JAN MÁCA

Czechoslovak species of the genus *Scaptomyza* HARDY *(Diptera, Drosophilidae)* and their bionomics

ABSTRACT

Central European material of the genus *Scaptomyza* has been studied, including the species *Scaptomyza* (*Parascaptomyza*) *pallida* (Zett.) and 3 species of the subgenus *Scaptomyza* s. str.: *S. graminum* (Fallén), *S. griseola* (Zett.) and *S. apicalis* Hardy. A key to the Central European species based on phallic organs and a key to described larvae of Central European species have been worked out. *Scaptomyza griseola* is recorded for the first time from Czechoslovakia on the basis of verified records. The synonymy of *S. apicalis* Hardy = *S. montana* Wheeler, syn. n. is established. Wing indices, morphology of phallic organs, seasonal dynamics, praeimaginal stages and geographical variability of individual species have been studied. Nonconformity with Burla's rule has been ascertained by comparing the wing indices of individual species.

Separatum
Tom. 69, No. 2
25. 3. 1972

Acta ent. bohemoslov., **69** : 119—132, 1972

Czechoslovak species of the genus *Scaptomyza* HARDY *(Diptera, Drosophilidae)* and their bionomics

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Received March 31, 1971

The taxonomy and faunistic of the palaearctic species of the genus *Scaptomyza* have recently been studied by BASDEN (1954), HACKMAN (1955, 1959), OKADA (1956, 1968) and other authors, who also mentioned important ecological data. Nevertheless, questions concerning the variability of colouring and morphological characters in some species have still remained open, little is known about developmental stages and — with phytophagous species — about the range of host-plants. The occurrence of this genus in Czechoslovakia has been mentioned only in catalogues of the whole order *Diptera*, and in phytopathological papers and papers dealing with entomocoenoses of various habitats (for important publications see the list of references).

Present paper is a contribution to the knowledge of the development and ecology of Central European species and a study of some aspects of their morphology, especially the phallic organs and the structure of wings.

MATERIAL AND METHODS

The material was collected by the author at various places in Czechoslovakia (650 adults, 186 larvae); some specimens were reared in the laboratory (150 adults). Available Czechoslovak material from the following collections was revised: Coll. Doskočil (Department of Systematic Zoology, Charles University, Praha) — 4798 specimens; Coll. Vimmer (Department of Entomology, National Museum, Praha) — 31 specimens; Coll. Landrock (Department of Entomology, Moravian Museum, Brno) — 34 specimens; Collection of the Central Research Institute of Food Industry, Praha — 61 specimens.

For geographical variability I examined 18 specimens of *Scaptomyza graminum* (FALLÉN) from Japan, presented by Professor T. Okada (Department of Zoology, Tokyo Metropolitan University), 8 specimens of *Scaptomyza apicalis* HARDY from California, USA, presented by Professor Wheeler (Department of Zoology, University of Texas, Austin) and 13 specimens of *Scaptomyza apicalis* HARDY from Scotland (ex Coll. E. B. Basden, Edinburgh).

Material preserved in alcohol as well as dried material was studied. The terminology of OKADA (1956, 1968) is followed when describing morphological details. Some wing characters were chosen for statistical evaluation; at least 15 males and 15 females of each species were measured. Genitalia and larval mounts were fixed in Swann's liquid. Since the genitalia of the genus *Scaptomyza* were studied by HACKMAN (1955, 1959), OKADA (1956) and WHEELER & TAKADA (1966), I will mention only unknown or little known structures. The measurements of spiracles and details of the buccal armature given for larvae represent averages of 5—20 specimens measured.

The method of a constant number of sweeps (300 sweeps in the year 1966, 500 sweeps in 1967) was employed for investigating the seasonal and daily dynamics at two localities representing two different types of habitat of the genus *Scaptomyza*. The locality Veselí nad Lužnicí in southern Bohemia is a swampy meadow on alluvial sands by a brook, with a phytocoenosis of the *Phalarion arundinaceae* type. The locality Prague-Šárka is a meadow on stony ground, not as damp as the previous one, with a phytocoenosis of the *Arrhenatheretum elatioris* type. Sweeping was carried

out at both localities 1—5 times a month, usually at weekly or fortnightly intervals, always in the evening after sunset. Daily dynamics were studied by collecting at three-hour intervals (between 5 a.m. and 11 p.m.) on 8 August, 1966 and 25 September, 1967 in Prague-Šárka, and on 20 September, 1967 at the locality Veselí nad Lužnicí.

