-7.380000	31.460000	1600	Mousses	Végétation xérophytique	Saadi, F.	J Guiot/Peyron, O.	Peyron et al., 1998
M095		Maroc	-7.380000	31.460000	1500	Mousses	Végétation xérophytique	Saadi, F.	J Guiot/Peyron, O.	Peyron et al., 1998
M096		Maroc	-7.480000	31.540000	900	Mousses	Steppe chaude	Saadi, F.	J Guiot/Peyron, O.	Peyron et al., 1998
M097		Maroc	-6.050000	32.540000	500	Mousses	Steppe chaude	Saadi, F.	J Guiot/Peyron, O.	Peyron et al., 1998
M102		Maroc	-5.580000	33.080000	1150	Mousses	Végétation xérophytique	Saadi, F.	J Guiot/Peyron, O.	Peyron et al., 1998
M103		Maroc	-5.480000	32.970000	1530	Mousses	Végétation xérophytique	Saadi, F.	J Guiot/Peyron, O.	Peyron et al., 1998
M106		Maroc	-5.500000	32.950000	1500	Mousses	Steppe chaude	Saadi, F.	J Guiot/Peyron, O.	Peyron et al., 1998
M112		Maroc	-4.920000	32.680000	1600	Mousses	Végétation xérophytique	Saadi, F.	J Guiot/Peyron, O.	Peyron et al., 1998
M113		Maroc	-4.950000	32.680000	1650	Mousses	Végétation xérophytique	Saadi, F.	J Guiot/Peyron, O.	Peyron et al., 1998
M117		Maroc	-4.480000	33.220000	1650	Mousses	Steppe chaude	Saadi, F.	J Guiot/Peyron, O.	Peyron et al., 1998
M121		Maroc	-4.700000	33.400000	1900	Mousses	Végétation xérophytique	Saadi, F.	J Guiot/Peyron, O.	Peyron et al., 1998
M123		Maroc	-5.120000	33.320000	1900	Mousses	Forêt tempérée décidue	Saadi, F.	J Guiot/Peyron, O.	Peyron et al., 1998
M131		Maroc	-5.100000	33.420000	1900	Mousses	Végétation xérophytique	Saadi, F.	J Guiot/Peyron, O.	Peyron et al., 1998
M132		Maroc	-5.100000	33.420000	1900	Mousses	Végétation xérophytique	Saadi, F.	J Guiot/Peyron, O.	Peyron et al., 1998
M133		Maroc	-5.100000	33.420000	1910	Mousses	Végétation xérophytique	Saadi, F.	J Guiot/Peyron, O.	Peyron et al., 1998
M134		Maroc	-5.100000	33.400000	1920	Mousses	Végétation xérophytique	Saadi, F.	J Guiot/Peyron, O.	Peyron et al., 1998
M135		Maroc	-5.120000	33.400000	1930	Mousses	Végétation xérophytique	Saadi, F.	J Guiot/Peyron, O.	Peyron et al., 1998
M144		Maroc	-5.160000	33.480000	1700	Mousses	Forêt mixte chaude	Saadi, F.	J Guiot/Peyron, O.	Peyron et al., 1998
M145		Maroc	-5.160000	33.480000	1700	Mousses	Forêt mixte chaude	Saadi, F.	J Guiot/Peyron, O.	Peyron et al., 1998
M149		Maroc	-6.820000	33.720000	320	Mousses	Steppe chaude	Saadi, F.	J Guiot/Peyron, O.	Peyron et al., 1998
M151		Maroc	-6.850000	33.720000	400	Mousses	Steppe chaude	Saadi, F.	J Guiot/Peyron, O.	Peyron et al., 1998
M152		Maroc	-6.880000	33.720000	450	Mousses	Steppe chaude	Saadi, F.	J Guiot/Peyron, O.	Peyron et al., 1998
M178		Maroc	-6.400000	34.220000	20	Mousses	Végétation xérophytique	Saadi, F.	J Guiot/Peyron, O.	Peyron et al., 1998
M182		Maroc	-5.020000	34.120000	700	Mousses	Végétation xérophytique	Saadi, F.	J Guiot/Peyron, O.	Peyron et al., 1998
M187		Maroc	-5.020000	34.120000	300	Mousses	Végétation xérophytique	Saadi, F.	J Guiot/Peyron, O.	Peyron et al., 1998
M188		Maroc	-5.120000	34.260000	300	Mousses	Végétation xérophytique	Saadi, F.	J Guiot/Peyron, O.	Peyron et al., 1998
M189		Maroc	-5.120000	34.260000	270	Mousses	Végétation xérophytique	Saadi, F.	J Guiot/Peyron, O.	Peyron et al., 1998
M190		Maroc	-5.120000	34.260000	250	Mousses	Végétation xérophytique	Saadi, F.	J Guiot/Peyron, O.	Peyron et al., 1998
M191		Maroc	-5.120000	34.260000	250	Mousses	Végétation xérophytique	Saadi, F.	J Guiot/Peyron, O.	Peyron et al., 1998
M192		Maroc	-5.120000	34.260000	250	Mousses	Végétation xérophytique	Saadi, F.	J Guiot/Peyron, O.	Peyron et al., 1998
M193		Maroc	-5.120000	34.260000	250	Mousses	Steppe chaude	Saadi, F.	J Guiot/Peyron, O.	Peyron et al., 1998
M194		Maroc	-5.220000	34.460000	700	Mousses	Végétation xérophytique	Saadi, F.	J Guiot/Peyron, O.	Peyron et al., 1998
M195		Maroc	-5.220000	34.460000	750	Mousses	Végétation xérophytique	Saadi, F.	J Guiot/Peyron, O.	Peyron et al., 1998
M198		Maroc	-5.550000	34.900000	300	Mousses	Végétation xérophytique	Saadi, F.	J Guiot/Peyron, O.	Peyron et al., 1998
M199		Maroc	-5.550000	34.900000	300	Mousses	Steppe chaude	Saadi, F.	J Guiot/Peyron, O.	Peyron et al., 1998
M200		Maroc	-4.600000	34.850000	1800	Mousses	Forêt tempérée décidue	Saadi, F.	J Guiot/Peyron, O.	Peyron et al., 1998
M202		Maroc	-4.600000	34.850000	1760	Mousses	Forêt tempérée décidue	Saadi, F.	J Guiot/Peyron, O.	Peyron et al., 1998
M204		Maroc	-4.600000	34.850000	1700	Mousses	Forêt tempérée décidue	Saadi, F.	J Guiot/Peyron, O.	Peyron et al., 1998
M205		Maroc	-4.600000	34.850000	1680	Mousses	Végétation xérophytique	Saadi, F.	J Guiot/Peyron, O.	Peyron et al., 1998
M206		Maroc	-4.600000	34.850000	1650	Mousses	Végétation xérophytique	Saadi, F.	J Guiot/Peyron, O.	Peyron et al., 1998
M207		Maroc	-4.600000	34.850000	1620	Mousses	Végétation xérophytique	Saadi, F.	J Guiot/Peyron, O.	Peyron et al., 1998
M208		Maroc	-4.600000	34.850000	1600	Mousses	Végétation xérophytique	Saadi, F.	J Guiot/Peyron, O.	Peyron et al., 1998

Nom	Site	Pays	Longitude	Latitude	Altitude	Nature du prélèvement	Biome	Auteur	Source	Référence
M209		Maroc	-4.600000	34.850000	1580	Mousses	Végétation xérophytique	Saadi, F.	J Guiot/Peyron, O.	Peyron et al., 1998
M210		Maroc	-4.600000	34.850000	1540	Mousses	Végétation xérophytique	Saadi, F.	J Guiot/Peyron, O.	Peyron et al., 1998
M211		Maroc	-4.600000	34.850000	1500	Mousses	Forêt tempérée décidue	Saadi, F.	J Guiot/Peyron, O.	Peyron et al., 1998
M212		Maroc	-4.650000	34.880000	1500	Mousses	Végétation xérophytique	Saadi, F.	J Guiot/Peyron, O.	Peyron et al., 1998
M213		Maroc	-4.620000	34.900000	1500	Mousses	Forêt tempérée décidue	Saadi, F.	J Guiot/Peyron, O.	Peyron et al., 1998
M214		Maroc	-4.600000	34.950000	1200	Mousses	Végétation xérophytique	Saadi, F.	J Guiot/Peyron, O.	Peyron et al., 1998
M215		Maroc	-4.600000	34.950000	1200	Mousses	Végétation xérophytique	Saadi, F.	J Guiot/Peyron, O.	Peyron et al., 1998
M216		Maroc	-4.600000	35.100000	800	Mousses	Végétation xérophytique	Saadi, F.	J Guiot/Peyron, O.	Peyron et al., 1998
M217		Maroc	-4.680000	35.150000	750	Mousses	Végétation xérophytique	Saadi, F.	J Guiot/Peyron, O.	Peyron et al., 1998
M218		Maroc	-4.680000	35.150000	700	Mousses	Végétation xérophytique	Saadi, F.	J Guiot/Peyron, O.	Peyron et al., 1998
M221		Maroc	-5.260000	35.140000	1460	Mousses	Végétation xérophytique	Saadi, F.	J Guiot/Peyron, O.	Peyron et al., 1998
M222		Maroc	-5.260000	35.140000	1490	Mousses	Végétation xérophytique	Saadi, F.	J Guiot/Peyron, O.	Peyron et al., 1998
M223		Maroc	-5.260000	35.140000	1500	Mousses	Végétation xérophytique	Saadi, F.	J Guiot/Peyron, O.	Peyron et al., 1998
M226		Maroc	-5.150000	35.180000	1570	Mousses	Végétation xérophytique	Saadi, F.	J Guiot/Peyron, O.	Peyron et al., 1998
M227		Maroc	-5.150000	35.180000	1510	Mousses	Végétation xérophytique	Saadi, F.	J Guiot/Peyron, O.	Peyron et al., 1998
M228		Maroc	-5.280000	35.180000	1250	Mousses	Végétation xérophytique	Saadi, F.	J Guiot/Peyron, O.	Peyron et al., 1998
M229		Maroc	-5.280000	35.180000	1280	Mousses	Végétation xérophytique	Saadi, F.	J Guiot/Peyron, O.	Peyron et al., 1998
M230		Maroc	-5.280000	35.180000	1290	Mousses	Végétation xérophytique	Saadi, F.	J Guiot/Peyron, O.	Peyron et al., 1998
M231		Maroc	-5.280000	35.180000	1300	Mousses	Végétation xérophytique	Saadi, F.	J Guiot/Peyron, O.	Peyron et al., 1998
M232		Maroc	-5.280000	35.180000	1320	Mousses	Végétation xérophytique	Saadi, F.	J Guiot/Peyron, O.	Peyron et al., 1998
M233		Maroc	-5.280000	35.180000	1320	Mousses	Végétation xérophytique	Saadi, F.	J Guiot/Peyron, O.	Peyron et al., 1998
M234		Maroc	-5.280000	35.180000	1320	Mousses	Végétation xérophytique	Saadi, F.	J Guiot/Peyron, O.	Peyron et al., 1998
M235		Maroc	-5.280000	35.180000	1320	Mousses	Végétation xérophytique	Saadi, F.	J Guiot/Peyron, O.	Peyron et al., 1998
M237		Maroc	-5.280000	35.180000	1320	Mousses	Végétation xérophytique	Saadi, F.	J Guiot/Peyron, O.	Peyron et al., 1998
M238		Maroc	-5.280000	35.200000	1300	Mousses	Steppe chaude	Saadi, F.	J Guiot/Peyron, O.	Peyron et al., 1998
M240		Maroc	-5.280000	35.200000	1320	Mousses	Steppe chaude	Saadi, F.	J Guiot/Peyron, O.	Peyron et al., 1998
M241		Maroc	-5.280000	35.300000	1350	Mousses	Steppe chaude	Saadi, F.	J Guiot/Peyron, O.	Peyron et al., 1998
M242		Maroc	-5.280000	35.300000	1370	Mousses	Steppe chaude	Saadi, F.	J Guiot/Peyron, O.	Peyron et al., 1998
M243		Maroc	-5.280000	35.400000	1420	Mousses	Végétation xérophytique	Saadi, F.	J Guiot/Peyron, O.	Peyron et al., 1998
M244		Maroc	-5.280000	35.400000	1450	Mousses	Steppe chaude	Saadi, F.	J Guiot/Peyron, O.	Peyron et al., 1998
M245		Maroc	-5.280000	35.400000	1480	Mousses	Forêt tempérée décidue	Saadi, F.	J Guiot/Peyron, O.	Peyron et al., 1998
M246		Maroc	-5.280000	35.400000	1500	Mousses	Végétation xérophytique	Saadi, F.	J Guiot/Peyron, O.	Peyron et al., 1998
M247		Maroc	-5.280000	35.400000	1520	Mousses	Végétation xérophytique	Saadi, F.	J Guiot/Peyron, O.	Peyron et al., 1998
M248		Maroc	-5.280000	35.400000	1620	Mousses	Végétation xérophytique	Saadi, F.	J Guiot/Peyron, O.	Peyron et al., 1998
M249		Maroc	-5.280000	35.500000	1620	Mousses	Végétation xérophytique	Saadi, F.	J Guiot/Peyron, O.	Peyron et al., 1998
M251		Maroc	-5.280000	35.500000	1660	Mousses	Végétation xérophytique	Saadi, F.	J Guiot/Peyron, O.	Peyron et al., 1998
M252		Maroc	-5.250000	35.600000	1680	Mousses	Forêt tempérée décidue	Saadi, F.	J Guiot/Peyron, O.	Peyron et al., 1998
M253		Maroc	-5.250000	35.600000	1700	Mousses	Végétation xérophytique	Saadi, F.	J Guiot/Peyron, O.	Peyron et al., 1998
M256		Maroc	-5.250000	35.700000	1800	Mousses	Végétation xérophytique	Saadi, F.	J Guiot/Peyron, O.	Peyron et al., 1998
M257		Maroc	-5.220000	35.080000	1200	Mousses	Végétation xérophytique	Saadi, F.	J Guiot/Peyron, O.	Peyron et al., 1998
M258		Maroc	-5.280000	35.150000	1200	Mousses	Végétation xérophytique	Saadi, F.	J Guiot/Peyron, O.	Peyron et al., 1998
M259		Maroc	-5.280000	35.150000	1200	Mousses	Végétation xérophytique	Saadi, F.	J Guiot/Peyron, O.	Peyron et al., 1998

Nom	Site	Pays	Longitude	Latitude	Altitude	Nature du prélèvement	Biome	Auteur	Source	Référence
M260		Maroc	-5.280000	35.150000	1200	Mousses	Végétation xérophytique	Saadi, F.	J Guiot/Peyron, O.	Peyron et al., 1998
M261		Maroc	-5.280000	35.150000	1250	Mousses	Végétation xérophytique	Saadi, F.	J Guiot/Peyron, O.	Peyron et al., 1998
M262		Maroc	-5.280000	35.150000	1300	Mousses	Végétation xérophytique	Saadi, F.	J Guiot/Peyron, O.	Peyron et al., 1998
M264		Maroc	-5.280000	35.150000	1250	Mousses	Végétation xérophytique	Saadi, F.	J Guiot/Peyron, O.	Peyron et al., 1998
M265		Maroc	-5.280000	35.150000	1250	Mousses	Végétation xérophytique	Saadi, F.	J Guiot/Peyron, O.	Peyron et al., 1998
M266		Maroc	-5.280000	35.150000	1200	Mousses	Végétation xérophytique	Saadi, F.	J Guiot/Peyron, O.	Peyron et al., 1998
M267		Maroc	-5.280000	35.150000	1200	Mousses	Végétation xérophytique	Saadi, F.	J Guiot/Peyron, O.	Peyron et al., 1998
M268		Maroc	-5.280000	35.150000	1200	Mousses	Végétation xérophytique	Saadi, F.	J Guiot/Peyron, O.	Peyron et al., 1998
M269		Maroc	-5.260000	35.150000	1200	Mousses	Végétation xérophytique	Saadi, F.	J Guiot/Peyron, O.	Peyron et al., 1998
M270		Maroc	-5.260000	35.150000	1250	Mousses	Végétation xérophytique	Saadi, F.	J Guiot/Peyron, O.	Peyron et al., 1998
M272		Maroc	-4.940000	35.250000	250	Mousses	Végétation xérophytique	Saadi, F.	J Guiot/Peyron, O.	Peyron et al., 1998
M273		Maroc	-5.100000	35.360000	300	Mousses	Végétation xérophytique	Saadi, F.	J Guiot/Peyron, O.	Peyron et al., 1998
M274		Maroc	-5.200000	35.440000	500	Mousses	Végétation xérophytique	Saadi, F.	J Guiot/Peyron, O.	Peyron et al., 1998
M275		Maroc	-5.540000	35.520000	500	Mousses	Végétation xérophytique	Saadi, F.	J Guiot/Peyron, O.	Peyron et al., 1998
M276		Maroc	-5.920000	35.740000	100	Mousses	Végétation xérophytique	Saadi, F.	J Guiot/Peyron, O.	Peyron et al., 1998
M277		Maroc	-5.920000	35.740000	150	Mousses	Végétation xérophytique	Saadi, F.	J Guiot/Peyron, O.	Peyron et al., 1998
M278		Maroc	-5.920000	35.740000	200	Mousses	Végétation xérophytique	Saadi, F.	J Guiot/Peyron, O.	Peyron et al., 1998
M279		Maroc	-5.920000	35.740000	200	Mousses	Végétation xérophytique	Saadi, F.	J Guiot/Peyron, O.	Peyron et al., 1998
M282		Maroc	-5.920000	35.740000	280	Mousses	Végétation xérophytique	Saadi, F.	J Guiot/Peyron, O.	Peyron et al., 1998
M283		Maroc	-5.920000	35.740000	280	Mousses	Végétation xérophytique	Saadi, F.	J Guiot/Peyron, O.	Peyron et al., 1998
M284		Maroc	-5.920000	35.740000	300	Mousses	Végétation xérophytique	Saadi, F.	J Guiot/Peyron, O.	Peyron et al., 1998
MC54	Sud de la France	France	5.250000	44.870000	1000	Mousses	Forêt tempérée décidue	Reille, M.	Peyron, O.	Peyron et al., 1998
MC55	Corse	France	9.070000	41.570000	1250	Mousses	Forêt tempérée décidue	Reille, M.	Peyron, O.	Peyron et al., 1998
MC66	Sud de la France	France	4.850000	43.520000	1000	Mousses	Forêt tempérée décidue	Reille, M.	Peyron, O.	Peyron et al., 1998
MC69	Sud de la France	France	5.480000	44.420000	1450	Mousses	Forêt tempérée décidue	Reille, M.	Peyron, O.	Peyron et al., 1998
MC70	Sud de la France	France	5.380000	44.420000	1400	Mousses	Forêt tempérée décidue	Reille, M.	Peyron, O.	Peyron et al., 1998
MC71	Sud de la France	France	4.350000	43.430000	900	Mousses	Forêt tempérée décidue	Reille, M.	Peyron, O.	Peyron et al., 1998
MC81	Sud de la France	France	3.620000	44.470000	1380	Mousses	Forêt tempérée décidue	Reille, M.	Peyron, O.	Peyron et al., 1998
MC85	Sud de la France	France	4.920000	43.800000	45	Mousses	Forêt mixte chaude	Reille, M.	Peyron, O.	Peyron et al., 1998
MK0301	Gna Gora	République de Macédoine	21.635278	42.209167	589	Mousses	Forêt tempérée décidue	Bordon, A.		Bordon et al., submitted
MK0303	Gna Gora	République de Macédoine	21.540833	42.08	1200	Mousses	Forêt tempérée décidue	Bordon, A.		Bordon et al., submitted
MK0612	Baba	République de Macédoine	21.218367	41.039783	1385	Mousses	Forêt tempérée décidue	Bordon, A.		Bordon et al., submitted
MK0613	Baba	République de Macédoine	21.222167	41.0429	1240	Mousses	Forêt tempérée décidue	Bordon, A.		Bordon et al., submitted
MK0617	Valamarë	Albanie	20.505483	40.768767	1300	Mousses	Forêt tempérée décidue	Bordon, A.		Bordon et al., submitted
MK0622	Pindhos	Grèce	21.119667	40.196767	1280	Mousses	Forêt mixte chaude	Bordon, A.		Bordon et al., submitted
MK0623	Pindhos	Grèce	21.048933	40.216967	1250	Mousses	Forêt tempérée décidue	Bordon, A.		Bordon et al., submitted
MK0624	Pindhos	Grèce	21.048933	40.216967	1120	Mousses	Forêt tempérée décidue	Bordon, A.		Bordon et al., submitted
MON6	Moncayo	Espagne	-1.850000	41.830000	1100	Mousses	Forêt tempérée décidue	Belmonte, J.	J Guiot/Peyron, O.	Peyron et al., 1998

Nom	Site	Pays	Longitude	Latitude	Altitude	Nature du prélèvement	Biome	Auteur	Source	Référence
MONB	Moncayo	Espagne	-1.820000	41.820000	1130	Mousses	Forêt tempérée décidue	Belmonte, J.	J Guiot/Peyron, O.	Peyron et al., 1998
MOR1	Morena	Espagne	-4.330000	38.650000	850	Mousses	Végétation xérophytique	Belmonte, J.	J Guiot/Peyron, O.	Peyron et al., 1998
MOR2	Morena	Espagne	-4.370000	38.580000	650	Mousses	Forêt mixte chaude	Belmonte, J.	J Guiot/Peyron, O.	Peyron et al., 1998
MOR3	Morena	Espagne	-4.380000	38.530000	902	Mousses	Végétation xérophytique	Belmonte, J.	J Guiot/Peyron, O.	Peyron et al., 1998
MOR5	Morena	Espagne	-4.370000	38.480000	760	Mousses	Végétation xérophytique	Belmonte, J.	J Guiot/Peyron, O.	Peyron et al., 1998
MOR6	Morena	Espagne	-4.320000	38.380000	550	Mousses	Végétation xérophytique	Belmonte, J.	J Guiot/Peyron, O.	Peyron et al., 1998
MUN1	Munianc	Espagne	-5.530000	42.980000	1200	Mousses	Forêt tempérée décidue	Belmonte, J.	J Guiot/Peyron, O.	Peyron et al., 1998
MUN2	Munianc	Espagne	-6.750000	42.750000	800	Mousses	Forêt tempérée décidue	Belmonte, J.	J Guiot/Peyron, O.	Peyron et al., 1998
MUN3	Munianc	Espagne	-6.900000	42.850000	850	Mousses	Forêt tempérée décidue	Belmonte, J.	J Guiot/Peyron, O.	Peyron et al., 1998
NEV8	Nevada	Espagne	-3.330000	37.120000	1420	Mousses	Forêt mixte chaude	Belmonte, J.	J Guiot/Peyron, O.	Peyron et al., 1998
OR12	Oraate	France	-1.100000	43.030000	1268	Mousses	Forêt tempérée décidue	Galop, D.	Peyron, O.	données non publiées
OR16	Oraate	France	-1.120000	43.030000	1163	Mousses	Forêt tempérée décidue	Galop, D.	Peyron, O.	données non publiées
OR18	Oraate	France	-1.120000	43.030000	1126	Mousses	Forêt tempérée décidue	Galop, D.	Peyron, O.	données non publiées
OR28	Oraate	France	-1.130000	43.030000	973	Mousses	Forêt tempérée décidue	Galop, D.	Peyron, O.	données non publiées
ORAM	Oraate	France	-1.120000	43.030000	1228	Mousses	Forêt tempérée décidue	Galop, D.	Peyron, O.	données non publiées
RON1	Ronda	Espagne	-5.370000	36.780000	1357	Mousses	Végétation xérophytique	Belmonte, J.	J Guiot/Peyron, O.	Peyron et al., 1998
RON2	Ronda	Espagne	-5.330000	36.750000	770	Mousses	Forêt mixte chaude	Belmonte, J.	Guiot/Peyron, O.	Peyron et al., 1998
RON3	Ronda	Espagne	-5.270000	36.780000	740	Mousses	Forêt mixte chaude	Belmonte, J.	J Guiot/Peyron, O.	Peyron et al., 1998
RON4	Ronda	Espagne	-5.250000	36.780000	660	Mousses	Forêt mixte chaude	Belmonte, J.	J Guiot/Peyron, O.	Peyron et al., 1998
RON5	Ronda	Espagne	-5.180000	36.820000	1160	Mousses	Végétation xérophytique	Belmonte, J.	J Guiot/Peyron, O.	Peyron et al., 1998
RON6	Ronda	Espagne	-4.970000	36.700000	1400	Mousses	Végétation xérophytique	Belmonte, J.	J Guiot/Peyron, O.	Peyron et al., 1998
RON7	Ronda	Espagne	-4.980000	36.680000	1140	Mousses	Végétation xérophytique	Belmonte, J.	J Guiot/Peyron, O.	Peyron et al., 1998
RON8	Ronda	Espagne	-5.080000	36.670000	1075	Mousses	Forêt mixte chaude	Belmonte, J.	J Guiot/Peyron, O.	Peyron et al., 1998
SAN3	Santande	Espagne	-3.620000	43.400000	150	Mousses	Forêt mixte chaude	Belmonte, J.	J Guiot/Peyron, O.	Peyron et al., 1998
SC01	Gettrygen	Suède	12.370000	63.150000	715	Mousses	Végétation pionnière	Bégeot, C.	Peyron, O.	Peyron et al., 2005
SC02	Gettrygen	Suède	12.370000	63.150000	718	Mousses	Végétation pionnière	Bégeot, C.	Peyron, O.	Peyron et al., 2005
SC03	Gettrygen	Suède	12.370000	63.150000	720	Mousses	Végétation pionnière	Bégeot, C.	Peyron, O.	Peyron et al., 2005
SC04	Gettrygen	Suède	12.380000	63.150000	720	Mousses	Végétation pionnière	Bégeot, C.	Peyron, O.	Peyron et al., 2005
SC06	Gettrygen	Suède	12.380000	63.150000	745	Mousses	Végétation pionnière	Bégeot, C.	Peyron, O.	Peyron et al., 2005
SC07	Gettrygen	Suède	12.380000	63.150000	765	Mousses	Végétation pionnière	Bégeot, C.	Peyron, O.	Peyron et al., 2005
SC08	Gettrygen	Suède	12.380000	63.150000	785	Mousses	Forêt mixte fraîche	Bégeot, C.	Peyron, O.	Peyron et al., 2005
SC09	Gettrygen	Suède	12.380000	63.150000	805	Mousses	Végétation pionnière	Bégeot, C.	Peyron, O.	Peyron et al., 2005
SC10	Gettrygen	Suède	12.380000	63.150000	825	Mousses	Végétation pionnière	Bégeot, C.	Peyron, O.	Peyron et al., 2005
SC11	Gettrygen	Suède	12.400000	63.150000	865	Mousses	Végétation pionnière	Bégeot, C.	Peyron, O.	Peyron et al., 2005
SC12	Gettrygen	Suède	12.400000	63.150000	875	Mousses	Végétation pionnière	Bégeot, C.	Peyron, O.	Peyron et al., 2005
SC13	Gettrygen	Suède	12.400000	63.150000	875	Mousses	Végétation pionnière	Bégeot, C.	Peyron, O.	Peyron et al., 2005
SC14	Gettrygen	Suède	12.400000	63.150000	944	Mousses	Végétation pionnière	Bégeot, C.	Peyron, O.	Peyron et al., 2005
SC15	Gettrygen	Suède	12.400000	63.170000	970	Mousses	Végétation pionnière	Bégeot, C.	Peyron, O.	Peyron et al., 2005
SC16	Gettrygen	Suède	12.400000	63.170000	987	Mousses	Végétation pionnière	Bégeot, C.	Peyron, O.	Peyron et al., 2005
SC17	Gettrygen	Suède	12.400000	63.170000	1002	Mousses	Végétation pionnière	Bégeot, C.	Peyron, O.	Peyron et al., 2005
SC18	Gettrygen	Suède	12.400000	63.170000	1064	Mousses	Forêt boréale	Bégeot, C.	Peyron, O.	Peyron et al., 2005

Nom	Site	Pays	Longitude	Latitude	Altitude	Nature du prélèvement	Biome	Auteur	Source	Référence
SC19	Gettrygen	Suède	12.400000	63.170000	1114	Mousses	Forêt boréale	Bégeot, C.	Peyron, O.	Peyron et al., 2005
SC20	Gettrygen	Suède	12.420000	63.170000	1115	Mousses	Forêt boréale	Bégeot, C.	Peyron, O.	Peyron et al., 2005
SC21	Gettrygen	Suède	12.420000	63.170000	1171	Mousses	Végétation pionnière	Bégeot, C.	Peyron, O.	Peyron et al., 2005
SC22	Gettrygen	Suède	12.350000	63.180000	840	Mousses	Végétation pionnière	Bégeot, C.	Peyron, O.	Peyron et al., 2005
SC23	Gettrygen	Suède	12.350000	63.180000	840	Mousses	Végétation pionnière	Bégeot, C.	Peyron, O.	Peyron et al., 2005
SC24	Gettrygen	Suède	12.350000	63.180000	840	Mousses	Végétation pionnière	Bégeot, C.	Peyron, O.	Peyron et al., 2005
SC25	Gettrygen	Suède	12.360000	63.180000	835	Mousses	Végétation pionnière	Bégeot, C.	Peyron, O.	Peyron et al., 2005
SC26	Gettrygen	Suède	12.360000	63.170000	830	Mousses	Végétation pionnière	Bégeot, C.	Peyron, O.	Peyron et al., 2005
SC27	Gettrygen	Suède	12.360000	63.170000	830	Mousses	Végétation pionnière	Bégeot, C.	Peyron, O.	Peyron et al., 2005
SC28	Gettrygen	Suède	12.360000	63.170000	810	Mousses	Végétation pionnière	Bégeot, C.	Peyron, O.	Peyron et al., 2005
SC29	Gettrygen	Suède	12.360000	63.170000	810	Mousses	Végétation pionnière	Bégeot, C.	Peyron, O.	Peyron et al., 2005
SC30	Gettrygen	Suède	12.360000	63.170000	800	Mousses	Végétation pionnière	Bégeot, C.	Peyron, O.	Peyron et al., 2005
SC31	Gettrygen	Suède	12.360000	63.170000	800	Mousses	Végétation pionnière	Bégeot, C.	Peyron, O.	Peyron et al., 2005
SC32	Gettrygen	Suède	12.370000	63.170000	780	Mousses	Forêt de conifères	Bégeot, C.	Peyron, O.	Peyron et al., 2005
SC33	Gettrygen	Suède	12.370000	63.170000	763	Mousses	Végétation pionnière	Bégeot, C.	Peyron, O.	Peyron et al., 2005
SC34	Gettrygen	Suède	12.370000	63.170000	763	Mousses	Forêt de conifères	Bégeot, C.	Peyron, O.	Peyron et al., 2005
SC35	Gettrygen	Suède	12.370000	63.170000	753	Mousses	Forêt boréale	Bégeot, C.	Peyron, O.	Peyron et al., 2005
SC36	Gettrygen	Suède	12.370000	63.170000	752	Mousses	Toundra	Bégeot, C.	Peyron, O.	Peyron et al., 2005
SU_01		Russie	35.000000	68.016667	161		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_02		Russie	35.000000	68.016667	161		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_03		Russie	29.800000	66.466667	275		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_04		Russie	29.800000	66.466667	275		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_05		Russie	29.800000	66.466667	275		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_06		Russie	29.950000	66.266667	137		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_07		Russie	29.950000	66.266667	137		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_08		Russie	29.950000	66.266667	137		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_09		Russie	29.950000	66.266667	137		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_10		Russie	29.950000	66.266667	137		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_100		Mongolie	104.750000	47.800000	1050		Steppe froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_1000		Russie	34.580300	67.499800	190		Végétation pionnière	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_1001		Russie	34.261000	67.445800	150		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_1002		Russie	34.256200	67.405700	150		Forêt de conifères	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_1003		Russie	33.800000	67.550000	145		Forêt de conifères	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_1004		Russie	33.467000	67.700000	450		Forêt de conifères	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_1005		Russie	35.617000	68.850000	110		Forêt de conifères	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_1006		Russie	35.400000	68.800000	150		Végétation pionnière	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_1007		Russie	32.950000	69.233000	101		Forêt de conifères	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_1008		Russie	32.617000	69.183000	240		Végétation pionnière	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_1009		Russie	34.983000	69.183000	170		Forêt de conifères	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_101		Mongolie	105.433333	47.866667	1000		Steppe froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_1010		Russie	34.883000	68.883000	230		Forêt de conifères	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000

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SU_1011		Russie	34.883000	68.950000	260		Forêt de conifères	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_1012		Russie	34.967000	69.050000	110		Forêt de conifères	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_1013		Russie	34.000000	68.917000	219		Forêt de conifères	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_1014		Russie	31.117000	68.733000	104		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_1015		Russie	30.567000	68.717000	120		Forêt de conifères	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_1016		Russie	28.683000	68.633000	150		Forêt de conifères	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_1017		Russie	28.833000	68.517000	105		Forêt de conifères	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_1018		Russie	29.283000	68.533000	110		Végétation pionnière	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_1019		Russie	30.683000	68.717000	112		Végétation pionnière	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_102		Mongolie	106.083333	47.950000	1195		Steppe froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_1020		Russie	33.483000	67.567000	150		Forêt de conifères	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_1021		Russie	33.400000	68.767000	151		Forêt de conifères	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_1022		Russie	35.883000	69.033000	117		Forêt de conifères	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_1023		Russie	36.067000	69.067000	79		Végétation pionnière	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_1024		Russie	35.950000	69.050000	125		Végétation pionnière	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_1025		Russie	32.483000	67.950000	475		Forêt de conifères	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_1026		Russie	79.616600	66.683300	50		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_1028		Russie	129.150000	71.600000	40		Toundra	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_1029		Russie	129.150000	71.600000	40		Toundra	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_103		Mongolie	106.566667	48.350000	1200		Steppe froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_1030		Russie	90.212000	69.548000	77		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_1031		Russie	62.800000	69.716700	15		Toundra	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_1032		Russie	54.200000	68.133300	5		Toundra	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_1033		Russie	54.316700	68.133300	5		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_1034		Russie	143.833300	75.333300	30		Toundra	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_1035		Russie	99.717000	72.383000	48		Toundra	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_1036		Russie	99.717000	72.383000	48		Steppe froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_1037		Russie	100.533300	74.550000	35		Steppe froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_1038		Russie	100.533300	74.550000	35		Steppe froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_1039		Russie	100.533300	74.550000	35		Steppe froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_104		Mongolie	106.616667	48.450000	1400		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_1040		Russie	100.533300	74.550000	35		Toundra	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_1042		Russie	76.666700	62.000000	50		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_1043		Russie	127.101400	72.600900	10		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_1044		Russie	32.480000	59.863600	50		Forêt de conifères	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_1045		Russie	39.521800	56.681800	70		Forêt de conifères	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_1046		Russie	39.521800	56.681800	70		Forêt de conifères	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_1047		Russie	39.621800	56.681800	70		Forêt mixte fraîche	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_1048		Russie	39.411800	56.681800	70		Forêt mixte fraîche	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_1049		Ouzbékistan	63.855400	39.764100	150		Désert froid	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_105		Mongolie	106.283333	48.900000	780		Steppe froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_1050		Ouzbékistan	63.855400	39.764100	150		Désert chaud	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000

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SU_1051		Ouzbékistan	63.855400	39.764100	200		Désert chaud	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_1052		Russie	-179.649994	71.167000	204		Steppe froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_1053		Russie	-179.750000	70.833000	7		Steppe froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_1054		Russie	-179.750000	70.833000	7		Steppe froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_1055		Russie	-179.417007	70.917000	8		Steppe froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_1056		Russie	-179.417007	70.917000	7		Steppe chaude	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_1057		Russie	-179.417007	70.917000	7		Steppe froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_1058		Russie	-179.167007	70.949997	55		Steppe froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_1059		Russie	-178.750000	71.199997	120		Steppe froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_106		Mongolie	106.133333	49.016667	800		Steppe froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_1060		Russie	-178.800003	71.199997	215		Steppe froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_1061		Russie	-178.832993	67.750000	280		Toundra	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_1062	Yakutie	Russie	176.550003	63.419998	103		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_1063	Yakutie	Russie	176.750000	63.169998	120		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_1064	Yakutie	Russie	149.500000	62.169998	822		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_1065	Yakutie	Russie	149.500000	62.166668	870		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_1066	Yakutie	Russie	149.000000	62.080002	1040		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_1067	Yakutie	Russie	149.000000	62.099999	1053		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_1068	Yakutie	Russie	151.720001	61.016998	900		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_1069	Yakutie	Russie	151.880005	60.750000	810		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_107		Mongolie	105.716667	49.366667	750		Steppe froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_1070	Yakutie	Russie	150.616669	59.849999	115		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_1071	Yakutie	Russie	151.833328	59.549999	95		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_1072	Yakutie	Russie	149.919998	59.750000	3		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_1073	Yakutie	Russie	149.500000	62.169998	820		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_1074	Yakutie	Russie	149.500000	62.166668	870		Végétation pionnière	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_1075	Yakutie	Russie	151.880005	60.750000	810		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_1076	Yakutie	Russie	151.880005	60.750000	810		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_1077	Yakutie	Russie	151.880005	60.750000	810		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_1078	Yakutie	Russie	151.000000	60.119999	400		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_1079	Yakutie	Russie	151.149994	60.320000	850		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_108		Mongolie	106.266667	49.716667	600		Steppe froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_1080	Yakutie	Russie	151.716660	61.033333	980		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_1081	Yakutie	Russie	152.080002	61.169998	870		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_1082	Yakutie	Russie	152.270004	61.119999	810		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_1083	Yakutie	Russie	152.330002	61.130001	750		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_1084	Yakutie	Russie	147.649994	63.380001	969		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_1085	Yakutie	Russie	147.630005	63.320000	850		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_1086	Yakutie	Russie	148.199997	64.180000	850		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_1087	Yakutie	Russie	144.929993	64.300003	700		Toundra	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_1088	Yakutie	Russie	144.899994	64.300003	700		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_1089	Yakutie	Russie	143.779999	64.500000	550		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000

