Belgian Journal of Entomology 8 (2006) : *107-118*

Description of the larva and the pupa of *Bagous frivaldszkyi* TOURNIER, 1874 (Coleoptera: Curculionidae), with comments on its biology

Rafał GOSIK

Department of Zoology, Maria Curie-Skłodowska University, Akademicka 19, 20-033 Lublin, Poland (e-mail: rgosik@op.pl).

Abstract

The article contains the first, detailed description of the larva and the pupa of *Bagous frivaldszkyi* TOURNIER. Presented are the diagnostic characters of the *B. frivaldszkyi* larva and pupa, complete lifecycle, remarks on the ecology, biology and distribution of the species. *Bagous frivaldszkyi* is a univoltine species with the summer development, and overwintering adults. This weevil belongs to a rare and highly endangered group of water beetles.

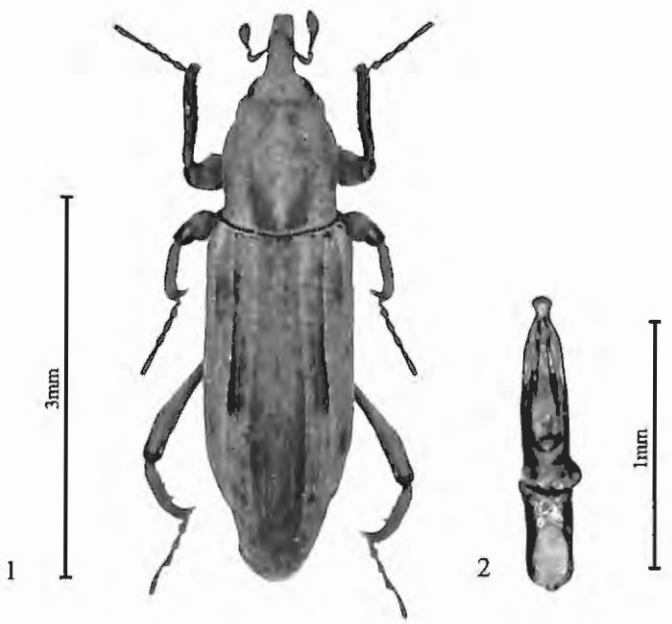
Keywords. Coleoptera, Curculionidae, *Bagous frivaldszkyi,* morphology, larva, pupa, lifecycle, distribution.

Introduction

A total of 72 species of the genus *Bagous* GERMAR have been described from the Palearctic and 27 of them are recorded from Poland (WANAT & MOKRZYCKI, 2005). The insects under discussion are in the majority, tiny, rarely medium sized beetles (2-6 mm in length). Except for a few species they are associated with aquatic plants in lakes, ponds, old riverbeds and slow-flowing waters. According to SCHERF (1964), they do not often proceed below the surface of the water. Morphology of the larvae of the genus *Bagous* is known in detail from 5 species: *B. collignensis* HERBST, *B. nodulosus* GYLL., *B. australasiae* BLACKBURN, *B. subcarinatus* GYLLENHAL and *B. alismatis* (MARSH.) (GOSIK, 2006; MAY, 1994; STANIEC & GOSIK, 2003; SCHERF, 1964); and partially known in: *B. nigritarsis* THOMSON, *B. binodulus* HERBST, *B. glabrirostris* HERBST (SCHERF, 1964). Moreover, the pupae have been described and illustrated so far only for: *B. collignensis*, *B. nodulosus* and *B. subcarinatus* (GOSIK, 2006; SCHERF 1964; STANIEC & GOSIK, 2003).

Bagous frivaldszkyi TOURNIER a European species, is recorded from the following: Czech Republic, Estonia, Germany, Hungary, Poland, Romania and

Slovakia (ALONSO-ZARAZAGA, 2005). It is considered as an extremely rare and endangered species (SPRICK, 2001). In Poland it is known from four regions. Fortunately this rare weevil still generates relatively large populations in the Bug River Valley (WANAT & GOSIK, 2003). Compared to other species belonging to this genus *B. frivaldszkyi* is distinguishable, for instance, by the relative slender, elongated body and the characteristic shape of prothorax and aedagus (Figs 1-2) (DIECKMANN, 1964; SMRECZYŃSKI, 1972). It could be regarded as a stenotopic species (KOCH, 1992). The biology of the mentioned weevil is only partly described. The adults of *B. frivaldszkyi* are collected from aquatic plants in lakes, ponds and old riverbeds (BURAKOWSKI *et al.*, 1995). The first, elementary information about the ecology and lifecycle of this species was given in KANIA (1994). The adults were collected from the middle of April until the beginning of August from stems and leaves of the canarygrass reed (*Phalaris arundinacea* L.) The larvae and pupae were collected in July and August from inside of the stems on this plant. Probably this weevil overwinters in the site of pupation (inside of stems) (KANIA, 1994). The preimaginal stages of the mentioned species were unknown until now. The detailed description of developmental stages and lifecycle of this unique species is especially necessary since *B. frivaldszkyi* belongs to a group of endangered water beetles.



