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Taxonomy and distribution of *Taraxacum* sect. *Erythrosperma* (Asteraceae) in Poland

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Abstract

The dandelions from *Taraxacum* sect. *Erythrosperma* are taxonomically well distinguished and ecologically restricted to warm and sunlit habitats of steppes, dry and sandy grasslands, and distributed in temperate regions of Europe and Central Asia, with some being introduced to North America. Despite the long tradition of botanical research, the taxonomy and distribution of dandelions of *T.* sect. *Erythrosperma* is still underexplored in central Europe. In this paper, by combining traditional taxonomic studies supported by micromorphological, molecular and flow cytometry analyses as well as potential distribution modelling we shed light on taxonomical and phylogenetical relationships between members of *T.* sect. *Erythrosperma* in Poland. We also provide an identification key, species-checklist, detailed descriptions of morphology and occupated habitats as well as distribution maps for 14 Polish erythrosperms (*T. bellicum*, *T. brachyglossum*, *T. cristatum*, *T. danubium*, *T. disseminatum*, *T. dissimile*, *T. lacistophyllum*, *T. parnassicum*, *T. plumbeum*, *T. proximum*, *T. sandomiriense*, *T. scanicum*, *T. tenuilobum*, *T. tortilobum*). Finally, conservation assessments performed using the IUCN method and threat categories for all the examined species are proposed.

Keywords

Dandelions, distribution, ecological modelling, flow cytometry, genome size, identification key, morphology, nuclear DNA content, SCoT markers, taxonomy

Introduction

Human activity, climate warming and biological invasions have recently become the main factors threatening natural biodiversity in many regions of the world (Robinson et al. 2020; Wallingford et al. 2020). Environmental changes, to cite some examples, the deforestation of tropical forests, drying of bogs and meadows and their conversion to arable fields as well as expansive urban development, have a strong negative impact on the diversity of many groups of organisms. Many species become extinct even before they are discovered and described (Costello et al. 2013; Lees and Pimm 2015). This phenomenon is clearly visible in tropical regions, and the most prominent example is orchids, one of the most diversified and still underexplored groups of species (Szlachetko and Kolanowska 2021; Kolanowska et al. 2022). However, the problem also concerns species within taxonomically problematic and species-rich genera with morphologically similar or cryptic species, such as *Rubus*, *Hieracium*, *Campanula*, *Orobanche*, *Stipa*, *Oxytropis*, etc. (Wolanin et al. 2016, 2020; Aleksić et al. 2018; Piwowarczyk et al. 2019; Chen et al. 2020; Nobis et al. 2020a; Baiakhmetov et al. 2021; Kosiński et al. 2021; Trávníček et al. 2021; Havlíček et al. 2022; Szeląg 2022; Vintsek et al. 2022; Wang et al. 2022; Nobis et al. 2023). Globally distributed dandelions (*Taraxacum*, Asteraceae) can also be included in this group (Uhlemann 2002, 2016; Scott and Rich 2013; Štěpánek and Kirschner 2017; Marciniuk et al. 2018; Kirschner et al. 2020, 2022).

The genus *Taraxacum* Wigg. comprises ca. 3000 species classified into 60 sections distributed globally throughout the temperate zone (Vašut 2003; Reisch 2004; Kirschner et al. 2015; Vašut and Majeský 2015). Most of them are apomicts, sexually reproducing diploids being rare (Richards 1970; Mogie and Ford 1988; Van Dijk 2003). Diploids coexist with polyploidy apomicts in most sections. Only a few of them are considered primitive (*T.* sect. *Piesis* (DC.) Kirschner & Štěpánek, *T.* sect. *Dioszegia* (Heuffel) Heuffel, *T.* sect. *Biennia* R. Doll, *T.* sect. *Glacialia* Handel-Mazzetti, *T.* sect. *Wendelboa* (Soest) R. Doll), containing exclusively diploid species (Kirschner and Štěpánek 1996). The majority of the young European and Asian sections (e.g. *T.* sect. *Taraxacum*, *T.* sect. *Palustria*, *T.* sect. *Erythrosperma*) originate from hybrid taxa most likely formed during the Pleistocene glaciation as a result of multiple contacts of southern and northern species ranges (Kirschner and Štěpánek 1996; Marciniuk et al. 2010).

Taraxacum sect. *Erythrosperma* (Lindb.) Dahlst. consists of at least one sexual diploid species *T. erythrospermum* Andrz. ex Besser and approximately 150 apomictic polyploid species distributed in Europe, Anatolia, Central Asia (Kirschner and Štěpánek 1994; Wittzell 1999; Vašut 2003; Reisch 2004; Marciniuk et al. 2009, 2010; Mártonfiová et al. 2010; Štěpánek and Kirschner 2012; Wendt and Øllgaard 2015) and introduced to North America. In Poland, however, all confirmed species of erythrosperms were triploids (Wolanin and Musiał 2017, 2018; Wolanin et al. 2018), although some tetraploids were also reported in central Europe (Van Soest 1967). Species belonging to *T.* sect. *Erythrosperma* are usually small-sized, forming a tunic of dried leaf leftover, with deeply lobed leaves, narrow lobes and petioles, small outer bracts, and mostly red or straw-coloured, strongly spinulose achenes with long cylindrical cone. Dandelions belonging to this group are adapted to warm and sunlit habitats, such as sandy grasslands, pseudosteppes, steppes, xerothermic swards, and ruderal communities (Dudman and Richards 1997; Vašut 2003; Wendt and Øllgaard 2015).

In his revision of European erythrosperms, Doll (1973a, b) mentioned 115 species. Based on those works, in the first revision of Polish dandelions of *T.* sect. *Erythrosperma*, Tacik (1980) listed 18 species as present in Poland (Table 1) and 20 as possible to be found. Twenty years later, four species previously unknown from Poland, *T. disseminatum* G. E. Haglund, *T. bellicum* Sonck (= *T. prunicolor* Schmid, Vašut & Oosterv.), *T. maricum* Vašut, Kirschner & Štěpánek and *T. cristatum* Kirschner, Štěpánek & Vašut, were reported by Øllgaard et al. (2002a), Vašut et al. (2005) and Marciniuk et al. (2009). Subsequently, three species, *T. danubium* Richards, *T. tortilobum* Florstr., and *T. sandomiriense* Wolanin, were very recently recorded by Wolanin and Musiał (2018) and Wolanin et al. (2018). All species reported from Poland so far have been listed in the most recent checklist by Mirek et al. (2020).

Table 1. *Taraxacum* sect. *Erythrosperma* species reported from Poland. The 'Recent sources' are Øllgaard et al. (2000, 2002a, 2002b), Głowacki and Czarna (2003), Vašut et al. (2005), Marciniuk et al. (2009), Wolanin and Musiał (2018), Wolanin et al. (2018); ? – determination uncertain.

Species	Tacik 1980	Recent sources	Mirek et al. 2020
T. bellicum	·	+	+
T. brachyglossum	+	+	+
T. brunneum	+	·	+
T. cristatum	·	+	+
T. danubium	·	+	+
T. discretum	+	·	+
T. disseminatum	·	+	+
T. dissimile	+	+	+
T. erythrospermum	+	·	+
T. falcatum	+	·	+
T. fulvum	+	·	+
T. gracillimum	+	·	+
T. lacistophyllum	+	+	+
T. laetum	+	·	+
T. leptocarpum	+	·	+
T. marginatum	+	·	+
T. maricum	·	+?	+
T. parnassicum	+	+	+
T. plumbeum	+	+	+
T. proximum	+	+	+
T. sandomiriense	·	+	+
T. scanicum	+	+	+
T. simile	+	·	+
T. tenuilobum	+	+	+
T. tortilobum	·	+	+

Due to enormous species-richness in the genus *Taraxacum*, the presence of multiple hybridisation events, frequent polyploidy and apomictic reproduction, as well as the limited number of studies related to the diversity and distribution of its species (Kirschner and Štěpánek 1996; Marciniuk et al. 2010; Kirschner et al. 2016; Jafari et al. 2018; Lee et al. 2021), the biogeography, phylogeny and genetic diversity of dandelions unfortunately still remain poorly explored. Most of the research so far focused on establishing general intrageneric phylogenetic relationships by using representatives belonging to different sections (Van der Hulst et al. 2003; Kirschner et al. 2016) or between selected species occurring in a given area of interest (Majeský et al. 2012; Marciniuk et al. 2020; Lee et al. 2021). Some more detailed studies concerned population genetics (Jafari et al. 2018) or variation between complete chloroplast genomes (Salih et al. 2017; Lee et al. 2021) regarding selected individual species. Research on phylogenetic relationships between species within particular sections is also relatively sparse (Marciniuk et al. 2020). The studies of Reisch (2004) and Majeský et al. (2015) are, to the best of our knowledge, the only ones to concentrate exclusively on species from *T.* sect. *Erythrosperma*, and the authors used various analyses such as random amplified polymorphic DNA (RAPD), nuclear Simple Sequence Repeats (SSR), amplified fragment length polymorphism (AFLP) DNA markers and a selected sequenced region of chloroplast DNA to study phylogenetic relationships and genetic differentiation respectively between and within the examined taxa.

In terms of the evolution of the genus *Taraxacum*, other important aspects to consider are the level of ploidy and genome size (Záveský et al. 2005; Macháčková et al. 2018). In this respect, some taxa are better studied (e.g. sect. *Taraxacum*; Macháčková et al. 2018), whereas others, including *T.* sect. *Erythrosperma*, much less so. Although the karyology of Central European representatives of *T.* sect. *Erythrosperma* is well known (Gustafsson 1934; Małecka 1967, 1969; Doll 1973b; Dudman and Richards 1997; Uhlemann 2000; Schmid et al. 2004; Grzesiuk et al. 2008; Trávníček et al. 2010; Majeský et al. 2015; Wolanin and Musiał 2017, 2018; Wolanin et al. 2018), nuclear DNA content has been reported only for *T. brachyglossum* (Záveský et al. 2005).

It is assumed that evolutionary processes within different sections of *Taraxacum* are linked to the appearance of new habitats or habitat specialisation within a group of hybrids (Kirschner and Štěpánek 1996), and microspecies commonly show some different eco-geographical patterns (Trávníček et al. 2010; Macháčková et al. 2018). Sexually reproducing diploids and asexual triploids from the same sections have been proven to differ in terms of geographic ranges and occupied niches (Meirmans 2021). Triploid plants from *T.* sect. *Erythrosperma* are characterised by a wider geographic range and a much more extensive ecological niche compared to the diploids (Meirmans 2021), which may suggest noticeable differences between triploid taxa within the section. Due to the vegetation period suitable for proper collection of dandelions being restricted to early spring and some of the localities having been found accidentally during excursions, the distribution maps of *Taraxacum* species may be incomplete. Thus, species distribution modelling (SDM) can contribute important information for the studied dandelions.

