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Moth flies (Diptera: Psychodidae) of Abkhazia (western Caucasus, Georgia) with some additional faunistic data from Armenia, Georgia, and Russia

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Abstract: This paper attempts to fill the knowledge gaps in biodiversity of non-biting moth flies in the Caucasus (especially in Abkhazia) and create a suitable basis for subsequent (not only) ecological studies. In total, records of 65 Psychodidae (Sycoracinae – one sp., Psychodinae 64 spp., altogether 33 genera) species/subspecies are presented based on specimens collected mainly in Abkhazia, with some additional data from Armenia, Georgia, and Russia (12 new records). The Psychodidae fauna of Abkhazia now comprises 57 species, 31 of which are newly listed here. The Caucasus region (including the territory of Abkhazia presented here) should be considered the most biologically rich and most endangered region in the world, with an exceptional richness of endemic and endangered species also from the point of view of psychodids biodiversity. Sixteen extremely rare species in this family (probably Caucasian or highland endemics) which need to be given increased attention, whether from the point of view of island ecology or biodiversity protection, have been herein confirmed.

Keywords: Abkhazia, biodiversity, checklist, distribution, faunistics, moth flies, new records, Palaearctic Region, Transcaucasia, western great Caucasus, zoogeography

Introduction

Taxonomy is an essential tool for understanding biodiversity. It is also essential in biodiversity conservation and in addressing many critical and current nature conservation issues (e.g. McNeely, 2002; Kociolek & Stoermer, 2001; Schlick-Steiner et al., 2010). Therefore, much recent research in ecology and biodiversity conservation has been based mainly on taxonomic and faunal works. However, the availability of these data varies considerably from a spatial, temporal, and often taxonomic point of view. This creates gaps in biodiversity information (Amano et al., 2016). Particularly large gaps in biodiversity research can be observed in the Caucasus countries (Wetzel et al., 2018), and Diptera, specifically the family Psychodidae, are a good example of this (see Oboňa et al. (2017, 2019a, b); Ježek et al. (2018, 2021a) and supplemented checklist here. In particular, the low intensity of research is the reason why part of the entomofauna of the Caucasus is still unknown.

Many papers have presented the characteristics of Caucasian mountains of Abkhazia; they are listed, e.g., in the book Priroda Abchazii (The Nature of Abkhazia) – Kuftyreva et al. (1961). Some important entomological papers (Diptera: Psychodidae) concerning the countries of Transcaucasia have been published in the last several decades: Wagner (1981, 1990); Vaillant & Joost (1983); Oboňa et al. (2017, 2019a, b); Ježek et al. (2018, 2021a) as well as some added accounts with non-western Caucasian species included, incl. neighbouring countries – Ježek (1992a, 1995b, 1999). However, the Psychodidae of Abkhazia are still rather poorly known. In particular, data on non-phlebotomine
moth flies have been scattered in various papers and never summarised. New faunistic records and new taxa from the Abkhazian mountains (Western Caucasus) and their foothills were reported in following papers: Parajungiella abchazica Ježek, 1985 in Ježek (1985); Yomormia acharischenica Ježek, 1987, Y. afonensis Ježek, 1987, Y. furva (Tonnoin, 1940) and Mormia eckvitariorum Ježek, 1987 in Ježek (1987); Seoda svanetica (Ježek, 1989) in Ježek (1989); Psychodocha cinerea (Banks, 1894), P. gemina (Eaton, 1904) and Psychodula minuta (Banks, 1894) in Ježek (1990a); Paramormia (P.) polyascoidea (Krek, 1971) in Ježek (1990b); Sycorax caucasica Ježek, 1990 in Ježek (1990c); Philosepedon clouense Ježek, 1994 in Ježek (1994); Kvazbormormia pshkuensis Ježek, 1995 in Ježek (1995a); Threticus petrosus Ježek, 1997 and Tonnioiriella arcuata Ježek, 1997 in Ježek (1997); Szaboiella hibernica (Tonnoin, 1940) in Ježek (2004a); Lepimormia georgica (Wagner, 1981), Peripsychoda auriculata (Haliday in Curtis, 1839), Philosepedon (Trichosepedon) balkanicum Krek, 1971, Threticus balkanoealpinus Krek, 1972, T. negrobobi Vaillant, 1972, Chodopsycha lobata (Tonnoin, 1940), Logima erminea (Eaton, 1893), Pericomia (Pachypericoma) blandula Eaton, 1893, P. (P.) fallax Eaton, 1893 and Pneumia g. gracilis (Eaton, 1893) in Ježek (2004b – balkanoealpinus as well in 1995c); Pneumia nibila (Meigen, 1818) and P. palustris (Meigen, 1804) in Ježek & Hájek (2007, erratum).

As it is very important to fill these knowledge gaps, the presented research is devoted to expanding knowledge (filling the knowledge gap) of the biodiversity of non-biting Psychodidae of the Caucasus (especially from Abkhazia), thus creating a suitable basis for subsequent, not only ecological, studies.

Material and methods

Moth flies (for concise characteristics and biology, see e.g. Ježek et al., 2019, 2021b) were collected by the first author in Abkhazia (Fig. 1) the summer seasons of 1983, 1985 and 1988 by sweep-netting from vegetation growing in swamps, source areas and along watercourses and water reservoirs, alpine and subalpine habitats, as well as lowland biotopes. P. Chvojka, J. Dlaba and J. Šumpich (National Museum, Prague, Department of Entomology) provided extensive additional material from Georgia, Russia and Armenia.

The captured specimens were preserved in 75% ethanol in the field, and the Psychodidae specimens (cleared in chlorophenol, treated in xylol, and mounted on glass slides in Canada balsam) were identified by J. Ježek in a laboratory and deposited at the National Museum (Natural History Museum), Department of Entomology, Prague, Czech Republic. The slides are numbered with two separate series of numbers: INS = Inventory Slide Number of the family Psychodidae, and Cat. No. = Catalogue Numbers of slides of types and historical specimens of Diptera and are included in the Diptera collection (National Museum Prague collections – NMPC, see Tkoč et al., 2014).


The List of localities section contains the following data: transcript of the site name from the site label, locality number (in parentheses), the currently used site name (if available) and country, more detailed characteristics of the collection habitat, approximate collection coordinates (found according to site descriptions), approximate altitude, habitat vegetation inventory (if available).

The Unpublished records section contains the following data: country, transcript of the site name from the site label, locality number (in parentheses), the number and sex of the samples examined, date, collector’s name and collection method (if available) and slides numbers.

The map presented in Fig. 1 is prepared using QGIS software (version: 3.10.10-A Coruña), data derived from the USGS/NASA SRTM providing seamless continuous topography surfaces (Jarvis et al., 2008), and from Natural Earth (free vector and raster map data @ naturalearthdata.com).

List of localities

(recorded species are summarised in Table 1)

1 Achalsopeli (Akhalsopeli – Georgia (Abkhazia)), wet small meadow, 43°00′N 41°06′E, 140 m a.s.l., veg.: Almus, Alisma, Scirpus, Carex, Mentha.

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2 Achalseni (Akhalsheni – Georgia (Abkhazia)), village env. Sukhumi, farms, wet road banks, rocks, swamps near crossways, 43°07’N 41°01’E, 490 m a.s.l., veg.: Acer, Alnus, Corylus, Rubus, Hedera, Fragaria, Marchantiopsida, Musci.

3 Achalseni near Sroma (Akhalsheni near Shroma – Georgia (Abkhazia)), Sukhumi environs, Vostočnaja Gumista River, rillets near a stone crusher, 43°05’N 41°01’E, 200 m a.s.l., veg.: Alnus, Sambucus, Rubus.

4 Acigvara (Achigvara – Georgia (Abkhazia)), Gali environs, muddy brook in tea plantations, 42°41’N 41°38’E, 40 m a.s.l., veg.: Alnus, Pteris, Polygonum, Rubus, Camellia.

5 Adanga Pass (Adange – Georgia (Abkhazia)), a basin with swamps, small brook from the pass, big stones, 43°19’N 41°16’E, 2470 m a.s.l., veg.: Fagus, Picea, Rhododendron, Petasites, Caltha, Scirpus, Rumex, Luzula, Orchis, Pteropsida.

6 Adjaria (Georgia), Mtirala NP, Chakvistavi ca. 20 km NE of Batumi, left and right tributaries of Chakvistskali River, brooks, streams, springs, 41°40’N 41°51’E, 250–410 m a.s.l., Chvojka leg.

7 Anaria (Anaria – Georgia (Abkhazia)), 7 km E of Ilori, spring area, 42°42’N 41°34’E, 30 m a.s.l., veg.: Alnus, Sambucus, Robinia, Polygonum, Marchantiopsida.

8 Areni (Armenia), Noravank monastery environs, rocky steppe, 39°41’N, 45°12’E, 1330 m a.s.l., Šumpich leg.

9 Azgara (Azhara – Georgia (Abkhazia)), environs of Levyj Pys, forest brook, wet road banks, Alnetum, muddy pasture near river, 43°06’N 41°42’E, 920 m a.s.l., veg.: Alnus, Carpinus, Fagus, Picea, Corylus, Rubus, Fragaria, Leonurus, Juncus, Hieracium, Urtica, Impatiens, Valeriana, Petasites, Musci, Pteropsida.
10 Azgara – Narzan (Azhara – Georgia (Abkhazia)), larger environs of Maruch Pass, wet bank or slope of a road near a river, Alnetum, marshes, tea plantations, montane stream, 43°06′N 41°42′E, 940 m a.s.l., veg.: Alnus, Fagus, Picea, Eucalyptus, Rubus, Rumex, Inula, Scirpus, Caltha, Carex, Pteropsida.

11 Baskacara (Georgia (Abkhazia)), Levyj Ptys environs, swamps, small forest brooks near river, Alnetum, streams below glaciers, 43°12′N 41°40′E, 3330 m a.s.l., veg.: Alnus, Fagus, Picea, Rubus, Fragaria, Juncus, Scirpus, Trollium, Urtica, Lycopodium, Inula, Petasites, Musci, Pteropsida.

12 Below Adanga Pass (Adange Pass – Georgia (Abkhazia)), 8 km from the pass, marches, small forest brook, Azgara River, clump of alders, slope, 43°19′N 41°16′E, 2470 m a.s.l., veg.: Alnus, Fagus, Picea, Petasites, Scirpus, Luzula, Orchis, Rumex, Fragaria, Caltha, Pteropsida.

13 Below Chimsa Pass – River Ubus (Ubusch R.– Georgia (Abkhazia)), small sources, 43°20′N 41°05′E, 1590 m a.s.l., veg.: Rhododendron, Salix, Alchemilla, Musci, Pteropsida.

14 Below Maruch Pass (Georgia (Abkhazia)), Levyj Ptys environs, spring areas, small brooks in Alnetum near river, high alder forest, fountain, marches, 43°10′N 41°43′E, 1150 m a.s.l., veg.: Alnus, Fagus, Picea, Abies, Rubus, Petasites, Asperula, Rumex, Ranunculus, Urtica, Caltha, Alisma, Musci, Pteropsida.

