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REVIEW OF THE SUBGENUS *TRIFURCULA* (*LEVARCHAMA*),
WITH TWO NEW SPECIES (LEPIDOPTERA: NEPTICULIDAE)

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The subgenus *Trifurcula* (*Levarchama*) is reviewed. It comprises seven species, two of which are described as new: *Trifurcula* (*Levarchama*) *peloponnesica* VAN NIEUKERKEN sp. n., found in Greece: Peloponnesus and feeding on *Anthyllis hermanniae*, and *Trifurcula* (*Levarchama*) *manygoza* VAN NIEUKERKEN, A. LAŠTŮVKA et Z. LAŠTŮVKA sp. n., from Croatia and northern Greece, feeding on *Lotus corniculatus*. The subgenus occurs throughout Europe and the Mediterranean, and all species make leafmines on Fabaceae: Loteae. All species are diagnosed and biology and distribution are discussed, including new hostplant and distributional records. The phylogeny is discussed on the basis of morphological characters and hostplant relationships are discussed. The Macaronesian *T. ridiculosa* WALSINGHAM is sister to a clade comprising the remaining species. *Lotus* is most likely the plesiomorphic hostplant choice, with two host shifts to respectively *Anthyllis* and *Coronilla*.

Key words: Nepticulidae, new species, leafminers, biology, distribution, hostplants, Fabaceae, Loteae, *Anthyllis*, *Coronilla*

INTRODUCTION

The nepticulid subgenus *Levarchama* BEIRNE, 1945 is the smallest of the three subgenera of the genus *Trifurcula* ZELLER, 1848, with five known species (VAN NIEUKERKEN 1986a, b). This contrasts with the larger subgenera *Trifurcula* s. str. and *Glaucolepis* BRAUN which have 28 and 27 named species respectively and to which belong many unnamed species that are known in collections (VAN NIEUKERKEN 1990, VAN NIEUKERKEN & PUPLESIS 1991, Z. & A. LAŠTŮVKA 1994, A. & Z. LAŠTŮVKA 2000, 2005, DIŠKUS & PUPLESIS 2003). For *Levarchama* only two unnamed species were known to us, which are here described as new; for comparison the southern European and Macaronesian species *T. anthyllidella* KLIMESCH, 1975 and *T. ridiculosa* (WALSINGHAM, 1908) are redescribed. The other three, widespread, European species have been amply described (VAN NIEUKERKEN & JOHANSSON 1990, A. & Z. LAŠTŮVKA 1997) and are only diagnosed here with notes on biology and distribution. Host plant relationships and phylogeny are discussed.

MATERIAL AND METHODS

Material – For the collections I use the abbreviations from EVENHUIS and SAMUELSON (2004) with the following additions: AL – Collection – A. LAŠTŮVKA (Prostejov, Czech Republic); GB Collection Giorgio Baldizzone (Asti, Italy). Material from Spain, Portugal, France and Corsica listed recently (VAN NIEUKERKEN *et al.* 2004a, 2006), is not repeated here.

Methods – Distribution maps were prepared with DMAP 7.0 (Morton 2000). For these maps I have used the examined material supplemented with the data from the original descriptions and reliable literature records. UTM coordinates (here given in the material lists) or longitude/latitude when not given on labels or in references, were mainly derived from a few major internet gazetteers and one atlas (IGN 1997–2003, Times 2000, NIMA 2004).

Genitalia preparations were embedded in Euparal, following the methods described in VAN NIEUKERKEN *et al.* (1990). Slide numbers, when given without letters, refer to EvN numbers, from which RMNH numbers (if relevant) can be calculated by adding 20,000 (slide EvN 3717 = RMNH INS 23717).

Morphological terms follow VAN NIEUKERKEN *et al.* (1990). Hostplant nomenclature follows ILDIS (2005) (Table 1).

Photographs of moths, leafmines and genitalia slides were taken with a Zeiss AxioCam digital camera attached to respectively a Zeiss Stemi SV11 stereo-microscope or a Zeiss Axioskop H, using Carl Zeiss AxioVision software. Drawings of genitalia were made with a drawing tube attached to the Zeiss Axioskop. The SEM micrographs were made in 1980–1984 in the Free University, Amsterdam, with an ISI-40 scanning electron microscope, with a beam current of 5 or 10 kV on gold coated, air dried specimens.

Measurements of genitalia (presented in Table 2) were recently obtained from digital images, using AxioVision, 20× objective for male genitalia and 10× or 20× for females. Some older measurements were taken with an eyepiece graticule, with a precision of about 5 µm. Capsule length was measured from vinculum to middle of pseuduncus, excluding the uncus; valva length from tip of posterior process to ventral edge, excluding the sublateral process; aedeagus length was measured from the sclerotized tube, from tip of ventral process/carina, excluding any protruding vesica parts; length of cornuti was measured as the longest distance in ventral view, including any sclerotised basal pieces. Bursa length is measured from cloaca to anterior tip. Forewing length (see Table 2) was measured from tip of cilia to attachment on thorax, usually at magnification of 20×. Antennal segment counts (see Table 2) include scape and pedicel. Because measurements were obtained by different methods, with different accuracies, I refrain from giving mean and standard deviation; moreover, the sample size for genitalia measurements is usually very low, with exception for males of *T. eurema* (15 measured).

Table 1. Hostplants of *Trifurcula* (*Levarchama*) species, with sources

Species	Host	Sources
<i>T. ridiculosa</i>	<i>Lotus sessilifolius</i>	WALSINGHAM 1908, KLIMESCH 1977
	<i>Lotus campylocladus</i>	KLIMESCH 1977
	<i>Lotus glaucus</i>	KLIMESCH 1977
	<i>Lotus glinoides</i> (as <i>arabicus</i> L.)	KLIMESCH 1977
	<i>Lotus pedunculatus</i> (=uliginosus)	this study

Table 1 (continued)

Species	Host	Sources
<i>T. anthyllidella</i>	<i>Anthyllis cytisoides</i>	KLIMESCH 1975, NIEUKERKEN <i>et al.</i> 2004a
	<i>Anthyllis terniflora</i>	NIEUKERKEN <i>et al.</i> 2004a
<i>T. peloponnesica</i>	<i>Anthyllis hermanniae</i>	this study
<i>T. cryptella</i>	<i>Lotus corniculatus</i>	TUTT 1899, NIEUKERKEN & JOHANSSON 1990
	<i>Lotus pedunculatus</i> (= <i>uliginosus</i>)	NIEUKERKEN & JOHANSSON 1990, NIEUKERKEN <i>et al.</i> 2004a
	<i>Lotus hispidus</i>	LHOMME [1963]
	<i>Hippocrepis comosa</i>	KLIMESCH 1951b, NIEUKERKEN & JOHANSSON 1990, NIEUKERKEN <i>et al.</i> 2006
	<i>Hippocrepis emerus</i>	KLIMESCH 1936, NIEUKERKEN & JOHANSSON 1990, NIEUKERKEN <i>et al.</i> 2006
	<i>Securigera varia</i>	KLIMESCH 1951b, NIEUKERKEN & JOHANSSON 1990, NIEUKERKEN <i>et al.</i> 2006
	<i>Anthyllis montana</i>	NIEUKERKEN & JOHANSSON 1990, NIEUKERKEN <i>et al.</i> 2006
	<i>T. eurema</i>	<i>Lotus corniculatus</i>
<i>Lotus pedunculatus</i>		KARSHOLT & SKOU 1987, KUCHLEIN <i>et al.</i> 1988, NIEUKERKEN & JOHANSSON 1990
<i>Lotus cytisoides</i>		this study
<i>Lotus maritimus</i>		SZŐCS 1959, NIEUKERKEN & JOHANSSON 1990
<i>Dorycnium pentaphyllum</i>		SUIRE 1928, NIEUKERKEN & JOHANSSON 1990, NIEUKERKEN <i>et al.</i> 2006
<i>Dorycnium hirsutum</i>		TUTT 1899, NIEUKERKEN & JOHANSSON 1990, NIEUKERKEN <i>et al.</i> 2004a, 2006
<i>Dorycnium rectum</i>		this study
<i>T. manygoza</i>	<i>Lotus corniculatus</i>	this study
<i>T. ortneri</i>	<i>Coronilla coronata</i>	KLIMESCH 1951b, NIEUKERKEN & JOHANSSON 1990
	<i>Coronilla vaginalis</i>	KLIMESCH 1961, NIEUKERKEN & JOHANSSON 1990
	<i>Coronilla minima</i>	NIEUKERKEN <i>et al.</i> 2004a, 2006
	<i>Coronilla valentina</i> ssp. <i>valentina</i>	NIEUKERKEN <i>et al.</i> 2006, this study
	<i>Coronilla valentina</i> ssp. <i>glauca</i>	this study
	<i>Coronilla viminalis</i>	this study (mines only)

Table 2. Numerical characters for *Trifurcula* (*Levarchama*) species. The ratio cornutus/aedeagus length refers to the largest cornutus.

	<i>ridiculosa</i>	<i>anthyllidella</i>	<i>pelopomesica</i>	<i>cryptella</i>	<i>eurema</i>	<i>manygoza</i>	<i>ortneri</i>
Male							
Forewing length	1.85–2.1 mm	2.9–3.65 mm	2.15–2.8 mm	2.4–3.0 mm	2.0–3.2 mm	2.1–2.7 mm	2.5–2.92 mm
Antennal segments	33–35	37–44	33–34	33–37	30–36	32–34	36–40
Female							
Forewing length	1.55–1.8 mm	2.8–3.3 mm	2.25–2.6 mm	2.1–2.7 mm	2.1–2.65 mm	2.55 mm	2.3–2.7 mm
Antennal segments	25–28	32–38	27–33	28–33	28–31	29	31–35
Male genitalia							
capsule length	226–268 µm	329–360 µm	299–315 µm	270–317 µm	243–300 µm	247–282 µm	257–268 µm
valva length	174–212 µm	282–288 µm	263–267 µm	227–249 µm	193–240 µm	194–218 µm	204–215 µm
aedeagus length	259–284 µm	371–399 µm	308–327 µm	279–304 µm	256–300 µm	253–290 µm	295–325 µm
longest cornutus	121 µm	132 µm	110–116 µm	86–116 µm	49–75 µm	50–82 µm	97–133 µm
2nd cornutus	95 µm	104 µm	74–94 µm	79–94 µm	43–64 µm	29–68 µm	70–95 µm
ratio cornutus/aedeagus	0.46	0.33	0.34–0.38	0.29–0.39	0.18–0.27	0.18–0.28	0.32–0.45
Female genitalia							
longest signum	351 µm	439 µm	380–442 µm	394–459 µm	347–420 µm	441 µm	399–505 µm
shortest signum	273 µm	421 µm	380–404 µm	381–429 µm	334–399 µm	386 µm	296–475 µm
setae on T8 (half)	12	11–12	11–12	12–14	13–14	21	8–16
setae on T9 (half)	14	–	–	11–14	10–18	15–17	13–22
convolutions ductus spermathecae	3	10	7.5	9	7–8	9.5	6–7.5

Phylogeny – Species were used as terminal taxa. As outgroup I included exemplar species from the other subgenera and species groups: *Trifurcula (Glaucolepis) headleyella* (STAINTON, 1854), *T. (T.) subnitidella* (DUPONCHEL, 1843) and *T. (T.) immundella* (ZELLER, 1839). The 24 characters scored are listed in the Appendix, the data matrix is given in Table 3. Parsimony analysis was executed with Paup 4.0b10 for Windows (SWOFFORD 2001).

RESULTS

Trifurcula (Levarchama)

Diagnosis – All species of *Levarchama* share the three most important apomorphies of the genus *Trifurcula*: the trifurcate condition of R+M in hindwing, the male abdomen with paired tufts on T6, T7 and T8 and the velvet patch of special scales on male hindwing underside (Fig. 10). Further in the forewing the connection between R2+3 and R4+5 is lost, shared with *Trifurcula* s. str. The only synapomorphy for *Levarchama* of the two listed by VAN NIEUKERKEN (1986b), that is present in all species is the longitudinally split uncus. The character: bursa being suddenly narrowed anteriorly may well be another apomorphy for *Levarchama*. The European species (thus excluding the Macaronesian *T. ridiculosa*) also share the hairpencil on the underside of the male hindwing (Fig. 9, the only external character), the globose group of strongly sclerotized cornuti at left side of the aedeagus, the pectinations in the female vestibulum, and the ductus spermathecae with more than six convolutions. Only the last character is also known within the other subgenera: in several *T. (Glaucolepis)* species, but in these the ductus starts with a long straight part before the coiled part.

Characters – Most species of *Levarchama* can be identified by a combination of colour pattern and geographic distribution, but *T. ortneri* and *T. manygoza* may be sympatric, at least in Croatia, and thus genitalia dissection is necessary for sepa-

Table 3. Data matrix (for explanation of numbers in the header see the Appendix)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
<i>headleyella</i>	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0
<i>subnitidella</i>	0	0	0	0	0	0	0	0	0	1	1	0	1	0	1	0	1	0	1	1	0	0	1	1
<i>immundella</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	2	0	1	2	0	0	1	1
<i>ridiculosa</i>	0	0	0	0	0	0	0	1	1	0	1	0	1	0	1	1	1	0	0	1	0	0	1	0
<i>anthylidella</i>	1	1	1	1	1	0	1	1	1	1	0	1	1	1	1	0	1	1	1	1	0	1	1	0
<i>peloponnesica</i>	1	1	1	1	1	0	1	1	1	0	0	0	1	1	1	0	1	1	1	1	0	1	1	0
<i>eurema</i>	0	0	0	1	0	0	1	1	1	0	0	0	0	0	1	0	1	1	1	1	1	1	1	0
<i>cryptella</i>	0	0	0	1	0	0	1	1	1	0	0	0	0	0	1	0	1	1	1	1	1	1	1	0
<i>ortneri</i>	0	0	0	1	0	0	1	1	1	0	0	0	0	1	1	0	1	1	1	1	0	1	1	0
<i>manygoza</i>	0	0	0	1	0	0	1	1	1	0	0	0	0	0	1	0	1	1	1	1	0	1	1	0

rating this pair when not reared. In general dissection is providing better identifications, especially worn examples can easily be confused with species from other subgenera.