In this paper, by combining traditional taxonomic studies supported by micromorphological, molecular and flow cytometry analyses as well as potential distribution modelling, we shed light on taxonomical relationships between members of *T.* sect. *Erythrosperma* in Poland. In particular we would like to answer the following questions: I) which species in *T.* sect. *Erythrosperma* occur in Poland; II) in which regions and types of habitat do the species occur; III) which morphological characters are species-specific and helpful in species identification; IV) could micromorphological characters of achenes be useful in species identification; V) does the molecular analysis confirm the distinctiveness of the taxa identified on the basis of morphological characters, and what are their phylogenetic relationships? This work also contains an easy-to-use identification key, morphological descriptions and photos of representative specimens that significantly facilitate their determination.

Materials and methods

Field studies, distribution and morphological analyses

Field studies were carried out in 2012–2019, from mid-April to mid-May, and supplemented in May 2021. Plants were initially determined in the field and collected from each population. Individuals that were causing problems with determination (juvenile plants or damaged plants from habitats under anthropopressure) were dug out, cultivated and observed for several seasons. The geographic coordinates of the localities were determined by GPS equipment. For a description of plant communities with a share of dandelions of the sect. *Erythrosperma*, floristic lists were prepared. The notes were complemented in mid-June, and the names of the species were given after Mirek et al. 2020. The herbarium collection is deposited in the Institute of Biology, University of Rzeszów (UR), with the exception of *T. sandomiriense* types, which were deposited earlier in the Herbarium of the Institute of Botany of the Jagiellonian University (KRA). The revision of plant collections was carried out in the following herbaria: KRA, KRAM, WRAB, KTU, UGDA, SZUB, POZNB, MPD and Herb. J&P Marciniuk. Maps of species distribution in Poland were prepared using the cartogram (ATPOL) method (Zając 1978) on a 10×10 km square grid. Morphological studies were conducted on both living and herbarium plants using a ruler and a stereo microscope equipped with an eyepiece reticle.

Macromorphological analyses of achenes

Achenes for macromorphological studies were collected from mature plants, at least 40 achenes per 3–5 plants from each population (Table 2). Five morphological characters were studied: achene length (incl. cone), cone length, achene body width, length of achene body spinose part, and length of beak. Samples are deposited in the Institute of Biology, University of Rzeszów.

Table 2. List of populations of *Taraxacum* sect. *Erythrosperma* examined for macromorphology of the achenes.

Species	Locality	Geographical coordinates
T. bellicum	Kraków Kostrze	50°02'N, 19°52'E
	between Zaklików and Lipa	50°42'N, 22°04'E
	Klimaszewnica	53°28'N, 22°30'E
T. brachyglossum	Miasteczko Śląskie	50°29'N, 18°55'E
	Sosnowiec Maczki	50°15'N, 19°17'E
	Olsztyn	50°45'N, 19°16'E
T. cristatum	Grząby Bolmińskie	50°48'N, 20°21'E
	Przewodziszowice	50°38'N, 19°23'E
	Grząby Bolmińskie II	50°48'N, 20°21'E
T. danubium	Olsztyn	50°45'N, 19°16'E
	Olsztyn II	50°45'N, 19°16'E
	Pychowicka Górka	50°02'N, 19°53'E
T. disseminatum	Piątnica (Fort Łomża)	53°12'N, 22°07'E
	Chwałkowo Kościelne	51°59'N, 17°18'E
T. dissimile	Osowiec	53°29'N, 22°38'E
	between Krynica Morska and Piaski	54°24'N, 19°31'E
	Hel Leśna Street	54°36'N, 18°49'E
T. lacistophyllum	Gdańsk Stogi	54°22'N, 18°34'E
	Gdańsk (Roland pleasure ground)	54°24'N, 18°36'E
	Łeba	54°45'N, 17°32'E
T. parnassicum	Kusięta	50°46'N, 19°16'E
	Miedzianka	50°50'N, 20°21'E
	Sąspów	50°13'N, 19°46'E
T. plumbeum	between Zaklików and Lipa	50°42'N, 22°04'E
	Stare Bielice	52°51'N, 15°55'E
	Kraków Kostrze	50°02'N, 19°52'E
T. proximum	Krynica Morska	54°23'N, 19°28'E
	Piątnica (Fort Łomża)	53°11'N, 22°07'E
	Chwałkowo Kościelne	51°59'N, 17°18'E
T. sandomiriense	Kamień Łukawski	50°41'N, 21°47'E
T. scanicum	Zbrzeźnica	53°02'N, 22°10'E
	Gdańsk Stogi	54°22'N, 18°43'E
	Ługi	51°59'N, 17°11'E
T. tenuilobum	Kroczyce	50°34'N, 19°31'E
	Miedzianka	50°50'N, 20°21'E
	Łeba	54°46'N, 17°34'E
T. tortilobum	Gdańsk Stogi	54°22'N, 18°43'E
	Gdańsk Stogi II	54°22'N, 18°43'E
	Gdańsk Stogi III	54°22'N, 18°43'E

Micromorphological analyses of achenes (SEM observations)

For the SEM observations, the achenes were attached to aluminium stubs using Pelco conductive liquid silver and sputtered with 20 nm of gold using a turbo-pumped Quorum Q 150T ES coater. Samples (Table 3) were observed using a scanning electron microscope (Hitachi High-Technologies Corporation, Tokyo, Japan) operated at 5 kV and 10 mm distance.

Table 3. Samples used in SEM observations of the achenes.

Species	Locality	Geographical coordinates
T. bellicum	between Zaklików and Lipa	50°42'N, 22°04'E
T. brachyglossum	Kusięta	50°46'N, 19°16'E
T. cristatum	Przewodziszowice	50°38'N, 19°23'E
T. danubium	Olsztyn	50°45'N, 19°16'E
T. disseminatum	Chwałkowo Kościelne	51°59'N, 17°18'E
T. dissimile	Łeba	54°46'N, 17°34'E
T. lacistophyllum	Grańsk Stogi	54°22'N, 18°34'E
T. parnassicum	Sąspów	50°13'N, 19°46'E
T. plumbeum	between Zaklików and Lipa	50°42'N, 22°04'E
T. proximum	Gdańsk Stogi	54°22'N, 18°43'E
T. sandomiriense	Kamień Łukawski	50°41'N, 21°47'E
T. scanicum	Łeba	54°46'N, 17°35'E
T. tenuilobum	Łeba	54°46'N, 17°34'E
T. tortilobum	Gdańsk Stogi	54°22'N, 18°43'E

Micromorphological structures of achenes were observed and photographs taken by means of the scanning electron microscope Hitachi SU 8010 at various magnifications (Figs 5–7). Achenes were studied from base to distal portions. The following qualitative characters were studied: the shape and arrangement of achene spines; details of surface ornamentation of the achene body, achene spines, the upper part of the achene body and the middle part of the cone. Samples are deposited in the Institute of Biology, University of Rzeszów.

DNA extraction

Isolation of genomic DNA was performed from dried leaf tissues, which were ground to a fine powder using a mixer mill MM400 (Retsch) and 3–5 mm glass beads. Isolation of genomic DNA was performed using a modified CTAB method (Doyle and Doyle 1987). The isolated DNA was purified using a gDNA Clean kit (Syngen, Poland) when necessary. The purity and concentration of extracted DNA were evaluated using a NanoDrop ND-1000 spectrophotometer (Thermo Fisher Scientific, USA). The quality of extracted DNA was roughly verified by electrophoresis on 1% agarose gels. The total number of samples used for further molecular analysis was 34. We decided to use *T. jugiferum* H. Øllg. and *T. stridulum* Trávn. ined as outgroups. The latter species is easy to distinguish although still not described (*nomen provisorium*; Trávníček pers. comm.) (Table 4).

SCoT-PCR amplifications

Start Codon Targeted (SCoT) polymorphism is a newly emerged DNA molecular marker developed based on the targeting start codon of the genes and their surrounding consensus sequences in a gene family (Collard and Mackill 2009). Due to their

Table 4. List of samples used in molecular analysis.

Sample ID	Species	Section	Locality	Geographical coordinates
T56	*T. bellicum*	Erythrosperma	Siematycze	52°24'N, 22°56'E
T57	*T. bellicum*	Erythrosperma	Klimaszewnica II	53°28'N, 22°30'E
T58	*T. bellicum*	Erythrosperma	Klimaszewnica	53°28'N, 22°30'E
T59	*T. bellicum*	Erythrosperma	Arbasy	52°31'N, 22°32'E
T2	*T. brachyglossum*	Erythrosperma	Kusięta	50°46'N, 19°16'E
T31	*T. brachyglossum*	Erythrosperma	Kusięta II	50°46'N, 19°16'E
T13	*T. cristatum*	Erythrosperma	Grząby Bolmińskie	50°48'N, 20°21'E
T28	*T. danubium*	Erythrosperma	Olsztyn	50°45'N, 19°16'E
T51	*T. danubium*	Erythrosperma	Góra Sfinks	50°44'N, 19°16'E
T52	*T. danubium*	Erythrosperma	Kraków Kostrze	50°02'N, 19°52'E
T10	*T. disseminatum*	Erythrosperma	Chwałkowo Kościelne	51°59'N, 17°18'E
T5	*T. dissimile*	Erythrosperma	Osowiec	53°29'N, 22°38'E
T11	*T. lacistophyllum*	Erythrosperma	Gdańsk Stogi	54°22'N, 18°34'E
T27	*T. parnassicum*	Erythrosperma	Miedzianka	50°50'N, 20°21'E
T30	*T. parnassicum*	Erythrosperma	Kusięta	50°46'N, 19°16'E
T9	*T. parnassicum*	Erythrosperma	Kusięta II	50°46'N, 19°16'E
T14	*T. plumbeum*	Erythrosperma	Dźwirzyno	54°10'N, 15°26'E
T48	*T. plumbeum*	Erythrosperma	between Kębłowo and Świętno	52°03'N, 16°05'E
T49	*T. plumbeum*	Erythrosperma	Sąsieczno	52°57'N, 18°51'E
T50	*T. plumbeum*	Erythrosperma	near Golub-Dobrzyń	53°04'N, 18°58'E
T38	*T. cf. plumbeum*	Erythrosperma	Wola Mała	50°33'N, 22°46'E
T33	*T. sandomiriense*	Erythrosperma	Kamień Łukawski	50°41'N, 21°47'E
T36	*T. scanicum*	Erythrosperma	Łysaków Kolonia	50°45'N, 22°07'E
T44	*T. scanicum*	Erythrosperma	Piła	53°09'N, 16°47'E
T45	*T. scanicum*	Erythrosperma	Młodzieszyn	52°19'N, 20°12'E
T46	*T. scanicum*	Erythrosperma	Sowia Góra	52°42'N, 15°51'E
T6	*T. scanicum*	Erythrosperma	Zbrzeźnica	53°02'N, 22°10'E
T4	*T. tenuilobum*	Erythrosperma	Miedzianka	50°50'N, 20°21'E
T53	*T. tortilobum*	Erythrosperma	Gdańsk Stogi	54°22'N, 18°43'E
T54	*T. tortilobum*	Erythrosperma	Gdańsk Stogi II	54°22'N, 18°43'E
T55	*T. tortilobum*	Erythrosperma	Gdańsk (Roland pleasure ground)	54°25'N, 18°36'E
T21	*T. jugiferum*	Taraxacum	Błażowa	49°53'N, 22°06'E
T20	*T. stridulum*	Taraxacum	Błażowa	49°53'N, 22°06'E