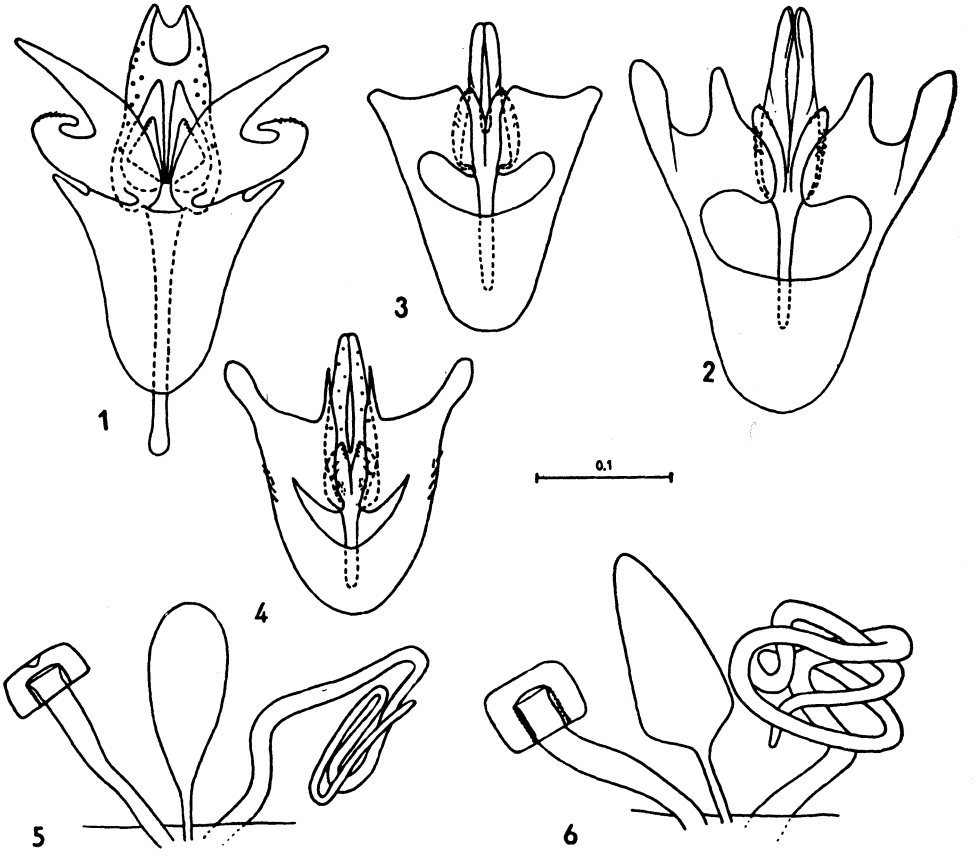
Acknowledgement

I am much indebted to Docent Dr J. Doskočil (Department of Systematic Zoology, Charles University, Prague) for valuable comments, to the late Dr H. Buhr (Mühlhausen) for the loan of interesting material of mines, to Docent Dr W. Hackman for redetermination of some doubtful specimens, and to all who enabled me to examine the material mentioned above.

Genus *Scaptomyza* HARDY, 1849

Scaptomyza HARDY, 1849. Proc. Berwickshire Nat. Club, 2: 359.
Drosophila FALLÉN, 1823, Diptera Sueciae, Geomyzidae: 2 pp.
Scaptomyza subg. *Parascaptomyza* DUDA, 1924, Arch. Naturg., 90A(3): 203; as gen. propr., auctt.

Type: *Drosophila graminum* FALLÉN, 1823. Diptera Sueciae, Geomyzidae: 8.



Figs. 1—4. Phallic organs of the *Scaptomyza species*. 1 — *S. pallida* (Zett.), 2 — *S. graminum* (Fall.), 3 — *S. griseola* (Zett.), 4 — *S. apicalis* Hardy. Figs. 5—6. Spermatheca, parovarium, ventral receptacle (each of the first two organs is paired). 5 — *S. griseola*, 6 — *S. apicalis*. Scale in mm.

The genus *Scaptomyza* comprises at the present time about 90 described species; it is cosmopolitan. The most conspicuous characters of the genus are as follows: Arista branching, most often with only 1 lower branch situated distally, acrostichal setae usually in 2—4 rows. The anterior sternopleural seta is longer than the medial one. Apart from the cleaning apparatus (on 1st and 3rd tibiae and metatarsi) there are no conspicuous groups of hairs on legs. The body is slender, and the wings are narrower than in *Drosophila* FALL. (the ratio of the wing length to width is 2.4—2.6 in palaearctic species), with sensillae on the base of r and with one sensilla on the posterior transverse vein. Inner organs, as far as they were studied, did not show too marked difference from the genus *Drosophila*.

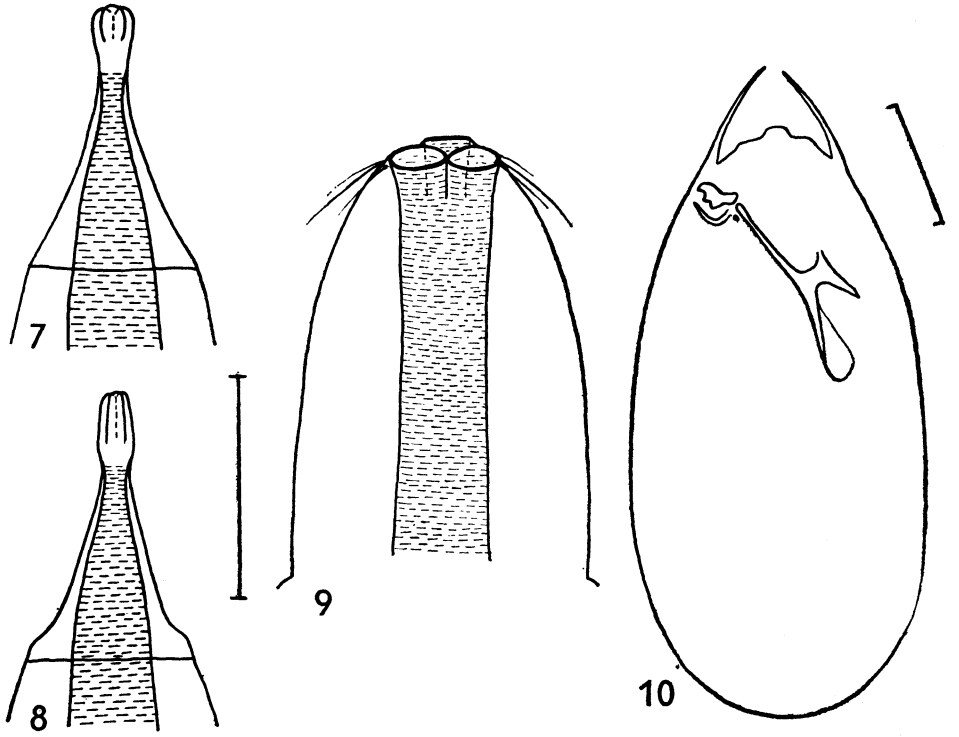
Adults are but little attracted by fermenting matter. They feed on nectar, sap from squashed plant tissues, etc., insects reared in the laboratory accept syrup.