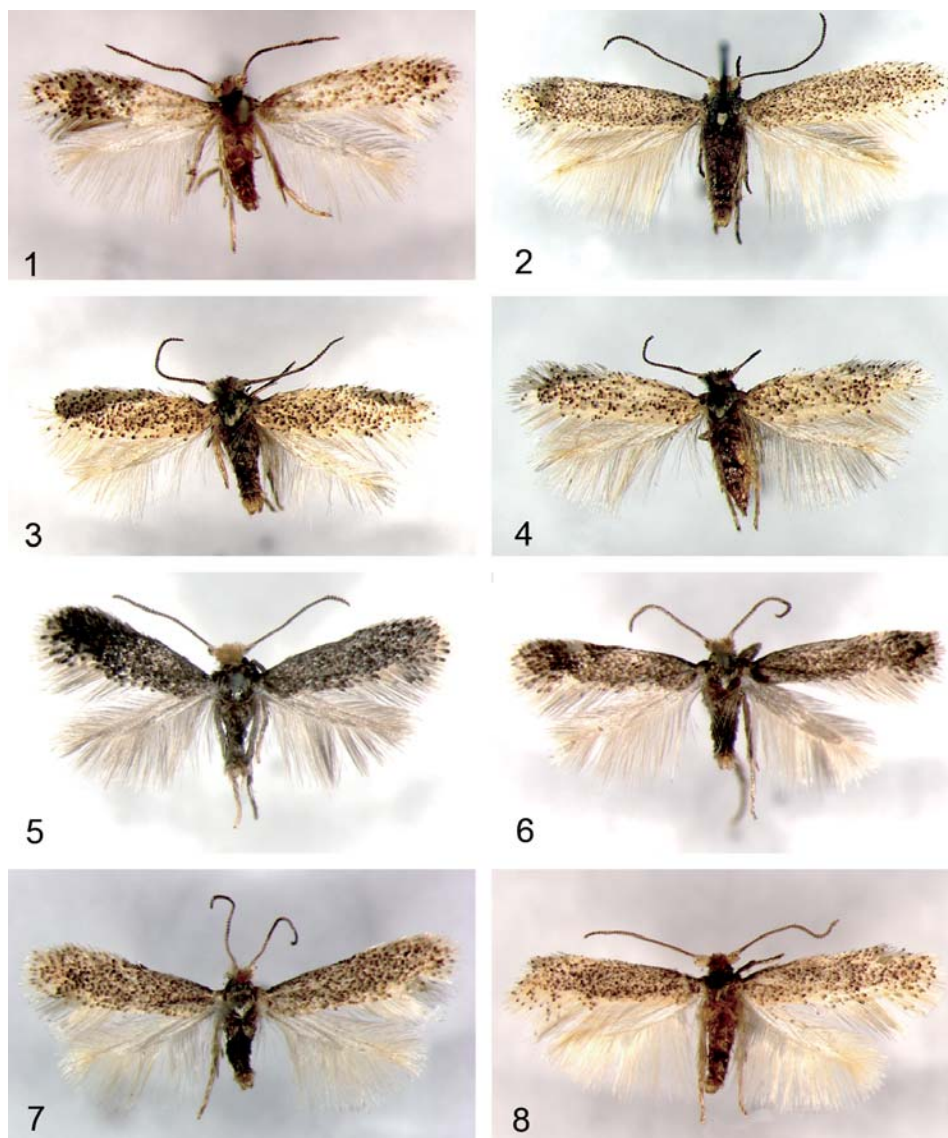
The hair-pencil (Fig. 9), separating the species from other *Trifurcula* subgenera, may be difficult to observe, especially in the pale species where there is very little contrast with the wings. Carefully moving the forewing upwards may sometimes be helpful to show the hairpencil better, because it then appears from underneath the costal fold of the forewing.

The male genitalia are very uniform within this group, with best characters being the shape of the valva and inner processes, the shape of the uncus and size and shape of cornuti (Figs 34–40). The aedeagus of *T. ridiculosa* is rather different from the remaining species: the globose group of cornuti is missing, and two processes resemble the large cornuti, resulting in four long cornuti-like structures. One of these is the very narrow, needle-like ventral process (carina) or juxta, which is more triangular and bifurcate in the other species, another one is the narrow sclerotized part of the dorsal process of the aedeagus proper (Fig. 41). This dorsal process is also very characteristic in *T. anthyllidella*, where it has a serrate margin (very similar to some species in the *Trifurcula (T.) subnitidella* group, see VAN NIEUKERKEN 1990) and in *T. peloponnesica*, where it is spatulate (Figs 42, 43). In the remaining four species, the dorsal lobe is a conspicuous asymmetric extension at the right side (Figs 27, 44, 45), most strongly developed in *T. ortneri*. Measurement of cornuti is not always equivocal, the sclerotization of the basic structure is variable, resulting sometimes in uncertainty about the starting point for measurement. However, the large size of the cornuti in *cryptella* is diagnostic, and also the difference between *manygoza* and *ortneri* is usually easy (see Table 2).

The female genitalia are rather similar to those of other *Trifurcula* subgenera, but the pectinations in the vestibulum in all species except *ridiculosa*, are unique (Figs 53, 58). In *T. peloponnesica* these are more elaborate and include spinelike structures (Fig. 59). This species and *T. anthyllidella* also share indistinct sclerotizations in the vestibulum and a distinct pointed ovipositor (S7 and T8), resulting in loss of the setose anal papillae (Figs 54–57).

Immature stages – The final instar larvae of three species were described by GUSTAFSSON & VAN NIEUKERKEN (1990). The larvae are yellow and feed with the ventral side upwards (Figs 65–70).

Biology (Figs 65–74) – All species make leafmines on herbs or small shrubs belonging to Fabaceae: Loteae. The mines are ophio-stigmatonomes: they start with a gallery and end with a blotch. In contrast to many other Nepticulidae, the larval exit-hole is typically on the leaf underside, although this is variable in *T.*



Figs 1–8. *Trifurcula* (*Levarchama*) species, adults (all from RMNH): 1 = *T. ridiculosa*, male, Canary Islands, La Gomera, Hermigua, ex *Lotus* sp., Klimesch; 2 = *T. anthyllidella*, male, Spain (Almería): Sierra Almahilla, ex *Anthyllis cytisoides*; 3 = *T. peloponnesica*, male, Greece (Messinía), Exokhóri, ex *Anthyllis hermanniae*, paratype; 4 = *T. peloponnesica*, female, Greece (Messinía), Exokhóri, ex *Anthyllis hermanniae*, paratype; 5 = *T. cryptella*, male, Portugal (Beira Alta): Serra da Estrela, ex *Lotus pedunculatus*; 6 = *T. eurema*, male, Netherlands (Zuid-Holland): Katwijk, ex *Lotus corniculatus*; 7 = *T. manygoza*, male, Greece (Trikala): Oxinia; 8 = *T. ortneri*, male, Spain (Teruel): Rubielos de Mora, ex *Coronilla minima*



Figs 9–10. *Trifurcula cryptella*, hindwing structure, SEM micrographs (scales 20 μm): 9 = frenulum and hairpencil on hindwing underside, 10 = raised androconial scales of velvet patch and microtrichia on hindwing underside

anthyllidella. *T. eurema* pupates usually inside the mine, the other species outside, on the soil or on debris.

Distribution – The subgenus occurs throughout Europe, from southern Scandinavia to the Mediterranean borders and also occurs in northern Africa, Macaronesia and Asia Minor.

CHECKLIST

Trifurcula ZELLER, 1848

Subgenus *Levarchama* BEIRNE, 1945

Type-species: *Nepticula cryptella* STAINTON, 1856 (original designation)

ridiculosa (WALSINGHAM, 1908)

anthyllidella KLIMESCH, 1975

peloponnesica VAN NIEUKERKEN sp. n.

cryptella (STAINTON, 1856)

? *trifolii* (SORHAGEN, 1885)

eurema (TUTT, 1899)

dorycniella (SUIRE, 1928)

gozmanyi (SZÓCS, 1959)

manygoza VAN NIEUKERKEN, A. LAŠTŮVKA et Z. LAŠTŮVKA sp. n.

ortneri (KLIMESCH, 1951)

Trifurcula (Levarchama) ridiculosa WALSINGHAM

(Figs 1, 11–14, 28, 33, 34, 41, 46, 60, 71, 75)

Stigmella ridiculosa WALSINGHAM, 1908: 1011. LECTOTYPE ♂ (here designated): CANARY ISLANDS: Tenerife, Santa Cruz, Guimar, 8–14.ii.1907, larva on *Lotus sessilifolius*, e.l. 6–8.iv.1907, Wlsm. No 99255 [labelled as female], Genitalia slide BM30259 (BMNH) [examined].

Trifurcula ridiculosa; KLIMESCH 1975: 15, 18 [genitalia and leafmines illustrated].

Trifurcula (Levarchama) ridiculosa; KLIMESCH 1977: 199 [redescription]; AGUIAR & KARSHOLT 2006: 17 [recorded from Madeira].

Diagnosis – *Trifurcula ridiculosa* is a pale species, smaller than the next two species, which are also pale. It differs from the remaining *Levarchama* species by the absence of a hairpencil on hindwing. The only other *Trifurcula* with which it may be confused on the Canary islands is *T. (Glaucolepis) sanctaecrucis* (WALSINGHAM, 1908); it is the only known *Trifurcula* on Madeira. Male genitalia are very characteristic by the medial lobe of the valva, the absence of the globose group of cornuti and the presence of a long spiny juxta and dorsal lobe of aedeagus,

both resembling *cornuti*. Female genitalia differ from other *Levarchama* by few coils in ductus spermathecae and absence of group of pectinations in vestibulum.

Description – Male (Fig. 1). Forewing length 1.95–2.1 mm, wingspan *ca.* 4.1–4.5 mm. Head: frontal tuft mixed white and grey-brown, collar white, comprising piliform scales; scape white, mixed with grey-brown tipped scales. Antennae grey-brown, with 33–35 segments. Thorax and forewings cream white, irrorate with grey-brown tipped scales, cilia line distinct; underside grey-brown. Hindwings white to grey-white, underside with velvet patch of raised scales, without hairpencil. Abdomen grey-brown, anal tufts white.

Female. Forewing length 1.55–1.8 mm, wingspan *ca.* 3.8–4.1 mm. Antennae with 25–28 segments. Hindwing without velvet patch, abdomen without tufts; otherwise as male.

Male genitalia (Figs 11–14, 28, 33–34, 41). Capsule slightly longer than wide. Vinculum rounded anteriorly. Tegumen produced into pointed pseuduncus. Uncus split lengthwise, pointed. Gnathos with asymmetrical central element, with longitudinal keel. Valva relatively narrow, with prominent inner process in middle on ventral surface, outer margin rather straight in ventral view; sublateral process rather short, transverse bar of transtilla almost twice as long as sublateral process. Aedeagus: vesica with group of long needle like *cornuti* at anterior right hand side; two large slightly curved *cornuti* (Fig. 34), also some minute *cornuti*; aedeagus with two very long posterior prongs, slightly resembling *cornuti* in ventral view; one is the ventral carina or juxta process, the other the sclerotization of the dorsal lobe, at the left hand side (see lateral view in Fig. 14).

Female genitalia (Figs 46, 60). Abdominal tip broadly rounded. T8 wide, broadly truncate posteriorly, with *ca.* 12 setae on each half. T9 forming distinct anal papillae, with *ca.* 14 setae each. Posterior apophyses slightly shorter than anterior. Bursa total length *ca.* 870 μm . Vestibulum without sclerotizations. Corpus bursae elongate, suddenly narrowed anteriorly; signa different in length, *ca.* 275 μm and 350 μm respectively; 2–3 cells wide, outer margin with spiny margins. Ductus spermathecae convoluted almost from start, *ca.* 3 convolutions.

Biology – Hostplants: *Lotus* species, both endemic and widespread introduced species (see Table 1). Egg deposited on either side of a leaflet. Leafmine (Fig. 71) usually starting as a narrow gallery with thin broken frass, later gallery suddenly enlarging into elongate blotch; on *Lotus* with small leaflets eating out leaflet completely. Larval exit hole on leaf underside. There is a remarkable difference between mines from Madeira (Fig. 71) and from the Canary islands (KLIMESCH 1975, 1977): the early gallery in Madeiran mines is usually very much contorted, whereas the Canarian mines show a rather straight course. Larva yellow [from literature data, not examined].

Probably breeding continuously: larvae have been found in February, April, September, October and December, adults always emerged within 3–6 weeks after collecting.

Distribution (Fig. 75) – Only known from Canary Islands: Tenerife, La Palma, La Gomera, El Hierro (new record) and Madeira, including Porto Santo island.

Material examined – Portugal, Madeira: mines, larvae, Curral das Frias [Freiras] [28S CB12], 850 m, 21.ix.1997, O. Karsholt (RMNH); 1♂, 1♀, Porto Santo island, Pico do Castelo [28S CB75], 200 m, 17.i.1996, *Lotus* sp. e.l. 10.ii.1996, H. Henderickx (RMNH); Sao Vicente [28S CB03], 10 m,

9.x.1994, *Lotus uliginosus*, O. Karsholt (RMNH) – Spain, Canary Islands: 3♂, 2♀, La Gomera, Hermigua [28R BS81], 30.iv. 1965, 26.xi.1966, *Lotus* sp., e.l. 9–14.v.1965, 24–28.xii.1966, J. KLIMESCH (RMNH, coll. JOHANSSON).

Additional record: Spain, Canary Islands: leafmines, El Hierro, Las Puntas, Embarcadero de Punta [28S BR08], 9 & 13.ii.2002, *Lotus sessilifolius*, A. C. ELLIS & W. N. ELLIS (ZMAN) (W. N. ELLIS, pers. comm.).

Trifurcula (Levarchama) anthyllidella KLIMESCH
(Figs 2, 15–17, 30, 31, 35, 42, 47, 54, 55, 58, 65, 66, 72, 75)

Trifurcula (Levarchama) anthyllidella KLIMESCH, 1975: 14. HOLOTYPE ♂: SPAIN, Baleares, Mallorca: Palma Nova, e.l. 8.12.68, J. KLIMESCH, Mine an *Anthyllis cytisoides*, 5.3.1968, Zucht Nr. 969 (ZSM) [not examined].

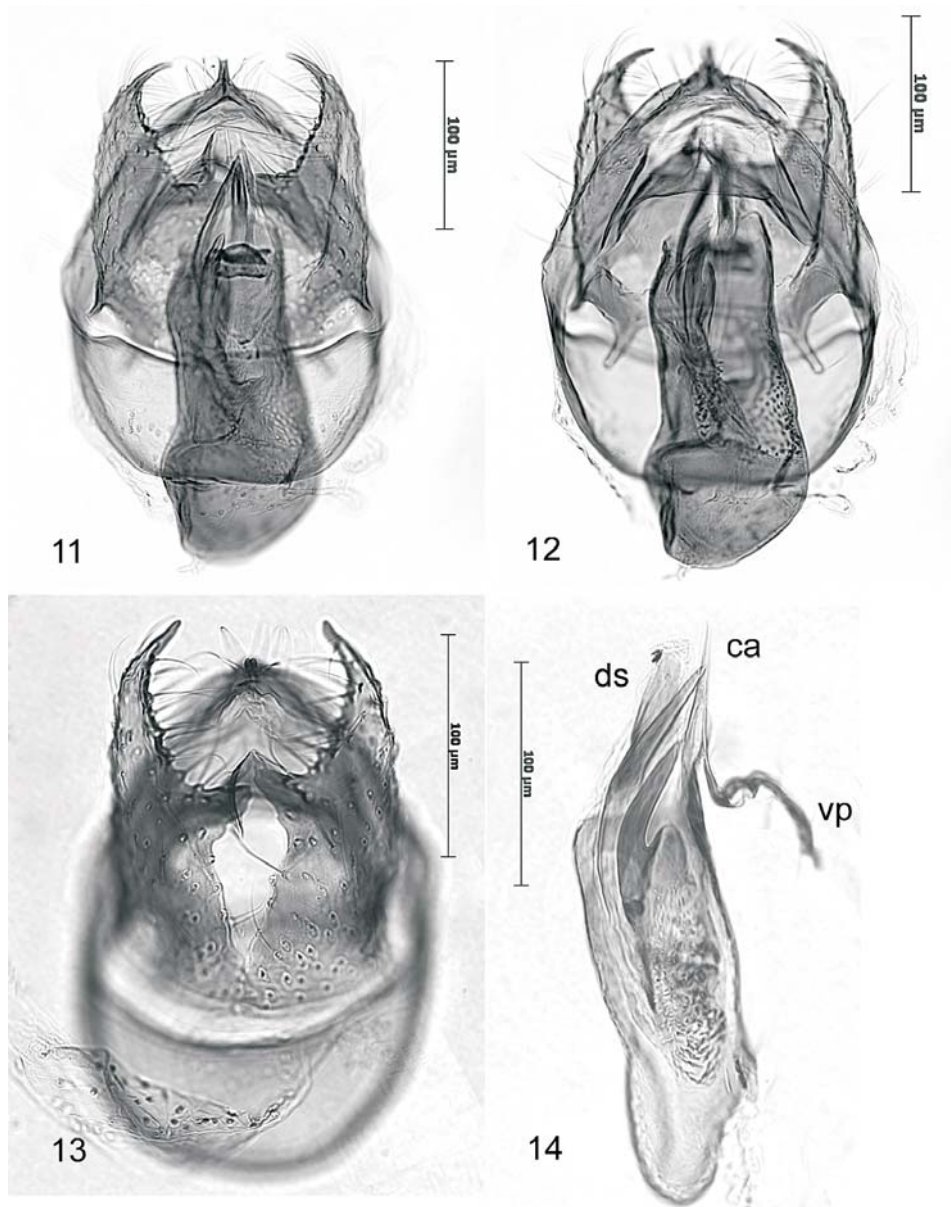
Trifurcula (Levarchama) anthyllidella; VAN NIEUKERKEN *et al.* 2004a: 233 [distribution in Spain], VAN NIEUKERKEN *et al.* 2006: 380 [corrections].