15 Below Ulm Pass (Georgia (Abkhazia)), rills of marches, 43°20′N 40°42′E, 1880 m a.s.l., veg.: Rhododendron, Salix, Alchemilla, Pteropsida.

16 Beslachuba (Beslakhuba – Georgia (Abkhazia)), Ocancira environs, large pools near road, swamps in the vicinity of a churchyard, 42°45′N 41°31′E, 55 m a.s.l., veg.: Alnus, Populus, Sambucus, Rubus, Polygonum, Urtica, Pteropsida.

17 Bzyb (Bzipi – Georgia (Abkhazia)), river 2–7 km from source area, Baskacara environs, small brooks in beech wood, sometimes with mineral water, marches, clump of alders, 43°13′N 40°22′E, 30 m a.s.l., veg.: Alnus, Fagus, Picea, Rubus, Petasites, Rumex, Asperula, Oxalis, Ranunculus, Caltha, Pteropsida.

18 Cebelda (Tsebelda – Georgia (Abkhazia)), arable land, fields, canals of irrigation, wet meadows, dried Alnetum, 43°01′N 41°16′E, 470 m a.s.l., veg.: Alnus, Sambucus, Salix, Rubus, Scirpus, Typha, Fragaria, Pieris, Lythrum, Urtica.

19 Chimsa near Ulm (Georgia (Abkhazia)), Bzybskij Chrebet comb (Bzybskij Khrebet), waterfalls, subalpine meadows in vicinity of passes, 43°20′N 40°43′E, 2300 m a.s.l., veg.: Rhododendron, Alchemilla, Pteropsida.

20 Cimuri (Georgia (Abkhazia)), larger environs of Sukhumi, Bzybskij Chrebet comb (Bzybskij Khrebet), glades, marches in Alnetum, hygropetric rocky walls, spring areas, rotten wood, Vostočnaja Gumista River, stream below a bridge, rocks, gate to NR, 43°05′N 41°00′E, 85 m a.s.l., veg.: Alnus, Fagus, Carpinus, Juglans, Rhododendron, Sambucus, Hedera, Rumex, Juncus, Pteropsida, Marchantiospida, Musci.

21 Cimuri near Achalseni (nr. Akhalsheni – Georgia (Abkhazia)), Sukhumi district, pastures, sources almost without plants, 43°05′N 41°01′E, 150 m a.s.l., veg.: Fagus, Fragaria.

22 Cchalta (Chkhalta – Georgia (Abkhazia)), marches near river, spring areas, 43°05′N 41°39′E, 720 m a.s.l., veg.: Juglans, Alnus, Sambucus, Geranium, Polygonum, Leonurus, Urtica, Persicaria, Marchantiospida.

23 Clou – Kodorskij Chrebet comb (Kodorskij Khrebet – Georgia (Abkhazia)), gorge, brook, hygropetric rocky walls, 42°58′N 41°51′E, 2330 m a.s.l., veg.: Alnus, Rhododendron, Rosa, Rubus, Petasites, Hepatica, Phyllitis, Urtica, Inula, Pteropsida, Marchantiospida, Musci.

24 Cerná Voda (Georgia (Abkhazia)), Baskacara environs, river, small brooks with flocculated Fe, marches, beech wood, 43°12′N 41°40′E, 3430 m a.s.l., veg.: Alnus, Fagus, Picea, Rubus, Caltha, Petasites, Ranunculus.

25 Dagomys (Dagomys – Krasnodar Krai, Russia), settlement, 13 km NW from Sochi, 43°40′N 39°40′E, 20 m a.s.l., Dlabola leg.

26 Dou Pass (Dou Pass – Georgia (Abkhazia)) – small brook, 43°17′N 40°52′E, 1390 m a.s.l., veg.: Fagus, Rhododendron, Alnus, Juglans, Prunus, Urtica, Pteropsida.

27 Dou near Bzyb (Dou Pass near Bzipi – Georgia (Abkhazia)), slope glade on the way from the pass to river, small brook, 43°20′N 40°50′E, 580 m a.s.l., veg.: Fagus, Rhododendron, Alnus, Juglans, Prunus, Urtica, Pteropsida.

28 Dvurecje near Dou (Georgia (Abkhazia)), slope habitat 1200–1350 m below pass, path course to Dou River, plant liana strings above water, Bryophyta of flow stones, glade with small brook.
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and gamekeeper’s lodge, fallen branches, hygropetric rocky walls, small streams, 43°16’N 40°54’E, 1100 m a.s.l., veg.: Fagus-forest, Rhododendron, Alnus, Phyllitis, Asplenium, Alchemilla, Viola, Pteris, Pteropsida, Musci.

29 Dzgerda (Igerda – Georgia (Abkhazia)), Kodorskij Chrebet comb, small forest brook, pastures, impervious fences, rills, fluvials, 42°54’N 41°21’E, 176 m a.s.l., veg.: Alnus, Fraxinus, Fagus, Cretaegus, Ilx, Rhododendron, Rubus, Hederæ, Pteris, Marchantiopsida.

30 Gagra (Gra – Georgia (Abkhazia)), town spring areas, gardens, 43°16’N 40°16’E, 125 m a.s.l., veg.: Salix, Ficus, Sambucus, Rubus.

31 Gali (Gali – Georgia (Abkhazia)), rivulet, swamps, Camellia hedgerows, 42°37’N 41°44’E, 60 m a.s.l., veg.: Alnus, Pteris, Polygonum, Scirpus, Camellia.

32 Gencvici (Gentsvishi – Georgia (Abkhazia)), river, brook, swamps in Alnetum, paludal habitats, 43°06’N 41°48’E, 895 m a.s.l., veg.: Alnus, Picea, Urtica, Polygonum, Musci.

33 GES – Sukhumi (Georgia (Abkhazia)), district town environs, hydroelectric power station, monkey farm env. River Gumista nr. Achalseni (Akhalsheni) (6 km from Sukhumi), branches of Corylus over footpath, 43°05’N 41°00’E, 90 m a.s.l., veg.: Sambucus, Rhododendron, Urtica.

34 Ilori (Ilori – Georgia (Abkhazia)), creek, turning from main flow to Pokveš (Pokvesh), marches in Alnetum, 42°55’N 41°05’E, 7 m a.s.l., veg.: Alnus, Corylus, Sambucus, Scirpus, Hederæ, Urtica, Pteropsida, Musci.

35 Imereli (Georgia), prov., Baghdati near Saime, Tsablarastskali River, 41°58’ N, 42°47’ E, 385 m a.s.l., Chvojka leg.

36 Juznyj Prijut Pass (Georgia (Abkhazia)), waterfalls, hygropetric rocky walls, 43°08’N 42°03’E, 1940 m a.s.l., veg.: Alnus, Rhododendron.

37 Kaldachvara (Kaldakhvara – Georgia (Abkhazia)), eastern border of the settlement, town Bzyb (Bizip) region, tunnel below road, small brook in Alnetum, 43°13’N 40°25’E, 80 m a.s.l., veg.: Alnus, Sambucus, Corylus, Hederæ, Urtica, Rubus, Pteropsida, Musci.

38 Kaldachvara near Mjusoera (Kaldakhvara near Myussera – Georgia (Abkhazia)), crossways, swamps in Alnetum, 43°13’N 40°26’E, 130 m a.s.l., veg.: Tupeha, Alisma, Juncus, Mentha.

39 Kaman (Kamani – Georgia (Abkhazia)), village env. Sukhumi, well in glade with small brook, white stones, 43°03’N 41°02’E, 230 m a.s.l., veg.: Carpinus, Sambucus, Zea, Pteropsida, Marchantiopsida, Musci.

40 Kelasuri (Kelasuri – Georgia (Abkhazia)), river and settlement env. Sukhumi, Kodorskij Chrebet comb (Kodorskiy Khrebet), Alnetum, swamps near riverbed, small brook, pastures, clough, hygropetric rocky walls, 43°01’N 41°06’E, 200 m a.s.l., veg.: Alnus, Carpinus, Rhododendron, Sambucus, Hederæ, Rubus, Phyllitis, Petasites, Alisma, Impatiens, Pteropsida, Marchantiopsida, Musci.

41 Kingdi – vicinity of Gulripši (Gulripshi – Georgia (Abkhazia)), 3 km NW of Gali, swamps in Alnetum near road, 42°40’N 41°44’E, 140 m a.s.l., veg.: Alnus, Rhododendron, Rubus, Polygonum.

42 Kochora (Kokhora – Georgia (Abkhazia)), a pastoral community of grazing management approximately 2350 m a.s.l., Bzybskij Chrebet comb (Bzybskiy Khrebet), nr. peak Khimsa (3033 m a.s.l.), 43°19’N 40°43’E, 1880 m a.s.l., veg.: Hieracium, Alchemilla, Polygonum, Pteropsida.

43 Kot – Kot (Georgia (Abkhazia)), village env. Sukhumi, well in glade with small brook, white stones, 43°03’N 41°02’E, 230 m a.s.l., veg.: Carpinus, Sambucus, Zea, Pteropsida, Marchantiopsida, Musci.

44 Kutol Kodorskij Chrebet comb (Kodorskiy Khrebet – Georgia (Abkhazia)), village, small meadow, fountain, 42°56’N 41°51’E, 130 m a.s.l., veg.: Alnus, Carpinus, Rhododendron, Sambucus, Hederæ, Urtica, Pteropsida, Musci.

45 Kot – Kot near Nartsikuri (Georgia (Abkhazia)), a pastoral community in Bzybskij Chrebet comb. (Bzybskiy Khrebet), Sukhumi distr., glade, forest zone, lakes, small brooks, pools, trilling rocky slopes, peat and swamp bogs, river, marches, beech wood, 43°18’N 40°42’E, 2070 m a.s.l., veg.: Alnus, Acer, Picea, Sambucus, Carpinus, Robinia, Sorbus, Fagus, Rhododendron, Petasites, Caltha, Juncus, Scirpus, Impatiens, Rumex, Inula, Asperula, Hieracium, Alchemilla, Polygonum, Sphagnum, Lemna, Pteropsida, Musci.

46 Kutol Kodorskij Chrebet comb behind Ulm Pass, pastoral community, lakes, swamps, 43°17’N 40°39’E, 1000 m a.s.l., veg.: Fagus, Alnus, Acer, Sorbus, Juncus, Rumex, Petasites, Caltha, Pteropsida.

47 Lehvaz (Armenia), environs, 3 km NW of Meghri, Arevik NP, rocky steppe, gorge, 38°54’N 46°13’E, 844 m a.s.l., Šumpich leg.
48 Levyj Ptys (Georgia (Abkhazia)), spring area near river, fallen branches, trickling banks of road, brook, 43°12′N 41°40′E, 3430 m a.s.l., veg.: *Alnus, Fagus, Juglans, Corylus, Polygonum, Lythrum, Fragaria, Leonurus*, Pteropsida, Marchantiopsida, Musci.

49 Macara (Machara – Georgia (Abkhazia)), Sukhumi distr., mandarin garden plantation (day as well as night collecting), walled WC, river, irrigation canal, village rill, shallow stony riverbed, almost dried ditch in building site, 42°55′N 41°32′E, 230 m a.s.l., veg.: *Alnus, Salix, Sambucus, Lythrum, Polygonum*.

