

GORTANIA - Atti Museo Friul. Storia Nat.	11('89)	189-206	Udine, 30.VI.1990	ISSN: 0391-5859
--	---------	---------	-------------------	-----------------

F. ZANTA, A. BATTISTI

NOTES ON THE DISTRIBUTION AND BIOLOGY  
OF THE ELM BARK BEETLES IN NORTH-EASTERN ITALY  
(COLEOPTERA SCOLYTIDAE)\*

NOTE SULLA DISTRIBUZIONE E SULLA BIOLOGIA  
DEGLI SCOLITIDI DEGLI OLMI NELL'ITALIA NORD-ORIENTALE  
(COLEOPTERA SCOLYTIDAE)

**Abstract** — In North-eastern Italy (Veneto and Friuli-Venezia Giulia) nine species of elm bark beetles, known as vectors of the fungus causing the Dutch elm disease, have been recorded. The life history, distribution and ecological requirements in relation to the host plant and to the Dutch elm disease, are described for the most common species (*Scolytus multistriatus* (MARSHAM), *S. pygmaeus* (FABRICIUS), *S. sulcifrons* REY and *Pteleobius vittatus* (FABRICIUS)). For the other species recorded (*S. scolytus* (FABRICIUS), *S. triarmatus* EGGERS, *S. laevis* CHAPUIS, *S. kirschii* SKALITZKY and *P. kraatzi* EICHHOFF) some facts about distribution and bio-ecology are given. The elm bark beetles seem to be characterized by very different affinities with the main host plant (*Ulmus minor* and *U. glabra*) and the corresponding environments. Moreover, the bark beetle species are well differentiated in their feeding preferences and consequently in the power of transmission of the disease.

**Key words:** Elm bark beetle, Biology, North-eastern Italy.

**Riassunto breve** — Vengono segnalate per l'Italia nord-orientale nove specie di scolitidi dell'olmo, note come vettori del fungo responsabile della grafiosi dell'olmo. Per le specie più comuni (*Scolytus multistriatus* (MARSHAM), *S. pygmaeus* (FABRICIUS), *S. sulcifrons* REY and *Pteleobius vittatus* (FABRICIUS)) sono descritti il ciclo biologico, la distribuzione e le esigenze ecologiche, in relazione alle piante ospiti e alla grafiosi. Per le altre specie osservate (*S. scolytus* (FABRICIUS), *S. triarmatus* EGGERS, *S. laevis* CHAPUIS, *S. kirschii* SKALITZKY e *P. kraatzi* EICHHOFF) sono riportate notizie sulla distribuzione e sulla bio-ecologia. Gli scolitidi degli olmi sembrano essere caratterizzati da diverse affinità nei confronti delle piante ospiti (*Ulmus minor* e *U. glabra*) e dei relativi ambienti. Inoltre, essi sono ben differenziati nelle preferenze alimentari e, di conseguenza, anche nella trasmissione della grafiosi.

**Parole chiave:** Scolitidi dell'olmo, Biologia, Italia nord-orientale.

\* Work supported by M.A.F. grant: "Lotta biologica e lotta integrata per la difesa delle colture agrarie e forestali (L. 752/86)".

## Introduction

The presence and importance of the elm bark beetles belonging to the genus *Scolytus* GEOFFROY and *Pteleobius* BEDEL for the Italian territory was first discussed by CECCONI (1924) while the first record of the Dutch elm disease caused by *Ceratocystis ulmi* (BUISM.) MOREAU was made by SIBILIA (1930).

Afterwards A. & G. GOIDANICH (1934) pointed out the prominent activity of the bark beetles as vectors of the fungus, spreading the fungal spores during the maturation feeding on elm twigs.

The first outbreak of the Dutch elm disease regarded all Italian territories (G. GOIDANICH, 1936); cultivated and natural elms suffered large damages. Subsequently the disease declined until the second outbreak which developed in 1970 and was caused by an aggressive strain of *C. ulmi* (GIBBS & BRASIER, 1973 in GIBBS, 1978). At present the disease is spread all over Italy; in some Northern and Central regions more than 50 per cent of the trees were killed (MITTEMPERGER, 1980).

The analysis of the bark beetle species involved in the transmission of the disease was recently performed by COVASSI & MASUTTI (1980), which also gave directions for the control procedures.

The aim of the present work is the study of the distribution and biology of the elm bark beetles in North-eastern Italy, in relation to their host plants and to the Dutch elm disease.

## Material and methods

The study concerned both highland and lowland territories in North-eastern Italy (Veneto and Friuli-Venezia Giulia).

In this area the Smooth-leaved elm (*Ulmus minor* MILLER) is particularly abundant in the cultivated lands, where it forms small woods and hedgerows together with other broadleaved trees. The elms are frequently felled by the farmers and grazed by cattle, so that they often have a scrub aspect. *U. minor* is also present in a few lowland woods, where it could be a dominant tree and natural regeneration frequently occurs. These woods, accounted for an area of 400 ha, are considered remnants of once extensive natural forests (PAGANELLI, 1984).

The Wych elm (*Ulmus glabra* HUDSON) is diffused sporadically in the moun-

tain broadleaved forests between 400 and 1300 metres and it is rarely used in hedgerows or as shade tree.

The Siberian elm (*Ulmus pumila* LINNAEUS) is a species introduced after the first outbreak of the Dutch elm disease for its resistance to the fungus (PASSAVALLI, 1935). It has been largely used in hedgerows along roads and as shade tree in the gardens.

The researches have been carried out by (1) periodical observations and gathering of logs and barks infested with bark beetles and (2) examination of the material in the laboratory.

The life history of bark beetles has been studied in two sites (Venezia, Cà Noghera; Venezia, Bosco Carpenedo) by observations every 10 days over two years (1986 and 1987).