simplicity, relatively low cost requirements, high reproducibility, and considerable association with phenotypic data, SCoT markers has been applied to many genetic studies, including analysis of genetic diversity, detecting intra- and inter-genetic variation in different plant species, stability of *in vitro* derived plants, phylogenetic relationships, taxonomy, species/cultivar identification, quantitative trait loci (QTL) mapping and DNA fingerprinting in various plants (e.g. Zhang et al. 2015; Etminan et al. 2018; Jalilian et al. 2018; Jedrzejczyk 2020; Zarei and Erfani-Moghadam 2021; Rai 2023).

Of a set of 20 tested SCoT primers (Genomed, Poland), 19 generated stable band patterns were selected for further studies (Table 5). All the PCR reactions were carried out within a total volume of 12.5 µl, containing 30 ng of genomic DNA template, 0.1 U/µl Taq DNA polymerase, 4 mM $MgCl_2$ and 0.5 mM of each dNTPs (2xPCR Master Mix Plus; A&A Biotechnology, Poland), 10 µM of primer and sterile deionised water to the final volume. The DNA amplifications were performed using T100 Ther-

Table 5. SCoT primers used in the molecular description of *Taraxacum* samples.

Primer code	Primer sequence (5'-3')	Annealing temperature (°C)	No. of total loci	No. of polymorphic loci	Percentage of polymorphism	PIC
SCoT-2	CAACAATGGCTACCACCC	51.0	23	23	100	0.42
SCoT-4	CAACAATGGCTACCACCT	49.5	14	13	93	0.50
SCoT-5	CAACAATGGCTACCACGA	50.0	16	16	100	0.47
SCoT-6	CAACAATGGCTACCACGC	51.0	19	19	100	0.49
SCoT-7	CAACAATGGCTACCACGG	51.0	10	9	90	0.49
SCoT-9	CAACAATGGCTACCACGT	50.0	18	17	94	0.37
SCoT-11	AAGCAATGGCTACCACCA	50.0	15	13	87	0.49
SCoT-12	ACGACATGGCGACCAACG	56.0	17	15	88	0.46
SCoT-14	AGGACATGGCGACCACGC	56.0	15	14	93	0.46
SCoT-17	ACCATGGCTACCACCGAG	54.0	17	16	94	0.33
SCoT-21	CACCATGGCTACCACCAT	51.0	14	13	93	0.46
SCoT-25	ACCATGGCTACCACCGGG	56.0	13	12	92	0.50
SCoT-26	ACCATGGCTACCACCGTC	54.0	11	10	91	0.42
SCoT-27	ACCATGGCTACCACCGTG	54.0	22	22	100	0.50
SCoT-32	CCATGGCTACCACCGCAC	56.0	18	18	100	0.46
SCoT-33	CCATGGCTACCACCGCAG	56.0	26	23	88	0.44
SCoT-34	ACCATGGCTACCACCGCA	54.0	19	18	95	0.48
SCoT-35	CATGGCTACCACCGGCCC	63.5	17	17	100	0.46
SCoT-36	GCAACAATGGCTACCACC	51.0	15	13	87	0.42
Average			**18**	**16**	**94**	**0.45**

mal Cycler (BioRad, USA) under the following conditions: initial denaturation at 94 °C for 5 min., followed by 35 cycles of 94 °C for 1 min., annealing for 1 min., and extension at 72 °C for 2 min. The last cycle was followed by the final extension step of 7 min. at 72 °C. The annealing temperature for each primer was optimised, and varied from 49.5 °C to 63.5 °C (Table 5). Amplified PCR products were separated by electrophoresis using 1.5% (w/v) agarose gel made in 1.0× TBE buffer and stained with ethidium bromide (0.5 µg/mL). A DNA ladder of 3000 bp (Thermo Fisher Scientific, USA) was used to determine the size of the amplicons. The gels were visualised under UV light and photographed using GelDoc XR+ (BioRad, USA).

Data analysis of SCoT-PCR products

The PCR-amplified SCoT products were detected on gels and scored as a binary data matrix, as the presence (1) or absence (0) of a band. Only clear, reproducible and well-defined bands were counted. The numbers of monomorphic and polymorphic amplification products generated by each SCoT primer were determined. Polymorphic information content (PIC) was calculated according to Ghislain et al. (1999) by the formula: PIC = 1 – p2 – q2, where p is band frequency, and q is no band frequency. Genetic distances were calculated for all *Taraxacum* accessions, according to Nei and Li (1979), followed by a dendrogram construction using the unweighted pair group method, with arithmetic average (UPGMA), using the Treecon ver. 3.1 software (Van de Peer and De Wachter 1994). Statistical support of the branches was tested with bootstrap analysis using 2000 replicates.

2C DNA content measurements

Genome size estimation was prepared according to the procedure of Jedrzejczyk and Sliwinska (2010) with minor modifications. The leaves of *Vicia villosa* 'Minikowska' (2C = 3.32 pg; Dzialuk et al. 2007) were used as an internal standard. Young and fresh leaves of 11 *Taraxacum* species (Table 6) and the internal standard were chopped simultaneously with a sharp razor blade in a plastic Petri dish with 1 ml of Galbraith's nucleus-isolation buffer (Galbraith et al. 1983) supplemented with an antioxidant of 1% (w/v) polyvinylpyrrolidone (PVP-10), propidium iodide (PI, 50 µg/mL) and ribonuclease A (50 µg/mL). The nuclei suspension was passed through a 50-µm mesh nylon and for each sample, 5000–7000 nuclei were measured using a CyFlow Ploidy Analyser (Sysmex Partec GmbH, Görlitz, Germany) equipped with a high-grade solid state laser with green light emission at 532 nm as well as with side (SSC) and forward (FSC) scatters. Histograms were evaluated using the CyFlow Cube software (Sysmex Partec GmbH, Görlitz, Germany). Genome size was estimated using the linear relationship between the ratio of *Taraxacum* and the internal standard 2C peak positions on the histogram. At least three replicates were analysed for each *Taraxacum* species. Mean coefficients of variation of the 2C DNA content were estimated for all samples and ranged from 5.00 to 6.20 (Table 7). The 2C DNA content (pg) was transformed to megabase pairs (Mbp) of nucleotides using the following conversion: 1 pg = 978 Mbp (Doležel and Bartoš 2005). The results were estimated using a one-way analysis of variance followed by Duncan's test ($P < 0.05$; Statistica v. 13, StatSoft, Poland).

Table 6. Samples used in genome size analysis.

Sample ID	Species	Locality	Geographical coordinates
43	*T. lacistophyllum*	Łeba	54°46'N, 17°32'E
9	*T. sandomiriense*	Kamień Łukawski	50°41'N, 21°47'E
10	*T. danubium*	Olsztyn	50°45'N, 19°16'E
12	*T. plumbeum*	Kraków Kostrze	50°02'N, 19°52'E
39	*T. plumbeum*	between Zaklików and Lipa	50°42'N, 22°04'E
13	*T. bellicum*	Kraków Kostrze	50°02'N, 19°52'E
14	*T. bellicum*	between Goniądz and Szafranki	53°29'N, 22°42'E
40	*T. bellicum*	between Zaklików and Lipa	50°42'N, 22°04'E
17	*T. cristatum*	Przewodziszowice	50°38'N, 19°23'E
19	*T. brachyglossum*	Miasteczko Śląskie	50°29'N, 18°55'E
20	*T. brachyglossum*	Kusięta	50°46'N, 19°16'E
38	*T. scanicum*	Łysaków Kolonia	50°45'N, 22°07'E
42	*T. scanicum*	Łeba	54°46'N 17°33'E
27	*T. tenuilobum*	Miedzianka	50°50'N, 20°21'E
28	*T. tenuilobum*	Bużka	52°21'N 22°54'E
41	*T. tenuilobum*	Łeba	54°46'N, 17°34'E
30	*T. dissimile*	Łeba	54°46'N, 17°34'E
33	*T. dissimile*	Hel Leśna Street	54°36'N, 18°49'E
34	*T. parnassicum*	Kusięta	50°46'N, 19°16'E
36	*T. parnassicum*	Miedzianka	50°50'N, 20°21'E
37	*T. parnassicum*	Sąspów	50°13'N, 19°46'E

Distribution data

Distribution data of species from the *Taraxacum* sect. *Erythrosperma* were obtained from herbarium collections, published taxonomic studies (Uhlemann 2003; Vašut 2003; Schmid et al. 2004; Vašut et al. 2005; Dudáš 2014, 2018; Zámečník 2016; Dudáš et al. 2020; Nobis et al. 2020b; Dudáš and Vašut 2022), and our herbarium materials collected in the field. Since the studied species are a group of critical, morphologically similar taxa, we decided not to use data from available online databases. We determined the geographical coordinates of records from herbaria and the literature that had only locality descriptions and entered all coordinates into the WGS84 coordinate system. To avoid statistical artefacts related to pseudo-replications, only one datum of the species was considered for each 1 km cell of the grid (in correspondence with the resolutions of environmental layers used in our study). As a result, we used 633 localities for 11 species, including 113 localities for *T. bellicum*, 33 – *T. brachyglossum*, 32 – *T. cristatum*, 71 – *T. danubium*, 20 – *T. disseminatum*, 32 – *T. lacistophyllum*, 145 – *T. parnassicum*, 52 – *T. plumbeum*, 41 – *T. proximum*, 67 – *T. scanicum*, 27 – *T. tenuilobum*. Many species belonging to the studied complex are rare, known only from single localities; however, to meet the assumptions of ecological niche modelling, we chose only those known from at least 10 localities.

