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Life history and larva of *Tenthredo (Elinora) koehleri* KLUG, 1817

(Hymenoptera, Tenthredinidae)

With 6 figures

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Summary

Bionomics and juvenile stages of *Tenthredo (Elinora) koehleri* KLUG, 1817 are briefly described and the most important larval characters illustrated. Though adults are mostly found feeding in flowers of *Geranium*, oviposition was observed on *Cardamine amara* L. and *Myosotis palustris* L. (Hill). The larvae feed on *Cardamine amara* L. and on *Cardaminopsis halleri* (L.) HAYEK (Brassicaceae) but not on *Myosotis*. Adaptations of the larva to its environment and adaptation of the labiomaxillary complex in the adult are discussed.

Zusammenfassung

Die Bionomie und Larvenstadien von *Tenthredo (Elinora) koehleri* KLUG, 1817 werden kurz beschrieben und die wichtigsten Merkmale der Larven werden abgebildet. Obwohl die Imagines meist bei der Nahrungsaufnahme an Blüten von *Geranium* anzutreffen sind, wurde die Eiablage an *Cardamine amara* L. und *Myosotis palustris* L. (Hill) beobachtet. Die Larven fressen an *Cardamine amara* L. und *Cardaminopsis halleri* (L.) HAYEK (Brassicaceae), jedoch nicht an *Myosotis*. Weiterhin werden die Anpassung der Larven an ihre Umwelt und die Adaption des Labio-Maxillar-Komplexes der Imagines diskutiert.

Key words

juvenile stages, behaviour, labiomaxillary complex, adaptations

Tenthredo LINNÉ, 1758 comprises a rich assemblage of species complexes. One of them, *Elinora* BENSON, 1946, is morphologically characterized by usually elongated mouthparts and often truncate labrum. While most of the 52 described *Elinora* species (TAEGER & BLANK 2008) are prevalently distributed from the Mediterranean to Central Asia and are found in steppe-like habitats, *T. (E.) koehleri* KLUG, 1817 occurs in humid montane regions of Europe. By interpretation of its habitat preference and based on particular morphological features, LACOURT (1998) erected for this species and the closely related *T. radoszkowskii* ANDRÉ, 1881 the new genus *Blankia*. However, BLANK & TAEGER (2006) have considered this as a synonym of *Tenthredo (Elinora)*. Though there are both morphological and behavioural characters indicating generic status, for now I follow their concept.

It is worthy of mention that in *Elinora*, as in other mainly pollen and nectar feeding species of *Tenthredo* s. str. which can mostly be found exposed on inflorescences of Daucaceae and Asteraceae and on flowers of several other families (see e. g. LISTON, 1980b), black and yellow striped wasp-like warning coloration of the body is encountered, while a cryptic, mostly black and/or green

coloration is typical for the most voraciously predatory species of the species-groups related to *T. mesomela*, *T. olivacea* and *Rhogogaster viridis*, flying around shrubs and trees or waiting on leaves for prey.

T. (E.) koehleri is locally common in the hills and mountains of central and south-eastern Europe from the Pyrenees to Bulgaria and from Belgium to south Italy. Revised data on its distribution have been summarized by BLANK & TAEGER (2006). It is mostly absent in the lowlands while in the Alps it has been recorded up to 1800-1980 m (FENILI, 1976; SCHEDL, 1976). Published records are from Germany, France, Switzerland, Spain, Andorra, Italy, Austria, Czech Republic, Slovakia, Poland, Belgium, Russia, Romania, Bulgaria, former Yugoslavia and Albania. Records from the Caucasus, Armenia and Asian part of Turkey (ZHELOCHOVTSEV, 1941; ZHELOCHOVTSEV & ZINOVJEV, 1988; BENSON, 1968, ÇALMAŞUR & ÖZBEK, 2004) refer to the closely related *T. (E.) radoszkowskii* (see BLANK & TAEGER, 2006).

