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Biogeographical aspects of the bark beetle fauna of *Pinus mugo* Turra in the Southeastern Alps

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SUMMARY

In the S E Alps the Mountain pine (*Pinus mugo* Turra) occurs only in the reclining form which is largely distributed on calcareous substrata from 500 to 2000 m of altitude.

The bark beetles species recorded and their distributions are: *Tomius piniperda* (Linnaeus), holopalearctic; *Polygraphus grandicola* (Thomson), N cen Europe; *Dryococetes amographus* (Ratzeburg), Eurosiberic; *D. hecetographus* Reitter, Eurosiberic; *Pityophthorus glabratus* (Eichhoff), cen Europe; *Pityophthorus borscheli* (Seitzner), E cen Europe; *Pityophthorus pityographus* (Ratzeburg), Euroturanian; *Pityogenes bidentatus* (Herbst), Eurosiberic; *P. bistri dentatus* (Eichhoff), S cen Europe; *P. chaleographus* (Linnaeus), Eurosiberic; *P. conjunctus* Reitter, S cen Europe; *Orthotomicus laricis* (Fabricius), holopalearctic.

Several species present an European or wider distribution and their are frequently recorded also on *Pinus sylvestris* L., *Pinus nigra* Arn. and *Picea abies* Karst.

However the formations of the reclining form of *P. mugo* seem to be characterized by some oligophagous elements that are typical of the European mountains and are wide-spread at high altitude also on *Pinus cembra* L. and *Pinus pence* Griseb. In the S E Alps, where other altitude pines are absent, *P. mugo* seems to offer the only chance of colonization for the species of bark beetles living at high altitude.

INTRODUCTION

Some interesting aspects of the distribution of high altitude bark beetles were observed by Masutti (1968) in the Central Alps and in the massif of Pollino (Calabria), with particular reference to the species living on conifers belonging to the genus *Pinus* L. The importance of the relationships between these insects and their hosts is well-known, even though the oligophagy of several species sometimes makes it difficult to interpret their presence in some forest stands. It has also been pointed out that the biogeography of bark beetles is strictly linked to the distribution of the hosts and of its history. According to the palinological researches of Paganelli (1984), in Northeastern Italy some pines (*Pinus sylvestris* L., *Pinus cembra* L., *Pinus mugo* Turra) resulted to be coexistent in the same plain biotopes since the Würmian glacial stage. In the last Postglacial stage, various broadleaf trees spread on the plains, and *Picea, Abies* and *Fagus* in altitude. In the same period *P. cembra* and *P. mugo* were distributed approximately as at the present time, with *P. cembra* in the regions with a more continental climate and *P. mugo* just about everywhere but particularly abundant in the Eastern Alps.
In this territory _P. mugo_ maintains always its typical reclining form, which is linked to calcareous or dolomitic substrata, and which is well differentiated in the sphere of the botanical entity commonly known as Mountain Pine or _Pinus mugo_ (Pignatti, 1982).

The distribution of this species concerns the Central and Southern European mountains; in this area some «growth forms» (Susmel, 1954) can be singled out, which have been catalogued as species, subspecies, varieties or forms according to different authors. Authors generally agree upon the identification of main groups, which belong to _Pinus mugo_ Turra (= _P. mughus_ Scop. = _P. montana_ Áuct. in Miller) and to _Pinus uncinata_ Miller (= _P. montana_ Miller), which can hybridize along the contact zones of their ranges (Tutin et al., 1964; Marcet, 1967; Fenaroli and Gambi, 1976; Zoller, 1981; Pignatti, 1982).

Heer in Zoller (1981) proposes the subdivision of the «Formenkreis» of _P. mugo_ with regard to two characters (growth form and morphology of the cones) individuating three geographical and ecological entities: subsp. _prostrata_ Tubauf - Eastern Alps, Balkans, Apennines; subsp. _arborea_ Tubauf - Pyrenees, Central France, Jura, Black Forest, Central and Western Alps; subsp. _uliginosa_ Schwarz - moors from Southern Germany to Galicia (Eastern Carpathians).

The latter distinction is particularly useful in comparing the entomofauna of _P. mugo_ from different European regions.

This study is based on specimens gathered by the authors, by L. Masutti and by F. Stergulc in various biotopes in Friuli. Some data gathered by the authors in Veneto are also reported for comparison.

