

# 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: *Tomicus piniperda* (Linnaeus), holopalaearctic; *Polygraphus grandiclava* (Thomson), N cen Europe; *Dryocoetes autographus* (Ratzeburg), Eurosibiric; *D. hectographus* Reitter, Eurosibiric; *Pityophthorus glabratus* (Eichhoff), cen Europe; *Pityophthorus henscheli* (Seitner), E cen Europe; *Pityophthorus pityographus* (Ratzeburg), Euroturanian; *Pityogenes bidentatus* (Herbst), Eurosibiric; *P. bistridentatus* (Eichhoff), S cen Europe; *P. chalcographus* (Linnaeus), Eurosibiric; *P. conjunctus* Reitter, S cen Europe; *Orthotomicus laricis* (Fabricius), holopalaearctic.

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 peuce* 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 North-eastern 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* Auct. 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* Tubeuf - Eastern Alps, Balkans, Apennines; subsp. *arborea* Tubeuf - 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*<sup>(1)</sup>

##### *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 holopalaearctic distribution, lives on various conifers of the genus *Pinus*. Lekander et al. (1977) consider it occasional on *P. mugo*.

##### *Polygraphus grandiclava* 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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(<sup>1</sup>) 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 Tredl (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* (Ratzeburg)

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 hectographus* 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 hectographus* 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)

Holopaleartic 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 bistridentatus* (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 beetle on *P. mugo*, as observed by Cecconi (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 Eurosibirc 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 glabratus* 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. glabratus* 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* Seitner

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 Cimosiana, m 1000, 33TUM 054377, 03.11.85; 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, Passo di Malera, m 1605, 32TPR 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.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, Passo di Malera, m 1605, 32TPR 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: holopalaearctic species (*Tomicus piniperda*, *Orthotomicus laricis*), N European and eurosibiric species (*Polygraphus grandiclava*, *Dryocoetes autographus*, *D. hectographus*, *Pityogenes bidentatus*, *P. chalcographus*), E cen European species (*Pityogenes bistridentatus*, *P. conjunctus*, *Pityophthorus henscheli*, *P. glabratus*, *P. pityographus*).

The holopalaearctic elements generally follow the pines in the whole of their ranges. The N European and eurosibiric 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. hectographus*, *Pityogenes chalcographus*) and *Pinus sylvestris* (for *Pityogenes bidentatus*). *Polygraphus grandiclava* 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. henscheli*, 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 euroturanian 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 (Masutti, 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), evidences 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» biocoenosis (Heer's *uliginosa*) of S Bohemia are *Pityophthorus glabratus* 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 grandiclava*, *Ips amitinus*, *Pityogenes conjunctus*), or in E European mountains (*Pityophthorus henscheli*, *P. knoteki*), and are wide-spread at high altitudes also on *Pinus cembra* and on *Pinus peuce* (Pfeffer, 1959; Masutti, 1968; Hellrigl, 1985). Probably the vast diffusion reached by these altitude pines in the last Glacial Period and perhaps

TABLE 1 - Comparison of the bark beetle fauna of *Pinus mugo* Turra in various European regions.

Species	Regions							Distribution
	1	2	3	4	5	6	7	
<i>Pityogenes conjunctus</i> Reitter	x	x	x	x	x			S cen Europe
<i>Pityophthorus henscheli</i> Seitner	x	x	x	x	x			E cen Europe
<i>Hylurgops glabratus</i> (Zetterstedt)			x	x	x			Eurosibiric
<i>Pityophthorus knoteki</i> Reitter			x	x	x			E cen Europe
<i>Pityophthorus pityographus</i> (Ratzeburg)	x	x						Euroturanian
<i>Dryocoetes autographus</i> (Ratzeburg)	x	x						Eurosibiric
<i>Dryocoetes hectographus</i> Reitter	x							Eurosibiric
<i>Orthotomicus laricis</i> (Fabricius)	x							Holopaleartic
<i>Cryphalus abietis</i> (Ratzeburg)		x						Holopaleartic
<i>Polygraphus grandiclava</i> Thomson	x	x	x	x	x	x		N cen Europe
<i>Ips amitinus</i> (Eichhoff)			x	x	x	x		E cen Europe
<i>Pityogenes chalcographus</i> (Linnaeus)	x	x	x			x		Eurosibiric
<i>Hylastes brunneus</i> Erichson			x	x	x	x	x	Eurosibiric
<i>Pityophthorus glabratus</i> Eichhoff	x	x				x	x	cen Europe
<i>Tomicus piniperda</i> (Linnaeus)	x				x	x	x	Holopaleartic
<i>Pityogenes bidentatus</i> (Herbst)	x					x	x	Eurosibiric
<i>Hylastes ater</i> (Paykull)		x			x	x		Eurosibiric
<i>Pityogenes bistridentatus</i> (Eichhoff)	x						x	S cen Europe
<i>Crypturgus pusillus</i> (Gyllenhal)					x	x	x	Holopaleartic
<i>Ips acuminatus</i> (Gyllenhal)						x	x	Eurosibiric
<i>Hylurgops palliatus</i> (Gyllenhal)					x	x	x	Eurosibiric
<i>Hylastes angustatus</i> (Herbst)					x	x		S cen Europe
<i>Hylastes opacus</i> Erichson					x	x		Eurosibiric
<i>Pityogenes quadridens</i> (Hartig)					x	x		N cen Europe
<i>Hylastes attenuatus</i> Erichson					x			Eurosibiric
<i>Tomicus minor</i> (Hartig)						x		Eurosibiric
<i>Crypturgus cinereus</i> (Herbst)						x		Holopaleartic
<i>Crypturgus hispidulus</i> Thomson					x			Eurosibiric
<i>Orthotomicus suturalis</i> (Gyllenhal)						x		Eurosibiric