Adult and larval behaviour

The adults of *T. (E.) koehleri* are most commonly found during summer (July and first half of August) in Bohemia. They visit flowers of *Geranium* spp. (STRITT, 1952; SCHEDL, 1976; LISTON, 1980a) but also of *Ranunculus* (AERTS, 1956). It is interesting that other published plant associations within the genus include *T. (E.) radoszkowskii* (as *E. confinis*) collected on flowers of *Geranium psilostemon* LEDEB. and *T. (E.) longipes* (KONOW, 1886) from flowers of *Ranunculus* (BENSON, 1968; MUCHE, 1968, 1973). Adults of *T. (E.) davidi* BLANK & TAEGER, 2006 were found on *Geranium* and Apiaceae, and BLANK (personal communication) gives the same data for *T. (E.) lacourtiana* BLANK & TAEGER, 2006. The larva of *T. (E.) flaveola* (GMEL.) is known to feed on Brassicaceae (LORENZ & KRAUS, 1957) and all other known host plants also belong to this family (TAEGER et al., 1998).

During summer of 1980 in the Giant Mountains (Benecko, 850 m altitude) both sexes of *T. (E.) koehleri* were locally abundant in flowers of *Geranium sylvaticum* L. (*G. pratense* L., *G. palustre* L. and *G. sanguineum* L. are also mentioned by several authors). Their behaviour was the same as given by STRITT (1952) and LISTON (1980a), quite different from that of other representatives of the genus *Tenthredo* with similar life habits. The females feed on stamens, devouring both the pollen sacks and filaments and often even the ovaries, leaving only the petals untouched. During rainy weather or at night the adults remain hidden in the flowers, resting curled round the ovaries in the same way as some solitary bees often do. Though the adults were strictly associated with *Geranium* in the Giant Mts., in captivity the females refused to oviposit on this or on other plants common at the locality (*Petasites*, *Rubus*, *Salix*, *Sorbus*, *Galium*, *Senecio* etc.).

On the other hand, in 1982 in the Šumava Mountains (Bohemian forest, Kubova huť, 950 m altitude) where *Geranium* was not common and quite absent on sites where the sawflies were found, the species was observed to visit yellow inflorescences of *Hieracium* and *Crepis* spp. and flowers of *Ranunculus repens*. The consumption of stamens was not observed; both sexes fed only on nectar and pollen.

As the host plant of this species remained unknown and the presumed association with *Geranium* spp. proved to be incorrect, the females were placed in cages with *Ranunculus repens* L. and *Myosotis palustris* L. (HILL.), two plant species common to all localities where the species was abundant. Oviposition took place on *Myosotis* but larvae did not feed on it. To test suitability of potential food plants, the freshly hatched larvae were placed in a cage with the following herbaceous plants found at the locality (in alphabetical order): *Alchemilla*, *Cardamine*, *Chamaeropsis*, *Calamagrostis*,

Dactylis, *Deschampsia*, *Dryopteris*, *Epilobium*, *Galeopsis*, *Hieracium*, *Hypericum*, *Juncus*, *Lotus*, *Lysimachia*, *Melampyrum*, *Melandrium*, *Prenanthes*, *Prunella*, *Solidago*, *Vaccinium*, *Veronica* and *Viola*. Upon reaching the leaves of *Cardamine amara* L., the larvae immediately started to feed. Oviposition on *C. amara* was subsequently observed in the field, and in the following rearings the larvae fed also on *Cardaminopsis halleri* (L.) HAYEK.

The reared larvae went through four feeding instars (see Tab. 1), differences in the number of instars in females and males were not observed. Both host plants grow in the undergrowth on the banks of small streams and brooks or grow directly from the mud of shallow waters. This is correlated with larval behaviour which is quite different from that of the other species of *Tenthredo*.