**Species recorded(1)**

*Tomicus piniperda_ (Linnaeus)

The most frequent and dangerous bark beetle of _P. sylvestris_ has been found on _P. mugo_ in two sites (Ugovizza UD, m 1200, 33TUM 034528, 14.08.79; Selva di Progno VR, Val Fraselle, m 1280, 32TPR 675608, 14.09.85) only in the maturation feeding in shoots. The species, with a holo-palearctic distribution, lives on various conifers of the genus _Pinus_. Lekander et al. (1977) consider it occasional on _P. mugo_.

*Polygraphus grandicula* Thomson

This bark beetle of N cen Europe lives above all on Prunoideae, but various authors have often observed it also on _Pinus cembra_, both in Europe

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(1) The systematic order followed in the survey of the species is that recently proposed by Wood (1978).

The distributions, when not specifically indicated, are sighted from Treddl (1907), Kleine (1913), Reitter (1913), Balachowsky (1949), Schedl (1981) and gathered in the chorologic groups proposed by La Greca (1964) for the Italian fauna.
(Kleine, 1913 and 1935) and in Italy (Masutti, 1968; Peez and Kahlen, 1977). Schedl (1954/55) and Franz (1974) recorded this species on P. mugo in Austria; in this study a single specimen was found at Barcis PN, torr. Prescudin, m 600, 33TUM 057188, 03.10.73. According to Pfeffer (1959), P. grandiclava is typical of the biocoenosis of high altitude conifers.

**Dryocoetes autographus** (Ratzelburg)

It is a typical element of the European fauna (Kleine, 1913) but it is present in Siberia as well, and lives on various conifers, preferably though *Picea abies*. It has been found on *P. mugo* together with another species of its genus, *Dryocoetes hectorographus* Reitter (Tarvisio UD, C. del Cacciatore, m 1900, 33TUM 870472, 23.06.82).

We know of only one record concerning specimens caught in flight in a *P. mugo* formation in the Austrian Alps (Franz, 1974).

**Dryocoetes hectorographus** Reitter

Balachowsky (1948) regards it as a glacial relict; it presents an eurosibiric-boreoalpine distribution. It is a typical species of northern woods of *Picea abies* and it has occasionally been observed on *Pinus* and *Abies*. It was recorded by Peez and Kahlen (1977) in Alto Adige and it seems to be present only at high altitudes, as is confirmed by our record (Tarvisio UD, C. del Cacciatore, m 1900, 33TUM 870472, 23.06.82).

**Orthotomicus laricis** (Fabricius)

Holopalearctic species linked to *P. sylvestris* and secondarily present on other conifers (Lekander et al., 1977). In Italy it is diffused in forests of *P. sylvestris* (Porta, 1932). Only one specimen was gathered on *P. mugo* (Tramonti di Sopra UD, F.lla M. Rest, m 980, 33TUM 299357, 22.03.86).

**Pityogenes bidentatus** (Herbst)

Typical bark beetle of N cen European forests of *P. sylvestris* (Kleine, 1913). It is sometimes recorded even on *P. mugo* (Lekander et al., 1977; Balachowsky, 1949). In Italy it is particularly diffused in the pine-woods of the Apennines (Masutti, 1964 and 1965); it is sporadic in the *P. mugo* formations of S E Alps (Tramonti di Sopra PN, F.lla M. Rest, m 980, 33TUM 299357, 22.03.86).

**Pityogenes bistri dentatus** (Eichhoff)

Species of European and Asiatic diffusion; in its range it is present with two forms often indicated by various authors as two distinct species. In par-
ticular, the form linked to the altitude pines of Alps, Carpathians, and Balkans (P. cembra, P. mugo, P. peuce Griseb.) has been included by Pfeffer (1955) and Grüne (1979) in the species Pityogenes conjunctus Reitter.

In Italy the presence of the P. bistridentatus forms has already been noticed by Masutti (1968), Ratti (1972) and Hellrigl (1985).

It is undoubtedly the most frequent bark bee on P. mugo, as observed by Ceconi (1924) and confirmed by our records: Tarvisio UD, M. Lussari, m 1800, 33TUM 870475, 10.08.80; Cimolais PN, Val Postegae, m 1200, 33TUM 092392, 03.11.85; Tramonti di Sopra PN, F.lla M. Rest, m 980, 33TUM 299357, 22.03.86; Selva di Progno VR, Val Fraselle, m 1050, 32TPR 669578, 04.05.86; Selva di Progno VR, M. Terrazzo, m 1876, 32TPR 666612, 29.06.86; Ferrara di M. Baldo VR, Bocchetta di Naole, m 1648, 32TPR 414589, 10.08.86; Cortina d'Ampezzo BL, Rif. Luzzatti, m 1920, 33TTM 875559, 04.09.86.