Diagnosis – *Trifurcula anthyllidella* is by far the largest species of *Levarchama*, externally resembling other large and pale *Trifurcula* species, in Spain it can be confused with *T. (T.) pallidella* (DUPONCHEL, 1843) (see VAN NIEUKERKEN 2006), *T. (T.) immundella* (ZELLER, 1939), *T. calycotomella* A. et Z. LAŠTŮVKA, 1997 and with some as yet undescribed species. None of these has the conspicuous irroration of *anthyllidella*, nor the hairpencil on the hindwing underside. Some other large pale species have patches of yellow scaling on underside forewing (*T. luteola* VAN NIEUKERKEN, 1990 and *T. victoris* VAN NIEUKERKEN, 1990). Females are easily separated by the distinct pointed ovipositor. Male genitalia well recognisable by incurved outer margin of valva, inner lobe of valva and pointed gnathos; female genitalia by narrow truncate T8 and pointed S7.

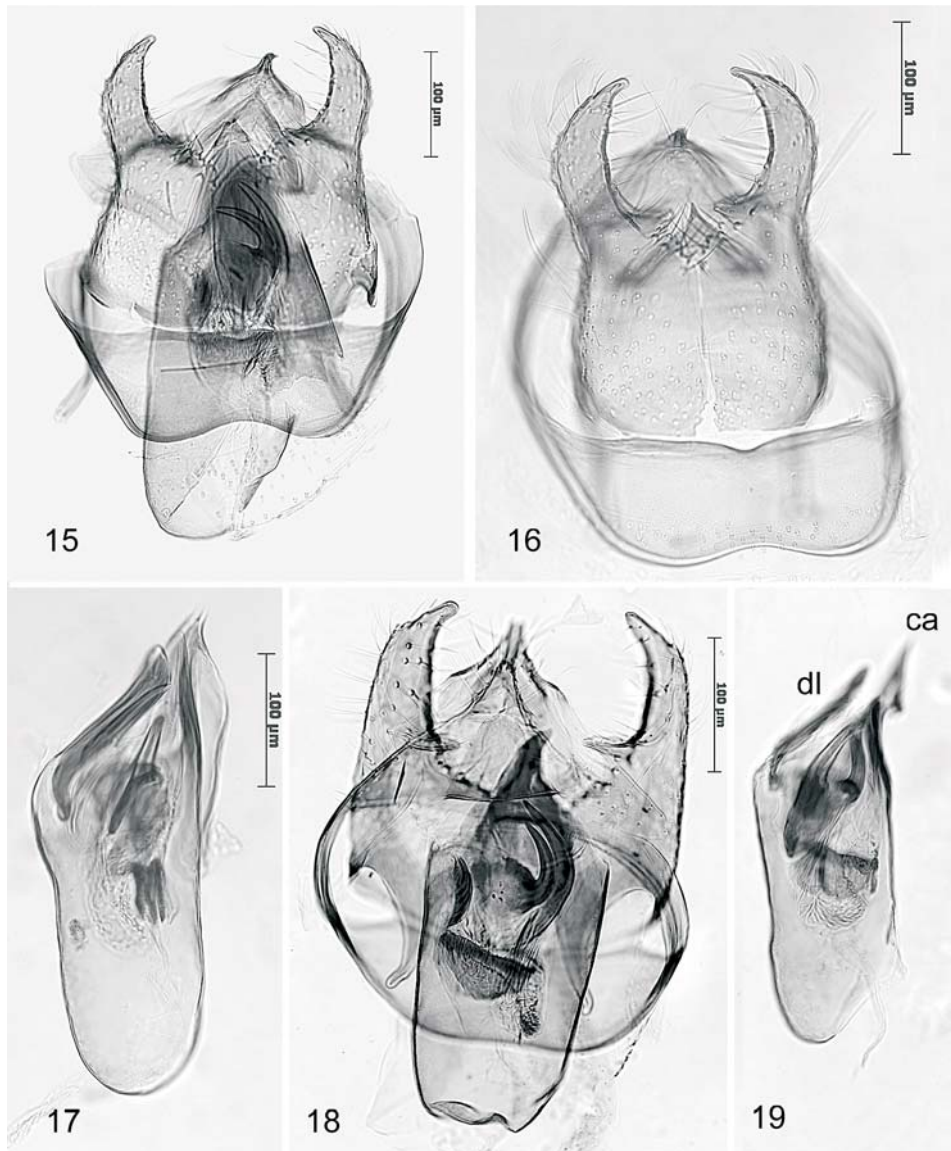
Description – Male (Fig. 2). Forewing length 2.9–3.65 mm; wingspan *ca.* 5.6–7.4 mm. Head: frontal tuft white, occasionally mixed with grey-brown, collar white, comprising piliform scales; scape white with some grey-brown tipped scales. Antennae with 37–44 segments. Thorax and forewings uniform white, irrorate with a variable amount of grey-brown tipped scales, giving the whole wing a greyish appearance; underside dark grey-brown. Hindwing white, underside with velvet patch of raised scales; a long white hairpencil arising near frenulum, inserting under forewing costal fold. Abdomen grey-white, anal tufts white.

Female. Forewing length 2.8–3.3 mm, wingspan *ca.* 5.6–7.1 mm. Antennae with 32–38 segments. Hindwing without velvet patch, abdomen without tufts, ovipositor distinctly pointed; otherwise as male.

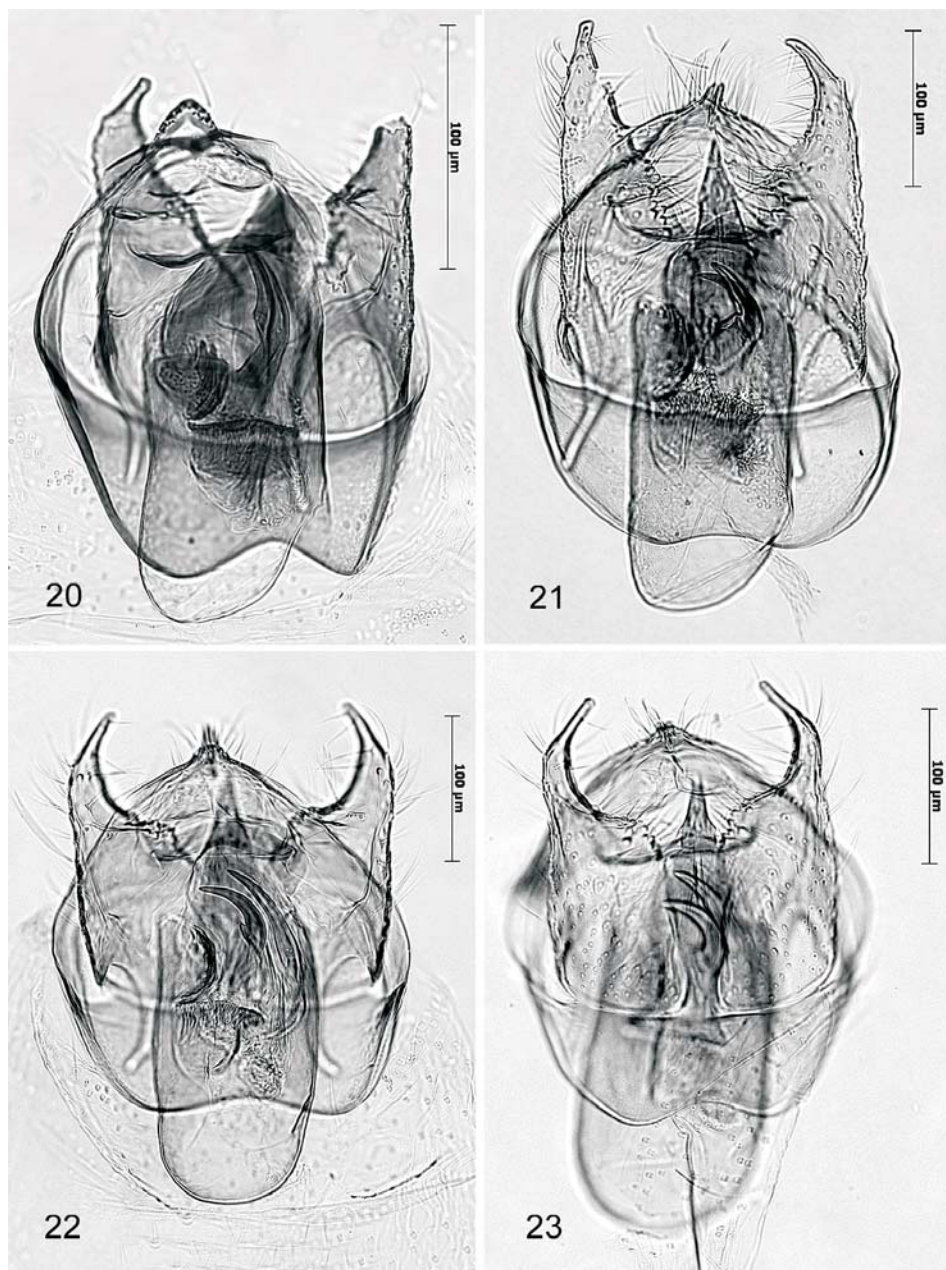
Male genitalia (Figs 15–17, 30–31, 35, 42). Capsule longer than wide. Vinculum hardly excavated anteriorly. Tegumen produced into pointed pseuduncus. Uncus split lengthwise, pointed. Gnathos with central element with a sharp central pointed tip (Fig. 31). Valva (Fig. 30) rather narrow, outer margin distinctly incurved in middle, with narrow conspicuous inner process on ventral surface; sublateral process long, transverse bar of transtilla relatively long. Aedeagus elongate; vesica with group of long needle like cornuti at anterior right hand side; two large curved cornuti (Fig. 35)



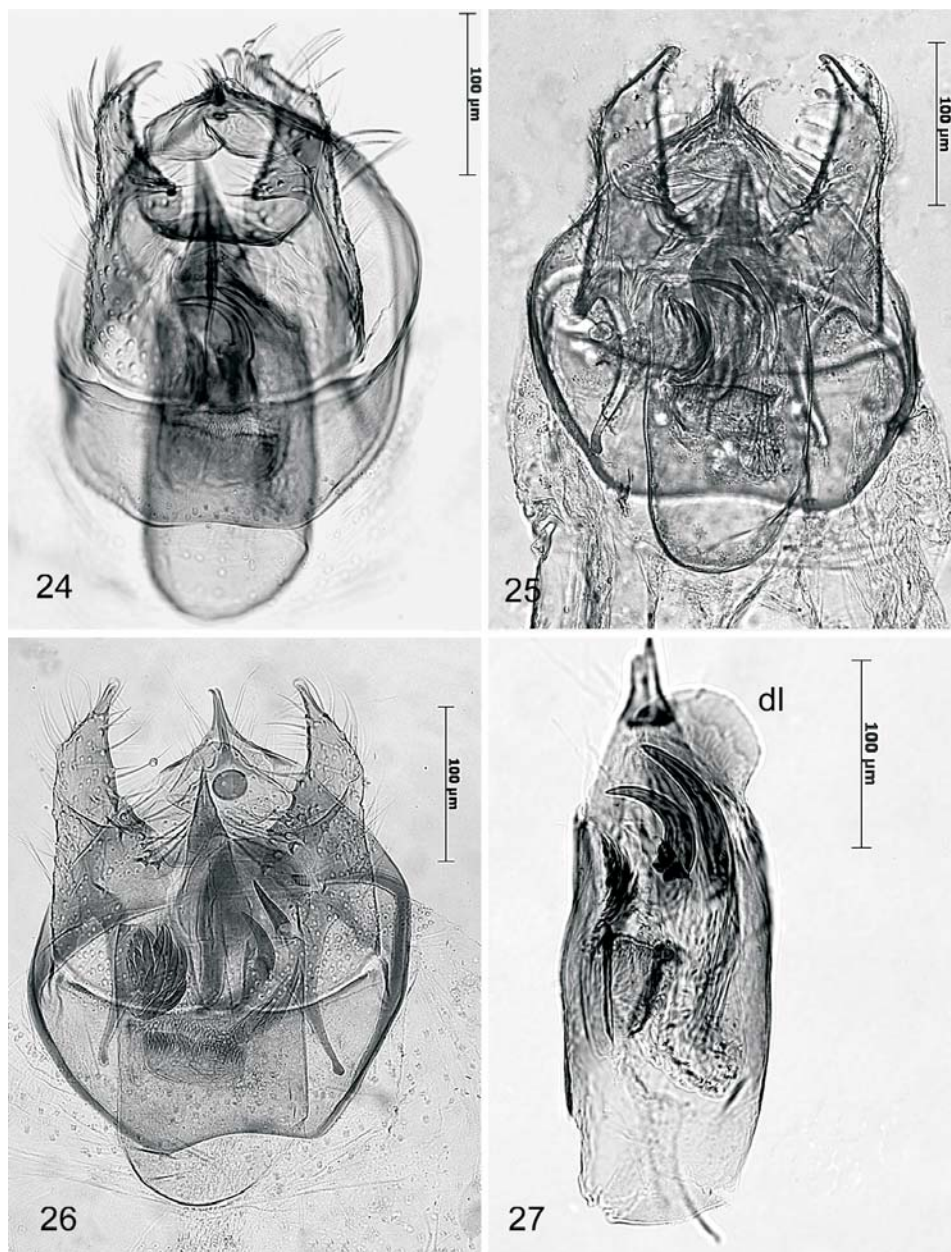
Figs 11–14. *Trifurcula ridiculosa*, male genitalia in ventral view: 11–12 = slide 3706, Madeira, Porto Santo, 13–14, Lectotype, slide BM30259, aedeagus in lateral view, ventral side to the right. Abbreviations: ca = carinal process, ds = dorsal lobe, vp = ventral process/juxta