Nom	Site	Pays	Longitude	Latitude	Altitude	Nature du prélèvement	Biome	Auteur	Source	Référence
SU_109		Mongolie	106.083333	50.200000	560		Steppe froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_1090	Yakutie	Russie	141.116669	64.766670	800		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_1091	Yakutie	Russie	145.160004	64.220001	800		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_1092	Yakutie	Russie	151.729996	62.650002	790		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_1093	Yakutie	Russie	149.199997	62.317001	340		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_1094	Yakutie	Russie	172.080002	67.500000	490		Steppe froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_1095	Yakutie	Russie	172.080002	67.500000	490		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_1096	Yakutie	Russie	172.080002	67.500000	490		Toundra	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_1097	Yakutie	Russie	152.316666	60.133335	480		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_1098	Yakutie	Russie	152.100006	59.950001	660		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_1099	Yakutie	Russie	151.833328	59.000000	700		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_11		Russie	29.950000	66.266667	137		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_110		Mongolie	106.166667	50.266667	550		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_1100	Yakutie	Russie	151.850006	59.016666	580		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_1101	Yakutie	Russie	175.516663	64.783333	32		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_1102	Yakutie	Russie	175.300003	64.816666	36		Toundra	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_1103	Yakutie	Russie	175.250000	64.833336	36		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_1104	Yakutie	Russie	174.633331	64.766670	30		Toundra	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_1105	Yakutie	Russie	177.166672	64.500000	55		Steppe froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_1106	Yakutie	Russie	150.649994	59.566666	309		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_1107	Yakutie	Russie	151.250000	59.683300	35		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_1108	Yakutie	Russie	151.330002	59.599999	6	Mousses	Toundra	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_1109	Yakutie	Russie	151.330002	59.599999	6	Mousses	Toundra	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_111		Mongolie	105.950000	50.033333	600		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_112		Mongolie	106.916667	49.516667	570		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_113		Russie	106.616667	50.250000	600		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_114		Mongolie	106.866667	47.800000	1850		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_115		Mongolie	106.350000	48.066667	1800		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_116		Mongolie	109.400000	48.133333	1326		Steppe froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_117		Mongolie	108.583333	48.350000	1600		Steppe froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_118		Mongolie	108.666667	48.316667	1400		Steppe froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_119		Mongolie	109.916667	47.400000	1100		Steppe froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_12		Russie	29.916667	66.350000	440		Forêt de conifères	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_120		Mongolie	114.116667	48.216667	800		Steppe froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_121		Mongolie	116.883333	47.216667	660		Steppe froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_122		Mongolie	117.750000	47.666667	600		Steppe froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_123		Mongolie	109.333333	46.600000	1300		Steppe froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_124		Mongolie	118.883333	47.533333	700		Steppe froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_125		Mongolie	119.766667	46.716667	1050		Steppe froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_126		Mongolie	118.700000	47.483333	710		Steppe froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_127		Mongolie	108.350000	46.333333	1160		Steppe froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_128		Mongolie	110.216667	45.000000	900		Steppe froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000

Nom	Site	Pays	Longitude	Latitude	Altitude	Nature du prélèvement	Biome	Auteur	Source	Référence
SU_129		Mongolie	109.550000	44.700000	1000		Steppe froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_13		Russie	34.466667	65.833333	10		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_131		Mongolie	96.033333	48.416667	2100		Steppe froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_132		Mongolie	98.516667	47.533333	2455		Steppe froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_133		Mongolie	97.516667	47.583333	2200		Steppe froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_134		Mongolie	95.433333	48.600000	1600		Désert froid	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_135		Mongolie	100.100000	46.516667	2029		Steppe froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_136		Mongolie	101.850000	46.516667	2500		Steppe froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_137		Mongolie	94.983333	46.133333	1013		Steppe froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_138		Mongolie	95.366667	46.250000	1020		Steppe froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_139		Mongolie	94.583333	47.416667	1400		Steppe froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_14		Russie	32.983333	65.116667	100		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_140		Mongolie	99.333333	51.416667	1543		Steppe froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_141		Mongolie	99.333333	51.433333	1543		Steppe froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_142		Mongolie	99.016667	50.166667	1750		Forêt de conifères	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_143		Mongolie	98.250000	49.266667	1700		Steppe froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_144		Mongolie	98.016667	48.733333	1760		Steppe froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_145		Mongolie	100.566667	48.483333	1500		Steppe froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_146		Mongolie	100.500000	48.450000	1790		Steppe froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_147		Mongolie	100.566667	48.450000	1500		Steppe froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_148		Mongolie	100.450000	48.350000	1780		Steppe froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_149		Mongolie	100.183333	47.716667	1900		Steppe froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_15		Russie	32.983333	65.116667	100		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_150		Mongolie	100.316667	47.700000	1900		Steppe froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_151		Mongolie	100.300000	47.616667	1900		Steppe froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_152		Mongolie	99.916667	47.266667	2250		Steppe froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_153		Mongolie	99.833333	47.183333	2300		Steppe froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_154		Mongolie	99.916667	47.166667	2500		Steppe froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_155		Mongolie	100.533333	47.100000	2300		Steppe froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_156		Mongolie	102.616667	46.483333	1800		Steppe froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_157		Mongolie	101.200000	46.316667	2100		Steppe froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_158		Mongolie	100.633333	45.450000	1450		Steppe froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_159		Mongolie	93.883333	48.133333	1200		Steppe froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_16		Russie	32.983333	65.116667	100		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_160		Mongolie	95.250000	47.533333	1400		Steppe froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_161		Mongolie	95.300000	47.550000	1350		Steppe froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_163		Russie	39.480000	57.170000	93		Forêt de conifères	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_164		Russie	39.480000	57.170000	93		Forêt de conifères	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_165		Russie	39.480000	57.170000	93		Forêt mixte fraîche	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_166		Russie	39.480000	57.170000	93		Forêt mixte fraîche	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_167		Russie	39.480000	57.170000	93		Forêt mixte fraîche	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_168		Russie	39.480000	57.170000	93		Forêt de conifères	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000

Nom	Site	Pays	Longitude	Latitude	Altitude	Nature du prélèvement	Biome	Auteur	Source	Référence
SU_169		Russie	39.480000	57.170000	93		Forêt mixte fraîche	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_17		Russie	32.633333	65.116667	110		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_170		Russie	39.480000	57.170000	93		Forêt mixte fraîche	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_171		Russie	39.480000	57.170000	93		Forêt de conifères	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_172		Russie	39.480000	57.170000	93		Forêt de conifères	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_173		Russie	39.480000	57.170000	93		Forêt de conifères	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_174		Russie	39.480000	57.170000	93		Forêt de conifères	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_175		Russie	39.480000	57.170000	93		Forêt de conifères	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_176		Russie	39.480000	57.170000	93		Forêt de conifères	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_177		Kazakhstan	67.800000	54.150000	90	Mousses	Steppe froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_178		Kazakhstan	70.580000	52.880000	382		Steppe froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_179		Kazakhstan	70.930000	51.930000	370	Mousses	Steppe froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_18		Russie	43.333333	64.666667	65		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_180		Kazakhstan	67.830000	53.750000	156	Mousses	Steppe froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_181		Kazakhstan	66.850000	52.950000	235	Mousses	Steppe froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_182		Kazakhstan	69.250000	54.080000	123	Mousses	Steppe froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_183		Kazakhstan	69.350000	53.320000	223	Mousses	Steppe froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_184		Kazakhstan	73.420000	53.330000	64	Mousses	Steppe froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_185		Kazakhstan	67.930000	51.580000	260	Mousses	Steppe froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_186		Kazakhstan	67.320000	50.900000	270	Mousses	Steppe froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_187		Kazakhstan	68.900000	50.470000	304	Mousses	Steppe froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_188		Kazakhstan	69.310000	50.680000	304	Mousses	Steppe froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_189		Kazakhstan	69.140000	50.370000	307	Mousses	Steppe froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_19		Russie	36.416667	63.566667	230		Forêt de conifères	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_190		Kazakhstan	66.330000	43.880000	59	Mousses	Steppe froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_191		Kazakhstan	62.000000	46.170000	59	Mousses	Désert froid	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_192		Kazakhstan	63.950000	45.580000	90		Steppe froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_193		Kazakhstan	64.580000	45.170000	110		Steppe froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_194		Kazakhstan	74.620000	45.020000	342		Désert froid	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_195		Kazakhstan	73.660000	45.420000	342		Désert froid	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_197		Kazakhstan	80.740000	46.670000	350		Steppe froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_198		Kazakhstan	81.320000	46.400000	346		Steppe froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_199		Kazakhstan	81.650000	45.930000	343		Steppe froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_20		Russie	33.016667	63.500000	150		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_200		Kazakhstan	70.700000	43.420000	400		Désert froid	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_201		Kazakhstan	70.720000	43.120000	438		Steppe froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_202		Kazakhstan	76.240000	42.430000	1608	Mousses	Désert froid	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_203		Kazakhstan	78.120000	42.560000	1608	Mousses	Steppe froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_204		Kazakhstan	85.670000	48.800000	1449	Mousses	Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_205		Kazakhstan	69.250000	54.520000	140	Mousses	Steppe froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_206		Kazakhstan	68.420000	54.370000	125	Mousses	Steppe froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_207		Kazakhstan	69.330000	53.830000	175	Mousses	Steppe froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000

Nom	Site	Pays	Longitude	Latitude	Altitude	Nature du prélèvement	Biome	Auteur	Source	Référence
SU_208		Kazakhstan	70.580000	52.530000	505		Steppe froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_209		Kazakhstan	70.670000	52.830000	400	Mousses	Végétation pionnière	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_21		Russie	36.016667	62.933333	150		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_210		Kazakhstan	70.680000	52.850000	400	Mousses	Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_211		Kazakhstan	73.200000	51.580000	450	Mousses	Steppe froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_212		Kazakhstan	67.830000	54.200000	150	Mousses	Steppe froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_213		Kazakhstan	69.670000	54.200000	140	Mousses	Steppe froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_214		Kazakhstan	67.000000	53.880000	160	Mousses	Steppe froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_215		Kazakhstan	66.770000	53.780000	160	Mousses	Steppe froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_216		Kazakhstan	67.450000	53.750000	150	Mousses	Steppe froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_217		Kazakhstan	69.380000	53.330000	240	Mousses	Steppe froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_218		Kazakhstan	71.000000	52.000000	370	Mousses	Steppe froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_219		Kazakhstan	71.000000	51.670000	370	Mousses	Steppe froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_22		Russie	36.033333	62.933333	148		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_220		Kazakhstan	71.500000	51.170000	350	Mousses	Steppe froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_221		Kazakhstan	67.230000	51.200000	260	Mousses	Steppe froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_222		Kazakhstan	72.880000	50.080000	500	Mousses	Steppe froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_223		Kazakhstan	66.220000	52.000000	220	Mousses	Steppe froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_224		Kazakhstan	67.920000	50.580000	280	Mousses	Steppe froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_225		Kazakhstan	75.080000	51.080000	300	Mousses	Steppe froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_226		Kazakhstan	72.880000	49.170000	650	Mousses	Steppe froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_227		Kazakhstan	80.330000	49.830000	400	Mousses	Steppe froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_228		Kazakhstan	57.200000	50.250000	250		Steppe froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_229		Kazakhstan	69.000000	50.670000	330	Mousses	Steppe froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_23		Russie	33.566667	62.816667	157		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_230		Kazakhstan	69.670000	50.670000	320	Mousses	Steppe froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_231		Kazakhstan	69.920000	50.220000	330	Mousses	Steppe froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_232		Kazakhstan	72.220000	50.830000	470	Mousses	Désert froid	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_233		Kazakhstan	80.430000	47.920000	650	Mousses	Steppe froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_234		Kazakhstan	57.920000	50.280000	430	Mousses	Désert froid	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_235		Kazakhstan	71.670000	48.670000	480	Mousses	Steppe froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_236		Kazakhstan	72.830000	48.250000	700	Mousses	Steppe froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_237		Kazakhstan	66.050000	47.830000	370		Steppe froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_238		Kazakhstan	70.000000	48.380000	400	Mousses	Steppe froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_239		Kazakhstan	74.050000	47.980000	800	Mousses	Steppe froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_24		Russie	33.200000	62.800000	160		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_240		Kazakhstan	66.750000	47.830000	500	Mousses	Désert froid	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_241		Kazakhstan	77.500000	47.000000	550		Steppe froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_242		Kazakhstan	73.800000	46.370000	350		Désert froid	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_244		Kazakhstan	50.330000	44.500000	50		Steppe froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_245		Kazakhstan	78.950000	46.250000	450		Steppe froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_246		Kazakhstan	73.670000	45.420000	350		Désert froid	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000

Nom	Site	Pays	Longitude	Latitude	Altitude	Nature du prélèvement	Biome	Auteur	Source	Référence
SU_247		Russie	52.170000	47.170000	0		Désert froid	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_248		Russie	52.080000	47.330000	0		Désert froid	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_249		Kazakhstan	69.920000	43.750000	330		Steppe froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_25		Russie	33.200000	62.800000	160		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_250		Kazakhstan	70.920000	42.730000	950		Steppe froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_251		Kazakhstan	71.250000	42.830000	650		Steppe froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_252		Kazakhstan	76.330000	43.600000	600	Mousses	Steppe froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_253		Kazakhstan	76.830000	43.350000	700	Mousses	Steppe froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_254		Kazakhstan	85.500000	48.750000	1700		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_255		Kazakhstan	85.670000	48.830000	1700		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_256		Kazakhstan	76.330000	42.300000	1700	Mousses	Désert froid	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_257		Kazakhstan	83.080000	48.250000	400		Désert froid	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_258		Kazakhstan	80.470000	50.420000	210		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_259		Kazakhstan	70.400000	53.180000	239		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_26		Russie	33.200000	62.800000	160		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_260		Kazakhstan	70.220000	53.030000	435	Mousses	Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_261		Kazakhstan	70.230000	53.030000	436	Mousses	Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_263		Kazakhstan	75.400000	49.370000	872		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_264		Kazakhstan	75.380000	49.370000	875		Steppe froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_265		Kazakhstan	64.250000	53.770000	178	Mousses	Steppe froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_266		Kazakhstan	64.270000	53.780000	190		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_267	Yakutie	Russie	136.270000	70.750000	0	Mousses	Toundra	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_268	Yakutie	Russie	136.270000	70.750000	0	Mousses	Toundra	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_269	Yakutie	Russie	136.270000	70.750000	0	Mousses	Toundra	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_27		Russie	33.033333	62.766667	172		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_270	Yakutie	Russie	136.270000	70.750000	0	Mousses	Toundra	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_271	Yakutie	Russie	136.270000	70.750000	0	Mousses	Toundra	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_272	Yakutie	Russie	136.270000	70.750000	0	Mousses	Toundra	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_273	Yakutie	Russie	136.530000	70.970000	0	Mousses	Toundra	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_274	Yakutie	Russie	136.530000	70.840000	0	Mousses	Toundra	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_275	Yakutie	Russie	136.000000	71.150000	0	Mousses	Toundra	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_276	Yakutie	Russie	136.000000	71.150000	0	Mousses	Toundra	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_277	Yakutie	Russie	136.000000	71.150000	0	Mousses	Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_278	Yakutie	Russie	136.000000	71.150000	0	Mousses	Toundra	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_279	Yakutie	Russie	135.750000	70.000000	100	Mousses	Toundra	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_28		Russie	33.033333	62.766667	172		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_280	Yakutie	Russie	134.580000	67.750000	180	Mousses	Toundra	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_281	Yakutie	Russie	134.580000	67.750000	180	Mousses	Toundra	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_282	Yakutie	Russie	134.750000	67.780000	180	Mousses	Toundra	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_283	Yakutie	Russie	134.920000	67.780000	190	Mousses	Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_284	Yakutie	Russie	134.830000	67.670000	190	Mousses	Toundra	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_285	Yakutie	Russie	134.830000	67.500000	200	Mousses	Toundra	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000

Nom	Site	Pays	Longitude	Latitude	Altitude	Nature du prélèvement	Biome	Auteur	Source	Référence
SU_286	Yakutie	Russie	134.870000	67.830000	200	Mousses	Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_287	Yakutie	Russie	135.580000	67.580000	200	Mousses	Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_288	Yakutie	Russie	135.420000	67.670000	200	Mousses	Toundra	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_289	Yakutie	Russie	135.580000	67.920000	200	Mousses	Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_29		Russie	33.033333	62.766667	172		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_290	Yakutie	Russie	136.500000	66.750000	250	Mousses	Toundra	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_291	Yakutie	Russie	134.750000	67.330000	220	Mousses	Toundra	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_292	Yakutie	Russie	134.500000	67.670000	190	Mousses	Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_293	Yakutie	Russie	134.670000	67.620000	220	Mousses	Toundra	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_294	Yakutie	Russie	134.750000	67.750000	220	Mousses	Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_295	Yakutie	Russie	135.000000	67.750000	200	Mousses	Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_296	Yakutie	Russie	135.170000	67.990000	200	Mousses	Toundra	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_297	Yakutie	Russie	134.830000	67.500000	220	Mousses	Toundra	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_298	Yakutie	Russie	135.580000	67.720000	200	Mousses	Toundra	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_299	Yakutie	Russie	135.420000	67.920000	220	Mousses	Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_30		Russie	33.666667	62.633333	150		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_300	Yakutie	Russie	136.500000	66.500000	250	Mousses	Toundra	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_301	Yakutie	Russie	125.000000	64.000000	120	Mousses	Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_302	Yakutie	Russie	125.000000	64.000000	120	Mousses	Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_303	Yakutie	Russie	125.000000	64.000000	120	Mousses	Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_304	Yakutie	Russie	125.000000	64.000000	120	Mousses	Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_305	Yakutie	Russie	135.000000	67.750000	150	Mousses	Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_306	Yakutie	Russie	135.000000	67.750000	150	Mousses	Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_307	Yakutie	Russie	141.670000	64.670000	600	Mousses	Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_308	Yakutie	Russie	143.170000	64.670000	600	Mousses	Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_309	Yakutie	Russie	150.750000	59.500000	150	Mousses	Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_31		Russie	33.650000	62.283333	117		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_310	Yakutie	Russie	150.750000	59.920000	300	Mousses	Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_311	Yakutie	Russie	151.000000	65.500000	100	Mousses	Toundra	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_312	Yakutie	Russie	161.330000	69.000000	50	Mousses	Forêt mixte froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_313	Yakutie	Russie	151.000000	65.500000	100	Mousses	Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_314	Yakutie	Russie	151.330000	60.170000	500	Mousses	Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_315	Yakutie	Russie	150.750000	59.500000	150	Mousses	Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_316	Yakutie	Russie	147.500000	62.670000	500	Mousses	Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_317	Yakutie	Russie	151.330000	60.170000	1060	Mousses	Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_318	Yakutie	Russie	151.330000	60.170000	1000	Mousses	Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_319	Yakutie	Russie	151.000000	65.500000	100	Mousses	Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_32		Russie	33.650000	62.283333	117		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_320	Yakutie	Russie	141.670000	64.700000	500	Mousses	Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_321	Yakutie	Russie	141.670000	64.670000	400	Mousses	Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_323	Yakutie	Russie	150.750000	59.500000	200	Mousses	Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_324	Yakutie	Russie	150.170000	60.000000	300	Mousses	Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000

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SU_325	Yakutie	Russie	147.500000	62.670000	600	Mousses	Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_326	Yakutie	Russie	150.170000	60.000000	300	Mousses	Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_327	Yakutie	Russie	161.330000	69.000000	50	Mousses	Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_328	Yakutie	Russie	151.000000	65.500000	100	Mousses	Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_329	Yakutie	Russie	141.750000	64.750000	500	Mousses	Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_33		Russie	34.433333	62.466667	54		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_330	Yakutie	Russie	135.000000	67.750000	150	Mousses	Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_331	Yakutie	Russie	147.500000	62.670000	500	Mousses	Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_332	Yakutie	Russie	147.500000	62.670000	400	Mousses	Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_333	Yakutie	Russie	173.000000	69.500000	70	Mousses	Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_334	Yakutie	Russie	173.000000	69.500000	70	Mousses	Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_335	Yakutie	Russie	173.330000	69.750000	50	Mousses	Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_336	Yakutie	Russie	173.330000	69.750000	50	Mousses	Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_337	Yakutie	Russie	180.000000	66.000000	100		Steppe chaude	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_338	Yakutie	Russie	180.000000	66.000000	100		Steppe froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_339	Yakutie	Russie	118.500000	63.500000	150	Mousses	Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_34		Russie	34.433333	62.466667	54		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_340	Yakutie	Russie	117.500000	62.250000	150	Mousses	Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_341	Yakutie	Russie	117.500000	62.250000	150	Mousses	Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_342	Yakutie	Russie	128.750000	63.500000	250	Mousses	Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_343	Yakutie	Russie	129.500000	62.250000	250	Mousses	Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_344	Yakutie	Russie	129.500000	62.250000	250	Mousses	Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_345	Yakutie	Russie	128.750000	63.300000	250	Mousses	Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_346	Yakutie	Russie	129.330000	62.000000	200	Mousses	Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_347	Yakutie	Russie	129.330000	62.000000	200	Mousses	Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_349	Yakutie	Russie	128.750000	63.500000	250	Mousses	Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_35		Russie	33.850000	62.316667	66		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_350	Yakutie	Russie	129.500000	62.420000	250	Mousses	CLDE	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_351	Yakutie	Russie	129.330000	62.000000	200	Mousses	Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_352	Yakutie	Russie	129.330000	62.000000	200	Mousses	Toundra	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_353	Yakutie	Russie	132.170000	62.000000	200	Mousses	Steppe froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_354	Yakutie	Russie	132.170000	62.000000	200	Mousses	Toundra	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_355	Yakutie	Russie	132.170000	62.000000	200	Mousses	Steppe froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_356	Yakutie	Russie	132.170000	62.000000	200	Mousses	Steppe froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_357	Yakutie	Russie	132.170000	62.000000	200	Mousses	Steppe froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_359	Yakutie	Russie	133.500000	62.250000	150	Mousses	Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_36		Russie	34.066667	62.250000	55		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_360	Yakutie	Russie	129.000000	63.330000	200	Mousses	Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_361	Yakutie	Russie	129.000000	63.330000	200	Mousses	Désert froid	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_362	Yakutie	Russie	129.000000	63.330000	200	Mousses	Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_363	Yakutie	Russie	129.000000	63.330000	200	Mousses	Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_364	Yakutie	Russie	129.000000	63.330000	200	Mousses	Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000

Nom	Site	Pays	Longitude	Latitude	Altitude	Nature du prélèvement	Biome	Auteur	Source	Référence
SU_365	Yakutie	Russie	127.500000	63.000000	150	Mousses	Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_366	Yakutie	Russie	127.500000	63.000000	150	Mousses	Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_367	Yakutie	Russie	127.500000	63.000000	150	Mousses	Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_369	Yakutie	Russie	129.370000	61.990000	200	Mousses	Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_37		Russie	34.050000	62.250000	58		Végétation pionnière	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_370	Yakutie	Russie	135.230000	71.050000	15	Mousses	Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_371	Yakutie	Russie	121.620000	63.720000	150	Mousses	Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_372	Yakutie	Russie	123.250000	63.670000	20	Mousses	Toundra	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_373	Yakutie	Russie	129.370000	61.990000	200	Mousses	Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_374	Yakutie	Russie	129.550000	61.300000	260	Mousses	Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_375	Yakutie	Russie	120.970000	64.840000	160	Mousses	Toundra	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_376	Yakutie	Russie	123.250000	63.670000	120	Mousses	Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_377		Russie	30.330000	60.050000	77		Forêt de conifères	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_378		Russie	69.000000	59.350000	77		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_38		Russie	34.066667	62.233333	50		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_380		Russie	83.080000	56.870000	458		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_381		Russie	86.583333	67.466667	77		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_382		Russie	84.000000	70.000000	77		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_383		Russie	78.400000	60.333333	77		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_384		Russie	68.820000	58.750000	77		Forêt de conifères	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_385		Russie	60.500000	57.916667	229		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_386		Russie	60.080000	57.000000	229		Forêt de conifères	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_387		Russie	34.830000	57.520000	229		Forêt de conifères	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_389		Georgie	41.720000	42.080000	458		Forêt mixte fraîche	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_39		Russie	34.066667	62.233333	50		Forêt de conifères	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_390		Russie	32.200000	61.750000	77		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_391		Russie	31.083333	64.583333	229		Toundra	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_392		Russie	37.900000	57.570000	77		Forêt mixte fraîche	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_393		Russie	39.000000	56.830000	77		Forêt mixte fraîche	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_394		Russie	30.170000	60.000000	77		Forêt mixte fraîche	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_395		Russie	52.550000	67.170000	77		Toundra	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_396		Russie	110.030000	54.330000	458		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_397		Russie	56.320000	57.780000	229		Forêt de conifères	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_398		Russie	79.020000	60.030000	77		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_399		Russie	35.950000	56.950000	77		Forêt mixte fraîche	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_40		Russie	34.066667	62.233333	50		Forêt de conifères	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_400		Russie	84.450000	56.830000	77		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_401		Lettonie	24.970000	58.150000	77		Forêt mixte fraîche	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_402		Russie	83.083333	56.866667	77		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_403		Russie	37.000000	67.500000	77		Toundra	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_404		Russie	35.933333	52.600000	229		Steppe froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_405		Russie	35.416667	52.250000	229		Forêt mixte fraîche	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000

Nom	Site	Pays	Longitude	Latitude	Altitude	Nature du prélèvement	Biome	Auteur	Source	Référence
SU_406		Georgie	43.250000	43.200000	77		Steppe froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_407		Russie	35.370000	53.030000	77		Forêt mixte fraîche	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_409		Russie	65.470000	64.170000	77		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_41		Russie	34.066667	62.233333	50		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_410		Russie	80.000000	55.320000	77		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_411		Russie	81.570000	55.500000	77		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_412		Russie	69.000000	66.000000	77		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_413		Russie	70.000000	69.000000	77		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_414		Russie	59.170000	54.670000	458		Forêt de conifères	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_415		Russie	78.250000	65.670000	77		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_416		Russie	92.950000	53.166667	458		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_417		Kirghizstan	78.000000	42.333333	1068		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_418		Russie	48.720000	55.550000	77		Forêt de conifères	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_419		Russie	47.533333	54.216667	229		Forêt mixte fraîche	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_42		Russie	34.066667	62.233333	50		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_420		Ukraine	31.350000	49.816667	77		Forêt tempérée décidue	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_421		Ukraine	25.500000	49.666667	229		Steppe froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_422		Ukraine	24.650000	50.366667	229		Forêt mixte fraîche	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_423		Russie	142.080000	51.400000	229		Forêt mixte fraîche	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_424		Russie	158.800000	54.800000	150		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_425		Russie	159.970000	56.220000	150		Toundra	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_426	Yakutie	Russie	129.580000	62.000000	229		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_427		Russie	140.450000	52.330000	77		Forêt mixte fraîche	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_428	Yakutie	Russie	141.870000	64.300000	458		Toundra	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_429		Russie	84.000000	70.000000	0		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_43		Russie	34.066667	62.233333	50		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_430		Russie	72.450000	67.400000	20		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_431		Russie	72.860000	67.660000	20		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_432		Russie	70.580000	68.830000	20		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_433		Russie	67.160000	67.600000	80		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_435		Russie	70.000000	66.000000	20		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_436		Russie	86.250000	69.410000	100		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_437		Russie	86.700000	66.880000	100		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_438		Russie	53.180000	67.880000	20		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_439		Russie	52.550000	67.160000	20		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_44		Russie	33.833333	62.183333	90		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_440		Russie	69.000000	66.000000	50		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_441		Russie	70.000000	69.000000	50		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_442		Russie	65.030000	63.930000	50		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_443		Russie	71.000000	67.000000	20		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_444		Russie	65.000000	64.660000	50		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_445		Russie	65.500000	63.500000	20		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000

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SU_446		Russie	65.460000	64.160000	50		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_447		Russie	78.250000	65.660000	50		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_448		Russie	83.000000	66.830000	100		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_449		Russie	86.000000	68.660000	150		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_45		Russie	35.200000	62.050000	35		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_450		Russie	88.500000	64.660000	100		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_451		Russie	69.500000	66.330000	100		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_452		Russie	65.000000	63.660000	50		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_453		Russie	73.000000	61.500000	50		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_454		Russie	74.660000	61.000000	50		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_455		Russie	73.330000	61.230000	50		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_456		Russie	86.580000	67.460000	160		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_457		Russie	87.500000	68.000000	150		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_458		Russie	86.500000	66.500000	150		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_459		Russie	82.760000	66.560000	100		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_46		Russie	35.200000	62.050000	35		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_460		Russie	66.500000	66.830000	200		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_461		Russie	56.950000	65.950000	80		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_462		Russie	56.000000	66.350000	80		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_463		Russie	32.450000	67.180000	120		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_464		Russie	71.000000	61.080000	50		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_465		Russie	68.500000	63.500000	100		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_466		Russie	76.960000	60.930000	100		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_467		Russie	78.433300	60.330000	100		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_468		Russie	79.010000	60.030000	100		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_469		Russie	89.000000	66.000000	150		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_47		Russie	35.216667	62.066667	35		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_470		Russie	79.660000	59.660000	100		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_471		Russie	81.830000	59.000000	100		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_472		Russie	83.830000	57.330000	100		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_473		Russie	79.000000	61.330000	100		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_474		Russie	88.330000	62.660000	150		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_475		Russie	92.160000	58.450000	150		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_476		Russie	45.310000	67.660000	20		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_477		Russie	69.000000	61.000000	50		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_478		Russie	64.530000	67.750000	200		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_479		Russie	56.660000	63.830000	80		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_480		Russie	32.990000	67.776700	150		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_482		Kazakhstan	76.950000	52.300000	150		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_483		Kazakhstan	76.700000	52.700000	150		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_484		Kazakhstan	75.300000	53.530000	150		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_485		Russie	75.080000	55.750000	100		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000

Nom	Site	Pays	Longitude	Latitude	Altitude	Nature du prélèvement	Biome	Auteur	Source	Référence
SU_486		Russie	94.000000	56.160000	300		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_487		Russie	31.750000	67.000000	150		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_488		Russie	69.000000	59.350000	50		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_489		Russie	68.810000	58.750000	50		Forêt de conifères	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_49		Russie	35.216667	62.050000	35		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_490		Russie	33.180000	67.460000	120		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_491		Russie	32.980000	67.080000	150		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_492		Russie	67.500000	62.160000	100		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_493		Russie	37.000000	67.500000	200		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_494		Russie	34.850000	67.810000	200		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_495		Russie	33.830000	69.260000	150		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_496		Russie	83.080000	56.860000	173		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_497		Russie	84.450000	56.830000	170		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_498		Russie	80.000000	55.310000	150		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_499		Russie	81.560000	55.500000	133		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_50		Russie	35.216667	62.050000	35		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_500		Russie	84.000000	56.830000	150		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_501		Russie	83.330000	56.000000	150		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_502		Russie	83.500000	55.330000	200		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_503		Russie	87.000000	57.250000	150		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_504		Russie	84.660000	56.160000	200		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_505		Russie	88.500000	64.000000	200		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_506		Russie	89.000000	61.660000	150		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_507		Russie	93.500000	57.000000	200		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_508		Russie	67.160000	67.600000	300		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_509		Russie	53.660000	61.700000	100		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_51		Russie	35.383333	62.516667	37		Forêt de conifères	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_510		Russie	49.000000	63.250000	150		Forêt de conifères	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_511		Russie	54.000000	61.830000	200		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_512		Russie	51.910000	62.750000	150		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_513		Russie	92.950000	53.160000	400		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_514		Russie	31.250000	69.530000	20		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_515		Russie	30.810000	69.680000	50		Végétation pionnière	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_516		Russie	33.460000	67.153300	50		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_517		Russie	35.000000	66.950000	120		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_518		Russie	85.000000	52.410000	200		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_519		Russie	82.660000	54.830000	200		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_52		Russie	33.483333	61.800000	20		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_520		Russie	82.000000	53.330000	200		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_521		Russie	83.660000	54.750000	200		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_522		Russie	31.860000	63.210000	200		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_523		Russie	36.410000	63.960000	100		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000

Nom	Site	Pays	Longitude	Latitude	Altitude	Nature du prélèvement	Biome	Auteur	Source	Référence
SU_524		Russie	41.280000	66.980000	100		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_526		Russie	44.000000	64.000000	50		Forêt de conifères	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_527		Russie	42.330000	63.310000	80		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_528		Russie	56.310000	57.780000	200		Forêt de conifères	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_529		Russie	84.000000	69.330000	100		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_53		Russie	33.483333	61.800000	20		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_530		Kazakhstan	75.410000	45.110000	200		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_531		Russie	93.500000	56.500000	400		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_532		Russie	86.580000	67.460000	300		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_533		Russie	60.080000	57.000000	300		Forêt de conifères	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_534		Russie	82.610000	53.460000	300		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_535		Russie	85.250000	52.560000	300		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_536		Russie	31.135000	61.870000	75		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_537		Russie	34.510000	63.080000	117		Forêt de conifères	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_538		Russie	34.510000	61.750000	147		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_539		Russie	32.200000	61.750000	100		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_54		Russie	33.483333	61.800000	20		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_540		Russie	60.500000	57.910000	200		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_541		Arménie	43.600000	41.050000	2200		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_542		Russie	53.280000	55.880000	80		Forêt de conifères	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_543		Russie	53.980000	57.160000	150		Forêt de conifères	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_544		Russie	86.000000	69.660000	100		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_545		Kazakhstan	71.250000	48.460000	400		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_546		Kazakhstan	75.000000	44.160000	300		Désert froid	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_547		Kazakhstan	76.750000	47.250000	300		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_548		Kazakhstan	79.250000	50.610000	250		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_549		Kazakhstan	81.660000	51.000000	300		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_55		Russie	34.150000	61.766667	120		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_550		Russie	87.830000	50.500000	400		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_551		Russie	49.200000	55.360000	50		Forêt mixte fraîche	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_552		Russie	48.710000	55.550000	80		Forêt de conifères	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_553		Russie	86.210000	52.680000	400		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_554		Russie	85.595000	52.695000	350		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_555		Russie	29.136700	60.536700	40		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_556		Russie	29.383300	61.096700	50		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_557		Russie	29.680000	60.530000	20		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_558		Russie	30.510000	60.560000	50		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_559		Russie	30.910000	60.110000	25		Forêt de conifères	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_56		Russie	34.150000	61.766667	120		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_560		Russie	40.960000	57.760000	100		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_561		Russie	38.380000	59.860000	150		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_562		Russie	38.580000	59.950000	150		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000

Nom	Site	Pays	Longitude	Latitude	Altitude	Nature du prélèvement	Biome	Auteur	Source	Référence
SU_563		Russie	28.500000	60.680000	20		Forêt de conifères	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_564		Russie	29.485000	60.245000	20		Forêt de conifères	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_565		Russie	29.780000	60.880000	50		Forêt mixte fraîche	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_566		Russie	37.550000	58.550000	80		Forêt mixte fraîche	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_567		Russie	67.160000	67.580000	500		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_568		Russie	58.910000	54.550000	1000		Forêt de conifères	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_569		Kazakhstan	73.610000	46.250000	400		Désert froid	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_57		Russie	34.150000	61.766667	120		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_570		Kazakhstan	63.000000	49.210000	50		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_571		Kazakhstan	74.000000	45.000000	340		Forêt mixte froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_572		Kazakhstan	79.830000	50.660000	300		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_573		Kazakhstan	81.750000	46.410000	400		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_574		Kazakhstan	80.830000	45.580000	400		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_575		Kazakhstan	80.660000	47.660000	400		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_576		Kazakhstan	82.050000	47.410000	1285		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_577		Russie	49.060000	54.960000	50		Forêt mixte fraîche	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_578		Russie	49.430000	53.510000	100		Forêt tempérée décidue	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_579		Russie	50.150000	53.200000	80		Forêt mixte fraîche	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_58		Russie	34.150000	61.766667	120		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_580		Russie	49.960000	52.400000	80		Forêt mixte fraîche	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_581		Russie	49.660000	53.500000	100		Forêt de conifères	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_582		Russie	49.400000	53.210000	50		Forêt de conifères	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_583		Russie	49.160000	53.300000	200		Forêt de conifères	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_584		Kazakhstan	76.660000	43.410000	400		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_585		Russie	28.000000	58.810000	50		Forêt de conifères	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_586		Russie	31.030000	56.560000	100		Forêt de conifères	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_587		Russie	30.282500	60.007500	28		Forêt de conifères	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_588		Estonie	27.390000	59.310000	20		Forêt mixte fraîche	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_589		Estonie	27.250000	58.420000	50		Forêt mixte fraîche	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_59		Russie	36.050000	61.066667	50		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_590		Estonie	26.660000	59.500000	20		Forêt de conifères	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_591		Russie	30.495000	59.730000	35		Forêt de conifères	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_592		Estonie	27.000000	59.310000	100		Forêt de conifères	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_593		Estonie	26.680000	58.710000	100		Forêt de conifères	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_594		Russie	37.750000	56.500000	100		Forêt mixte fraîche	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_595		Russie	31.310000	58.500000	100		Forêt mixte fraîche	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_596		Russie	34.830000	57.510000	165		Forêt de conifères	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_597		Russie	59.160000	54.660000	800		Forêt de conifères	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_598		Russie	37.510000	56.350000	120		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_599		Russie	37.860000	55.980000	150		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_60		Russie	32.166667	62.083333	124		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_600		Russie	37.380000	56.065000	200		Forêt mixte fraîche	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000