When not feeding, the larvae rest either stretched on stems and leaf petioles or coiled on the ventral side of a leaf. Due to high humidity of the environment, the larvae do not hide in litter during warm days but are diurnal. Unlike the mostly nocturnal larvae of other *Tenthredo*, they remain firmly attached to the host plant when disturbed. When a larva nevertheless accidentally falls into water, it remains stretched and motionless on the surface before surface tension directs it to the bank or to a stem of a nearby plant. Due to its hydrophobic waxy cuticle, the larva remains dry.

As can be seen from the above notes, that both adult and larval bionomics and behavioural pattern differ conspicuously from these of other related groups, as also does their morphology. Some characters are shared with the herbivorous adults of *Sciapteryx*.

Oviposition

The leaves are cut from a dorsal surface near to lateral margin, incisions are about 0.3 mm long, parallel with the mid-vein or leaf margin and eggs are inserted in pockets made between chlorenchyma and lower epidermis, well visible from the ventral side but distinguishable as swellings also from the dorsal side. Eggs are laid either singly or in rows of two to four parallel to the mid-vein of a leaf, but not necessarily close to it.

Egg

Initially, the bean-shaped egg is approximately 1.5 mm long and 0.8 mm wide, with smooth and shining yellowish white chorion. On the third day after oviposition an embryonic disc is clearly visible. By the fourth day an embryo is already distinct and on the fifth day dark ocelli visible. After the sixth day regular lateral movements of the head can be observed.

Hatching

In rearings (temperature 20-25°C, relative air humidity 90-100 %), larvae hatched on the eighth day after oviposition from the ventral side of the leaf. Immediately after eclosion the larvae started to search for a suitable feeding site. After having found this, they either started to chew hollows from the dorsal side or fed from the edge of the leaf.

1st instar larva (for measurements and duration of this and following instars see Tab. 1)

Freshly hatched whitish larvae are about 3 mm long, with large and conspicuous black ocellaria and strongly tapering body. Within a few hours the head becomes yellow and trunk turns a little darker. On the second day the head is already light ochraceous yellow, with indistinct darker transverse stripe across the frons; clypeus remains whitish, distinctly paler than frons; ocellaria are conspicuous, their diameter equal to the length of narrowly conical antenna; apices of mandibles dark. Dorsal side of trunk above the spiracular line light grey, ventral side dirty yellowish, spiracles brownish. Towards the end of the instar the body is only slightly tapering, with dorsal side light olivaceous grey, with dark greyish green contents of the digestive tract visible through the cuticle; ventral side light greenish to whitish yellowish grey, head brownish yellow. Shortly before moulting the dark spots of the 2nd instar larva shine through from under the cuticle.

2nd instar larva

Head uniformly ochraceous yellow, dorsal side of the body ash grey, ventrally whitish grey; characteristic pattern of small black spots already developed; postepipleurites of thoracic and abdominal segments with rounded grey spots; suranal plate paler, without spots.