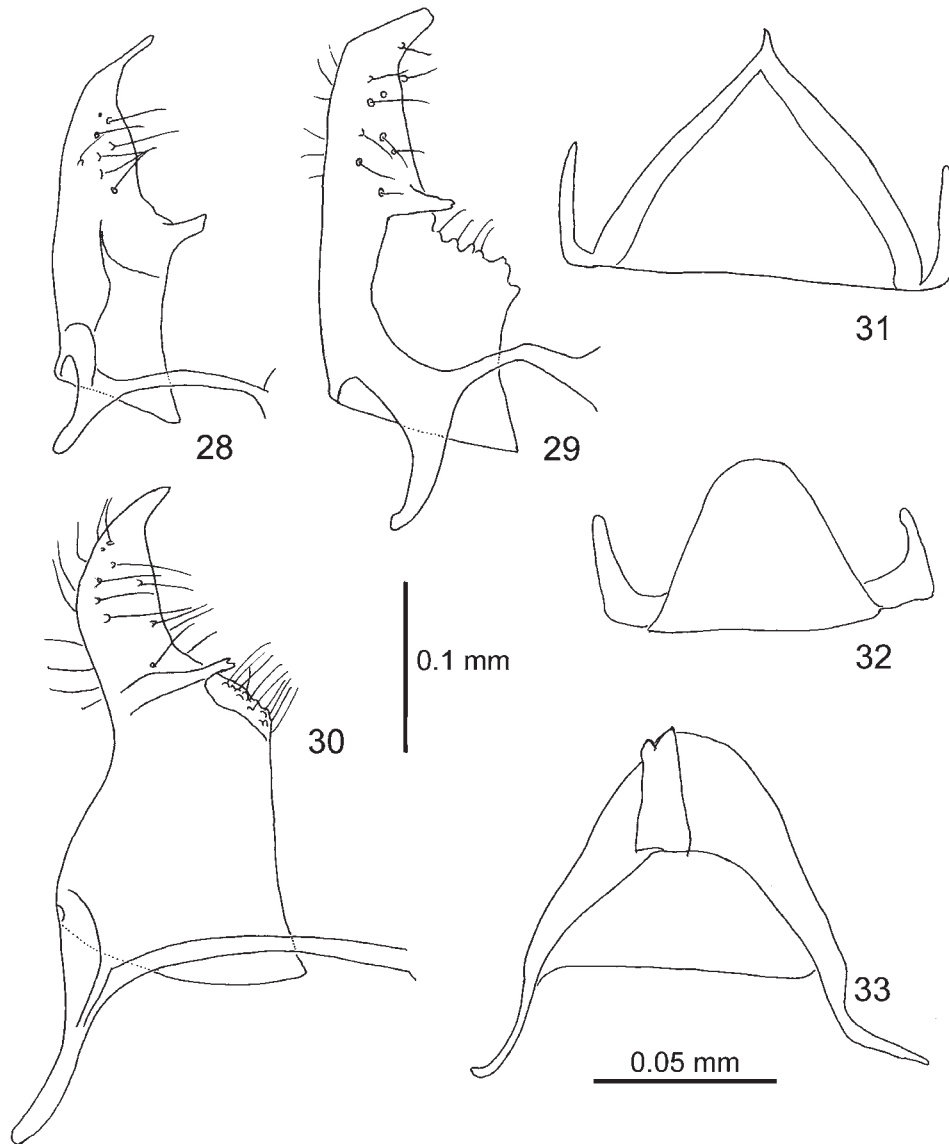
Figs 15–19. *Trifurcula (Levarchama)* species, male genitalia in ventral view (15, 16, 18) or lateral view (17, 19): 15–17 = *T. anthyllidella*, Spain (Almeria): Sierra Almahilla, slides 3715 (15) and 2795 (16, 17); 18, 19 = *T. peloponnesica*, Greece (Messinía): Exokhóri, slides 3710 and 3719. Abbreviations: ca = carinal process; dl = dorsal lobe



Figs 20–23. *Trifurcula (Levarchama)* species, male genitalia in ventral view: 20 = *T. cryptella*, slide 1719, Netherlands (Limburg): Kunrade, Kunderberg; 21 = *T. eurema*, slide 2296, Spain (Malaga), Sierra Blanca; 22–23 = *T. ortneri*, slides 2622, Germany (Thüringen): Bad Blankenburg and 3240, Spain (Murcia): Sierra Espuña. dl = dorsal lobe



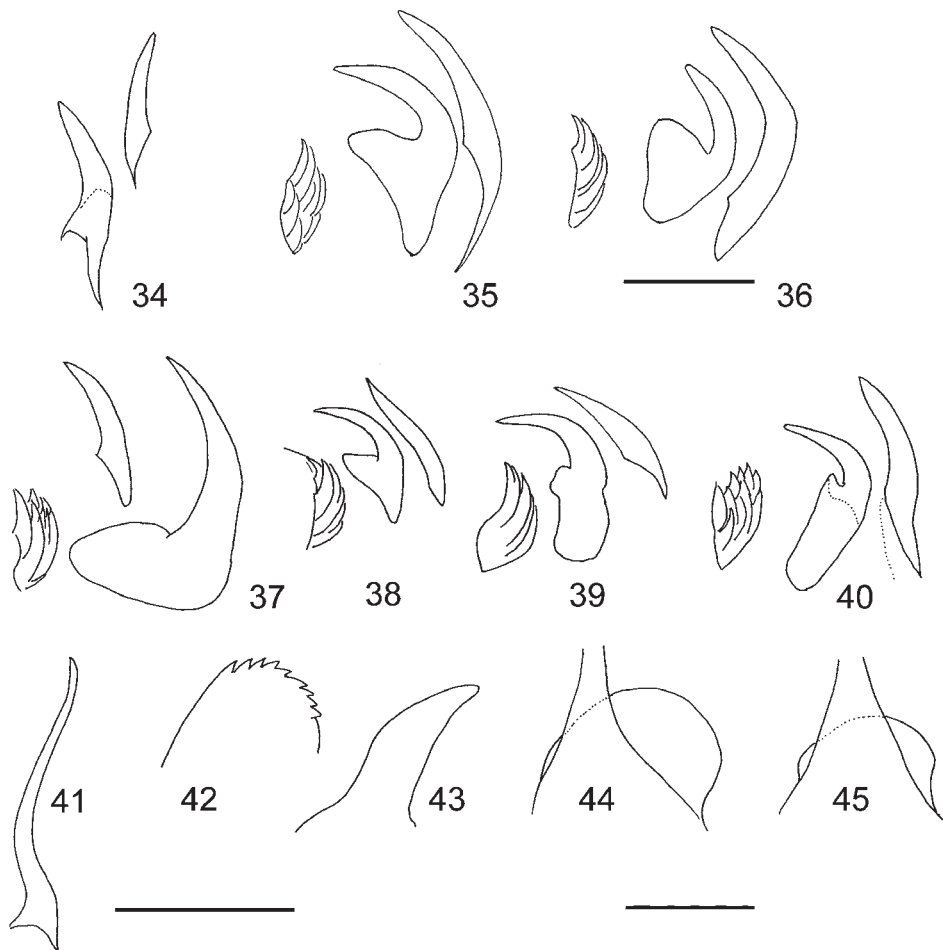
Figs 24–27. 24–26 = *Trifurcula (Levarchama) manygoza*, male genitalia in ventral view: 24 = slide 3717, Greece (Trikala), Oxinia, paratype, 25 = slide K1877, holotype, 26 = slide BÅB2005, Croatia, Velebit, Karlobag, paratype; 27 = *T. (L.) ortneri*, aedeagus, ventral view, slide 2363, Croatia, Makarska. Abbreviation: dl = dorsal lobe



Figs 28–33. *Trifurcula (Levarchama)* species, details of male genitalia. 28–30 = left valva in dorsal view, on same scale; 31–33 = gnathos in ventral view, on same scale. 28, 33 = *T. ridiculosa*, slide 2889, Madeira, São Vicente; 29, 32 = *T. peloponnesica*, slide 3710, Greece (Messínia): Exokhóri; 30, 31 = *T. anthyllidella*, slide 3715, Spain (Almeria): Sierra Almahilla

and semi globular group of close set curved cornuti at left side, also some minute cornuti; aedeagus dorsal side distally ending with rounded sclerotized lobe with serrate margin at right side (Fig. 42).

Female genitalia (Figs 47, 54–55, 58). Abdominal tip distinctly pointed. S7 particularly distinctly produced into cuspidate tip (Fig. 55), ventrally covered with many setae. T8 narrow, truncate at tip, longitudinally split, with *ca.* 11–12 setae at either side of medial division line and a row of *ca.* 7



Figs 33–45. *Trifurcula (Levarchama)* species, details of male genitalia: 34–40 = larger cornuti in ventral view, all on same scale: 34 = *T. ridiculosa*, slide 2889; 35 = *T. anthyllidella*, slide 3715; 36 = *T. peloponnesica*, slide 3710; 37 = *T. cryptella*, slide 1719; 38 = *T. eurema*, slide 2290, Denmark, Tipperne; 39 = *T. manygoza*, slide 3717; 40 = *T. ortneri*, slide 2622. 41–45 = strongly sclerotized dorsal lobe of aedeagus in ventral view, all on same scale (in 44 and 45 part of ventral process/carina drawn as well): 41 = *T. ridiculosa*, slide 2889; 42 = *T. anthyllidella*, slide 3715; 43 = *T. peloponnesica*, slide 3710; 44 = *T. ortneri*, slide 2363; 45 = *T. manygoza*, slide 3717. Scales 50 μ m

short setae along distal margin (Fig. 54). No distinct anal papillae. Anterior and posterior apophyses pronounced, of subequal length. Bursa total length ca. 1020 μm . Vestibulum with two indistinct sclerotizations and group of pectinations (Fig. 58). Corpus bursae elongate, suddenly narrowed anteriorly; signa subequal in length, ca. 420–440 μm ; 3–4 cells wide, outer margin with spiny margins. Ductus spermathecae convoluted almost from start, ca. 10 convolutions ending in elongate vesicle.

Biology – Hostplant: *Anthyllis cytisoides* and *A. terniflora*, small shrubs growing in garigue (mattoral) vegetations on limestone hills. Egg deposited on leaf underside. Leafmine (Figs 65–66, 72) starting as narrow, relatively straight, gallery with thin broken frass, later frass filling most of gallery, and gallery suddenly enlarging into elongate blotch; mine usually starting along leaf margin, later doubling back. Larval exit hole on leaf under- or upperside. Larva yellow, feeding with venter upwards.

Larvae found almost throughout the year, adults found from March to August, with extended period of emergence.

Distribution (Fig. 75) – Spain: Mallorca and along the South and East coast from Cadiz to Gerona on limestone, up into the mountains (VAN NIEUKERKEN *et al.* 2004a).

Material examined. Not repeated here, all the material was listed by VAN NIEUKERKEN *et al.* (2004a). Two records of this material have recently been removed, because they were incorrectly identified (VAN NIEUKERKEN 2006): Spain (Granada): Sierra Nevada, Carretera del Veleta, 1750 m, 15.vii.1971, J. KLIMESCH [re-identified as *T. cryptella*]; Spain (Málaga): Marbella 10 km N, 24–25.iv.2001, J. Junnilainen [re-identified as *Trifurcula pallidella*].

***Trifurcula (Levarchama) peloponnesica* VAN NIEUKERKEN sp. n.**
(Figs 3, 4, 18, 19, 29, 32, 36, 43, 48, 56, 57, 59, 73, 76)

? ‘eine Neptikel’; SKALA 1937: 110 [description of mines on Corsica].

? *Nepticula* sp.; BUHR 1942: 29 [description of mines on Corsica].

? *Trifurcula (Levarchama)* sp.; VAN NIEUKERKEN *et al.* 2006: 99 [Corsica].

Trifurcula sp. 2; GOZMÁNY 2007: in press [Greece].

Type material – Holotype ♂, Greece: Arkadia: Parnon O., 10 km W Leonidhion, near Moni Elonis, 34S FG5512, 11.ii.1990, leafmines on *Anthyllis hermanniae*, EvN no 90025, e. l. 21.iii.–15.iv.1990, E. J. VAN NIEUKERKEN, Genitalia slide EvN 3704 (RMNH).

Paratypes 4 ♂, 5 ♀♂, 1 ♀, same data as holotype; 3 ♂, 4 ♀, Messinía: 1.5 km NE Exokhóri, gorge in Taiyetos Oros, UTM 34S FF1386, 17.ii.1990, leafmines on *Anthyllis hermanniae*, EvN no 90054, e.l. 24.iii.–10.viii.1990, E. J. van Nieukerken. Genitalia slides 3179, 3710 (males), 3705, 3711 (females) (all in RMNH).

Other material – Leafmines on *Anthyllis hermanniae*, from the two localities cited above and from the following: Lakonia: 3.5 km N Molaioi, maquis, 34S FF6578, 120 m, 14.ii.1990, EvN no. 90036; Lakonia: Nomia, 7 km SW Monemvasia, 34S FF7958, 100 m, 12.ii.1990, EvN no. 90027;

Messinía: Exokhóri-Kardhamlí, 34S FF1084, 0–500 m, 15–17.vi.1984, EvN no. 84090; Messinía: Kardhamlí, gorge with dense maquis, 34S FF1084, 18.ii.1990, EvN no. 90061; all leg. E. J. VAN NIEUKERKEN (RMNH).

Diagnosis – *Trifurcula peloponnesica* is externally very similar to the allopatric and much larger *T. anthyllidella*. In the male genitalia it is easily distinguished by the rounded gnathos and the straight outer margin of the valva. Female genitalia differ from *anthyllidella* by pointed T8 (truncate in *anthyllidella*), group of spines in vestibulum in contrast to pectinations only and fewer convolutions in the ductus spermathecae (ca 7.5 against 10). Externally *T. peloponnesica* may be confused with other pale *Trifurcula* species in other subgenera, in the area where it occurs, particularly *T. (T.) pallidella*, which, however, is overall paler (see VAN NIEUKERKEN *et al.* 2004b).