Environmental data

In our studies, we used 19 bioclimatic variables, including Annual Mean Temperature (bio1), Mean Diurnal Range (bio2), Isothermality (bio3), Temperature Seasonality (bio4), Max Temperature of Warmest Month (bio5), Min Temperature of Coldest Month (bio6), Temperature Annual Range (bio7), Mean Temperature of Wettest Quarter (bio8), Mean Temperature of Driest Quarter (bio9), Mean Temperature of Warmest Quarter (bio10), Mean Temperature of Coldest Quarter (bio11), Annual Precipitation (bio12), Precipitation of Wettest Month (bio13), Precipitation of Driest Month (bio14), Precipitation Seasonality (bio15), Precipitation of Wettest Quarter (bio16), Precipitation of Driest Quarter (bio17), Precipitation of Warmest Quarter (bio18), Precipitation of Coldest Quarter (bio19), derived from the WorldClim 1.4 database (Hijmans et al. 2005; available online: http://www.worldclim.org/). Soil variables, including bulk density in tonnes per cubic-meter (bld), weight percentage of clay particles (< 0.0002 mm; cly), weight percentage of silt particles (0.0002–0.05 mm; slt), weight percentage of sand particles (0.05–2 mm; snd), soil organic carbon content in permilles (orc), volume percentage of coarse fragments (> 2 mm; crf), cation exchange capacity in cmol+/kg (cec), soil water-holding capacities (AWCtS), and pH (soil pH × 10 in H_2O), were derived from the ISRIC database (Hengl et al. 2017) (https://www.isric.org/). We used layers at a spatial resolution of 30 arcseconds for both bioclimatic and soil variables.

Ecological niche modelling

To model the potential distribution of species from *Taraxacum* sect. *Erythrosperma*, we used MaxEnt software version 3.3.3 k., a generative species distribution modelling tool recommended for applications involving presence-only datasets (Phillips et al. 2006; Phillips and Dudík 2008). We ran the model with default values (a maximum of 500 iterations, convergence threshold 0.00001, and five auto feature classes). We opted for a logistic format, as it is currently considered easier and potentially more accurate for interpretation than cumulative and raw approaches (Phillips and Dudík 2008; Baldwin 2009). Because some of the occurrence data were determined on the basis of descriptions of locations and maps, not coordinates obtained in the field, we decided to use 10 percentile training presence as a threshold rule, which eliminated the most outlying data. The model was calibrated using 75% of the occurrence records and tested on the remaining 25%. We performed 20 replicates using the subsample replicated run type and then averaged the results. To provide a different random test/ train partition in each replicate, we used the 'random seed' option. We evaluated the final model using the threshold-independent area under the curve (AUC) generated automatically by MaxEnt (Phillips et al. 2006).

To select a set of variables appropriate for all species from the studied section, the initial model was run using all the above-mentioned variables as well as all 711 localities from all species. To avoid overfitting the model, we built a correlation matrix (Pearson's correlation coefficient) and removed highly correlated variables ($r > 0.7$). To choose which of the strongly correlated variables to remove, we performed a jackknife test of variable importance and eliminated variables that showed low or negative gain values (Baldwin 2009). However, when selecting the variables, we also took into account whether the variable could be easily explained from a biological point of view. Finally, we ran 17 models, separately for each species. To make the niches of individual species comparable, all models were run on the same set of 11 variables, six bioclimatic (bio3, bio7, bio10, bio11, bio18, bio19), and five physical and chemical properties of soil (awcts, cly, crf, orc, pH) (for abbreviation see Environmental data chapter). To make the models easier to interpret, we divided the probability of occurrence into 5 categories: very low (<0.2), low (0.2–0.4), medium (0.4–0.6), high (0.6–0.8), very high (>0.8), by using ArcMap 10.5 software (ESRI Inc 2016).

Results and discussion

SCoT markers analysis

We performed Internal transcribed spacer (ITS) analysis in the initial phase of the studies. The total alignment across the 32 individuals sampled was 680 bp. Although the alignment revealed differences in sequence length between the samples of dandelions, the tree topologies from the Bayesian inference method contained many polytomies, and were inconsistent with the morphological variation of studied species. Thus, we decided to use highly variable SCoT markers to differentiate species and establish the taxonomic relationships within section *Erythrosperma*. In total, 34 *Taraxacum* samples were analysed using 19 SCoT primers, which revealed reproducible band patterns. The primers amplified 319 loci, with 301 polymorphic bands. The number of bands generated per primer varied from 10 (SCoT-7) to 26 (SCoT-33). The size of the amplified bands ranged between 170 and 3000 bp. The percentage of polymorphism ranged from 87 to 100%, with an average of 94%. The PIC value, which describes the informativeness of the primer, varied from 0.33 (SCoT-17) to 0.50 (SCoT-4, SCoT-25 and SCoT-27), with an average of 0.45 (Table 5). The genetic distances estimated between 34 accessions of *Taraxacum* ranged from 0.03 to 0.56 (Suppl. material 1). In contrast to ITS, the UPGMA analysis based on SCoT markers revealed that samples belonging to the same taxon were grouped together, within the same cluster, thus confirming their proper taxonomic identification. However, the ordination of clusters in the UPGMA dendrogram is partially in polytomy. The largest clade with the two sister subclades comprise eight species in total: *T. bellicum*, *T. brachyglossum*, *T. danubium*, *T. cristatum*, *T. disseminatum* and *T. dissimile* in the first and *T. scanicum* and *T. plumbeum* in the second (Fig. 1). It is in polytomy with the subsequent two clusters, which comprise specimens belonging to *T. tenuilobum*, *T. parnassicum* and *T. tortilobum*. The remaining species, i.e., *T. sandomiriense*, *T. lacistophyllum* as well as *T. stridulum* and *T. jugiferum* form the outermost branches of the three. Although the last two mentioned species, as representatives of the section *Taraxacum*, represent an outgroup, based on SCoT analysis, *T. stridulum* was located closer to *T. sandomiriense* than to *T. jugiferum*. Whereas *T. jugiferum* was the most distant and not clustered with any of the examined species (Fig. 1). Similar results in terms of clustering of particular samples were presented by Reisch (2004). The author studied six species of erythrosperms, of which five also occurred in Poland. However, compared to our results, the relation of species segregated into particular clusters was somewhat different.

Genome size of the examined *Taraxacum* species

The 2C DNA content of the 11 studied species ranged from 2.29 pg in *T. cristatum* and *T. danubium* to 2.76 pg in *T. lacistophyllum*, which corresponds to 2,240 and 2,699 Mbp, respectively (Table 7). All studied species possessed a very small genome size (Soltis et al. 2003), however, this is in line with the genomic size of other triploid representatives of the genus *Taraxacum* studied so far (Záveský et al. 2005; Macháčková et al. 2018). Statistical differences in genome size between species were detected, and two species (*T. lacistophyllum* and *T. parnassicum*) could be distinguished based on 2C DNA content. Within the species examined to date, similar minor variations or even no significant differences in genome size were observed, which may be explained by their asexual reproduction mode (Záveský et al. 2005; Macháčková et al. 2018). The differences in genome size (2.35 pg/2C vs. 2.62 pg/2C) in *T. brachyglossum* between our studies and the previous ones (Záveský et al. 2005) may result from both natural

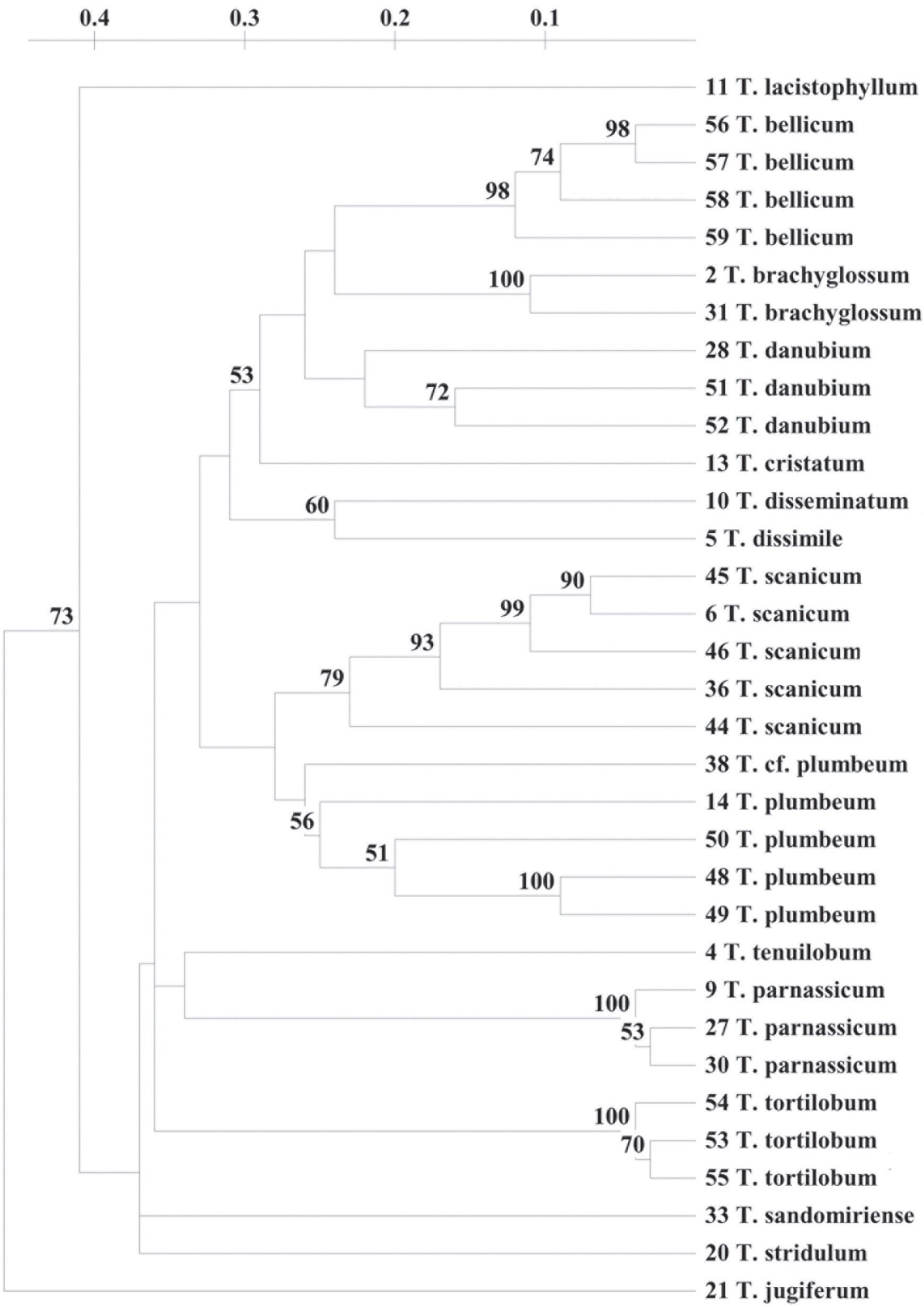

Figure 1. UPGMA dendrogram computed using a genetic distance matrix based on SCoT markers. Only bootstrap values > 50% are indicated. Scales demonstrate genetic distances.