Praeimaginal stages of only a few species have been described so far. Eggs are finely rugose, without projections or with 2—4 short filaments. In the mining species, the eggs are laid in pits hollowed in the leaf parenchyma with the ovipositor; saprophagous species lay them on the surface of substrate.

Larvae are elongate, with several rows of tiny spines in the basal part of each segment. Above the mouth cavity there are three pairs of sensory organs. The buccal armature with mouth hooks bearing minute teeth in prevalently saprophagous larvae, in the phytophagous species these teeth are unequal and very strong. Usually there are four of them. In the first instar the anterior part of buccal armature is connected with the pharyngeal sclerite and the teeth on the mouth hooks are less conspicuous. The mouth hooks of each new instar are without teeth when they are being formed. In this phase there is a dark chitinous matter between the mentum and the mouth hooks, of which new sclerites are formed. The dental sclerite of *Scaptomyza*, s. str. is horseshoe-shaped in the first instar (Fig. 10).

In the pharynx of larvae of saprophagous as well as phytophagous species there are longitudinal furrows (fanoni pharyngei — VIMMER, 1931); the oesophagus is longer than the pharynx. The proventriculus bears sac-like appendages. The mesenteron and proctodaeum are broad and straight. The tracheal system corresponds to that of the genus *Drosophila*. Anterior spiracles are lacking in the 1st instar, in the 2nd they are small and without any processes, in the 3rd instar they have 6—9 processes. In the subgenus *Parascaptomyza* their stem is projected. Posterior spiracles are conical, on short stems protruding from a common base; each spiracle is distally tripartite.

A list of host-plant families is given for individual species. Within individual families the species with fine leaves and not very tall are infested in particular, disregarding their phylogenetical relationship. Therefore I mention the host-plant species only when the genus *Scaptomyza* is not expected to occur on all suitable plants of the family. Although mines of the genus *Scaptomyza* can be found on many crops as well as ornamental plants, the damage caused by them is not too serious. The following host-plants are economically important: *Brassica oleracea*, *B. napus*, *B. rapa*, *Raphanus sativus* and *Pisum sativum* for *S. apicalis*; *Spinacia vulgaris*, *Beta vulgaris* and *Anthyllis vulneraria* for *S. graminum*. The puparium is brownish red, with caudal processes typical of individual species. Pupation takes place on the ground or inside a leaf of the infested plant. Adults usually emerge in the morning.



Figs. 7—10. Posterior spiracles of 3rd instar larvae. 7 — *Scaptomyza graminum*, 8 — *S. apicalis*, 9 — *S. pallida*. 10. — *S. apicalis*· Egg (1st instar buccal armature showing through). Scales: 0.05 mm for Figs. 7 — 9; 0.1 mm for Fig. 10.

At present the genus *Scaptomyza* is divided into 13 subgenera, two of which — *Parascaptomyza* and *Scaptomyza* s. str. — also occur in Central Europe. The occurrence there of *Scaptomyza trochanterata* COLLIN, 1953 of the subgenus *Hemiscaptomyza* HACKMAN, 1959 is not excluded either.

COLLIN's (1953) key supplemented by HACKMAN (1955) is best for identifying the Central European species of the genus. For doubtful cases I am offering a key to the Central European species of the genus *Scaptomyza* according to the phallic organs (Figs. 1—4).

1 Aedeagus not forked, only slightly emarginate distally, with minute sensillae. Gonites (submedial processes of the caudal margin of hypandrium) as long as the aedeagus without apodeme, or longer . . . . . *S. pallida* (ZETT)
— Aedeagus forked almost down to its base, gonites shorter than the aedeagus 2
2 Gonites narrow, distally more or less spiked. Submedial setae present. Aedeagus with sensillae . . . . . *S. apicalis* HARDY
— Gonites broad and rounded or almost lacking. Submedial setae undeveloped. Aedeagus without sensillae.
3 Gonites slightly indicated, not elongate. The length of hypandrium (from the cranial end of the ventral phragma to the outer corner of the caudal margin) less than 0.25 mm . . . . . *S. griseola* (ZETT.)
— Gonites digitate. Hypandrium longer than 0.27 mm . . . . . *S. graminum* (FALL.)

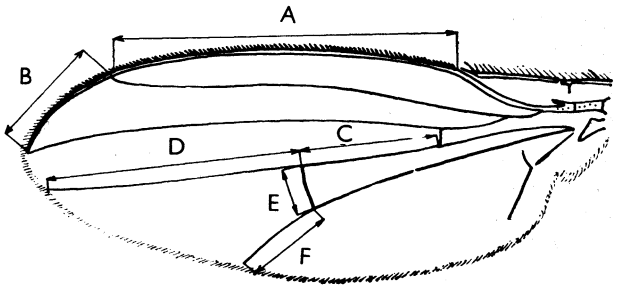
For the identification of larvae I suggest a key according to the shape of posterior spiracles (Figs. 7 — 9). (Usually they can be distinguished by their host-plants; see HERING, 1957).

1 Posterior spiracles with setae arranged in a ring on the apex. Mouth hooks narrow, usually with 4 weak teeth . . . . . *S. pallida* (ZETT.)
— Posterior spiracles sclerotised, without setae near the apex. (Mouth hooks robust, with 4 unequal, strong teeth) 2
2 Posterior spiracles dark, with approximately round apices (Fig. 7) . . . *S. graminum* (FALL.)
— Posterior spiracles light, with elongate, parallel apices (Fig. 8) . . . *S. apicalis* HARDY

Subgenus *Parascaptomyza* DUDA, 1924

Parascaptomyza DUDA, 1924. Arch. Naturgesch., 90 A(3): 203.
Scaptomyza, s. str.: HENDEL, 1928, Zool. Anz., 76 : 290.
Type: *Drosophila pallida* ZETTERSTEDT, 1847, Diptera Scandinaviae, 6: 2571.