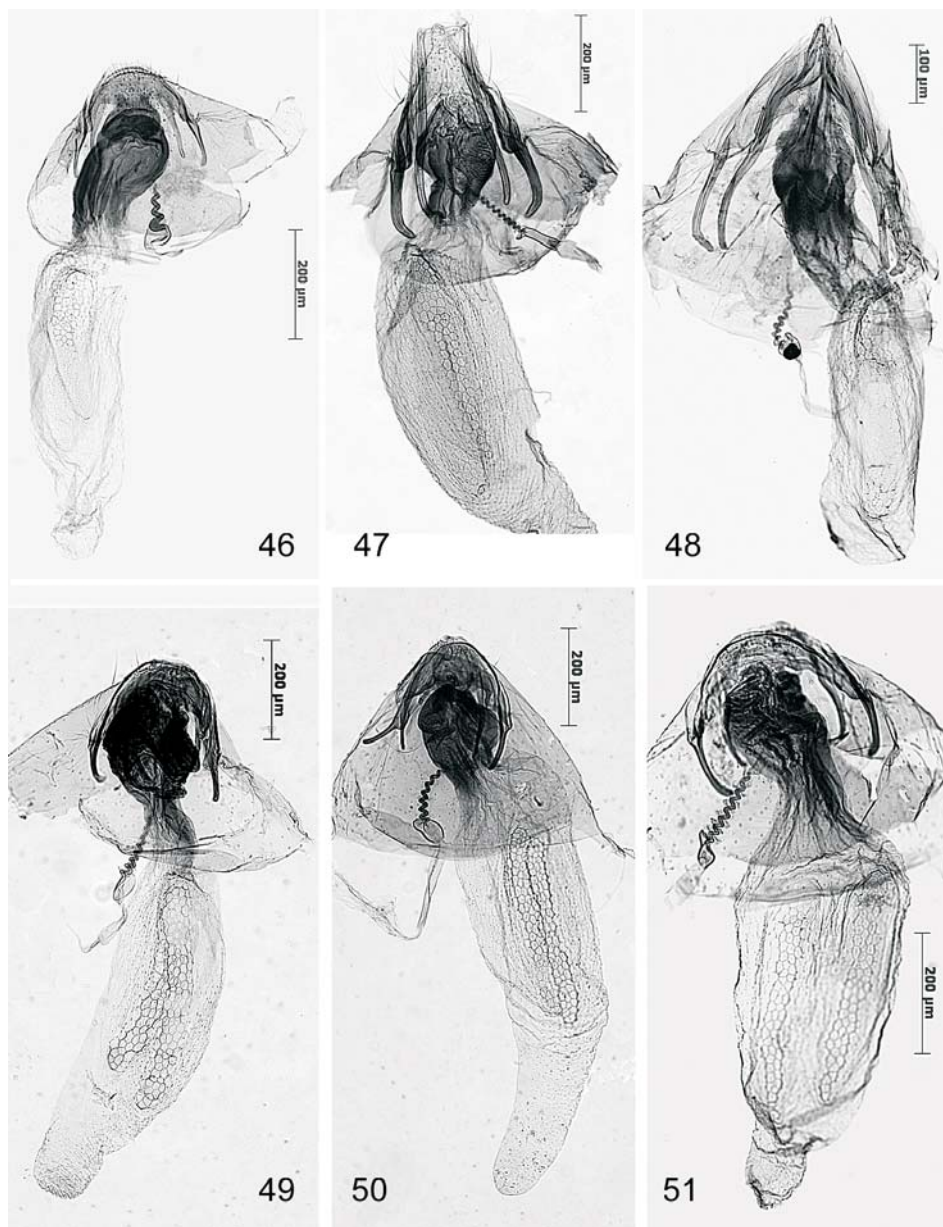
Description – Male (Fig. 3). Forewing length 2.15–2.8 mm, wingspan ca. 4.6–5.7 mm. Head: frontal tuft pale ochreous, mixed with white to almost completely white, collar white, comprising piliform scales; scape white, with some dark tipped scales. Antennae with 33–34 segments. Thorax and forewings cream white, irrorate with brown tipped scales; underside grey. Hindwings white, underside with velvet patch of raised scales; hairpencil on hindwing underside present, but very difficult to distinguish. Abdomen pale grey, anal tufts whitish.

Female (Fig. 4). Forewing length 2.25–2.6 mm, wingspan 4.9–5.3 mm. Antennae with 27–33 segments. Hindwing without velvet patch, abdomen without tufts, but with pointed ovipositor; otherwise as male.

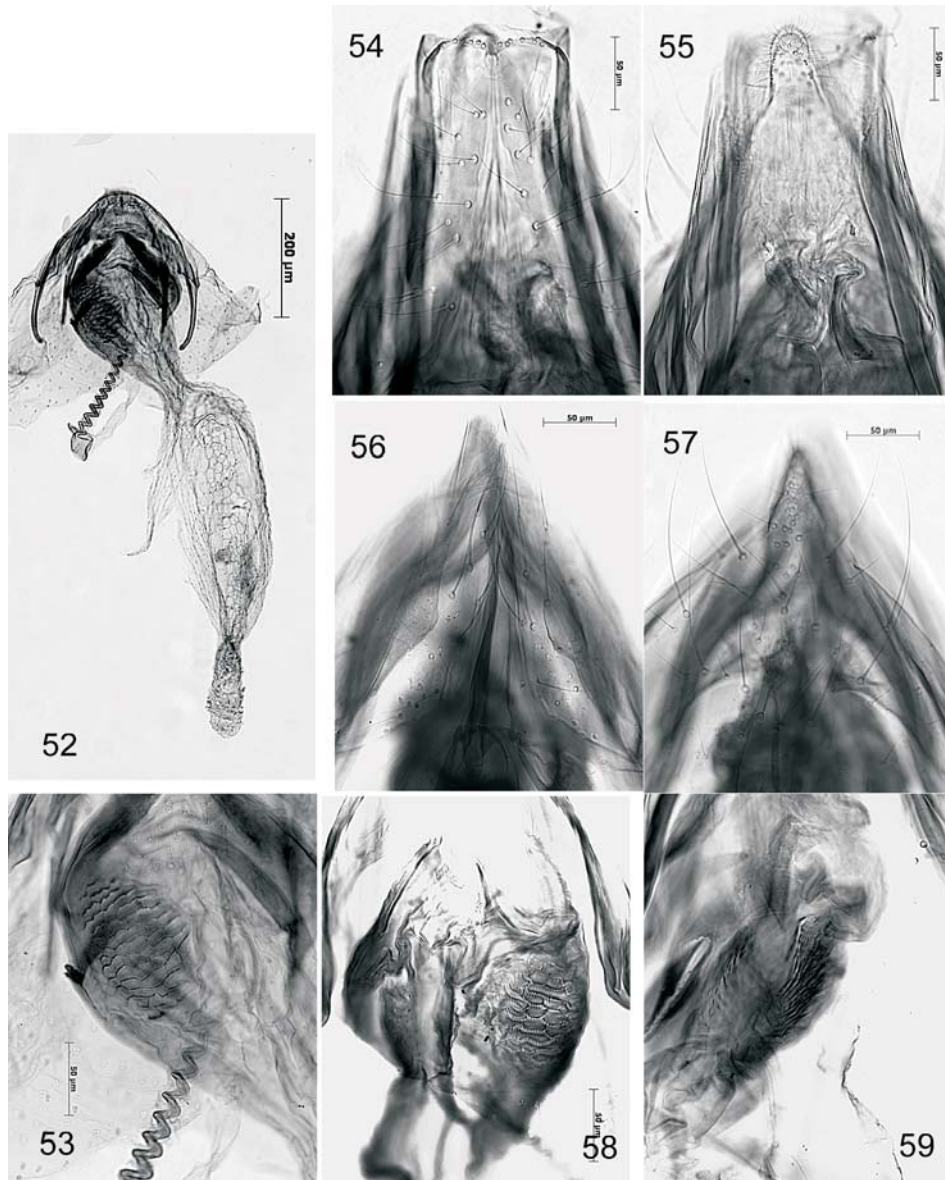
Male genitalia (Figs 18, 19, 29, 32, 36, 43). Capsule slightly longer than wide. Vinculum hardly excavated anteriorly. Tegumen produced into pointed pseuduncus. Uncus split lengthwise, pointed. Gnathos with broad rounded central element. Valva basally broad, suddenly narrowed slightly before middle, with narrow conspicuous inner process on dorsal surface, outer margin straight in ventral view; sublateral process relatively long, transverse bar of transtilla short. Aedeagus rather broad and short; vesica with group of long needle like cornuti at anterior right hind side; two large curved cornuti (Fig. 36) and semi globular group of close set curved cornuti at left side, also some minute cornuti; aedeagus dorsal side distally ending with pointed sclerotized lobe at right side (Fig. 43).

Female genitalia. Abdominal tip distinctly pointed. S7 particularly distinctly produced into narrow cuspidate tip (Fig. 57), ventrally covered with many setae. T8 approximately triangular, longitudinally split, with ca. 11–12 setae at either side of medial division line (Fig. 58). No distinct anal papillae. Anterior and posterior apophyses pronounced, of equal length. Bursa total length ca. 825–840 µm. Vestibulum with pocket of small spines and pectinations (Fig. 59). Corpus bursae elongate, slightly narrowed anteriorly; signa 2–3 cells wide, outer margin of incomplete cells with spiny margins. Ductus spermathecae convoluted almost from start, ca. 7.5 convolutions, ending in a globose vesicle.

Biology – Hostplant: *Anthyllis hermanniae*, a small shrub growing in garigue or phrygana vegetations. Egg deposition not observed. Leafmine (Fig. 73) starting as narrow, relatively straight, gallery with thin broken frass, later frass filling most



Figs 46–51. *Trifurcula (Levarchama)* species, female genitalia in ventral (46, 47) and dorsal view: 46 = *T. ridiculosa*, slide 3714, Madeira, São Vicente; 47 = *T. anthyllidella*, slide 3716, Spain (Almería): Sierra Almahilla; 48 = *T. peloponnesica*, slide 3705, Greece (Messinía): Exokhóri; 49 = *T. cryptella*, slide 1720, Netherlands (Limburg), Kunrade; 50 = *T. eureka*, slide 2297, Spain (Málaga), Sierra Blanca; 51 = *T. ortneri*, slide 2626, Hungary, Budapest, Rupphegy



Figs 52–59. *Trifurcula (Levarchama)* species, female genitalia and details thereof: 52–53 = *T. manygoza*, slide 3718, Greece (Trikala): Oxinia, Paratype, in 53 detail of pectinations in vestibulum; 54–55 = *T. anthyllidella*, slide 3716, detail of abdominal tip, dorsal T8 (54) and more ventral S7 (55); 56–57 = *T. peloponnesica*, slide 3705, detail of abdominal tip, dorsal T8 (56) and more ventral S7 (57); 58 = *T. anthyllidella*, slide 3716, detail of pectinations in vestibulum; 59 = *T. peloponnesica*, slide 3705, detail of spines and pectinations in vestibulum

of gallery, and gallery suddenly enlarging into elongate blotch. Larval exit hole on leaf underside. Larva yellow, feeding with venter upwards.

Larvae found plentiful in February, and a few still in June. Adults in laboratory emerging over long period from March to August.

Distribution (Fig. 76) – Up to now only known with certainty from Greece: Peloponnesus, where I found the species everywhere I searched the host. *Anthyllis hermanniae* occurs on Corsica, very locally on Sardinia, Malta, on the Italian mainland only in southern Calabria and the Peninsola Salentina, in Greece on the Peloponnesus, Evvoia, Crete, the Aegean islands, southern Thrace and the west coast of Turkey: Asia Minor plus a few isolated localities in Albania and Montenegro (see map in RIKLI 1946: 480); records for Sicily appear to be incorrect (ILDIS 2005). In Corsica H. Buhr found also leafmines on this plant (SKALA 1937; BUHR 1942), and it is very well possible that they also belong to *T. peloponnesica*. However, this should be confirmed by reared material. In May 2006, P. SAMMUT (pers. comm.) searched in vain for mines on Malta.

Etymology – *Peloponnesica*, an adjective, after the area where the species was first found.

Trifurcula (Levarchama) cryptella STAINTON
(Figs 5, 20, 37, 49, 61, 68)

Nepticula cryptella STAINTON, 1856 (12 January): 41. LECTOTYPE ♂ (designated by EMMET 1975): Switzerland: [Zürich, June], Frey, “6 2024”, STAINTON Coll., Genitalia slide 24090 (BMNH) [examined].

Nepticula cryptella FREY, 1856 (published later than May): 378.

? *Nepticula trifolii* SORHAGEN, 1885: 280. SYNTYPES: Leafmines, Germany: Hamburg, Eppendorfer Moor, Juli, on *Trifolium* sp., leg. Lueders & Sorhagen (types probably lost) [not examined, identity and identification host uncertain].

Levarchama cryptella; BEIRNE 1945: 207 [recombination]; EMMET 1976: 211 [British Isles].

Trifurcula cryptella; BORKOWSKI 1975: 501 [recombination, Poland].

Trifurcula (Levarchama) cryptella; VAN NIEUKERKEN & JOHANSSON 1990: 264 [redescription]; A. & Z. LAŠTŮVKA 1997: 134 [diagnosed]; VAN NIEUKERKEN *et al.* 2004a: 232 [Iberian Peninsula]; NIEUKERKEN *et al.* 2006: 65 [France]; VAN NIEUKERKEN *et al.* 2006: 380 [Spain, corrections].

Diagnosis – Differs from all other species by dark forewings with a costal spot only. In this it resembles a number of *Trifurcula (Glaucolepis)* species, such as *T. magna* A. et Z. LAŠTŮVKA, 1997 and *T. bupleurella* (CHRÉTIEN, 1907), which, however, lack the hairpencil on hindwing underside. Other Nepticulidae with this colour pattern may be confused, but differ by the generic characters. Male genitalia very similar to *T. eurema* and *manygoza*, but cornuti markedly larger (Fig. 37): largest 86–116 µm.

Biology – *T. cryptella* is the most polyphagous *Trifurcula* species, occurring on several *Lotus* and *Hippocrepis* species, and also on *Securigera varia* and *Anthyllis montana* (Table 1). These genera – although all in the tribe Loteae – are not closely related (ALLAN & PORTER 2000, ARAMBARRI 2000, ALLAN *et al.* 2003). The leafmines of *T. cryptella* (Fig. 68) are very similar to those of *eurema*, but in contrast to that, *T. cryptella* never pupates inside the mine; mines on *Lotus* are inseparable from those of *T. manygoza*. According to COMPTON (1981), *T. cryptella* prefers the terminal leaflet of a *Lotus* leaf (25 out of 33 mines). This author also provides information on three parasitic Hymenoptera (Eulophidae), reared from *T. cryptella*.

Present data suggest that *T. cryptella* is always univoltine, with the majority of larvae found from June to August, but especially in the south also in September and October. Adults fly from April to August.

Distribution – Widespread throughout Europe, northwards to southern parts of Norway and Sweden, but not in Finland, eastwards to Poland and the Balkan Peninsula, and south to the Mediterranean countries, but there rare and confined to mountainous regions: in Italy only recorded from the northern part, in Portugal in the Serra da Estrêla, in Spain in the Cantabrian mountains and possibly the Sierra Nevada. Absent from the Mediterranean islands. In this area not yet recorded from Albania, Belgium, Bosnia, Rumania, and Turkey.

Remarks – The record from Spain: Barcelona (VAN NIEUKERKEN *et al.* 2004a) was a misidentification for *T. eurema* (VAN NIEUKERKEN 2006). In the latter paper, *T. cryptella* was reported from the Sierra Nevada, based on material earlier misidentified as *T. anthyllidella*. These specimens were reported as reared from *Rhamnus myrtifolius*. I have checked photographs of these plants and mines kindly provided by ANDREAS SEGERER (Zucht: 1028), and they almost certainly represent *Stigmella* mines, most likely *S. alaternella* (LE MARCHAND, 1937) and the hostplant seems to be correctly identified (by P. LITZLER, Dijon). How the *cryptella* specimens got mixed into that material is a mystery. The specimens are very pale compared to normal *cryptella*, but show normal male genitalia. Further research of this population (if it exists) is required to find the correct host and to study the relationship between this (isolated?) population and more northern populations.