Table 7. Genome size of *Taraxacum* species.

Species	DNA content			CV sample
	(pg/2C)±SD		Mbp/2C	
T. bellicum	2.33±0.014	de	2,279	5.61
T. brachyglossum	2.35±0.035	cd	2,298	5.77
T. cristatum	2.29±0.010	e	2,240	6.12
T. danubium	2.29±0.012	e	2,240	5.75
T. dissimile	2.37±0.019	cd	2,318	5.99
T. lacistophyllum	2.76±0.017	a	2,699	5.00
T. parnassicum	2.63±0.034	b	2,572	5.48
T. plumbeum	2.36±0.008	cd	2,308	5.75
T. sandomiriense	2.31±0.012	e	2,259	6.20
T. scanicum	2.36±0.022	cd	2,308	5.88
T. tenuilobum	2.38±0.019	c	2,328	6.04

variance in DNA content as well as differences in the measurement methodology (Macháčková et al. 2018). To the best of our knowledge, the presented results provided new data on the genome size for 10 *Taraxacum* species.

Macro- and micromorphology of achenes

The shape and colour of achenes are important morphological features that greatly facilitate the identification of species representing the section *Erythrosperma* (Tacik 1980; Vašut 2003; Savadkoohi et al. 2012; Rewicz et al. 2020), (Figs 2, 3). During field work, we observed that, depending on the habitat conditions in which particular dandelions grow, the size of their achenes varies considerably, e.g. in the population of *T. lacistophyllum* from Roland pleasure ground in Gdańsk, the achenes of individuals growing in shadow (under the canopy of trees) were almost twice as long as compared to specimens growing in extremely dry conditions a few meters away. Preliminary analysis of five measurable achene features in *Erythrosperma* species showed very high similarity and a similar range of variability. All the examined taxa have rather similar achenes in terms of cone length, achene body width, length of the spinose part of the achene body, and beak length. Achene length (incl. cone) is one of the most species-specific morphological characters. Three species, *T. tortilobum*, *T. proximum* and *T. dissimile*, have the longest achenes as well as the longest cone, whereas the achenes of *T. tenuilobum*, *T. plumbeum* and *T. danubium* are the shortest (Fig. 4). However, there is also a group of the three species, *T. scanicum*, *T. brachyglossum* and *T. cristatum*, in which the length of achenes varies considerably. SEMs observations of achenes showed some morphological differences in the achenes' ornamentation (Figs 5–7), and in particular the spines' shape and extent of their fusion with the pericarp surface. For example in *T. parnassicum* and *T. proximum* (Figs 5–7H, J) the spines protrude only at the ends, while in *T. tenuilobum* the spines are slender and not fused in almost their entire

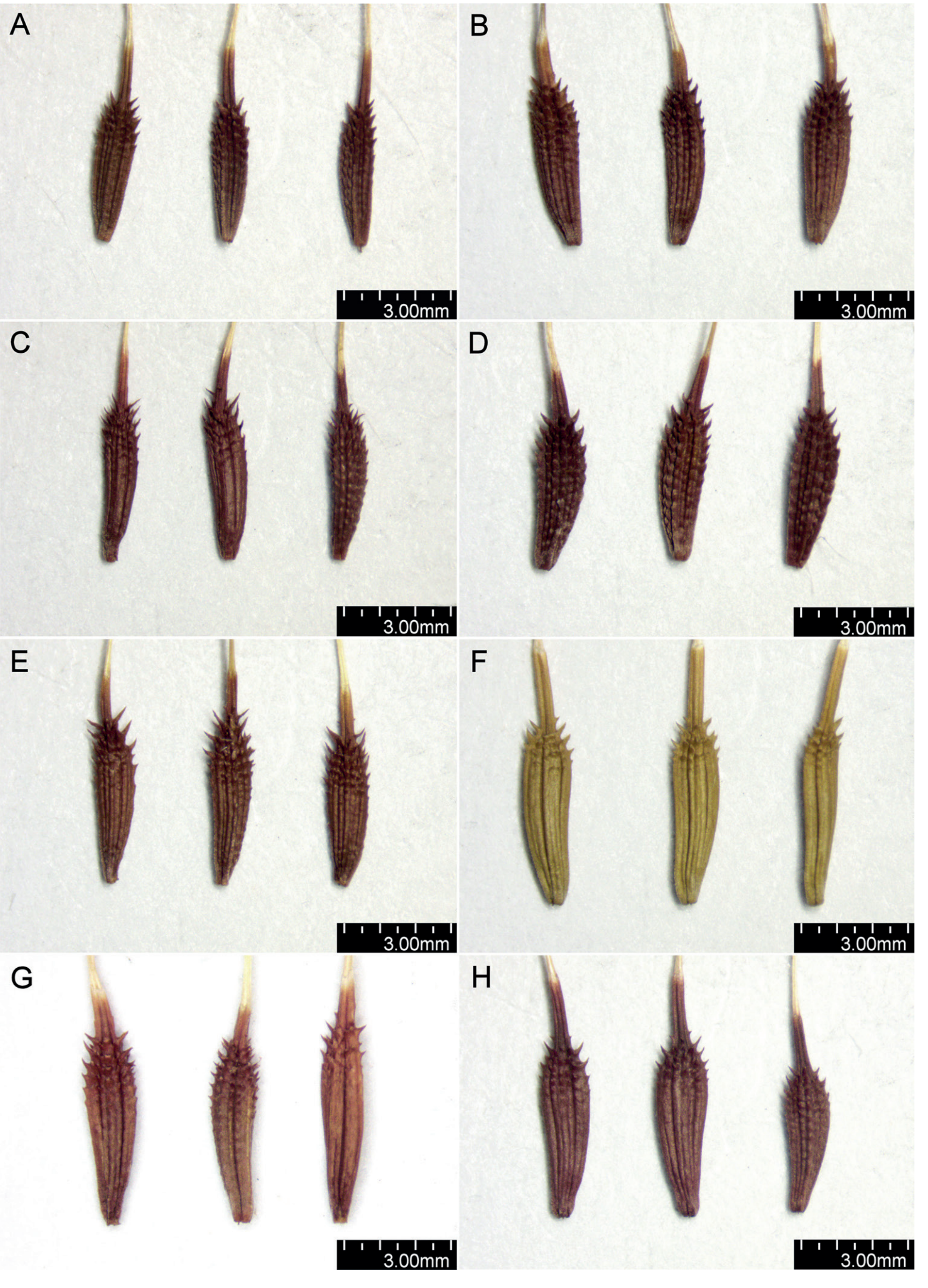

Figure 2. Shape and colour of achenes **A** *T. bellicum* **B** *T. brachyglossum* **C** *T. cristatum* **D** *T. danubium* **E** *T. disseminatum* **F** *T. dissimile* **G** *T. lacistophyllum* **H** *T. parnassicum*.

length (Figs 5–7M). Such comparison may be helpful in the determination of juvenile specimens of some taxa, e.g. *T. scanicum* and *T. tenuilobum* (Figs 5–7L, M). The middle part of the cone seems to be a good area for such comparisons.

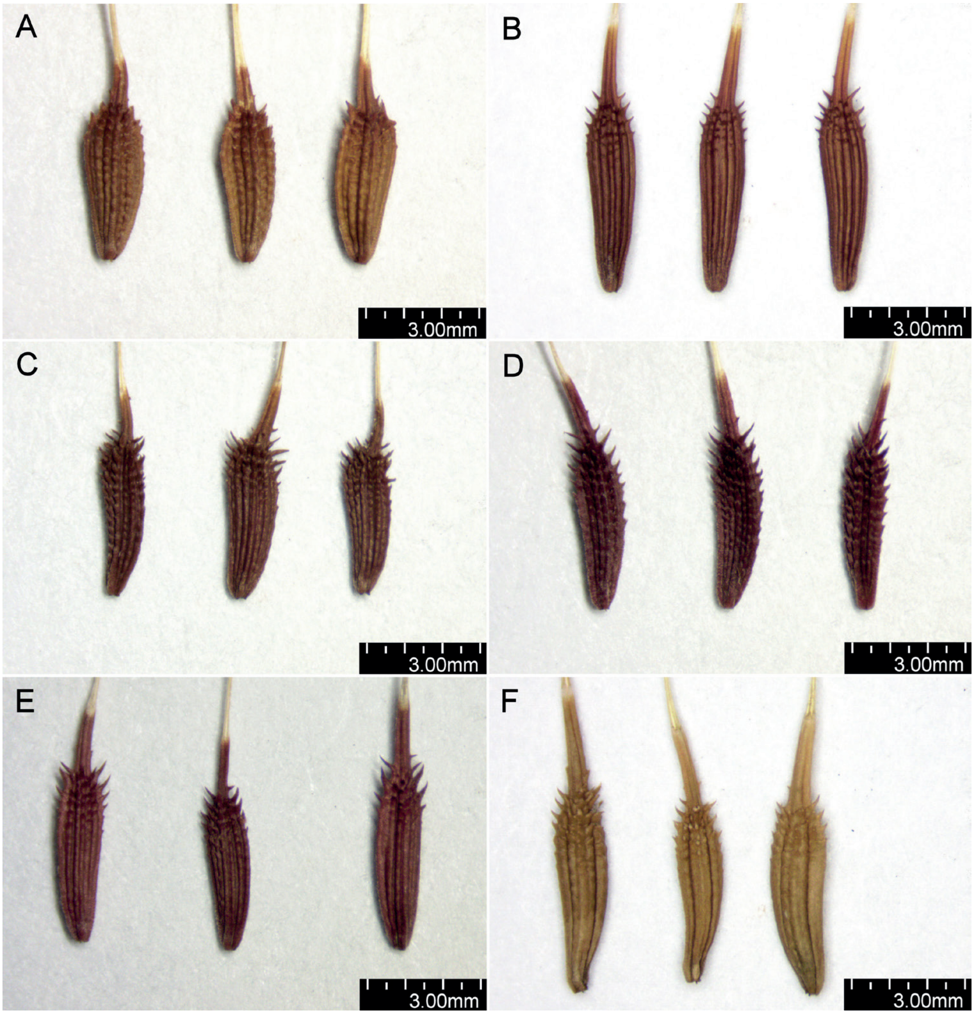

Figure 3. Shape and colour of achenes **A** *T. plumbeum* **B** *T. proximum* **C** *T. sandomiriense* **D** *T. scanicum* **E** *T. tenuilobum* **F** *T. tortilobum*.