The determination of the bark beetles was made on the basis of the keys of SCHEDL (1948), BALACHOWSKY (1949), MICHALSKI (1973) and GRÜNE (1979). Furthermore from all *Scolytus* species the male genitalia and the 8th sternal plate of the female were extracted, for the comparison with the descriptions of BUTOVITSCH (1929).

For each finding locality, geographical coordinates according to U.T.M. projection, altitude, date, host plant, are given.

The length of adult bark beetles was measured by adding the pronotal to the elytral length while the width by measuring the maximum pronotal width.

## Results and discussion

Among the 9 species of bark beetles collected, belonging to the genus *Scolytus* GEOFFROY and *Pteleobius* BEDEL, 4 species (*S. multistriatus*, *S. pygmaeus*, *S. sulcifrons* and *P. vittatus*) occurred frequently inside the study area. For these species it was possible to point out the life history and bio-ecology. For the other species (*S. kirschii*, *S. triarmatus*, *S. laevis*, *S. scolytus* and *P. kraatzi*) the information is limited to the data drawn from few records only.

### *Scolytus multistriatus* (MARSHAM)

#### Friuli-Venezia Giulia:

Muzzana del Turgnano UD, Bosco Baredi, 33TUL538727, m 2, 5-06-1986, *U. minor*;

Codroipo UD, Risorgive di Codroipo, 33TUL444893, m 28, 26-08-1986, *U. minor*.

*Veneto:*

Cintocaomaggiore VE, 33TUL284774, m 11, 27-06-1986, *U. minor*;  
 Pramaggiore VE, 33TUL249745, m 11, 27-06-1986, *U. minor*;  
 Lison VE, Bosco del Merlo, 33TUL243685, m 5, 29-08-1987, *U. minor*;  
 Cessalto VE, Bosco Olmè, 33TUL146638, m 5, 29-08-1987, *U. minor*;  
 Cà Noghera VE, 33TTL948455, m 2, 1986-87, *U. minor*;  
 Mestre VE, 33TTL859443, m 3, 1986-87, *U. minor* and *U. pumila*;  
 Mestre VE, Bosco Carpenedo, 33TTL850437, m 4, 1986-87, *U. minor*;  
 Camponogara VE, 33TTL69 31, m 2, 23-04-1986, *U. minor*;  
 Fregona TV, 33TTL74 98, m 300, 15-05-1986, *U. minor*;  
 Revine TV, 33TTL877982, m 270, 23-08-1987, *U. minor*;  
 Treviso, 33TTL867596, m 13, 7-05-1987, *U. minor*;  
 Cornuda TV, Bosco Fagarè, 32TQR306806, m 225, 23-05-1987, *U. minor*;  
 Asolo TV, 32TQR256765, m 154, 22-08-1987, *U. minor*;  
 Monfumo TV, 32TQR267798, m 226, 22-08-1987, *U. minor*;  
 Castelcucco TV, 32TQR246801, m 180, 22-08-1987, *U. minor*;  
 Nervesa della Battaglia TV, 33TTL818784, m 150, 1-03-1987, *U. minor*;  
 Possagno TV, 32TQR229824, m 380, 22-08-1987, *U. minor*;  
 Padova, 32TQR266327, m 12, 1986-87, *U. minor* and *U. pumila*;  
 Legnaro PD, 32TQR328246, m 8, 23-07-1987, *U. minor*;  
 Arquà Petrarca PD, M. Calbarina, 32TQR148172, m 130, 23-06-1987, *U. minor*;  
 Cornedo Vicentino VI, 32TPR832535, m 182, 5-07-1987, *U. minor*;  
 Vicenza, 32TQR027454, m 33, 5-07-1987, *U. minor*;  
 Valdagno VI, 32TPR803559, m 230, 5-07-1987, *U. minor*;  
 Grezzana VR, Costa Grande, 32TPR553423, m 470, 20-02-1989, *U. minor*;  
 Tregnago VR, S. Anna, 32TPR708426, m 410, 27-07-1986, *U. minor*.

Size of adults - length: ♂ 2.61 ± 0.21, n. 18; ♀ 2.73 ± 0.25, n. 13;  
 width: ♂ 1.20 ± 0.1, n. 18; ♀ 1.21 ± 0.08, n. 13.

*S. multistriatus* is a typical species of the bark beetle complex living on elms in Europe (BALACHOWSKY, 1949; MICHALSKI, 1973; PFEFFER, 1979) but it is present in North America, imported from Europe at the beginning of this century (CHAPMAN, 1910 in OWEN & LOWNSBERY, 1989), and in Australia also (ROSEL & FRENCH, 1974 in NEUMANN & MINKO, 1985).

In Italy *S. multistriatus* has been known since the last century and it is widely diffused (HALBHERR, 1896; BERTOLINI, 1899; LEONARDI, 1923; CECCONI, 1924; RAGUSA, 1924; BOSELLI, 1928; LUIGIONI, 1929; PORTA, 1932; DELLA BEFFA, 1949; MASUTTI, 1964; PEEZ & KAHLEN, 1977; COVASSI & MASUTTI, 1980; ANGELINI & MONTEMURRO, 1984; RATTI, 1984).

In North-eastern Italy, *S. multistriatus* follows the main host plant (*U. minor*) all over its range. It has also been observed on other elm species, as *U. pumila* and *U. glabra* whereas the occurrence of *S. multistriatus* on *U. glabra* is only recorded in sites where *U. minor* is present. *S. multistriatus* was also observed on *Prunus avium* L. during an outbreak at Cà Noghera (VE). The age of the preferred trees varies from 15 to 30 years but *S. multistriatus* can successfully colonize younger or older trees especially during outbreaks. *S. multistriatus* colonizes the trunk, branches and even uncovered roots, with bark thickness of 2.7-15.2 mm (av. 7.82, s.e. 3.82, n. 20).