1. S E Alps (original data), reclining form.
2. N E Alps (Franz, 1974), reclining form.
3. Styria and Engadine (Pfeffer, 1976), reclining form.
4. Carpathian (Pfeffer, 1976), reclining form.
5. Engadine (Pfeffer, 1976), erected form.
6. Bohemia and Moravia (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 pleistocoenic 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.

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## REFERENCES

- BALACHOWSKY A., 1948 - *Sur la presence en France de Dryocoetes hectographus Reitter (Col. Scolytidae)*. - Rev. Path. Vég. Ent. Agr. de France, **27**: 167-172.
- BALACHOWSKY A., 1949 - *Coléoptères Scolytides. Faune de France*, 50. - Lechevalier, Paris, 320 pp.
- BASSET Y., 1985 - *Les peuplements d'arthropodes sur Pinus mugo Turra dans les tourbières du Haut-Jura neuchâtelois*. Bull.Soc.neuchâteloise Sci. Nat., **108**: 63-76.
- BASSET Y., 1986 - *Aspects de la répartition des peuplements d'arthropodes sur le tronc, sous les écorces et le bois mort de Pinus mugo Turra*. - Mitt. Schweiz. Ent. Gesell., **59**: 349-364.
- CECCONI G., 1924 - *Manuale di entomologia forestale*. - Tip. Seminario, Padova, 680 pp.
- FENAROLI L. AND GAMBI G., 1976 - *Alberi-Dendroflora italiana*. - Mus. Trid. Sc. Nat., Trento, 717 pp.
- FRANZ H., 1974 - *Die Nordost-Alpen im Spiegel ihrer Landtierwelt*. Vol IV. Wagner, Innsbruck, 707 pp.
- GALLO S., 1985 - *Saggio sull'entomofauna di Pinus mugo Turra in alta Val Cimoniana (Prealpi Carniche)*. Tesi di laurea in Sc. Forestali, Univ. di Padova, 108 pp.
- GRÜNE S., 1979 - *Handbuch zur Bestimmung der europäischen Borkenkäfer*. - Schaper, Hannover, 182 pp.
- HELLRIGL K., 1985 - *Über Borkenkäfer (Col., Scolytidae) in Zweigen der Zirbe (Pinus cembra) in Südtirol*. - Anz. Schädlingsskde., Pflanzenschutz, Umweltschutz, **58**: 108-110.
- KLEINE R., 1913 - *Die geographische Verbreitung der Ipsiden*. - Ent. Blätt., **9**: 32-38, 240-251.
- KLEINE R., 1935 - *Die Borkenkäfer (Ipsidae) und ihre Standpflanzen. Eine vergleichende Studie*. - Z. ang. Ent., **21**: 123-181, 597-646.
- LA GRECA M., 1964 - *Le categorie corologiche degli elementi faunistici italiani*. - Mem. Soc. Ent. It., **43**: 147-165.
- LEKANDER B., BEJER-PETERSEN B., KANGAS E. AND BAKKE A., 1977 - *The distribution of bark beetles in the Nordic countries*. - Acta Ent. Fenn., **32**: 1-37.
- MARCEY E., 1967 - *Über den Nachweis spontaner Hybriden von Pinus mugo Turra und Pinus sylvestris L. aufgrund Nadelmerkmalen*. - Berichte Schweiz. Bot. Gesell., **77**: 314-361.
- MASUTTI L., 1959 - *Reperti sull'entomofauna del Pinus nigra Arn. var. austriaca Hoess nelle Prealpi Giulie*. - Ann. Acc. It. Sc. For., **8**: 263-308.
- MASUTTI L., 1964 - *Considerazioni preliminari sui Coleotteri Scolitidi della Foresta di Campigna e notizie su alcune specie reperibili lungo la catena appenninica*. - Mem. Soc. Ent. It., **43**: 172-183.
- MASUTTI L., 1965 - *Significato ecologico e biogeografico della presenza di alcuni Coleotteri xilofagi nella Foresta di Campigna (Appennino Tosco-Romagnolo)*. - Arch. Bot. Biog. It., **41**: 1-11.
- MASUTTI L., 1968 - *Coleotteri Scolitidi dei pini d'altitudine in alcuni biotopi delle Alpi e sul Massiccio del M. Pollino*. - Arch. Bot. Biog. It., **44**: 213-223.
- MASUTTI L., 1977 - *Vicissitudini di insetti e di piante nella storia recente delle biocenosi terrestri*. - Monti e Boschi, **28**: 37-44.
- PAGANELLI A., 1984 - *Storia climatico-forestale del Pliocene e del Quaternario*. In A. Aspes (ed.) - *Il Veneto nell'antichità*. Banca Popolare, Verona: 69-94.
- PEEZ VON A. AND KAHLER M., 1977 - *Die Käfer von Südtirol*. - Tir. Landesmus. Ferd., Innsbruck, 525 pp.
- PFEFFER A., 1955 - *Kurovci-Scolytoidea* - Fauna ČSR, Praha, 324 pp.
- PFEFFER A., 1959 - *Corrélation entre les Scolytides (Coléoptères) et les essences nourricières considérée du point de vue géographique*. - The Ontogeny of Insects. Acta symposii de evolutione insectorum. Praha: 344-347.
- PFEFFER A., 1976 - *Insekten als Indikatoren von Veränderungen in der Bestandzusammensetzung der süd-böhmische Moore*. Quaest. Geobiol., **16**: 74-96.
- PIGNATTI S., 1982 - *Flora d'Italia*, Vol. I. - Edagricole, Bologna, 790 pp.
- PORTA A., 1932 - *Fauna Coleopterorum Italica*, Vol. V. - Stab. Tip. Piacentino, Piacenza, 476 pp.
- RATTI E., 1972 - *Studio eco-morfo-biologico su due popolazioni di Pityogenes bistridentatus (Eichhoff) s.l. (Coleoptera, Scolytidae)*. - Tesi di laurea in Sc. Biol., Univ. di Padova, 63 pp.
- REITTER E., 1913 - *Bestimmungs-Tabellen der Borkenkäfer (Scolytidae) aus Europa und angrenzenden Ländern*. - Wien. Ent. Zeit., **32**: 1-116.