Distribution of *Taraxacum* sect. *Erythrosperma* in Poland

Of the 14 examined species of *Taraxacum* sect. *Erythrosperma* in Poland, 7 are definitely rare, known from 3 to 13 localities to date. Three of them (*T. danubium*, *T. cristatum*, *T. sandomiriense*) are distributed in south-central Poland in relatively small areas, the next 3 are known from the north-eastern part of the country (*T. dissimile*) and the Baltic Sea seashore (*T. tortilobum*, *T. lacistophyllum*). Another rare species, *T. disseminatum*, is known from 11 localities scattered over a relatively large area. The other species from the section are fairly frequent (>20 localities), although they are known from no more than 50 localities. The most common is *T. scanicum*, known from 42 localities. As for the concentration

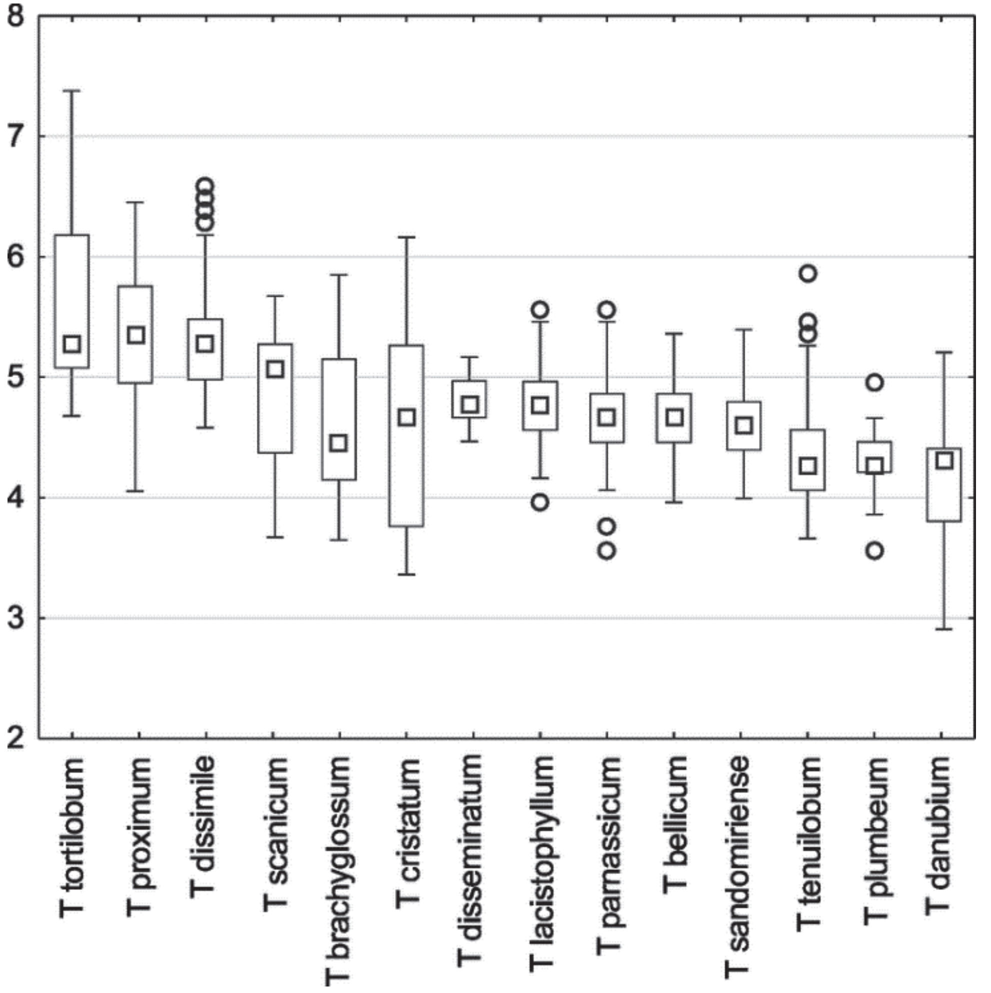

Figure 4. Box-and-whisker plots of achene length (incl. cone) in examined species. White squares indicate mean value (☐), boxes represent the 25th and 75th percentile.

of *T.* sect. *Erythrosperma* species-localities per grid square, the highest is observed within the Kraków-Częstochowa Upland, the Gdańsk Coastland and the Wielkopolska Lowland (Fig. 8).

Potential distribution modelling

The distribution model was performed for 11 species of dandelions. All the models show a high value of AUC (0.98 up to 1.00), which confirmed their reliability (Table 8). Variables with a relatively higher percentage of contribution in the MaxEnt models for the greatest number of species were bio11, bio3 and bio7 and, among soil factors, crf (Table 9).

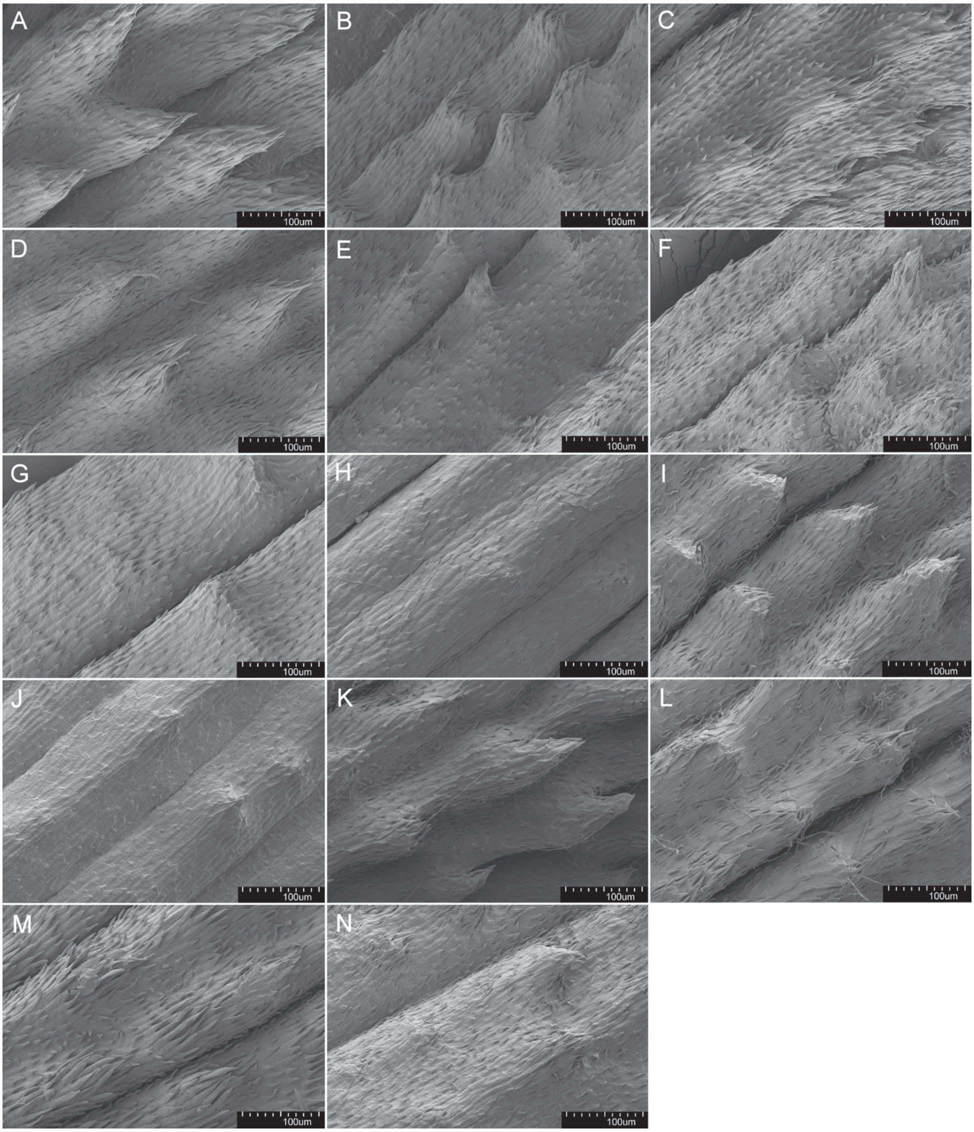

Figure 5. Micromorphology of achene spines of **A** *T. bellicum* **B** *T. brachyglossum* **C** *T. cristatum* **D** *T. danubium* **E** *T. disseminatum* **F** *T. dissimile* **G** *T. lacistophyllum* **H** *T. parnassicum* **I** *T. plumbeum* **J** *T. proximum* **K** *T. sandomiriense* **L** *T. scanicum* **M** *T. tenuilobum* **N** *T. tortilobum* [magnification 300×].