New data: Greece: one vacated mine, Fthiotis: Oítí Oros, 4 km E Pávlani, 34S FH2189, 850m, 16.ix.1980, *Hippocrepis emerus*, MENKEN & VAN NIEUKERKEN (ZMAN); mines, Ioánnina: Métsovon, 34T EK1503, 1000m, 23.ix.1980, *H. emerus*, MENKEN & VAN NIEUKERKEN (ZMAN); 1♂, 1♀, mines, Ioánnina: Voutonási, valley, 34T EK1003, 700m, 25.ix.1980, *H. emerus*, e.l. 9.iv.1980, MENKEN & VAN NIEUKERKEN (RMNH); mines, Messinía: Exokhóri, 34S FF1384, 300m, 17.vi.1984, *H. emerus*, E. J. VAN NIEUKERKEN.

Trifurcula (Levarchama) eurema TUTT
(Figs 6, 21, 38, 50, 62, 69, 70)

- Nepticula eurema* TUTT, 1899: 332. LECTOTYPE (designated by VAN NIEUKERKEN & JOHANSSON 1990): Great Britain: England [Melvish, Sutherland], Harper Coll., Walsingham Coll., Genitalia slide BM24091 (BMNH) [examined].
- Nepticula dorycniella* SUIRE, 1928: 128. SYNTYPES: France: Montpellier, iv.1927, SUIRE (depository unknown) (synonymised by VAN NIEUKERKEN 1986a: 15) [not examined].
- Nepticula gozmányi* SZÓCS, 1959: 417. HOLOTYPE ♂: Hungary: Római-fürdő, Budapest, 2 June 1957, e.l., leg. SZÓCS, gen. prep. no 669, GOZMÁNY (HNHM) (synonymised by VAN NIEUKERKEN 1986a: 15) [paratypes examined].
- Levarchama eurema* BEIRNE 1945: 207 [recombination]; EMMET 1976: 212 [British Isles].
- Stigmella eurema*; KLIMESCH 1951a: 66 [Italy].
- Trifurcula eurema*; BORKOWSKI 1975: 501 [recombination].
- Trifurcula (Levarchama) eurema*; VAN NIEUKERKEN & JOHANSSON 1990: 265 [redescription]; A. & Z. LAŠTŮVKA 1997: 135 [diagnosed]; VAN NIEUKERKEN *et al.* 2004a: 232 [Iberian Peninsula]; A. & Z. LAŠTŮVKA 2005: 10 [Sicily]; VAN NIEUKERKEN *et al.* 2006: 66 [France], VAN NIEUKERKEN *et al.* 2006: 380 [Spain, corrections].

Diagnosis – Differs from all other species of *Levarchama* by the dark forewings with a costal and dorsal spot, sometimes united as a fascia. Within European *Trifurcula* this colour pattern is unique. Other Nepticulidae with this colour pattern may be confused, but differ by the generic characters. Male genitalia almost inseparable from *T. manygoza* (see there), cornuti markedly smaller than in *T. cryptella* (Fig. 38): 49–75 µm.

Biology – Recorded from several *Lotus* and *Dorycnium* species, which, according to recent phylogenetic studies, belong to one clade (ALLAN *et al.* 2003). Here for the first time recorded from *Dorycnium rectum* and *Lotus cytisoides* (see material). The leafmines of *T. eurema* can usually be distinguished from sympatric *T. cryptella* by the habit of the larva to spin the cocoon inside the mine. However, occasionally populations or parts thereof do not pupate inside the mine. This may be caused by climatic conditions. *T. eurema* has at least two broods annually, probably more in southern Europe, where larvae can also be found in winter.

Distribution – Widespread throughout Europe, very similar to *T. cryptella*, northwards to southern Norway (AARVIK *et al.* 2004) and Sweden, but not in Finland, Poland or the Baltic states; more widespread and common in the Mediterranean region than *cryptella* and also common on the larger Mediterranean islands and eastwards to Bulgaria (BUSZKO & BESHKOV 2004), Asiatic Turkey and Ukraine (new record). In this area not yet recorded from: Albania, Belgium, Bosnia, Rumania and Serbia-Montenegro.

New data: Bulgaria: 1 ♂, 1 ♀, Burgas, 40 km SE, Ropotamo, 35T NG68, 16–20.vi.2001, J. Junnilainen (coll. Junnilainen); Croatia: 22 ♂, 7 ♀, Krk, several localities, 1974–2006, G. Baldiz-

zone, E. Jäckh (GB, RMNH, USNM); Germany: 1 ♂, mines, Nordrhein-Westfalen, Marmagen, 1 km NW: NSG Gillesbachtal, 32U LA2795, 490 m, 5.x.1999, *Lotus corniculatus*, e.l.7.iv.2000, E. J. van Nieukerken & T. Jin (RMNH); Greece: 1 ♂, Argolis, Epidavros, 34S FG8361, 19–20.iv.1983, M. Fibiger (ZMUC); 1 adult, Chalkidiki, Petralona, 34T FK8370, *Dorycnium hirsutum*, e.l. vi.1991, A. & Z. LAŠTŮVKA (AL); 4 ♂, 5 ♀, mines, Fókis, Parnassos Oros, N. slopes, 5–6 km S Polidhrosos, 34S FH3573, 1100 m, 28.ix.1980, *D. pentaphyllum*, e.l. 5–22.v.1981, Menken & van Nieukerken (RMNH); 1 ♂, Fthiotis, 2 km N. Kamena Vourla, 34S FH5494, 5.vii.1985, P. Skou & B. Skule (ZMUC); 13 ♂, Ilia, Loutra Killinis [34S EG19], 12–19.vi.1981, P. Grotenfelt (FMNH); mines, Ilía, Olympia, 34S EG5865, 150 m, 7–9.vi.1984, *D. hirsutum* and *D. rectum*, E. J. VAN NIEUKERKEN (RMNH); 1 ♂, Ilía, Olympia surr., 34S EG56, 100 m, 1.x.1993, Lingenhöhle (RMNH); 3 ♂, Ioannina, Pindos Konitsa, Pades [34T DK93], 6.vii.1981, P. Grotenfelt (FMNH); 3 ♂, 1 ♀, Kerkyra, Benitsai, 34S DJ0576, 1–14.vi.1978 (MZHF); 4 ♂, Korinthia, Ag. Vassilios, 17.vi.1996, A. & Z. LAŠTŮVKA (AL); 1 ♀, Lakonia, 5 km S Monemvasia, 34S FF8156, 28.vii.1979, G. Christensen (ZMUC); 1 ♀, Lakonia, 5 km S Monemvasia, 34S FF8156, 13.ix.1980, G. CHRISTENSEN (RMNH); 1 ♂, Lakonia, 7 km SW Monemvasia, 34S FF7958, 22.ix.1979, G. CHRISTENSEN (RMNH); 1 ♂, Lakonia, 7 km SW Monemvasia, 34S FF7958, 25.vii.1980, G. CHRISTENSEN (ZMUC); 12 ♂, 4 ♀, mines, Lakonia, Monemvasia, Kastro: on cliff, 34S FF8362, 12ii.1990, *L. cytisoides*, e.l. 16.iii–14.iv.1990, E. J. van Nieukerken (RMNH); 2 ♂, Messinía, Exokhori, 34S FF1084, 18.vi.1997, A. & Z. LAŠTŮVKA (AL); 2 ♂, Messinia, Filiatra [34S EG51], 18.ix.1980, P. Grotenfelt (FMNH); 4 ♂, Messinía, Kardamili, 34S FF18, s.l., 2–3.vi.1994, O. Karsholt (ZMUC, RMNH); 2 ♂, Messinía, Kardhamili, gorge with dense maquis, 34S FF1084, 18.ii.1990, *D. hirsutum*, e.l. 30.iii–9.iv.1990, E. J. van Nieukerken (RMNH); 1 ♀, Xanthi, 20 km NW Xanthi, at Kallithea, 35T LF1069, 650 m, 6.vii.1985, P. Skou & B. Skule (ZMUC); Turkey: 1 ♀, Ankara, 10 km NW Kizilcahamam, 36T VK68, 1150–1250 m, 6.viii.1989, Fibiger & Esser (ZMUC); 1 ♂, 1 ♀, Istanbul: Kemerburgaz, 35T PF6058, 250 m, 28.iii.1975, *Dorycnium* sp., e.l. 2–9.v.1975, G. Deschka (SMNK); 1 ♂, Nigde, Ciftehan, Taurus, 36S XG5455, 1100 m, 11.viii.1965, M. & E. Arenberger (SMNK); Ukraine: 1 ♂, Luganskaya, Melovoj r., zap. Strel'tsovskaya step', 6.vii.2002, A. Bidzilya. (coll. Bidzilya).

Trifurcula (Levarchama) manygoza

VAN NIEUKERKEN, A. LAŠTŮVKA et Z. LAŠTŮVKA sp. n.
(Figs 7, 24–26, 39, 45, 52–53, 63, 76)

Trifurcula sp. 1; GOZMÁNY 2007: in press [Greece].

Type material – Holotype ♂, Croatia: 1 ♂, Krk, Misucaynica [33T VK7289] 6.viii.1976, G. Baldizzone, genitalia slide Kl877 (RMNH).

Paratypes 38 ♂, 5 ♀ – Croatia: 1 ♂, Dugopolje near Split [33T XJ22], 28.vii.2006, about 10 larvae in mines on *Lotus corniculatus*, e.l. viii. 2006, A. Laštůvka (AL); 1 ♂, Fiume [Rijeka], 3.V., Krone, [as confertella Fuchs. in coll. Krone], genitalia slide EvN3713 (HNHM); 2 ♂, Istria, Rabac, 15.viii.1997 and 20.viii.1998, A. LAŠTŮVKA (AL); 1 ♂, Krk, Misucaynica, 19.viii.1976, at light, E. Jäckh, Abdomen lost (USNM); 1 ♂, Krk, Misucaynica [33T VK7289] 6.viii.1976, G. Baldizzone, genitalia slide Kl874 (GB); 1 ♂, Velebit, 10 km E Karlobag [33T WK1729], 26.vi.1983, B. Å. Bengtsson, genitalia slide BÅB2005 (coll. Bengtsson); 2 ♂, Volosca [Volosko, 33T VL42], Krone (HNHM) – Greece: 1 ♂, Kastoria, Aposkepos [34T EK29], 11.vi.1996, A. & Z. LAŠTŮVKA (AL); 1 ♂, Kozani, Galáni [34T EK7267], 9.vi.1997, A. & Z. LAŠTŮVKA (AL); 1 ♂, Pindos [Ioánnina], Katarata [34S EK10], 3.vii.1981, P. Grotenfelt, genitalia slide EvN3764 (FMNH); 7 ♂, Pindos [Ioánni-

na], Konitsa, Pades [34 TDK93], 6.vii.1981, P. Grotenfelt, genitalia slide EvN3765 (FMNH, RMNH); 19 ♂, 5 ♀, Trikala, Oxinia, [34S EK40], 8.vi.1999, genitalia slides EvN3717, 3718 (AL, 1 ♂, 1 ♀ RMNH).

Diagnosis – *Trifurcula manygoza* is recognised by its uniform pale ochreous wings, externally very similar to *T. ortneri*; the male genitalia are almost inseparable from those of *T. eurema*, the female from those of *T. cryptella*. From *T. ortneri* it is separated by the more obtuse angle of the valva inner margin, the less conspicuous dorsal lobe of aedeagus and the slightly smaller cornuti (longest 50–82 µm against 97–133 in *ortneri*).

Description – Male (Fig. 7). Forewing length 2.1–2.7 mm, wingspan *ca.* 4.7–6 mm. Head: frontal tuft, yellowish white to orange; collar white, comprising piliform scales; scape white. Antennae pale grey, with 32–34 segments. Thorax and forewings uniform yellowish white, with ochreous tipped scales; underside grey. Hindwings white, underside white, with velvet patch of raised scales; a long, ochreous, hairpencil arising on hindwing underside near frenulum, inserting under the forewing costal fold. Abdomen with anal tufts yellowish.

Female. Forewing length 2.55 mm, wingspan *ca.* 5.5 mm. Antennae with *ca.* 29 segments. Hindwing without velvet patch, abdomen without tufts; otherwise as male.

Male genitalia (Figs 24–26, 39, 45). Vinculum slightly indented anteriorly. Tegumen produced into pointed pseuduncus. Uncus split lengthwise, pointed. Gnathos with rounded central element. Valva elongate triangular, with obtuse angle medially on inner margin; sublateral process rather long, transverse bar of transtilla longer than sublateral process. Aedeagus short (Fig. 39) and group of long needle like cornuti at anterior right hind side; two large curved cornuti (Fig. 39) and semi globular group of close set curved cornuti at left side, also some minute cornuti; aedeagus dorsal side distally ending with rounded sclerotized lobe at right side (Fig. 45); juxta ending into bifurcate ventral carina.

Female genitalia (Figs 52, 53, 63). T8 divided, slightly narrowed posteriorly, each half with *ca.* 21 setae; anal papillae each with 15–17 setae; apophyses subequal in length. Bursa total length 872 µm. Vestibulum with patch of close set pectinations near spermathecal papilla (Fig. 53); signa 3–4 cells wide. Ductus spermathecae with *ca.* 9½ convolutions, ending in a globose vesicle.

Biology – Hostplant: *Lotus corniculatus*. Egg deposited on leaf underside. Leafmine starting as narrow, rather straight gallery with frass in thin central line, often close to leaf margin, suddenly enlarging in large blotch, often consuming entire leaflet. Larval exit hole on leaf underside. Larva yellow. Cocoon made outside mine.

Mines are inseparable from those of *T. cryptella* on the same host, so that vacated mines on *Lotus* in the Balkan area, where both species occur, cannot be identified.

Larvae found in July, adults collected in June and August.

Distribution (Fig. 76) – Croatia and north-western Greece. To be expected in the other Balkan countries.

Etymology – Manygoza: a noun in apposition. It is a pleasure for us to dedicate this species to Dr. LÁSZLÓ GOZMÁNY, in honour of his contributions to lepidopterology and particularly in his stimulation of studies on the Greek fauna. Since the name *Trifurcula gozmanyi* was already in use (unfortunately synonymised with *T. eurema*), we are using an anagram of his name: it should be pronounced in the Latin way with the ‘y’ as vowel (similar to ‘i’) and not in the Hungarian way where the ‘y’ only changes the sound of the previous ‘n’.

Trifurcula (Levarchama) ortneri KLIMESCH
(Figs 8, 22, 23, 27, 40, 44, 51, 64, 67, 74, 77)

Nepticula (Levarchama) ortneri KLIMESCH, 1951b: 66. SYNTYPES: AUSTRIA: Wien, Leopoldsb-
berg, late viii–late ix., *Coronilla montana*, e.l. 28.iii – mid v., A. Ortner (ZSM) [not examined].

Stigmella ortneri; KLIMESCH 1961: 763 [Austria].

Nepticula ortneri; SZÓCS 1965: 89 [Hungary].

Trifurcula ortneri; BORKOWSKI 1975: 501 [recombination, Hungary].