*S. multistriatus* produces two generations per year and overwinters as larva. The oviposition occurs in May-July and July-September respectively; so, the same tree may be colonized simultaneously by both generations of *S. multistriatus*.

The maternal gallery, single-armed and longitudinal, runs mainly in the phloem. Its length varies from 1.8 to 6.5 cm (av. 3.2, s.e. 1.2, n. 98). The number of egg niches, counted after the egg hatching, is 23.1 per cm of maternal gallery on average (s.e. 4.8, n. 70). Usually the female dies in the maternal gallery after the oviposition. Eggs hatch 6-8 days after being laid and the larvae become mature in 25-30 days through 5 instars. The average length of the larval galleries is 4.06 cm (s.e. 0.83, n. 70). The pupal stage lasts 12-14 days and the pupal cell is partially cut in the sapwood. The adult remains for a short period in the pupal cell. The diameter of adult emergence hole is 15-20 mm. The maturation feeding takes place at the base of 3-4-year-old twigs of healthy trees. Usually the duration of the maturation is 15-17 days.

*Scolytus pygmaeus* (FABRICIUS)

*Friuli-Venezia Giulia:*

Muzzana del Turgnano UD, Bosco Baredi, 33TUL538727, m 2, 5-06-1986, *U. minor*.

*Veneto:*

Pramaggiore VE, 33TUL249745, m 11, 27-06-1986, *U. minor*;

Cintocaomaggiore VE, 33TUL284774, m 11, 27-06-1986, *U. minor*;  
 Lison VE, Bosco del Merlo, 33TUL243685, m 5, 29-08-1987, *U. minor*;  
 Cessalto VE, Bosco Olmè, 33TUL146638, m 5, 29-08-1987, *U. minor*;  
 Cà Noghera VE, 33TTL948455, m 2, 1986-87, *U. minor*;  
 Mestre VE, 33TTL859443, m 3, 1986-87, *U. pumila* and *U. minor*;  
 Mestre VE, Bosco Carpenedo, 33TTL850437, m 4, 1986-87, *U. minor*;  
 Camponogara VE, 33TTL69 31, m 2, 23-04-1986, *U. minor*;  
 Fratta TV, 33TTL853957, m 259, 23-08-1987, *U. pumila*;  
 Cornuda TV, Bosco Fagarè, 32TQR306806, m 225, 23-05-1987, *U. minor*;  
 Castalcucco TV, 32TQR246801, m 180, 22-08-1987, *U. minor*;  
 Possagno TV, 32TQR229824, m 380, 22-08-1987, *U. minor*;  
 Treviso, 33TTL867596, m 13, 7-05-1987, *U. minor*;  
 Padova, 32TQR266327, m 12, 1986-87, *U. pumila* and *U. minor*;  
 Legnaro PD, 32TQR328246, m 8, 23-07-1987, *U. minor*;  
 Arquà Petrarca PD, M. Calbarina, 32TQR148172, m 130, 23-06-1987, *U. minor*;  
 Teolo PD, 32TQR094253, m 180, 23-06-1987, *U. minor*;  
 Valdagno VI, 32TPR803559, m 875, 5-07-1987, *U. glabra* and *U. minor*;  
 Fongara VI, 32TPR738609, m 875, 5-07-1987, *U. glabra*;  
 Tregnago VR, 32TPR694422, m 305, 27-07-1986, *U. minor*.

Size of adults - length: ♂ 1.92 ± 0.16, n. 8; ♀ 1.76 ± 0.26, n. 14;  
 width: ♂ 0.98 ± 0.08, n. 8; ♀ 0.88 ± 0.12, n. 14.

It is the smallest *Scolytus* species living on elms in South, Central and Eastern Europe (ESCHERICH, 1923; BALACHOWSKY, 1949; MICHALSKI, 1973; PFEFFER, 1979) and it is diffused widely in Italy (DISCONZI, 1865; BERTOLINI, 1899; LEONARDI, 1923; RAGUSA, 1924; BOSELLINI, 1928; LUIGIONI, 1929; MASUTTI, 1964; PEEZ & KAHLEN, 1977; ANGELINI & MONTEMURRO, 1984; RATTI, 1984).

In North-eastern Italy *S. pygmaeus* is linked to *U. minor* but it is recorded by authors also on *U. glabra* and *U. pumila* and occasionally on *Carpinus betulus* L.

*S. pygmaeus* colonizes young plants of the minimum age of 6 years and of the minimum diameter of 0.7 cm. The bark thickness suitable for the colonization varies from 0.7 to 3.9 mm (av. 2.38, s.e. 0.91, n. 20).

The life cycle of *S. pygmaeus* is very like to that of *S. multistriatus*: it produces two generations per year and overwinters as larva. The maternal gallery, single-armed

and longitudinal, runs through the phloem slightly grooving the xylem. In lower density conditions the maternal gallery may be of a two branched-longitudinal type. Usually, the maternal gallery is characterized by the presence of a nuptial chamber; if this is not present, the gallery has been constructed by a mated female. The length of maternal gallery usually varies from 0.6 to 4.2 cm (av. 1.9, s.e. 0.6, n. 60). The egg niches, counted after egg hatching, are in average 25.5 per cm of maternal gallery (s.e. 3.8, n. 60). The adults emerge through holes from 1 to 1.5 mm of diameter. The maturation feeding takes place at the base of 2-3-year-old twigs of the healthy trees but during the outbreaks it can occur on seedlings or on young stool shoots, and even at the insertion point of the leaf on the twig.

#### *Scolytus kirschii* SKALITZKY

##### Veneto:

Tregnago VR, 32TPR694422, m 305, 27-07-1986, *U. pumila*.

Size of adults - length: ♂ 2.06 ± 0.22, n. 8;  
 width: ♂ 0.98 ± 0.13, n. 8.