Nom	Site	Pays	Longitude	Latitude	Altitude	Nature du prélèvement	Biome	Auteur	Source	Référence
SU_601		Russie	31.060000	58.950000	50		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_602		Russie	37.900000	57.560000	100		Forêt mixte fraîche	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_603		Russie	38.910000	56.800000	150		Forêt mixte fraîche	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_604		Russie	38.660000	57.000000	150		Forêt mixte fraîche	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_605		Russie	40.410000	56.800000	100		Forêt mixte fraîche	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_606		Russie	39.450000	57.150000	100		Forêt mixte fraîche	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_607		Russie	37.350000	55.780000	180		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_608		Russie	41.630000	57.100000	100		Forêt tempérée décidue	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_609		Russie	30.000000	60.410000	100		Forêt mixte fraîche	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_61		Mongolie	88.300000	48.666667	2083		Steppe froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_610		Russie	58.750000	54.580000	600		Forêt de conifères	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_611		Russie	37.280000	55.450000	150		Forêt de conifères	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_612		Estonie	25.930000	59.250000	50		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_613		Ukraine	24.510000	48.160000	1110		Forêt de conifères	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_614		Georgie	43.250000	43.200000	1800		Forêt mixte fraîche	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_616		Kazakhstan	73.330000	44.250000	300		Désert froid	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_618		Russie	89.810000	54.930000	700		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_619		Kazakhstan	67.750000	47.000000	300		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_62		Mongolie	88.600000	48.566667	2072		Steppe froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_620		Kazakhstan	67.330000	46.550000	250		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_621		Russie	52.300000	52.780000	80		Forêt de conifères	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_622		Kazakhstan	78.160000	45.200000	500		Steppe froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_623		Russie	85.000000	52.410000	500		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_624		Russie	86.000000	52.610000	500		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_625		Estonie	26.705000	58.380000	100		Forêt de conifères	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_626		Russie	27.410000	57.960000	50		Forêt mixte fraîche	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_627		Estonie	26.410000	58.560000	80		Forêt de conifères	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_628		Russie	35.950000	56.950000	80		Forêt mixte fraîche	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_629		Russie	48.500000	53.000000	50		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_63		Mongolie	88.916667	48.600000	2493		Steppe froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_630		Russie	49.250000	52.610000	50		Forêt mixte fraîche	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_631		Russie	37.180000	54.710000	180		Forêt de conifères	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_632		Russie	41.750000	54.960000	100		Forêt mixte froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_633		Lettonie	26.600000	57.300000	100		Forêt de conifères	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_634		Russie	31.850000	55.500000	180		Forêt mixte fraîche	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_635		Russie	39.040000	51.690000	90		Forêt de conifères	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_636		Russie	39.660000	54.660000	150		Forêt mixte fraîche	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_637		Russie	39.300000	54.950000	100		Forêt mixte fraîche	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_638		Russie	38.780000	55.080000	100		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_639		Russie	35.880000	55.580000	180		Forêt mixte fraîche	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_64		Mongolie	88.883333	48.333333	2232		Steppe froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_640		Russie	47.530000	54.510000	200		Forêt mixte fraîche	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000

Nom	Site	Pays	Longitude	Latitude	Altitude	Nature du prélèvement	Biome	Auteur	Source	Référence
SU_641		Lettonie	24.640000	58.043300	20		Forêt mixte fraîche	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_642		Estonie	26.000000	58.460000	80		Forêt de conifères	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_643		Russie	31.590000	54.970000	165		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_644		Estonie	25.000000	59.210000	100		Forêt de conifères	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_645		Lettonie	27.310000	57.660000	200		Forêt mixte fraîche	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_646		Lettonie	26.210000	57.960000	100		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_647		Russie	47.500000	51.750000	80		Forêt mixte fraîche	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_648		Lettonie	24.960000	58.150000	20		Forêt mixte fraîche	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_649		Georgie	42.150000	43.410000	1600		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_65		Mongolie	90.100000	48.583333	2079		Steppe froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_650		Georgie	41.630000	43.300000	1800		Forêt mixte fraîche	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_651		Kazakhstan	66.750000	47.660000	400		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_652		Kazakhstan	67.250000	45.780000	180		Forêt mixte froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_653		Russie	93.660000	55.830000	800		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_655		Kazakhstan	67.250000	45.280000	180		Forêt tempérée décidue	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_656		Kazakhstan	82.750000	48.000000	600		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_657		Russie	46.250000	51.500000	50		Forêt mixte fraîche	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_658		Lituanie	25.690000	55.610000	100		Forêt de conifères	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_659		Lettonie	28.110000	56.030000	120		Forêt de conifères	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_66		Mongolie	90.666667	48.283333	2094		Steppe froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_660		Biélorussie	28.830000	55.180000	180		Forêt mixte fraîche	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_661		Biélorussie	30.160000	55.260000	100		Forêt mixte fraîche	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_662		Russie	35.360000	53.030000	250		Forêt mixte fraîche	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_663		Russie	37.160000	53.960000	150		Forêt mixte fraîche	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_664		Russie	38.830000	52.460000	200		Forêt mixte fraîche	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_665		Russie	36.850000	53.100000	150		Forêt mixte fraîche	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_666		Russie	44.500000	53.000000	200		Forêt tempérée décidue	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_667		Lettonie	23.580000	56.830000	20		Forêt de conifères	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_668		Ukraine	33.350000	52.310000	150		Forêt mixte fraîche	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_669		Russie	35.930000	52.600000	200		Forêt de conifères	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_67		Mongolie	89.800000	49.500000	2097		Steppe froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_670		Russie	36.250000	54.100000	180		Forêt mixte fraîche	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_671		Russie	39.580000	52.610000	150		Forêt mixte fraîche	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_672		Russie	39.050000	51.380000	100		Forêt tempérée décidue	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_673		Russie	40.160000	51.160000	100		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_674		Russie	39.850000	52.550000	180		Forêt mixte fraîche	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_675		Lituanie	25.670000	55.185000	135		Forêt de conifères	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_676		Lituanie	25.010000	55.760000	100		Forêt mixte fraîche	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_677		Lituanie	26.000000	55.160000	150		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_678		Lettonie	27.510000	56.080000	180		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_679		Lituanie	24.030000	54.780000	80		Forêt mixte fraîche	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000

Nom	Site	Pays	Longitude	Latitude	Altitude	Nature du prélèvement	Biome	Auteur	Source	Référence
SU_68		Mongolie	90.600000	49.500000	1435		Steppe froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_680		Lituanie	25.260000	54.810000	120		Forêt de conifères	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_681		Lituanie	25.000000	54.950000	100		Forêt mixte fraîche	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_682		Lituanie	25.250000	54.410000	150		Forêt de conifères	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_683		Lituanie	23.160000	56.210000	50		Forêt mixte fraîche	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_684		Lettonie	21.880000	56.430000	100		Forêt de conifères	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_685		Estonie	24.760000	58.830000	20		Forêt de conifères	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_686		Estonie	24.450000	59.250000	20		Forêt de conifères	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_687		Kazakhstan	72.050000	47.910000	800		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_688		Kazakhstan	67.500000	44.830000	150		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_69		Mongolie	92.300000	47.866667	1157		Steppe froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_690		Kazakhstan	80.330000	42.910000	700		Forêt mixte froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_691		Biélorussie	30.530000	53.510000	150		Forêt mixte fraîche	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_692		Ukraine	31.130000	51.780000	120		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_693		Ukraine	32.000000	51.500000	120		Forêt mixte fraîche	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_694		Ukraine	31.760000	52.010000	150		Forêt mixte fraîche	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_695		Ukraine	31.520000	51.570000	110		Forêt mixte fraîche	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_696		Biélorussie	29.160000	53.110000	100		Forêt mixte fraîche	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_697		Ukraine	25.500000	49.660000	250		Forêt mixte fraîche	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_698		Russie	46.500000	50.660000	20		Forêt mixte fraîche	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_699		Russie	37.600000	51.350000	200		Forêt tempérée décidue	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_70		Mongolie	93.116667	47.950000	1132		Steppe froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_700		Ukraine	35.080000	51.500000	200		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_701		Russie	47.000000	50.160000	20		Steppe froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_702		Russie	45.580000	50.010000	20		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_703		Lituanie	24.560000	55.430000	50		Forêt mixte fraîche	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_704		Ukraine	32.380000	52.200000	200		Forêt tempérée décidue	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_705		Russie	35.410000	52.250000	200		Forêt mixte fraîche	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_706		Russie	35.000000	53.330000	200		Forêt tempérée décidue	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_707		Russie	36.175000	51.630000	190		Forêt tempérée décidue	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_708		Russie	41.630000	51.100000	100		Forêt tempérée décidue	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_709		Lituanie	23.735000	54.580000	105		Forêt mixte fraîche	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_71		Mongolie	93.283333	48.033333	1132		Steppe froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_710		Lituanie	22.380000	55.715000	125		Forêt mixte fraîche	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_711		Lituanie	23.310000	54.880000	50		Forêt de conifères	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_712		Russie	20.810000	54.510000	20		Forêt mixte fraîche	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_713		Lituanie	21.850000	55.996700	40		Forêt mixte fraîche	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_714		Lituanie	22.880000	55.750000	100		Forêt mixte fraîche	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_715		Lituanie	24.030000	54.380000	100		Forêt de conifères	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_716		Lituanie	24.280000	54.710000	120		Forêt mixte fraîche	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_717		Pologne	23.810000	52.660000	200		Forêt mixte fraîche	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_718		Lituanie	24.350000	54.350000	100		Forêt de conifères	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000

Nom	Site	Pays	Longitude	Latitude	Altitude	Nature du prélèvement	Biome	Auteur	Source	Référence
SU_719		Lituanie	23.700000	54.300000	100		Forêt mixte fraîche	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_72		Mongolie	93.566667	48.916667	1030		Désert froid	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_720		Pologne	22.810000	49.110000	670		Forêt mixte fraîche	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_721		Russie	44.660000	43.000000	1000		Forêt mixte froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_722		Kazakhstan	76.330000	46.830000	700		Désert froid	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_723		Kazakhstan	71.830000	47.210000	800		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_724		Kazakhstan	70.030000	44.110000	250		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_725		Biélorussie	29.810000	52.250000	150		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_726		Ukraine	30.630000	51.430000	120		Forêt tempérée décidue	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_727		Ukraine	28.470000	49.220000	250		Forêt mixte fraîche	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_728		Ukraine	31.350000	49.810000	150		Forêt tempérée décidue	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_73		Mongolie	95.183333	48.466667	1491		Steppe froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_730		Russie	41.710000	49.630000	80		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_731		Russie	46.850000	49.360000	20		Désert froid	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_732		Russie	45.430000	49.660000	20		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_733		Ukraine	34.350000	50.410000	120		Forêt tempérée décidue	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_734		Ukraine	36.830000	49.500000	150		Forêt mixte fraîche	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_736		Ukraine	27.660000	51.250000	190		Forêt mixte fraîche	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_737		Biélorussie	27.500000	52.000000	150		Forêt mixte froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_738		Ukraine	27.610000	51.750000	150		Forêt mixte froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_739		Ukraine	29.590000	50.755000	165		Forêt tempérée décidue	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_74		Mongolie	94.033333	49.983333	931		Désert froid	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_740		Ukraine	24.650000	50.360000	200		Forêt tempérée décidue	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_741		Ukraine	28.050000	51.110000	150		Forêt tempérée décidue	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_742		Ukraine	24.030000	51.230000	150		Forêt tempérée décidue	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_743		Ukraine	27.350000	51.260000	150		Forêt de conifères	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_744		Ukraine	24.070000	48.920000	350		Forêt mixte fraîche	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_745		Ukraine	24.350000	48.260000	400		Forêt de conifères	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_746		Estonie	24.360000	58.960000	100		Forêt mixte fraîche	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_749		Kazakhstan	68.080000	44.160000	300		Désert froid	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_75		Mongolie	99.400000	51.266667	1538		Steppe froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_750		Kazakhstan	69.510000	43.780000	400		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_751		Kazakhstan	70.250000	43.830000	450		Steppe froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_752		Ukraine	40.080000	49.300000	150		Forêt mixte froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_753		Ukraine	27.160000	48.570000	150		Forêt mixte froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_755		Ukraine	34.330000	49.410000	100		Forêt tempérée décidue	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_756		Arménie	45.000000	40.750000	1000		Forêt tempérée décidue	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_757		Kazakhstan	76.660000	43.080000	1900		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_758		Russie	24.330000	48.250000	150		Forêt de conifères	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_759		Georgie	43.000000	42.000000	800		Forêt de conifères	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_76		Mongolie	99.450000	51.200000	1539		Steppe froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_760		Kazakhstan	75.000000	47.000000	800		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000

Nom	Site	Pays	Longitude	Latitude	Altitude	Nature du prélèvement	Biome	Auteur	Source	Référence
SU_762		Kazakhstan	71.260000	42.910000	600		Steppe froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_763		Kazakhstan	68.530000	43.000000	180		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_766		Ukraine	38.330000	47.150000	50		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_767		Georgie	44.960000	42.110000	700		Forêt tempérée décidue	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_768		Kazakhstan	70.750000	42.660000	450		Steppe froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_769		Kazakhstan	68.910000	42.780000	250		Steppe froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_77		Mongolie	99.366667	51.383333	1538		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_770		Kazakhstan	69.410000	42.750000	400		Steppe froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_771		Ukraine	34.330000	45.830000	50		Forêt tempérée décidue	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_772		Ukraine	33.900000	46.450000	20		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_773		Turkménistan	59.000000	41.660000	50		Forêt mixte froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_774		Turkménistan	58.750000	41.500000	50		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_775		Turkménistan	58.080000	41.455000	80		Forêt mixte froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_776		Turkménistan	57.580000	41.410000	50		Forêt tempérée décidue	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_777		Turkménistan	57.580000	41.160000	50		Forêt tempérée décidue	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_778		Ouzbékistan	57.160000	41.750000	0		Forêt mixte froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_779		Russie	41.710000	42.080000	20		Forêt mixte fraîche	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_78		Mongolie	100.150000	50.400000	1650		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_780		Turkménistan	53.500000	39.410000	0		Forêt tempérée décidue	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_781		Turkménistan	54.160000	39.910000	200		Forêt mixte froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_782		Turkménistan	57.410000	39.410000	50		Forêt mixte froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_783		Turkménistan	57.080000	39.080000	50		Forêt mixte froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_784		Turkménistan	54.330000	39.410000	0		Forêt mixte froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_785		Turkménistan	54.750000	39.410000	50		Forêt mixte froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_786		Turkménistan	55.660000	39.330000	20		Forêt mixte froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_787		Turkménistan	57.580000	40.000000	80		Forêt mixte froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_788		Turkménistan	54.120000	38.955000	0		Forêt mixte froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_79		Mongolie	100.150000	50.400000	1662		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_790		Kirghizstan	75.300000	40.720000	3536		Steppe froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_791		Russie	38.378333	60.000000	130		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_792		Russie	79.500000	74.500000	7		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_793	Yakutie	Russie	149.500000	62.170000	820		forêt décidue froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_794		Biélorussie	28.600000	54.033333	165		Forêt mixte fraîche	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_795		Biélorussie	26.500000	52.733333	144		Forêt mixte fraîche	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_796		Biélorussie	28.800000	51.850000	146		Forêt mixte fraîche	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_797		Biélorussie	25.550000	52.600000	147		Forêt mixte fraîche	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_798		Biélorussie	30.000000	55.850000	165		Forêt mixte fraîche	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_799		Biélorussie	31.233333	54.000000	195		Forêt mixte fraîche	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_80		Mongolie	102.566667	49.883333	1000		Steppe froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_800		Biélorussie	28.683333	53.700000	242		Forêt mixte fraîche	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_801		Biélorussie	28.600000	53.550000	166		Forêt mixte fraîche	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_802		Biélorussie	28.183333	55.233333	260		Forêt mixte fraîche	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000

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SU_803		Biélorussie	25.483333	51.983333	139		Forêt mixte fraîche	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_804		Lettonie	28.083333	56.050000	129		Forêt de conifères	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_805		Russie	87.150000	68.166667	100		Toundra	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_806		Russie	79.733330	66.700000	60		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_807		Russie	57.883333	56.316667	220		Forêt de conifères	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_808		Russie	57.883333	56.316667	220		Forêt de conifères	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_809		Russie	57.883333	56.316667	220		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_81		Mongolie	102.933333	48.816667	1440		Steppe froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_810		Russie	57.883333	56.316667	220		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_811		Russie	59.266667	54.900000	720		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_812		Russie	59.150000	54.883333	700		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_813		Russie	59.150000	54.883333	700		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_814		Russie	59.050000	54.666667	900		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_815		Russie	58.966667	54.500000	990		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_816		Russie	58.766667	54.700000	1040		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_817		Russie	60.316667	56.900000	310		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_818		Russie	62.350000	56.850000	200		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_819		Russie	64.833333	56.883333	100		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_82		Mongolie	103.316667	48.800000	1540		Steppe froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_820		Russie	59.733333	57.450000	400		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_821		Russie	59.683333	57.450000	380		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_822		Russie	59.733333	57.516667	700		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_823		Russie	59.450000	57.500000	400		Forêt de conifères	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_824		Russie	77.983333	64.966667	75		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_826		Russie	90.252778	50.320833	2280		Steppe froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_827		Russie	90.238889	50.317222	2350		Steppe froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_828		Russie	90.231389	50.308611	2420		Steppe froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_829		Russie	90.219444	50.303333	2480		Steppe froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_83		Mongolie	99.550000	48.183333	2060		Steppe froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_830		Russie	90.199444	50.333333	2350		Steppe froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_831		Russie	90.164167	50.317222	2600		Steppe froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_832		Russie	90.186111	50.320000	2500		Steppe froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_833		Russie	90.192500	50.323333	2450		Steppe froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_834		Russie	90.225000	50.310278	2420		Steppe froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_835		Russie	90.189722	50.321667	2500		Steppe froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_836		Russie	90.216667	50.300556	2500		Steppe froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_837		Russie	90.218056	50.300000	2510		Steppe froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_838		Russie	90.195278	50.285556	2580		Steppe froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_839		Russie	90.155556	50.312500	2610		Steppe froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_84		Mongolie	99.833333	48.133333	2060		Désert froid	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_840		Russie	90.153611	50.305556	2650		Steppe froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_841		Russie	90.149444	50.305556	2700		Steppe froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000

Nom	Site	Pays	Longitude	Latitude	Altitude	Nature du prélèvement	Biome	Auteur	Source	Référence
SU_842		Russie	90.144722	50.307778	3000		Steppe froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_843		Russie	90.138889	50.306944	2800		Steppe froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_844		Russie	89.973611	50.020833	2090		Steppe froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_845		Russie	89.978611	50.021667	2100		Steppe froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_846		Ukraine	31.500000	49.666667	200		Forêt tempérée décidue	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_847		Ukraine	35.150000	49.666667	200		Forêt tempérée décidue	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_848		Ukraine	29.750000	50.933333	140		Forêt tempérée décidue	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_849		Ukraine	29.750000	50.933333	140		Forêt tempérée décidue	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_85		Mongolie	99.616667	48.183333	2060		Steppe froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_850		Ukraine	35.000000	51.116667	160		Forêt tempérée décidue	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_851		Ukraine	35.000000	51.116667	160		Forêt tempérée décidue	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_852		Ukraine	35.000000	51.116667	160		Forêt tempérée décidue	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_853		Ukraine	35.000000	51.116667	160		Forêt tempérée décidue	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_854		Ukraine	37.283333	47.266667	230		Steppe chaude	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_855		Ukraine	37.283333	47.266667	230		Steppe chaude	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_856		Ukraine	37.283333	47.266667	230		Steppe chaude	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_857		Ukraine	37.283333	47.266667	230		Steppe chaude	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_858		Ukraine	25.000000	51.633333	170		Forêt tempérée décidue	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_859		Ukraine	25.000000	51.633333	170		Forêt tempérée décidue	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_86		Mongolie	101.850000	47.383333	1700		Steppe froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_860		Ukraine	31.416667	49.666667	220		Forêt tempérée décidue	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_861		Ukraine	31.416667	49.666667	220		Forêt tempérée décidue	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_862		Ukraine	31.416667	49.666667	220		Forêt tempérée décidue	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_863		Ukraine	31.416667	49.666667	220		Forêt tempérée décidue	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_864		Ukraine	31.000000	48.883333	220		Forêt tempérée décidue	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_865		Ukraine	38.183333	47.266667	50		Steppe froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_866		Ukraine	38.183333	47.266667	50		Steppe chaude	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_867		Ukraine	38.183333	47.266667	50		Steppe froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_868		Ukraine	38.183333	47.266667	50		Steppe chaude	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_869		Ukraine	38.183333	47.266667	50		Désert froid	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_87		Mongolie	101.933333	47.333333	1640		Steppe froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_870		Ukraine	38.183333	47.266667	50		Steppe chaude	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_871		Ukraine	34.666667	46.333333	20		Steppe froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_872		Ukraine	34.666667	46.333333	20		Steppe chaude	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_873		Ukraine	34.666667	46.333333	20		Désert chaud	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_874		Ukraine	34.666667	46.333333	20		Désert chaud	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_875		Ukraine	24.000000	51.216667	200		Forêt tempérée décidue	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_876		Ukraine	24.000000	51.216667	200		Forêt tempérée décidue	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_877		Ukraine	24.000000	51.216667	200		Forêt tempérée décidue	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_878		Ukraine	24.000000	51.216667	200		Forêt tempérée décidue	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_879		Ukraine	24.000000	51.216667	200		Forêt tempérée décidue	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_88		Mongolie	101.916667	47.450000	1500		Steppe froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000

Nom	Site	Pays	Longitude	Latitude	Altitude	Nature du prélèvement	Biome	Auteur	Source	Référence
SU_880		Ukraine	25.333333	50.750000	200		Forêt tempérée décidue	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_881		Ukraine	25.333333	50.750000	200		Forêt tempérée décidue	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_882		Ukraine	34.133333	50.733333	165		Steppe froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_883		Ukraine	34.133333	50.733333	165		Steppe froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_884		Ukraine	34.133333	50.733333	165		Steppe froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_885		Ukraine	34.133333	50.733333	165		Steppe chaude	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_886		Ukraine	34.133333	50.733333	165		Steppe froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_887		Ukraine	34.133333	50.733333	165		Steppe froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_888		Ukraine	25.400000	49.050000	360		Forêt tempérée décidue	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_89		Mongolie	101.916667	47.416667	1600		Steppe froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_891		Ukraine	28.000000	51.116667	190		Forêt tempérée décidue	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_892		Ukraine	28.000000	51.116667	190		Forêt tempérée décidue	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_893		Ukraine	28.000000	51.116667	190		Forêt tempérée décidue	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_894		Ukraine	28.000000	51.116667	190		Forêt tempérée décidue	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_895		Ukraine	27.816667	51.150000	200		Forêt tempérée décidue	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_896		Ukraine	27.816667	51.150000	200		Forêt tempérée décidue	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_897		Ukraine	28.033333	51.166667	200		Forêt tempérée décidue	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_898		Ukraine	28.033333	51.166667	200		Forêt tempérée décidue	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_899		Ukraine	28.033333	51.166667	200		Forêt tempérée décidue	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_90		Mongolie	101.866667	47.350000	1650		Steppe froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_900		Ukraine	32.350000	46.166667	20		Désert chaud	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_901		Ukraine	32.350000	46.166667	20		Désert chaud	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_902		Ukraine	32.350000	46.166667	20		Désert froid	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_903		Ukraine	32.350000	46.166667	20		Désert froid	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_904		Russie	99.717000	72.383000	48		Steppe froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_905		Russie	99.717000	72.383000	48		Steppe froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_906		Russie	99.717000	72.383000	48		Steppe froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_907		Russie	99.717000	72.383000	48		Steppe froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_908		Russie	99.717000	72.383000	48		Steppe froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_909		Russie	99.717000	72.383000	48		Steppe froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_91		Mongolie	105.666667	46.583333	1500		Steppe froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_910		Russie	99.717000	72.383000	48		Steppe froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_911		Russie	99.717000	72.383000	48		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_912		Russie	99.717000	72.383000	48		Steppe froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_913		Russie	99.717000	72.383000	48		Steppe froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_914		Russie	99.717000	72.383000	48		Toundra	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_915		Russie	99.717000	72.383000	48		Steppe froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_916		Russie	99.717000	72.383000	48		Steppe froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_917		Russie	99.717000	72.383000	48		Steppe froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_918		Russie	99.717000	72.383000	48		Steppe froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_919		Russie	99.717000	72.383000	48		Steppe froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_92		Mongolie	105.950000	46.750000	1316		Steppe froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000

Nom	Site	Pays	Longitude	Latitude	Altitude	Nature du prélèvement	Biome	Auteur	Source	Référence
SU_920		Russie	99.717000	72.383000	48		Steppe froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_922		Russie	99.717000	72.383000	48		Toundra	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_923		Russie	99.717000	72.383000	48		Toundra	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_924		Russie	99.717000	72.383000	48		Toundra	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_925		Russie	99.717000	72.383000	48		Toundra	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_926		Russie	99.717000	72.383000	48		Toundra	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_927		Russie	99.717000	72.383000	48		Toundra	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_928		Russie	98.592000	74.536000	45		Toundra	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_929		Russie	90.212000	69.548000	53		Toundra	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_93		Mongolie	105.916667	46.900000	1500		Steppe froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_930		Russie	72.631600	65.450000	50		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_931		Russie	72.631600	65.450000	50		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_932		Russie	72.631600	65.450000	50		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_933		Russie	72.631600	65.450000	50		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_934		Russie	72.631600	65.450000	50		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_935		Russie	72.567600	70.200000	10		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_936		Russie	72.567600	70.200000	10		Toundra	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_937		Russie	72.567600	70.200000	10		Toundra	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_938		Russie	72.567600	70.200000	10		Toundra	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_939		Russie	72.567600	70.200000	10		Toundra	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_94		Mongolie	105.466667	46.700000	1550		Steppe froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_940		Russie	72.567600	70.200000	10		Toundra	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_941		Russie	72.567600	70.200000	10		Toundra	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_942		Russie	72.567600	70.200000	10		Toundra	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_943		Russie	72.567600	70.200000	10		Forêt boréale	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_944		Russie	72.567600	70.200000	10		Toundra	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_945		Russie	72.567600	70.200000	10		Toundra	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_946	Yakutie	Russie	128.866700	71.500000	50		Toundra	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_947	Yakutie	Russie	128.850000	71.500000	50		Toundra	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_948	Yakutie	Russie	128.883300	71.500000	50		Toundra	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_949	Yakutie	Russie	128.883300	71.483300	50		Toundra	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_95		Mongolie	106.283333	45.950000	1200		Steppe froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_950	Yakutie	Russie	128.866700	71.483300	50		Toundra	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_951	Yakutie	Russie	128.850000	71.500000	50		Toundra	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_952	Yakutie	Russie	127.066700	71.866700	50		Toundra	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_953	Yakutie	Russie	127.033300	71.883300	50		Toundra	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_954	Yakutie	Russie	127.016700	71.900000	50		Toundra	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_955	Yakutie	Russie	127.966700	71.866700	50		Toundra	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_956	Yakutie	Russie	127.033300	71.866700	50		Toundra	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_957	Yakutie	Russie	127.033300	71.866700	50		Toundra	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_958	Yakutie	Russie	127.050000	71.866700	50		Toundra	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_959	Yakutie	Russie	127.050000	71.866700	50		Toundra	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000

Nom	Site	Pays	Longitude	Latitude	Altitude	Nature du prélèvement	Biome	Auteur	Source	Référence
SU_96		Mongolie	106.483333	45.766667	1350		Steppe froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_960	Yakutie	Russie	127.083300	71.866700	50		Toundra	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_961	Yakutie	Russie	125.866700	70.666700	50		Toundra	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_962	Yakutie	Russie	125.866700	70.666700	50		Toundra	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_963	Yakutie	Russie	125.866700	70.666700	50		Toundra	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_964	Yakutie	Russie	128.133300	69.383300	50		Toundra	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_965	Yakutie	Russie	125.116700	69.383300	50		Toundra	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_966	Yakutie	Russie	125.116700	69.383300	50		Toundra	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_967	Yakutie	Russie	125.116700	69.383300	50		Toundra	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_968	Yakutie	Russie	125.116700	69.400000	50		Toundra	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_969	Yakutie	Russie	125.116700	69.400000	50		Toundra	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_97		Mongolie	106.733333	45.766667	1450		Steppe froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_970	Yakutie	Russie	124.200000	69.033300	50		Toundra	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_971	Yakutie	Russie	124.216700	69.033300	50		Toundra	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_972		Russie	36.006700	69.069800	75		Forêt de conifères	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_973		Russie	35.999800	69.066500	74		Forêt de conifères	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_974		Russie	35.051500	69.065200	54		Forêt de conifères	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_975		Russie	35.943800	69.064300	74		Forêt de conifères	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_976		Russie	35.035300	69.063300	90		Forêt de conifères	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_977		Russie	35.943800	69.062700	85		Forêt de conifères	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_978		Russie	35.934700	69.062300	74		Forêt de conifères	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_979		Russie	35.853300	69.018500	82		Forêt de conifères	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_98		Mongolie	102.050000	47.683333	1400		Steppe froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_980		Russie	34.281200	68.875300	200		Végétation pionnière	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_981		Russie	35.631200	68.867200	120		Forêt de conifères	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_982		Russie	35.322000	68.815200	131		Forêt de conifères	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_983		Russie	35.316700	68.813800	130		Forêt de conifères	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_984		Russie	35.399200	68.811000	160		Forêt de conifères	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_985		Russie	35.323200	68.427800	180		Forêt de conifères	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_986		Russie	35.342500	68.426300	180		Forêt de conifères	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_987		Russie	35.362000	68.419500	180		Forêt de conifères	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_988		Russie	35.279800	68.403800	180		Forêt de conifères	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_989		Russie	35.341700	68.402800	260		Forêt de conifères	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_99		Mongolie	101.850000	47.716667	1400		Steppe froide	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_990		Russie	35.350000	68.402700	260		Forêt de conifères	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_991		Russie	35.298000	68.387200	200		Végétation pionnière	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_992		Russie	35.292800	68.381500	200		Végétation pionnière	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_993		Russie	33.561200	68.108500	240		Forêt de conifères	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_994		Russie	34.062300	68.098500	280		Forêt de conifères	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_995		Russie	34.527800	68.014800	200		Végétation pionnière	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_996		Russie	34.498300	68.013800	200		Végétation pionnière	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_997		Russie	32.439500	67.561700	180		Végétation pionnière	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000

Nom	Site	Pays	Longitude	Latitude	Altitude	Nature du prélèvement	Biome	Auteur	Source	Référence
SU_998		Russie	34.043000	67.530300	200		Forêt de conifères	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU_999		Russie	34.652700	67.507500	200		Forêt de conifères	Tarasov, P.E.	Tarasov, P.E.	Tarasov et al. 1998, 2000
SU16	Beglors	Suède	19.200000	68.300000	400	Mousses	Forêt boréale		Peyron, O.	Peyron et al., 1998
SU18	Kilpisjärvi	Suède	20.800000	69.000000	500	Mousses	Végétation pionnière		Peyron, O.	Peyron et al., 1998
SU20	Soppero	Suède	21.800000	68.000000	500	Mousses	Forêt boréale		Peyron, O.	Peyron et al., 1998
SU21	Karesuvanto	Suède	22.300000	68.500000	500	Mousses	Végétation pionnière		Peyron, O.	Peyron et al., 1998
SU22	Karesuvanto	Suède	22.200000	68.500000	500	Mousses	Végétation pionnière		Peyron, O.	Peyron et al., 1998
SUT1	Abisko 1	Suède	18.600000	68.300000	950	Mousses	Toundra		Peyron, O.	Peyron et al., 1998
SUT2	Abisko 2	Suède	18.600000	68.300000	950	Mousses	Forêt boréale		Peyron, O.	Peyron et al., 1998
SUT4	Abisko-Kiruna	Suède	20.000000	66.800000	500	Mousses	Forêt de conifères		Peyron, O.	Peyron et al., 1998
SY01		Syrie	40.260000	34.720000	240	Mousses	Steppe chaude	Bottema S, Barkoudah Y	Peyron, O.	Bottema Barkoudah, 1979
SY02		Syrie	40.380000	34.890000	245	Mousses	Steppe chaude	Bottema S, Barkoudah Y	Peyron, O.	Bottema Barkoudah, 1979
SY03		Syrie	40.390000	35.070000	230	Mousses	Steppe chaude	Bottema S, Barkoudah Y	Peyron, O.	Bottema Barkoudah, 1979
SY04		Syrie	40.600000	35.430000	225	Mousses	Steppe chaude	Bottema S, Barkoudah Y	Peyron, O.	Bottema Barkoudah, 1979
SY05		Syrie	40.570000	35.490000	225	Mousses	Ecosystèmes anthropisés	Bottema S, Barkoudah Y	Peyron, O.	Bottema Barkoudah, 1979
SY06		Syrie	40.320000	35.500000	230	Mousses	Steppe chaude	Bottema S, Barkoudah Y	Peyron, O.	Bottema Barkoudah, 1979
SY07		Syrie	38.540000	34.910000	1150	Mousses	Steppe chaude	Bottema S, Barkoudah Y	Peyron, O.	Bottema Barkoudah, 1979
SY08		Syrie	38.230000	34.470000	500	Mousses	Steppe chaude	Bottema S, Barkoudah Y	Peyron, O.	Bottema Barkoudah, 1979
SY09		Syrie	37.970000	34.500000	500	Mousses	Steppe chaude	Bottema S, Barkoudah Y	Peyron, O.	Bottema Barkoudah, 1979
SY10		Syrie	37.210000	34.600000	650	Mousses	Steppe chaude	Bottema S, Barkoudah Y	Peyron, O.	Bottema Barkoudah, 1979
SY11		Syrie	36.950000	34.660000	650	Mousses	Steppe chaude	Bottema S, Barkoudah Y	Peyron, O.	Bottema Barkoudah, 1979
SY12		Syrie	37.710000	34.420000	530	Mousses	Désert chaud	Bottema S, Barkoudah Y	Peyron, O.	Bottema Barkoudah, 1979
SY13		Syrie	37.420000	34.320000	600	Mousses	Steppe chaude	Bottema S, Barkoudah Y	Peyron, O.	Bottema Barkoudah, 1979
SY14		Syrie	37.160000	34.190000	750	Mousses	Steppe chaude	Bottema S, Barkoudah Y	Peyron, O.	Bottema Barkoudah, 1979
SY15		Syrie	36.960000	34.000000	825	Mousses	Steppe chaude	Bottema S, Barkoudah Y	Peyron, O.	Bottema Barkoudah, 1979
SY16		Syrie	36.830000	33.890000	800	Mousses	Steppe chaude	Bottema S, Barkoudah Y	Peyron, O.	Bottema Barkoudah, 1979
SY17		Syrie	36.750000	33.820000	800	Mousses	Steppe chaude	Bottema S, Barkoudah Y	Peyron, O.	Bottema Barkoudah, 1979
SY18		Syrie	36.690000	33.740000	900	Mousses	Steppe chaude	Bottema S, Barkoudah Y	Peyron, O.	Bottema Barkoudah, 1979
SY19		Syrie	36.630000	33.800000	1100	Mousses	Steppe chaude	Bottema S, Barkoudah Y	Peyron, O.	Bottema Barkoudah, 1979
SY20		Syrie	36.690000	34.000000	1400	Mousses	Steppe chaude	Bottema S, Barkoudah Y	Peyron, O.	Bottema Barkoudah, 1979
SY21		Syrie	36.590000	33.950000	1450	Mousses	Steppe chaude	Bottema S, Barkoudah Y	Peyron, O.	Bottema Barkoudah, 1979
SY22		Syrie	36.480000	33.910000	1550	Mousses	Steppe chaude	Bottema S, Barkoudah Y	Peyron, O.	Bottema Barkoudah, 1979
SY23		Syrie	36.350000	33.910000	2050	Mousses	Steppe chaude	Bottema S, Barkoudah Y	Peyron, O.	Bottema Barkoudah, 1979
SY24		Syrie	36.360000	33.900000	2000	Mousses	Steppe chaude	Bottema S, Barkoudah Y	Peyron, O.	Bottema Barkoudah, 1979
SY25		Syrie	36.360000	33.890000	1950	Mousses	Steppe chaude	Bottema S, Barkoudah Y	Peyron, O.	Bottema Barkoudah, 1979
SY26		Syrie	36.410000	33.860000	1650	Mousses	Steppe chaude	Bottema S, Barkoudah Y	Peyron, O.	Bottema Barkoudah, 1979
SY27		Syrie	36.400000	33.800000	1700	Mousses	Steppe chaude	Bottema S, Barkoudah Y	Peyron, O.	Bottema Barkoudah, 1979
SY28		Syrie	36.390000	33.760000	1800	Mousses	Steppe chaude	Bottema S, Barkoudah Y	Peyron, O.	Bottema Barkoudah, 1979
SY29		Syrie	36.370000	33.700000	1500	Mousses	Steppe chaude	Bottema S, Barkoudah Y	Peyron, O.	Bottema Barkoudah, 1979
SY30		Syrie	35.880000	33.370000	1400	Mousses	Steppe chaude	Bottema S, Barkoudah Y	Peyron, O.	Bottema Barkoudah, 1979
SY31		Syrie	35.980000	33.630000	1350	Mousses	Steppe chaude	Bottema S, Barkoudah Y	Peyron, O.	Bottema Barkoudah, 1979
SY32		Syrie	35.980000	36.660000	1300	Mousses	Steppe chaude	Bottema S, Barkoudah Y	Peyron, O.	Bottema Barkoudah, 1979