Figs 1-2. *Bagous frivaldszkyi*, 1 - adult (dorsal aspect), 2 - aedeagus.

Material and methods

The examined material contained: L_1 – 9 specimens, L_2 – 10 specimens, L_3 – 6 specimens, pupae – 13 specimens, and adults – 43 specimens.

The examined material was collected in the following localities: Ślipcze near Hrubieszów (UTM nets: GB02), Milejów near Lublin (FB37), Magazyn near Włodawa (FC80), Dorohusk (FB97) (CE Poland). The specimens used in this study were collected on the following dates: Larvae: 06 June 2001; 20 May, 23 June 2005; 08 June, 20 June, 13 July, 20 July 2006; Pupae: 23 June 2005; 20 June, 13 July, 20 July 2006; Adults: (in collection of the author) Ślipcze: 11 May 2000 (17 exx.), 4 May (1 ex.), 06 June 2001 (8 exx.); 07 May 2003 (3 exx.), 14 May 2006 (2 exx.): Milejów: 24 May 1986 (1 ex.), 15 July 1986 (3 exx.); Magazyn: 10 April (2 exx), 25 May 2002 (6 exx.). The number of collected specimens of adults and immature stages were reduced to an indispensable minimum because of the species scarcity.

The immature stages were collected from the reed stems of canarygrass growing on scant, shallow meadow water reservoirs in the Bug River Valley. In order to correctly determine the immature stages of *B. frivaldszkyi*, some larvae were kept alive until pupation, and some pupae until the emergence of adults. The preimaginal stages were preserved in a 1:1 solution of glycerine and alcohol. The punctured larvae and pupae were rinsed in distilled water and cleared in chloralphenol and finally placed in Berlesy's liquid to prepare microscopic slides. The drawings were made using camera lucida. The terminology used in the morphological description of the larva and pupa was taken from SCHERF (1964) and MAY (1994).

Results

1. Morphological description

Larva (Figs 3-10): L_1: body length: 3.75 – 4.78 mm, (mean) 4.48 mm; head width: 0.57 mm.

L_2: body length: 5.91 - 6.93 mm, (mean) 6.11 mm; head width: 0.69 mm.

L_3: body length: 7.58 - 9.91 mm, (mean) 8.42 mm; head width: 0.78 mm.

Length (L_1 – L_3): 3.75-9.91 mm, head width: 0.57-0.78 mm; body slender, slightly curved, light yellow, head light brown, pronotum greyish-brown, setal numbers greatly reduced, setae short, light yellow, on protuberance (Fig. 3a). Cuticule minutely spiculate. Antenna (Fig 3b): antennae conical, broadly slender, basal membranous area with 4 setal sensillae. Head globose with macro, setal sensillae, pores and single ocellus (oc) on each side latero-posteriorly, frontal suture distinct (Figs 4-5). Macro setae of head: 6 dorsal epicranial setae (2 des_1, 2 des_2, 2 des_4), 2 frontal setae (fs_2), dorsal epicranial setae des_2 located on frontal suture, 2 lateral epicranial setae (les_2). Front with 5 pairs of pores. Lateral parts of head with 3 pairs of setal sensillae. Distribution of pores and setal sensillae of remaining part of head as in Figs 4, 5. Clypeus and labrum (Fig. 6): clypeus (cl) 1.6 x as wide as long with 6 setal