With regard to this species, some authors have distinguished two subspecies: *S. k. kirschii* SKALITZKY and *S. k. fasciatus* REITTER (BUTOVITSCH, 1929; MICHALSKI, 1973; PFEFFER, 1979). The former would be present in Southern Europe, Algeria and URSS (Ucraina, Southern URSS), the latter in URSS (Caucasus, Turkestan, Central Asia) (PFEFFER, 1979). Recently HALPERIN (1986) found "a geographical variant" of *S. kirschii* also in Israel.

In North-eastern Italy, *S. kirschii* is sporadic; the few specimens recorded belong to *S. k. kirschii* according to BUTOVITSCH (1929), as those found on *U. minor* by the authors in three sites of Central Italy (Assisi PG, Bosco PG and Scafa PE, on *U. minor*). This bark beetle seems to be more frequent in South-Central Italy, as confirmed by the findings of other authors (RAGUSA, 1924; COVASSI, 1980; ANGELINI & MONTEMURRO, 1984).

The records collected by the authors and those found in the literature (PFEFFER, 1979; COVASSI, 1980) allow us to assume that *S. kirschii* performs two generations per year in Italy.



*Scolytus sulcifrons* REY*Friuli-Venezia Giulia:*

Muzzana del Turgnano UD, Bosco Baredi, 33TUL538727, m 2, 5-07-1986, *U. minor*.

*Veneto:*

Cà Noghera VE, 33TTL948455, m 2, 1986-87, *U. minor*;

Lison VE, Bosco del Merlo, 33TUL243685, m 5, 29-08-1987, *U. minor*;

Mestre VE, 33TTL859443, m 3, 1986-87, *U. minor*;

Revine TV, 33TTL877982, m 270, 23-08-1987, *U. minor*;

Nervesa della Battaglia TV, 33TTL818784, m 150, 5-12-1989, *U. minor*;

Legnaro PD, 32TQR328246, m 8, 23-07-1987, *U. minor*;

Arquà Petrarca PD, M. Calbarina, 32TQR148172, m 170, 23-06-1987, *U. minor*;

Tregnago VR, S. Anna, 32TPR708426, m 410, 27-07-1986, *U. minor*;

Grezzana VR, Costa Grande, 32TPR553423, m 470, 20-02-1989, *U. minor*.

Size of adults - length: ♂  $4.15 \pm 0.69$ , n. 5; ♀  $4.57 \pm 0.35$ , n. 12;

width: ♂  $2.07 \pm 0.29$ , n. 5; ♀  $2.23 \pm 0.22$ , n. 12.

*S. sulcifrons* is diffused in Southern France, Italy, Spain, Bulgaria, Yugoslavia, Greece and Southern URSS (BALACHOWSKY, 1949; MICHALSKI, 1973; PFEFFER, 1979).

It is very similar to *S. scolytus* so that some authors consider it as belonging to the same species (SCHEDL, 1948; POSTNER, 1974); however, other authors (BUTOVITSCH, 1929; BALACHOWSKY, 1949; MICHALSKI, 1973) found several internal and external features which allow the distinction of the two species.

In Italy *S. sulcifrons* is very frequent (DISCONZI, 1865; BOSELLI, 1928; LUIGIONI, 1929; A. & G. GOIDANICH, 1934). In North-eastern Italy it has been observed exclusively on *U. minor*. *S. sulcifrons* develops on adult trees with bark thickness of 7.6-20.0 mm (av. 13.4, s.e. 3.42, n. 21).

In North-eastern Italy *S. sulcifrons* produces two generations per year overwintering as larva.

The oviposition occurs in May-July and August-September. The maternal gallery is of the single-armed longitudinal type and grooves the xylem slightly. Generally, after the oviposition, the female dies in the maternal gallery. In some cases (above all during the outbreaks) the female can go out through a new hole and may colonize other trees. The length of the maternal gallery varies from 1.2 to 7.5 cm (av. 4.2,

s.e. 1.6, n. 50). The shorter galleries are generally due to females which go out to colonize other sites. The number of the egg niches, counted after the egg hatching, is on average 13.1 per cm of the maternal gallery (s.e. 3.71, n. 40). Eggs hatch about 10 days after being laid and the larvae become mature in 28-30 days through 5 instars. The length of the larval galleries varies from 6.3 to 11.2 cm (av. 9.5, s.e. 1.3, n. 40). The larvae often overwinter inside the sapwood and here they pupate in spring. The pupal stage lasts 12-15 days. The teneral adults remain some days in the pupal cell. They emerge through holes from 2.6 to 3 mm of diameter. The adult feeds at the base of 4-6-year-old twigs making deep wounds. The duration of the maturation feeding is generally of 17-18 days.

*Scolytus scolytus* (FABRICIUS)*Veneto:*

Cornuda TV, Bosco Fagarè, 32TQR306806, m 225, 20-03-1986, *U. minor*.

Size of adults - length: ♀  $4.31 \pm 0.36$ , n. 4;

width: ♀  $2.12 \pm 0.19$ , n. 4.

*S. scolytus* is a typical bark beetle of Central Europe, England, Bulgaria and URSS (PFEFFER, 1979). The Italian distribution is unknown because in the past *S. scolytus* was confused with *S. sulcifrons* (CECCONI, 1924; PORTA, 1932). It is recorded by PEEZ & KAHLEN (1977) for Southern Tyrol.

In North-eastern Italy *S. scolytus* has been found on *U. minor* only in one site. The finding consisted only of 4 dead females in their galleries, so that it was not possible to study the life cycle of this beetle. According to the observations made in North-Central Europe by various authors (BEAVER, 1967; KIRBY & FAIRHURST, 1983), *S. scolytus* could produce two generations a year.

The presence of *S. scolytus* in North-eastern Italy seems to be sporadic and restricted to the highlands forests of broadleaved trees where *U. minor* is at times present.

*Scolytus triarmatus* EGGERS*Friuli-Venezia Giulia:*

Tarvisio UD, Coccau, 33TUM947536, m 710, 27-07-1987, *U. glabra*.