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SY33		Syrie	35.960000	33.680000	1300	Mousses	Steppe chaude	Bottema S, Barkoudah Y	Peyron, O.	Bottema Barkoudah, 1979
SY34		Syrie	36.230000	33.930000	1600	Mousses	Steppe chaude	Bottema S, Barkoudah Y	Peyron, O.	Bottema Barkoudah, 1979
SY36		Syrie	36.190000	33.970000	1300	Mousses	Steppe chaude	Bottema S, Barkoudah Y	Peyron, O.	Bottema Barkoudah, 1979
SY37		Syrie	36.200000	33.990000	1300	Mousses	Steppe chaude	Bottema S, Barkoudah Y	Peyron, O.	Bottema Barkoudah, 1979
SY38		Syrie	36.150000	34.070000	1000	Mousses	Steppe chaude	Bottema S, Barkoudah Y	Peyron, O.	Bottema Barkoudah, 1979
SY39		Syrie	36.130000	34.090000	1000	Mousses	Steppe chaude	Bottema S, Barkoudah Y	Peyron, O.	Bottema Barkoudah, 1979
SY57		Syrie	35.780000	34.110000	900	Mousses	Steppe chaude	Bottema S, Barkoudah Y	Peyron, O.	Bottema Barkoudah, 1979
SY61		Syrie	35.670000	34.110000	300	Mousses	Steppe chaude	Bottema S, Barkoudah Y	Peyron, O.	Bottema Barkoudah, 1979
SY62		Syrie	36.200000	35.510000	1000	Mousses	Steppe chaude	Bottema S, Barkoudah Y	Peyron, O.	Bottema Barkoudah, 1979
SY72		Syrie	36.590000	35.800000	1100	Mousses	Steppe chaude	Bottema S, Barkoudah Y	Peyron, O.	Bottema Barkoudah, 1979
SY73		Syrie	36.520000	35.790000	650	Mousses	Steppe chaude	Bottema S, Barkoudah Y	Peyron, O.	Bottema Barkoudah, 1979
SY74		Syrie	36.470000	35.810000	500	Mousses	Steppe chaude	Bottema S, Barkoudah Y	Peyron, O.	Bottema Barkoudah, 1979
SY75		Syrie	35.830000	35.720000	200	Mousses	Végétation xérophytique	Bottema S, Barkoudah Y	Peyron, O.	Bottema Barkoudah, 1979
SY76		Syrie	35.840000	35.730000	200	Mousses	Végétation xérophytique	Bottema S, Barkoudah Y	Peyron, O.	Bottema Barkoudah, 1979
SY77		Syrie	35.850000	35.750000	200	Mousses	Végétation xérophytique	Bottema S, Barkoudah Y	Peyron, O.	Bottema Barkoudah, 1979
SY78		Syrie	35.810000	35.830000	200	Mousses	Végétation xérophytique	Bottema S, Barkoudah Y	Peyron, O.	Bottema Barkoudah, 1979
SY79		Syrie	35.810000	35.830000	200	Mousses	Végétation xérophytique	Bottema S, Barkoudah Y	Peyron, O.	Bottema Barkoudah, 1979
SY81		Syrie	35.810000	35.830000	200	Mousses	Végétation xérophytique	Bottema S, Barkoudah Y	Peyron, O.	Bottema Barkoudah, 1979
SY82		Syrie	35.850000	36.460000	200	Mousses	Steppe chaude	Bottema S, Barkoudah Y	Peyron, O.	Bottema Barkoudah, 1979
SY86		Syrie	41.080000	35.190000	200	Mousses	Steppe chaude	Bottema S, Barkoudah Y	Peyron, O.	Bottema Barkoudah, 1979
SY87		Syrie	41.200000	35.180000	162	Mousses	Steppe chaude	Bottema S, Barkoudah Y	Peyron, O.	Bottema Barkoudah, 1979
SY89		Syrie	41.040000	35.270000	200	Mousses	Steppe chaude	Bottema S, Barkoudah Y	Peyron, O.	Bottema Barkoudah, 1979
SY90		Syrie	40.710000	35.600000	250	Mousses	Steppe chaude	Bottema S, Barkoudah Y	Peyron, O.	Bottema Barkoudah, 1979
SY91		Syrie	41.020000	36.170000	350	Mousses	Steppe chaude	Bottema S, Barkoudah Y	Peyron, O.	Bottema Barkoudah, 1979
SY92		Syrie	40.790000	36.150000	300	Mousses	Steppe chaude	Bottema S, Barkoudah Y	Peyron, O.	Bottema Barkoudah, 1979
SY94		Syrie	40.880000	36.430000	300	Mousses	Steppe chaude	Bottema S, Barkoudah Y	Peyron, O.	Bottema Barkoudah, 1979
SY95		Syrie	41.060000	36.410000	400	Mousses	Steppe chaude	Bottema S, Barkoudah Y	Peyron, O.	Bottema Barkoudah, 1979
SY97		Syrie	40.680000	36.380000	350	Mousses	Steppe chaude	Bottema S, Barkoudah Y	Peyron, O.	Bottema Barkoudah, 1979
T100	Namocuo	Tibet	90.856400	30.678300	4718	Mousses	Steppe froide		Peyron, O.	Yu et al., 2001
T101	Gerencuo 1	Tibet	92.447200	34.588600	4650	Mousses	Steppe froide		Peyron, O.	Yu et al., 2001
T102	Xiongoucuo	Tibet	91.634400	31.040000	4637	Mousses	Steppe froide		Peyron, O.	Yu et al., 2001
T103	Cuoer	Tibet	91.500000	31.469400	4515	Mousses	Steppe froide		Peyron, O.	Yu et al., 2001
T104	Ali	Tibet	90.620000	31.959200	4450	Mousses	Steppe froide		Peyron, O.	Yu et al., 2001
T105	Pengcuo	Tibet	91.616900	31.536400	4545	Mousses	Steppe froide		Peyron, O.	Yu et al., 2001
T106	Hangcuo	Tibet	91.791900	31.315600	4370	Mousses	Steppe froide		Peyron, O.	Yu et al., 2001
T107	Ali	Tibet	90.657800	31.951900	4585	Mousses	Steppe froide		Peyron, O.	Yu et al., 2001
T108	Erluco	Tibet	91.702800	31.551900	4530	Mousses	Steppe froide		Peyron, O.	Yu et al., 2001
T109	Ali	Tibet	90.620000	31.959700	4450	Mousses	Steppe froide		Peyron, O.	Yu et al., 2001
T110	Naripingcuo	Tibet	91.471700	31.292800	4520	Mousses	Steppe froide		Peyron, O.	Yu et al., 2001
T111	Angren	Tibet	87.400000	29.200000	4300	Mousses	Steppe froide		Peyron, O.	Yu et al., 2001
T112	Xugecuo	Tibet	90.332800	31.968600	4540	Mousses	Steppe froide		Peyron, O.	Yu et al., 2001

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T113	Cengcuo	Tibet	90.520000	28.966100	4421	Mousses	Steppe froide		Peyron, O.	Yu et al., 2001
T114	Cuomorong	Tibet	92.068300	31.617200	4410	Mousses	Steppe froide		Peyron, O.	Yu et al., 2001
T115	Pengcuo	Tibet	91.027800	31.515300	4522	Mousses	Steppe froide		Peyron, O.	Yu et al., 2001
T116	Ali	Tibet	90.456700	31.980000	4520	Mousses	Steppe froide		Peyron, O.	Yu et al., 2001
T117	Ali	Tibet	90.728300	31.955000	4570	Mousses	Steppe froide		Peyron, O.	Yu et al., 2001
T118	Cuoer	Tibet	91.523300	31.568900	4545	Mousses	Steppe froide		Peyron, O.	Yu et al., 2001
TA08		Turquie	38.500000	37.220000	610	Mousses	Steppe chaude	Van Zeist, W.	Guiot J., Peyron O	Peyron et al., 1998
TA09		Turquie	38.500000	37.220000	610	Mousses	Steppe chaude	Van Zeist, W.	Guiot J., Peyron O	Peyron et al., 1998
TA15		Turquie	39.720000	38.180000	914	Mousses	Forêt tempérée décidue	Van Zeist, W.	Guiot J., Peyron O	Peyron et al., 1998
TA24		Turquie	42.490000	37.930000	1067	Mousses	Steppe chaude	Van Zeist, W.	Guiot J., Peyron O	Peyron et al., 1998
TA25		Turquie	42.419000	37.919000	914	Mousses	Steppe chaude	Van Zeist, W.	Guiot J., Peyron O	Peyron et al., 1998
TA28		Turquie	42.229000	37.930000	914	Mousses	Steppe chaude	Van Zeist, W.	Guiot J., Peyron O	Peyron et al., 1998
TA31		Turquie	37.549000	37.750000	850	Mousses	Steppe chaude	Van Zeist, W.	Guiot J., Peyron O	Peyron et al., 1998
TA33		Turquie	39.529000	38.500000	1219	Mousses	Steppe chaude	Van Zeist, W.	Guiot J., Peyron O	Peyron et al., 1998
TA35		Turquie	39.669000	38.400000	1158	Mousses	Steppe chaude	Van Zeist, W.	Guiot J., Peyron O	Peyron et al., 1998
TA41		Turquie	39.819000	38.200000	762	Mousses	Steppe chaude	Van Zeist, W.	Guiot J., Peyron O	Peyron et al., 1998
TA42		Turquie	41.029000	38.500000	1219	Mousses	Steppe chaude	Van Zeist, W.	Guiot J., Peyron O	Peyron et al., 1998
TB01		Turquie	27.250000	37.880000	50	Mousses	Végétation xérophytique	Van Zeist, W.	Guiot J., Peyron O	Peyron et al., 1998
TB06		Turquie	27.740000	37.890000	150	Mousses	Végétation xérophytique	Van Zeist, W.	Guiot J., Peyron O	Peyron et al., 1998
TB07		Turquie	27.740000	37.890000	150	Mousses	Forêt mixte chaude	Van Zeist, W.	Guiot J., Peyron O	Peyron et al., 1998
TB08		Turquie	28.440000	36.990000	100	Mousses	Forêt mixte chaude	Van Zeist, W.	Guiot J., Peyron O	Peyron et al., 1998
TB12		Turquie	28.780000	36.790000	20	Mousses	Végétation xérophytique	Van Zeist, W.	Guiot J., Peyron O	Peyron et al., 1998
TB13		Turquie	28.730000	36.900000	20	Mousses	Forêt mixte chaude	Van Zeist, W.	Guiot J., Peyron O	Peyron et al., 1998
TB14		Turquie	28.630000	36.840000	0	Mousses	Steppe chaude	Van Zeist, W.	Guiot J., Peyron O	Peyron et al., 1998
TB20		Turquie	27.960000	37.650000	130	Mousses	Végétation xérophytique	Van Zeist, W.	Guiot J., Peyron O	Peyron et al., 1998
TB25		Turquie	28.860000	37.850000	500	Mousses	Steppe chaude	Van Zeist, W.	Guiot J., Peyron O	Peyron et al., 1998
TB26		Turquie	29.420000	37.390000	850	Mousses	Steppe chaude	Van Zeist, W.	Guiot J., Peyron O	Peyron et al., 1998
TB34		Turquie	30.510000	37.900000	930	Mousses	Steppe chaude	Van Zeist, W.	Guiot J., Peyron O	Peyron et al., 1998
TB36		Turquie	30.600000	37.090000	220	Mousses	Végétation xérophytique	Van Zeist, W.	Guiot J., Peyron O	Peyron et al., 1998
TB37		Turquie	30.670000	36.980000	100	Mousses	Végétation xérophytique	Van Zeist, W.	Guiot J., Peyron O	Peyron et al., 1998
TB57		Turquie	31.940000	38.390000	1030	Mousses	Steppe chaude	Van Zeist, W.	Guiot J., Peyron O	Peyron et al., 1998
TC05		Turquie	35.830000	39.069000	900	Mousses	Steppe chaude	Van Zeist, W.	Guiot J., Peyron O	Peyron et al., 1998
TC09		Turquie	36.529000	39.950000	1400	Mousses	Forêt tempérée décidue	Van Zeist, W.	Guiot J., Peyron O	Peyron et al., 1998
TC11		Turquie	36.500000	40.020000	1200	Mousses	Ecosystèmes anthropisés	Van Zeist, W.	Guiot J., Peyron O	Peyron et al., 1998
TC12		Turquie	36.150000	40.270000	500	Mousses	Ecosystèmes anthropisés	Van Zeist, W.	Guiot J., Peyron O	Peyron et al., 1998
TC17		Turquie	35.720000	40.979000	750	Mousses	Steppe chaude	Van Zeist, W.	Guiot J., Peyron O	Peyron et al., 1998
TC19		Turquie	36.209000	41.380000	50	Mousses	Forêt tempérée décidue	Van Zeist, W.	Guiot J., Peyron O	Peyron et al., 1998
TC20		Turquie	35.250000	41.729000	200	Mousses	Forêt tempérée décidue	Van Zeist, W.	Guiot J., Peyron O	Peyron et al., 1998
TC21		Turquie	35.180000	41.819000	75	Mousses	Forêt tempérée décidue	Van Zeist, W.	Guiot J., Peyron O	Peyron et al., 1998
TC22		Turquie	35.029000	41.810000	1300	Mousses	Forêt tempérée décidue	Van Zeist, W.	Guiot J., Peyron O	Peyron et al., 1998
TC24		Turquie	34.279000	41.569000	550	Mousses	Forêt tempérée décidue	Van Zeist, W.	Guiot J., Peyron O	Peyron et al., 1998

Nom	Site	Pays	Longitude	Latitude	Altitude	Nature du prélèvement	Biome	Auteur	Source	Référence
TC27		Turquie	33.220000	41.150000	500	Mousses	Ecosystèmes anthropisés	Van Zeist, W.	Guiot J., Peyron O	Peyron et al., 1998
TC30		Turquie	32.630000	41.180000	250	Mousses	Steppe chaude	Van Zeist, W.	Guiot J., Peyron O	Peyron et al., 1998
TC31		Turquie	32.009000	40.779000	980	Mousses	Steppe chaude	Van Zeist, W.	Guiot J., Peyron O	Peyron et al., 1998
TC34		Turquie	30.440000	40.869000	50	Mousses	Ecosystèmes anthropisés	Van Zeist, W.	Guiot J., Peyron O	Peyron et al., 1998
TI01	Plaine de Kashgar	Tibet	77.200000	39.900000	1200	Mousses	Steppe froide	Van Campo, E.	Peyron, O.	Van Campo et al., 1996
TI02	Plaine de Kashgar	Tibet	74.500000	39.500000	1500	Mousses	Steppe froide	Van Campo, E.	Peyron, O.	Van Campo et al., 1996
TI03	Karakorum	Tibet	74.900000	38.800000	3400	Mousses	Steppe froide	Van Campo, E.	Peyron, O.	Van Campo et al., 1996
TI04	Karakorum	Tibet	74.900000	38.600000	3360	Mousses	Steppe froide	Van Campo, E.	Peyron, O.	Van Campo et al., 1996
TI05	Karakorum	Tibet	74.900000	38.300000	4070	Mousses	Steppe froide	Van Campo, E.	Peyron, O.	Van Campo et al., 1996
TI06	Karakorum	Tibet	75.100000	37.900000	3150	Mousses	Steppe froide	Van Campo, E.	Peyron, O.	Van Campo et al., 1996
TI07	Karakorum	Tibet	75.400000	37.000000	3680	Mousses	Steppe froide	Van Campo, E.	Peyron, O.	Van Campo et al., 1996
TI08	Karakorum	Tibet	75.200000	37.400000	3600	Mousses	Steppe froide	Van Campo, E.	Peyron, O.	Van Campo et al., 1996
TI09	Karakorum	Tibet	75.300000	37.600000	3300	Mousses	Steppe froide	Van Campo, E.	Peyron, O.	Van Campo et al., 1996
TI10	Plaine de Kashgar	Tibet	76.800000	38.400000	1340	Mousses	Steppe froide	Van Campo, E.	Peyron, O.	Van Campo et al., 1996
TI11	Massif de Kunlun	Tibet	77.100000	36.400000	3800	Mousses	Steppe froide	Van Campo, E.	Peyron, O.	Van Campo et al., 1996
TI12	Massif de Kunlun	Tibet	77.800000	36.400000	3850	Mousses	Steppe froide	Van Campo, E.	Peyron, O.	Van Campo et al., 1996
TI13	Massif de Kunlun	Tibet	79.400000	35.600000	4890	Mousses	Steppe froide	Van Campo, E.	Peyron, O.	Van Campo et al., 1996
TI14	Massif de Kunlun	Tibet	79.300000	35.800000	5100	Mousses	Steppe froide	Van Campo, E.	Peyron, O.	Van Campo et al., 1996
TI15	Massif de Kunlun	Tibet	78.200000	36.300000	3750	Mousses	Steppe froide	Van Campo, E.	Peyron, O.	Van Campo et al., 1996
TI16	Massif de Kunlun	Tibet	78.700000	36.200000	4050	Mousses	Steppe froide	Van Campo, E.	Peyron, O.	Van Campo et al., 1996
TI17	Massif de Kunlun	Tibet	77.100000	37.200000	2500	Mousses	Steppe froide	Van Campo, E.	Peyron, O.	Van Campo et al., 1996
TI18	Plaine de Kashgar	Tibet	77.400000	37.700000	1500	Mousses	Désert froid	Van Campo, E.	Peyron, O.	Van Campo et al., 1996
TI19	Minshan	Tibet	102.890000	35.375300	1964	Mousses	Steppe froide		Peyron, O.	Yu et al., 2001
TI20	Hezuo	Tibet	102.865800	34.937200	3147	Mousses	Végétation pionnière		Peyron, O.	Yu et al., 2001
TI21	Hezuo	Tibet	102.748300	34.814200	2996	Mousses	Steppe froide		Peyron, O.	Yu et al., 2001
TI22	Hezuo	Tibet	102.748300	34.814200	2996	Mousses	Steppe froide		Peyron, O.	Yu et al., 2001
TI23	Hezuo	Tibet	102.464200	34.623900	3002	Mousses	Steppe froide		Peyron, O.	Yu et al., 2001
TI24	Gahai	Tibet	102.303600	34.348900	3610	Mousses	Steppe froide		Peyron, O.	Yu et al., 2001
TI25	Gahai	Tibet	102.311100	34.241100	3440	Mousses	Steppe froide		Peyron, O.	Yu et al., 2001
TI27	Zoige	Tibet	102.483300	33.713900	3440	Mousses	Steppe froide		Peyron, O.	Yu et al., 2001
TI28	Zoige	Tibet	102.358300	33.856900	3438	Mousses	Steppe froide		Peyron, O.	Yu et al., 2001
TI31	Gahai	Tibet	102.310600	34.241100	3440	Mousses	Steppe froide		Peyron, O.	Yu et al., 2001
TI32	Dalijia	Tibet	102.835800	35.564200	2760	Mousses	Steppe froide		Peyron, O.	Yu et al., 2001
TI33	Dalijia	Tibet	102.792500	35.569700	3064	Mousses	Désert froid		Peyron, O.	Yu et al., 2001
TI34	Dalijia	Tibet	102.743100	35.573600	3612	Mousses	Steppe froide		Peyron, O.	Yu et al., 2001
TI35	Huangshui	Tibet	101.228600	36.585000	2732	Mousses	Steppe froide		Peyron, O.	Yu et al., 2001
TI36	Reyueshan	Tibet	101.111100	36.428100	3440	Mousses	Steppe froide		Peyron, O.	Yu et al., 2001
TI37	Reyueshan	Tibet	101.027200	36.411700	3361	Mousses	Steppe froide		Peyron, O.	Yu et al., 2001
TI38	Qinghai	Tibet	100.457500	36.588100	3207	Mousses	Steppe froide		Peyron, O.	Yu et al., 2001
TI39	Qinghai	Tibet	100.102500	36.630600	3250	Mousses	Steppe froide		Peyron, O.	Yu et al., 2001
TI40	Qinghai	Tibet	100.735300	36.555600	3000	Mousses	Steppe froide		Peyron, O.	Yu et al., 2001

Nom	Site	Pays	Longitude	Latitude	Altitude	Nature du prélèvement	Biome	Auteur	Source	Référence
TI41	Xiangpishan	Tibet	99.607200	36.754400	3817	Mousses	Steppe froide		Peyron, O.	Yu et al., 2001
TI42	Caidamo	Tibet	99.280600	36.709400	3100	Mousses	Steppe froide		Peyron, O.	Yu et al., 2001
TI43	Caidamo	Tibet	98.888600	36.729700	3150	Mousses	Désert froid		Peyron, O.	Yu et al., 2001
TI44	Dulan	Tibet	98.174700	36.187800	3360	Mousses	Steppe froide		Peyron, O.	Yu et al., 2001
TI45	Dulan	Tibet	98.058100	36.055600	3290	Mousses	Steppe froide		Peyron, O.	Yu et al., 2001
TI46	Keligao	Tibet	97.559200	36.003100	3110	Mousses	Steppe froide		Peyron, O.	Yu et al., 2001
TI47	Geermo	Tibet	95.085600	36.348300	2817	Mousses	Désert froid		Peyron, O.	Yu et al., 2001
TI48	Geermo	Tibet	94.814700	36.075300	3184	Mousses	Désert froid		Peyron, O.	Yu et al., 2001
TI49	Kunlun	Tibet	94.322200	35.770600	4090	Mousses	Désert froid		Peyron, O.	Yu et al., 2001
TI50	Kunlun	Tibet	94.049200	35.678900	4690	Mousses	Steppe froide		Peyron, O.	Yu et al., 2001
TI51	Bodongquan	Tibet	93.867200	35.523100	4672	Mousses	Steppe froide		Peyron, O.	Yu et al., 2001
TI52	Bodongquan	Tibet	93.866900	35.520800	4662	Mousses	Steppe froide		Peyron, O.	Yu et al., 2001
TI53	Wudaoliang	Tibet	93.154700	35.261100	4676	Mousses	Steppe froide		Peyron, O.	Yu et al., 2001
TI54	Wudaoliang	Tibet	92.797200	34.617200	4758	Mousses	Steppe froide		Peyron, O.	Yu et al., 2001
TI55	Kekexili	Tibet	92.442500	34.215600	4570	Mousses	Steppe froide		Peyron, O.	Yu et al., 2001
TI56	Kekexili	Tibet	92.409400	34.578600	4668	Mousses	Steppe froide		Peyron, O.	Yu et al., 2001
TI57	Kekexili	Tibet	92.442200	34.215800	4560	Mousses	Steppe chaude		Peyron, O.	Yu et al., 2001
TI58	Yanshiping	Tibet	92.065800	33.584200	4700	Mousses	Steppe froide		Peyron, O.	Yu et al., 2001
TI59	Tanggula	Tibet	91.857200	33.214200	5121	Mousses	Steppe froide		Peyron, O.	Yu et al., 2001
TI60	Tanggula	Tibet	91.918600	32.881400	5231	Mousses	Steppe froide		Peyron, O.	Yu et al., 2001
TI61	Cuona	Tibet	91.396400	32.067800	4772	Mousses	Steppe froide		Peyron, O.	Yu et al., 2001
TI62	Naqu	Tibet	91.400000	31.400000	4700	Mousses	Steppe froide		Peyron, O.	Yu et al., 2001
TI63	Naqu	Tibet	91.538300	30.624200	4654	Mousses	Steppe froide		Peyron, O.	Yu et al., 2001
TI64	Nianqingtanggula	Tibet	91.400000	30.544400	4440	Mousses	Steppe froide		Peyron, O.	Yu et al., 2001
TI65	Nianqingtanggula	Tibet	91.120800	30.563300	4443	Mousses	Désert froid		Peyron, O.	Yu et al., 2001
TI66	Nianqingtanggula	Tibet	91.113300	30.593100	4463	Mousses	Steppe froide		Peyron, O.	Yu et al., 2001
TI68	Nianqingtanggula	Tibet	91.108100	30.623600	4870	Mousses	Steppe froide		Peyron, O.	Yu et al., 2001
TI69	Nianqingtanggula	Tibet	91.094700	30.671400	5000	Mousses	Steppe froide		Peyron, O.	Yu et al., 2001
TI70	Nianqingtanggula	Tibet	91.097500	30.681400	5152	Mousses	Steppe froide		Peyron, O.	Yu et al., 2001
TI71	Lasha	Tibet	90.988300	30.420300	4219	Mousses	Steppe froide		Peyron, O.	Yu et al., 2001
TI72	Yangbajing	Tibet	90.557200	30.083300	4323	Mousses	Steppe froide		Peyron, O.	Yu et al., 2001
TI73	Budla Palace	Tibet	91.250000	29.666700	3000	Mousses	Steppe froide		Peyron, O.	Yu et al., 2001
TI74	Ruomohong	Tibet	96.426900	36.380800	2940	Mousses	Désert froid		Peyron, O.	Yu et al., 2001
TI75	Ruomohong	Tibet	96.177800	36.373300	2763	Mousses	Désert froid		Peyron, O.	Yu et al., 2001
TI76	Tanggula	Tibet	91.951400	32.905600	5180	Mousses	Steppe froide		Peyron, O.	Yu et al., 2001
TI77	Naqu	Tibet	92.250000	31.608300	4580	Mousses	Steppe froide		Peyron, O.	Yu et al., 2001
TI78	Naqu	Tibet	91.870800	31.315300	4510	Mousses	Steppe froide		Peyron, O.	Yu et al., 2001
TI79	Kekexili	Tibet	92.951100	34.949400	4657	Mousses	Steppe froide		Peyron, O.	Yu et al., 2001
TI80	Kekexili	Tibet	92.605300	34.375000	4680	Mousses	Steppe froide		Peyron, O.	Yu et al., 2001
TI81	Kekexili	Tibet	92.455000	34.236900	4532	Mousses	Steppe froide		Peyron, O.	Yu et al., 2001
TI82	Cuona	Tibet	91.396100	32.066700	4740	Mousses	Steppe froide		Peyron, O.	Yu et al., 2001

Nom	Site	Pays	Longitude	Latitude	Altitude	Nature du prélèvement	Biome	Auteur	Source	Référence
TI83	Zigetangcuo	Tibet	90.943300	32.007500	4566	Mousses	Steppe froide		Peyron, O.	Yu et al., 2001
TI84	Zigetangcuo	Tibet	90.951700	32.011900	4570	Mousses	Steppe froide		Peyron, O.	Yu et al., 2001
TI85	Zigetangcuo	Tibet	90.943300	32.008300	4600	Mousses	Steppe froide		Peyron, O.	Yu et al., 2001
TI86	Zigetangcuo	Tibet	90.952500	32.020000	4580	Mousses	Steppe froide		Peyron, O.	Yu et al., 2001
TI87	Zigetangcuo	Tibet	90.945300	32.005600	4576	Mousses	Steppe froide		Peyron, O.	Yu et al., 2001
TI88	Zigetangcuo	Tibet	90.941700	32.008300	4575	Mousses	Steppe froide		Peyron, O.	Yu et al., 2001
TI89	Zigetangcuo	Tibet	90.931900	32.030000	4560	Mousses	Steppe froide		Peyron, O.	Yu et al., 2001
TI90	Kekexili	Tibet	92.720300	34.469700	4632	Mousses	Steppe froide		Peyron, O.	Yu et al., 2001
TI91	Tanggula	Tibet	91.873900	32.685600	5010	Mousses	Steppe froide		Peyron, O.	Yu et al., 2001
TI92	Gerencuo 2	Tibet	92.391700	34.628900	4650	Mousses	Steppe froide		Peyron, O.	Yu et al., 2001
TI93	Gerencuo 3	Tibet	92.400000	34.613100	4650	Mousses	Steppe froide		Peyron, O.	Yu et al., 2001
TI94	Caidamo	Tibet	98.183300	36.733300	3120	Mousses	Désert froid		Peyron, O.	Yu et al., 2001
TI95	Namocuo	Tibet	90.869400	30.707200	4710	Mousses	Steppe froide		Peyron, O.	Yu et al., 2001
TI96	Cuona	Tibet	91.439400	32.059400	4588	Mousses	Steppe froide		Peyron, O.	Yu et al., 2001
TI97	Cuona	Tibet	91.450000	32.150800	4600	Mousses	Steppe froide		Peyron, O.	Yu et al., 2001
TI98	Namocuo	Tibet	90.851100	30.680300	4710	Mousses	Steppe froide		Peyron, O.	Yu et al., 2001
TI99	Namocuo	Tibet	90.853900	30.679200	4712	Mousses	Steppe froide		Peyron, O.	Yu et al., 2001
VA 1	Massif central	France	2.695000	45.422000	942	Mousses	Forêt tempérée décidue	Vergne, V.	Peyron, O.	Vergne, thèse
VB05	Massif central	France	2.730000	45.500000	1140	Mousses	Forêt tempérée décidue	Vergne, V.	Peyron, O.	Vergne, thèse
VB15	Massif central	France	2.750000	45.485000	1180	Mousses	Forêt mixte fraîche	Vergne, V.	Peyron, O.	Vergne, thèse
VB32	Massif central	France	2.829000	45.500000	1575	Mousses	Forêt mixte fraîche	Vergne, V.	Peyron, O.	Vergne, thèse
VB33	Massif central	France	2.829000	45.500000	1500	Mousses	Forêt tempérée décidue	Vergne, V.	Peyron, O.	Vergne, thèse
VC41	Massif central	France	2.619000	45.430000	770	Mousses	Forêt mixte fraîche	Vergne, V.	Peyron, O.	Vergne, thèse
VC43	Massif central	France	2.599000	45.380000	800	Mousses	Forêt mixte fraîche	Vergne, V.	Peyron, O.	Vergne, thèse
VC45	Massif central	France	2.679000	45.380000	680	Mousses	Forêt tempérée décidue	Vergne, V.	Peyron, O.	Vergne, thèse
VC47	Massif central	France	2.669000	45.400000	880	Mousses	Forêt tempérée décidue	Vergne, V.	Peyron, O.	Vergne, thèse
VC50	Massif central	France	2.683000	45.443000	870	Mousses	Forêt mixte fraîche	Vergne, V.	Peyron, O.	Vergne, thèse
VC55	Massif central	France	2.669000	45.520000	920	Mousses	Forêt mixte fraîche	Vergne, V.	Peyron, O.	Vergne, thèse
VC59	Massif central	France	2.789000	45.470000	1200	Mousses	Forêt mixte fraîche	Vergne, V.	Peyron, O.	Vergne, thèse
VC64	Massif central	France	2.849000	45.430000	1030	Mousses	Forêt mixte fraîche	Vergne, V.	Peyron, O.	Vergne, thèse
VC68	Massif central	France	2.829000	45.450000	1160	Mousses	Forêt tempérée décidue	Vergne, V.	Peyron, O.	Vergne, thèse

Annexe 2

La base de données actuelles a été testée dans la région des Balkans mais elle a aussi été appliquée dans d'autres régions et d'autres écosystèmes pour la même période de temps couvrant le Tardiglaciaire, une période de transition ce qui complique les reconstitutions climatiques à partir de la végétation, et, l'Holocène.

La première étude concerne des reconstitutions climatiques et environnementales en mer Egée, au cours de l'Holocène et principalement pendant la période de formation du sapropel S1. Ces résultats font l'objet d'une publication dans la revue Quaternary Science Reviews (Kothoff et al., 2008).

La deuxième étude porte sur des reconstitutions climatiques au cours de la dernière déglaciation et de l'Holocène, à partir de cinq séquences polliniques (Laghi dell'Orgials, Lago delle Fate, Torbiera del Biecai, Refugio Mondovi, Pian Marchisio) dans les Alpes liguriennes. Les résultats obtenus font l'objet d'une publication dans la revue Quaternary International (Ortu et al., 2008).

Ces deux applications ont permis de tester la validité de la base de données, en travaillant séparément dans des écosystèmes méditerranéens (Kotthoff et al., 2008) et médio-européens (Ortu et al., 2008).

Timing and characteristics of terrestrial vegetation change in the NE Mediterranean region associated with the formation of marine Sapropel S1: A land-sea correlation

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Abstract

To unravel the environmental and climatic dynamics in the borderlands of the Aegean Sea during the early and middle Holocene, and notably for the interval of sapropel S1 formation, we have performed a high-resolution (~30 to ~140 yr) analysis of terrestrial palynomorphs from a marine core in the northern Aegean Sea. The qualitative palynological results were complemented by quantitative pollen-based climate reconstructions. As a measure of Mediterranean-type climate conditions, the taphonomically inert index IQ (based on the ratio of deciduous and evergreen oak pollen) was introduced. Through the comparison of these terrestrial vegetation data with marine sediment lightness data from the same core and previously published benthic foraminiferal data from a neighbouring core, a direct land-sea correlation was achieved.

The northern borderlands of the Aegean Sea underwent a transition from an open vegetation to oak-dominated woodlands between ~10.4 and ~9.5 kyr BP. The reforestation was primarily due to increasing winter precipitation, suggesting that moisture availability was the dominant factor controlling Holocene reforestation. The overall humid and mild winter conditions during sapropel S1 formation were repeatedly punctuated by short-term climatic events that caused a partial deforestation and a reorganisation within the arboreal vegetation. The strongest of these events (from ~8.4 to ~8.0 kyr BP) represents the regional expression of the 8.2 kyr cold event widely known from the northern hemisphere. It is intimately connected to an interruption of sapropel S1 formation in the marine realm. Generally, phases of decreased winter precipitation and partially also temperature in the northern borderlands correlate with intervals of improved benthic oxygenation in the northern Aegean Sea. This supports the previously suggested scenario that northerly outbreaks from the Siberian High in the winter and spring repeatedly led to a decrease in runoff into the northern Aegean Sea and/or enhanced surface-water cooling. An increase in the frequency and/or intensity of such events may have caused local overturn in the northern Aegean Sea, thus improving the oxygenation of the deeper water column and leading to a cease in sapropel formation. The ~50% higher winter precipitation during S1 formation as compared to “pre-sapropelic” conditions and also the ~25 % decrease in winter precipitation with the termination of sapropel S1 suggest a strong contribution from the northern borderlands of the Aegean Sea to the freshwater surplus during sapropel S1 formation in the Eastern Mediterranean Sea. For the early and middle Holocene, the pollen-derived winter temperatures correlate with the smoothed GISP2 K^+ series, thus supporting the previously published, marine-based concept that the intensity of the Siberian High exerted strong control on winter climate in the Aegean region. During the

interval of sapropel S1 formation in the Aegean Sea, however, the terrestrial climate dynamics in the northern borderlands appear to have been more strongly affected by the monsoonally-influenced climate system of the lower latitudes.

Keywords: land-sea correlation; pollen; vegetation change; Sapropel S1; Holocene; Aegean; climate change; Siberian High

Introduction

Numerous layers of dark-coloured, organic-rich sediments, termed ‘sapropels’, have been deposited in the eastern Mediterranean Sea at least since the late Miocene in a periodicity correlating with precession-related Northern Hemisphere summer insolation maxima (e.g. Cita and Grignani, 1982; Rossignol-Strick et al., 1982; Hilgen, 1991; Rohling, 1994). Their formation is explained by increased riverine runoff that caused a reduction of surface-water salinities in the Mediterranean Sea and served as a source for enhanced nutrient supply, ultimately leading to deep-water oxygen starvation (see Rohling, 1994, and Cramp and O’Sullivan, 1999 for reviews).

The understanding of sapropel formation in the Mediterranean Sea is strongly based on information from the most recent sapropel S1 (S1), deposited in the Mediterranean Sea between ~9 and ~6 kyr BP. Mechanisms invoked for S1 formation mainly rely on increased freshwater runoff from the southern catchment areas of the Mediterranean Sea, notably through the Nile river, resulting from enhanced monsoonal activity over equatorial Africa during the Holocene insolation maximum (e.g. Rossignol-Strick et al., 1982; Rossignol-Strick, 1985; Casford et al., 2002). While the link between sapropel formation and African runoff is firmly established, the role of the northern borderlands of the Mediterranean Sea in this process is less well understood. It has been repeatedly suggested that increased precipitation in the Mediterranean region (including its northern borderlands), resulting from an enhanced influence of the westerlies (e.g. Rossignol-Strick, 1987; Cramp et al., 1988; Rohling and Hilgen, 1991), also played a role in S1 formation (Kallel et al., 1997 a, b; Emeis et al., 2000). Runoff derived from the melting of European ice sheets may also have contributed to enhanced freshwater input (e.g. Thunell and Williams, 1989; Aksu et al., 1999a, b, 2002; Rossignol- Strick and Paterne, 1999). According to neodymium isotope data, Nile river outflow was particularly strong during the peak phases of sapropel formation in the Eastern Mediterranean, but cannot fully account for the freshwater excess recorded in the basin at those times. Particularly prior to and after the peak in Nile river discharge other freshwater sources appear to have rivalled the Nile flux enhancement in magnitude (Scrivner et al., 2004).