For most species, the area of high and very high probability of occurrence is quite large, indicating that these species may be much more common in Central Europe than previously thought, and their poorly recognised distribution is an effect of insufficient study. Such species include *T. bellicum*, *T. cristatum*, *T. danubium*, *T. parnassicum* or *T. plumbeum*. All of these species are characterised by a similar pattern of potential distribution, covering steppe regions of Central Europe, from southern (Bavaria) and

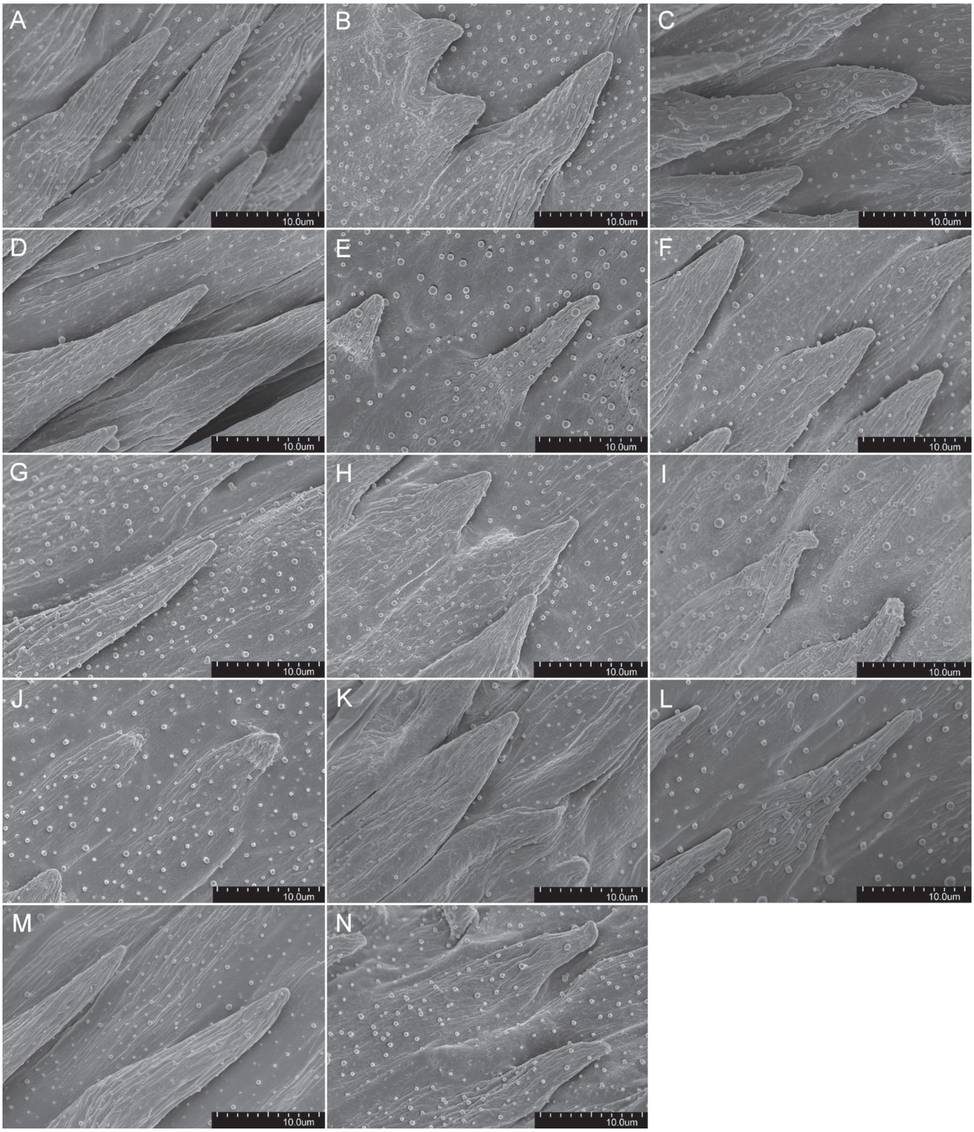

Figure 6. Micromorphology of the upper part of the achene body of **A** *T. bellicum* **B** *T. brachyglossum* **C** *T. cristatum* **D** *T. danubium* **E** *T. disseminatum* **F** *T. dissimile* **G** *T. lacistophyllum* **H** *T. parnassicum* **I** *T. plumbeum* **J** *T. proximum* **K** *T. sandomiriense* **L** *T. scanicum* **M** *T. tenuilobum* **N** *T. tortilobum* [magnification 4000×].

north-eastern Germany (areas on the middle and lower Elbe river valley), through central and southern Czech Republic (including Moravia), northern and central Slovakia, north-eastern Austria (on the Danube), the highlands of Silesia and Central Poland, the valleys of the lower Odra and Vistula rivers, to eastern Poland, and in the case of some species also south-western Ukraine (Fig. 9A, C, D, G, H). For *T. brachyglossum*,

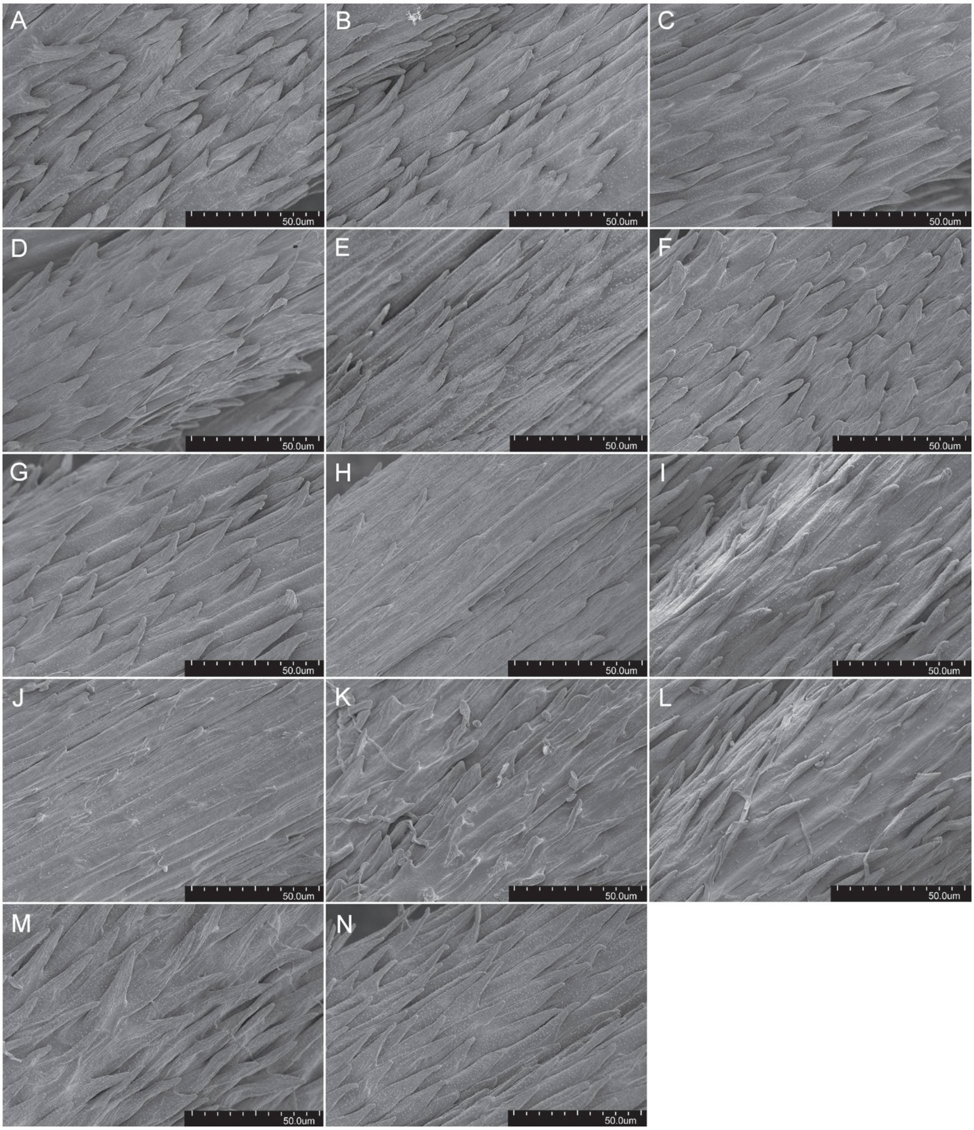

Figure 7. Micromorphology of the middle part of the cone of **A** *T. bellicum* **B** *T. brachyglossum* **C** *T. cristatum* **D** *T. danubium* **E** *T. disseminatum* **F** *T. dissimile* **G** *T. lacistophyllum* **H** *T. parnassicum* **I** *T. plumbeum* **J** *T. proximum* **K** *T. sandomiriense* **L** *T. scanicum* **M** *T. tenuilobum* **N** *T. tortilobum* [magnification 1000×].

the general pattern of distribution is similar, but the area of high probability of occurrence is much smaller (Fig. 9B). Three species (*T. lacistophyllum*, *T. proximum*, *T. scanicum*), are characterised by a potentially more concentrated range in the north-western part of Poland (mostly Pomerania and Silesia) and eastern Germany (the middle Elbe river valley, Saxony and Brandenburg), (Fig. 9F, I, J). This is especially noticeable in the case of *T. lacistophyllum*, which in Poland probably occurs only in Pomerania, but is