50 Maruch near Adanga (Marukhi Pass Georgia (Abkhazia)), small brook near footpath in the vicinity of both passes, 43°12′N 41°16′E, 450 m a.s.l., veg.: *Quercus, Corylus, Alnus, Pteris, Urtica*.

51 Mercheuli (Merkheuli – Georgia (Abkhazia)), 8 km from Macara (bridge), Sukhumi district, houses, brook, marches, hills, hygropetric rocky wells, conglomerate rocks, 42°55′N 41°05′E, 10 m a.s.l., veg.: *Alnus, Rubus, Pteropsida, Marchantiopsida, Musci*.

52 Mramba – Cebelda (Tsebelda – Georgia (Abkhazia)), environs, sheer slope, pasture, well, muddy pools of domestic pigs, stream, branches of oak and hazel shrubs above water, 43°01′N 41°16′E, 450 m a.s.l., veg.: *Alnus, Acer, Corylus, Picea, Rumex, Petasites*.

53 Niznaja Zemo – Azara) (Azhara – Georgia (Abkhazia)), marches near village, rubbish, crocks, 43°06′N 41°41′E, 560 m a.s.l., veg.: *Alnus, Fagus, Juglans, Sambucus, Corylus, Rubus, Inula, Carex, Equisetum, Juncus, Mentha, Pteris, Hedera, Poaceae, Fragaria, Hepatica, Urtica, Impatiens, Plantago, Mentha, Alisma, Trollius, Lythrum, Pteropsida, Musci, Marchantiopsida*.

54 Novyj Afon near Anuchva (54) (Akhali Atoni – Georgia (Abkhazia)), Psyrccha River, riverbed, spring areas, fountain, small brooks, rocks, 43°06′N 41°41′E, 560 m a.s.l., veg.: *Alnus, Polygonum, Leonurus*.

55 Ocamcira (Ochamchire – Georgia (Abkhazia)), refuse in ditches, 42°43′N 41°29′E, 10 m a.s.l., veg.: *Alnus, Carpinus, Rhododendron, Rubus, Polygonum, Urtica, Pteris*.

56 Okumi (Okumi – Georgia (Abkhazia)), 2–4 km SW of the village, Tkvarceli env., S of Kodorskij Chrebet comb (Kodorskij Khrebet), brook, pastures, marches, tunnel in tenuous pine wood, 42°42′N 41°44′E, 170 m a.s.l., veg.: *Alnus, Pinus, Larix, Robinia, Rubus, Luzula, Carex, Polygonum, Pteris, Mentha*.

57 Otap (Otapi – Georgia (Abkhazia)), Kodorskij Chrebet comb (Kodorskij Khrebet), slope, pasture, wet places, branches of alders above stream, swamps near way and in hillside, brook, thorny fences, 42°55′N 41°32′E, 230 m a.s.l., veg.: *Alnus, Salix, Sambucus, Lythrum, Polygonum*.

58 Ps khu (nr. Ps khu Nakrdzali – Georgia (Abkhazia)), a beautiful green valley, alluvial zone and wet places on banks of the River Bzyb (Bzipi), (2.5 km from the settlement, approximately 1400 m a.s.l. – southern and northern border), marshes, swamps, pools, pastures, clearings, tenuous alder forest, shaded sources by different plants, small forest brooks, streams, rills, (trickling southern slopes incl. regional airport), farming residents 100 m from Bzyb (Bzipi) River, small meadows, fenced gardens, branches of alders above flows, 43°20′N 40°54′E, 1830 m a.s.l., veg.: *Alnus, Fagus, Juglans, Sambucus, Corylus, Rubus, Inula, Carex, Equisetum, Juncus, Mentha, Pteris, Hedera, Poaceae, Fragaria, Hepatica, Urtica, Impatiens, Plantago, Mentha, Alisma, Trollius, Lythrum, Pteropsida, Musci, Marchantiopsida*.

59 Ps khu near Dou (nr. Ps khu Nakrdzali near Dou Pass – Georgia (Abkhazia)), southern footpath from border of the village to Dou Pass, farming residents, small brooks, spring areas, 43°12′N 40°52′E, 1900 m a.s.l., veg.: *Juglans, Corylus, Rubus, Inula, Impatiens, Urtica, Mentha*.

60 Reka near Gali – Ilori environs (Georgia (Abkhazia)), crossways, 42°41′N 41°29′E, 2 m a.s.l., veg.: *Alnus, Polygonum*.

61 Resava) (Georgia (Abkhazia)) environs, ca. 1300 m below Dou Pass, swamps in beech forest, fallen tree branches, 43°17′N 40°52′E, 1390 m a.s.l., veg.: *Fagus, Alnus, Corylus, Juncus, Carex, Pteropsida*.

62 Rica (Georgia (Abkhazia)), larger Gagra environs, dried canal with wet places, road, small rocky brook, lake, 43°19′N 40°15′E, 120 m a.s.l., veg.: *Acer, Carpinus, Picea, Petasites, Inula, Asplenium, Urtica, Fragaria, Stachys*.

63 Sagra near Tamys (Tsagera near Tamishi – Georgia (Abkhazia)), road to Ocamcira (Sukhumi environs), arable land, fields, ditch in tea plantations, 42°47′N 41°23′E, 20 m a.s.l., veg.: *Eucalyptus, Alnus, Rubus, Juncus, Zea, Camelia*.

64 Saken (Sakeni – Georgia (Abkhazia)), 90 km from Sukhumi, river, small montane brooks with pools,
swamps in alder forest, 43°05′N 41°53′E, 990 m a.s.l., veg.: *Alnus*, *Corylus*, *Geranium*, *Leonurus*, *Urtica*, *Musciet.

65 Saken – Narzan (nr. Sakeni – Georgia (Abkhazia)), montane chalets near peaks above settlement, spring areas, small brooks, river, lush alder growth, forest marches and swamps, pasture muddy sections, slopes, glade streams, tributaries of lakes, branches of alders above water flows, fallen tree branches, collecting as well in night (22:00), 43°04′N 41°53′E, 1170 m a.s.l., veg.: *Alnus*, *Fagus*, *Acer*, *Picea*, *Corylus*, *Juglans*, *Prunus*, *Sambucus*, *Rubus*, *Equisetum*, *Juncus*, *Impatiens*, *Fragaria*, *Inula*, *Ranunculus*, *Trollius*, *Petasites*, *Alchemilla*, *Myosotis*, *Aquilegia*, *Heracleum*, *Rumex*, *Geranium*, *Pteropsida*, *Musciet.

66 Saken near Juznyj Prijut Pass (Sakeni – Georgia (Abkhazia)), marches near road (crossways), small brook, *Alnus*, 43°04′N 41°57′E, 1300 m a.s.l., veg.: *Alnus*, *Geranium*, *Leonurus*, *Urtica*.

67 Serbista (Georgia (Abkhazia)), larger environs of the Maruch Pass, alder forest, small brooks, muddy pasture, 43°10′N 41°42′E, 1410 m a.s.l., veg.: *Alnus*, *Petasites*, *Rumex*, *Caltha*, *Inula*.

68 Shvanidzor (Armenia), environs, Arevik NP, rocky steppe, 38°56′N 44°22′E, 780 m a.s.l., Šumpich leg.

69 Svanetia (Georgia), SE, N and W of Mestia, left brook (stream) tributary of Mulkhura River, and Dolra River (left tributary of) above Ushkhvan, source area, 43°02′N 42°46′E, 1370–1700 m a.s.l., Chvojka leg.

70 Sroma (Shroma – Georgia (Abkhazia)), Sukhumi distr., hills, sources near stone crusher, 43°04′N 41°01′E, 240 m a.s.l., veg.: *Alnus*, *Robinia*, *Rubus*, *Juncus*, *Mentha*.

71 Tamys (Tamish – Georgia (Abkhazia)), vicinity of Sukhumi, alder growth near road, brook, swamps, tea plantations, 42°47′N 41°22′E, 15 m a.s.l., veg.: *Alnus*, *Eucalyptus*, *Rubus*, *Scirpus*, *Caltha*, *Camellia*.

72 Tkvarecli (Tkvarcheli – Georgia (Abkhazia)), 3 km E of the settlement, stream near Galidzga (Ghalidzga) river, limestone areas, branches of alders above water, 42°51′N 41°38′E, 160 m a.s.l., veg.: *Alnus*, *Buxus*.

73 Ubus (Ubusch – Georgia (Abkhazia)), river as tributary of Bzyb (Bzipi) flow (in a distance 3–5 km), wet slopes and small brooks in beech wood, pasture, glade, grazing banks, 43°20′N 41°06′E, 1390 m a.s.l., veg.: *Fagus*, *Alnus*, *Picea*, *Petasites*, *Rumex*, *Inula*, *Caltha*, *Pteropsida*.

74 Ubus near Bzyb (Ubusch near Bzipi – Georgia (Abkhazia)), confluence of rivers, clearings in riverbed, 43°21′N 41°06′E, 1340 m a.s.l., veg.: *Alnus*, *Heracleum*, *Caltha*.

75 Vedi (Armenia), Goravan village environs, Goravan sands, Sanctuary sandy steppe, 39°53′N 44°43′E, 956 m a.s.l., Šumpich leg.

76 Yerevan (Armenia), 13 km SE of the town, Hatsavan nr. Azat Reservoir, steppe, 40°06′N 44°50′E, 1071 m a.s.l., Šumpich leg.

77 Zemo – Azara (Kvemo Azhara – Georgia (Abkhazia)), swamps in Alnetum near river, brook, stream, small flows, spring area, branches of alders above flows, grazing banks, swamps, old pots, 43°06′N 41°42′E, 540 m a.s.l., veg.: *Alnus*, *Sambucus*, *Rhododendron*, *Corylus*, *Buxus*, *Rubus*, *Fragaria*, *Leonurus*, *Geranium*, *Polygonum*, *Urtica*, *Marchantiopsida*, *Musciet*.

**Results**

**List of species**


*Kvazbamormia pshkuensis* Ježek, 1995 – Published record: Ježek (1995a): Pskuh (58). Distribution: This species and genus are known so far only from the original description (Ježek, 1995a) from Abkhazia (single locality). See also Oboňa et al. (2019).


known only by its original description (Ježek, 1987) from Abkhazia.


Historia naturalis bulgarica 45 (2023)
Moth flies of Abkhazia with some additional faunistic data from Armenia, Georgia, and Russia


INS 30411 and 30731. Distribution: Common European species, Transcaucasian sites represent Abkhazia and Georgia s. str. More information in detail see Ježek et al. (2021a, b).


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Historia naturalis bulgarica 45 (2023)


Moth flies of Abkhazia with some additional faunistic data from Armenia, Georgia, and Russia

Holarctic species, known from Azerbaijan and Georgia; see some details e. g. in Ježek et al. (2019, 2020, 2021a, b) and Oboňa et al. (2019). New for Abkhazia.


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Georgia (the original description of Wagner, 1981; for the second record, see Oboňa et al., 2019). New for Abkhazia.