Clearly, more data are necessary to better understand the character and regional imprints of climate dynamics in the borderlands of the Mediterranean Sea during sapropel formation. There is a particular need for data that allow to quantify the magnitude of climatic changes and to identify the timing of these changes with regard to sapropel formation. Ideally, these data yield a direct land-sea correlation, thus avoiding potential dating inconsistencies as they are encountered in limnic climate archives of the Eastern Mediterranean region due to hard water effects and the often unclear origin of radiocarbon-dated material (Rossignol-Strick, 1995).

In the light of the above, we have performed a high-resolution study of terrestrial palynomorphs (pollen and spores) from a marine core recovered from the Mount Athos Basin (Northern Aegean Sea) that comprises the interval of S1 deposition. Here, high sedimentation rates allow the detailed analysis of the timing between S1 formation and terrestrial ecosystem change in the northern borderlands of the Aegean Sea (NBAS). The high sedimentation rates warrant a good preservation of pollen and spores not only within S1, but also in sediments pre- and post-dating sapropel deposition. This is in stark contrast to the normal situation in the Eastern Mediterranean Sea where pollen assemblages in non-sapropelic sediments are severely oxidized, thus yielding only a fragmentary and/or strongly biased record of terrestrial vegetation change (Cheddadi and Rossignol-Strick, 1995 a, b; Rossignol-Strick, 1999; Rossignol-Strick and Paterne, 1999). A direct land-sea correlation was achieved through the combination of pollen analysis and sediment lightness measurements on the same samples. To assess seasonal temperature and precipitation changes in the northern borderlands of the Aegean Sea, qualitative and quantitative information was derived from the evaluation of palynological parameters and numerical pollen-based climate reconstructions, respectively. Because winter-sensitive proxy data are particularly important in order to decipher the characteristics of Holocene short-term climate variability (Rohling and Pälike, 2005) and palynological signals can yield such information, we have focussed our quantitative reconstructions on winter climate parameters. Due to the lower inertia of terrestrial ecosystems with respect to climatic forcing as compared to marine settings, the direct land-sea correlation link allows to elucidate the relationships between short-term signals of atmospheric change and the formation of S1 in the marine realm.

Regional setting

Core GeoTü SL152 (40°05.19’N, 24°36.65’E, water depth 978 m) has been retrieved in 2001 during R.V. Meteor cruise M51/3 from the Mount Athos Basin, ca. 200 km SE of Thessaloniki (Fig. 1). In total, the 6.7 m long core comprises the last 20 kyr. A decadal- to centennial-scale resolution study of the interval from 3.71 to 1.60 m (i.e., from ~10.4 to ~4.4 kyr BP; Fig. 2) comprising S1 is presented here.

The present-day wind field in the Mount Athos Basin is dominated by northerly directions, with cold and dry arctic/polar outbreaks during the winter and spring months (Poulos et al., 1997). Terrigenous sediment components are transported into the Mount Athos Basin predominantly (in the order of their individual sediment contributions) through the Evros/Meric, Axios, Strimon, and Nestos rivers draining the NBAS (Fig. 1; Ehrmann et al., 2006). A subordinate input of terrigenous material (including pollen and spores) into the Mount Athos Basin is also possible from western Turkey. This is due the surface water circulation in the Aegean Sea, with a counter-clockwise current delivering surface waters from the Levantine Basin into the Aegean Sea along the western coast of Turkey (Pickard and Emery, 1990). A further potential source for terrigenous material in the Aegean Sea is the outflow of Black Sea surface waters. However, this process was only fully established around 6.5 kyr BP (Sperling et al., 2003), and present-day surface waters entering the Aegean Sea from the Sea of Marmara contain only very little suspended material (Aksu et al., 1995; Ehrmann et al. 2006).

Thus, Black-Sea outflow cannot have affected the pollen and spore input into the Mount Athos Basin during the time interval studied. In summary, terrestrial palynomorphs carried into the Mount Athos Basin both via aerial and fluvial transport can be expected to closely reflect the vegetation in the NBAS.

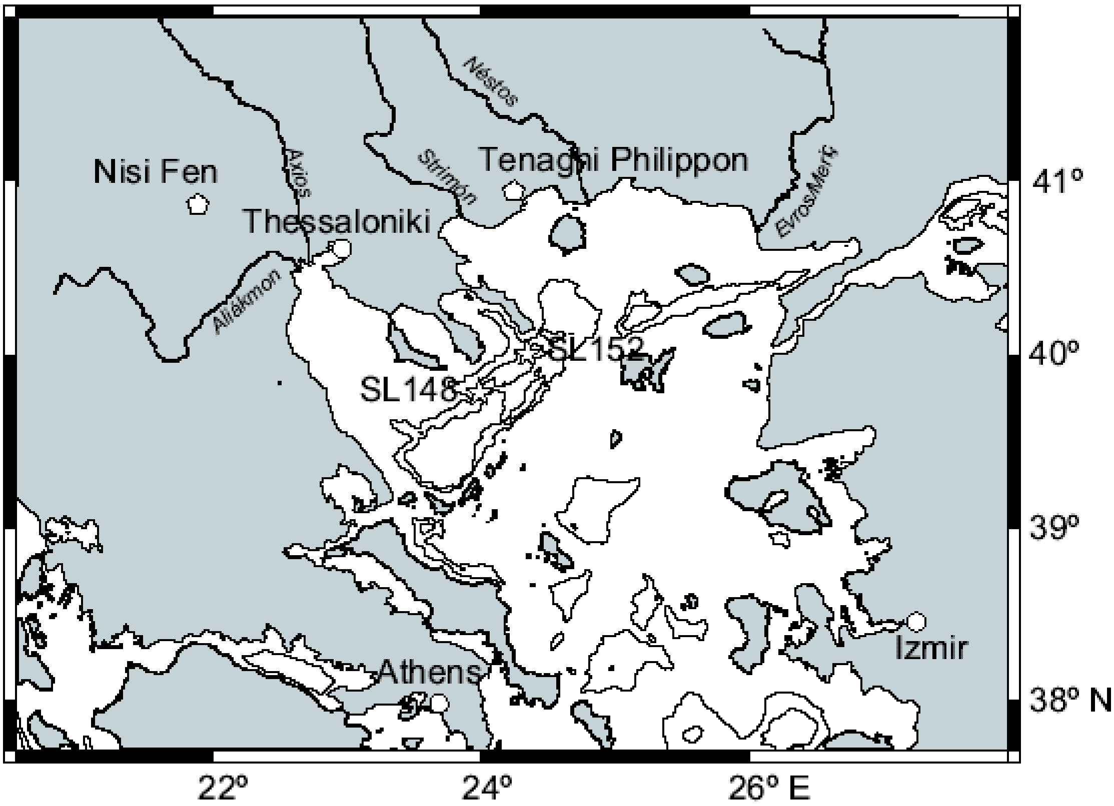

Figure 1: Map of the Aegean Sea showing locations of cores GeoTÜ SL152 (large white star), GeoTÜ SL148 (small white star) and other climate archives mentioned in the text (pentagons). Isolines show water depths of 600 and 1000 m.

Material and methods

Age model

The age model established for core GeoTü SL152 is based on eight accelerator mass spectrometry ^{14}C dates. Most dates were obtained from tests of *Globigerinoides ruber* (Tab. 1). The ^{14}C analyses were performed at the Leibniz Laboratory for Radiometric Dating and Stable Isotope Research, Kiel, with a precision of ±30 to ±90 years standard deviation (Tab. 1). All ^{14}C dates were converted into calendar years using the Fairbanks 0805 calendar age conversion software (Fairbanks et al., 2005). Reservoir effects were calculated following Siani et al. (2001) and range between 400 and 600 years. The developed age-depth curve shows that the eight ^{14}C dates yield highly consistent ages (Fig. 2). Differences in sedimentation rates across the interval presented here are only minor, thus justifying linear interpolation between the ^{14}C datings.

Table 1: Age control for core GeoTÜ SL152 based on AMS radiocarbon measurements. Calibration was performed with the Fairbanks 0805 calendar age conversion software (Fairbanks et al., 2005), corrections for reservoir effects are after Siani et al. (2001).

	Depth (cm)	^{14}C yr BP	Material/Taxa	Grain size (µm)	Reservoir Correction/yr	Calendar Years BP
	0	0			0	0
KIA 28410	161	4400±30	*Globigerinoides ruber*	>200	400	4462±37
KIA 28411	210	5265±35	*Globigerinoides ruber*	>200	400	5599±26
KIA 28412	270	6570±45	*Globigerinoides ruber*	>200	400	7078±78
KIA 28413	300	7805±40	*Gs. ruber* and *G. bulloides*	>200	400	8226±56
KIA 28414	356	9205±55	*Globigerinoides ruber*	>200	400	9851±143
KIA 28415	400	10410±50	Pteropoda	>315	400	11479±136
KIA 28408	505	12430±60	Mixed planctic Foraminifera	200-400	600	13738±114
KIA 28409	645	16990±90	Mixed planctic Foraminifera	>200	400	19704±124

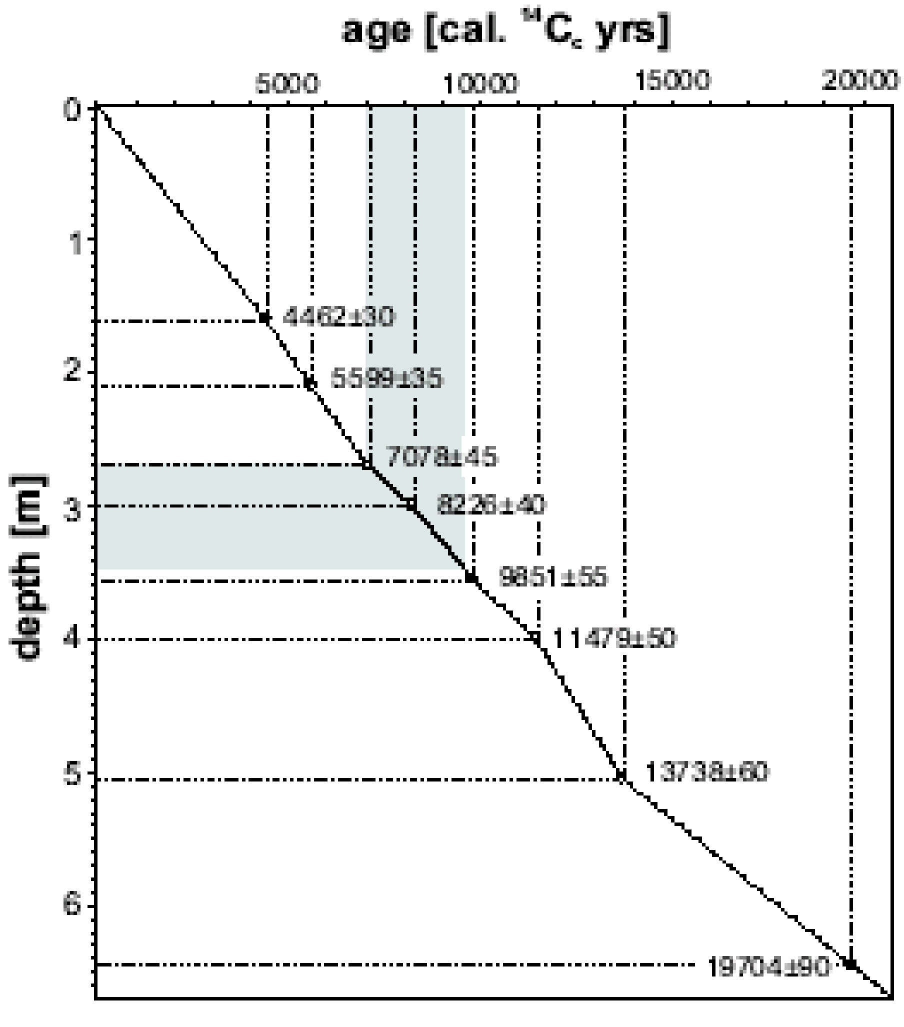

Figure 2: Age-depth curve for core GeoTÜ SL152. Grey bars mark sapropelic sediments.

Identification of sapropelic sediments, sampling strategy and pollen analysis

To differentiate between sapropelic and non-sapropelic sediments in core SL152, sediment lightness was measured using a Pausch Messtechnik hand colorimeter. In accordance with the visual core description, a lightness value of 46% was selected to delimit darker sapropelic from lighter non-sapropelic sediments. To validate the lightness-based distribution of sapropelic sediments in core SL152, we compared the results to the distribution pattern of low-oxygen indicators within benthic foraminifera in the neighbouring core GeoTü SL148 (39°45.20’N, 24°05.75’E, water depth 1094 m; Fig. 1; Kuhnt et al., subm.).

Terrestrial palynomorph samples were taken from the interval corresponding to S1 with a sample spacing of 1 cm (sample thickness: 0.5 cm). Non-sapropelic sediments adjacent to S1 were sampled in a resolution of 5 cm (sample thickness: 1 cm). Based on the age model for core SL152 (Fig. 2), an average temporal resolution of ~30 yr for the S1 interval and ~140 yr below and above was achieved. The samples were treated with HCl and HF, and sieved through a 6 µm nylon mesh. Whenever possible, a minimum of 300 terrestrial palynomorphs (excluding bisaccate pollen and spores) was analyzed per sample. For the calculation of pollen percentages, bisaccate pollen was excluded from the counting sums. This is because bisaccate pollen is overrepresented in marine pollen assemblages due to its good transport properties and particularly high resistivity to oxidation (e.g. Traverse, 1988; Rossignol-Strick and Paterne, 1999).

Pollen-based climate reconstructions

Qualitative reconstructions

As indicators of climatic conditions in the NBAS, several palynological parameters were used. The degree of forestation was measured using the percentage of broad-leaved tree pollen relative to the sum of all pollen excluding bisaccates. The index IQ = QIT/(QIT + QOQ), with QIT = number of *Quercus*-*ilex*-type pollen grains and QOQ = number of *Quercus* pollen grains other than *Q. ilex*-type, was established as a measure of Mediterranean-type climate conditions which are characterized by pronounced summer droughts and wet, cool winters (Nahal, 1981). This index is based on the notion that in the Mediterranean region *Q.-ilex*-type pollen is mainly derived from evergreen *Quercus* taxa, whereas the remaining *Quercus* pollen is largely from deciduous taxa within the genus.

Based on the climatic requirements of evergreen and deciduous *Quercus* taxa as outlined below, high IQ values (i.e. the dominance of pollen from evergreen over that from deciduous *Quercus*) delineate a climate characterized by summer drought in combination with relatively mild and humid winters. Accordingly, low IQ values characterize a climate with a less expressed summer drought in combination with relatively cold and/or dry winters.

In the Mediterranean region, *Q.-ilex*-type pollen predominantly comprises that of *Q. ilex* and *Q. coccifera*. Both these evergreen, sclerophyllous taxa are highly tolerant to summer drought stress, but require substantial winter precipitation and react sensitively to low winter temperatures. *Quercus ilex*, which is more robust to harsh winters than *Q. coccifera*, cannot endure a mean temperature of the coldest month <3°C (Barbero et al., 1992; Leonardi et al., 1992). Near-fatal damage occurs in adult *Q. coccifera* and *Q. ilex* stands once temperatures drop to -12°C and -15°C, respectively (Larcher, 2000; Cavender-Bares et al., 2005). This is in accordance with the observation that seedlings of Mediterranean tree taxa can be destroyed through frost at -5 to -10°C. Their survival is severely compromised by the occurrence of such frosts over successive winters (Larcher, 2000). Deciduous *Quercus* taxa in the Mediterranean region mainly comprise *Q. pubescens* and *Q. robur*. Although *Q. pubescens* can also tolerate prolonged summer drought, deciduous *Quercus* taxa have higher requirements with regard to soil water availability (particularly in summer) than their evergreen counterparts (Damesin and Rambal, 1995). On the other hand, they can endure cold, dry winters as documented by their distribution areas extending as far north as Bohemia for *Q. pubescens* and the Baltic region for *Q. robur* (Lang, 1994).

The morphological similarity of pollen from deciduous and evergreen *Quercus* taxa renders their differentiation in palynological slides difficult, with some authors even taking the view that such a differentiation is impossible (Cheddadi and Rossignol-Strick, 1995a). However, morphological studies on pollen from different Mediterranean *Quercus* taxa show that the *Q.-ilex*- or *coccifera*-type pollen is clearly distinguishable from other *Quercus* pollen types (Colombo et al., 1983), and many workers routinely distinguish evergreen (predominantly *Q. ilex* or *coccifera*-type) pollen from deciduous-*Quercus*-type pollen (e.g. Follieri et al., 1988; Reille et al., 1999; Cheddadi et al., 1998; Sadori and Narcisi, 2001; Tzedakis et al., 2002; Bottema and Sarpaki, 2003; Magny et al., 2006). The validity of this approach is best demonstrated when its results are successfully integrated with those from other proxy data. For the discrimination between *Q.-ilex*-type and *Q.-robur*-type pollen we have employed size and shape criteria. Pollen of the *Q. ilex* type is slightly smaller in diameter (<22 um) and exhibits a more rhombic shape in equatorial view, whereas the *Q. robur* type is slightly larger in diameter (>22 um) and has a more elliptical or rectangular shape in equatorial view (cf. Reille, 1992; Beug, 2004). Because the index IQ is based on morphologically very similar pollen from taxonomically closely related parent plants, it is inert to taphonomical bias potentially resulting from differences in hydrodynamic properties or degradational resistivity. The use of a solely *Quercus*-pollen-based index also does justice to the fact that *Quercus* tends to be overrepresented in the pollen rain as compared to its proportion in the arboreal vegetation (Rossignol-Strick, 1995). Hence, it can be expected to yield a robust climatic signature.

Quantitative reconstructions

To support the qualitative climate information derived from the pollen assemblages, seasonal temperatures and precipitation parameters were calculated from the generated pollen data using the Modern Analogue Technique (MAT; Guiot, 1990). Originally developed for continental records, the MAT has been successfully applied to marine pollen assemblages from the Mediterranean region (Desprat et al., 2005; Sánchez Goñi et al., 2005). In this method, the similarity between fossil and modern pollen assemblages is evaluated by a chord distance calculated as a sum of differences between log-transformed taxa percentages. The method does not imply a direct analogy between modern and fossil assemblages, although the quality of the results depends on the size and diversification of the modern data set (Peyron et al., 2005). Here, this technique is based on a recently improved database including 3000 modern pollen spectra from Europe, Asia and northern Africa (Bordon and Peyron, unpubl. data). Because of its overrepresentation in marine pollen assemblages, *Pinus* pollen was removed from the evaluated pollen samples and the pollen database. The ten modern spectra with smallest chord distances were considered the best modern analogues of the evaluated pollen spectrum and used for the reconstruction. Their climatic parameters were averaged by a weighting inverse to the chord distance. Here, the climatic parameters reconstructed are the mean winter temperature (MTDJF) and mean winter precipitation (MPDJF) (Peyron et al., 1998). The variability among the climates represented by the dataset of modern analogues is given by the most extreme positive and negative deviations among the ten analogues used in comparison to the mean value. This variability explicitly includes errors in the modern climate observations and the influence of non-climatic factors on the assemblages such as soil conditions (Cheddadi et al., 1998). To further improve the reconstructions, the MAT results were constrained by a standardized biomisation procedure (Guiot et al., 1993), where the final climate estimates are based on the modern analogues assigned to the same biome as the fossil assemblage.

Results

Overall character and fidelity of pollen and spore signals

All 96 palynological samples studied from core SL152 have yielded rich, diverse pollen and spore assemblages in good preservation. Differential preservation cannot have severely affected the originally deposited assemblages as is documented by the curves of broad-leaved tree pollen and bisaccate pollen percentages (Fig. 3). The lowermost 0,4 and uppermost 1.0 m of the section studied exhibit the highest sediment lightness values (i.e. lowest organic content) measured (Fig. 3). The curve of broad-leaved tree pollen percentages fluctuates strongly over these intervals although lightness values remain high. If differential preservation had significantly affected the pollen signal, an inverse correlation between broad-leaved tree pollen percentages and sediment lightness would be expected. Bisaccate pollen percentages are also decoupled from sediment lightness values. In fact, their curve does not exhibit any significant changes across the boundaries between sapropelic and non-sapropelic sediments. It is only in the uppermost part of the section (starting at ~2.40 m) that bisaccate pollen percentages show a pronounced rise, and the increase again does not correlate with changes in sediment lightness (Fig. 3). The close correspondence between the curve of the taphonomically robust index IQ and the curve of broad-leaved tree pollen (Fig. 4) corroborates the view that strong differential preservation can be excluded for the section studied.

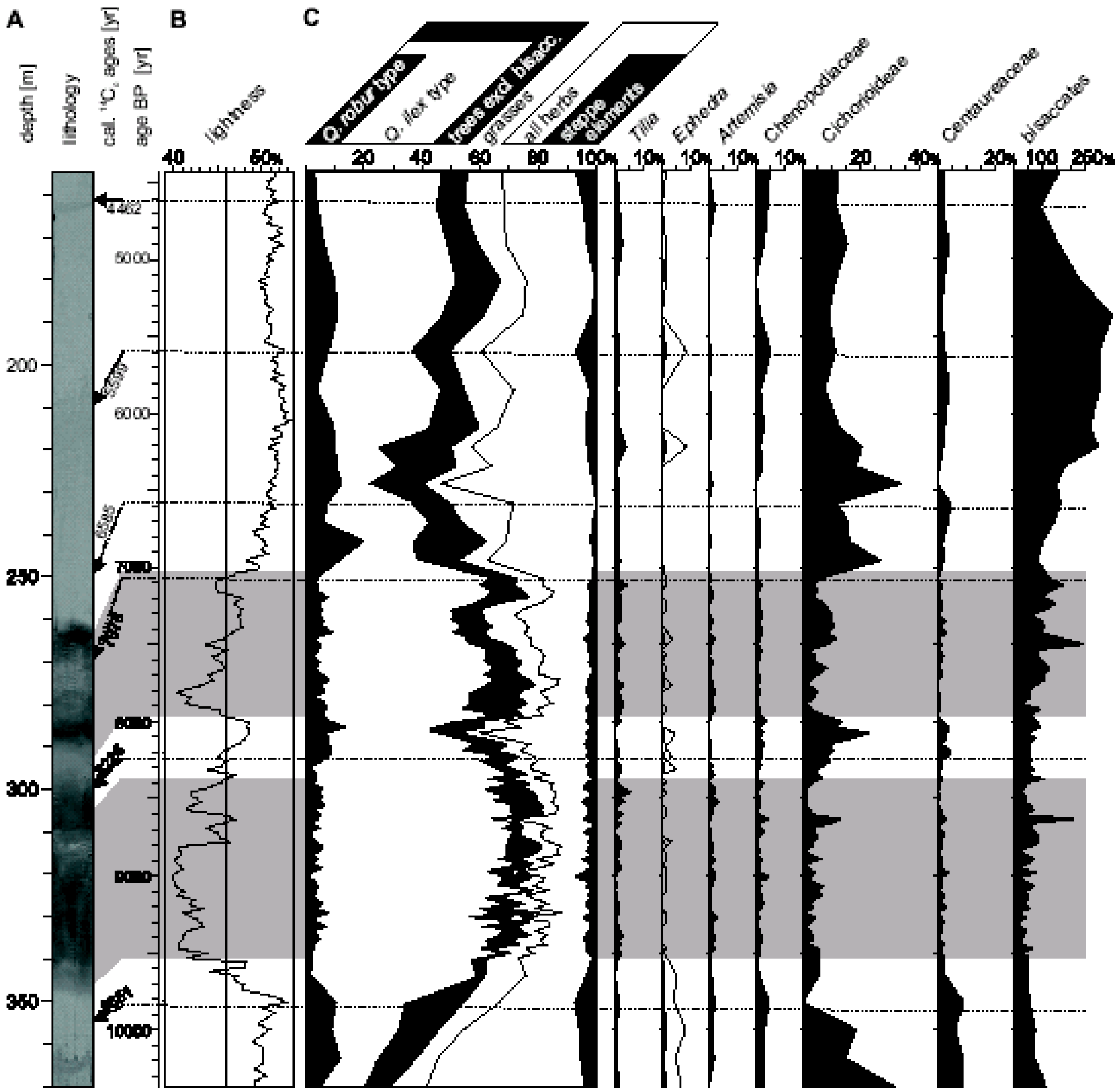

Figure 3: Results from the analysis of marine and terrestrial proxies in core GeoTÜ SL152. A: Digital core photo plotted versus depth. B: Sediment lightness plotted versus age (in reservoir-corrected calendar years). In accordance with the visual core description, lightness percentages <46% were considered to reflect sapropelic sediments. C: Percentages of selected pollen types plotted versus age. The percentages are based on total terrestrial pollen excluding bisaccate pollen. Grasses comprise Cyperaceae and Gramineae. Steppe elements comprise *Ephedra*, *Artemisia* and Chenopodiaceae. Dashed arrows mark reservoir-corrected ^{14}C-based calendar ages, arrowheads indicate positions of 14C samples in the core. In accordance with the visual core description, grey bars mark sapropelic sediments (sediment lightness <46 %).

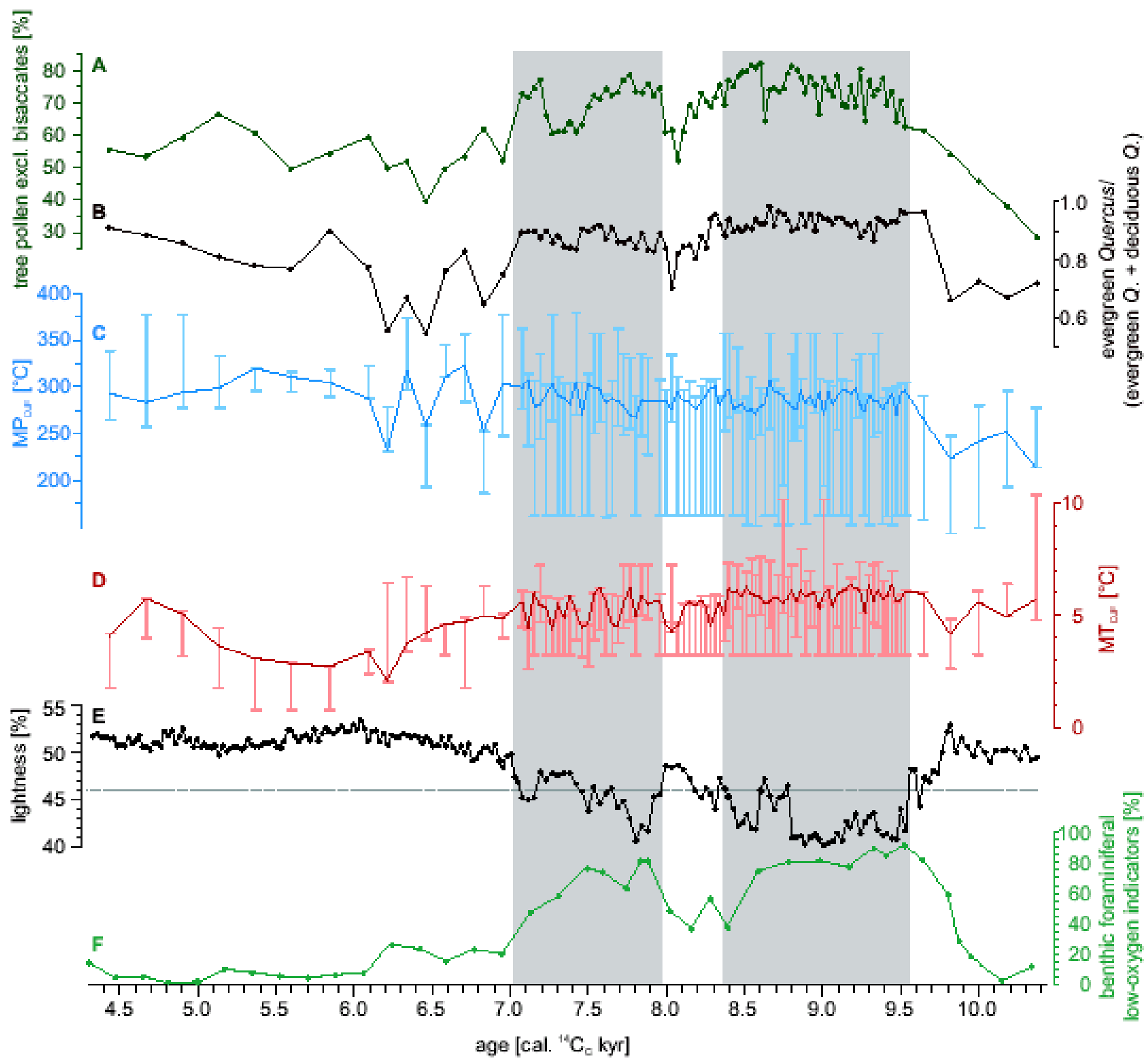

Figure 4: Broad-leaved tree pollen percentages, index IQ, pollen-based quantitative climate reconstructions, and sediment lightness from core GeoTü SL152 as well as percentages of low-oxygen indicators within benthic foraminifera from neighbouring core GeoTü SL148 plotted versus age (in reservoir-corrected calendar years). A: Pollen percentages of broadleaved trees. B: index IQ, with high values indicating a dominance of evergreen *Quercus* pollen over that from deciduous *Quercus* pollen and vice versa. C: Mean precipitation during the winter months (MPDJF). D: Mean temperature during the winter months (MTDJF). E: Sediment lightness, with values <46 % indicating sapropelic sediments. F: Percentages of low-oxygen indicators within benthic foraminifera from neighbouring core GeoTü SL148 (data from Kuhnt et al., subm.). C und D are based on the Modern Analogue Technique constrained by biomisation procedure. Vertical bars in C and D indicate the variability among the climates represented by the modern-analogue dataset, with upper and lower limits delineating the most extreme positive and negative deviations among the ten analogues used in comparison to the mean value. In accordance with the visual core description, grey bars mark sapropelic sediments (sediment lightness <46 %).

Environmental and climatic signals

The high-resolution record of core SL152 starts at a depth of 3.71 m, well below the onset of S1. Based on our age model, this corresponds to an age of ~10.4 kyr BP (Figs. 3, 4). At that time, an open vegetation dominated the NBAS, characterized by non-steppe herbs such as Cichorioideae and Centaureaceae. Steppe elements, mainly consisting of Chenopodiaceae, played only a minor role (Fig. 3). From ~10.4 kyr BP until ~9.5 kyr BP, broad-leaved tree pollen percentages steadily rose from 30% to up to 65% (Fig. 4A). The index IQ was <0.75 until ~9.8 kyr BP and rose to >0.95 at ~9.6 kyr BP (Fig. 4B). The quantitatively reconstructed mean winter precipitation (MPDJF) and mean winter temperature (MTDJF) fluctuated strongly during the interval preceding S1 formation. They show an anti-phase behaviour prior to ~9.8 kyr BP when a strong low is recorded both in the MPDJF and MTDJF that coincides with an IQ minimum (Fig. 4B-D). In the marine dataset, this climatic deterioration is reflected by a peak in sediment lightness (Fig. 4E). Subsequently, the MPDJF and MTDJF rose strongly, with the MTDJF reaching a plateau ~200 yrs prior to the onset of S1 formation. For the interval before ~9.9 kyr BP, the marine proxy data (i.e., sediment lightness data in core SL152 and percentages of low-oxygen indicators within benthic foraminifera in core SL148) consistently indicate high benthic oxygenation. They document a first benthic oxygenation minimum at ~9.5 kyr BP, with the strongest oxygenation drop occurring between 9.8 and 9.6 kyr BP (Fig. 4E, F).

Summarizing the above, the NBAS witnessed a transition from an open vegetation to oakdominated woodlands during the “pre-S1” interval between ~10.4 and ~9.5 kyr BP. The final phase of this reforestation process from ~9.8 kyr BP onwards was paralleled by a strong IQ increase and also by pronounced MPDJF and MTDJF rises to values typical of those during S1 formation. In the marine datasets, this amelioration in winter climate conditions coincides with a decline in sediment lightness values and an increase in the percentages of low-oxygen indicators within benthic foraminifera in core SL148.

Throughout the interval of S1 formation (i.e. from ~9.6 to ~7.0 kyr BP; Fig. 4), pollen assemblages from the NBAS are characterized by high (> 50%) percentages of broad-leaved tree pollen (Fig. 4A). High IQ values document a prevalence of evergreen over deciduous *Quercus* pollen (Fig. 4B). The quantitative climate reconstructions reveal relatively high MPDJF and MTDJF values as compared to the “pre-sapropel” interval (Fig. 4C, D). The MPDJF remained above 270 mm throughout the interval of S1 formation. Humid winters are also evidenced by reduced percentages of pollen from the aridity indicator *Ephedra* (Fig. 3).

The MTDJF fluctuated between 4 and 6°C, with a slight overall cooling trend being superimposed on this signal.

For the marine realm, the data show generally reduced sediment lightness values and increased percentages of low-oxygen indicators within benthic foraminifera from ~9.6 to ~7.0 kyr BP, although there is a pronounced, closely coupled variability in both datasets during that interval (Figs. 4E, F).

The relatively humid and warm winter conditions in the NBAS during S1 formation were, however, punctuated by perturbations of different magnitudes that are also documented in the marine proxy data. The most pronounced perturbation started at ~8.4 kyr BP and peaked at ~8.1 kyr BP. It is documented in a transient reduction of broad-leaved tree pollen percentages to values as low as 52 % (Fig. 4A) and a slightly delayed IQ reduction (Fig. 4B). The MAT reconstructions reveal a ~1.5°C MTDJF reduction centered at ~8.1 kyr BP (Fig. 4C), but do not indicate any significant MPDJF changes during that time (Fig. 4D). In the marine proxy data, the perturbation is documented by increased sediment lightness. Based on the threshold value of 46 % selected to discern sapropelic from non-sapropelic sediments, the sediment lightness curve indicates an interruption of S1 formation from ~8.4 to ~8.0 kyr BP (Fig. 4E). The interval of increased sediment lightness in core SL152 is paralleled by reduced percentages of low-oxygen indicators within benthic foraminifera in core SL148 (Fig. 4F). Lowermagnitude perturbations during S1 formation are predominantly documented in the broadleaved tree pollen percentage and partially also in the IQ and lightness data (Fig. 4A, B, E). Between ~7.5 and ~7.2 kyr BP, the broad-leaved tree pollen and IQ records consistently exhibit reduced values. In the lightness record, this event is registered by a transient return to higher values. A similar, albeit weaker perturbation is documented in the curves of broadleaved tree pollen and lightness between ~8.8 and ~8.6 kyr BP. The termination of S1 formation in the northern Aegean Sea at ~7.0 kyr BP is connected to the first of a series of perturbations registered both in terrestrial and marine proxies between ~7.1 and ~5.5 kyr BP. The broad-leaved pollen percentages and IQ index exhibit pronounced minima at ~7.0 and ~6.9 kyr BP, respectively (Fig. 4A, B). This change in terrestrial vegetation proxies is also documented in the MPDJF which drops to 250 mm, a value previously only attained during the “pre-S1” interval (Fig. 4C). The MTDJF decreased slightly, but steadily during that time (Fig. 4D). The marine data show a rise in lightness values and a decline in the percentages of low-oxygen indicators within benthic foraminifera to nearly “pre-S1” values around 7.0 kyr BP. After a transient recovery to higher values, broad-leaved pollen percentages and IQ values decrease again. In the quantitative climate reconstructions, this perturbation is first documented in a MPDJF decline at ~6.5 kyr BP and a later simultaneous MPDJF and MTDJF decline at ~6.2 kyr BP (Fig. 4A-D). In the marine data, the simultaneous MPDJF/MTDJF decline is reflected by a final drop of percentages of low-oxygen indicators within benthic foraminifera to values typical of "pre-S1" conditions (Fig. 4F). Subsequently, broad-leaved pollen and IQ values recover, but fall short of reaching the levels as attained during S1 formation. Within the quantitative climate reconstructions, a recovery to values typical of the S1 interval is witnessed in the MPDJF at ~6.1 kyr BP. The MTDJF remained low and only returned to values typical of those during S1 formation at 4.9 kyr BP (Fig. 4A-D).

Discussion

Vegetation dynamics in the northern borderlands of the Aegean Sea

The qualitative and quantitative terrestrial data from core SL152, comprising the general distribution pattern of pollen and spores, the percentages of broad-leaved tree pollen, the index IQ, and the reconstructions for the MPDJF and MTDJF, yield an internally consistent picture of terrestrial ecosystem dynamics. The combined qualitative and quantitative pollen-based data from core SL152 indicate that the vegetation in the NBAS changed from steppic to arboreal between 10.4 and ~9.5 kyr BP. The vegetation and climate signals during the steppic phase preceding reforestation are reminiscent of the environmental conditions prevailing in the Eastern Mediterranean region during the Younger Dryas (~12.5-11.0 kyr BP; see Rossignol-Strick, 1995 for an in-depth review). Palynologically, the Younger Dryas is characterized by high percentages of Chenopodiaceae pollen both in marine (e.g. Rossignol-Strick, 1995; Geraga et al., 2005) and terrestrial (e.g. Wijmstra, 1969; Digerfeldt et al., 2000; Lawson et al., 2005) records. The Younger Dryas interval in core SL152 also exhibits a peak in Chenopodiaceae pollen, with percentages reaching up to 15 % (Kotthoff et al., in prep.). The fact that Chenopodiaceae pollen percentages remain below 5 % in the "pre-sapropel" interval presented here implies that climate conditions during that time had already considerably improved as compared to those of the Younger Dryas.