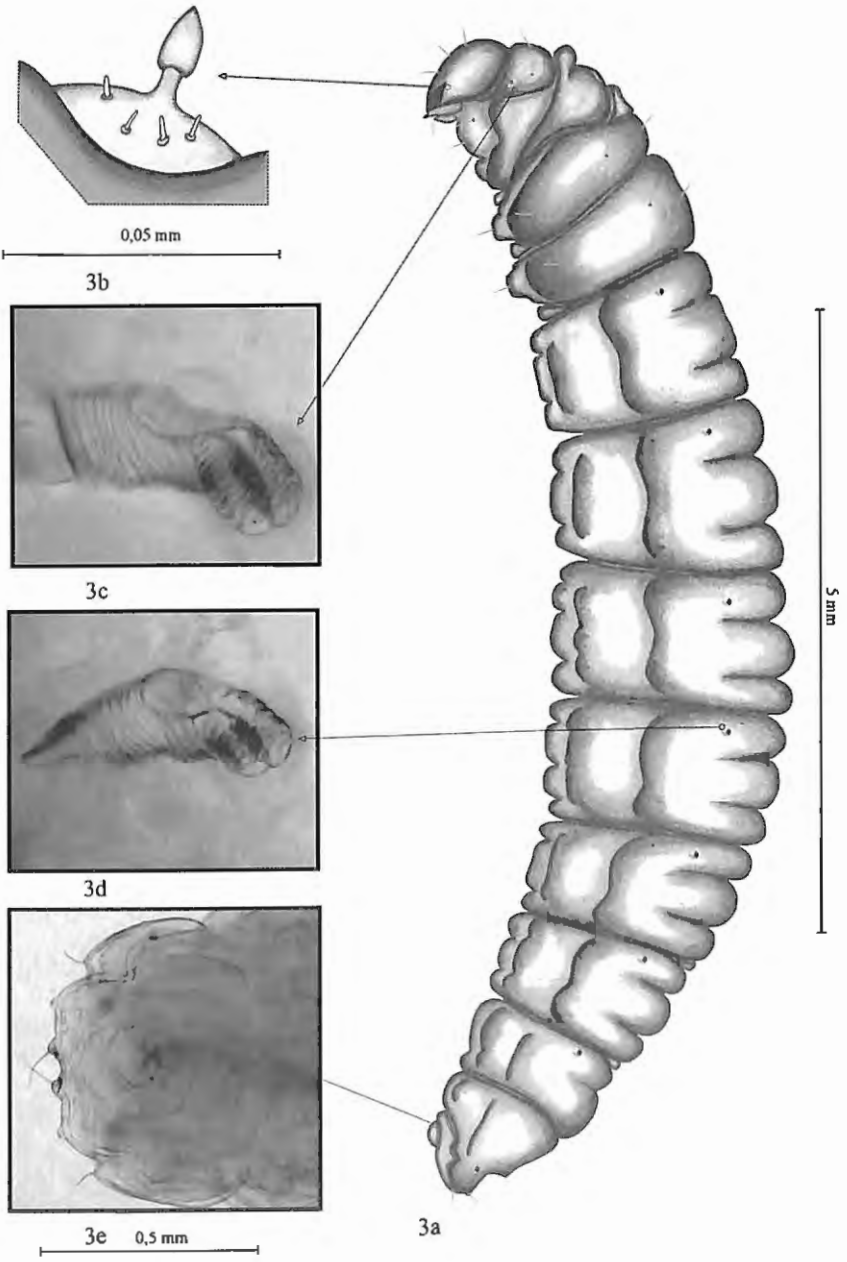
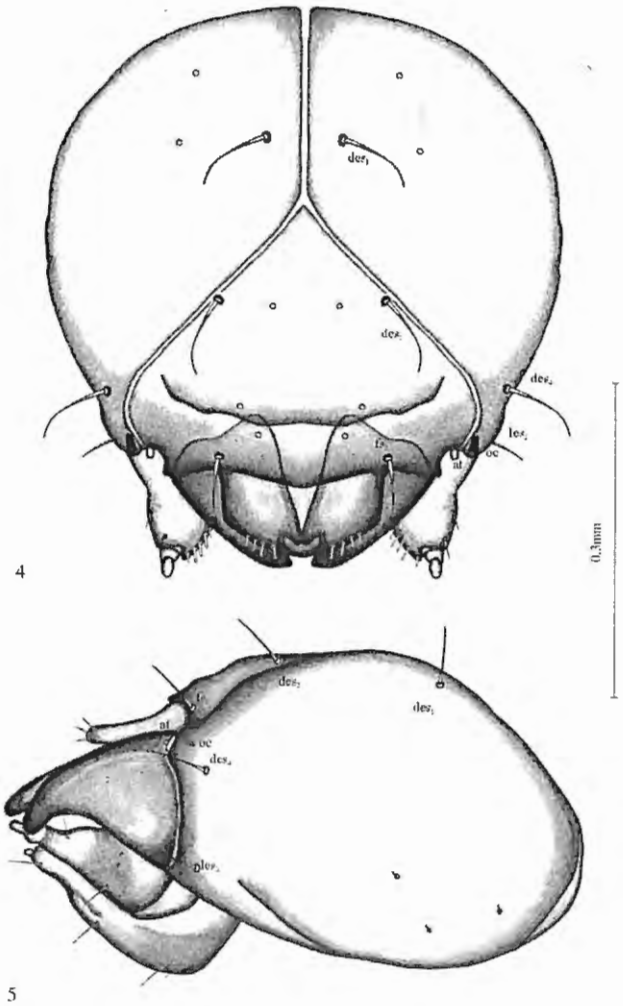