*Pericoma (Pachypericoma) fallax* Eaton, 1893 – Published record: Ježek (2004b): Tshlou (23). Distribution: Europan and West-Siberian species, also known as well from Transcaucasia (Abkhazia, Azerbaijan and Georgia) – Oboňa et al. (2019); Ježek et al. (2021a).

Moth flies of Abkhazia with some additional faunistic data from Armenia, Georgia, and Russia


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Jan Ježek, Jozef Oboňa, Peter Manko


Summary of the results and conclusion

Psychodids fauna, mainly from Abkhazia and rarely from adjacent countries, such as Armenia, Georgia and Russia, is presented. Altogether 65 species were found from 33 genera. The most species-rich localities include the following: site 65 – Saken – Narzan (26 species), 58 – Pskhu (22 spp.), 77 – Zemo – Azara (20 spp.), and these localities, with a large diversity of plants and interesting different landscape morphology, were the mostly frequently sampled. On the other hand, the localities with the lowest species diversity (usually with a minimum diversity of plants and almost dried former wet habitats) were sites with just one species (localities 13 – Below Chimsa Pass, 15 – Below Ulm Pass, 24 – Cerna Voda, 34 – Ilori) and with two species (sites 1 – Achalsopeli, 3 – Achalseni near Sroma, 7 – Anaria, 30 – Gagra). The
### Table 1. List of localities with recorded species.

<table>
<thead>
<tr>
<th></th>
<th>Localities</th>
<th>Species Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Achalsopeli (Abkhazia)</td>
<td><em>abchazica, auriculata</em></td>
</tr>
<tr>
<td>2</td>
<td>Achalseni (Abkhazia)</td>
<td><em>achalshenica, cvitariorum, gemina, nubila, trinodulosa</em></td>
</tr>
<tr>
<td>3</td>
<td>Achalseni near Sroma (Abkhazia)</td>
<td><em>abchazica, blandula</em></td>
</tr>
<tr>
<td>4</td>
<td>Acigvara (Abkhazia)</td>
<td><em>abchazica, nubila, trinodulosa</em></td>
</tr>
<tr>
<td>5</td>
<td>Adanga Pass (Abkhazia)</td>
<td><em>cognata, phalaenoides, schumpkanica</em></td>
</tr>
<tr>
<td>6</td>
<td>Adjaria (Georgia)</td>
<td><em>ambigua, arcuata, balkaneoalpinus, caucasica (S.), cognata, furva, grusinicus, lobata, nubila, pseudexquisita, satchelli, silesiensis</em></td>
</tr>
<tr>
<td>7</td>
<td>Anaria (Abkhazia)</td>
<td><em>abchazica, nubila</em></td>
</tr>
<tr>
<td>8</td>
<td>Areni (Armenia)</td>
<td><em>albipennis, alternata, buna, lativenris, pannonica, piliullaria, satchelli, ustulata</em></td>
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<td>9</td>
<td>Azgara (Abkhazia)</td>
<td><em>abchazica, arcuata, balkaneoalpinus, caucasica (S.), furva, grusinicus, lobata, nubila, resili, rotunda, setigera, vaillanti</em></td>
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<td>10</td>
<td>Azgara – Narzan (Abkhazia)</td>
<td><em>alternata, arcuata, balkaneoalpinus, blandula, buxtoni, caucasica (S.), cognata, furva, grusinicus, lobata, nubila, polyascoidea, resili, rotunda, satchelli, trinodulosa</em></td>
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<td>11</td>
<td>Baskacara (Abkhazia)</td>
<td><em>albipennis, alticola, arcuata, balkaneoalpinus, clouense, cognata, furva, gemina, grusinicus, hibernica, lobata, minuta, montana, petrosus, phalaenoides, pseudexquisita, resili, schumpkanica, setigera, svenetica</em></td>
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<td>12</td>
<td>Below Adanga Pass (Abkhazia)</td>
<td><em>albipennis, alticola, arcuata, balkaneoalpinus, grisescens, hibernica, nubila, petrosus, phalaenoides, resili, satchelli</em></td>
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<td>13</td>
<td>Below Chimsa Pass (Abkhazia)</td>
<td><em>schumpkanica</em></td>
</tr>
<tr>
<td>14</td>
<td>Below Maruch Pass (Abkhazia)</td>
<td><em>abchazica, albipennis, arcuata, balkaneoalpinus, gemina, lobata, phalaenoides, piliullaria, satchelli, svenetica, trinodulosa, zetterstedt</em></td>
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<tr>
<td>15</td>
<td>Below Ulm Pass (Abkhazia)</td>
<td><em>schumpkanica</em></td>
</tr>
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<td>16</td>
<td>Beslachuba (Abkhazia)</td>
<td><em>abchazica, erminea, nubila</em></td>
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<td>17</td>
<td>Bzyb (Abkhazia)</td>
<td><em>arcuata, balkaneoalpinus, cognata, compta, g. gracilis, lobata, nubila, palustris, phalaenoides</em></td>
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<td>18</td>
<td>Cebelda (Abkhazia)</td>
<td><em>abchazica, alternata, gemina, nubila, trinodulosa</em></td>
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<td>19</td>
<td>Chimsa near Ulm (Abkhazia)</td>
<td><em>resili, schumpkanica</em></td>
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<td>20</td>
<td>Cimuri (Abkhazia)</td>
<td><em>abchazica, albipennis, alternata, arcuata, balkaneoalpinus, blandula, buxtoni, cinerea, gemina, g. gracilis, minuta, nubila</em></td>
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<td>21</td>
<td>Cimuri near Achalseni (Abkhazia)</td>
<td><em>g. gracilis, inopinata</em></td>
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<td>22</td>
<td>Chalta (Abkhazia)</td>
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<td>Clou (Abkhazia)</td>
<td><em>abchazica, arcuata, balkaneoalpinus, blandula, caucasica (S.), cvitariorum, clouense, erminea, fallax, grusinicus, lobata, satchelli, trinodulosa</em></td>
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<td>24</td>
<td>Cerna Voda (Abkhazia)</td>
<td><em>balkaneoalpinus</em></td>
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<td>25</td>
<td>Dagonmys (Russia)</td>
<td><em>cinerea</em></td>
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<td>26</td>
<td>Dou Pass (Abkhazia)</td>
<td><em>albipennis, arcuata, phalaenoides</em></td>
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<td>27</td>
<td>Dou near Bzyb (Abkhazia)</td>
<td><em>caucasica (S.)</em></td>
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<td>28</td>
<td>Dvurecje near Dou (Abkhazia)</td>
<td><em>abchazica, arcuata, balkaneoalpinus, caucasica (S.), furva, grusinicus, hibernica, lobata, nubila, satchelli</em></td>
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<td>29</td>
<td>Dzgerda (Abkhazia)</td>
<td><em>abchazica, buxtoni, nubila</em></td>
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Table 1 continued…

<table>
<thead>
<tr>
<th>No.</th>
<th>Location</th>
<th>Species</th>
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<tr>
<td>30</td>
<td>Gagra (Abkhazia)</td>
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<td>Gali (Abkhazia)</td>
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<td>Genevici (Abkhazia)</td>
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<td>GES – Sukhumi (Abkhazia)</td>
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<td>Ilori (Abkhazia)</td>
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<td>Imereli (Georgia)</td>
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<td>36</td>
<td>Juznyj Prijut Pass (Abkhazia)</td>
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<td>Kaldachvare (Abkhazia)</td>
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<td>Kaldachvare near Mjusoera (Abkhazia)</td>
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<td>Kaman (Abkhazia)</td>
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<td>Kot – Kot near Ulm Pass (Abkhazia)</td>
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<td>Lehvaz (Armenia)</td>
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<td>Maruch near Adanga (Abkhazia)</td>
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<td>Mramba (Abkhazia)</td>
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<td>Nizznaja Zemo – Azara (Abkhazia)</td>
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<td>Ocamcira (Abkhazia)</td>
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<td>Pskhu (Abkhazia)</td>
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Table 1 continued…

<table>
<thead>
<tr>
<th>Location</th>
<th>Species</th>
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<tr>
<td>Pakhu near Dou (Abkhazia)</td>
<td>abchazica, arcuata, balkaneoalpinus, erminea, g. gracilis, grusinicus, nubila, palustris, polyscoidea, trinodulosa, uniformata</td>
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<td>Reka near Gali (Abkhazia)</td>
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<td>Resava (Abkhazia)</td>
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<td>Rica (Abkhazia)</td>
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<td>Sagra near Tamys (Abkhazia)</td>
<td>abchazica, brevicornis, trinodulosa</td>
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<tr>
<td>Saken (Abkhazia)</td>
<td>abchazica, arcuata, balkaneoalpinus, furva, gemina, grusinicus, nubila, polyscoidea, ressli, trinodulosa</td>
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<td>Saken – Narzan (Abkhazia)</td>
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<td>Saken near Juzynej Prijut Pass (Abkhazia)</td>
<td>abchazica, furva, nubila, polyscoidea</td>
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<td>Serbista (Abkhazia)</td>
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<td>Shvanidzor (Armenia)</td>
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<td>Svanetia (Georgia)</td>
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<tr>
<td>Ubus (Abkhazia)</td>
<td>abchazica, albipennis, alticola, arcuata, balkaneoalpinus, caucasica (B), cognata, grisescens, lobata, petrosus, phalaenoides, schumpkanica, setigera</td>
</tr>
<tr>
<td>Ubus near Bzyb (Abkhazia)</td>
<td>schumpkanica</td>
</tr>
<tr>
<td>Vedi (Armenia)</td>
<td>achalshenica</td>
</tr>
<tr>
<td>Yerevan (Armenia)</td>
<td>albipennis, alternata, ustulata</td>
</tr>
<tr>
<td>Zemo – Azara (Abkhazia)</td>
<td>abchazica, achalshenica, arcuata, balkaneoalpinus, blandula, caucasica (B), caucasica (S), erminea, furva, g. gracilis, grusinicus, inopinata, m. motasi, nubila, phalaenoides, polyscoidea, pseudexquisita, ressli, schumpkanica, trinodulosa</td>
</tr>
</tbody>
</table>

Most common species in this study include Parajungiella abchazica Ježek, 1985 (41 sites), Pneumia nubila (Meigen, 1818) (36), Tomnoiriella arcuata Ježek, 1997 (24), and Threticus balkaneoalpinus Krek, 1972 (22). Some species are known so far, unfortunately, from only the holotype locality – one specimen (Kvazbamormia pskhuensis Ježek, 1995) in contrast to species with a generally large distribution and registered here infrequently by accident: e.g. Seoda carthusiana (Vaillant, 1972), Pneumia compta (Eaton, 1893), Pericoma (Pachypericoma) fallax Eaton, 1893, Trichopsychoda hirtella (Tonnoin, 1919), Berdeniella manicata (Tonnoin, 1920), Pneumia trivialis (Eaton, 1893) and Psychomormia vaillanti (Wagner, 1977).