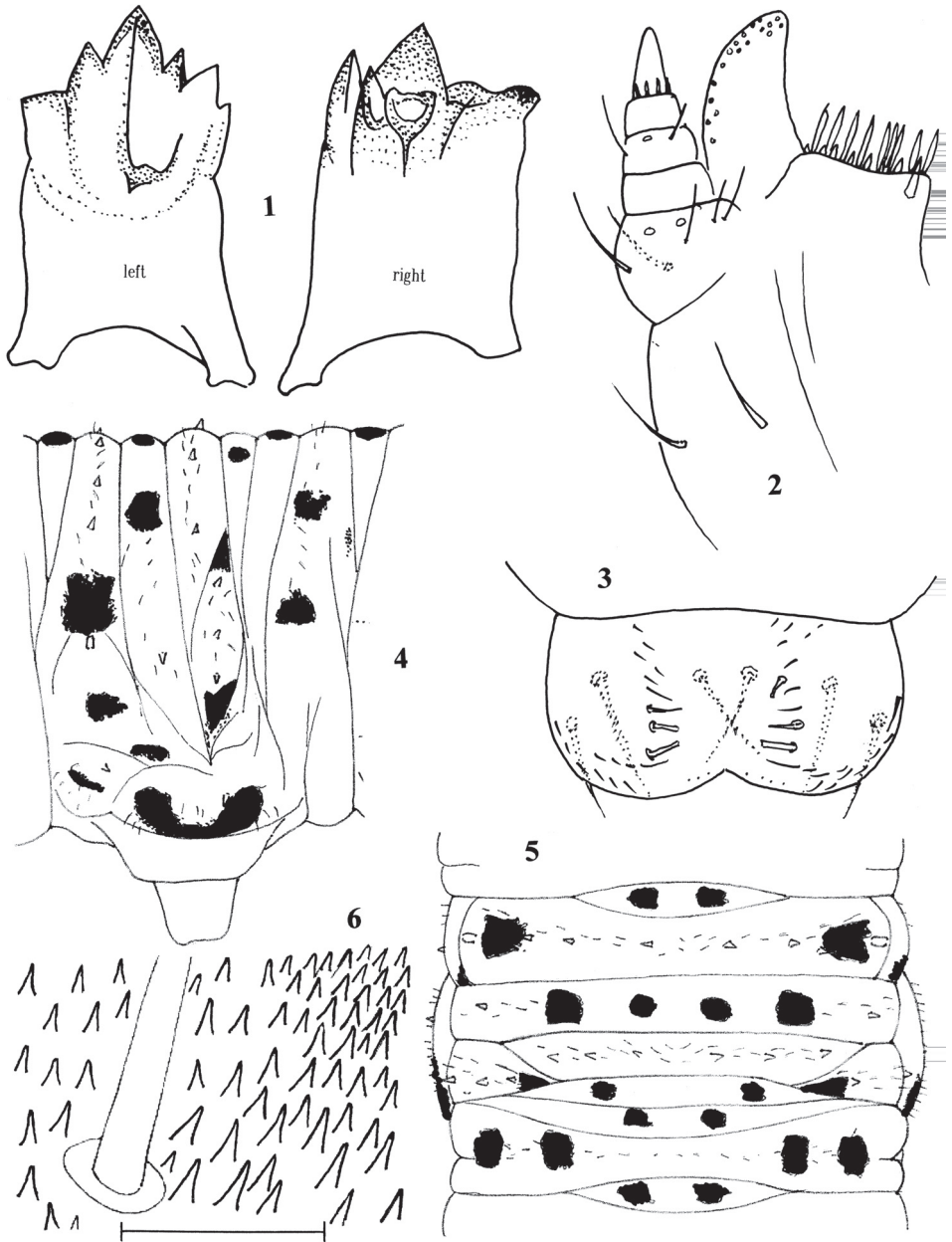
3rd instar larva

Head uniformly ochraceous, slightly paler ventrally, with conspicuous black ocellaria. Body ash grey above the spiracular line, sharply contrasting with the light whitish grey ventral side and thoracic legs; black pattern on thorax and abdomen as in instar 4, more sharply defined and more conspicuous than in instar 2; two black spots on postepipleurite fused in anterior abdominal segments but remain separate on posterior ones; whitish tubercles distinctly developed on annulets 2 and 4 and on epipleurites but smaller and less conspicuous than in the following instar.

4th instar larva

Head smooth, uniformly amber yellow, with ocellaria black, antennae and palpi light yellow, mandibles apically piceous. Entire head covered with numerous short setae; setae on lower gena much longer than those on vertex, about as long as 5-segmented conical antenna; frons with 34-36 setae, those along the ventral margin much longer than dorsal ones; clypeus with 2+2 long setae dorsolaterally, labrum medially slightly excised, with 3+3 setae, median ones close together, crossing each other; mandibles (Fig. 1) asymmetrical, with 2 subequal setae laterally; maxilla (Fig. 2): stipes (1) 2 setae, palpifer 5 setae and 2nd segment of palpus 2 setae, 3rd segment apically with about 6 short adjacent sensillae dorsally; galea with a number of flat sensillae along the lateral margin and apically; lacinia with a dense comb of about 12 stout setae, the inner ones being flattened apically, between them in second row are short stout setae; labium: submentum 3 setae on each side, 2nd segment of labial palpus 1 seta; epipharynx (Fig. 3) with a row of fine sensillae along the ventrolateral margins and parallel vertical rows of longer and stouter sensillae medially.