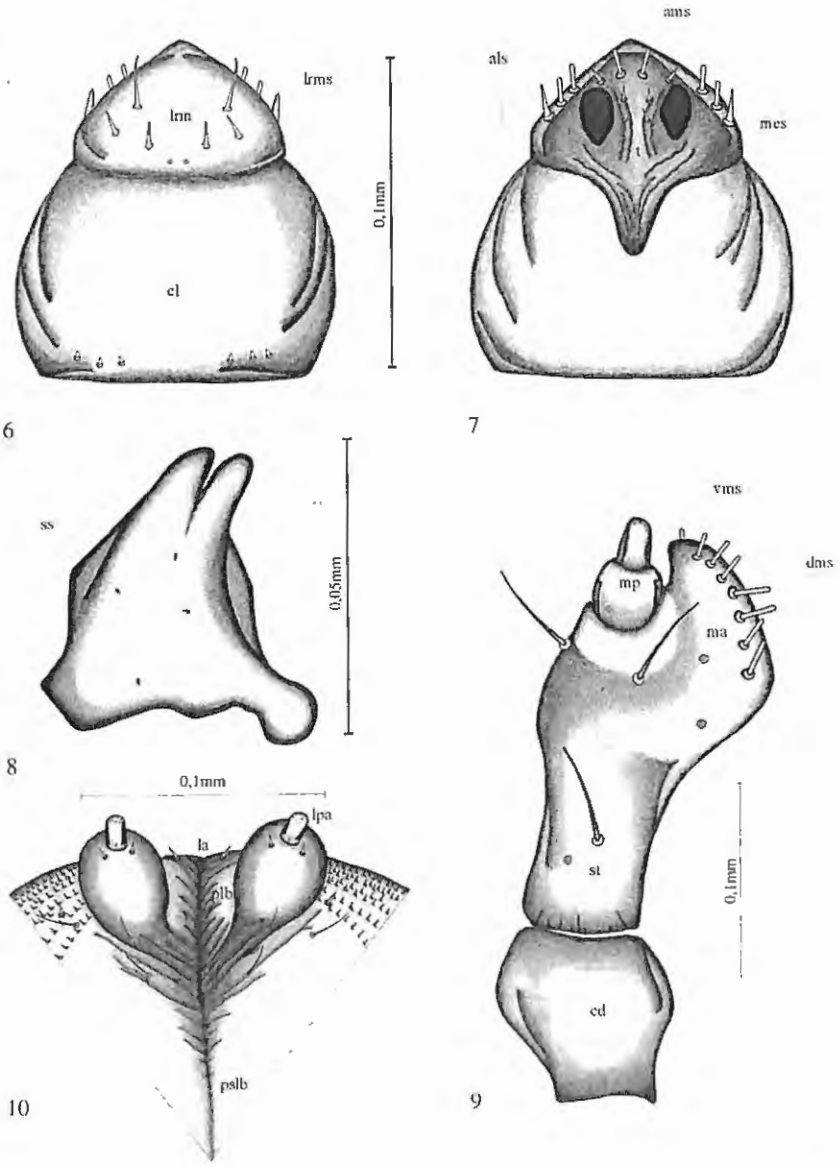