Only one species in Central Europe.



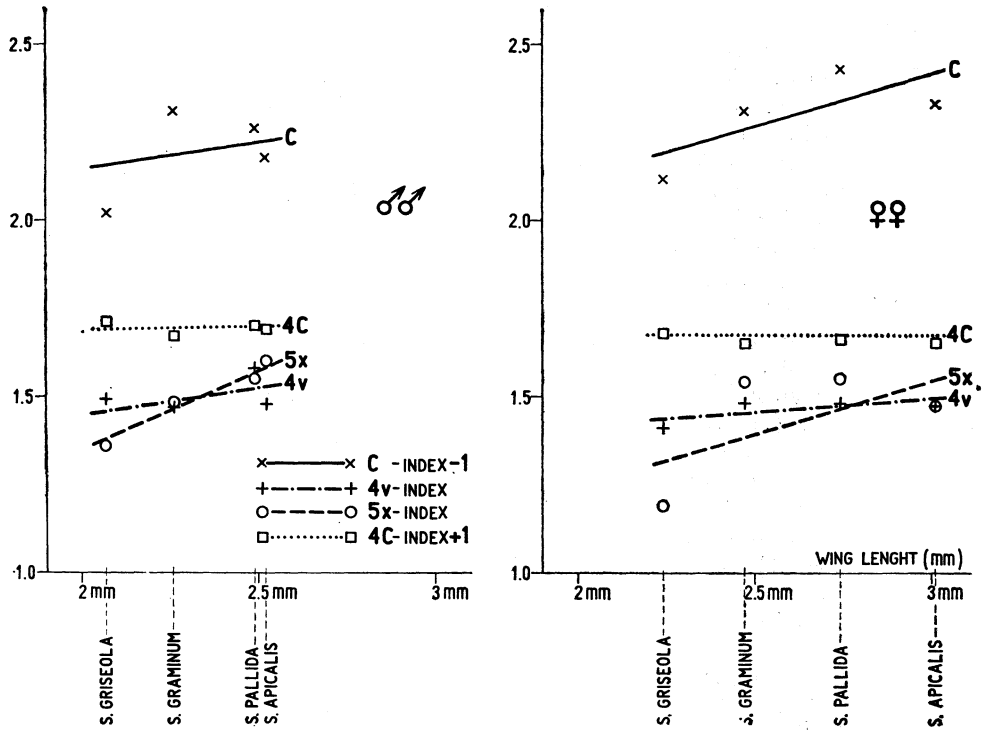


Fig. 11. — Wing indices of *Scaptomyza* and their dependence on the wing length.
A : B = C-index; D : C = 4v-index; F : E = 5x-index; B : C = 4C-index.

Scaptomyza (*Parascaptomyza*) *pallida* (ZETTERSTEDT, 1847)

(Figs. 1, 9, 11, 12)

Drosophila pallida ZETTERSTEDT, 1847, Diptera Scandinaviae, 6: 2571.
Drosophila graminum, auctt. nec FALLÉN, 1823.
Scaptomyza disticha DUDA, 1921, Jh. Ver. schles. Insektenk. Breslau, 13 : 64.

The analysis of the morphology of this species, supplemented by anatomical characters, was published by OKADA (1956).

Wings: See Fig. 11. s = medium quadratic divergence = $\sqrt{\frac{\Sigma d^2}{N-1}}$

N = number of specimens examined, d = divergence from the arithmetical mean.

Wing length: ♂♂ — 2.49 mm (s = 0.18 mm); ♀♀ — 2.74 (s = 0.17 mm).
C-index: ♂♂ — 3.26 (s = 0.28); ♀♀ — 3.43 (s = 0.29).
4v-index: ♂♂ — 1.58 (s = 0.14); ♀♀ — 1.48 (s = 0.04).
5x-index: ♂♂ — 1.55 (s = 0.22); ♀♀ — 1.55 (s = 0.17).
4C-index: ♂♂ — 0.70 (s = 0.07); ♀♀ — 0.66 (s = 0.04).

The phallic organs have been described by OKADA (1956). Presence of the second pair of parameres (?) is an outstanding detail (Fig. 1).

Egg: see PATTERSON (1943).

Larva: see OKADA (1968) and the key to larvae given above.

The length of mouth hooks (for individual instars): 0.04 mm; 0,07 mm; 0.09 mm. Length of the buccal armature: 0.18 mm; 0.32 mm; 0.54 mm. Length of the posterior spiracle: 0.04 mm; 0.06 mm; 0.11 mm.

Larval bionomics. Larvae are saprophagous, living on decaying plant material (sugarbeet — RAMBOUSEK, 1928), and they can be easily reared on agar medium (BASDEN, 1954) or decaying potatoes, etc. For the present study I obtained larvae from eggs laid by 3 gravid females captured in the field (reared on potatoes and tomatoes). Exceptionally larvae are found on plants, apparently as inquilines in mines of the genus *Acrolepia* CURT. (*Lepidoptera, Acrolepiidae*) on *Allium*, or in galls of the genus *Lipara* MEIGEN (*Diptera, Chloropidae*) on *Phragmites* (KRÖBER, 1910).

Imaginal bionomics. Adults of this species are abundant in damp meadows as well as in other habitats (woods, especially deciduous). They occur also in houses and food shops and stores much more often than the other species of the genus.

Seasonal dynamics were studied at two localities (Fig. 12) The results of DOSKOČIL's (1963) research on seasonal dynamics show 2—3 maxima of occurrence. In summer (June—July) development under normal conditions takes 25—30 days, oviposition about 8 days after emergence, so that each maximum represents one generation.