Trifurcula (Levarchama) ortneri; STEUER 1988: 313 [Germany]; VAN NIEUKERKEN & JOHANSSON
1990: 267 [redescription]; A. & Z. LAŠTŮVKA 1997: 136 [diagnosed; Slovakia]; VAN
NIEUKERKEN *et al.* 2004a: 233 [Iberian Peninsula]; HUEMER & TRIBERTI 2004: 199; [Italy];
A. & Z. LAŠTŮVKA 2005: 10 [Italy]; VAN NIEUKERKEN *et al.* 2006: 66 [France].

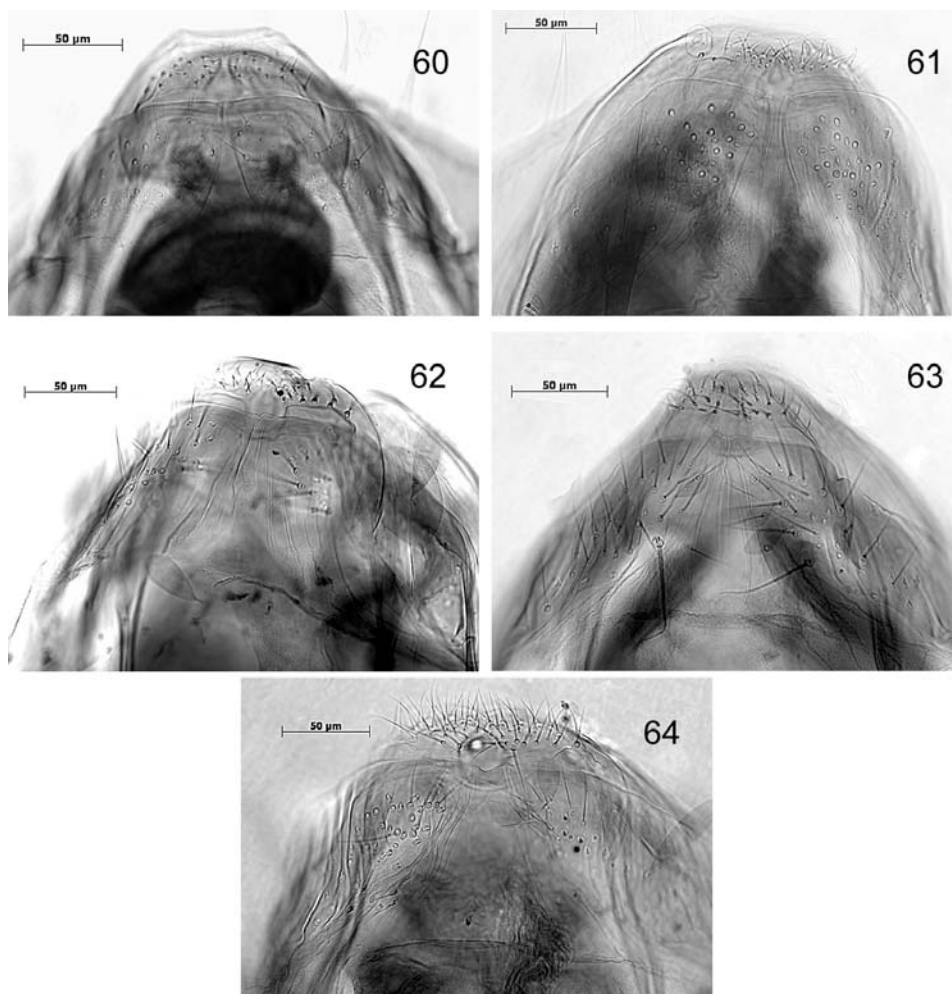
Diagnosis – Externally *T. ortneri* cannot be distinguished from *T. manygoza* (see there). The male genitalia are distinguished from *manygoza*, *eurema* and *cryptella* by the valva with a prominent right or almost right angle medially in the inner margin (Figs 22–23). The dorsal lobe of the aedeagus is more prominent than in the related species (Figs 27, 40). Female genitalia hardly separable from those of *T. eurema*, but anal papillae usually with more setae (14–22 in contrast to 11–14); separated from *T. manygoza* by the smaller number of coils (6–7½) in the ductus spermathecae.

Biology – Recorded from a variety of perennial *Coronilla* species, here recorded for the first time from *C. viminalis* SALISB. (see material). A possible record from *Hippocrepis emerus* (HUEMER & TRIBERTI 2004) (as *Coronilla emerus*) is based on adults beaten from that plant; since *Coronilla minima* occurs on these localities as well, this record is regarded as dubious and omitted from Table 1. An earlier record from *H. emerus* (A. & Z. LAŠTŮVKA 1997) was based on a misidentification of *Coronilla valentina* (Z. LAŠTŮVKA, *in litt.* 7.vi.2006), which superficially resembles *H. emerus*.

T. ortneri is usually found on limestone, the preferred soil for all recorded hosts.

The leafmine (Figs 67, 74) differs from most other *Levarchama* species, because the transition between gallery and blotch is less abrupt, and the blotch therefore more a widened gallery.

Distribution (Fig. 77) – Widespread in Western Mediterranean: Portugal: Algarve (new record), Spain, France, three records in Italy (Emilia-Romagna, Veneto), one record from Croatia: Dalmatia, Morocco and Algeria (new records), eastern Austria, Hungary, Slovakia, Germany: Baden-Württemberg and Thüringen. The record for Morocco is based on mines (on *Coronilla viminalis*) only, which resemble those on *Coronilla minima* in Spain closely. Since no other species is known to make leafmines on *Coronilla* in this area, and *T. ortneri* is also found in Algeria,



Figs 60–64. *Trifurcula (Levarchama)* species, dorsal view of female terminalia (T8 and T9 or anal papillae): 60 = *T. ridiculosa*, slide 3714; 61 = *T. cryptella*, slide 1720; 62 = *T. eurema*, slide 2297; 63 = *T. manygoza*, slide 3718; 64 = *T. ortneri*, slide 2625, Germany (Thüringen), Bad Blankenburg

the identity of these mines as *T. ortneri* is most likely correct. Also the Portuguese record is based on mines only, on *Coronilla valentina* ssp. *glauca*.

Remarks – Earlier we stated (VAN NIEUKERKEN *et al.* 2004a, 2006) that specimens reared from *Coronilla minima* are always smaller and more greyish than central European specimens reared from *C. coronata*. Upon re-examination of the material, I cannot maintain this statement: although the material reared from *C. minima* does include some very small specimens, many specimens have a size and coloration not different from other populations. Leaflet-size of *C. minima* is variable, and it is expected that very small leaflets will produce smaller adults.

New data: Algeria: 2 ♂, Krenchela [=Khenchela], [32S LE32], 27.iv.1906, Walsingham (BMNH); 2 ♂, 3 ♀, many mines, Croatia: Dalmatia, Makarska [33T XJ5801], 6.x.1980, *Coronilla vaginalis* [det. E. van Nieukerken], e.l. iii.1981, J. Klimesch (ZSM); Germany: 1 ♂, 1 ♀, Baden-Württemberg, Schwäb. Alb., Urach, 4 km SSW [32U NU27], 630 m, e.l. vi.1978, vi.1979, L. Süssner (TLMF); Morocco: 3 vacated mines, Marrakech, Tahanaoute – Asni, on vertical siliceous cliffs [29R NQ9863], 1000 m, 16.v.1981, *Coronilla viminalis* Salisb., S. Castroviejo (ex Sevilla Herbarium, in RMNH); Portugal: vacated leafmines, Silves [29S NB51], 23.iv.1992 and 13.v.1999, on *C. valentina* ssp. *glauca*, M.F.V. Corley (coll. Corley).

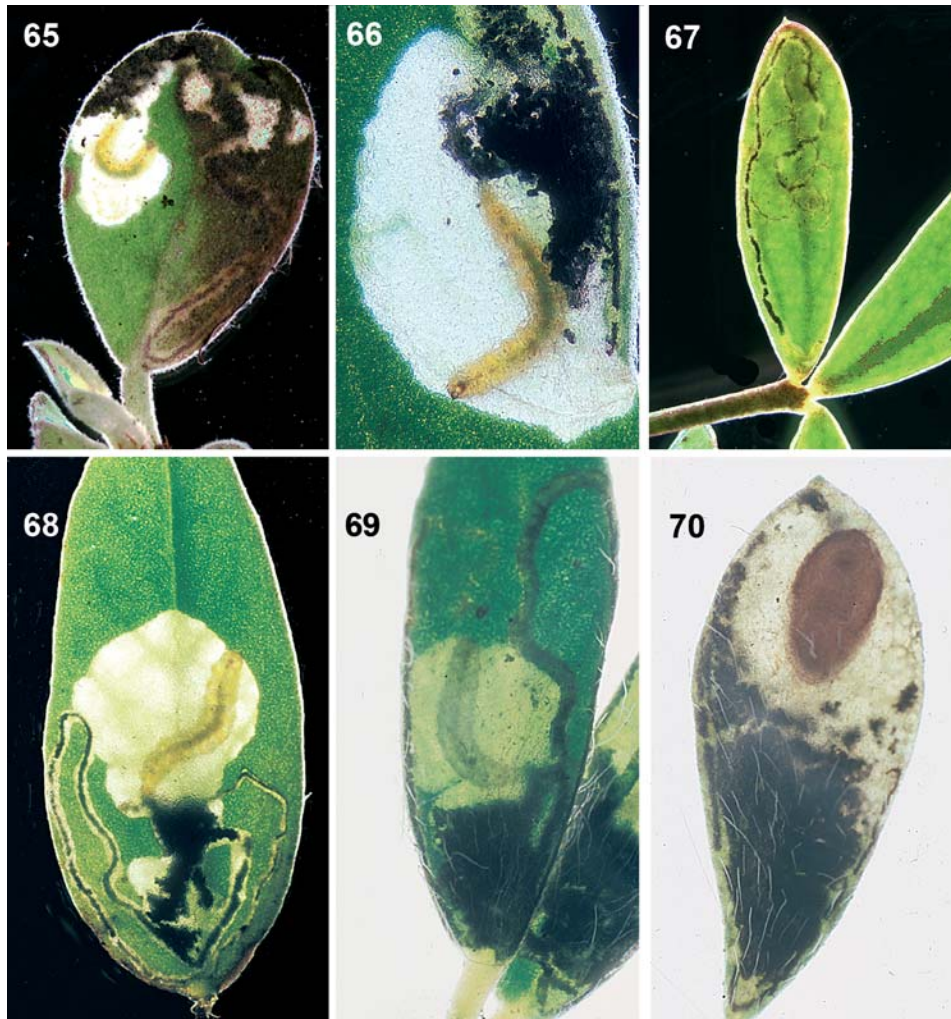
DISCUSSION

Phylogeny

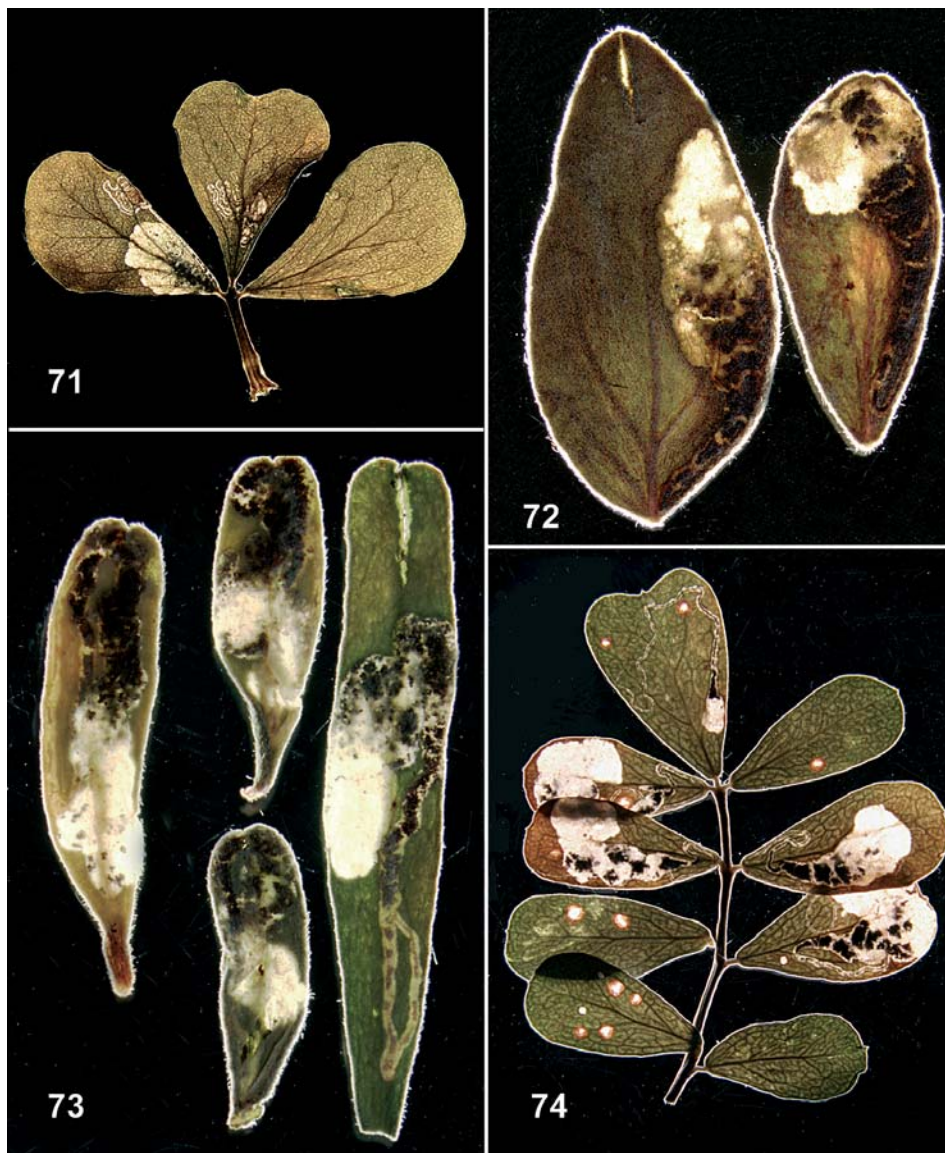
An exhaustive search with Paup software for maximum parsimony found four shortest trees, with a tree length of 34 steps. 17 out of the 24 characters are parsimony informative, the indexes are CI = 0.765 and RI = 0.758. As outgroups the species *Trifurcula (Glaucolepis) headleyella*, *T. (T.) immundella* and *T. (T.) subnitidella* represent the other subgenera of *Trifurcula*. The Majority Rule Consensus Tree is given in Fig. 78. The shown position of *T. manygoza* is supported in three of the four trees, all other branches are the same as in the strict consensus tree.