However, the onset of reforestation was still inhibited until ~10.4 kyr BP. This cannot have been the result of thermal constraints. Firstly, our quantitative climate reconstructions demonstrate that the reforestation process was not paralleled by a MTDJF increase. In fact, during the early stage of reforestation the MTDJF was already as high as (and partially even higher than) during the later Holocene (Fig. 4D). Secondly, higher-latitude and more continental settings in Central Europe were already densely forested at that time (Lang, 1994). These observations imply that the available humidity was yet insufficient to support the development of closed forests. The low MPDJF values at (and probably also prior to) ~10.4 kyr BP and at ~9.8 kyr BP suggest that during these times the NBAS were little influenced by the rainbearing westerlies which provide winter precipitation for the northeastern Mediterranean region via cyclones generated in the North Atlantic (e.g. Cullen et al., 2002). Further insights into the changes in winter climate conditions associated with the reforestation are provided through the IQ index. It exhibits a strong shift between ~9.8 and ~9.6 kyr BP towards a dominance of evergreen oaks. This shift is clearly related to the fact that the MPDJF crossed a critical threshold value, ultimately providing sufficient winter humidity to facilitate a restructuring of the *Quercus* population within the arboreal vegetation towards higher abundances of evergreen *Quercus* taxa. Again, our data demonstrate that the role of the MTDJF in this process must have been minor. This is evidenced by a comparison with vegetation and climate conditions at ~10.4 kyr BP. At that time, the IQ was extremely low, thus testifying to a very minor proportion of evergreen *Quercus* within the *Quercus* population. Because the MTDJF was virtually identical with that at ~9.6 kyr BP, the spread of evergreen *Quercus* must have been inhibited by other factors controlling winter climate conditions. Indeed, the MPDJF was markedly lower than at ~9.6 kyr BP, suggesting that the available humidity during wintertime was insufficient to support the proliferation of evergreen *Quercus*. These considerations highlight the critical role of winter precipitation in controlling vegetation dynamics in the eastern Mediterranean region. However, ecological factors are also to be considered when explaining the late increase of evergreen *Quercus* within the arboreal vegetation. Based on recent field studies, *Q. ilex* is underrepresented during the early stages of vegetation successions and only becomes dominant once the vegetation is structurally more developed (Barberis et al., 1992).

Reforestation was essentially completed at ~9.6 kyr BP when broad-leaved tree pollen percentages stabilized for the first time following their previous strong increase. As demonstrated above, this process was primarily connected to an increase in winter precipitation and less strongly to an increase in winter temperature. The timing of reforestation completion documented in core SL152 shows substantial discrepancies with respective signals from terrestrial pollen records in the NBAS (see Fig. 1 for locations). Based on broad-leaved tree pollen percentages of ¡Ý60 % to delineate fully developed woodlands (Wijmstra 1969), available data suggest that reforestation was completed at ~17 kyr BP at Tenaghi Philippon (altitude: 40 m; Wijmstra, 1969) and at ~11.5 kyr BP at Nisi Fen (475 m; Lawson et al. 2005). Besides being internally highly inconsistent, both these dates significantly pre-date the reforestation signal in core SL152. The differences are too high to be explained through local climatic and/or topographic differentiations and therefore must result from inconsistencies in the radiocarbon chronologies. Similar discrepancies between vegetation events recorded in marine and terrestrial archives of the Eastern Mediterranean region have been described for the Younger Dryas interval (Rossignol-Strick 1995). In accordance with the results of Rossignol-Strick (1995), the fact that the early Holocene terrestrial records in the NBAS suggest older ages than those recorded in core SL152 is best explained by an offset in the terrestrial radiocarbon chronologies through contamination by older carbon. Hence, these findings underscore the potential of dating palynological signals of terrestrial environmental change via the more firmly established radiocarbon chronologies in marine archives.

The combined qualitative and quantitative pollen-based parameters exhibit a strong variability even after reforestation was completed, pointing to recurring short-term climate perturbations that influenced the vegetation. The most pronounced of these perturbations occurred from ~8.4 to ~8.0 kyr BP, ~7.5 to ~7.2 kyr BP and from ~7.1 to ~5.5 kyr BP. The perturbation from ~8.4 to ~8.0 kyr BP, peaking at ~8.1 kyr BP, is characterized by a successively increasing decline in the percentages of broad-leaved deciduous pollen that started at ~8.4 kyr BP and accelerated at ~8.2 kyr BP. Based on the temporal resolution of our data, the minimum in broad-leaved deciduous pollen percentages was reached ~30 years prior to the respective minimum in IQ values, indicating that the decline in evergreen *Quercus* abundance postdated the decline in broad-leaved tree abundances. This seemingly contradicts a link between vegetation change and decreasing winter precipitation because drier winters should first affect evergreen *Quercus* abundances and only later the general broad-leaved arboreal vegetation. The apparent contradiction can be explained, however, through the ecological characteristics of *Q. ilex* within modern Mediterranean-type forests. As an element of the forest understory, *Q. ilex* initially benefits from an elimination of overstory foliage. This results in a transient competitive advantage such that the advantage of location temporarily overcompensates for the effects of increasingly adverse climate conditions (Floret et al., 1992).

The climatic perturbation peaking at ~8.1 kyr BP as expressed in the vegetation signal from the NBAS strongly resembles signals documented in coeval vegetation records in Central Europe. There, pollen percentages of deciduous trees exhibit an abrupt setback at ~8.15 kyr BP (e.g. Tinner and Lotter, 2001) and reduced tree-ring widths suggest reduced temperatures and increased drought stress centered around 8.1 kyr BP (Spurk et al., 2002). In continental archives from the Eastern Mediterranean region, a similar vegetation setback has not yet been unequivocally identified. Its strong expression in the pollen data from core SL152 suggests, however, that this is merely due to the low temporal resolution of available records and does not result from the lack of such a signal in that region. The timing and character of the initially gradual and finally sharply defined vegetation setback between ~8.4 and ~8.0 kyr BP suggests a connection to the centennial-scale climate deterioration with a sudden cold event around 8.2 kyr BP widely known from ice cores and marine and terrestrial archives in the northern hemisphere (see Mayewski et al., 2004; Alley and Ágústsdóttir, 2005; Rohling and Pälike, 2005 for reviews). This climate deterioration is generally attributed to a surfacewater freshening in the North Atlantic Ocean resulting from the catastrophic drainage of ice-dammed lakes in North America that ultimately caused a slowdown of North Atlantic deepwater formation (Alley et al., 1997; Barber et al., 1999). Further insights into the anatomy of the 8.2 kyr BP cold event as expressed in the NBAS are available through our MTDJF and MPDJF reconstructions (Fig. 4C, D). They consistently document a MTDJF drop of >1°C culminating at ~8.1 kyr BP, whereas the MTDJF remained stable. Thus, it appears that the climate perturbations associated with the 8.2 kyr BP cold event in the northern Aegean region were governed by reduced winter temperature rather than by reduced winter precipitation. Support for the scenario of reduced winter temperature in the Aegean region associated with the 8.2 kyr BP cold event is provided through planktonic foraminiferal assemblage data from the Aegean Sea which suggest a pronounced winter cooling of the surface waters between 8.5 and 8.0 kyr BP (Rohling et al., 2002).

The similar, but less pronounced setback in the arboreal vegetation of the NBAS between 7.5 and 7.2 kyr BP is not expressed in the quantitative climate reconstructions. However, its unequivocal documentation in broad-leaved tree pollen percentages and IQ values suggests that respective MPDJF and MTDJF changes were below the resolution of the MAT, thus testifying to the high sensitivity of our qualitative palynological parameters in the detection of climatic fluctuations. Independent support for a climatic signature of this perturbation comes from the sediment lightness data of core SL152. Higher lightness values in the respective interval demonstrate that that the perturbation was also felt in the marine realm. This excludes non-climatic causations for the declines of arboreal taxa such as pathogen outbreaks which have repeatedly been described for the middle Holocene of western Europe and North America (Birks, 1986).

The NBAS underwent a series of pronounced climatic and vegetational oscillations shortly after ~7.1 until ~5.5 kyr BP. Throughout this interval, the degree of forestation was lower than during S1 formation. The evergreen *Quercus* population experienced repeated setbacks, indicating a degradation in winter climate conditions. This is supported by concurrent MPDJF and MTDJF drops. The repeated lag in the IQ curve relative to the curve of broad-leaved tree pollen is again explained by ecological factors, i.e. the temporary benefit of *Q. ilex* subsequent to an elimination of overstory foliage (Floret et al., 1992) respectively its underrepresentation during the early stages of vegetation successions (Barberis et al., 1992). Hence, the qualitative and quantitative data consistently imply that terrestrial ecosystems in the northern borderlands of the Aegean Sea underwent a stage of reduced winter moisture availability and/or temperature shortly after ~7.1 until ~5.5 kyr BP.

Summarizing the above, pronounced, climatically driven environmental changes occurred in the NBAS between ~10.9 and ~4.4 kyr BP. Between ~10.4 and ~9.6 kyr BP, a predominantly steppe-like vegetation characterizing the aftermath of the Younger Dryas was rapidly replaced by forest vegetation dominated by broad-leaved trees. Reforestation coincided with a significant amelioration in winter climate conditions, notably in winter precipitation. For the remainder of the section studied, and particularly during the interval of S1 formation in the northern Aegean Sea, broad-leaved forests prevailed. The vegetation development during that time was, however, punctuated by short-term, centennial-scale climate perturbations of different magnitudes that repeatedly caused partial deforestation (as documented in the broad-leaved pollen record) and a slightly delayed reorganisation within the broad-leaved arboreal vegetation (as documented in shifts between evergreen and deciduous *Quercus* abundances). During the interval of S1 formation in the northern Aegean Sea, these perturbations occurred between ~8.4 and ~8.0 kyr BP and, somewhat less pronounced, between ~7.5 and ~7.2 kyr BP. The interval from shortly after ~7.1 to ~5.5 kyr BP is marked by repeated pulses of generally dryer and/or cooler winter climate conditions that led to overall less favourable growth conditions for the broad-leaved arboreal vegetation in the NBAS.

Comparison with supraregional climate signals

In an effort to unravel the driving factors responsible for winter climate conditions in the Aegean region during the Holocene, Rohling et al. (2002) have identified a direct atmospheric linkage between winter sea-surface temperatures in the Aegean Sea and the high-latitude climate system. Based on the correlation between relative abundances of warmer-water versus cooler-water planktonic foraminifers in a core from the SE Aegean Sea with the smoothed K+ series in the GISP2 ice core from Greenland, Rohling et al. (2002) suggested that the intensity of the Siberian High exerted strong control on winter climate conditions in the Aegean Sea. The rationale behind this argumentation is that the K+ concentration in Greenland ice represents a measure for the winter and spring intensity of the Siberian High, with high K+ deposition rates being associated with a strong Siberian High and vice versa. An increase in the strength of the Siberian High results in increased intensity, duration, and/or frequency of northerly air outbreaks over the Aegean Sea that ultimately lead to episodes of enhanced winter surface-water cooling in the Aegean Sea. Although the foraminifer-based SST reconstructions for the Aegean Sea were not strictly quantitative, Rohling et al. (2002) inferred winter SST changes during the Holocene of 2 to 4° C. The lack of high-resolution data has yet precluded an analysis of how these winter cooling episodes are expressed in terrestrial environments of the Aegean region. To provide such quantitative information and to obtain a more comprehensive view of Holocene climate variability in the Aegean region, we have compared our terrestrial MTDJF record from core SL152 with the smoothed GISP2 K+ series.

This comparison yields an in-phase behaviour of both records (Fig. 5). The inverse correlation between the terrestrial MTDJF record and the GISP2 K+ series is most strongly pronounced during the middle Holocene between ~7.0 and ~4.5 kyr BP and, to a lesser degree, during the early Holocene prior to ~9.5 kyr BP. During the interval corresponding to S1 formation in the Aegean Sea, no straightforward correlation emerges between the MTDJF and K+ records, although there appears to be a correspondence between the MTDJF minimum connected to the 8.2 kyr cold event (compare Section 5.1) and a particularly strong peak in the K+ signal. However, a closer inspection reveals that the MTDJF minimum lags the K+ maximum by ~250 yr. This offset may result from minor inconsistencies in the age model for core SL152. However, this is unlikely given the consistency of the timing of the MTDJF minimum in core SL152 with other firmly dated records of the 8.2 kyr cold event (compare Rohling & Pälike, 2005). It rather appears that between ~9.5 and ~7.0 kyr BP (i.e., during S1 formation in the Aegean Sea) the terrestrial climate dynamics in the northern borderlands were largely decoupled from the high-latitude climate system as represented by the influence of the Siberian High. We speculate that winter climate conditions during that time were more strongly affected by the monsoonally-influenced climate system of the lower latitudes. The influence of the lower-latitude climate system was, however, punctuated by the effects of the 8.2 kyr cold event. Originating from a meltwater-induced slowdown of North Atlantic deep-water formation and thus representing a signal from the North Atlantic climate system, this perturbation was obviously strong enough to leave an imprint in the MTDJF signature even when the NBAS were under the influence of low-latitude climate forcing.

In summary, our MTDJF reconstructions are in support of the concept of Rohling et al. (2002) particularly for the early (prior to ~9.5 kyr BP) and middle Holocene (~7.0 and ~4.5 kyr BP). However, for the interval corresponding to S1 in the Aegean Sea, there is little evidence for a correlation of our MTDJF data from the NBAS and the intensity of the Siberian high as documented in the GISP2 K+ series. This seemingly contradicts the findings of Rohling et al. (2002) which suggest a correlation of Aegean winter SST with the GISP2 K+ series even during that interval. However, the Aegean winter SST response to the GISP2 K+ variability also appears somewhat muted during that time as compared to prior to and after the interval of S1 formation. We therefore conclude that the terrestrial MTDJF record from the northern borderlands and the winter SST record from the Aegean Sea as presented by Rohling et al. (2002) reveal a consistent picture, both indicating a strong control of the intensity of the Siberian High on winter climate conditions in the Aegean region. Differences between the vegetation-based terrestrial MTDJF record and the foraminifer-based marine SST record, as they emerge for the interval of S1 formation in the Aegean Sea, may be due to the fact that the respective proxy signals emphasise slightly different parts within the seasonal cycle. The Holocene MTDJF variability in the northern borderlands is in the order of 4° C (Fig. 5) and thus compares favourably with the Aegean Sea winter SST variability of 2 to 4° C as inferred by Rohling et al. (2002). We interpret the somewhat higher amplitudes in the terrestrial MTDJF signals to reflect the lower thermal inertia of terrestrial settings as compared to the marine realm. The magnitude of this variability must have been strong enough to affect early cultures in the Eastern Mediterranean region. The pronounced Holocene MTDJF variability in the NBAS testifies to the high sensitivity of the Aegean region with regard to short-term climate changes. These findings support earlier observations of teleconnections between the lower and high latitudes during the early and middle part of the Holocene (de Menocal et al., 2000; Rohling et al., 2002; Mayewski et al., 2004).

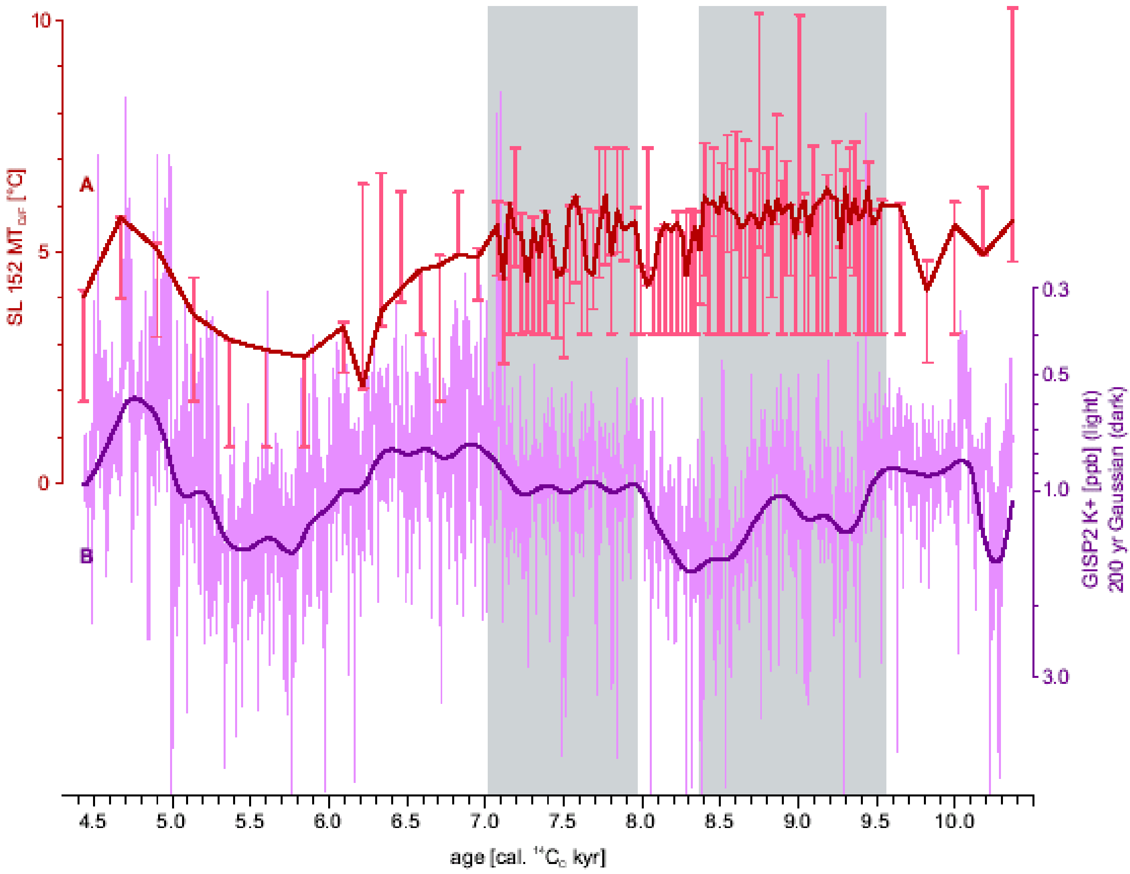

Figure 5: Correlation of the pollen-based mean temperature during the winter months (MTDJF; top) with the smoothed (200-year moving Gaussian) K+ record from the GISP2 Greenland 30 ice core (bottom). Grey bars mark sapropelic sediments (sediment lightness <46 %). K+ data are from the National Snow and Ice Data Center (http://nsidc.org). See text for discussion.

Terrestrial constraints on benthic oxygenation during S1 formation in the northern Aegean Sea

Between ~9.5 and ~6.0 kyr BP, the particularly warm and humid conditions in the Eastern Mediterranean region resulted in enhanced freshwater runoff and nutrient supply into the Mediterranean basin, leading to a stratification of the water column that ultimately resulted in the basin-wide formation of S1 (e.g. Rossignol-Strick et al., 1982; Rossignol-Strick, 1985; Rohling and Hilgen, 1991; Casford et al., 2002). The exact timing of S1 formation within the Mediterranean Sea depends on water depth, sediment accumulation rates, organic matter flux, and the position relative to intermediate and deep-water sources (e.g. Mercone et al., 2000; Casford et al., 2003; Sperling et al., 2003). Information from the Aegean Sea suggests that the interval of S1 formation comprises ~10.0 to ~7.0 kyr BP and ~9.5 to ~7.0 kyr BP in the southern and northern Aegean Sea, respectively (Kuhnt et al., subm.).

As described in Section 4.2, the records of benthic oxygen availability in cores SL 152 and 148 reveal a close temporal correlation with climatic changes in the northern borderlands, suggesting causal relationships between the environmental dynamics in the marine and terrestrial realm. In brief, the lightness and foraminiferal data from cores SL152 and SL148 show that benthic oxygen depletion connected to S1 formation began to decrease shortly after winter climate conditions (notably the MPDJF and MTDJF) in the northern borderlands had started to ameliorate (Fig. 4). Based on the temporal resolution of our pollen data in the respective interval, the lag appears to be in the order of 100 to 200 years. The climatic perturbations in the northern borderlands during the interval of S1 formation from 8.4 to 8.0 and 7.5 to 7.2 kyr BP are also reflected in the benthic oxygenation records from the northern Aegean Sea, with phases of partial deforestation corresponding to intervals of increased benthic oxygen availability. As demonstrated in Section 5.1, the partial deforestations in the northern borderlands unequivocally result from climatic perturbations, and the fact that they are only partially documented in the MTDJF and remain unresolved in the MPDJF reconstructions may be ascribed to the limited resolution of the MAT. Again, the benthic oxygenation signal lags the climatic change in the northern borderlands. The high temporal resolution of our pollen and lightness data from the core interval corresponding to S1 allows to narrowly constrain this lag. Signals in the lightness curve lag respective signals in the broad-leaved pollen curve by one or two data points. According to our age model, this corresponds to ~30 to ~60 years.

The interval post-dating S1 formation clearly exhibits a general correspondence of benthic oxygenation in the marine realm with climate-induced vegetation dynamics in the northern borderlands. However, the temporal resolution of the pollen and foraminiferal datasets in that interval does not allow to decipher the exact phase relationships between these signals, and the low variability within the high-resolution lightness data from the interval post-dating S1 formation does not provide reliable tie points for a correlation with terrestrial signals.

Summarizing the above, there is a strong link between the climatic perturbations in the NBAS to S1 formation, with intervals of lower forestation (partially also manifested in decreased winter precipitation and/or temperature) corresponding to intervals of improved benthic oxygenation.

Based on the available data, the climatically induced vegetation changes in the northern borderlands of the Aegean Sea lead respective benthic oxygenation signals by 200 to 30 years. This link is explained through the oceanographic boundary conditions of the Aegean Sea. Although the Adriatic Sea was long considered the only source for the formation of dense waters in the Eastern Mediterranean Sea, observational and theoretical studies have increasingly stressed that the Aegean Sea also plays a role in this process (e.g. Roether et al., 1996; Wu et al., 2000). Zervakis et al. (2000) have observed that deep-water formation occurred in the North Aegean Sea resulting from a buoyancy loss due to the influence of very cold and dry winter winds. These authors also stress the role of freshwater input into the North Aegean Sea in modulating this process, with lower freshwater input increasing the amount of heat loss to the atmosphere during extreme cold events. Hence, phases of reduced winter precipitation and/or temperature can ultimately lead to local, intensified deepwater formation in the northern Aegean Sea, resulting in higher deep-water ventilation and therefore in a weakening or even interruption in S1 formation. In the light of our data, the onset of deep-water formation occurred with a delay in the order of 30 to 200 years relative to terrestrially registered signals of climate change. This observation testifies to the considerably lower response time to climatic forcing in terrestrial environments as compared to the marine realm, particularly to changes in benthic conditions, even in relatively small marine basins as the Aegean Sea that lack the inertia of larger water masses.

Our data support the concept of Rohling et al. (2002) that northerly outbreaks from the Siberian High in winter and spring led to repeated surface-water cooling in the northern Aegean Sea also during the generally warm and humid conditions of the early and middle Holocene.

On decadal to centennial time scales, an increased frequency and/or intensity of such events may have caused local convection, thus supplying at least some oxygen to northern Aegean deep-sea basins while southern Aegean and Levantine deep-sea basins received less oxygen. According to our quantitative climate reconstructions from the northern borderlands, MPDJF and MTDJF reductions may both have played a role in causing transient bottom-water re-ventilation in the northern Aegean Sea. The role of precipitation in this process is supported by observations on short-term changes in the thermohaline circulation in the Eastern Mediterranean. The recently observed massive outflow of dense water from the Aegean Sea into the deep layers of the Eastern Mediterranean was first triggered by a salinity increase due to a significant precipitation decrease in the Aegean region. It was only later that consecutively following cold winters (with mean air temperatures 2° C lower than average values) added to this process (Tselepidaki et al., 1992; Theocharis et al., 1999).

Sapropel S1 formation in the Eastern Mediterranean Sea: Role of freshwater flux from the northern borderlands

While the crucial role of enhanced freshwater flux in S1 formation is well established, the sources and their respective proportion in this process is still a matter of debate. Discharge through the Nile river is often referred to as the main source for surface-water freshening in the Eastern Mediterranean Sea (e.g. Rossignol-Strick et al., 1982; Fontugne et al., 1994).

However, the homogeneity of surface-water salinity in the Eastern Mediterranean Sea during S1 formation is consistent with multiple freshwater sources, suggesting that the enhanced freshwater flux did not solely result from the catchment area of the Nile river (Kallel et al., 1997a; Emeis et al., 2000). Other potential freshwater sources are low-salinity outflow from the Black Sea (e.g. Aksu et al., 1995, 1999a, b; Lane-Serff et al., 1997; Catagay et al., 2000), and increased precipitation-induced runoff from all of the Mediterranean borderlands (e.g. Rossignol-Strick, 1987; Kallel et al., 1997a, b). However, the role of glacial melt water derived from the decay of northern European ice sheets and released through the Black Sea in S1 formation in the Aegean Sea has recently been refuted. Based on sea-surface temperature and salinity data from the Sea of Marmara, Sperling et al. (2003) concluded that the Black Sea was not a major freshwater source contributing to formation of S1. The terrestrial data from core SL152 allow to assess the role of riverine input from the northern borderlands of the Mediterranean Sea. They indicate a strong increase in winter precipitation during S1 formation as compared to “pre-sapropelic” values. With the termination of S1 formation, the MPDJF decreased from 300 to 250 mm (Fig. 4C). These observations support the prominent role of winter runoff from the northern borderlands in S1 formation in the Aegean Sea.

For the Levantine Basin, a comparison of neodymium and oxygen isotope data from planktonic foraminifera across S1 has shown that the contribution of Nile discharge to the freshwater surplus during S1 formation was strongest during the early and middle part of S1 formation, but then tailed off and declined to typical “post-sapropelic” values in the late part of S1 formation, considerably before the termination of S1 (Scrivner et al., 2004). Clearly, other freshwater sources must have outlasted the contribution of Nile discharge to the freshwater excess in the Eastern Mediterranean Sea. The exact origin of these freshwater sources has, however, remained somewhat elusive. Based on the terrestrial data from core SL152, the winter precipitation in the northern borderlands remained on a stable, relatively high level until the end of S1 formation at ~7.1 kyr BP (Fig. 4). This suggests that runoff from the northern borderlands of the Aegean Sea was indeed a source that significantly contributed to the freshwater surplus in the Eastern Mediterranean Sea during the late phase of S1 formation.

This view is supported by the observation that there is no indication for increased runoff entering the Mediterranean Sea from the Adriatic Sea (Emeis et al., 2000).

Conclusions

The analysis of terrestrial palynomorphs from marine core SL152 (Mount Athos Basin, northern Aegean Sea) has yielded qualitative and quantitative information on the paleoenvironmental dynamics in the northern borderlands of the Aegean Sea (NBAS) during the early and middle Holocene, and notably for the interval of sapropel S1 formation. The direct land-sea correlation of our dataset allowed to elucidate the relationships between short-term signals of atmospheric change and sapropel formation of in the marine realm. The most salient features of our study are the following:

- As a measure of Mediterranean-type climate conditions, the index IQ was established based on the ratio of deciduous and evergreen *Quercus* pollen. Being inert to taphonomical bias, IQ yields a robust climatic signature. The consistency of the IQ signals with those of our other palynological proxies rules out that originally deposited assemblages were severely affected by differential preservation.
- The NBAS underwent a transition from an open vegetation to oak-dominated woodlands during the “pre-sapropel S1” interval between ~10.4 and ~9.5 kyr BP. The reforestation coincided with a successive increase in mean winter precipitation, whereas the mean winter temperature remained nearly stable. This observation and the fact that more northerly settings in Central Europe were already densely forested at that time suggests that moisture availability was the dominant factor controlling Holocene reforestation in the NBAS.
- The relatively humid and mild winter conditions during S1 formation were punctuated by short-term climatic events that caused a partial deforestation and a reorganisation within the arboreal vegetation. The strongest event (from ~8.4 to ~8.0 kyr BP) represents the regional expression of the 8.2 kyr cold event widely known from the northern hemisphere. In the marine data, it is intimately connected to an interruption in S1 formation. A similar, but weaker event occurred between ~7.5 and ~7.2 kyr BP.
- For the early and middle Holocene, the winter temperatures in the NBAS correlate with the smoothed GISP2 K+ series, thus supporting the marine-based concept of Rohling et al. (2002) that the intensity of the Siberian High exerted strong control on winter climate in the Aegean region. Our data suggest, however, that during the interval corresponding to S1 formation in the Aegean Sea (i.e., from ~9.5 kyr to ~7.0 kyr BP) the terrestrial climate dynamics in the

NBAS were largely decoupled from the high-latitude climate system and were more strongly affected by the monsoonally-influenced climate system of the lower latitudes.

- Phases of decreased winter precipitation and partially also temperature in the northern borderlands correlate with intervals of improved benthic oxygenation in the northern Aegean Sea. Our data support a scenario that northerly outbreaks from the Siberian High in the winter and spring repeatedly led to a decrease in runoff into the northern Aegean Sea and/or enhanced surface-water cooling. An increase in the frequency and/or intensity of such events may have caused local overturn in the northern Aegean Sea, thus improving the oxygenation of the deeper water column and leading to a cease in S1 formation.
- The reconstructed ~50 % increase in winter precipitation during S1 formation as compared to “pre-sapropelic” conditions and also its ~25 % decrease with the termination of S1 suggest a strong contribution from the NBAS to the freshwater surplus during S1 formation in the Eastern Mediterranean Sea.

Acknowledgements

Discussions with Kay Emeis, Oliver Friedrich and Bas van de Schootbrugge are gratefully acknowledged. XXX and YYY constructively reviewed an earlier version of the manuscript. Tanja Kuhnt provided benthic foraminiferal data from core SL148. We thank the crew and scientific party of R.V. Meteor cruise M51/3 for continuing support. The Greek authorities are thanked for permitting research to be carried out in their territorial waters. This study was supported by the Deutsche Forschungsgemeinschaft (DFG grant Pr 651/6-1).

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Figure and table captions

Figure 1. Map of the Aegean Sea showing locations of cores GeoTÜ SL152 (large white star), GeoTÜ SL148 (small white star) and other climate archives mentioned in the text (pentagons). Isolines show water depths of 600 and 1000 m.

Figure 2. Age-depth curve for core GeoTÜ SL152. Grey bars mark sapropelic sediments.

Figure 3. Results from the analysis of marine and terrestrial proxies in core GeoTÜ SL152. A: Digital core photo plotted versus depth. B: Sediment lightness plotted versus age (in reservoir-corrected calendar years). In accordance with the visual core description, lightness percentages <46% were considered to reflect sapropelic sediments. C: Percentages of selected pollen types plotted versus age. The percentages are based on total terrestrial pollen excluding bisaccate pollen. Grasses comprise Cyperaceae and Gramineae. Steppe elements comprise *Ephedra*, *Artemisia* and Chenopodiaceae. Dashed arrows mark reservoir-corrected ^{14}C-based calendar ages, arrowheads indicate positions of 14C samples in the core. In accordance with the visual core description, grey bars mark sapropelic sediments (sediment lightness <46 %).

Figure 4. Broad-leaved tree pollen percentages, index IQ, pollen-based quantitative climate reconstructions, and sediment lightness from core GeoTü SL152 as well as percentages of low-oxygen indicators within benthic foraminifera from neighbouring core GeoTü SL148 plotted versus age (in reservoir-corrected calendar years). A: Pollen percentages of broadleaved trees. B: index IQ, with high values indicating a dominance of evergreen *Quercus* pollen over that from deciduous *Quercus* pollen and vice versa. C: Mean precipitation during the winter months (MPDJF). D: Mean temperature during the winter

months (MTDJF). E: Sediment lightness, with values <46 % indicating sapropelic sediments. F: Percentages of low-oxygen indicators within benthic foraminifera from neighbouring core GeoTü SL148 (data from Kuhnt et al., subm.). C und D are based on the Modern Analogue Technique constrained by biomisation procedure. Vertical bars in C and D indicate the variability among the climates represented by the modern-analogue dataset, with upper and lower limits delineating the most extreme positive and negative deviations among the ten analogues used in comparison to the mean value. In accordance with the visual core description, grey bars mark sapropelic sediments (sediment lightness <46 %).

Figure 5. Correlation of the pollen-based mean temperature during the winter months (MTDJF; top) with the smoothed (200-year moving Gaussian) K+ record from the GISP2 Greenland 30 ice core (bottom). Grey bars mark sapropelic sediments (sediment lightness <46 %). K+ data are from the National Snow and Ice Data Center (http://nsidc.org). See text for discussion.

Table 1: Age control for core GeoTÜ SL152 based on AMS radiocarbon measurements. Calibration was performed with the Fairbanks 0805 calendar age conversion software (Fairbanks et al., 2005), corrections for reservoir effects are after Siani et al. (2001).

Lateglacial and Holocene climate oscillations in the South-western Alps: an attempt at quantitative reconstruction.

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Abstract

The high topographic complexity of the Alpine region is at the origin of important climate differences which characterise the different areas of the Alps. These differences might have had a strong influence on vegetation and on migrations of human populations in the past. Based on an improved data base containing about 3000 modern pollen samples, the standard "Modern Analogue Technique" has been applied to five pollen sequences from the subalpine belt of the South-western Italian Alps (Laghi dell'Orgials, 2240 m, Lago delle Fate, 2130 m, Torbiera del Biecai, 1920 m, Rifugio Mondovì, 1760 m, Pian Marchisio, 1624 m) to provide quantitative climate estimates for the Lateglacial and Holocene periods. Consistent climate trends are reconstructed for the different sequences. Sites recorded in detail the climate variations when they were located at the limit of two ecotones. Sites above the tree line recorded lower temperature values and less important variations. Climate was cold and dry during the Oldest and Younger Dryas and close to present-day values during the Bølling/Allerød interstadial. At the beginning of the Holocene, climate changed to warmer and moister conditions; a high number of climate fluctuations are recorded at several sites. A climate optimum is recorded in the Atlantic period, which caused a development of fir above its present-day altitudinal distribution. Climatic differences recorded at the various sites are discussed taking into account the limits of the method.

***Keywords**: Alps, Climate history, Holocene, Lateglacial, Modern Analogue Technique.*

Introduction

Past climate reconstruction in the Alpine area is of great importance for vegetation history and archaeological studies. The strong altitudinal gradient that characterises mountain areas results in a steep ecological gradient, so several ecotones occur in a small area. This results in an amplification of global climate signals so that vegetation response to climatic changes is more pronounced at higher altitudes than in the lowlands (Birks & Ammann, 2000). Important climate differences characterise the different areas of the Alps, which might have had a strong influence on species migrations during the Lateglacial. Further, the effect of climate fluctuations of higher intensity in some areas of the Alpine region during the Lateglacial and the Holocene certainly affected human populations, causing their migration to more propitious areas during these periods. This phenomenon is linked to the high topographic complexity of the Alpine region, so that climate parameters and vegetation depend on local physiographic conditions (altitude, slopes, aspect, geomorphology).

Palynology is the most common tool for Quaternary palaeoecology reconstructions (e.g. Lotter *et al.*, 2000; Peyron *et al.*, 2000; Davis *et al.*, 2003) and usually employed for palaeoclimate and for palaeoenvironmental reconstruction for archaeology (Richard, 1997; Gauthier, 2002), as it permits the reconstruction of the vegetation and the climate, and provides evidence of agriculture and human landscape modification (e.g. Miras *et al.*, 2004; Court-Picon *et al.*, 2005). In the Alps, the altitudinal vegetation zonation, which mainly depends on the temperature decrease with elevation, is reflected in the pollen record at different elevations, with variations in pollen spectra as a function of several factors.

Pollen-based palaeoclimate reconstruction in mountain areas is complicated by the phenomenon of wind-driven uphill transport of tree pollen into the sub-alpine and alpine zones; pollen spectra of the latter zones are dominated by non-local arboreal pollen (Rudolph & Firbas, 1926; Flenley, 1973; Barthélémy & Jolly, 1989; David, 1993; 1997; Brugiapaglia *et al.*, 1998; Ortu, 2002). Long distance wind-driven pollen transport varies from one pollen site to another; there are complex relationships between vegetation belts and relative pollen percentages in spectra from elevated sites (Ortu *et al.*, 2006). It is also important to realize that the vegetation cover in the Alps has been strongly affected by human impact which modified the alpine landscape in several ways, so that the natural timberline has been lowered, the distribution of the vegetation belts has been influenced and non-native species have been introduced (e.g. Ozenda, 1985; David, 1993; 1997; Wick, 1994; Ortu *et al.*, 2003).

The analysis of the limits in pollen-based palaeoclimate reconstruction in mountain areas was presented in a previous paper (Ortu *et al.*, 2006), which concluded that most of the problems were derived from the poor representation of samples from high elevation sites in the existing modern pollen databases used as a calibration set for palaeoclimate reconstructions. This means that the modern database lacks a sufficient number of samples characterised by the wind-driven uphill transport of tree pollen into the sub-alpine and alpine zones. Climate variations with altitude and the high topographic complexity of mountain areas yield important vegetation and pollen rain variations in relatively small areas. Consequently, a database representative of this variability is required to obtain reliable pollen-based paleoclimate reconstructions of the Alpine region.

Based on a database improved by the integration of up to 3000 modern pollen samples, 300 of which from the Western Alps (figure 4), the standard Modern Analogue Technique (MAT) (Guiot, 1990) was applied to five pollen sequences from the subalpine belt of the South-western Italian Alps (Laghi dell'Orgials, 2240 m, Lago delle Fate, 2130 m, Torbiera del Biecai, 1920 m, Rifugio Mondovì, 1760 m, Pian Marchisio, 1624 m) to provide quantitative climate estimates for the Lateglacial and Holocene periods. The analysis of results made it possible to describe the evolution of several climate parameters (Annual Temperature, Coldest Month Temperature, Warmest Month Temperature, Annual Precipitation) at the five sites since the Lateglacial. Differences in the intensity of climate variations reconstructed at the different sites are discussed.