Size of adults - length: ♂  $4.58 \pm 0.05$ , n. 2; ♀  $4.52 \pm 0.20$ , n. 4;  
width: ♂  $2.11 \pm 0.05$ , n. 2; ♀  $2.17 \pm 0.07$ , n. 4.

This species was described by EGGERS (1912) using one female probably coming from Southern France. Afterwards it was recorded only in Scandinavia (BUTOVITSCH, 1929; BALACHOWSKY, 1949; LEKANDER et al., 1977; PFEFFER, 1979; ANDERBRANT & SCHLYTER, 1987) so that our record is to be considered the first record in Italy. SCHEDL (1948) and MICHALSKI (1973) consider it as synonym of *S. scolytus*.

PFEFFER (1979) considers *S. triarmatus* as monophagous on *U. glabra*, where it shows a clear preference for the adult trees with thick bark. Our findings agree with the observations of this author.

In the study site *S. triarmatus* produces two generations per year while in North Europe it produces one generation only (LEKANDER et al., 1977), probably because of the severe climate. *S. triarmatus* is to be included in the group of insect species with North-Central European distribution which find a suitable environment in the South-eastern Alps (MASUTTI, 1989), reaching here the Southern limit of their range.

#### *Scolytus laevis* CHAPUIS

##### *Friuli-Venezia Giulia:*

Tarvisio UD, 33TUM915512, m 750, 14-07-1983, *U. glabra* (leg. F. Stergulc);  
Malborghetto UD, 33TUM784563, m 1080, 24-07-1983, *U. glabra* (leg. F. Stergulc);  
Tarvisio UD, Coccau, 33TUM947536, m 710, 27-07-1987, *U. glabra*.

Size of adults - length: ♂  $3.46 \pm 0.79$ , n. 2; ♀  $3.72 \pm 0.25$ , n. 12;  
width: ♂  $1.7 \pm 0.36$ , n. 2; ♀  $1.78 \pm 0.14$ , n. 12.

It is considered a species of Central, Northern and Eastern Europe (ESCHERICH, 1923; MICHALSKI, 1973; LEKANDER et al., 1977; PFEFFER, 1979). In Italy *S. laevis* was already recorded by MASUTTI (1965) for the Northern Apennines and by PEEZ & KAHLEN (1977) for Southern Tyrol. There is also an old record of LUIGIONI (1929) for Liburnia, which is now a Yugoslav territory. Moreover, the authors found it on *U. glabra* in two sites of Central Italy (Badia Prataglia AR, leg. Senni and Crognaleto TE).

In North-eastern Italy *S. laevis* lives on *U. glabra* colonizing the young and middle-age trees while the older trees are attacked by *S. triarmatus*. According to PFEFFER (1979), this species seems to be strictly related to *U. glabra*.

In Italy *S. laevis* can perform two generations per year while in the North-european regions it produces one generation only (PFEFFER, 1979).

#### *Pteleobius vittatus* (FABRICIUS)

##### *Friuli-Venezia Giulia:*

Muzzana del Turgnano UD, Bosco Baredi, 33TUL538727, m 2, 5-06-1986, *U. minor*.

##### *Veneto:*

Lison VE, Bosco del Merlo, 33TUL243685, m 5, 29-08-1987, *U. minor*;  
Cessalto VE, Bosco Olmè, 33TUL146638, m 5, 29-08-1987, *U. minor*;  
Favaro Veneto VE, 33TTL883452, m 3, 1986-87, *U. minor*;  
Mestre VE, Bosco Carpenedo, 33TTL850437, m 4, 1986-87, *U. minor*;  
Camponogara VE, 33TTL69 31, m 2, 23-04-1986, *U. minor*;  
Padova, 32TQR266327, m 12, 1986-87, *U. minor*;  
Arquà Petrarca PD, M. Calbarina, 32TQR148172, m 130, 23-06-1986, *U. minor*;  
Nervesa della Battaglia TV, 33TTL818784, m 150, 15-08-1986, *U. minor*;  
Asolo TV, 32TQR256765, m 154, 2-03-1987, *U. minor*.

Size of adults - length: ♂ ♀  $1.95 \pm 0.15$ , n. 15;  
width: ♂ ♀  $0.89 \pm 0.06$ , n. 15.

Species living on elms in Central, Southern and Eastern Europe (BALACHOWSKY, 1949; POSTNER, 1974; PFEFFER, 1979); it is widespread in Italy (BERTOLINI, 1894; LEONARDI, 1922; RAGUSA, 1924; BOSELLI, 1928; LUIGIONI, 1929; PEEZ & KAHLEN, 1977).

*U. minor* seems to be the only host plant of *P. vittatus* in North-eastern Italy, where it produces one generation per year.

The eggs are laid in the second half of May. The maternal gallery, two-branched and transversal, runs in the phloem and grooves the xylem slightly. *P. vittatus* is monogamous. The length of the maternal gallery varies from 2.2 to 4.5 cm (a.v. 3.04, s.e. 0.54, n. 30). The eggs hatch at the beginning of July. The length of the larval

galleries, perpendicular to the maternal ones, is usually 1.2 cm (s.e. 0.5, n. 30). If the intraspecific competition is low, they can measure up to 3 cm. Towards the end of July the majority of larvae pupate; the remaining larvae overwinter. In August, the teneral adults feed in the phloem enlarging the pupal cells. Most of adults emerge after 10-15 days; other adults remain in the pupal cells and overwinter. The emerged adults overwinter in short galleries excavated on the rougher bark of the trunk of healthy elms. The length of these galleries varies from 0.5 to 1 cm. In April the overwintering larvae pupate and the adults originating from them emerge and reach healthy trees for the maturation feeding (short galleries in the bark). At the same time the overwintering adults emerge from the bark and immediately mate.