In daily dynamics there are two periods of lower activity (maximum of specimens swept): about 5 a.m. and between 8 p.m. and 11 p.m.

One gravid female was parasitized by a larva of the family *Smaridiidae* (*Acarina*) and in a few cases a phoresia of the species *Macrocheles muscaedomesticae* SCOP., feeding on the eggs of flies, was noticed. The mites were identified by Dr K. Samšinák.

Distribution. Almost cosmopolitan. In Czechoslovakia found at all localities studied, and on mountains also above 1000 m (the Beskydy, top of Ropice, 1030 m, etc.).

Examples of localities. Bohemia: Horská Kvilda, vicinity of Prague, Veselí n. Lužnicí, Vochov near Plzeň. Moravia: Lednice, Řeka near Č. Těšín, Tovačov, Velké Losiny, Vranov. Slovakia: Silická Plain.

Subgenus *Scaptomyza*, s. str.

Scaptomyzella HENDEL, 1928, Zool. Anz., 76: 290.

Type: *Drosophila graminum*, FALLÉN, 1823, Diptera Sueciae, Geomyzidae: 8.

Three Central European species belong in this subgenus.

Scaptomyza (s. str.) *graminum* FALLÉN, 1823

(Figs. 2, 7, 11, 12)

Drosophila graminum, FALLÉN, 1823, Diptera Sueciae, Geomyzidae: 8.
Drosophila incana MEIGEN, 1830, Syst. Beschreibung, p. 66.
Scaptomyza tetrasticha BECKER, 1908, Mitt. Zool. Mus. Berlin, 6/1/:158.
Scaptomyza borealis WHEELER, 1952, Univ. Tex. Publ., 5204: 194.
? *Scaptomyza norica* HACKMAN, 1955, Notul. ent., 35: 86.

The principal characters of this species have been pointed out by DUDA (1935) and, in particular, OKADA (1956). According to OKADA (1956) the legs of Japanese specimens (♂♀?) are sometimes dark. The scutellar index of the Central European specimens is approximately 1.6, and that of Japanese specimens 1.55.

Wings. Wing length: ♂♂ 2.26 mm (s = 0.15 mm); ♀♀ 2.47 mm (s = 0.19 mm). In northern Europe the wing length does not reach 2.7 mm (HACKMAN, 1955); in Central and southern Europe individuals with longer wings are found. In a population sample from Bílý Kříž (the Beskydy, Doskočil lgt.) containing 12 specimens, 9 of them have wings longer than 2.7 mm (maximum 2.92 mm in a male and 3.27 mm in a female). Identification was revised by Hackman.

C-index: ♂♂ 3.31 (s = 0.24); ♀♀ 3.36 (s = 0.32).
4v-index: ♂♂ 1.47 (s = 0.13); ♀♀ 1.48 (s = 0.09).
5x-index: ♂♂ 1.48 (s = 0.26); ♀♀ 1.54 (s = 0.15).
4C-index: ♂♂ 0.67 (s = 0.07); ♀♀ 0.65 (s = 0.05).

Phallic organs (Fig. 2). The average length of hypandrium is 0.29 mm. *Scaptomyza norica* HACKMAN (1955) with genitalia resembling those of *S. graminum* (differing from it by a small forceps and a supernumerary orbital seta, sometimes also present in *S. graminum*) is probably a mere monstrosity of *S. graminum* (Hackman, personal communication). This form has also been found in Czechoslovakia.

Development. Egg similar to that of *S. apicalis*; length 0,35 mm. The morphology of larva was described by OKADA (1968). It can be distinguished from the larva of *S. apicalis* by the shape of posterior spiracles. Length of mouth hooks: 0,03 mm; 0.06 mm; 0.08 mm. Length of the buccal armature: 0,14 mm; 0.29 mm; 0.44 mm. Length of the sclerotized part of the posterior spiracle:? (eggs before moulting were measured; spiracles non-sclerotized); 0.03 mm; 0.06 mm.

Larval bionomics. The larvae always make mines. I collected specimens or examined material from the following families of host-plants: *Silenaceae*, *Chenopodiaceae*, *Amaranthaceae* and *Viciaceae* (*Anthyllis vulneraria*). In

addition, BUHR (1941) recorded *Mesembryanthemaceae*, and HERING (1957) *Portulacaceae*. Information on the family *Scrophulariaceae* (HERING, 1957) must be checked as well as all data given by FROST (1923). Artificially transferred larvae can develop on a wider range of plant families (BUHR, 1937). The occurrence on *Brassicaceae* mentioned by STARÝ (1930) (mines only have been preserved in a herbarium) probably concerns the grey form of *S. apicalis*; see ZAVŘEL (1967).

Imaginal bionomics. Adults are found in habitats similar to those of *S. pallida*, being almost as abundant.

Experiments with both pair mating and mass mating of *S. graminum* were made. Larvae were collected on *Malachium* and the emerged adults (about 40 ex.) were divided into 1 lt to 3 lt vessels with potted plants: *Malachium*, *Lupinus*, *Phaseolus*, *Pisum*, *Trifolium*, *Antirrhinum*, and *Tussilago*, respectively. The ♀♀ hollowed pits without eggs into leaves of all these plants, but only on *Malachium* further development was observed. Specimens removed after some time from the „sterile" plants to *Malachium* bred normally on the latter plant. Data on the length of development (at about 18°C) : 3. V. to 10. V. 1971 moulting adults from the collected larvae; adults without opportunity to copula lived till 1. VI. On the host-plants *(Malachium)*, 17. V.—31. V. eggs, 22. V.—31. V. lst instar, 25. V.—5. VI. 2nd instar, 1. VI.—10. VI. 3rd instar, 7. VI.—12. VI. puparia were observed. After 10 days, adults emerged from the puparia.