Fig. 3. *Bagous frivaldszkyi*, mature larva, habitus (lateral aspect) (Fig. 3a), with right antenna (lateral aspect) (Fig 3b), spiracles of first and seven pair (Figs 3c, 3d) and terminal segment of abdomen, ventral aspect (segments VIII and IX) (Fig 3e).

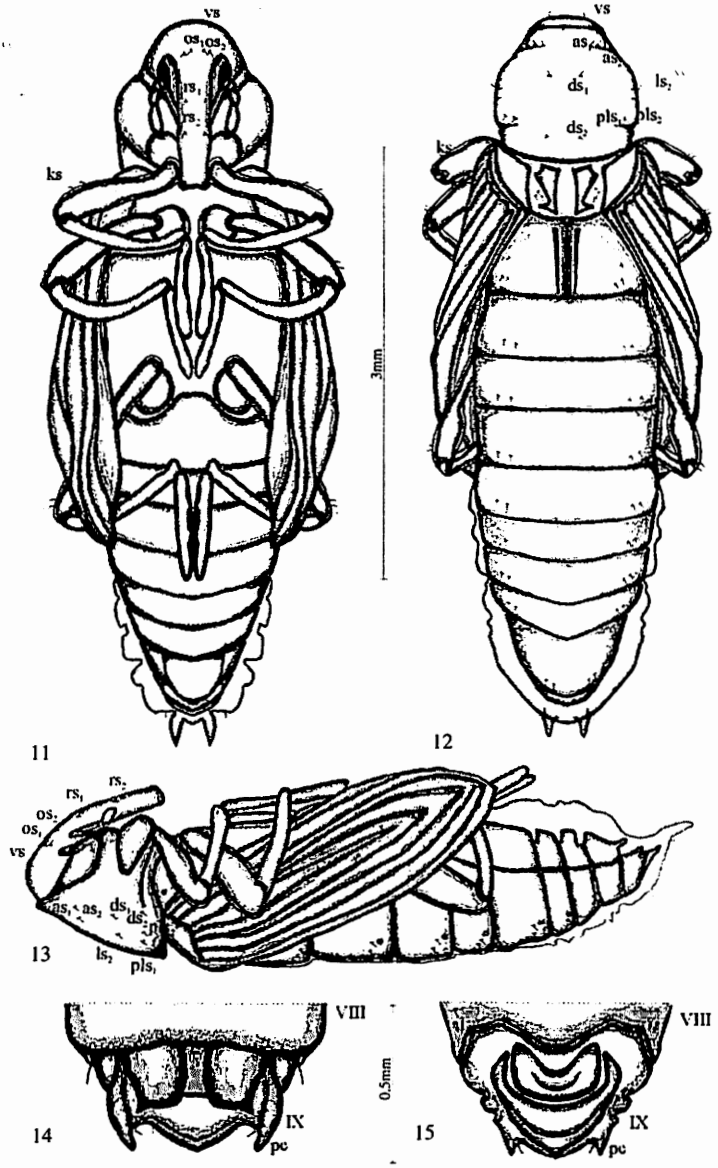


Figs 4-5. *Bagous frivaldszkyi*, mature larva, head. 4 – dorsal aspect (des - dorsal epicranial setae, fs - frontal seta), 5 – lateral aspect (les - lateral epicranial seta, oc – ocellus, at - antenna).

sensillae; labrum (lrm) about 1.6 x as wide as long with 6 labial setae (lrms) and 2 pores postero-medially. The posterior pairs of lrms conical, sharp, distinctly shorter than anterior pair. The posterior pairs of lrms 2 x shorter than anterior pair. Epipharynx (Fig. 7) with 4 anteromedian setae (ams). Median pair simple, truncate, lateral pair short, sharp, 2 x shorter than median pair. 6 antero-lateral setae (als). The posterior pair of als sharp, anterior pairs truncate. 2 pairs of median setae (mes) short, sharp; torma (t) parallel (Fig. 7).



Figs 6-10. *Bagous frivaldszkyi*, mature larva. 6 – labrum (lrm) and clypeus (cl) (lrms - labial setae), 7 – epipharynx (ams - anteromedial setae, als - anteriolateral setae, t – torma, 8 - left mandible (dorsal aspect) (ss - setal sensillae), 9 - left maxilla, dorsal aspect (cd – cardo, st – stipes, ma – mala, mp - maxillary palp, dms - dorsally mala setae, vms - ventrally mala setae), 10 - labium, ventral aspect (plb – praelabium, pslb – postlabium, lpa - labial palp, la - ligula).



Figs 11-15. *Bagous frivaldszkyi*, pupa, habitus. 11 – ventral aspect (vs - vertical seta, os - orbital setae, rs – rostral setae, ks –knee setae), 12 - dorsal aspect (as - apical setae, ls - lateral setae, ds - discal setae, pls - posterolateral setae), 13 – lateral aspect, 14 – terminal segment of female, ventral aspect, (pc – pseudocerci, segments VIII and IX), 15 – terminal segment of male.