Thoracic legs five-segmented, tarsal claws simple, with femur, trochanter and tibia subequal in length, tibia with about 14 setae; coxa with blackish spots laterally. Colour pattern and chaetotaxy of thorax similar to that of the abdomen.



Figs 1-6: *Tentredo (Elinora) koebleri* KLUG., 4th instar larva: Fig. 1: mandibles in mesal view; Fig. 2: left maxilla in posterior aspect; Fig. 3: epifarynx; Fig. 4: abdominal segment 4 in lateral aspect; Fig. 5: segment 3 in dorsal aspect; Fig. 6: microstructure of the cuticle. Measurement in Fig. 6 - 0.025 mm.

The trunk ash to bluish grey dorsolaterally above the spiracular line, whitish grey ventrally including thoracic legs and pseudopods, with characteristic pattern of irregular blackish spots (Figs 4 and 5); prothoracic segment deep grey to blackish dorsally; suranal plate setaceous with indistinct blackish pattern laterally and partly also medially, apically pale. Abdominal segments 1 and lateral lobes also with whitish conical warts. Chaetotaxy of 3rd abdominal segment: 2nd annulet 3-4 warts and 10-12 setae, 4th annulet 2-3 warts and 10-12 setae, 7th annulet 9-11 setae on each side; preepipleurite 1 wart and 6-8 setae, postepipleurite 1-2 warts and 18-20 setae; 1st postspiracular lobe 1-2 warts and 6-7 setae, 2nd postspiracular lobe 2-3 warts and 4-6 setae; hypopleurite glabrous, inner side of pseudopods with about 10-12 short setae. Spiracles blackish brown, indistinctly brownish winged. Suranal tergum apically rounded, setaceous, without warts.

Cuticle finely granulate, dull, densely covered with small conical protuberances (Fig. 6) which are smaller but more dense on dark areas.

Tab. 1: Larval instars I-IV of *Tenthredo (Elinora) koehleri*: head and frons size, body length (measurements in mm) and duration of the instar (in days).

Instar	head	frons	length	duration (at 20–25 C°)
I	0.61–0.65	0.32–0.34	3–7	6
II	1.1	0.49–0.54	7–10	4
III	1.7–1.8	0.68–0.70	10–16.5	4
IV	2.2	0.85–0.90	16–24	5–6

Eonymph

Head straw yellow, slightly darker around black ocellaria, distal half of clypeus and labrum whitish, palpi brownish, mandibles yellowish brown, dark brown apically. Mouth parts with the exception of clypeus, mandibles and labrum without changes, maxillae as in the 4th instar larva. Chaetotaxy of mouth parts as in the ultimate instar larva, setae of head capsule very short and fine, obsolescent; body dirty yellow, with greyish yellow shadows dorsally and paler spots instead of warts; spiracles brown, narrow, nearly twice as long as in the feeding larva; cuticle glabrous, only thoracic legs and inner side of pseudopods with distinct setae, the setae around anus scarce, short and indistinct.

Moulting

As can be seen from the previous paragraph, the larva belongs to the type A of KONTUNIEMI (1951, 1965) as do all known larvae of the subfamily Tenthredininae. Shortly before eonymphal moulting the larva stops feeding, remains nearly motionless, and its coloration turns paler. After instar 3 a sharp line between dark dorsal and pale ventro-lateral side disappears and the cuticle has a dull lustre. Before the proper moulting the larva sits motionless for about 5 minutes stretched on the ventral side of a leaf in lower part of the plant or on a stem with head and thorax slightly raised before it commences slow peristaltic movements of entire body. As a result of these movements the white tracheal lateral band is loosened from the caudal part of body towards thorax, and cuticle on the thorax ruptures in the midline of the dorsal side together with sutures of the head.