*P. vittatus* usually attacks young elms with thin bark or secondary branches from 2.5 cm diameter. However, *P. vittatus* can also colonize adult plants together with *S. multistriatus* and *S. sulcifrons*.

#### *Pteleobius kraatzii* EICHHOFF

##### Friuli-Venezia Giulia:

Muzzana del Turignano UD, Bosco Baredi, 33TUL538727, m 2, 22-03-1987, *U. minor*.

##### Veneto:

Favaro Veneto VE, 33TTL883452, m 3, 11-05-1986, *U. minor*;

Fregona TV, 33TTL74 98, m 300, 15-05-1986, *U. minor*;

Nervesa della Battaglia TV, 33TTL818784, m 150, 12-12-1987, *U. minor*.

Size of adults - length: ♂ ♀  $1.83 \pm 0.11$ , n. 10;

width: ♂ ♀  $0.8 \pm 0.05$ , n. 10.

It has the same distribution of *P. vittatus* and in Italy it is widely diffused (LEONARDI, 1923; CECCONI, 1924; BOSELLI, 1928; LUIGIONI, 1929; A. GOIDANICH, 1945-46). The species is linked to the genus *Ulmus* and was occasionally recorded on *Sorbus aucuparia* L. (BALACHOWSKY, 1949; POSTNER, 1974).

Because *P. kraatzii* was sporadic in the study sites, we are not able to supply useful data about its biology. According to POSTNER (1974), it seems likely that also *P. kraatzii* produces one generation per year only.

## Conclusion

The bark beetle species living on elms in North-eastern Italy are characterized by very different affinities with the elm species and the corresponding environments.

*S. triarmatus*, probably the only monophagous species (PFEFFER, 1979), seems to be present only on very large trees of *U. glabra* growing in the cold climate of the Alps. However, *U. glabra* is spread all over Italy in the highland broadleaved woods where the most common bark beetle is *S. laevis*.

On the other hand *S. sulcifrons* is a typical bark beetle of *U. minor*, well-known for many years for its importance in spreading the Dutch elm disease in Italy (A. & G. GOIDANICH, 1934). The finding of *S. scolytus* on *U. minor* in North-eastern Italy could not be ascribed to an hypothetical vicariance with *S. sulcifrons*, because the two species live in the same environment. In this region there is probably an overlapping of the distribution areas, being *S. scolytus* more northern and *S. sulcifrons* more southern concerning spread.

The small bark beetles *S. multistriatus* and *S. pygmaeus* are the most abundant species, living on both natural and introduced elms with the only exception of the colder sites of the Alps. Even if the two species have a very similar life history, their niche is well differentiated (see further on).

The finding of *S. kirschii*, a small bark beetle with a niche similar to that of *S. pygmaeus*, enlarges the distribution of this southern species (COVASSI, 1980) to Northern Italy. The collected specimens could be connected to the subspecies *S. k. kirschii* but further work is necessary to clarify this aspect.

The bark beetles of the genus *Pteleobius* were found only on *U. minor* in the lowland woods. In two sites both species were found but the few records of *P. kraatzii* do not allow to define the differences in ecological requirements with the more abundant *P. vittatus*.

Among all species of elm bark beetles recorded in Italy, only *S. ensifer* (EICHHOFF), known for Central and Southern Italy (PORTA, 1932; ANGELINI & MONTEMURRO, 1984), was not found in the study area.

With regard to the transmission of the Dutch elm disease, some considerations can be made in relation to the distribution and bio-ecology of the recorded species.

The species of the genus *Pteleobius* are in general less active than *Scolytus* species as vectors of the fungus due to the absence of maturation feeding on twigs and because they produced only one generation per year. Since their maturation feeding occurs



in the outer bark, however, in the case of young trees with thin bark the adults can easily reach the xylem and transmit fungal spores.

The *Scolytus* species are well differentiated in their feeding preferences and consequently in the transmission of the disease. In general, a direct relationship can be assumed among the size of the adult bark beetle, the size (age) of the twig suitable for maturation feeding and the thickness of the bark for brooding. Consequently, a niche overlapping among the *Scolytus* species involved is likely to occur. Our data clearly prove that such overlapping does exist between *S. pygmaeus* and *S. multistriatus* and between *S. multistriatus* and *S. sulcifrons*, but not between *S. pygmaeus* and *S. sulcifrons*.

At the beginning of the outbreak of the Dutch elm disease the most abundant *Scolytus* species was *S. sulcifrons* because of the large presence of adult elms, while *S. multistriatus* and *S. pygmaeus* colonized the branches (A. & G. GOIDANICH, 1934). Successively, the shoots sprouted from the rootstocks of the attacked trees and the natural regeneration provided an unsuitable site of development for the larger bark beetle species so that the smaller ones could take over. Therefore, at present it can be observed that shoots and seedlings can also be killed by the disease transmitted by the small bark beetles with maturation feeding. If they are not, the elms can survive up to the achievement of the size necessary for brooding of *S. pygmaeus* or *S. multistriatus*, usually reached at the age of 6-10 years in the case of *U. minor*. Consequently in the lowland woods and in the hedgerows *S. sulcifrons* has almost disappeared and *U. minor* is reduced to an undergrowth or scrub population by the activity of *S. pygmaeus* and *S. multistriatus*.

In the highland woods the typical scattered distribution of *U. glabra* has allowed a slackening of the disease diffusion: the mixed woods do not favour the colonization of the bark beetles and do not allow the infections through root grafts between diseased and healthy trees. This type of disease transmission causes much damage in hedgerows where the roots of neighbouring elms are grafted together (MITTEMPERGER, 1980).

*U. pumila* was introduced in Italy as a shade tree for its resistance to Dutch elm disease: *S. pygmaeus*, *S. multistriatus* and *S. kirschii* can reach the twigs of this elm during the maturation feeding but evidently the fungal spores rarely develop. Nevertheless, these species were frequently recorded colonizing Siberian elms, above all those weakened by phytophagous insects or broken by wind.