During the present study specimens coming from different biotopes were studied and it was confirmed the presence on P. mugo of both forms, subdivided according to altitude. In this study we find it opportune to indicate the altitude entity as P. conjunctus Reitter, which, besides, is already known for the P. mugo of the Carpathians (Pfeffer, 1976) and of the Austrian Alps, where it follows the conifer in its whole range (Franz, 1974).

**Pityogenes chalcographus** (Linnaeus)

Species of Eurosibiric diffusion. It follows the Norway spruce in its whole range, sometimes colonizing other conifers (Schedl, 1962). Its record on P. mugo falls within the sphere of occasional events (Cimolais PN, Val Postegae, m 1200, 33TUM 087397, 29.06.84; Cimolais PN, Val Meluzzo, m 1170, 33TUM 074398, 02.11.85).

**Pityophthorus glabatus** Eichhoff

Species linked to the genus *Pinus* in S E Europe. As for P. mugo, it is observed by Pfeffer (1976) in Bohemia and by Franz (1974) in Austria. With regard to this species, some authors have pointed out a Southern entity, described as *Pityophthorus buyssoni* Reitter. The distinction of the two entities needs a careful revision of the group. In the E Alps *P. glabatus* is sporadically found on *P. mugo* and it represents one of the elements mediated by *P. sylvestris* and *P. nigra* Arn. Masutti (1959 and 1964) described its main bionomic and distributive characters in the Julian Prealps and in the Apennines. The specimens come from Malborghetto UD, Cucco, m 700, 33TUM 787518, 05.05.82.

**Pityophthorus henscheli** Seitzner

Typical element of the high altitude pines of Alps, Carpathians and Balkans (Tredl, 1907; Pfeffer, 1959); in Italy it has been so far known only on
Pinus cembra (Masutti, 1968; Peez and Kahlen, 1977; Hellrigl, 1985). It represents one of the few phytophagous insects exclusively linked to the P. mugo in the considered region; even in the Austrian N E Alps it is exclusive of this conifer (Franz, 1974).

It has been found only in very wide formations (Cimolais PN, Val Cimoliana, m 1000, 33TUM 054377, 03.11.85; Cimolais PN, Val Postegae, m 1200, 33TUM 092392, 03.11.85; Tramonti di Sopra PN, F.Ila M. Rest, m 980, 33TUM 299357, 22.03.86; Selva di Progno VR, Passo di Malera, m 1605, 32 TPR 643618, 06.07.86).

Pityophthorus pityographus (Ratzeburg)

Species of euroturanian distribution; in Italy it is present in the same area of distribution of Picea abies and Abies alba (Masutti, 1964 and 1965), but it has been recorded even on Pinus nigra (Masutti, 1959) and on Pinus cembra (Hellrigl, 1985). In the S E Alps it is often found on P. mugo, colonizing the smallest twigs. Even Franz (1974) noticed P. pityographus on P. mugo in Austria.

It is interesting to note that the dimensions of the specimens collected exceed the maximum limit known for this species. It has been found at Cimolais PN, Val Meluzzo, m 1180, 33TUM 079398, 30.06.84; Cimolais PN, Val Meluzzo m 1170, 33TUM 074398, 02.11.85; Tramonti di Sopra PN, F. Ila M. Rest, m 980, 33TUM 299357, 22.03.86; Selva di Progno VR, Val Frasel, m 1050, 32TPR 669578, 04.05.86; Selva di Progno VR, Passo di Malera, m 1605, 32 TPR 643618, 06.07.86.

DISCUSSION

The bark beetles that inhabit P. mugo in the S E Alps can be divided in three fundamental chorologic groups: holopalaecctic species (Tomicus piniperda, Orthotomicus larici), N European and eurasibirc species (Polygraphus grandiclavus, Dryocoetes autographus, D. hectorgraphus, Pityogenes bidentatus, P. chalcographus), E cen European species (Pityogenes bisiridentatus, P. conjunctus, Pityophthorus bensceli, P. glabratus, P. pityographus).

The holopalaectic elements generally follow the pines in the whole of their ranges. The N European and eurasibirc species are polyphagous or oligophagous. Their presence on P. mugo is occasional and it is likely to be mediated by conifers characterized by vast ranges, among which Picea abies (for Dryocoetes autographus, D. hectorgraphus, Pityogenes chalcographus) and Pinus sylvestris (for Pityogenes bidentatus). Polygraphus grandiclavus is in a special position because of its singular aptitude for colonizing both broad-leaves (Prunus spp.) and conifers.