New records for Abkhazia (31 species) were ascertained: Logima albipennis (Zetterstedt, 1850), Tinea alternata Say, 1824, Psychoda alticola Vaillant, 1973, Copropsychoda brevicornis (Tonnoin, 1940), Chodopsycha buxtoni (Withers, 1988), Seoda carthusiana (Vaillant, 1972), Berdeniella caucasica Wagner, 1981, Ulomyia cognata (Eaton, 1893), Pneumia compta (Eaton, 1893), Psychoda crassipennis Tonnoin, 1940, Pericoma (Pericoma) exquisita Eaton, 1893, Psyche grisescens (Tonnoin, 1922), Clytocerus (Boreoclytocerus) grusinicus Wagner,

Several species from neighbouring countries were identified in this paper, e.g. Tonnoiriella arcuata Ježek, 1997, Clytocerus (Boreoclytocerus) grusinicus Wagner, 1981, Threticus balkanealpinus Krek, 1972, Thornburghiella montana Ježek, Oboňa & Manko, 2021, Pericoma (Pericoma) motasi motasi Vaillant, 1978, Pneumia nubila (Meigen, 1818), Psychoda phalaenoides (Linnaeus, 1758) and Pericoma (Pericoma) pseudexquisita Tonnoir, 1940, however, all mentioned species were published already from Georgia (Wagner 1981, Oboňa et al., 2019 and Ježek et al., 2021c), from territory other than Abkhazia. For all that, Seoda ambigua (Eaton, 1893), Philosepedon (Trichosepedon) balkanicum Krek, 1971, Yomormia furva (Tonnoir, 1940), Psychodula minuta (Banks, 1894), Berdeniella schumpkanica (Vaillant & Joost, 1983) and Promormia silesiensis Ježek, 1983, are new for Georgia.

Logima albipennis (Zetterstedt, 1850), Tinearia alternata (Say, 1824), Paramormia (Duckhousiella) ustulata (Walker, 1856) and Pneumia pilularia (Tonnoir, 1940) were published from Armenia (Ježek et al., 2018), however, Yomormia achalshenica Ježek, 1987, Pericoma (Pericoma) bunae Krek, 1979, Tinearia lativentris (Berdén, 1952) and Pericoma (Pericoma) pannonica Szabó, 1960, are new for Armenia.

Pericoma (Pachypericoma) blandula Eaton, 1893, was registered from Georgia and Armenia (Ježek et al., 2018, 2021a), nevertheless, Logima satchelli (Quate, 1955) represents a new record for both Georgia and Armenia.

Psychodocha cinerea (Banks, 1894) was published from Russia (Siberia – Ježek, 1992b) and Berdeniella schumpkanica Vaillant & Joost, 1983, is also known from Russia (see Vaillant & Joost, 1983: Terskol + stream Schumka).

The Caucasus region (Armenia, Azerbaijan, and Georgia) is considered to be the most biologically rich and most endangered region in the world, a so-called “Biodiversity hotspot” with an exceptional richness of endemic and endangered species (Myers et al., 2000; Krever et al., 2001; Williams et al., 2011; Mumladze et al., 2020). But there was only scarce information about the Psychodidae family from here. As there are also many, extremely rare species in this family in the Caucasus (probably Caucasus or highland endemics) (e.g. Sycorax caucasica, Kvaizamormia pskuensis, Lepimormia georgica, Mormia ekvitorium, Yormormia achalshenica, Yormormia afonensis, Parajungiella abchazica, Seoda svanetica, Philosopedon (Trichosepedon) clouense, Threticus petrosus, Berdeniella caucasica, Berdeniella schumpkanica, Clytocerus (Boreoclytocerus) grusinicus, Pericoma (Pericoma) inopinata, Saraieella ressli, Thornburghiella montana), it is appropriate to perceive this area as being the most biologically rich and most endangered region in the world also in terms of biodiversity of the Psychodidae family. However, it needs to be given increased attention not only for these rare species, but, for example, from the point of view of island ecology or biodiversity protection.

Research in this area can also contribute to understanding the spread of different species and may contribute to the understanding of the factors that limit this spread.

Knowledge about the biodiversity of the Caucasus is crucial for the protection not only of local nature, but also insects, especially Diptera; extremely “aesthetic” epidemiological/economic groups are unimportant and given only marginal attention. Also, the ecological significance of insects is often overlooked. Their main ecological functions and ecosystem services in ecosystems include nutrient recycling, pollination, predation/parasitism and decomposition of biological material (Samways, 1993; Kim, 1993; Naeem et al., 2021).

Acknowledgements

We thank in particular friends Mr K. Ckvitaria (Abkhazia, Sukhumi – Makhara) and Mr P. Kvaizba (Abkhazia, Psiku) as well as their families for the
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Jan Ježek, Jozef Oboňa, Peter Manko


Moth flies of Abkhazia with some additional faunistic data from Armenia, Georgia, and Russia


Checklist of species of the family Psychodidae from selected areas of Transcaucasia

Species new for country are marked with an asterisk (*). Abbreviations: Arm – Armenia, Aze – Azerbaijan, Geo – Georgia, (Abk) – Abkhazia (see in Ježek et al., 2018, 2021 and Oboňa et al., 2019).

Subfamily Phlebotominae

*Phlebotomus* (Adlerius) balcanicus Theodor, 1958 Aze, Geo

*Phlebotomus* (Adlerius) brevis Theodor et Mesghali, 1964 Aze, Geo

*Phlebotomus* (Adlerius) chinensis tauriae Perfiew, 1966 Geo

*Phlebotomus* (Adlerius) halepensis Theodor, 1958 Arm, Aze, Geo

*Phlebotomus* (Adlerius) longiductus Parrot, 1928 Geo

*Phlebotomus* (Adlerius) simici Nitzulescu, 1931 Arm, Aze, Geo

*Phlebotomus* (Larroussius) kandelaki Shurenkova, 1929 Arm, Aze, Geo

*Phlebotomus* (Larroussius) majorsyriacus Adler et Theodor, 1931 Arm, Aze, Geo

*Phlebotomus* (Larroussius) perfiliewiperfiliewi Parrot, 1930 Geo

*Phlebotomus* (Larroussius) perfiliewitranscaucasicus Perfiew, 1937 Aze, Geo

*Phlebotomus* (Larroussius) perniciosus Newstead, 1911 Aze

*Phlebotomus* (Larroussius) tobbi Adler et Theodor in Adler, Theodor et Lourie, 1930 Aze, Geo

*Phlebotomus* (Phlebotomus) papatasi (Scopoli, 1786) Arm Aze, Geo

*Sergentomyia* (Neophlebotomus) pawlowskyi (Perfiew, 1933) Arm, Aze, Geo

*Sergentomyia* (Parrotomyia) palestinensis (Adler et Theodor, 1927) Arm, Aze, Geo

*Sergentomyia* (Sergentomyia) dentata (Sinton, 1933) Aze, Geo

Subfamily Sycoracinae

*Sycorax* caucasica Ježek, 1990 Geo (Abk)

Subfamily Trichomyiinae

*Trichomyia* urbica Haliday in Curtis, 1839 Aze

Subfamily Psychodinae

*Apsycya* pusilla (Tonnoir, 1922) Aze

*Bazarella* centretinacula Wagner, 1981 Geo

*Berdeniella* manicata (Tonnoir, 1920) Geo (Abk*)

*Berdeniella caucasica* Wagner, 1981 Geo (Abk*)

*Berdeniella schumpkanica* Vaillant & Joost, 1983 Geo* (Abk*)

*Copropsycha* brevicornis (Tonnoir, 1940) Geo (Abk*)

*Feuerborniella obscurea* (Tonnoir, 1919) Geo

*Chodopsycya* lobata (Tonnoir, 1940) Geo (Abk)

*Chodopsycya* buxoni (Withers, 1988) Geo (Abk*)

*Clogmia* albibpunctata (Williston, 1893) Arm, Aze, Geo

*Clytocerus* (Boreoclytocerus) grusinicus Wagner, 1981 Aze, Geo (Abk*)

*Joostiella* caucasica Vaillant, 1983 Arm

*Kvazbamormia* pskhensis Ježek, 1994 Geo (Abk)

*Lepimormia* georgica (Wagner, 1981) Geo (Abk)
Moth flies of Abkhazia with some additional faunistic data from Armenia, Georgia, and Russia

Logima albipennis (Zetterstedt, 1850)  
Logima erminea (Eaton, 1893)  
Logima satchelli (Quate, 1955)  
Logima sigma (Kincaid, 1899)  
Logima zetterstedi Ježek, 1983  
Mormia cvitatorium Ježek, 1987  
Mormia malickyi Vaillant, 1974  
Parajungiella abchazica Ježek, 1985  
Parajungiella serbica (Krek, 1985)  
Parajungiella monikae (Wagner & Joost, 1986)  
Panimerus denticulatus Krek, 1971  
Paramormia (Duckhousiella) ustulata (Walker, 1856)  
Paramormia (Paramormia) fratercula (Eaton, 1893)  
Paramormia (Paramormia) polyascoidea (Krek, 1971)  
Parabazarella joosti lacleharica Ježek, 1990  
Pericoma (Pachypericoma) blanda Eaton, 1893  
Pericoma (Pachypericoma) fallax Eaton, 1893  
Pericoma (Pachypericoma) nielseni Kvitë, 2010  
Pericoma (Pericoma) hosniaca Krek, 1966  
Pericoma (Pericoma) bunae Krek, 1979  
Pericoma (Pericoma) exquisita Eaton, 1893  
Pericoma inopinata Ježek, Oboña & Manko 2021  
Pericoma (Pericoma) kariana Vaillant, 1978  
Pericoma (Pericoma) motasi motasi Vaillant, 1978  
Pericoma (Pericoma) pannonica Szabó, 1960  
Pericoma (Pericoma) pseudexquisita Tonnoir, 1940  
Pericoma platystyla Wagner, 1986  
Peripsycoma auriculata (Haliday in Curtis, 1839)  
? Philosepedon (Philosepedon) wagneri Omelková et Ježek, 2012  
? Philosepedon (Trichosepedon) aschitaricum Vaillant et Joost, 1983  
Philosepedon (Trichosepedon) balanicum Krek, 1971  
Philosepedon (Trichosepedon) clouense Ježek, 1994  
Pneumia canescens (Meigen, 1804)  
Pneumia compata (Eaton, 1893)  
Pneumia fuehzi Ježek, Oboña & Manko 2022  
Pneumia gracilis gracilis (Eaton, 1893)  
Pneumia gracilis kandavanica (Ježek 1990)  
Pneumia nubila (Meigen, 1818)  
Pneumia joosti (Wagner, 1981)  
Pneumia palustris (Meigen, 1804)  
Pneumia pilularia (Tonnoir, 1940)  
Pneumia trivialis (Eaton, 1893)  
Promormia silesiensis (Ježek, 1983)  
Psyche grisescens (Tonnoir, 1922)  
Psychoda alticola Vaillant, 1973  
Psychoda crassipennis Tonnoir, 1940  
Psychoda phalaenoides (Linné, 1758)  
Psychoda uniformata Haseman, 1907  
Psychodocha cinerea (Banks, 1894)  
Psychodocha gemina (Eaton, 1904)  
Psychodula minuta (Banks, 1894)  
Psychomora mycophila (Vaillant, 1988)  
Psychomora trinodulosa (Tonnoir, 1922)  
Psychomormia vaillanti (Wagner, 1977)
Jan Ježek, Jozef Oboňa, Peter Manko