On the basis of this analysis, the monophyly of *Levarchama* is supported by two apomorphies: the split uncus (character 9) and the anteriorly narrowed bursa (8). *T. ridiculosa* is sister to a core *Levarchama*, which monophyly is supported by four characters: vestibulum with group of pectinations (4), ductus spermathecae with many coils (7), aedeagus with globose group of cornuti (18) and male with hairpencil on hindwing underside (22). The monophyly of the species pairs *anthyllidella-peloponnesica* is supported by at least four characters in the female genitalia; however, some of these may be correlated with the narrowed ovipositor, an adaptation to oviposition on hairy leaves. Although the pair *eurema-cryptella* is

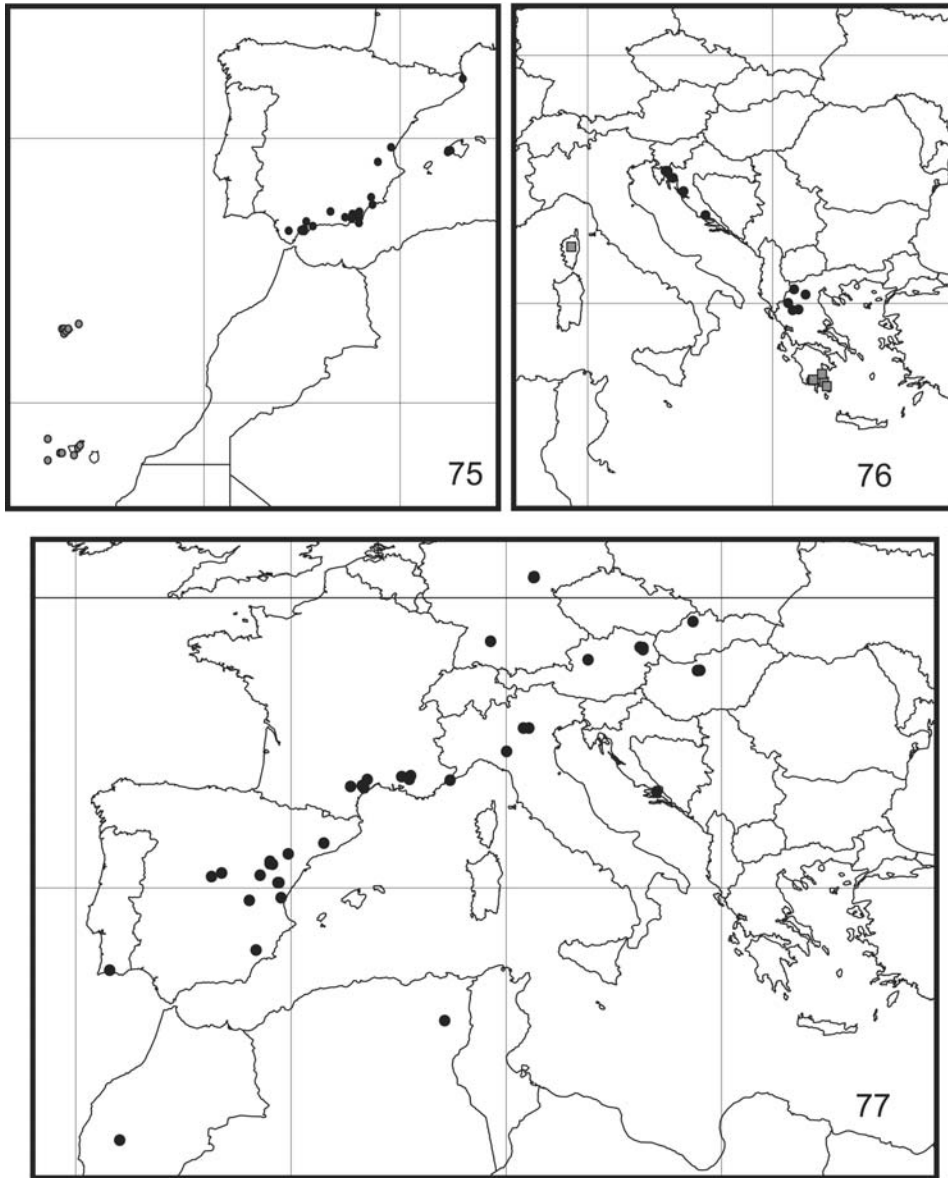
monophyletic in this analysis, this is only supported by one character (21). Sister-group relationship of *T. manygoza* and this pair is weakly supported by the valval shape (14). A possible – not scored – character for *T. ortneri* and this group of three, is the shape of dorsal lobe of the aedeagus, but this may also be the



Figs 65–70. *Trifurcula* (*Levarchama*) species, leafmines with larvae: 65–66 = *T. anthyllidella* on *Anthyllis cytisoides*, resp. Spain (Cádiz), Alcalá de los Gazules, 6.i.2001 and Spain (Málaga), Istán, 10.ii.1984; 67 = *T. ortneri* on *Coronilla minima*, young larva, Spain (Madrid), Los Santos de la Humosa, 11.i.2001; 68 = *T. cryptella* on *Securigera varia*, France (Savoie), Modane, 1100–1200 m, 24.viii.1979; 69–70 = *T. eureka* on *Dorycnium pentaphyllum*, Greece (Fókis), Parnassos Oros, 1100 m, 28.ix.1980, in 70 larva in cocoon



Figs 71–74. *Trifurcula* (*Levarchama*) species, leafmines in dried plants: 71 = *T. ridiculosa* on *Lotus pedunculatus*, Madeira, Curral das Frias [Freiras], 850 m, 21.ix.1997; 72 = *T. anthyllidella* on *Anthyllis cytisoides*, Spain (Cádiz), Alcalá de los Gazules, 6.i.2001; 73 = *T. peloponnesica* on *Anthyllis hermanniae*, Greece (Messinía), Exokhóri, 17.ii.1990; 74 = *T. ortneri* on *Coronilla valentina*, Croatia, Makarska, 6.x.1980



Figs 75–77. *Trifurcula* (*Levarchama*) species, distribution: 75 = *T. anthyllidella* (black dots in Spain) and *T. ridiculosa* (grey dots in Macaronesia); 76 = *T. manygoza* (black dots) and *T. peloponnesica* (grey squares), record for Corsica uncertain, based on vacated mines; 77 = *T. ortneri*

plesiomorphic shape in the core *Levarchama* clade. The phylogeny within the group of the last four, very similar species, is therefore far from resolved and more characters, preferably from immatures and DNA are required for a better resolution.

The position of *T. ridiculosa* is remarkable: it is confined to the Macaronesian islands, but being a sister to the remaining core group of *Levarchama*, suggests that it is unlikely to be a rather young endemic species of Macaronesia. It may therefore be a Tertiary relict, originating from the continent or older islands. The radiation of *Lotus* species on the Canary islands is a relatively recent event, although no dating is given (ALLAN *et al.* 2004); recent radiation occurred in many plant and animal groups on these islands. Examples are the brooms (Genisteae) and the associated Psyllidae (PERCY & CRONK 2002, PERCY 2003) and in Lepidoptera the Blastobasidae on Madeira (KARSHOLT & SINEV 2004). It would therefore be interesting to study the populations of *T. ridiculosa* from the different islands with molecular methods, in order to investigate the divergence of these popula-

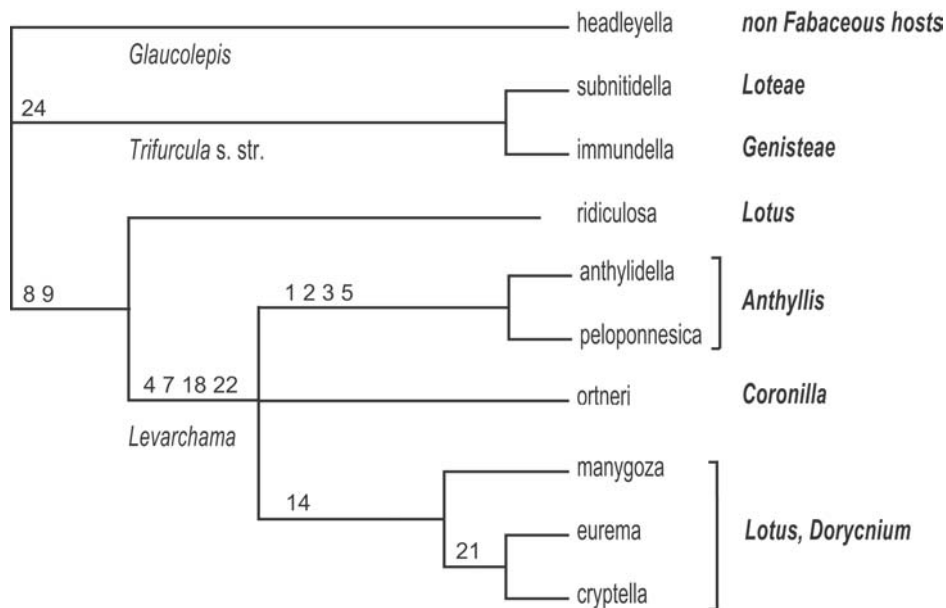


Fig. 78. Cladogram of *Levarchama*. 50% Majority Rule Consensus tree of four shortest trees; the only difference with the strict consensus tree is the position of *T. manygoza*, which forms in the strict tree a polytomy with *ortneri* and the two species pairs; the position shown here occurs in three of the shortest trees. Apomorphies mapped on branches; see appendix for explanation of numbers. The hostplant genera are given at the right, *T. cryptella* is oligophagous and feeds also on *Anthyllis*, *Securigera* and *Hippocrepis*. The hostplants for the outgroup species refer to the species groups/ subgenera they are representing

tions. Morphologically there is no strong evidence for isolation, but the leafmines on Madeira differ from those on the Canary Islands. In psyllids on the Canary Islands a high within-species sequence difference was found for taxa occurring on different islands, while displaying morphological stasis (PERCY 2003).

Levarchama and the *Trifurcula* (*T.*) *subnitidella* group share the characters 17: dorsal lobe of the aedeagus, and 20: the presence of two large cornuti. Since the characters listed for the subgenus *Trifurcula* (VAN NIEUKERKEN 1986a) are not very strong, the alternative that *Trifurcula* s. str. is not monophyletic should also be considered. Tentative results of our molecular analysis, however, suggest that *Levarchama* and *Trifurcula* are well supported sistergroups. A further analysis of morphology and molecular characters is needed to clarify this relationship. In this respect the two South African species are of special interest, since one of these has a hairpencil similar to that of *Levarchama* (SCOBLE 1980, VAN NIEUKERKEN 1990).

Hostplant relationships

All cited hosts belong to the tribe Loteae (Fabaceae), including the formerly separate Coronilleae. Recent molecular studies have shown this clade to be monophyletic and to belong to the “Robinoid clade” (ALLAN & PORTER 2000; WOJCIECHOWSKI *et al.* 2000, 2004, ALLAN *et al.* 2003). It is therefore very likely that the ancestor of *Levarchama* was feeding on a member of this tribe. The *Trifurcula subnitidella* group is also specialised on Loteae (with one exception on *Onobrychis* in the Hedysaroid clade), whereas the other group (the *T. pallidella* group) is specialised on the Genisteae. Whereas all species in *Levarchama* are leafminers, all *Trifurcula* s. str. are stem-miners. If the monophyly of *Trifurcula* s. str. is correct, a likely evolutionary scenario could have been that the ancestor of *Levarchama* + *Trifurcula* was a leafminer on Loteae, and in the *Trifurcula* clade the stem mining habit was evolved; later within this clade a shift to Genisteae as hostplant occurred. For testing this hypothesis, a detailed cladistic analysis of the subgenus *Trifurcula* is required.

Within *Levarchama* the genus *Lotus* (including *Dorycnium*) is the most frequented host, with the pair *anthyllidella-peloponnesica* specialising on *Anthyllis* and *T. ortneri* on *Coronilla*. In the shown cladogram this requires only two host shifts. In addition, *T. cryptella* has become more polyphagous than the other species, and is exploring a larger variety of not very closely related Loteae.

In the recent analyses of the phylogeny of Loteae (ALLAN & PORTER 2000, ALLAN *et al.* 2003), old world *Lotus* forms a monophyletic genus when *Dorycnium* is included. Intergeneric relationships were not fully resolved, but *Hippocrepis* is probably closer to the *Lotus* clade than any of the other genera.

*

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APPENDIX

Scoring of characters for phylogenetic analysis

Female genitalia

1. S7 tip: rounded (0), distinctly pointed (1)
2. T8, distal margin: broad (0), narrowed (1)
3. T9 anal papillae: distinct (0), absent (1)
4. Vestibulum: without pectinations (0), with group of pectinations (1)
5. Vestibulum: without sclerotization(s) (0), with sclerotization(s) (1)
6. Ductus spermathecae, basal straight part: much shorter than coiled part (0), long, longer than coiled part (1)
7. Ductus spermathecae coils: fewer than 5 (0), more than 5 (1)
8. Corpus Bursae: regularly narrowed anteriorly (0), with much narrowed anterior appendix (1)

Male genitalia

9. Uncus: Slightly indented medially (0), Deeply divided longitudinally (1)
10. Gnathos central element: rounded (0), sharply pointed (1)
11. Gnathos central element: symmetrical (0), asymmetrical (1)
12. Valva outer margin: evenly rounded or straight (0), distinctly bent (1)
13. Valva inner margin: without medial process (0), with medial process (1)
14. Valva inner margin medially: with obtuse angle(0), with almost right angle (1)
15. Transverse bar of transtilla: present (0), absent (1)
16. Ventral process of aedeagus: approximately triangular (0), ending bifid (1)
17. Aedeagus tube, sclerotised terminal lobes: absent (0), with dorsal lobe (usually) at right side, distinct (1), with more ventral lobe, at left side, distinct (2)
18. Cornuti globose group: absent (0), present (1)
19. Cornuti, basal group of long spines: absent (0), present (1)
20. Number of large cornuti: one (0), two (1), three (2)

Adults

- 21. Forewing pattern: pale uniform (0), darker, with distinct pale spot(s) or fascia (1)
- 22. Hairpencil on hindwing underside: absent (0), present (1)
- 23. Venation R sector, connection between R2+3 and Rs: present (0), absent (1)

Larval feeding

- 24. Mine type: leafmine (0), stemmine (1)

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REVIEW OF THE SUBGENUS *TRIFURCULA* (*LEVARCHAMA*),
WITH TWO NEW SPECIES (LEPIDOPTERA: NEPTICULIDAE)

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Corrections

Unfortunately, errors indicated to the editors after proof reading were not incorporated in the printed journal version. They have been corrected in the pdf version that is now online.

page 102, line 1 of text: 'we' is replaced by 'I' [For the collection we use]

page 102, par. 5, line 1: the 'i' in NIEUKERKEN is set in SMALL CAPS

page 102, paragraph 6, line 2: a multiplication sign is added after the figures 20 (before objective), 10 and 20.

page 208, figure numbers 9 and 10 are added in the figure

page 109, checklist.

The 3 synonymous names are indented in the pdf further than the other names, to show the difference from full species names: ? trifolii, dorycniella, gozmanyi

page 111. original reference for anthyllidella has been altered 3 times:

'Anthylli' into 'Anthyllis'

'Anthyllis cytioides' set in Italics

'not exained' changed into 'not examined'

page 123, section remarks, line 6: ZUCHT is set in normal letters, not SMALL CAPS.

page 123, line 2 from bottom: Menken is set in SMALL CAPS

page 127, section diagnosis, line 7: (6-7") is replaced by (6-7½)

Page 135, line 6: Bengt is set in SMALL CAPS

Page 135, line 10, "Jari Junnilainen (Vantaa, Finland)," is inserted

Page 135, references:

ALLAN, ZIMMER ea: 10. before "Royal Botanic" has been deleted

page 136:

ILDIS: changed into [Visited on: 12 December 2006]

LHOMME 1963: 1081-1253 pp. changed into pp. 1081-1253.

Erik van Nieukerken