The bark beetles of the third group seem to be more closely connected than the others to P. mugo. In particular P. conjunctus and P. bensceli, that characterize the entomofauna of European altitude conifers, appear to be the
only monophagous species in the territory considered. Thus, the continuity of high altitude fauna typical of *Pinus cembra*, which is absent in the S E Alps, is preserved all along the Alps.

Other oligophagous elements of vast European distribution (such as *Pityogenes bistridentatus*) have been found only at a low altitude, where, in the S E Alps, the unusual coexistence of *P. mugo*, *P. sylvestris* and *P. nigra* is observed.

*P. pityographus*, with an eurouturanian distribution, lives on various conifers and characterizes the formations of *P. mugo* in close contact with forests of other conifers. *P. mugo* can play a significant role in the transmission of some polyphagous or oligophagous pests to other conifers (Masutt, 1959). This is the case of some phyllophagous and xylophagous insects, that, colonizing wide areas in altitudinal succession, frequently leave *P. mugo* to move towards other hosts (Gallo, 1985).

The comparison of our findings with researches on the entomofauna of *Pinus mugo* in other regions of its range (Pfeffer, 1976; Basset, 1985 and 1986) and with the bark beetle lists (Kleine, 1935; Franz, 1974; Schedl, 1981), evidentiates some characteristics typical of the *P. mugo* formations in the S E Alps (Tab. 1).

The records that the authors have attributed to the various growth forms of *P. mugo* were considered separately. The erected forms, *arborea* and *uliginosa* according to Heer, of cen and W Europe, are characterized by widely distributed elements that reveal little specificity for the host.

With reference to this, Pfeffer (1976) points out how the species typical of «Moorspirke» biocenosis (Heer's *uliginosa*) of S Bohemia are *Pityophthorus glabratatus* and *Pityogenes bidentatus*, which were clearly mediated by *P. sylvestris*. Notwithstanding the shortage of data, an analogous situation seems to exist in the Swiss Jura (Basset, 1985 and 1986).

The fauna of the bark beetles of the reclining form was studied by Pfeffer (1976) in some Alpine (Styria, Engadine, Valais), Carpathian (Tatra mountains) and Transylvanian biotopes; further data regarding this form are furnished by Franz (1974) as far as the Northeastern Austrian Alps are concerned.

Our records agree as well with the observations of other authors. The more interesting differences regard the absence in the S E Alps of *Ips amitinus* (Eichhoff) and of *Pityophthorus knoteki* Reitter, and the presence of *Pityophthorus pityographus* and *Dryocoetes autographus*, which confirm their occurrence on *P. mugo* in this region.

Thus the formations of the reclining form of *P. mugo* seem to be characterized, in their whole range, by some oligophagous elements that are distributed only in European (*Polygraphus grandiclavus*, *Ips amitinus*, *Pityogenes conjunctus*), or in E European montains (*Pityophthorus henscheli*, *P. knoteki*), and are widespread at high altitudes also on *Pinus cembra* and on *Pinus peuce* (Pfeffer, 1959; Masutt, 1968; Hellrigl, 1985). Probably the vast diffusion reached by these altitude pines in the last Glacial Period and perhaps
<table>
<thead>
<tr>
<th>Species</th>
<th>Regions</th>
<th>Distribution</th>
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<tr>
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<tr>
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<td><em>Dryocoetes bicoloratus</em> Reitter</td>
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<tr>
<td><em>Ornithotomus laricis</em> (Fabricius)</td>
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<tr>
<td><em>Cryptophagus abietis</em> (Ratzeburg)</td>
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<td><em>Polygraphus grandelava</em> Thomson</td>
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<td><em>Ornithotomus nutans</em> (Gyllenhal)</td>
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<td>Eurosiberic</td>
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1. S E Alps (original data), reclining form.
5. Engadine (Pfeffer, 1976), erected form.
7. Swiss Jura (Basset, 1985 and 1986), erected form.

also in former ages, caused the differentiation of an exclusive fauna, now limited to small areas in the European mountains. With reference to this, Masutti (1977) suggests the hypothesis that the large pleistocene diffusion of *P. mugo* allowed the diffusion even to considerable distances of bark beetles, which were linked to different Alpine and Apennine high altitude conifers.

Thus, as far as bark beetles are concerned, at present *P. mugo* seems to offer the only chance of colonization for the species living at high altitudes in the S E Alps, where arboreal forms of hypsophylous pines are notoriously absent.
ACKNOWLEDGEMENT

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