*Saraiella reselli* Wagner, 1981
*Saraiella rotunda* (Krek, 1970)
*Seoda ambigua* (Eaton, 1893)
*Seoda carthusiana* (Vaillant, 1972)
*Seoda svanetica* (Ježek, 1989)
*Szaboiella hibernica* (Tonnoir, 1940)
*Thornburghiella montana* Ježek, Oboňa & Manko 2021
*Thornburghiella veve* Oboňa & Ježek, 2017
*Thornburghiella salihi* Ježek, Oboňa & Manko 2022
*Threticus balkanealpinus* Krek, 1972
*Threticus negrobovi* Vaillant, 1972
*Threticus petrosus* Ježek, 1997
*Trichopsychoda hirtella* (Tonnoir, 1919)
*Tinearia alternata* (Say, 1824)
*Tinearia lativentris* (Berdén, 1952)
*Tonnoiriella arcuata* Ježek, 1997
*Uloomyia cognata* (Eaton, 1893)
*Yomormia petrovii* Ježek, 1985
*Yomormia achalshenica* Ježek, 1987
*Yomormia afonensis* Ježek, 1987
*Yomormia furva* (Tonnoir, 1940)
*Ypsydocha setigera* (Tonnoir, 1922)

Summary: Arm (36 + 5*), Aze (61), Geo (88 + 7*) (Abk) (26 + 31*).
Winter activity of the snake-eyed lizard *Ophisops elegans* (Reptilia: Lacertidae) in the northwesternmost part of its range

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**Abstract:** There is a lack of information for potential winter activity of the snake-eyed lizard *Ophisops elegans* in Europe, where it has a limited distribution. To test the hypothesis that this species can be active during the winter months, two locations in Bulgaria were chosen. The visits were conducted in January, February and December 2022 near the village of Meden Buk and in December 2022 above the village of Mezek. A total of 19 individuals of *O. elegans* were recorded. In addition, we confirmed foraging behaviour based on faecal sample collection. To our knowledge, this is the northernmost record of winter activity in the snake-eyed lizard and the first consecutive observation of year-round activity for this species in Europe.

**Keywords:** Balkan Peninsula, hibernation, phenology, Sauria

Winter activity in lacertid lizards in temperate zones across Europe is rarely observed. In this area lizards normally are induced to hibernate during winter and show great ability to survive low temperatures (Grenot et al., 2022). In lowlands (up to 500 m a.s.l.) lizards usually hibernate between mid-October to early April, while at higher altitude this period may be prolonged from September to May (Stojanov et al., 2011; Zamora-Camacho et al., 2013) and some species may be active in hot days during this period or can escape earlier from hibernacula (Rugiero, 1995; Vongrej et al., 2008; Piccoli & De Lorenzis, 2018). These assumptions are general for all lacertids in Europe, but indeed there is lack of information for some species, like the snake-eyed lizard *Ophisops elegans* Ménétriers, 1832.

The genus *Ophisops* Ménétriers, 1832 includes at least eleven species, distributed across Southeast Europe, North Africa, the Middle East, and the Indian subcontinent including Sri Lanka (Bozkurt et al., 2022; Uetz et al., 2022). *Ophisops elegans* is the only European representative of the genus. It occurs from Algeria across North Africa, Asia Minor and Iran to West Pakistan, as well as in Southeast Europe (northeastern Greece, south-eastern Bulgaria, the islands along the Aegean coast, European Turkey and partially in the Caucasus region) (Ananjeva et al., 2006; Stojanov et al., 2011). In Bulgaria, the species has very limited distribution assigned to the easternmost part of the Rhodopes Mts up to 650 m a.s.l. (Tzankov, 2004, 2015). This area also represents the most north-western part of the species range in general. Here, *O. elegans* inhabits extremely dry and warm habitats with bare ground, stones and scarce xerophytic vegetation, rare shrubs (*Juniperus* sp.) and scattered wood (Beshkov & Nanev, 2006; Stojanov et al., 2011).

For the purpose of this study (testing the hypothesis that *Ophisops elegans* exhibits activity during the winter months) we choose two sites in Bulgaria where the presence of the species was previously known: (1) the area of Meden Buk Village (N 41.3805°, E
26.0230°, 120–200 m a.s.l.) – a south-southwest facing slope covered with rocks, stones and scarce vegetation, mainly Juniperus shrubs (Fig. 1); (2) the area above Mezek Village (N 41.7183°, E 26.0636°, 460–520 m a.s.l.) – an area near abandoned frontier post on a south-southeast ridge of the hill, containing dry and open area with scarce vegetation surrounded with xerophytic oak forest and scarp near a dirt road (Fig. 2).
Winter activity of the snake-eyed lizard *Ophisops elegans* in the northwesternmost part of its range

Table 1. Data and time of the observation of winter activity in *Ophisops elegans* in the two sites. Age, sex and snout-vent length (SVL) for each specimen were recorded, as well as temperatures and weather (TB, TA, and TS refer respectively to body, air, and substrate temperature in °C).

<table>
<thead>
<tr>
<th>Date</th>
<th>Time</th>
<th>Locality</th>
<th>Age &amp; sex</th>
<th>SVL</th>
<th>TB</th>
<th>TA</th>
<th>TS</th>
<th>Weather</th>
</tr>
</thead>
<tbody>
<tr>
<td>January 3</td>
<td>13:00</td>
<td>Meden Buk</td>
<td>ad. M</td>
<td>n/a</td>
<td>n/a</td>
<td>18.9</td>
<td>21.1</td>
<td>Sunny</td>
</tr>
<tr>
<td>February 19</td>
<td>11:47</td>
<td>Meden Buk</td>
<td>subad. M</td>
<td>40</td>
<td>31.1</td>
<td>19.4</td>
<td>20.4</td>
<td>Sunny</td>
</tr>
<tr>
<td>February 19</td>
<td>13:10</td>
<td>Meden Buk</td>
<td>ad. F</td>
<td>51</td>
<td>34.3</td>
<td>20.7</td>
<td>16.2</td>
<td>Sunny</td>
</tr>
<tr>
<td>February 19</td>
<td>13:52</td>
<td>Meden Buk</td>
<td>ad. M</td>
<td>42</td>
<td>29.8</td>
<td>20.2</td>
<td>n/a</td>
<td>Sunny</td>
</tr>
<tr>
<td>February 19</td>
<td>14:38</td>
<td>Meden Buk</td>
<td>ad. M</td>
<td>48</td>
<td>31.7</td>
<td>21.4</td>
<td>n/a</td>
<td>Sunny</td>
</tr>
<tr>
<td>February 19</td>
<td>15:04</td>
<td>Meden Buk</td>
<td>ad. M</td>
<td>42</td>
<td>28.4</td>
<td>19.2</td>
<td>n/a</td>
<td>Sunny</td>
</tr>
<tr>
<td>February 19</td>
<td>16:06</td>
<td>Meden Buk</td>
<td>ad. M</td>
<td>47</td>
<td>27.1</td>
<td>16.9</td>
<td>21.3</td>
<td>Sunny</td>
</tr>
<tr>
<td>February 20</td>
<td>11:59</td>
<td>Meden Buk</td>
<td>subad. M</td>
<td>40</td>
<td>22.8</td>
<td>16.9</td>
<td>26.2</td>
<td>Sunny</td>
</tr>
<tr>
<td>February 20</td>
<td>13:11</td>
<td>Meden Buk</td>
<td>subad. M</td>
<td>36</td>
<td>24.5</td>
<td>24.6</td>
<td>21.1</td>
<td>Sunny</td>
</tr>
<tr>
<td>February 20</td>
<td>13:51</td>
<td>Meden Buk</td>
<td>subad. F</td>
<td>40</td>
<td>26.5</td>
<td>21.6</td>
<td>25.5</td>
<td>Sunny</td>
</tr>
<tr>
<td>February 20</td>
<td>14:49</td>
<td>Meden Buk</td>
<td>ad. M</td>
<td>51</td>
<td>23.0</td>
<td>18.7</td>
<td>21.4</td>
<td>Sunny</td>
</tr>
<tr>
<td>February 20</td>
<td>15:10</td>
<td>Meden Buk</td>
<td>ad. F</td>
<td>42</td>
<td>20.6</td>
<td>17.8</td>
<td>20.6</td>
<td>Sunny</td>
</tr>
<tr>
<td>December 29</td>
<td>13:03</td>
<td>Meden Buk</td>
<td>ad. F</td>
<td>42</td>
<td>23.3</td>
<td>16.5</td>
<td>21.8</td>
<td>Sunny</td>
</tr>
<tr>
<td>December 29</td>
<td>13:16</td>
<td>Meden Buk</td>
<td>ad. F</td>
<td>47</td>
<td>26.1</td>
<td>15.4</td>
<td>25.9</td>
<td>Sunny</td>
</tr>
<tr>
<td>December 29</td>
<td>13:21</td>
<td>Meden Buk</td>
<td>ad. undet.</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>Sunny</td>
</tr>
<tr>
<td>December 29</td>
<td>13:26</td>
<td>Meden Buk</td>
<td>ad. M</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>Sunny</td>
</tr>
<tr>
<td>December 29</td>
<td>14:35</td>
<td>Meden Buk</td>
<td>ad. F</td>
<td>n/a</td>
<td>23.3</td>
<td>16.0</td>
<td>19.6</td>
<td>Sunny</td>
</tr>
<tr>
<td>December 30</td>
<td>13:34</td>
<td>Mezek</td>
<td>ad. M</td>
<td>43</td>
<td>29.1</td>
<td>19.0</td>
<td>26.3</td>
<td>Sunny</td>
</tr>
<tr>
<td>December 30</td>
<td>13:40</td>
<td>Mezek</td>
<td>ad. F</td>
<td>52</td>
<td>29.6</td>
<td>16.2</td>
<td>24.3</td>
<td>Sunny</td>
</tr>
</tbody>
</table>

The first site was visited three times (January, February and December 2022), and the second – only in December 2022. Individual visits lasted two days, taking into account the following factors: body, air and substrate temperatures (using a digital thermometer with probe – Multi Thermometer, Möller-Therm, with 1.0°C precision) and snout–vent length (SVL) of caught individuals; in several cases, faecal samples were also collected (preserved in ethanol and examined later under a stereomicroscope; for a more detailed description of the methodology see Vacheva & Naumov, 2020).

As a result of the conducted research, a total of 19 *Ophisops elegans* (8 males, 6 females, 1 indeterminate adult and 4 subadults) were recorded, respectively 1 in January, 11 in February and 7 in December (Table 1; Fig. 3). The body temperature of the captured lizards varied between 20.6 and 34.3°C, and the temperature of the air and substrate (at the place and time of registration of each individual) – between 15.4 and 24.6°C and 16.2 and 26.3°C, respectively. All individuals were registered in the afternoon, between 11:30 and 16:00 h. No other reptile species were observed, with the exception of one juvenile *Lacerta viridis* (Laurenti, 1768), spotted on January 3 at the site of Meden Buk. The analysis of the contents of the collected faecal samples (from 5 individuals from February and 1 from December) showed the presence of remains from the following invertebrate groups: order Araneae (in 5 individuals), order Opiliones (in 1
individual), order Diptera (in 1 individual), and order Hemiptera (in 2 individuals).