Several specimens *S. graminum*, from larvae collected on *Anthyllis*, were reared on *Malachium* quite easy. If the leaf of *Malachium* is too damaged by larvae, it is best to cut it and put it on the leaf of a sound plant and to let larvae move through.

Juvenile adults are rather light in colour. The ♀♀ have a light-coloured ovipositor plates (those of older ♀♀ are dark brown); the ♂♂ could be, in the extreme cases, similar to the light form of *S. apicalis*.

Graph of seasonal dynamics — Fig. 12. DOSKOČIL (1963) mentions 2—3 maxima of occurrence in his paper. HERING (1957) states 3 generations a year according to his study of larvae. Some aberrations can be brought about by quiescence which appears in a part of the population with the lack of moisture (BUHR, unpublished). In sheltered places larvae can develop in winter as well. Daily dynamics as in *S. pallida*.

Larvae are rarely parasitized by a braconid, *Dacnusa (Rhizarcha) faeroensis* ROMAN (Čapek det.); puparia are sometimes infected by a mould. When rearing *S. graminum*, *Dacnusa* emerged about 7 days later than the host.

Distribution: Holarctic region. Throughout Czechoslovakia, more abundant in submontane areas and in the mountains.

Examples of localities. Bohemia: Čelákovice, Karlovy Vary, Horská Kvilda, Stráž p. Ralskem, Veselí n. Lužnicí. Moravia: Bílý Kříž, Tovačov, Travná (Rychlebské Mountains), Vranov, Velké Vrbno. Slovakia: Bezovec (Považský Inovec), Silická Plain.

Scaptomyza (s. str.) *griseola* (ZETTERSTEDT, 1847)

(Figs. 3, 5, 11)

Drosophila griseola ZETTERSTEDT, 1847, Diptera Scandinaviae, 6: 2562.
Scaptomyza apicalis var. *grisescens* DUDA, 1921, Jh. Ver. schles. Insektenk. Breslau, 13 : 14.

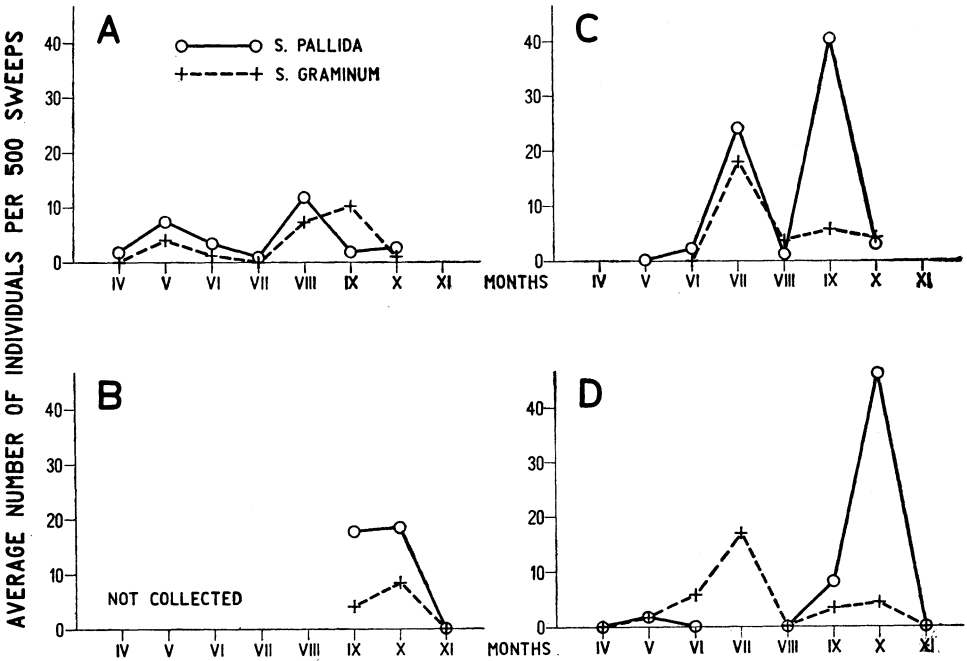


Fig. 12. Frequency of *Scaptomyza pallida* and *S. graminum* during collecting periods. A: Veselí n. Luž., 1966, B: Praha-Šárka, 1966, C: Veselí n. Luž., 1967, D: Praha-Šárka, 1967.

Most of the authors considered this species to be only a form of *S. graminum*. Both species are closely related and *S. griseola* differs mainly in the coloration of the thorax and legs and in some details of the male genitalia (HACKMAN, 1955).

Wings.

Wing length: ♂♂ 2.07 mm (s = 0.18 mm); ♀♀ 2.24 mm (s = 0.10 mm)
C-index: ♂♂ 3.02 (s = 0.22); ♀♀ 3.12 (s = 0.17).
4v-index: ♂♂ 1.49 (s = 0.15); ♀♀ 1.41 (s = 0.11).
5x-index: ♂♂ 1.36 (s = 0.14); ♀♀ 1.19 (s = 0.12).
4C-index: ♂♂ 0.71 (s = 0.07); ♀♀ 0.68 (s = 0.05).

Phallic organs (Fig. 4). Forcipes with 12—14 marginal, tooth-like setae. Hypandrium similar as in *S. graminum*, but smaller — average length 0.22 mm. Gonites are not elongate. Parameres with only 6 apicomarginal sensillae.

Female reproductive organs. Anal lamellae as in *S. graminum*. Lamellae of ovipositor brown, with 14—16 marginal setae, 4—5 apicomarginal setae, 4—6 discal, and 8 setae in the upper row.

Spermatheca much wider than high. Ventral receptacle coiled three times (Fig. 6).