Regional setting

The location of the study sites in the Italian Maritime Alps (South-western Alps) is shown in figure 1.

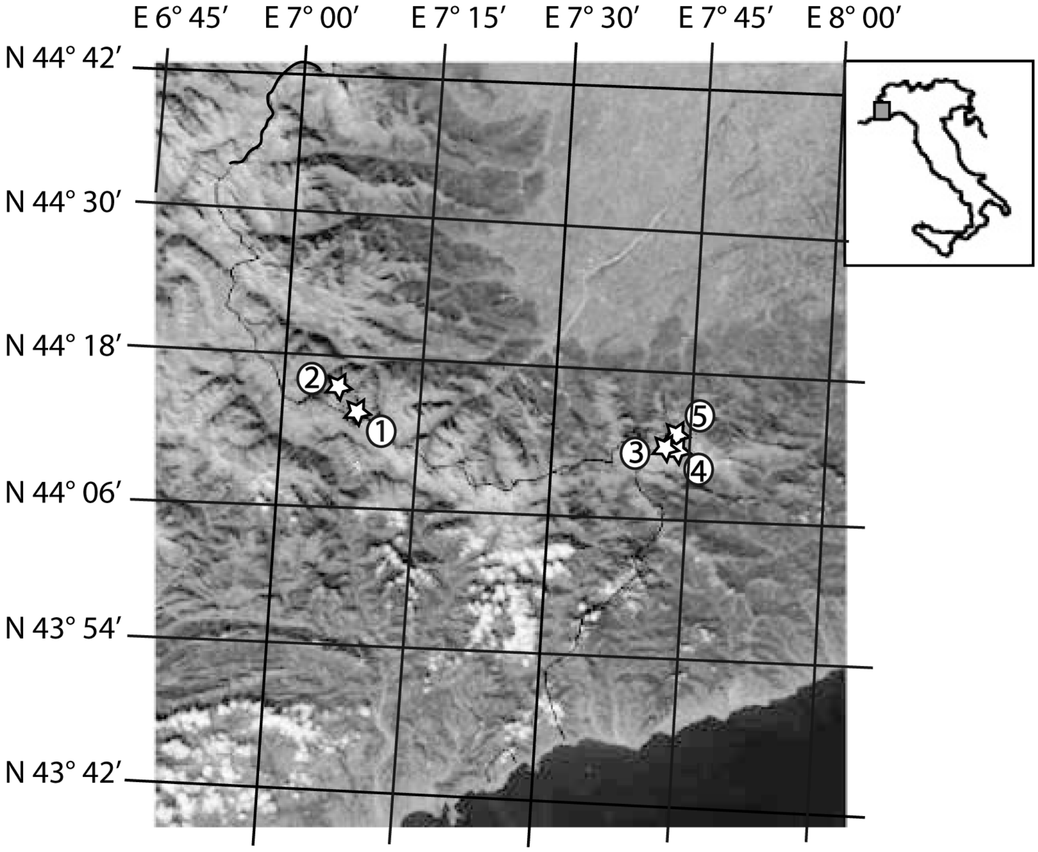

Figure 1: Location of the study sites in the Italian Maritime Alps: 1. Laghi dell'Orgials (2240 m); 2. Lago delle Fate (2130 m); 3. Torbiera del Biecai (1920 m), 4. Rifugio Mondovì (1760 m), 5. Pian Marchisio (1624 m).

Two sites (Laghi dell’Orgials and Lago delle Fate) are situated on opposing sides of the St. Anna di Vinadio Valley (in the western part of the area). Laghi dell'Orgials (2240 m asl) is a small peat bog on the western side of the valley, situated above the timberline formed by *Larix decidua*; several *Larix decidua* and *Pinus cembra* isolated trees are present close to the site, which is surrounded by pastures dominated by *Nardus stricta* and related to the *Nardion strictae* alliance (nomenclature follows Mucina *et al.*, 1993) and shrubs (*Vaccinium myrtillus, Rhododendron ferrugineum*, *Juniperus nana*). Lago delle Fate (2130 m asl) is situated on the eastern side of the valley, and surrounded by open *Larix decidua* formations with pastures and shrubs dominated by the same species than at Orgials. Pine formations (*Pinus uncinata*) are present downhill from the lake. A full description of the two sites is given in Ortu *et al.* (2005). Three sites (Pian Marchisio, Rifugio Mondovì and Torbiera del Biecai) are situated at different elevations on the western side of the Ellero Valley (in the southern part of the area). These three peat bogs are situated at 1624, 1760 and 1920 m respectively, and are surrounded by *Nardion strictae* pastures. *Alnus viridis* formations grow near Pian Marchisio and Rifugio Mondovì. Some isolated plants of larch (*Larix decidua)*, pine (*Pinus cembra* and *Pinus uncinata*) and silver fir (*Abies alba*) are present on the cliffs of Rifugio Mondovì. A full description of the three sites is given in Ortu *et al.* (in press).

The substratum of the St. Anna di Vinadio Valley is siliceous. The Laghi dell'Orgials peat bog is situated behind a moraine (Julian, 1976) on a crystalline substratum (Malaroda, 1970). The Lago delle Fate lake lies on a metamorphic substratum made up of migmatite (Julian, 1976). Several screes are present upstream and downstream from the lake.

The substratum of the lower part of the Ellero valley is composed of quartz porphyry and quartzite; the upper part is calcareous (Gallo, 1982). This differs from the adjacent valleys that are mainly siliceous.

The area is characterized by a subalpine climate, implying maximum rain in autumn and spring. Precipitation in the Ellero Valley is higher (1330 mm/yr) than in the St. Anna di Vinadio Valley (1090 mm/yr) (Cagnazzi & Marchisio, 1998), with differences of about 10 mm/years at the various sites. The climate in the St. Anna di Vinadio sites is presently very similar at both the Orgials and Fate sites; this is also the case of the three sites in the Ellero Valley as shown in table 1, based on data from the climate atlas "Atlante Climatologico del Piemonte" (Cagnazzi & Marchisio, 1998). Temperature values decrease with the increase in elevation in the two valleys. This variation is of the order of 0.57 °C per 100 m for the mean annual temperature, of 0.46 °C per 100 m for the mean temperature of the coldest month (T_c) and of 0.67 °C per 100 m for the mean temperature of the warmest month (T_w). These values are consistent with the mean seasonal variation of the temperature gradient with elevation described for the whole alpine region by Ozenda (1985).

Table 1: Modern climate values at the five study sites.

Sites	Mean temperature of the coldest month (Tc)	Mean annual temperature (Tann)	Mean temperature of the warmest month (Tw)	Annual precipitation (Pann)
Laghi dell'Orgials (2240 m)	-8.1 °C	1.1 °C	9 °C	1156 mm/yr
Lago delle Fate (2130 m)	-7.3 °C	1.7 °C	9.7 °C	1161 mm/yr
Torbiera del Biecai (1920 m)	-5 °C	3.8 °C	12 °C	1350 mm/yr
Rifugio Mondovì (1760 m)	-4.3 °C	4.3 °C	12.4 °C	1315 mm/yr
Pian Marchisio (1624 m)	-3.7 °C	4.9 °C	13 °C	1335 mm/yr

Materials and methods

Pollen analysis

Pollen analysis was carried out on a sediment core taken with a Russian corer (Jowsey, 1966) at each site. Twenty ^{14}C AMS dates (Table 2) were obtained on plant macro-remains (twigs, mosses), gyttja and peat samples by the Radiocarbon Dating Centre of "Claude Bernard Lyon 1" University and the Poznań Radiocarbon Laboratory. The dates are given as calibrated years Before Present (BP). CALIB RADIOCARBON CALIBRATION PROGRAM version 5.0.1 was used for the calibration of ^{14}C dates. Age calibration follows the most recent curve proposed by Reimer et al. (2004).

Table 2: Results of vegetal remains ^{14}C dating: codes, material, identification, depth, age of the dated samples.

Sample	Dated Material	Depth (cm)	Age (14C years BP)	Calibrated age (2 σ) (BP)	δ 13C (‰)
LAGHI DELL'ORGIALS					
LYON-1599(OXA)	Twigs	59	1875±35	1885-1719	-28,26
Poz-7107	Gyttja	142	4670±35	5473-5315	-
Poz-7108	Gyttja	234	7820±40	8723-8515	-
LYON-1611(OXA)	Bryophytes	359	9783±68	11351-11077	-
LYON-1598(GRA-19337)	Bryophytes	406	20930±130	25552-24719	-
LAGO DELLE FATE					
LYON-1597(GRA-19336)	Wood	133	6480±100	7572-7245	-28,03
LYON-1596(GRA-19335)	Wood	141	8850±60	10174-9730	28,45
LYON-1595(GRA-19334)	Wood	171	9300±60	10609-10283	-27,92
LYON-1594(GRA-19331)	Wood	214	9660±60	11206-10779	-
TORBIERA BIECAI					
Poz-17197	Peat	20	5080±40	5915-5738	-
Poz-17198	Peat	31	7880±50	8996-8540	-
Poz-4412	Peat	43	7840±40	8767-8543	-
Poz-4413	Peat	59	8460±50	9540-9406	-
Poz-4414	Peat	115	10550±60	12789-12255	-
RIFUGIO MONDOVÌ					
LYON-1606(GRA-19350)	Peat	140	965±45	960-780	-29,5
LYON-1607(GRA-19351)	Peat	210	1825±50	1876-1687	-27,35
LY-10757	Peat	260	1965±55	2054-1815	-28,68
LY-10758	Peat	290	2575±60	2792-2459	-28,67
LY-10759	Peat	370	5725±90	6680-6316	-28,02
LYON-1608(GRA-19353)	Peat	390	9790±60	11327-11095	-28,99
PIAN MARCHISIO					

Poz-12284	Peat	120	1000±30	967-898	-

The five pollen diagrams, which are presented in summary form (Figs. 2-3), show comparable regional vegetation phases. A full description of diagrams is given in Ortu *et al.* (2005) and Ortu *et al.* (in press). The correlation of the pollen zones recording similar vegetation phases is supported by the age/depth models inferred from radiocarbon dates using the GpalWin program (Goeury, 1997) and used as a backbone to draw on the same timescale the pollen data and the pollen-inferred climate curves at each site (Figs. 2-3; 5-6). Local taxa typically developing in alpine peat bogs (Cyperaceae, Juncaceae) and lakes (*Sparganium*/*Typha*; *Pediastrum* algae) have been excluded from the pollen total sum for the reconstruction of the palaeovegetation surrounding each site following Berglund & Ralska-Jasiewiczowa (1986). These percentages often obscure those of other taxa which are dominant in the vegetation surrounding the studied site, and whose development is primarily determined by climate. Therefore, these taxa have been excluded from the pollen total sum for the palaeovegetation reconstruction (Ortu *et al.*, 2005; Ortu *et al.*, in press), and they were not used for the climate reconstruction since their development is linked to processes concerning peat bog and lake evolution, such as in-filling or eutrophication.

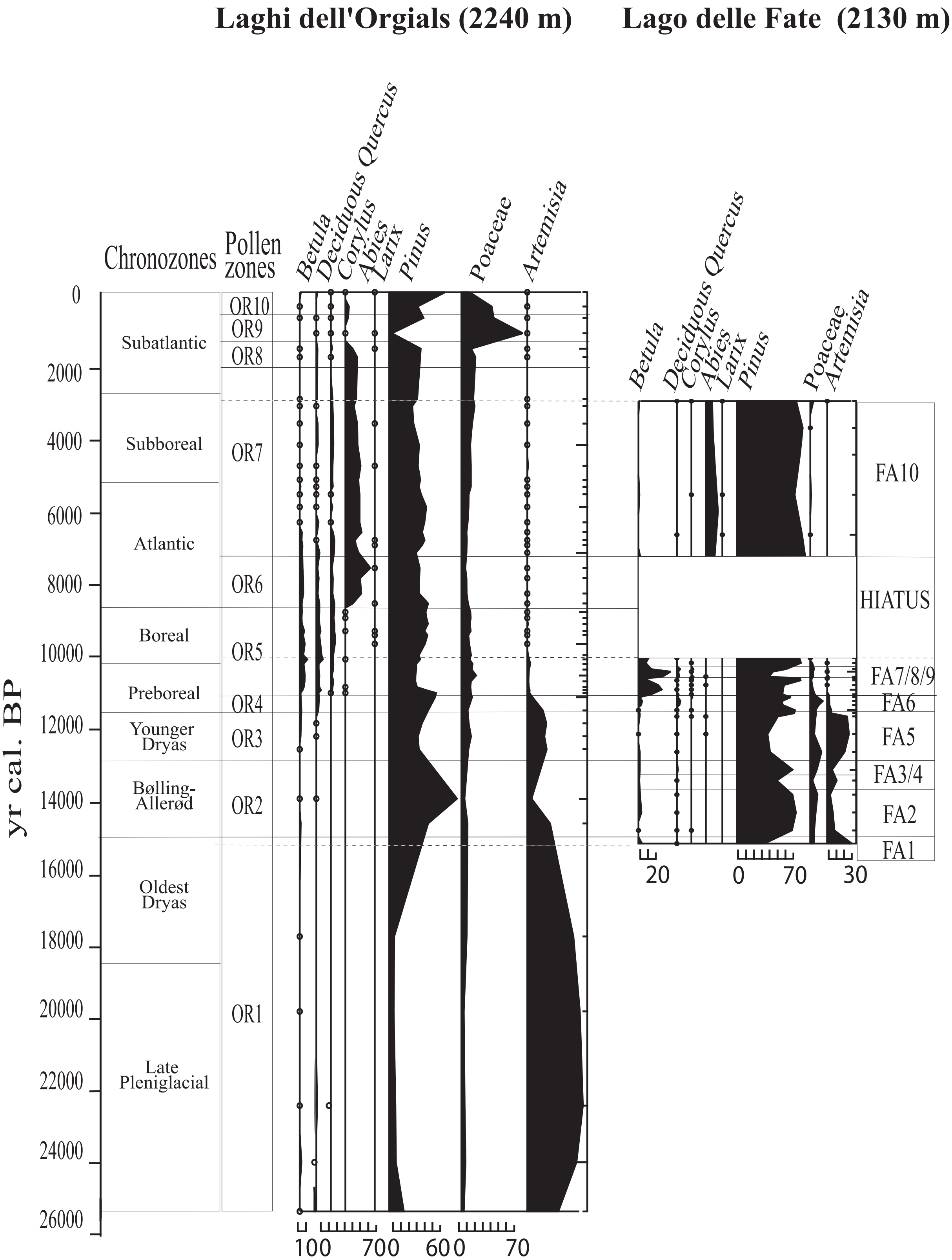

Figure 2: Synthetic pollen diagrams from Laghi dell'Orgials and Lago delle Fate in the St. Anna di Vinadio Valley: chronological correlation of pollen zones. The diagrams are shown on a calibrated timescale.

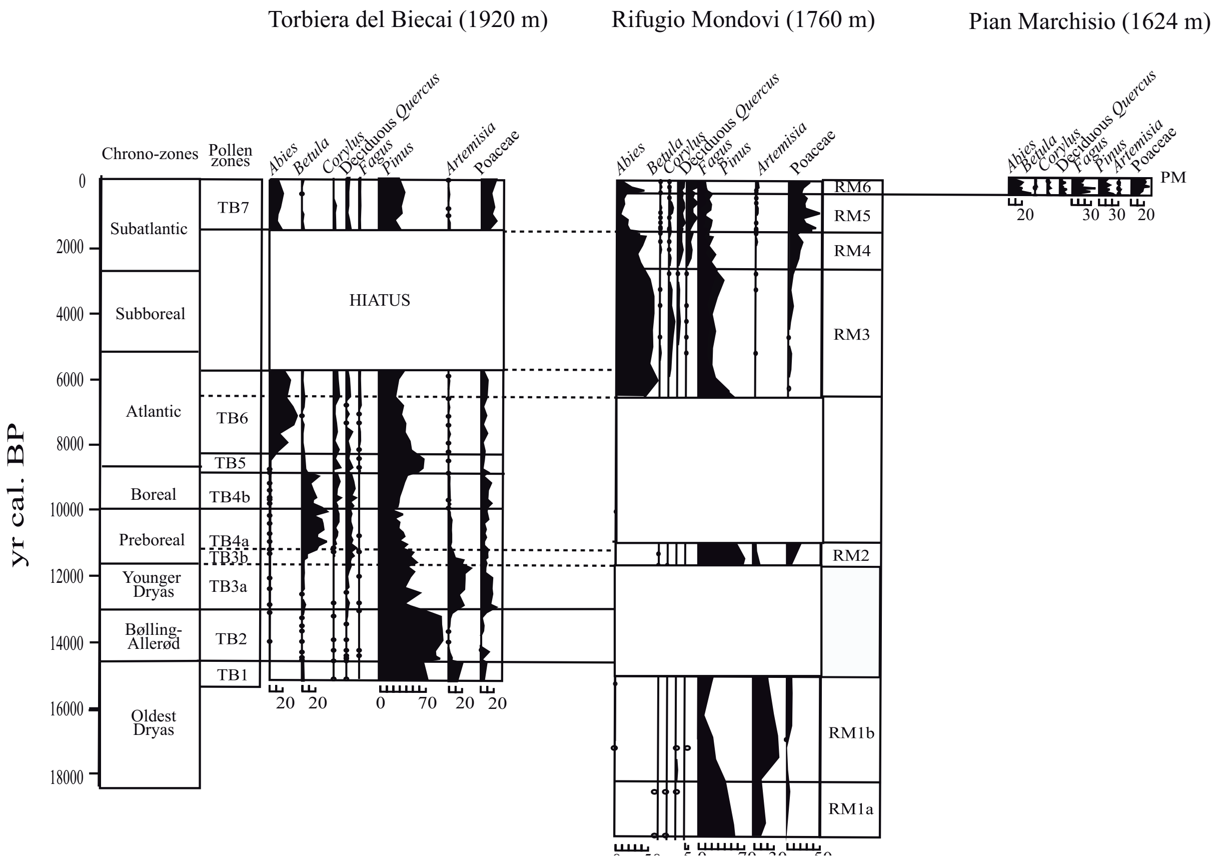

Figure 3: Synthetic pollen diagrams from Torbiera del Biecai, Rifugio Mondovì and Pian Marchisio in the Ellero Valley: chronological correlation of pollen zones. The diagrams are shown on a calibrated timescale.

Pollen-based palaeoclimate reconstruction

The standard "Modern Analogue Technique" (MAT) (Guiot, 1990) was applied to the five pollen sequences to estimate palaeotemperature and palaeoprecipitation during the Lateglacial and the Holocene (e.g. Guiot *et al.*, 1989; Cheddadi *et al.*, 1998; Peyron *et al.*, 2005). In the MAT method, eight similar modern pollen spectra are selected from a modern sample database for each fossil pollen assemblage and their climate is averaged to provide an estimate of the climate corresponding to the fossil assemblage (Guiot, 1990). The search for analogues is based on the squared chord distance (Overpeck *et al.*, 1985), using an equation to find a set of *s* (here $s = 8$) modern analogues of the fossil spectra (chord distance < 0.63). The quality of the reconstruction is expressed by the climate homogeneity of the *s* analogues, as well as the mean chord distance. The reconstructed climate value for each fossil spectrum is the distance-weighted mean of the climate values associated with the *s* best analogues. Instead of a unique standard deviation, the lower and upper errors are calculated using the variance of the samples with a climate respectively lower or higher than the mean. While it is acknowledged that this may underestimate the errors, we have retained this method to a) provide consistency with existing studies; b) provide palaeo-climate error estimates that are more reflective of the distribution of the chosen modern analogues.

The MAT was used to reconstruct the mean annual temperature (T_{ann}), total annual precipitation (P_{ann}), the mean temperature of the coldest month (T_c) and the mean temperature of the warmest month (T_w). Results from the five sequences are shown on a chronological scale (figs. 4-5-6) obtained by the interpolation of calibrated radiocarbon dates using the GPalWin program (Goeury, 1997). Because of the mineralogical nature of sediment (with the exception of the bottom of the OR1 zone), we did not obtain ^{14}C dates for the Lateglacial period. There is, however, a large body of existing studies available for the western Alps in which the transitions between the major Lateglacial fluctuations (Oldest Dryas – Bölling - Older Dryas – Alleröd - Younger Dryas) are dated (e.g. Ammann & Lotter, 1989; Beaulieu *et al.*, 1994). The regional radiocarbon dated pollen stratigraphy was used to date the Lateglacial sequences. This allows a direct comparison to be made between the five curves, despite differences in the sedimentation rate and the presence of hiatuses.

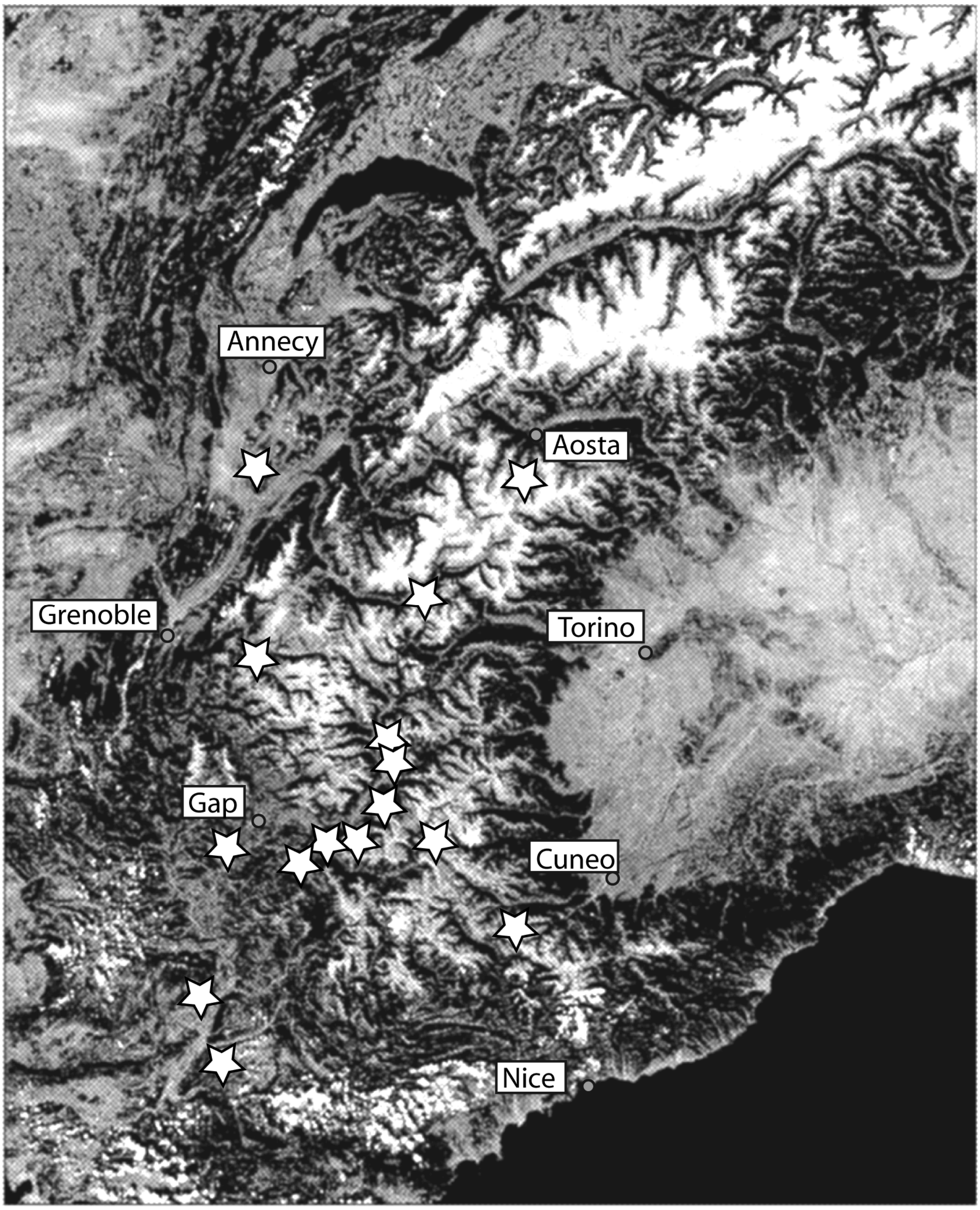

Figure 4: Location of the sites of new modern pollen spectra from the western Alps for the improvement of the modern database.

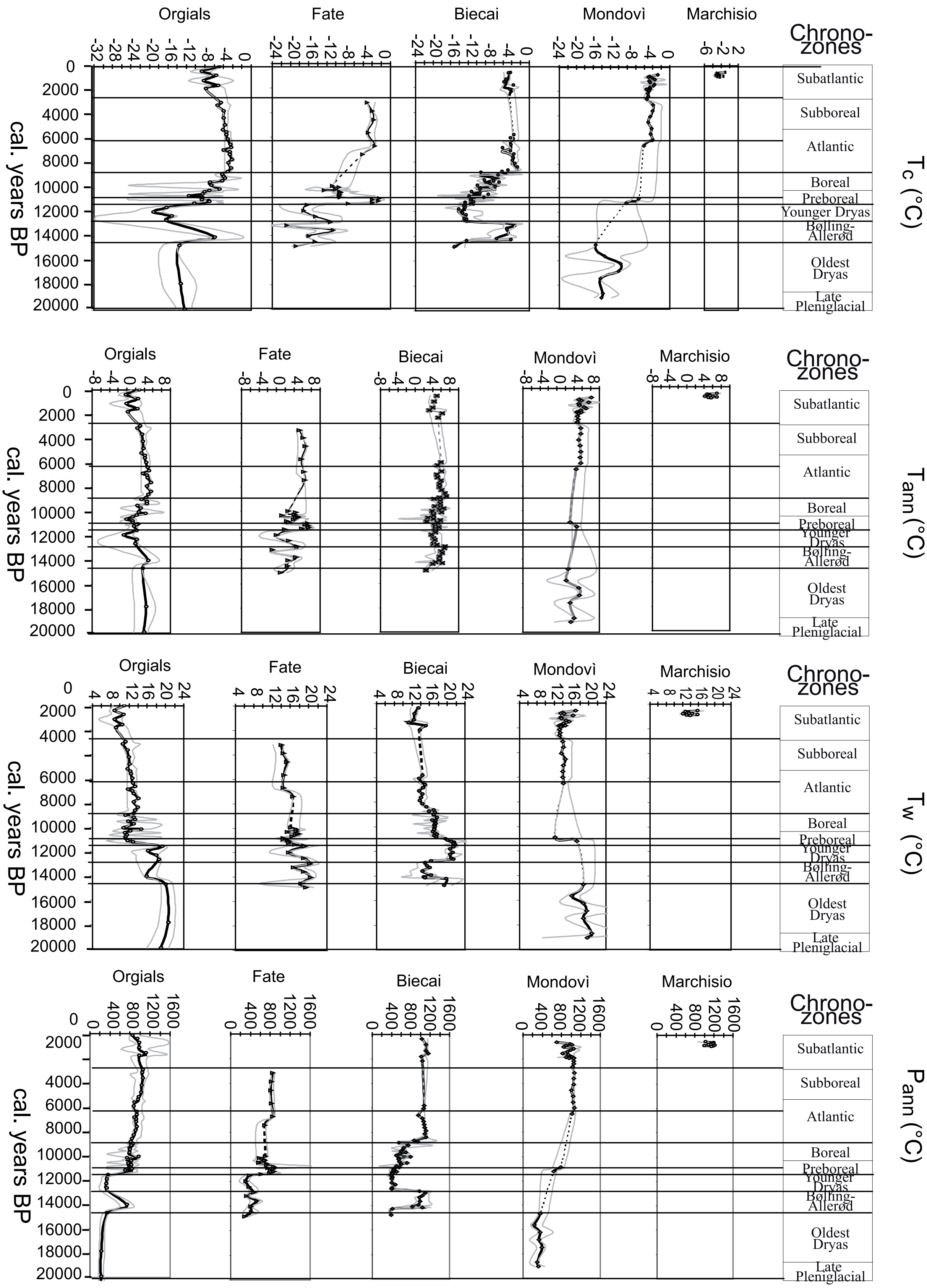

Figure 5: Palaeoclimate reconstruction at the five sites. Reconstructed parameters: T_c: mean temperature of the coldest month; T_w: mean temperature of the warmest month; T_{ann}: mean annual temperature; P_{ann}: mean annual precipitation.

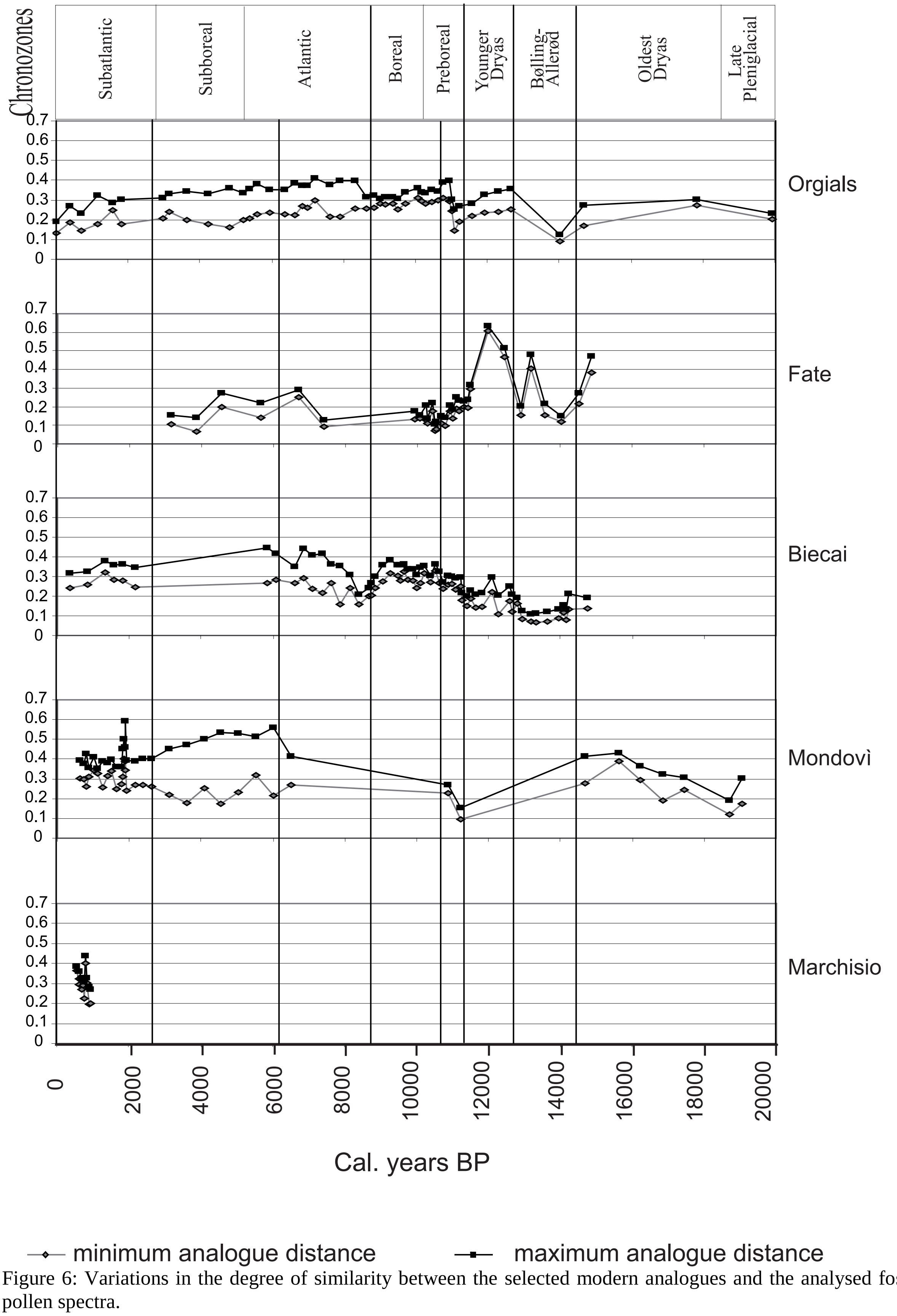

Figure 6: Variations in the degree of similarity between the selected modern analogues and the analysed fossil pollen spectra.

Modern pollen database improvement

The database used in previous studies included 868 modern pollen spectra (Peyron *et al.*, 2005; Ortu *et al.*, 2006). This was then subsequently improved by the addition of 210 new pollen spectra from the Western Alps and of about 2500 from Central Europe, Northern Europe, Southern Europe, Eastern Europe, Eurasia and Russia. These new modern pollen spectra were taken from the following vegetation formations: temperate deciduous and coniferous forest, forest steppe and *Artemisia* steppe, taiga and tundra.

Based on a previous study underlining problems linked to pollen transport by wind in mountain areas (Ortu *et al.*, 2006), particular attention was paid to the addition of modern pollen spectra from the Alps. The new modern pollen samples were collected along six altitudinal transects (about 20 samples each) between 500 and 2500 m a.s.l. The sampled sites are situated in National and Regional Parks on the two sides of the Italian-French Alps (Parc National du Grand Paradis, Parco Alpi Marittime, Parc de la Vanoise, Parc des Bauges) and from selected refuge areas (Bosco dell'Alevé, Abbazia di Staffarda) to reduce the bias caused by anthropogenic transformation of the landscape. These sites were selected as they are characterised by natural vegetation, reflecting climate conditions. Moss polsters were collected in the various vegetation formations developed at different elevations in the Alps: the mountainous belt, the subalpine belt, the alpine belt. The following vegetation formations developed at different elevations were sampled: montane woods with *Fagus sylvatica, Abies alba, Picea excelsa, Pinus cembra, Larix decidua*, heaths with *Alnus viridis*, Ericaceae and *Juniperus* above the tree line and alpine belt with meadows dominated by Poaceae or Cyperaceae. Based on pollen morphology, it is not possible to recognize, within the Cyperaceae family, taxa which dominate alpine pastures plant communities (e.g. *Carex curvula*) from taxa typically developing in peat bogs (e.g. *Carex fusca*). Despite its importance in some modern pollen spectra reflecting alpine pastures communities, we decided to exclude the Cyperaceae group from the total pollen sum as well in modern as in fossil pollen spectra.

Additional samples were obtained from Beaulieu (1977) from the Durance Valley, and Brugiapaglia *et al.* (1998) from the Taillefer Massif (Northern French Alps). In all, 210 samples from the western Alps were added (fig. 4).

Each modern sample site was assigned a modern climate based on a 0.5 degree lat/long dataset of monthly surface climate covering the period from 1901 to near real-time (currently 1995) over global land areas (New *et al.*, 2000). The following parameters, interpolated for each site, were used in this work: temperature of the coldest month (T_c), temperature of the warmest month (T_w), annual temperature (T_{ann}), annual precipitation (P_{ann}). However, because of problems of resolution when applying available methods to regions of high topographic complexity (0.5 degree lat/long can include a whole side of an alpine valley from the collinean to the alpine belt), temperature variations with elevation were checked and corrected for samples from the Alpine region. For this step, the lapse-rates induced decrease in temperature was calculated from observed climate data (from the New LocClim 1.06 database) at stations at various elevations on the western alpine chain. The altitudinal decrease in temperatures obtained per 100 m a.s.l. (T_c: -0.46 °C, T_w: 0.67 °C, T_{ann}: 0.57 °C) is consistent with Ozenda (1985). Temperature values for the site at lower elevation for each altitudinal transect were interpolated by the New LocClim 1.06 program for local climate estimation (Grieser *et al*., 2006). Temperature for each sampled point (Figure 3) was than calculated from its elevation a.s.l. by applying the temperature decrease described above. A comparison (Italy) with the climate atlas “Atlante Climatologico del Piemonte” (Cagnazzi & Marchisio, 1998) showed that the results for the Piemonte region were consistent with the interpolation from New LocClim 1.06 for each sampled point. To evaluate the reliability of the estimation by MAT, the climate parameters for each surface sample were estimated using the other modern samples. The difference between present-day climate data at the pollen sites and the estimated climate at each site indicates the reliability of the results (Table 2).

Pollen-based palaeoclimate reconstruction constrained by biomes

To reduce the possible bias linked to the lack of perfect analogues and to the phenomenon of wind-driven pollen transport from the lowland to higher elevation sites, resulting in the selection of modern analogues corresponding to biomes inconsistent with those which could develop in the past at the study areas (Ortu *et al*., 2006), the biome constraint (Guiot *et al*., 1996) was applied to the selection of the analogues following the biomization procedure described in detail in (Prentice *et al.*, 1996) and modified by Peyron *et al.* (1998). With this method, each modern and fossil pollen assemblage was attributed to a biome by the assignment of pollen taxa to plant functional types (PFT). Each biome is characterised by a combination of one or several PFT. 11 biomes are described for Europe: tundra, cold deciduous forest, taiga, cool conifer forest, cold mixed forest, temperate deciduous forest, cool mixed forest, warm mixed forest, xerophytic wood/shrub, cool steppe, warm steppe. During the selection of the analogues, the biome assigned to the fossil assemblage is compared to the modern samples, and modern analogues for which the biomes are not consistent are rejected (Guiot *et al.*, 1996). See also the extensive discussion of the application of this constraint to high elevation pollen sequences in Ortu *et al.* (2006).

Results

Vegetation history inferred from pollen data

We give here a short description of vegetation changes reconstructed from pollen data shown in a summary form in figures 2-3.