Our results provide strong evidence of regular activity in all winter months, as well as for foraging during winter. At least half of the captured specimens in February were fed, as well as one captured in December. This finding shows that the Snake-eyed lizards not incidentally emerge from hibernation during hot and sunny winter days, but they continue with their activities such as feeding. A similar type of activity seems to have been proven only for the İzmir Region (the Aegean Coast of Asia Minor, ca. 350 km south of Bulgarian localities), where according to Öktem (1963) it is possible to find *O. elegans* all the year round, except on rainy or cold days when the temperature is generally below 5°C. For other parts of the range however (e.g., Central Anatolia and Armenia), the species is known to hibernate from November to March (Darewskij & Beutler, 1981 and references therein). There are a number of occasional observations on the winter activity of *O. elegans* in the more southern parts of its range (e.g. Franzen, 1986 for the southern coast of Asia Minor). Among them, the data given by Özgül et al. (2022) are the most interesting, since the observations of *O. elegans* from the Bozcaada Island are of the same dates (February 19–20, 2022) as ours from Meden Buk (ca. 170 km north of the island), and the comparison shows a similar number of observed individuals in a similar time interval: 16 individuals in Bozcaada (between 11:00 and 16:00) vs. 11 individuals in Meden Buk (between 11:00 and 16:00).

For some other lacertid species in the temperate zone, winter activity was also documented, e.g.: *Podarcis muralis* (Laurenti, 1768) (Italy: Rugiero, 1995, Piccoli & De Lorenzis, 2018; Bulgaria: authors’ personal data), *Darevskia* spp. (Turkey: Franzen, 2000), *Lacerta viridis* (Slovakia: Vongrej et al., 2008), *Anatololacerta danfordi* ( Günther, 1876) (Turkey: Özkan & Bülbül, 2021), etc. Most of these data represent observations only of individuals going outside during warm and sunny days (i.e., basking), while other types of behaviour, such as feeding or breeding, have been observed rarely (e.g., Sahin, 2021). It should be noted that despite the relatively large number of lacertid species that are generally found in the sites we studied (Meden Buk: 4 species according to personal observations; Mezek: 6 species according to Tzankov, 2004), during the winter months of 2022, apart from *O. elegans*, it was only one specimen of another species observed (a juvenile *L. viridis*). In all probability, this is due to a significant difference in the temperature requirements of *O. elegans* compared to the other lacertids in Bulgaria.

In conclusion, it can be stated that in the temperate zone (in the sense of geographical region defined by latitude), *Ophisops elegans* seems to be active all year round, even in the northernmost parts of its range, as long as they are at low altitude. It is possible that this is only a consequence of more intensive and targeted research (as it is for the Eastern Rhodopes Mts), but in our opinion, it is also possible that the manifestation of year-round activity is a relatively recent phenomenon, reflecting the impact of global warming on *O. elegans*.
Further research with a larger geographic scope is needed to clarify this question.

Acknowledgements

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Variability character of conchological features in the mollusc *Gibbulinopsis signata* (Mousson, 1873) (Gastropoda: Pupillidae) in Northwestern Uzbekistan

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Abstract: Analysis of the results shows that mollusc of the species *Gibbulinopsis signata* (Mousson, 1873) from the northwestern region of Uzbekistan exhibits significant variability in conchological characteristics, including variability in shell size, shape, and colour, as well as variations in aperture shape and fittings. Among these characteristics, shell height is found to be the most variable and is recognised as an ecological and biological indicator of mollusc’s adaptability to habitat conditions. The results of molecular analysis, using the sequences of the gene 18S of ribosomal DNA showed that all three populations belonged to the same species.

Keywords: 18S rDNA, *Gibbulinopsis signata*, conchology, shell, terrestrial mollusc

Introduction

Despite more than 150 years of research on the molluscan fauna of Central Asia, the first information about the molluscan fauna of the northwestern part of Uzbekistan was only published in 2020 (Avazmetova, 2020; Pazilov & Avazmetova, 2020). Therefore, any research carried out on the molluscan fauna (fauna, zoogeography, ecology, and research) of this region is of significant scientific and practical importance.

Several studies have been conducted on the variability of terrestrial molluscs in Central Asia, including processes of variability by Matyokin (1959), Pazilov & Avazmetova (2020), Pazilov & Umarov (2022), and molecular genetic variability by Kuchboev et al. (2017, 2020), Kuchboev & Egamberdiev (2023). While information on the variability of conchological characteristics of terrestrial molluscs is provided by several scientists in other parts of the world, such as Harvey (1976), Bengston et al. (1979), Smet & Rompu (1984), Staykou (1999), Maltz (2007), Ozgo & Komorowska (2009), Johnson (1980), Fiorentino et al. (2008), Stankovskii (2011), and Haase et al. (2021), the processes of variation in the *Gibbulinopsis signata* (Mousson, 1873) tour have not been studied.

During the research on the species composition of *G. signata*, the variability of conchological signs in their populations was observed, which serves as the subject of this article. The main goal of this work is to study the inter-population variation of conchological features of the common species *G. signata*.

Material and methods

Material and study area

The study was conducted in agricultural areas located in the northwestern part of Uzbekistan, specifically in the Balitov, Bukantov, and Tomditov mountains (Fig.
1). The materials used in this study were collected during the spring (April, May) and autumn (September, October) periods of 2020–2021 years. A total of 132 samples of *G. signata* were collected. The materials were collected during humid weather in the morning between 7:00 and 10:00 am, as terrestrial molluscs are typically active during this time and can be easily found.

During the collection of live molluscs, they were placed in a jar filled with cold water and covered with a rubber pad. After one day, they were removed from the water and stored in 40% alcohol. After six days, the alcohol concentration was increased to 70%, and after 14 days, it was further increased to 75%. The collected materials were stored in 50–100 ml glass bottles in the malacology collection of Gulistan State University, Uzbekistan.

Morphology

The species composition of *G. signata* was determined using the methods described by Schileyko (1978, 1984) and Likharev & Wiktor (1980). The conchological characteristics of the molluscs were studied, and 30 sexually mature individuals were randomly selected from each group of molluscs to study the signs of conchological changes. Shell measurements were performed using the method described by Schileyko (1978, 1984), and the following parameters were measured: shell height (SH), width (SW), aperture height (AH), aperture width (AW), and last whorl height (LWH).

To conduct statistical analysis of the morphometric indicators for each local population, the following characteristics were calculated: arithmetic means (+), coefficient of variation (SV), and determination (r²). To compare the general variability of the under-researched shells, methods described by Terentev & Rostova (1977), Rostova (1978), and Lakin (1980) were used. Biometric processing of the data obtained from the study of shells was conducted using SPSS Statistics 17.0 and Microsoft Excel 7.0 to determine the conchological variability of mollusces.

DNA isolation, PCR and sequencing

The specimens of molluscs were analysed using molecular genetic methods. For each population of snails, a part of the foot was used for the molecular study. DNA extraction was performed using the Qiamp DNA mini kit (Qiagen, Germany), following the manufacturer’s instructions. PCR was carried out in a 25 µl volume using 1xPCR buffer, 0.2 µM each dNTP, 0.25 µl (1.25 units) of Taq polymerase (Qiagen, Germany), 2 µl of extracted DNA solution and 25 pmol of each of the primers F (5’-CTGGTTGAT(CT)CTGCCAGT-3’) and R (5’-CTGAGATCCAACTAGGAGCTT-3’) for amplification of the domain of 18S rDNA (Winnepenninx et al., 1998). Amplicons were analysed by electrophoresis in a 1.5% agarose gel containing ethidium bromide. The PCR products were directly sequenced in both directions with the primers used for DNA amplification (Synthol Company, Moscow). The obtained sequences were compared with sequences of terrestrial mollusks available in GenBank. The sequences have been deposited in Genbank with accession numbers ON584276, ON584352, and ON584384.

Results

Morphometrics

The variability of shell characters was studied in three populations.
Variability character of conchological features in the mollusc *Gibbulinopsis signata* in Northwestern Uzbekistan

The first population consists of dark brown cylindrical shell molluscs found among the tall shrubs under the rocks in Bukantov, which is 764 m above sea level. The mouth is whole with 5 teeth, with the parietal tooth connected to the angular bulge and the columellar tooth underdeveloped. There are 2 soft wrinkles, the bottom being long and the top relatively short, and the soft bulge is well-developed (Fig. 2A).

The second population consists of molluscs with round-cylindrical shells living among the tall shrubs in Tomditov, around the village of Ajritki, which is 922 m above sea level. The shells have 6 folds and are medium brown and glossy. The mouth has angular teeth and 2 soft bulges (Fig. 2B).

The third population consists of molluscs with straight cylindrical shells living in the stems of shrubs in Balitov, at high altitudes of 146 m above sea level. The shells are light brown and the mouth is whole with wide edges. There are 2 teeth in the mouth, with parietal curved teeth connected by an angular bulge (Fig. 2C).

It is worth noting that, besides the aforementioned changes, the variability of morphometric features of *G. signata* has also been investigated, including shell height (SH), shell width (SW), aperture height (AH), aperture width (AW), last whorl height (LWH), which can be diagnostically quantified. The variability of these morphometric markers among the three populations of *G. signata* is as follows. Statistical analysis of the first population revealed an arithmetic mean value of 4.12 mm for formed shell height under Bokantov conditions (Table 1), with minimum and maximum values of 3.70–4.60 mm. The variant coefficient of shell height was 5.74%, indicating relatively low variability. The shell width also exhibited low variability, with a variant coefficient of 6.80%. However, the height and width of the shell mouth had higher variability, with variant coefficients of 14.17–13.57%. According to accepted classification, these characters are moderately variable and dependent on external environmental factors.

Among the studied traits, AH (3) showed relatively strong determination in the first population (Fig. 3), indicating that its variability depends largely on the external environment. On the other hand, 1 – SH, 2 – SW, and 5 – LWH were found to be less variable and more genetically determined.

In the second population, the statistical analysis revealed that the mean shell height of molluscs in

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Table 1. The variability of morphometric markers of *Gibbulinopsis signata* across the three populations. The indicators of variability of all morphometric characters are given in millimetres.