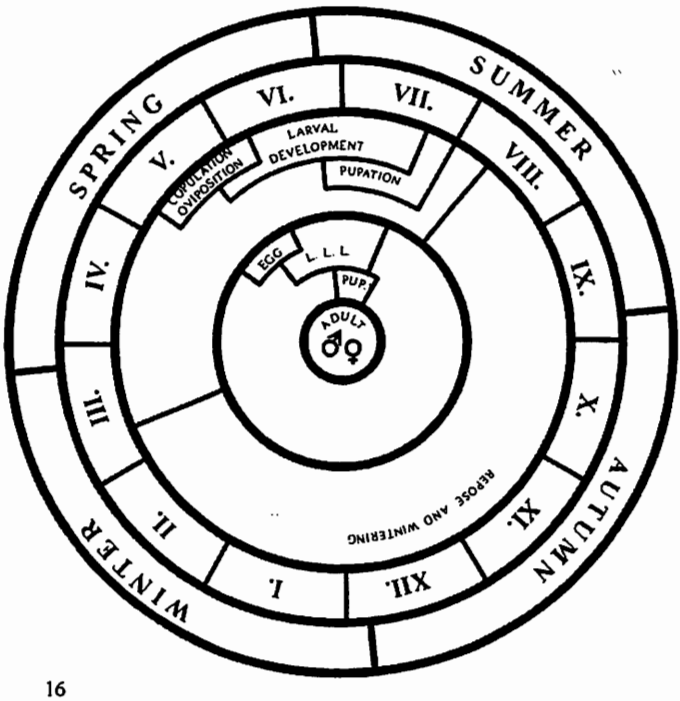
Mandible (Fig. 8) broad, bifid, with 4 setal sensillae (ss); teeth almost of equal height, slightly truncate. Maxilla (Fig. 9) consists of square cardo (cd), stipes (st), mala (ma) and maxillary palp (mp). Stipes and mala fused, stipes with 3 setae dorsally and 2 pores. Mala with 2 pores dorsally, 1 seta ventro-apically and ctenidium of 7 truncate, simple, macro setae on adoral margin. Maxillary palp 2-segmented; segment I is almost as long as segment II and distinctly wider than segment II, length ratio of segment I and II: 1:2. Segment II with 4 conical cuticular process apically. Segment I with 1 dorsal pore. Labium (Fig. 10): praelabium (plb) with 2 sharp, short setae antero-medial and 1 simple seta postero-medial, postlabium (pslb) with 3 pairs macro setae. The setae on pslb sharp; anterior pair distinctly shorter than the posterior pair. Labial palp (lpa) one-segmented, with 1 pore and 6 conical cuticular process apically. Ligula (la) concave, with 2 short, sharp setae medial. Surface of cuticle on apical parts of pslb with characteristic tooth-like cuticular processes (Fig. 10). Spiracles bicameral, those of abdominal segment VIII dorsal. Chaetotaxy of the body is strong reduced. Each segment of thorax with 6 simple setae. The segments of abdomen (except segment VIII) without simply setae, with sparse micro setae on pedal area. Segment VIII of abdomen with 2 simple setae. Chaetotaxy of the body and structure of the spiracles are in Figs 3c, d. Abdominal segments VIII, IX forming a dorsally concave disc with 2 long marginal setae (Fig. 3e).

Pupa (Figs 11-15).

Body length: 5.0-6.5 mm, (mean) 5.9 mm, width in widest place (between middle knees) 1.70-2.21 mm, (mean) 1.91 mm. Body slender, white; setae short, light-brown, on protuberance. Head with 2 vertical setae (vs), 4 orbital setae (os_1, os_2), super orbital setae (sos) and post antennal setae (pas) invisible; rostrum rather long, about 5x as long as wide, exceed apexes of fore coxae, with 4 rostral setae (2 rs_1, 2 rs_2), rs_2 3 x shorter than rs_1; antennae rather short and relatively stocky. Pronotum almost as long as wide at base with 4 apical setae (2 as_1, 2 as_2), 2 lateral setae (ls_2), ls_1, and ls_3 invisible, 4 discal setae (2 ds_1, 2 ds_2) and 4 posterolateral setae (2 psl_1, 2 psl_2). Metanotum 2.2x longer than mesonotum, meso- and metanotum each with 6 setae. Knee each with pair of setae (ks). Abdomen with segments I-VI have almost equal width, and stats to narrowing below segment III to terminal parts of the body. Chaetotaxy of abdomen (Figs 12-15): tergites I-VII each with 4 setae; tergite VIII with 4 setae, sternit VIII with 3 setae, sternit IX with 4 setae. Pseudocerci (pc) thorn-like, straight, short, slightly curved to inside; sexual dimorphism in structure of VII and IX sternites are well marked (Figs 14-15). Spiracles: 5 pairs functional on abdominal segment I-V and 3 pairs atrophied on abdominal segments VI-VIII dorsolaterally.

2. Remarks on the ecology and biology

The majority of the specimens (*in copula*) were observed on leafs of the reed canarygrass (*P. arundinacea* L.), which is growing on shallow meadow water reservoirs with dominant *Magnocaricion* rushes or in undergrowth of alder forest (*Ribeso nigri-Alnetum*). A few individuals were also found in the plant remains on the banks of water bodies. This indicates that *B. frivaldszkyi*



16

Fig. 16. Life cycle of *Bagous frivaldszkyi* in the field (L_1, L_2, L_3 – larval instars, I.-XII. – months).

inhabits both cold and shadow water ecosystems (alder forest) and warm insolate biotopes (meadow water-reservoirs). Single specimens were observed on undergrowth of melting floodplain forest (*Alno-Ulmion*) and on old riverbeds. Most probably their occurrences in these localities was accidental and connected with coexisting spring overflow. The first active specimens appeared in the first decade of April (10 April 2002) in Poland. Copulation took place in May and the first decade of June. The adults were observed on leafs the over water-surface, there were only one pair of the weevils on one plant. The slender, elongated shape of the body is doubtless an adaptation to occurrence on narrow leafs of canarygrass reeds. From one to three copulating pairs were observed on $1m^2$ of rushes (populations of mentioned weevil in Œlipcze may be estimated 250 specimens). After the copulation period the adults were not observed on plants under water-surface. Oviposition took place from beginning of May to the beginning of June. Eggs were laid separately (1-4) in the same plant, always under the water-surface. The immature stages were collected only from inside submerged, procumbented stems of canarygrass reeds. Different larval stages were observed in the fields from the beginning of May to the end of July. The development of larval stages lasted probably about 30 days. The pupae were found from the end of