Vegetation recorded in pollen sequences before 14700 cal. BP is characterised by steppe herbaceous taxa dominated by *Artemisia*. This period is currently named Oldest Dryas and it is recorded at Orgials and Mondovì; its ending is also recorded at the bottom of the Fate and the Biecai sequences. The abrupt increase in pine pollen associated with the decrease in steppe taxa is related to the transition to the Bølling-Allerød period (14700 cal. years BP), recorded at Orgials, Fate and Biecai. Pine-forests are supposed to have developed in the alpine valleys following the glaciers retreat. The decrease in pine and the return of steppe in 12650 cal. years BP are recorded at Orgials, Fate and Biecai. This vegetation change is typical of the transition to the so-called Younger Dryas period. Steppe retreat typically marks the end of this period, which is dated to 11500 cal. years BP in the western Alps. The development of trees is recorded in 10950 cal. years BP at Orgials, Fate, Biecai and Mondovì. An important birch development is recorded at Biecai between 10950 and 8700 cal. years BP; this taxon also dominates at Fate, where a sedimentary hiatus prevents the observation of the evolution of birch after 9950 cal. years BP. We suppose that *Betula* pollen recorded at Orgials at this period is due to wind-driven transport to this site (Ortu *et al.*, 2005). The development of fir is recorded at Orgials and Biecai after 8700 cal. years BP, while the beginning of this period, currently known as Atlantic, is not recorded at Fate and Biecai because of the presence of hiatuses in these sediment cores. On the average, fir dominates the mountain and subalpine belts in the St. Anna di Vinadio and the Ellero valleys until 6000 cal. years BP. Only a fir-forest was present at Mondovì, while fir trees formed open formations with larch and pine at Orgials, Fate and Mondovì. Fir is still dominant at Mondovì after 6000 cal. years BP; its gradual decrease begins in 2600 cal. years BP and it is related to human action. Pollen taxa indicating human activities are recorded at Orgials, Biecai, Mondovì and Marchisio after 2600 cal. years BP. This period is not recorded at Fate. Due to human action, the tree line was lowered below 1500 m asl in the Ellero Valley, so that the three study sites from this valley are presently surrounded by grassland. Human impact was different in the St. Anna di Vinadio Valley, were it resulted in uniformity of landscape in the subalpine belt, but it was less important in the last centuries, so that trees could again develop at higher elevation than in the Ellero Valley where deforestation above 1500 m is still common.

Palaeoclimate reconstruction

Modern analogues' selection

The "good analogue" squared chord distance (SCD) indicated by 3Pbase for the current data set is 0.63. Modern pollen samples with a SCD over this value were automatically excluded during the selection of modern analogues for each fossil sample. However among the chosen analogues, the best analogues are those with low SCD, while high SCD values indicate important differences between each fossil sample and its modern analogues; consequently low SCD values indicate a higher reliability of results and high SCD values a lower reliability. The quality of the climate reconstruction is also indicated by the homogeneity of climate values of the selected analogues; this means that, when important climate differences characterise the chosen analogues, the climate reconstruction can hardly be considered reliable despite floristic similarities between fossil pollen spectra and their modern analogues which are available in the modern database. This last indication is illustrated by the magnitude of lower and upper errors compared to the mean reconstructed climate values (figure 5). The evolution of chord distances (minimum SCD = distance between the fossil sample and the closest modern analogue; maximum SCD = distance between the fossil sample and the least close modern analogue) between modern and fossil pollen spectra at each site are shown in figure 6. An estimation of the quality of the reconstruction at each site is given below.

Table 3: Correlation coefficients between observed and reconstructed values of climate parameters obtained using the MAT approach to both modern pollen data bases. RMSE: Root Mean Square Error. Climate parameters: T_c: mean temperature of the coldest month; T_w: mean temperature of the warmest month; T_{ann}: mean annual temperature; P_{ann}: mean annual precipitation.

Climatic parameters	Correlation coefficient	RMSE
Tc (°C)	0.926	4.66
Tw (°C)	0.878	2.36
Tann (°C)	0.926	2.86
Pann (mm/yr)	0.818	186.63

Orgials

The climate reconstruction looks quite reliable all along the sequence: the best analogues are found for the Bølling-Allerød, while the modern analogues selected for the Atlantic-Subboreal periods show a higher floristic heterogeneity among the selected modern analogues (figure 5a). Besides, a high climatic heterogeneity is shown among the modern analogues selected for the Lateglacial (especially the Younger Dryas), the Preboreal and Boreal periods, while climate values associated to the modern analogues of the rest of the Holocene samples (especially from 8700 to 2600 cal. BP) are highly homogeneous.

Fate

The climate reconstruction looks reliable for the Bølling-Allerød and for the Holocene. Very low SCD are found for the Bølling-Allerød while the highest SCD are found for the Oldest, Older and Younger Dryas (figure 6). Globally, the selected analogues show homogeneous climatic values (figure 5b).

Biecai

The climate reconstruction looks reliable all along the sequence; better analogues are found for the Lateglacial and the early Holocene than for the more recent periods. Low differences between the lower and upper error bars (figure 5c) overall indicate a climate homogeneity among the selected modern analogues despite a more important floristic heterogeneity among the analogues selected for the samples recording the Atlantic and the beginning of the Subboreal period (figure 6c).

Mondovì

The graphic in figure 6 shows a poor choice of modern analogues for most of fossil pollen samples from this sequence. The best analogues are found for the Bølling-Allerød and, with higher SCD, for the period after 2600 cal. BP. Important climate differences characterise the modern analogues selected for the Lateglacial.

Marchisio

The analogue distances are quite low a floristic homogeneity of the selected modern samples is found at this site.

Comparison of results at various sites

The evolution of climate at the five sites during the last 20000 years is shown in figure 5. In order to simplify the comparison of climate values reconstructed at various sites, the results are summarized in table 4.

Table 4: Reconstructed climate values at the five sites for the various periods recorded in the pollen sequences. Climate parameters: T_c: mean temperature of the coldest month; T_w: mean temperature of the warmest month; T_{ann}: mean annual temperature; P_{ann}: mean annual precipitation.

Site	Before 14700	14700 – 12650	12650 - 11500	11500 - 10950	10950 -8700	8700 - 6000	6000 - 2600	2600 - present
Laghi dell'Orgials (2240 m)	Tc: -14 to –12 Tann ~ 4 Tw ~ 20 Pann: 200 to 400	Tc ~ -6 Tann ~ 5 Tw ~ 16 Pann ~ 700	Tc ~ -16 Tann : 0 to 2 Tw : 16 to 19 Pann ~ 400	Tc ~ -6 Tann ~ 2 Tw ~ 12 Pann : 400 to 1000	Tc : -12 to -4 Tann : 2 to 6 Tw ~ 11 to 13 Pann : 400 to 800	Tc : -5 to -3 Tann : 3 to 5 Tw : 14 to 12 Pann : 800 to 1000	Tc : -6 to -4 Tann : 5 to 3 Tw : 13 to 11 Pann : 800 to 1000	Tc ~ -9 to -5 Tann ~ 0 to 3 Tw ~ 9 to 11 Pann ~ 900 to 1100
Lago delle Fate (2130 m)	Tc : -18 to -16 Tann ~ 2 Tw ~ 20 Pann: 200 to 400	Tc ~ -11 Tann ~ 5 Tw : 18 to 20 Pann : 300 to 500	Tc ~ -16 Tann : 0 to 2 Tw : 16 to 19 Pann ~ 400	Tc ~ -2 Tann ~ 7 Tw ~ 16 Pann : 400 to 1000	Tc : -12 to -4 Tann : 2 to 6 Tw ~ 17 Pann : 400 to 600	Tc : -4 to -2 Tann ~ 6 Tw : 17 to 15 Pann : 700 to 800	Tc : -2 to -3 Tann : 7 to 5 Tw : 14 to 15 Pann ~ 800	
Torbiera del Biecai (1920 m)	Tc ~ -16 Tann ~ 2 Tw ~ 20 Pann: 200 to 400	Tc : -4 to -2 Tann ~ 6 Tw : 14 to 16 Pann : 900 to 1100	Tc ~ -13 Tann : 6 Tw ~ 21 Pann ~ 400	Tc ~ -11 Tann ~ 5 Tw ~ 20 Pann : 400 to 1000	Tc : -12 to -4 Tann : 2 to 6 Tw ~ 17 Pann : 400 to 600	Tc : -4 to 0 Tann : 7 to 4 Tw : 16 to 14 Pann ~ 1100	Tc ~ -2 Tann ~ 6 Tw ~ 14 Pann ~ 1000	Tc : -4 to -2 Tann : 3 to 5 Tw : 11 to 14 Pann : 1000 to 1100
Rifugio Mondovì (1760 m)	Tc ~ -14 Tann: 2 to 6 Tw: 16 to 21 Pann: 200 to 400					Tc ~ -5 Tann ~ 5 Tw ~ 14 Pann ~ 1100	Tc ~ -2 Tann ~ 5 Tw ~ 14 Pann ~ 1000	Tc : -3 to -1 Tann : 5 to 8 Tw : 14 to 17 Pann ~ 800 to 1000
Pian Marchisio (1624 m)								Tc : -4 to -1 Tann : 4 to 7 Tw : 12 to 16 Pann : 1000 to 1200

Before 14700 cal. years BP (Oldest Dryas)

This period, currently named Oldest Dryas, is recorded at Orgials (2240 m) and Mondovì (1760 m); the end of this period is also recorded at Fate (2130 m) and Biecai (1920 m) (fig. 2, fig. 3). Temperatures show different trends depending on the parameter which is reconstructed (fig. 5). Different temperature values are reconstructed at the various sites, while the reconstructed annual precipitation (P_{ann}) is about 200-400 mm/year at the four sites (table 4).

14700-12650 cal. years BP (Bølling-Allerød)

This period is recorded in pollen sequences at Orgials, Fate (fig. 2) and, with a better resolution, Biecai (fig. 3). Differences at the three sites in the reconstructed T_c and T_w values as well in the reconstructed P_{ann} characterise this period.

13200 cal. years BP (Older Dryas)

The Fate sequence (fig. 2) shows a peak in Artemisia at this period, which seems to be related to the Older Dryas oscillation (Ortu *et al.*, 2005) and that has no equivalent in any other sequence presented in this study. A drop down in T_c, T_{ann}, T_w and P_{ann} is reconstructed at this time-period.

12650-11500 cal. years BP (Younger Dryas)

This period is characterised by a climate change to cooler and dryer conditions. It is recorded at three of the study sites: Orgials, Fate and Biecai (figs. 2, 3, 5). The reconstruction of climate parameters at various sites shows consistent trends but differences in values.

11500-10950 cal. years BP (Early Preboreal)

The transition from the Lateglacial to the Holocene period in the Western Alps is dated to 11500 cal. years BP. This period is warmer and moister than the previous one. Different values are reconstructed at the three sites which recorded this period: a strong shift in T_c is recorded at Fate, with a warming to -2 °C, while a less important variation is reconstructed at Orgials (-6 °C) and Biecai (-11 °C). Variations in the T_{ann} and T_w also show differences in the reconstruction obtained at the three sites. P_{ann} strongly increases at Orgials and Fate, while a gradual increase is reconstructed at Biecai.

10950-8700 cal. years BP (Late Preboreal-Boreal)

This period is recorded at two sites: Orgials and Biecai. Its first part is also recorded at Fate (10950-9950 cal. years BP). The evolution of temperature shows a gradual warming ; T_w is about 17 °C at Biecai and Fate, about 11 °C at Orgials. A high number of fluctuations is reconstructed at the Biecai site (1920 m) which was located at the limit between two ecotones (the birch-forest and the pine-forest), while less variations are reconstructed at Orgials (2240 m) which was located above the tree line. Similarly, the T_c and T_{ann} reconstructed at Fate show a high number of variations for the period recorded at this site. The T_c and T_{ann} values reconstructed at Fate are close to the Biecai ones. The P_{ann} also shows a gradual increase in values from 10950 to 8700 cal. years BP. P_{ann} values are comparable at the Biecai and Fate sites, while they are slightly higher at Orgials (200 mm/year more).

8700-6000 cal. years BP (Atlantic)

Two sequences record this period (Orgials and Biecai). It is also partially recorded at Fate (7400-6000 cal. years BP) and Mondovì (6500-6000 cal. years BP). The reconstructed T_c and T_{ann} show similar values at the four sites. T_w is comparable at the four sites. T_c and T_{ann} values reconstructed at Orgials for this period are high compared to the rest of the sequence. P_{ann} shows different values at the four sites.

6000-2600 cal. years BP

Three sequences record this period: Orgials, Fate and Mondovì. The reconstructed T_{ann} and T_c values are close at Fate and Mondovì, while lower values, decreasing towards the bottom of this zone, are reconstructed at Orgials. T_w is about 14 °C at Fate, Mondovì and Biecai, while it decreases from 13 °C to 11 °C at Orgials during this period. P_{ann} shows close values at Orgials and Mondovì, while lower values are reconstructed at Fate.

2600 cal. years BP-present (Subatlantic)

This period is recorded at four sites: Orgials, Biecai, Mondovì and Marchisio. In this last period, T_c and T_{ann} values at the Orgials site decrease while they do not change at the other sites, compared to the previous time interval. The reconstructed temperature shows very close values at Biecai, Mondovì and Marchisio, while they are lower at Orgials. Higher differences in the T_w are found at the various sites, in consistency with the different elevation of sites: values vary from 14 °C to 16 °C at Mondovì and Marchisio, from 12 to 14°C at Biecai, and oscillate from 9 to 11 °C at Orgials. P_{ann} oscillates between 800 and 1200 mm/year at the four sites.

Discussion

Based on the comparison between the vegetation reconstruction from pollen data (Ortu *et al.*, 2005; Ortu *et al.*, in press), the palaeoclimate reconstruction by the MAT technique and the variations of the chord distances between the chosen modern analogues and the fossil pollen spectra for different time intervals, it is possible to attempt an interpretation of results by a critical approach, taking into account the reliability of the climate reconstruction.

The graphics in figure 5 show good reliability of results with the exception of several periods, for which few analogues were found: (1) the cold steppe dominated by *Artemisia* (fig. 2, 3) related to the Oldest, Older and Younger Dryas periods (20000-16000 cal. years BP; about 13000 cal. years BP; 12650-11500 cal. years BP); (2) the vegetation formations dominated by *Abies* (fig. 2, 3), developed over almost the whole Holocene (8400-2600 cal. years BP) in the western Alps. The graphics also show differences in the reconstruction of climate for the beginning of the Holocene at the various sites: based on the chord distance between modern and fossil pollen spectra, the climate reconstruction at Fate seems to be more reliable than at the other sites.

Several problems in palaeoclimate reconstructions linked to the importance of pollen transport by wind in mountain areas were pointed out in a previous paper (Ortu *et al.*, 2006). Compared to the previous work (Ortu *et al.*, 2006), which provided a first estimation of climate evolution in the St. Anna di Vinadio Valley after three different constraint steps, the results presented in this work just needed a minimum biome constraint to exclude the incidental selection of lowland biomes due to the pollen of deciduous taxa blown uphill to the study sites, which sometimes may reach important percentages. The climate reconstructed at various sites shows variations in trends and values that are globally comparable to previous data from the Alps, while our previous results just allowed to underline important differences between the climate at the Lateglacial and the Holocene and a temperature overestimation overall the Holocene was shown to affect the reconstruction (Ortu *et al.*, 2006). This shows that climate reconstruction can be highly improved by the addition of new modern pollen samples reflecting the variability of the vegetation cover, which is particularly strong in mountain areas because of the greater topographic complexity that characterises them. Consistent trends were obtained for climate evolution at the different sites. Differences in the reconstructed values at the various sites characterise several periods: (1) lower temperature and precipitation are reconstructed at Fate than at the other sites during the Bølling-Allerød (14700-12650 cal. years BP); (2) higher temperature is reconstructed at Fate at the beginning

of the Holocene (11500-10950 cal. BP); (3) reconstructed temperature values are lower at Orgials than at the other sites during the last 6000 cal. BP.
Results and their reliability are discussed in the following paragraphs.

Alpine cold steppe

The reconstruction of climate for periods recording the presence of cold steppes at the study sites (20000-14700 and 12650-11500 cal. years BP) yields very low values for T_c and P_{ann}, while values higher than present-day ones are obtained for T_w and T_{ann}. This phenomenon is linked to the selection of pollen samples from the continental steppe located in Kazakhstan and Mongolia as modern analogues for the Oldest Dryas steppe dominated by *Artemisia* that is recorded at the study sites. These analogues are associated with a climate characterised by very important differences between winter and summer temperatures. Several analogues are also selected from the present-day steppe developed on the Tibetan plateau which is associated with a less important seasonal climatic range. We believe that this vegetation is ecologically closer to the Dryas alpine steppe. Considering the high elevation of the study sites and the fact that important percentages of *Pinus* are commonly recorded above the tree line because of uphill transport by wind, we deducted (Ortu *et al.*, 2005; Ortu *et al.*, in press) that the study sites were located in an alpine cold steppe. This formation might have been climatically close to the present-day alpine zone in Tibet. This zone includes all areas where the average temperature during July, the warmest month of the year, does not exceed 10°C (Chang, 1981). This hypothesis is in agreement with results based on chironomid assemblages (Heiri & Millet, 2005) and on pollen data (Peyron *et al.*, 2005) reconstructing T_w values of about 11-12 °C at a site at 788 m asl in the French Alps. Besides, our reconstruction by the MAT in the Southern Alps yields T_w values comprised between 16 and 21 °C at our sites, which are located at higher elevations (comprised between 1620 and 2300). Compared to the T_w range expected for our sites in consistency with previous data at lower elevation in the Alps and with the hypothesis of their location at the Dryas periods in an alpine steppe comparable to the present-day Tibetan one, the reconstructed values are far too high. A lack of perfect modern analogues of the vegetation recorded by pollen data during the Oldest Dryas seems to prevent a reliable reconstruction of climate for this period. The reconstruction of climate for the Younger Dryas is affected by the same problems that were noted for the Oldest Dryas period. Moreover, several analogues were selected in the continental taiga because of the high percentages of pine which characterise the Younger Dryas. A more important seasonal range is then reconstructed for the Younger than for the Oldest Dryas.

However, the ecological and floristic differences (indicated by the chord distances in figure 6) between the fossil and the modern vegetation on which the reconstruction is based, make it highly unreliable. Supplementary samples from the Tibetan alpine steppe might help to obtain reliable results for this period.

While the bias in the reconstruction is evident when observing the evolution of T_w and T_{ann}, it is not the case for the reconstructed T_c and P_{ann}, for which we obtained the expected trends (e.g. Magny *et al.*, 2001; Magny, 2004). This is probably due to the importance of these climatic parameters (T_c and P_{ann}) on the development of the cold steppe vegetation during the Oldest Dryas in the Alps, where the winter temperature is the most important factor preventing the colonisation of high elevation lands by taxa intolerant to climatic stress. These two factors are linked since the availability of water at high elevation is low due to freezing as well as drought. The vegetation zonation typical of mountain areas is a result of the vegetation's tolerance or intolerance to thermic and hydric stress.

Pine-dominated pollen assemblages

Pollen records show a dominance of pine for two time intervals in particular: (a) between 14700 and 12650 cal. years BP (Bølling-Allerød interstadial) and (b) between 11500 and 10950 cal. years BP (beginning of the Holocene). The climate reconstruction of these periods shows similarities which are discussed in the following paragraphs.

(a) T_c and P_{ann} close to the present-day ones are reconstructed between 14700 and 12650 cal. years BP (Bølling-Allerød interstadial) at Orgials and Biecai, while lower values are obtained for the Fate site. The reconstruction of T_{ann} yields values that are slightly higher than today at the three sites (differences between the three sites lie in the standard error), while the T_w values are higher at Fate than at the other sites. The reconstructed values at Fate are different from those obtained at the other two sites because of differences in the pollen record, which led to the selection of modern analogues in the continental Russian taiga (colder and dryer) for the Fate site, while samples from the *Pinus sylvestris* forests in the Durance valley (South-western French Alps, fig. 4) are selected as analogues for the pine-forest recorded at Biecai and Orgials during the Bølling-Allerød. This phenomenon is probably linked to the lack of a sufficient number of modern analogues recording the variability of pollen spectra from the subalpine and montane pine-forests. While an important number of modern spectra were added to the reference database from the *Pinus cembra* and *Pinus sylvestris* forests of the western Alps (fig. 4), no modern analogues in the reference database record the subalpine mountain pine (*Pinus mugo* gr.) forest, which was probably the vegetation formation which colonised the Fate site in the past (Ortu, 2002; Ortu *et al.*, 2005) and which is still present on the slope downhill from the lake. We than believe that the reconstruction for the Bølling-Allerød at Fate is not reliable, despite the low SCD values between the modern and the fossil spectra shown in figure 6 for the three sites that recorded this period.

The SCD values indicate that the reconstruction for the Bølling-Allerød looks particularly reliable for the Biecai site. However, the climate values reconstructed at this site are based on the averaged climate of modern samples from a lower elevation than that of the studied site (1920 m asl). Most of the modern analogues come from an elevation of 1000-1200 m asl, while only one is located at an elevation of 1800 m. Furthermore, *Pinus sylvestris* is ecologically quite different from *Pinus uncinata* and *Pinus cembra*, which commonly develop at present-day in the subalpine belt in the Alps (fig. 7) (Filipello *et al.*, 1980-81a; Filipello *et al.*, 1980-81b). *Pinus sylvestris* develops in the mountain belt in warmer and drier conditions and it is typical of continental internal valleys in the Alps (the *Pinus sylvestris* valleys: e.g. Aosta Valley, Susa Valley, Pignatti, 1979; Ozenda, 1985), characterised by an east-west orientation and a climate with an important seasonal range. *Pinus sylvestris* was probably the species that developed in the area during the Bølling-Allerød, however, the location of the modern analogues on which the reconstruction of climate is based, at 1000 m lower than the study sites, certainly caused an over-estimation of temperature, affecting in particular the T_w and the T_{ann} for which the decrease with elevation is more important than for T_c (Ozenda, 1985). The averaged error may be about 5 °C for T_w and T_{ann} . Taking into account an over-estimation of temperatures of about 5-6 °C leads to climate values close to the present-day ones at the different sites (fig. 5), in agreement with previous studies based on insect remains (Atkinson, 1982) and chironomids (Heiri & Millet, 2005), which indicated a climate close to the present-day one for this interstadial. A further improvement of the reference database by the integration of supplementary data from various pine-forests would help to reconstruct with precision the intensity of this abrupt climate variation.

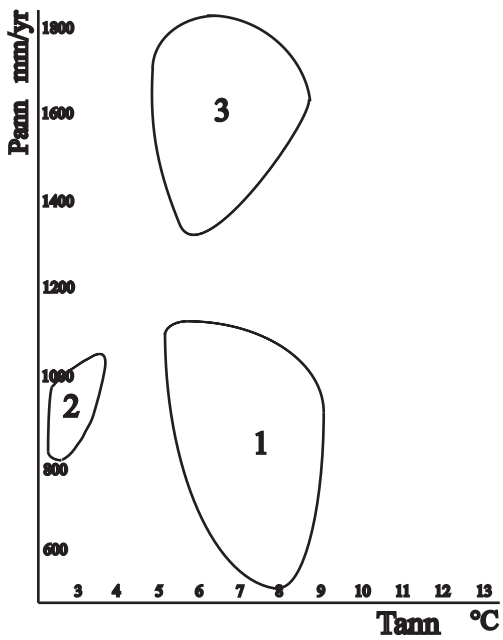

Figure 7: Differences in the ecology of Pinus sylvestris (1), Pinus mugo gr./Pinus cembra (2), Fagus sylvatica/Abies alba (3). Modified from Ozenda (1985).

(b) In 11500, the beginning of the Holocene is marked by a transition to warmer and moister conditions. The climatic change reconstructed at this period seems to occur abruptly at Fate and Orgials, while a gradual increase of T_c and P_{ann} is reconstructed at Biecai (figure 5). Chord distances in figure 6 show similar values for the different sites, but the similarity between modern and fossil spectra slightly increases at Fate while it slightly decreases towards the end of this period at Orgials and Biecai. Modern analogues for this period at Fate are selected from a pine-forest of *Pinus sylvestris* in the South-western French Alps, while modern analogues for the Orgials site were taken from alpine pastures in the western Italian/French Alps where *Pinus cembra* pollen is transported uphill by wind. The reconstruction obtained at Biecai is based on modern analogues from the Carpathian chain, but several analogues are also selected from the Russian taiga. Differences in the palaeoclimate reconstruction obtained for the different sites at this period are linked to the different climatic ranges that characterise these regions. Differences are particularly evident in the reconstruction of the T_{ann} and the T_w values, and they are due to the important seasonal climatic differences typical of continental taiga where some modern analogues for the Biecai site are selected. The pollen-based vegetation reconstruction makes it possible to suppose that a pine-forest (*Pinus mugo* gr.) was present close to Fate, while important percentages of *Pinus* pollen at Orgials and Biecai at this period are imputed to transport by wind (Ortu *et al.*, 2005; Ortu *et al.*, in press). The selection of analogues in the reference database is then in agreement with the ecological interpretation of pollen diagrams for the Orgials and the Fate sites, while the selection of samples from the continental taiga for this period at Biecai results in an over-estimation of T_w. An over-estimation of T_w, T_{ann} and T_c certainly affects the reconstruction at Fate because of the lower elevation of the sites from where the modern analogues were taken, as was explained for the temperature values reconstructed at Biecai for the Bølling-Allerød. However, we consider that, in taking into account the error due to differences in elevation at Fate (from 1000 to 2130 m: about 5 °C), the reconstructed climate trends are reliable for the Orgials and the Fate sites. In the case of Biecai, the reconstruction is biased by the selection of continental taiga, while modern analogues selected for this period from the Carpathians show climate values close to Fate's reconstructed ones (T_c=-6 °C; T_w=16 °C; T_{ann}= 6 °C, P_{ann}= 800 mm/year). Based on our data, we can suppose that an abrupt strong climate change characterised the transition from the Lateglacial to the Holocene, and that the gradual increase reconstructed at Biecai is an artefact due to the lack of good analogues for the vegetation cover recorded at this site.

Fir-dominated pollen records

A climatic optimum characterises the period between 8700 and 6000 cal. years BP. The development of *Abies* in the mountain and subalpine belts is recorded at the three sites that record this period and it typically indicates the beginning of the Atlantic period in the Western Alps (e.g. Beaulieu, 1982; Beaulieu *et al.*, 1993; Beaulieu *et al.*, 1994). The increasing distances between modern and fossil analogues is related to the similarity between the vegetation formations recorded in the modern and the fossil pollen samples which is lower than in the previous period. A higher heterogeneity between the selected analogues is found at Mondovì where the vegetation reconstruction indicates the presence of a fir-wood with *Rhododendron* on the site which is similar to the vegetation formations developed at present-day in the Dolomites (Ortu *et al.*, 2003). These vegetation formations are no longer present in the western Alps, where calcareous soils are rare. The climate reconstruction shows similar values for the various parameters at the different sites. This is consistent with the vegetation reconstruction indicating the presence of open tree formations at Orgials, the site at higher elevation, which was located above the tree line throughout the period under study with the exception of this time interval (Ortu *et al.*, 2005). The values reconstructed at our sites at this period are also consistent with previous results in the western Alps and the Jura (Magny *et al.*, 2001), taking into account the differences in the elevation of the study sites (e.g. T_{ann} ~ 5 °C at Orgials, 2240 m and ~9 °C at Le Locle, 915 m, Swiss Jura, Magny *et al.*, 2001).

Transition periods

A gradual increase in T_w, T_c, T_{ann} and P_{ann} is reconstructed between 10950 and 8700 cal. years BP at Fate and Orgials, while the Biecai, in comparison to these two sites, is characterised by differences in the trend of various parameters. Lower P_{ann} and higher T_w reconstructed at this site are related to the selection of several modern analogues in the continental Taiga, which causes an overestimation of temperature, affecting in particular the reconstruction of T_w. The reconstructed T_w and T_{ann} are lower at Orgials. This is in agreement with the pollen-based vegetation reconstruction (Ortu *et al.*, 2005) which affirms that this site was located above the tree line, contrary to the Fate and the Biecai sites, which were surrounded by birch formations (fig. 2, 3). Nevertheless, the magnitude of lower and upper errors (figure 5a) makes the reconstruction of T_w at Orgials unreliable concerning the mean values and the amplitude of climate variations. Furthermore, the T_w values (~11-12 °C) reconstructed at Orgials (2240 m) looks too high compared to previous data obtained at alpine sites located more than 1200 m lower: we cite the site of Gerzensee (603 m, T_w : 12 °C, Lotter *et al.*, 2000), Le Locle (915 m, Tw: 14-16 °C, Magny *et al.*, 2001), Lautrey (788 m, Tw : 15-17 °C, Peyron *et al.*, 2005; Tw: 16-18 °C, Heiri & Millet, 2005) for which the T_w estimation was obtained respectively from isotope and pollen data, lake-level and pollen data, pollen data, chironomid data. This indicates that an overestimation of temperature may affect also this site. However, despite the high number of fossil pollen analyses at sites located over 1000 m asl showing the response of vegetation to abrupt climate changes (e.g. Beaulieu, 1977; Brugiapaglia, 1996; Wick, 2000), we could not find in previous works a quantified estimation of climate parameters to directly compare our results with those from sites at comparable elevation. Difficulties in estimating the part of wind-driven pollen in high elevation sequences we underlined in a previous paper (Ortu *et al.*, 2006) are probably at the origin of this lack of quantitative climate data at sites over 1000 m asl.

A temperature decrease is again reconstructed between 6000 and 2600 cal. years BP at Orgials compared to the other sites. This is in agreement with the vegetation zonation reconstructed in the valley. The reconstructed values are similar at the sites belonging to the same vegetation belts (subalpine fir-wood with pine), while they are lower at Orgials which belongs to the upper subalpine belt (shrubs and meadows). The reconstructed climate shows here clearly its relationships with the vegetation zonation. The low climate errors shown in figure 5 for this period indicate a good reliability of the reconstruction at various sites. However, differences might be underlined at the Mondovì site, which was surrounded at this period by a pure subalpine fir-wood, which is ecologically different from the pine-dominated forest (fig. 7). Additional samples from similar modern formations present as relicts in the eastern Alps might help to underline the differences which appear in the vegetation cover at this site compared to the other sites. This may help to reconstruct climate differences related to differences in the vegetation cover.

Anthropogenic impact on vegetation

Human impact has been the most important factor acting on vegetation from 2600 cal. years BP to the present, so that vegetation from this period is the result of environmental factors combined with land use. This additional factor may cause difficulties in the reconstruction of the palaeoclimate. Nevertheless, consistent results are obtained at the various sites, thanks to the improvement of the modern database by new spectra from the Alps. Differences at the various sites are more marked for the T_w and the T_{ann} parameters, which are more affected than T_c and P_{ann} by the altitudinal variations of climate. We suppose that the lowering of the tree line by man caused the change in the capture of pollen transported by wind at the different sites. Pollen spectra change as a result of the increase in distance between the sites and the tree line, since the arboreal pollen of most taxa decreases with elevation as it moves away from forests, with the exception of *Pinus* whose pollen increases at a maximal distance from the source because of its adaptation to transport by wind (e.g., David, 1993; Ortu et al., in press).

Conclusion

The reconstruction of climatic parameters shows consistent trends at the different sites from the Lateglacial to the present. Overall, our results indicate that, at the Lateglacial, climate was cold and dry during the Oldest Dryas (before 14700 cal. years BP), it abruptly turned warmer and moister during the Bølling-Allerød interstadial (14700-12650 cal. years BP) and again cold and dry during the Younger Dryas (12650-11500 cal. years BP). An abrupt change to warmer and drier conditions is recorded at the transition to the Holocene (~11500 cal. years BP). Temperature and precipitation gradually increase after 10950 cal. years BP to an optimum recorded between 8400 and 6000 cal. years BP. A gradual temperature decrease is then recorded at the site located at higher elevation (Laghi dell'Orgials, 2240 m) from 8400 cal. years BP to the present. Higher climate differences between the various sites are recorded after 2600 cal. years BP.

Compared to previous data from the alpine areas, our results are consistent with quantifications obtained at lower elevations (from pollen and complementary palaeoecological data) for the Bølling-Allerød (best reconstruction: Biecai) and for the time-period after 8700 cal. BP (best reconstruction: Orgials). This comparison also indicates an overestimation of temperature at the beginning of the Holocene, already supposed by the analysis of our own data. However, the comparison is based on data from lower elevation than our sites, taking into account the difference in elevation. We could not find in previous works a quantified estimation of climate parameters at sites at elevation comparable to ours, probably because of difficulties in estimating the part of wind-driven pollen in high elevation sequences we underlined in a previous paper (Ortu *et al.*, 2006), which may explain the lack of quantitative climate data at sites over 1000 m asl.

Differences in the reconstruction obtained at the various sites for several time periods can be explained by variations in the reliability of results linked to the lack of perfect analogues in the modern pollen database or to differences in the ecology of the vegetation formations recorded by the modern and the fossil samples, despite similarities in the pollen flora. We underline in particular the following limits in the climate reconstruction:

(1) No perfect analogues are present in the reference database for the cold steppe dominated by *Artemisia* (fig. 2, 3) related to the Oldest, Older and Younger Dryas periods (20000-16000 cal. years BP; about 13000 cal. years BP; 12650-11500 cal. years BP); this vegetation might have been similar to the alpine Tibetan steppe associated with T_w values lower than 10 °C; (2) the selection of modern analogues for the Fate sequence (dominated by pine pollen) from the continental taiga (characterised by an important climatic seasonal range) for the Bølling- Allerød yields lower precipitation and T_c, and higher T_w at this site compared to the other sites; (3) T_c, T_w and T_{ann} reconstructed at Biecai during the Bølling-Allerød (14700-12650 cal. years BP) and at Fate at the beginning of the Holocene (11500-10950 cal. BP) are over-estimated because of the selection of modern analogues for this period from the *Pinus sylvestris* forest located at an elevation about 1000 m lower; (4) reconstructed temperature values are lower at Orgials than at the other sites during the last 6000 cal. BP. This results from the position of this site above the tree line, while the other sites were located below this limit. The reconstructed climate is a result of the vegetation zonation in the past, so that we reconstructed the average climate values for the vegetation formations recorded by pollen records at the different sites; (5) no perfect analogues for the vegetation formations dominated by *Abies* (fig. 2, 3), typical of the Atlantic and Subboreal periods (8700-2600 cal. years BP), were found in the reference database despite the integration of data from relicts of modern forests with fir in the western French Alps (the Bauges Massif fir-beech wood developed on calcareous soil and the Boscodon forest on siliceous soil). Consistent climate

trends are reconstructed at the various sites, but a high heterogeneity of the selected modern analogues is indicated by the chord distances in figure 6.

Future samplings are planned in order to improve the quality and the reliability of the climate reconstruction in the alpine area (forests of *Pinus sylvestris* from internal alpine valleys, *Pinus mugo* gr. forests from the subalpine belt, pure *Abies alba* forests on calcareous soils), although we know that analogues for every possible past situation would hardly be found, in particular for the Lateglacial periods, when a number of present-day common taxa were not yet came back to the Alps from refuge areas. However, good results were obtained from this work which made it possible to appreciate the amplitude of climate variations over the last 20000 years, and with higher reliability during the Holocene. Despite artefacts due to the lack of analogues for several past situations, the Orgials site show climate trends and values in consistency with its position in the upper vegetation belts (subalpine/alpine all along the Holocene, forested at the early Atlantic) compared to the other sites and a high number of climate fluctuations are reconstructed for sites located at the limit between different ecotones (Biecai and Fate) for the periods that they recorded with a good temporal resolution. This allows to conclude that, overall, a good spatial resolution was obtained, underlining climate differences between sites located in small areas but in different vegetation belts.

Figure and table captions

Table 1: Modern climate values at the five study sites.

Table 2: Results of vegetal remains ^{14}C dating: codes, material, identification, depth, age of the dated samples.

Table 3: Correlation coefficients between observed and reconstructed values of climate parameters obtained using the MAT approach to both modern pollen data bases. RMSE: Root Mean Square Error. Climate parameters: T_c: mean temperature of the coldest month; T_w: mean temperature of the warmest month; T_{ann}: mean annual temperature; P_{ann}: mean annual precipitation.

Table 4: Reconstructed climate values at the five sites for the various periods recorded in the pollen sequences. Climate parameters: T_c: mean temperature of the coldest month; T_w: mean temperature of the warmest month; T_{ann}: mean annual temperature; P_{ann}: mean annual precipitation.

Figure 1: Location of the study sites in the Italian Maritime Alps: 1. Laghi dell'Orgials (2240 m); 2. Lago delle Fate (2130 m); 3. Torbiera del Biecai (1920 m), 4. Rifugio Mondovì (1760 m), 5. Pian Marchisio (1624 m).

Figure 2: Synthetic pollen diagrams from Laghi dell’Orgials and Lago delle Fate in the St. Anna di Vinadio Valley: chronological correlation of pollen zones. The diagrams are shown on a calibrated timescale.

Figure 3: Synthetic pollen diagrams from Torbiera del Biecai, Rifugio Mondovì and Pian Marchisio in the Ellero Valley: chronological correlation of pollen zones. The diagrams are shown on a calibrated timescale.

Figure 4: Location of the sites of new modern pollen spectra from the western Alps for the improvement of the modern database.

Figure 5: Palaeoclimate reconstruction at the five sites. Reconstructed parameters: T_c: mean temperature of the coldest month; T_w: mean temperature of the warmest month; T_{ann}: mean annual temperature; P_{ann}: mean annual precipitation.

Figure 6: Variations in the degree of similarity between the selected modern analogues and the analysed fossil pollen spectra.

Figure 7: Differences in the ecology of Pinus sylvestris (1), Pinus mugo gr./Pinus cembra (2), Fagus sylvatica/Abies alba (3). Modified from Ozenda (1985).

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