Development. Palmén (fide HACKMAN, 1955) reared 1 specimen of this species from a mine on *Stellaria media*. The puparium has not been preserved. KRÖBER (1910) mistook a larva of this species for *S. pallida*.

Imaginal bionomics. *S. griseola* is relatively rare in Czechoslovakia, occurring mostly in highlands on vegetation along the banks of streams and ponds. As far as it is known, the seasonal and daily dynamics are the same as in *S. graminum*.

Distribution. Northern Europe, British Isles, Czechoslovakia. The only documented records of this species in Bohemia were made by DOSKOČIL (1963, unpublished). In the present paper *S. griseola* is recorded as new for Moravia and Slovakia.

Material. Bohemia: Čelákovice, 28. 8. 1959 — 1 ♂; 3. 9. 1960 — 1 ♂; 18. 9. 1960 — 1 ♂, 4 ♀♀; 10. 10. 1960 — 4 ♂♂. 30. 10. 1960 — 1 ♂ (Coll. Doskočil). Františkovy Lázně; ? — 1 ♂, 1 ♀ (Coll. Vimmer, both specimens identified by Vimmer as *Sc. graminum*). Horská Kvilda, 25. 10. 1960 — 1 ♀; 30. 5. 1961 — 25 ♂♂, 26 ♀♀; 21. 6. 1961 — 2 ♀♀; 15. 7. 1961 — 2 ♀♀; 26. 7. 1961 — 1 ♂, 2 ♀♀; 1. 10. 1961 — 1 ♂ (Coll. Doskočil). Praha-Šárka: 16. 4. 1967 — 1 ♂; 28. 6. 1967 — 1 ♂. (Máca lgt.). Veselí n. Lužnicí: 21. 5. 1966 — 1 ♂; 11. 6. 1966 — 1 ♂, 1 ♀; 14. 6. 1966 — 1 ♀; 17. 9. 1967 — 1 ♂; 25. 9. 1967 — 2 ♂♂; 28. 10. 1967 — 1 ♂. (Máca lgt.). Moravia: Travná, 31. 7. 1958 — 1 ♂ (Coll. Doskočil). Slovakia: Silica, 4. 8. 1960 — 1 ♂ (Coll. Doskočil).

Note: VIMMER (1913) mentions *S. griseola* from Bohemia without giving localities. There is *Scaptomyza griseola* in his collection, but erroneously identified. Because the distinguishing characters enabling correct identification of this species have been established only by HACKMAN (1955), I consider his reference non-substantiated. I have not revised BOBEK's (1890) information, but ARADI (1959) did not confirm it. "*Scaptomyza griseola*" from Landrock's collection is a female of *S. pallida*.

Scaptomyza (s. str.) *apicalis* HARDY, 1849

(Figs. 4, 6, 8, 10, 11)

Scaptomyza apicalis HARDY, 1849, Proc. Berwickshire Nat. Club, 2: 362.
Drosophila flava FALLÉN, 1823 sensu HENDEL, 1928, Zool. Anz., 76: 291.
Scaptomyza montana WHEELER, 1949, Univ. Tex. Publ. 4920: 166, **syn. n.**
? *Notiphila flaveola* MEIGEN, 1830, Syst. Beschreibung: 66.

WHEELER & TAKADA (1966) use the name *S. apicalis* only for palaearctic forms of this species, because they could not compare European and American specimens. I examined several specimens collected by Wheeler near Pasadena (California), but I did not find any difference from European ones.

Scaptomyza ? *montana* sensu BASDEN, 1954 (peristomal setae remote from the margin of eye, wing length 2.7—3.6 mm, dark, narrowing lamellae of the ovipositor) also belongs, in my opinion, to the variability range of *S. apicalis*. I examined several specimens, males as well as females, collected by Basden near Mortonhall (Scotland), and several similar individuals in the Czechoslovak material. The phallic organs show no difference from *S. apicalis*.

S. apicalis displays great variability of colour, but there are no morphological differences between dark and light forms. Probably the coloration depends on the temperature at which the larva develops (similarly as in *S. pallida* — see STALKER, 1945, and to a lesser degree in other species as well).

An analysis of the morphological characters of *S. apicalis* was made by HENDEL (1928).

Wings.

Wing length: ♂♂ 2.52 mm (s = 0.21 mm); ♀♀ 3.01 mm (s = 0.20 mm).

C-index: ♂♂ 3.18 (s = 0.27); ♀♀ 3.33 (s = 0.25).
4v-index: ♂♂ 1.48 (s = 0.11); ♀♀ 1.44 (s = 0.08).
5x-index: ♂♂ 1.60 (s = 0.14); ♀♀ 1.47 (s = 0.20).
4C-index: ♂♂ 0.69 (s = 0.05): ♀♀ 0.65 (s = 0.05).

Phallic organs (Fig. 3). The density of sensillae on the aedeagus is quite variable, irrespective the body colour.

Anatomy. ♂♂: Bulbus ejaculatorius with a pair of long, folded appendages. Ejaculatory apodeme transparent, tetragonal, with a short stem.

♀♀: Ovaria white, spermatheca slightly wider than long. Parovaria larger than the spermatheca, with an elliptical knob. Ventral receptacle coiled approximately five times (Fig. 5).

Rectal papillae oval.

Development. Egg (Fig. 10). Larvae: 3rd instar and puparium were described by HENDEL (1928). Posterior spiracles of all instars light coloured, with an elongate apex (Fig. 8). Mouth hooks: 0.04 mm; 0.07 mm; 0.10 mm. Buccal armature — length: 0.18 mm; 0.38 mm; 0.62 mm. Sclerotized part of posterior spiracle: 0.02 mm; 0.04 mm; 0.06 mm.