June until the end of July. The pupal stage took about 14 days. After emergence the adults were first found inside the stems in the middle of July. The new generation of adults lasted for 3-4 weeks in stems. After this time, they leave the stems and enter plant remains on the bottom of the lake to overwinter (Fig. 16). I had found no predators or other competitor, phytophagous species in the place where *B. frivaldszkyi* develops. I suppose that the fluctuation of the water level was a cardinal influence in the developmental success of the species, which is discussed. I found dead larvae and pupae on the water surface after the water level had fallen.

Conclusions

The larva of *B. frivaldszkyi* possesses majority of the essential generic features described by MAY (1994) for larva of the genus *Bagous* namely: (1) setal numbers greatly reduced, (2) head and pronotum pigmented, (3) head with frontal suture distinct, (4) antennae broadly conical, short, (5) ocelli present (in *B. collignesis* [HERBST] ocelli absent), (6) head without setae des_3 (in *B. collignesis* setae des_3 present), (7) labrum more or less truncate, with 4 or 6 macro setae, (8) labial palp one-segmented, (9) mandibles teeth slightly truncate, (10) ligula concave, (11) spiracles bicameral, those of abdominal segment VIII dorsal, (12) anus ventral. However, larva of this species present features which are different from the description given by MAY (1994) (Tab. 1).

Tab. 1. Comparison of the morphological larval characters given by MAY (1994) and in the present work.

Features	MAY (1994)	Present work
body shape	moderately slender	very slender
body length	1.0-5.0 mm	3.75-9.91 mm
head shape	Subglobose	globose
head width	max. 0.5 mm	max. 0.78 mm
Maxilla	with 6 (dms)	with 7 (dms)
abdominal segments VIII, IX	with several long setae	with two simple setae

The elongated, very slender body is most probably an adaptation to live inside of narrow stems of canarygrass reeds. The most visible, typical feature of *B. frivaldszkyi* larva is the extreme scarcity of setae. The chaetotaxy of larvae of the genus *Bagous* is greatly reduced (MAY, 1994; STANIEC & GOSIK, 2003; SCHERF, 1964). Nevertheless the larvae are distinguished from other known larvae of *Bagous* species by the very sparse number of micro- and macrosetae, especially on the pedal area and the abdominal segments.

Therefore, only the pupae of four species (*B. collignensis*, *B. nodulosus*, *B. subcarinatus* and *B. frivaldszkyi*) have been described and illustrated. Because the number of descriptions of the pupa of different species belonging to this genus is very small, the separation of the features characteristic to the genus is unfortunately impossible. Moreover, the features of pupae of the species mentioned above are not convergent (Tab. 2).

Tab. 2. Comparison of the some known morphological characters of pupae of *B. collignensis*, *B. nodulosus*, *B. subcarinatus* and *B. frivaldszkyi*.

Features	*B. collignensis*	*B. nodulosus*	*B. subcarinatus*	*B. frivaldszkyi*
body shape	relative slender	relative slender	relative stock	slender
body length	3.95 mm	6.0-6.35 mm	3.25-3.70 mm	5.0-6.5 mm
body width	1.65 mm	1.90-2.20 mm	1.85-2.13 mm	1.70-2.21 mm
chaetotaxy of the head	unknown	2 vs, 2 sos_1, 2 sos_2, 2 os_1, 2 os_2, 2 pas, 2 rs_1, 2 rs_2	2 vs, 2 sos_1, 2 sos_2, 2 os_1, 2 os_2, 2 pas, 2 rs_1, 2 rs_2	2 vs, 2 os_1, 2 os_2, 2 rs_1, 2 rs_2. pas, sos_1, sos_2 invisible
chaetotaxy of the prothorax	2 as_1, 2 ls_1, 2 ls_2, 2 ls_3, 2 ds_2, 2 pls_1. pls_2 as_2, ds_1 invisible	2 as_1, 2 as_2, 2 ls_1, 2 ls_2, 2 ls_3, 2 ds_1, 2 ds_2, 2 pls_1, 2 pls_2	2 as_1, 2 as_2, 2 ls_1, 2 ls_2, 2 ls_3, 2 ds_1, 2 ds_2, 2 pls_1, 2 pls_2	2 as_1, 2 as_2, 2 ls_2, 2 ds_1, 2 ds_2, 2 pls_1, 2 pls_2. ls_1, ls_3 invisible
chaetotaxy of the mesothorax	2 setae	6 setae	6 setae	6 setae
chaetotaxy of the metathorax	2 setae	6 setae	6 setae	6 setae
chaetotaxy of the abdomen segments I-VII	6 setae	8 setae	8 setae	4 setae

Finding the diagnostic characters of pupae of *B. frivaldszki* should be possible by the comparison of this stage with other *Bagous* species.