Thorax and head are freed first and entire moulting is finished in 1 (1st instar) to 2 minutes (ultimate instar larva). A freshly moulted larva remains for about 15 minutes after moulting in the same position as before moulting.

Immediately after moulting, the head and ventral side of the body including thoracic legs and pseudopods are yellowish white, dorsal side of the body dark grey. During following hours the coloration of the body turns still darker, being dorsally bluish grey-black so that the black patterns are only feebly visible in 3rd and 4th instar larvae. On the other hand, whitish tubercles on the body are very conspicuous. On the second day after moulting the coloration grows paler again.

Two days before the eonymphal moulting the ash-grey coloration of the dorsal side of the trunk changes to paler, dull, and whitish grey whilst the ventral side turns to greenish yellow, dully translucent. A day before this moult the larvae stop feeding. The yellow eonymph enters the soil and forms an earth pupation chamber (its character and pupa not known).

Adaptation of mouth parts

The structure of the labiomaxillary complex in the subgenus *Elinora*, is correlated with feeding habits. It is rather unusual among Symphyta and resembles in some aspects that of the genus *Megalodontes* LATREILLE, 1803. An other parallel is found in the Australian genus *Euryys* NEWMAN, 1841 of the family Pergidae (see BENSON, 1963, Figs 1-3). In several other groups of Symphyta the more or less lengthened parts of the labiomaxillary complex appear to be an adaptation to feeding habits (e. g. *Amauronematus* KONOW, 1890 and some species of *Athalia* LEACH, 1817) but their galea remains always short and lobate in contrast to a slightly curved and strongly elongate one in *Elinora*, comparable thus with some Apoidea (for example a genus *Hylaesus* FABRICIUS, 1793 [= *Prosopis*]). Unlike many species of other subgenera of *Tenthredo*, the adults of *Elinora* have never been observed to prey on other insects, even on those which are minute and soft-bodied such as aphids.

The structure of the mandibles is the same as in the *Tenthredo arcuata*-group, without a sharp cutting edge basally and without a long narrow apical tooth. These features are present in predacious species of *Tenthredo*, such as in the *T. mesomela*-group.

The basal parts of the maxillae are similar to other sawflies, but in comparison with *Tenthredo* s. str. the stipes is shorter, at most only scarcely longer than the cardo, with the palpi inserted nearly apically. The galea is strongly elongate, distinctly longer than the stipes, and evenly curved outwards, sclerotized, and covered with numerous sensillae, in the distal part narrowly membranous laterally.

The labium shows even more adaptations in comparison with other sawflies. The submentum is a well developed, elongate-rectangular sclerite tightly joined with the mesal margins of the cardo. The prementum is distinctly longer than the stipes, strongly sclerotized in the proximal part, with a narrow impression in the median line and only slightly sclerotized distally, with strengthened lateral margins. The most adapted structures are narrow, only slightly sclerotized glossae. The alaglossa is a very narrow, laterally compressed, apically bluntly pointed structure with scattered setae dorsally and a number of sensillae, its middle part being more heavily sclerotized than the flexible apical part. The paraglossae are similar in shape and structure, being slightly longer than the alaglossa. Thus, it cannot be unequivocally attributed to the CNEA (concealed-nectar extraction apparatus) type 1 of JERVIS & VILHELMSSEN (2000), for it is quite different from the mouthparts of the *Tenthredo arcuata*-group (see for example Figs 5 and 4 in ZHELOCHOVTSEV & ZINOVJEV, 1988: 214) and has nothing in common with *Amauronematus* (ZHELOCHOVTSEV & ZINOVJEV, 1988: 71, Fig. 1).

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