<table>
<thead>
<tr>
<th>Shell marker</th>
<th>Average arithmetic mean X ±</th>
<th>Coefficients of variability, CV, %</th>
<th>Coefficient of determination r²</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>The 1st population</td>
<td>The 2nd population</td>
<td>The 3rd population</td>
</tr>
<tr>
<td>Shell height</td>
<td>4.12±0.04</td>
<td>3.53±0.07</td>
<td>3.52±0.07</td>
</tr>
<tr>
<td>Shell width</td>
<td>1.96±0.02</td>
<td>1.65±0.03</td>
<td>1.89±0.028</td>
</tr>
<tr>
<td>Aperture height</td>
<td>1.04±0.03</td>
<td>0.87±0.03</td>
<td>1.01±0.02</td>
</tr>
<tr>
<td>Aperture width</td>
<td>1.01±0.02</td>
<td>0.94±0.02</td>
<td>0.98±0.02</td>
</tr>
<tr>
<td>Last whorl height</td>
<td>1.55±0.02</td>
<td>1.68±0.02</td>
<td>1.54±0.02</td>
</tr>
</tbody>
</table>

Fig. 2. Species of *Gibbulinopsis signata* shells are shown in the following figure. A – first population, B – second population, and C – third population. The scale bars are 1 mm.
Tomditov was 3.53 mm, while it was 4.12 mm in Bokantov (Table 1). The shell height was found to be 0.59 mm lower in Tomditov than in Bokantov, with a variance ratio of 10.18%. Notably, in Bokantov, this ratio was 5.74%. Thus, the height of the shell was found to be two times less in Tomditov’s conditions than in Bokantov’s.

In the second population (Fig. 2), as in the first, the most strongly determined trait was MW (3), while anterior fold height (PH) was one of the less variable and moderately variable characters.

Regarding the third population, the morphometric markers of variability (Table 1, Fig. 2) showed that the coefficient of variation (CV) of SH, AH, and MW was on average 12.24%, 13.66%, and 11.87%, respectively. The variability of SW and PH was relatively low (the variant coefficient was around 5.88–7.97%). The strongest determinant was again MW (3).

The data suggest that the conchological variability of *G. signata* is best reflected in the shape, colour, oral reinforcement, and size of the shell (Table 1).

Molecular analysis

Based on comparative molecular taxonomic studies of the nucleotide sequence of 18S rDNA regions, two nucleotide differences were found between the 1st population (Bukantov), the 2nd population (Tomditov) and the 3rd population of *G. signata* (Balitov) collected from different mountains in the northwestern part of Uzbekistan. These differences were explained by the substitution of G-guanine instead of A-adenine at 458 nucleotides and T-thymine nucleotides instead of A-adenine at 562 nucleotides (Fig. 4). The total difference between the populations of *G. signata* (Bukantov) and the populations of *G. signata* (Tomditov) and *G. signata* (Balitov) was 0.3%. The similarity between the 2nd population of *G. signata* (Tomditov) and the 3rd population of *G. signata* (Balitov) was 100%. These sequences were compared with the nucleotides of the species *Cochlicopa lubrica* (Cochlicopidae) (MN022682) from the GenBank database, and the difference between them was 4.2% (Fig. 4).

Discussion

The conchological variability of terrestrial molluscs has been studied by numerous foreign and local scientists, including Harvey (1976), Haase et al. (2020), and Pazilov & Avazmetova (2020). For example, studies have focused on the factors influencing shell changes in terrestrial molluscs, particularly in the genus *Cepaea* species, examining shell polymorphism (Harvey, 1976) and shell size in natural populations (Bengston et al., 1979). Other studies have explored the conchological polymorphism of shell molluscs, including shell colour and size (Smet & Rompu, 1984), as well as the dependence of shell colour on temperature, activeness, and drought resistance (Staikou, 1999). Additionally, shell
Variability character of conchological features in the mollusc *Gibbulinopsis signata* in Northwestern Uzbekistan

Polymorphism has been determined through the megalab database (Cameron & Cook, 2012), shell circumference and habitat dependence of *Theba pisana* have been studied (Johnson, 1980), and microgeographic variation in *Littorina striata* shell has been examined (Wolf et al., 1997). The vast variability of Central Asian terrestrial mollusc fauna is well known, making it of interest to

Fig. 4. Nucleotide sequences of samples mollusc from three populations of the species *Gibbulinopsis signata* (1 – Bukantov, 2 – Tomditov, 3 – Balitov) and *Cochlicopa lubrica* (MN022682) (direction from 5’ to 3’ end, dots indicate nucleotide bases)).

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Variability in shell shape and size, colour, and mouth and mouth fittings can be observed. The species *G. signata* is highly drought tolerant and often forms large clusters with a density of up to 100 individuals per square metre at heights of up to 3500 metres above sea level during unfavorable times of the year. It lives under rocks, bushes, and pebbles in semi-desert and mountain-desert areas, and is widespread in Central Asia, the Eastern Caucasus, northern Iran, and Afghanistan (Matyokin, 1959).

*G. signata* is known to inhabit under bedding, rocks, and rock crevices. Due to its small size, the shell of *G. signata* provides some protection from accidental falls into uncomfortable conditions, which may occur due to sudden changes in air temperature and humidity. In such situations, the snails may experience significant water loss, causing them to become inactive and cling to rocks. The cylindrical shells of *G. signata*, which live in very dry rocky crevices of Bokantov, Tomditov, and Balitov mountains, provide a clear example of this behaviour.

The flexibility of terrestrial mollusks is evident in the colour of their shells. In most taxa, the assimilation of new adaptation zones, such as open dry spaces, leads to a change in shell colour. For instance, *G. signata* living under rocks and boulders in the open air tend to have light brown shells, while those living among bushes and under rocks have dark brown shells, as observed in Bukantov. This difference is attributed to the fact that mollusks living in open areas are more exposed to sunlight than those living under rocks among bushes.

Moreover, the shell structure of *G. signata* varies across its range. In particular, different levels of advanced aperture structures can be seen within the studied type. Additionally, the number of oral teeth in *G. signata* varies depending on their habitat. For instance, those living under rocks between bushes in Bukantov have five teeth in their mouth, while those living on the stems of semi-shrubs in Balitov at a height of 146 m above sea level have two teeth in their mouth.

The research results indicate that molluscs which live among rocks between bushes and never climb on plant stems (even during the wettest times of the year) have well-developed mouth teeth. Apparently, these developed oral teeth serve to clear soil particles from the surface of their feet when they retract into their shells. On the other hand, molluscs living in the lower part of semi-shrub plants do not have mouth teeth, suggesting that there is no need for their development in this habitat.

**Conclusion**

The conchological signs of molluscs can vary in the shape and size of their shells, colour variability, as well as in the shape of the mouth and mouth aperture. This trait can be considered a moderate biological indicator, while a high level of variability in these traits indicates a balance of growth processes in the ontogenetic process (Pazilov & Azimov, 2003). In the north-western part of Uzbekistan, the optimal ratio of shell size and energy consumption in mollusc movement can be observed, which is crucial during recurrent high drought conditions. Molecular analysis was performed on specimens from three populations (1st, 2nd, and 3rd) of the mollusc *G. signata* in Bukantov, Tomditov, and Balitov mountains in Uzbekistan. The results showed that all populations belonged to *G. signata*, and the sequences obtained from these snails were identical (99.7–100%). Further studies using more specific markers of ribosomal and mitochondrial genes are proposed to identify intraspecific boundaries of variability within these populations.

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**Disclosure statement**

No potential conflict of interest was reported by the author(s).

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The first finding of a Habitats Directive species *Vertigo angustior* Jeffreys, 1830 (Mollusca: Gastropoda: Vertiginidae) from the Republic of North Macedonia

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Abstract: Five adults and one juvenile specimens of *Vertigo angustior* Jeffreys, 1830 (narrow-mouthed whorl snail) were found near Dunjska River, Mariovo for the first time in the Republic of North Macedonia. The species is included in Annex II of the Habitats Directive, and Convention on the conservation of European wildlife and natural habitats (Bern Convention).

Keywords: Natura 2000, new locality, protected species, terrestrial snails, Western Balkans, wetland

Introduction

*Vertigo* (*Vertilla*) *angustior* Jeffreys, 1830 was previously unknown for the gastropod fauna of North Macedonian. The shell of *V. angustior* is sinistral, yellowish or reddish-brown, thinly and uniformly striated. The shape is oblong-ovoid, with 4.5–5 convex whorls. The aperture is heart-shaped and has 5–6 teeth – upper palatal denticle high and relatively long, the small lower palatal denticle (as tuberculum), nearly vertical columellar denticle and two parietal denticles. The shell size is: height: 1.6–1.8 mm, width 0.8–1.0 mm (Kerney & Cameron, 1996; Welter-Schultes, 2012).

*V. angustior* in Europe occurs in a wide range of open habitats, as grasslands, marshes, bogs, coastal salt marshes, wet depressions among dunes, etc., but the proper micro-habitats only (Pokryszko, 1990; Cameron et al., 2003; Hornung et al., 2003; Killeen, 2003; Zoltan, 2005; Cochard et al., 2006; Moorkens, 2006; Książkiewicz, 2008; Feher 2009). In Bulgaria the species occurs in dense wet deciduous forests (with dominant species of alder, hornbeam, ash, beech, oak and hawthorn), or habitats with over 75% cover of reed and rush and stable water level of the floodplain region (Antonova et al., 2015).


Material and methods

The survey was carried out in the valley of Dunjska River, Mariovo, Republic of North Macedonia on 22.10.2021. Initially it was found in sandy sediments near the river, N41.21276 E21.71170, leg I. Dedov. Collection number – ID10924/ 3 adults and 1 juvenile specimens. The specimens were collected by soil sampling. The second collecting was conducted at the same location, among riparian vegetation on 6.05.2022. The soil sample was collected along the transect from a point N41.21926 E21.71149 to point N41.21531 E21.71082, leg I. Dedov. Collection
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Results

During the research conducted in Mariovo Region a total of five adults and one juvenile specimens of *Vertigo angustior* were found in the valley of Dunjska River. The specimens were collected along the river in sandy sediments and among riparian vegetation (Fig. 2). The shell characters of the specimens found fit to the published description of *V. angustior* (Kerney & Cameron, 1996; Welter-Schultes, 2012).

Discussion

Geographical aspect

Narrow-mouthed whorl snail is reported for all countries bordering North Macedonia: Albania, Bulgaria, Greek mainland, Kosovo and Serbia (Antonova et al., 2015; MolluscaBase eds., 2023). Given the presence of suitable habitats in North Macedonia, the finding of the species is not a surprise and fills an important gap in species distribution. The species is likely to be found in other localities in North Macedonia. The reason for such expectations are the relatively poorly studied wetlands of the country, as well as the possibility of *V. angustior* to spread.
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In North Macedonia *V. angustior* was found in a narrow strip of riparian vegetation along the Dunjska River. The general habitat is not a typical *Vertigo* spot, but there appears to be a small number of suitable microhabitats where the species inhabits. We assume that abundance of the species is not large.

Mariovo is sparsely populated and remoted area (Melovski et al., 2013), and there are no direct threats to *V. angustior*. A potential threat could be the planned construction of a system of dams along the Crna River, which will inundate the newly discovered locality of the species in North Macedonia.

Specimens can be transported by slugs, small mammals and by wind-blown plant debris (Cameron et al., 2003; Moorkens & Killeen, 2011).

**Habitat and threats**

Fig. 2. The area of Dunjska River, were the species *V. angustior* was found.

← Fig. 3. Adult specimens of *V. angustior*, collected along the Dunjska River.
Acknowledgments

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Stylommatophora1_Metodika_monitoring.pdf


The first finding of a Habitats Directive species *Vertigo angustior* Jeffreys, 1830 from the Republic of North Macedonia