The time of finding the successive development stages of *B. frivaldszkyi* (in the field) was compatible with information given by KANIA (1994). My observation that overwintering of adults takes place in the stems does not confirm information given by KANIA (1994). In the middle of October I found many empty stems with evidence of feeding. Inside two stems I found dead, putrid examples of *B. frivaldszkyi*. However, some live specimens were found in plant remains on the lake bottom. Thus, this explains that adults are also found at another time than during the vegetative season. In the last 50 years *B. frivaldszkyi* was found in Poland only in six localities (BURAKOWSKI *et al.*, 1995; KANIA, 1994; ŁĘTOWSKI & STANIEC, 1997; WANAT & GOSIK, 2003). In spite of canarygrass reed, that is a common water plant in Poland, the weevil associated with this plant is rarely observed. Probably this situation is a result of: the relatively short activity time of the adults; degradation of the biotopes and natural (related to weather) fluctuations of water levels in the habitats where the species lives. The inclusion of *B. frivaldszkyi* to Annex II of the Habitats Directive proposed by SPRICK (2001) is justifiable. The protection of non-degraded old riverbeds, unique biotopes on the European scale, may improve survival of this weevil. *Bagous frivaldszki* fulfills the criterions of the Red List of Threatened Animals, especially considering the sensitivity of this species to environmental degradation.

References

ALONSO-ZARAZAGA A. M., 2005. - Fauna Europaea, http://www.faunaeur.org.

BURAKOWSKI B., MROCZKOWSKI M. & STEFAŃSKA J., 1995. - Chrząszcze (Coleoptera) Ryjkowce – Curculionida, cz.2. *Katalog Fauny Polski*, 20: 1-310, PWN, Warszawa.

DIECKMANN L., 1964. - Die mitteleeuropäischen Arten aus Gattung *Bagous* GERM. *Entomologische Blätter*, 60: 88-111.

GOSIK R., 2006. – Description of the larva and the pupa of Bagous nodulosus Gyllenhal in Schoenherr, 1836 (Coleoptera: Curculionidae), with comments on its biology. *Baltic Journal of Coleopterology*, 6 (2): 143-150.

KANIA J., 1994. - Uwagi o niektórych krajowych ryjkowcach (Coleoptera, Curculionidae). *Wiadomoœci Entomologiczne*, 13 (4): 258-259.

KOCH K., 1992. - Die Käfer Mitteleuropas. Vol. 3 (Ökologie). Göcke & Evers, Krefeld, 1-380pp.

ŁETOWSKI J. & STANIEC B., 1997. - Materiały do poznania Attelabidae i Curculionidae (Coleoptera) wschodniej Polski. *Wiadomości Entomologiczne*, 16 (1): 21-28.

MAY B. M., 1994. - An introduction to the immature stages of Australian Curculionoidea, subfamily Bagoinae. In: E. C. Zimmerman's Australian Weevils: 533-535.

SCHERF H., 1964. - Die Entwicklungsstadien der mitteleuropäischen Curculioniden (Morphologie, Bionomie, Ökologie). *Abhandlungen der Senckenbergischen Naturforschenden Gesellschaft*, Frankfurt am Main, 1-336.

SMRECZYŃSKI S., 1972. - Chrząszcze - Coleoptera, Ryjkowce - Curculionidae, podrodzina Curculioninae. *Klucze do oznaczania owadów Polski*, 98d: 1-195.

SPRICK P., 2001. - Suitability of an Insects group for the Habitats Directive of the UE: The Weevils Subfamily Bagoine (Col. Curculionidae). Contributions to the Ecology of Phytophagous Beetles VII. *Snudebiller 2*, (CD):\Data\2text17rtf. CURCULIO-Institute, Mönchengladbach.

STANIEC B. & GOSIK R., 2003. - Morphology of the mature larva and pupa of Bagous subcarinatus Gyllenhal in Schoenherr, 1836 (Coleoptera: Curculionidae). *Genus*, 14 (4): 455-464.

WANAT M. & GOSIK R., 2003. - Materiały do znajomości ryjkowców (Insecta, Coleoptera: Curculionoidea) doliny Bugu. *Nowe Pamiętniki Fizjograficzne* 2(1-2): 31-52.

WANAT M. & MOKRZYCKI T., 2005. - A new checklist of weevils of Poland (Coleoptera: Curculionoidea). *Genus*, 16 (1): 69-117.

Received 13 October 2006, accepted 20 December 2006