A high number of species of bark beetle is linked to the elm, all susceptible

of being vectors of *C. ulmi*: this is the key factor in the spreading of the Dutch elm disease. This is due to each species having peculiar bio-ecological requirements and can colonize the elms in very different ways. This fact, as well as their capability to adapt both to native and introduced elm species, increases the difficulties of applying any approach to control.

*Manoscritto pervenuto il 6.III.1990.*

#### Acknowledgements

We thank prof. L. Masutti for useful suggestions and for critical reading of the manuscript. We thank also dr. O. Anderbrant and dr. F. Schlyter of the Dep. Animal Ecology of Lund-Sweden for confirming the determination of *S. triarmatus*.

**RIASSUNTO** — Lo studio riguarda alcuni coleotteri scolitidi appartenenti ai generi *Scolytus* GEOFFROY e *Pteleobius* BEDEL, vettori delle spore del fungo *Ceratocystis ulmi* (BUISM.) MOREAU, agente della malattia denominata grafiosi dell'olmo.

Nell'Italia nord-orientale (Veneto e Friuli-Venezia Giulia) si sono riscontrate 9 specie di scolitidi legati al genere *Ulmus* Linnaeus. Per le specie più diffuse, *S. multistriatus* (MARSHAM), *S. pygmaeus* (FABRICIUS), *S. sulcifrons* REY e *P. vittatus* (FABRICIUS), sono descritte la distribuzione, il ciclo biologico e le esigenze ecologiche in relazione alla pianta ospite e alla trasmissione del fungo. Gli *Scolytus* più piccoli, *S. multistriatus* e *S. pygmaeus*, sono stati osservati sia sugli olmi autoctoni (*U. minor* MILLER e *U. glabra* HUDSON) sia sull'olmo siberiano (*U. pumila* LINNAEUS): il primo colonizza piante di dimensioni medie (corteccie con spessore tra 2.7 e 15.2 mm), il secondo quelle di dimensioni inferiori (corteccie con spessore tra 0.7 e 3.9 mm). Il grande *S. sulcifrons* è stato osservato esclusivamente su esemplari adulti di *U. minor* (corteccie con spessore tra 7.6 e 20.0 mm). Pertanto, pur svolgendo un ciclo biologico simile (2 generazioni all'anno con svernamento allo stadio di larva), le tre specie presentano nicchie ecologiche ben differenziate tra loro e tali da rendere gli olmi suscettibili di attacco in ogni fase della loro vita.

*P. vittatus*, osservato esclusivamente su *U. minor*, presenta un ruolo secondario rispetto agli *Scolytus* sia perchè appare meno efficiente nella trasmissione della malattia sia perchè svolge un'unica generazione annuale.

Le altre specie riscontrate nell'area di studio sono state rinvenute su *U. glabra* (*S. triarmatus* EGGERS e *S. laevis* CHAPUIS), su *U. minor* (*S. scolytus* (FABRICIUS) e *P. kraatzii* EICHHOFF) e su *U. pumila* (*S. kirschii* SKALITZKY). In generale queste specie appaiono poco diffuse, per cui le notizie a loro riguardo si limitano ad alcuni dati su distribuzione e bio-ecologia. Il ritrovamento di *S. triarmatus* ha un particolare rilievo biogeografico, considerato che la specie era nota finora solo per la Scandinavia.

L'elevato numero di scolitidi legati al genere *Ulmus*, caratterizzati da diverse esigenze bio-ecologiche e tutti possibili vettori di *C. ulmi*, rappresenta il fattore chiave nella diffusione della grafiosi e rende di problematica attuazione ogni iniziativa di controllo.