Larval bionomics. Larvae usually mine in leaves, exceptionally in the leaf-like widening fruit of *Thlaspi arvense* — *Brassicaceae* (Coll. Buhr), in the stem of *Caylusea abyssinica* — *Resedaceae* (Coll. Buhr) or in the seed-leaves of *Raphanus sativus* — *Brassicaceae* (Máca lgt.). The families of host-plants — *Brassicaceae*, *Resedaceae*, *Capparidaceae*, *Tropaeolaceae*, *Asteraceae* (*Rhodanthe manglesii* — larvae in Coll. Buhr), *Viciaceae* (*Pisum sativum*) — given by various authors were ascertained by myself, too. Other data: *Papaveraceae* (HERING, 1957). BUHR (1937) found that artificially transferred larvae can develop on plants of certain other families as well. Most of the host-plants have a high content of thioglycosides.

Imaginal bionomics. Only sporadic occurrence on non-cultivated land, more frequent in gardens and in the fields of brassicaceous monocultures.

S. apicalis is easily reared in a vessel with a potted host-plant. Two couples of the yellow form reared in this way, both having emerged from puparia on *Brassica rapa*, produced together 43 adults of F 1 generation (the progeny of one couple was reared on *Brassica rapa*, of the other on *Pisum sativum*). All F 1 adults were yellow. Length of their development (at 18° C): 1st instar 2—3 days, 2nd instar 3—4 days, 3rd instar 8 days on the average, puparium 12 days. Oviposition about 10 days after emergence.

All adults reared from mines collected in the field (about 80 specimens) were yellow. Their development was completed at 16—18° C.

20 larvae in mines collected in July, 1969 on *Brassica* spp. and *Pisum sativum* were reared at an average temperature of 12° C. All adults were yellow, a few displayed transition to brown colour.

Only 1 grey-brown male emerged from the larvae in mines collected in September, 1970 on *Brassica* spp. and reared at a temperature ranging between 5° and 15° C.

HERING (1957) stated 3 generations a year. It is not always easy to determine in which generation adults belong, as at insufficient humidity (or by means of some other stimule?) larvae and puparia enter quiescence and the puparial stage can then last up to 300 days (BUHR, unpublished).

About 50 % of the larvae collected in the field were attacked by the braconid wasp *Dacnusa* (*Pachysema*) *temula* HALIDAY, which emerged from

the puparia (Čapek det.); a few were parasitized by a chalcid of the family *Eulophidae* (probably a hyperparasite). The braconids emerge 10 days later and the chalcids 20—25 days later than the host.

Distribution. *S. apicalis* occurs throughout the holarctic region. Generally distributed in Czechoslovakia.

Examples of localities: Bohemia: Benešov n. Černou, Cheb, Kotel (Krkonoše), Můstek (Šumava), Prague — Petřiny. Moravia: Ivančice, Komorní Lhotka, Travná, Velké Vrbno. Slovakia: Bratislava, Bezovec (Považský Inovec), Silická Plain.

DISCUSSION

1. Wing indices. Detailed comparative studies of wing indices have been made with the genus *Drosophila* (BURLA, 1954; OKADA, 1959, 1960). BURLA'S rule has been based on them: C-index in *Drosophila* increases in proportion to the length of wing (comparing individuals of the same species as well as of different species), whereas the 4v-, 5x- and 4C-indices decrease.

The comparison of the wing indices of the *Scaptomyza* species studied by me (Fig. 11) shows that all indices remain at approximately the same level or the degree of their dependence on the wing length is much lower than in the genus *Drosophila*. According to OKADA (1960) this is a phenomenon which occurs when the wing veins and membrane grow approximately isometrically and, consequently, Burla's rule does not apply (in some groups of insects, e.g. *Papilionidae*, the veins grow more slowly than the membrane and the correlation between wing indices and length of the wing is inversed, if compared to the genus *Drosophila*).

The correlation between the C-index and 5x-index can be explained, as follows: the costomedial and cubitoanal sections of venation grow in different manners — the basal section grows more rapidly in the costomedial part, the apical section in the cubitoanal part. This phenomenon is easily possible, as both parts of the venation are independent to a great extent, and even their expansion (at least in the genus *Drosophila* — see WADDINGTON, 1950) takes place at a different time. However, it would be necessary to find more explicit cases to confirm such allometry.

When the wing indices of both sexes are compared (females have longer wings), there is a more marked correlation with BURLA'S rule than in comparing individual species.

2. Praeimaginal stages and ecology. Whereas the ecology of adults of the *Scaptomyza* species studied is more or less the same and adaptive characters distinguishing both subgenera are negligible (only the shape of the lamellae of ovipositor), there are great differences of a pronounced adaptive character between the larvae of both ecological groups of the genus *Scaptomyza*.

a) Mouth hooks of the phytophagous species (subgenus *Scaptomyza* s.str.) are of a shape unique in the family *Drosophilidae* (adapted to feeding on living plant tissues), whereas in the saprophagous species (*Parascaptomyza*, nearctic subgenus *Mesoscaptomyza* HACKMAN 1959) the mouth hooks are of a common shape with tiny teeth.

b) The elongate anterior spiracles of *Parascaptomyza* are useful for locomotion in a semi-liquid substrate, whereas short spiracles (*Scaptomyza* s.str.) are suitable for locomotion in a close-fiting mine.

c) The posterior spiracles of *Parascaptomyza* are apically ciliate (adaptation against inflow of liquids), in the subgenus *Scaptomyza* they are sclerotized, thorn-like. Since similarly shaped posterior spiracles are also found in other mining larvae (*Hydrelliinae*, some *Agromyzidae*), we may consider this an adaptation to inhabiting mines.

3. Preliminary results of attempts at rearing *Scaptomyza* s. str. species allow us to presume that individual forms of phytophagous species might be experimentally cross-bred, and thus the degree of their reproductive isolation could be tested, as is common with saprophagous species of the family *Drosophilidae*.

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