- SCHEDL K.E., 1954/55 - *Bestimmungstabellen palaearktischen Borkenkäfer*. VII: Gattung *Polygraphus*. - Mitt. Münch. Ent. Gesell., **44/45**: 3-25.
- SCHEDL K.E., 1962 - *Bestimmungstabellen palaearktischen Borkenkäfer* XI: Gattung *Pityogenes* Bed. - Centralbl. ges. Forstw., **79**: 132-159.
- SCHEDL K.E., 1981 - *Fam. Scolytidae*. In H. Freude, K.W. Harde and G.A. Lohse (eds.) - *Die Käfer Mitteleuropas*, Vol. 10. Goecke & Evers, Krefeld: 34-99.
- SUSMEL L., 1954 - *Le conifere italiane: Pino montano*. - Monti e Boschi, **5**: 535-541.
- TREDL R., 1907 - *Nahrungspflanzen und Verbreitungsgebiete der Borkenkäfer Europas*. Ent. Blätt., **3**: 2-4, 18-22, 37-42, 53-56, 69-72.
- TUTIN T.G., HEYWOOD V.H., BURGESS N.A., VALENTINE D.H., WALTERS S.M. AND WEBB D.A., 1964 - *Flora Europaea*, Vol. 1. Cambridge, 464 pp.
- WOOD S.L., 1978 - *A reclassification of the subfamilies and tribes of Scolytidae (Coleoptera)*. - Ann. Soc. Ent. Fr., **14**: 95-122.
- ZOLLER H., 1981 - *Pinus mugo*. In G. Hegi (ed.) - *Illustrierte Flora von Mitteleuropa*, Vol. I. Parey, Berlin: 98-104.