## References

- ANDERBRANT O. & SCHLYTER F., 1987 - Differences in morphology and sexual size dimorphism between the Dutch elm disease vectors *Scolytus laevis* and *Scolytus scolytus* (Col., Scolytidae). *J. Appl. Ent.*, 103: 378-386.
- ANGELINI F. & MONTEMURRO F., 1984 - Coleotterofauna del bosco di Policoro (Matera) (Coleoptera). *Lav. Soc. It. Biogeogr.*, 10: 545-604.
- BALACHOWSKY A., 1949 - Faune de France 50, Scolytides. Paris.
- BARTEL J.M. & LANIER G.N., 1974 - Emergence and mating in *Scolytus multistriatus* (Coleoptera, Scolytidae). *Ann. Ent. Soc. America*, 67: 365-370. (R.A.E. (A), 1975, 63: 3256).
- BEAVER R.A., 1967 - Notes on the biology of the bark beetles attacking elm in Wytham Wood, Berks. *Entomologist's Mon. Mag.*, 102: 156-162.
- BERTOLINI S., 1899 - Catalogo dei Coleotteri d'Italia. *Riv. It. Sci. Nat.*, Siena.
- BOSELLI F., 1928 - Elenco delle specie d'insetti dannosi e loro parassiti ricordati in Italia dal 1911 al 1925. *Lab. Ent. Agr.*, Portici.
- BUTOVITSCH V., 1929 - Studien über die Morphologie und Systematik der paläarktischen Splintkäfer. *Stett. Ent. Ztg.*, 90: 1-72.
- CECCONI G., 1924 - Manuale di Entomologia forestale. *Tip. Seminario*, Padova.
- COVASSI M., 1980 - Sulla presenza dello *Scolytus kirschi* SKAL. su *Ulmus carpinifolia* GLED. in Toscana (Coleoptera, Scolytidae). *Redia*, 63: 177-184.
- COVASSI M. & MASUTTI L., 1980 - Generalità sull'Entomofauna degli olmi, con particolare riguardo ai Coleotteri Scolitidi vettori della grafiosi. *Inf.tore Fitopatol.*, 30 (1): 19-26.
- DELLA BEFFA G., 1949 - Gli insetti dannosi all'agricoltura e i moderni mezzi e metodi di lotta. *Hoepli*, Milano.
- DISCONZI F., 1865 - Entomologia Vicentina. *Randi*, Padova.
- EGGERS H., 1912 - Beiträge zur Kenntnis der Borkenkäfer. *Ent. Blätter*, 8: 203-211.
- ESCHERICH K., 1923 - Die Forstinsekten Mitteleuropas. II Band. *Parey*, Berlin.
- GIBBS J.N., 1978 - Intercontinental epidemiology of Dutch elm disease. *Ann. Rev. Phytopathol.*, 16: 287-307.
- GOIDANICH A., 1945-1946 - Le gallerie di moltiplicazione del *Pteleobius kraatzi* Eichhoff (Coleoptera Scolytidae). *Ann. Acc. Agric.*, 88: 99-105.
- GOIDANICH A. & G., 1934 - Lo *Scolytus sulcifrons* REY (Coleoptera Scolytidae) nella diffusione del Pirenomicete *Ceratostomella (Graphium) ulmi* (SCHWARZ) BUISM. nell'Emilia. *Boll. Lab. Ent. Bologna*, 7: 145-163.
- GOIDANICH G., 1936 - La "moria dell'olmo" (*Graphium ulmi*). *Reda*, Roma.
- GRÜNE S., 1979 - Handbuch zur Bestimmung der europäischen Borkenkäfer. *Schaper*, Hannover.
- HALBHERR B., 1896 - Elenco sistematico dei Coleotteri finora raccolti nella Valle Lagarina. Fasc. 9, Rovereto.
- KIRBY S.G. & FAIRHURST C.P., 1983 - The ecology of elm bark beetles in northern Britain. *For. Comm. Bull.*, 60: 29-39.
- LEKANDER B., BEJER-PETERSEN B., KANGAS E. & BAKKE A., 1977 - The distribution of bark beetles in the Nordic countries. *Acta Ent. Fenn.*, 32: 1-37.
- LEONARDI G., 1923 - Elenco delle specie d'insetti dannosi e loro parassiti ricordati in Italia fino all'anno 1911. Parte II. *Ann. R. Sc. Sup. Agr.*, Portici.
- LUIGIONI P., 1929 - I Coleotteri d'Italia. *Mem. Pont. Acc. Sci.*, Roma.
- 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 biologico e biogeografico della presenza di alcuni coleotteri xilofagi nella Foresta di Campigna (Appennino Tosco-Romagnolo). *Arch. Bot. Biog. It.*, 41: 1-11.
- MASUTTI L., 1989 - Biogeographical remarks on sawflies (Hymenoptera Symphyta) of the South-Eastern Alps. *Biogeographia*, 13: 755-761.
- MICHALSKI J., 1973 - Revision of the Palearctic species of the genus *Scolytus* Geoffroy (Col., Scolytidae). *PWN*, Warszawa.
- MITTEMPERGER L., 1980 - La grafiosi dell'olmo. Situazione attuale in Italia. *L'Italia Forestale e Montana*, 35 (4): 150-165.
- NEUMANN F.G. & MINKO G., 1985 - Studies on the introduced smaller European elm bark beetle, *Scolytus multistriatus*, a potential vector of Dutch elm disease in Victoria. *Australian Forestry*, 48: 116-126.
- OWEN D.R. & LOWNSBERY J.W., 1989 - Dutch Elm Disease. In: DAHLSTEN D.L. & GARCIA R. (eds.) - Eradication of Exotic Pests. *Yale Univ. Press*, New Haven and London: 128-146.
- PAGANELLI A., 1984 - Storia climatico-forestale del Pliocene e del Quaternario. In: ASPES A. (ed.) - Il Veneto nell'antichità. *Banca popolare*, Verona.
- PASSAVALLI L., 1935 - L'olmo siberiano (*Ulmus pumila* L.). Sua importanza nella difesa da *Ceratostomella (Graphium) ulmi* BUISM. *L'Alpe*, 23: 409-418.
- PEEZ VON A. & KAHLER M., 1977 - Die Käfer von Südtirol. *Tir. Landesmus. Ferd.*, Innsbruck.
- PFEFFER A., 1979 - Einfluss der Borkenkäfer auf der Ulmensterben (Coleoptera, Scolytidae). *Acta Ent. Bohemoslov.*, 76: 145-157.
- PORTA A., 1932 - Fauna Coleopterorum Italica. Vol. 5, *Stab. Tip. Piacentino*, Piacenza.
- POSTNER M., 1974 - Scolytidae (= Ipidae), Borkenkäfer. In: SCHWENKE W. - Die Forstschädlinge Europas. 2. *Parey*, Hamburg und Berlin.
- RAGUSA E., 1924 - Gli Ipidae della Sicilia. *Boll. Soc. Ent. It.*, 56: 114-118.
- RATTI E., 1984 - Il bosco di Carpenedo (Venezia). 3. Osservazioni sulla coleotterofauna di un lembo relitto di foresta planiziale. *Lavori, Soc. Ven. Sc. Nat.*, 9: 187-191.
- SCHEDL K.E., 1948 - Bestimmungstabellen der paläarktischen Borkenkäfer, Teil III. Die Gattung *Scolytus* Geoffr. *Zbl. Gesamtgeb. Ent.*, Mon. 1: 1-67.
- SIBILIA C., 1930 - La moria degli olmi prodotta da *Graphium ulmi* Schwarz. *Boll. R. Staz. Pat. Veg.*, Roma, 10: 311-325.

Authors' address - Indirizzo degli Autori:

— Dott. Andrea BATTISTI

— Dott. Fabio ZANTA

Istituto di Entomologia agraria

dell'Università degli Studi

Via Gradenigo 6, I-35131 PADOVA