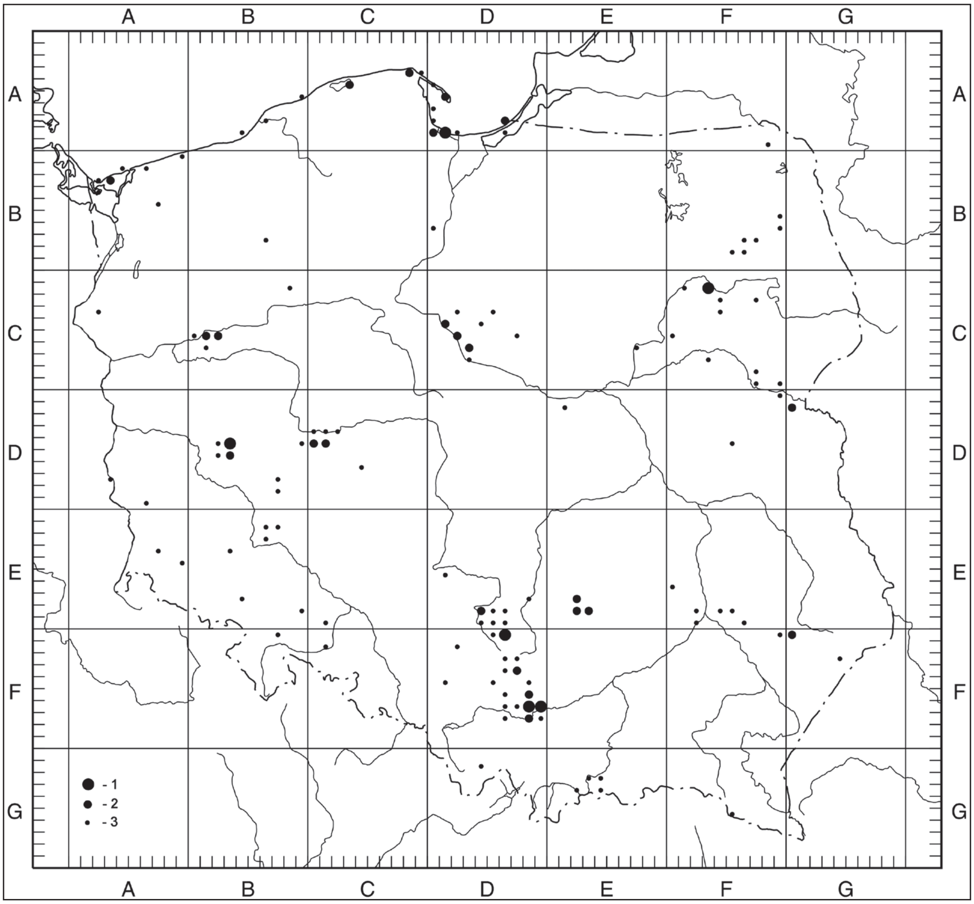

Figure 8. Collective distribution of *Taraxacum* sect. *Erythrosperma* species in Poland; **1** – 5–6 species per 10 km × 10 km square, **2** – 3–4 species per 10 km × 10 km square, **3** – 1–2 species per 10 km × 10 km square.

likely much more common in Germany (Fig. 9F). Two other species, *T. disseminatum* and *T. tenuilobum*, show rather scattered potential distribution patterns, with high and very high probability of occurrence in central and northern Czech Republic, eastern Germany (the middle Elbe river valley, Saxony and Brandenburg) to Pomerania (both in Germany and Poland), the valley of the lower Odra and the Vistula, highlands in Silesia, central, southern, and eastern Poland, as well as western Ukraine (Fig. 9E, K). In the case of *T. dissimile*, *T. sandomiriense*, and *T. tortilobum*, we were unable to construct reliable models due to an extremely small number of known localities (Figs 10F, 23E, 36B).

Remarks on plant collection and species identification

Determination of species representing the section *Erythrosperma* can be difficult for beginners, who are not familiar with the morphological variability that is observed in

Table 8. Area Under Curve (AUC) values for training and test data. The values shown are averaged over 20 replicate MaxEnt model runs.

Species	Training AUC	Test AUC
T. bellicum	0.98	0.98
T. brachyglossum	0.99	0.99
T. cristatum	0.99	0.99
T. danubium	1.00	0.99
T. disseminatum	0.99	0.99
T. lacistophyllum	1.00	0.99
T. parnassicum	0.99	0.99
T. plumbeum	0.99	0.99
T. proximum	0.99	0.99
T. scanicum	0.99	0.99
T. tenuilobum	0.99	0.98

Table 9. Variables' contribution (jackknife test) to training for model performance with only a particular variable, versus a model without a variable. The values shown are averaged over 20 replicate MaxEnt model runs.

			T. bellicum	***T. brachyglossum***	***T. cristatum***	***T. danubium***	***T. disseminatum***	***T. lacistophyllum***	***T. parnassicum***	***T. plumbeum***	***T. proximum***	***T. scanicum***	***T. tenuilobum***
Training gain	without variable	awcts	2.79	3.79	3.22	3.72	3.76	3.48	3.35	3.03	3.56	3.37	2.93
		bio10	2.78	3.85	3.29	3.78	3.78	3.46	3.36	3.07	3.53	3.35	2.95
		bio11	2.78	3.84	3.23	3.75	3.56	3.38	3.36	3.03	3.48	3.34	2.86
		bio18	2.70	3.74	3.04	3.70	3.78	3.46	3.31	3.02	3.53	3.36	2.89
		bio19	2.73	3.79	3.29	3.59	3.36	3.30	3.23	2.91	3.42	3.21	2.68
		bio3	2.80	3.77	3.26	3.77	3.78	3.49	3.29	3.07	3.56	3.32	2.75
		bio7	2.77	3.84	3.19	3.74	3.75	3.24	3.29	3.03	3.52	3.33	2.95
		cly	2.80	3.73	3.25	3.77	3.64	3.48	3.37	3.04	3.42	3.30	2.87
		crf	2.79	3.79	3.11	3.71	3.78	3.47	3.30	3.04	3.51	3.27	2.90
		orc	2.82	3.84	3.25	3.76	3.73	3.48	3.35	3.09	3.56	3.37	2.93
		pH	2.82	3.75	3.28	3.78	3.71	3.44	3.37	3.06	3.53	3.33	2.88
	only with variable	awcts	0.61	0.77	0.68	1.18	0.33	0.15	0.74	0.81	0.77	0.51	0.31
		bio10	1.17	0.69	0.44	0.81	0.44	0.55	1.01	0.91	0.99	1.12	0.55
		bio11	1.42	1.59	1.45	1.66	1.40	1.64	1.57	1.39	1.49	1.39	1.24
		bio18	1.02	1.51	1.16	1.00	0.46	0.70	0.94	0.62	0.81	0.69	0.62
		bio19	0.55	0.61	0.30	0.78	0.47	0.56	0.61	0.58	0.58	0.62	0.51
		bio3	1.16	1.67	1.39	1.64	0.94	0.57	1.66	1.10	1.25	1.09	1.04
		bio7	1.39	1.38	1.44	1.75	1.14	1.82	1.70	1.40	1.35	1.29	0.82
		cly	0.21	0.59	0.31	0.31	0.94	0.39	0.31	0.48	1.02	0.95	0.60
		crf	0.30	0.88	0.30	0.65	0.53	0.62	0.61	0.64	0.83	0.99	0.62
		orc	0.81	1.03	0.89	1.14	0.67	0.40	1.02	0.71	0.68	0.43	0.33
		pH	0.58	0.81	0.57	0.41	0.50	0.52	0.59	0.51	0.58	0.59	0.79

the field. Except for some features within the inflorescence, most of the measurable features are characterised by a very wide range of variability. During determination, it is extremely important to carefully analyse qualitative features, such as the absence or presence of pollen; the shape, colour and arrangement of the outer bracts; the shape

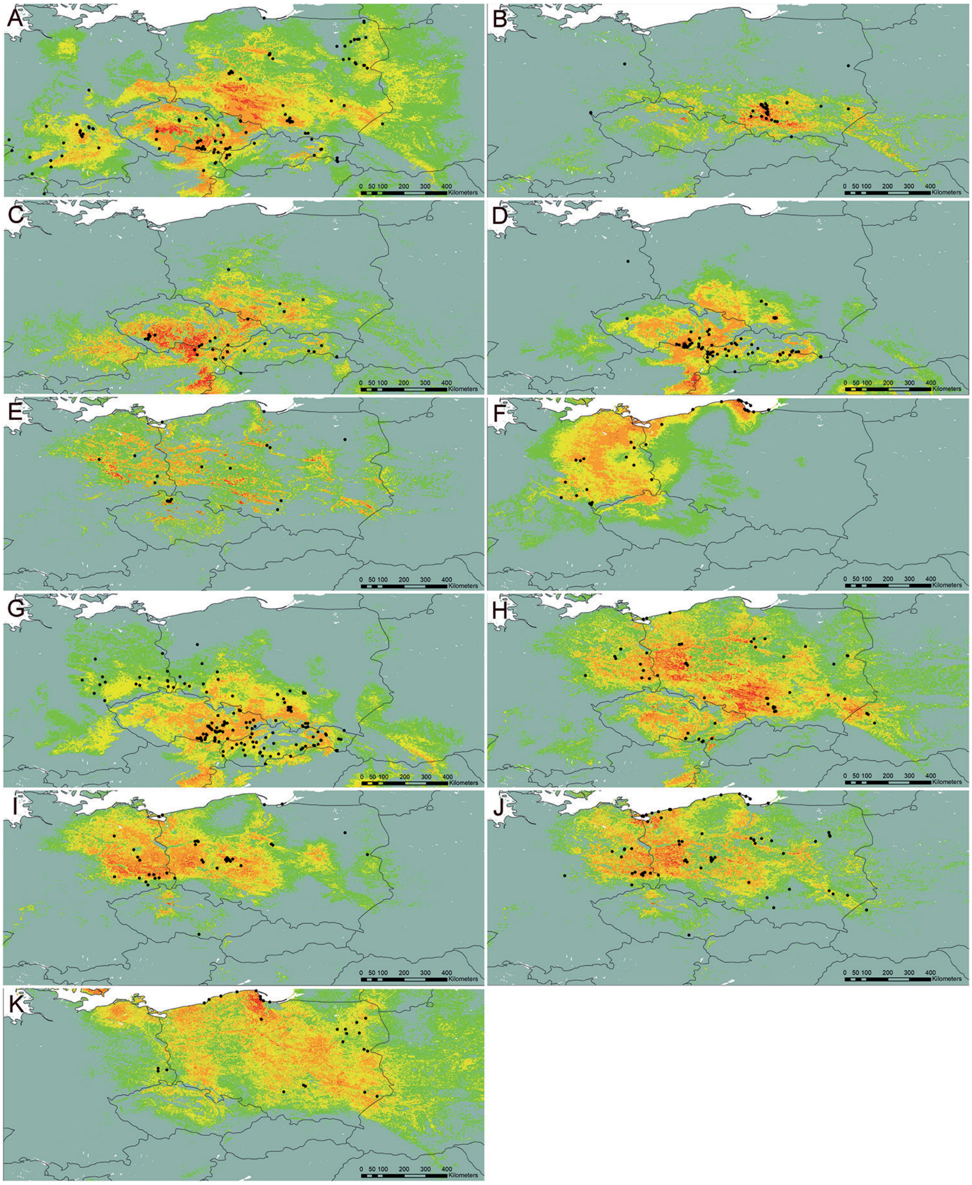

Figure 9. Models of the potential distribution of selected species of *Taraxacum* sect. *Erythrosperma* in central Europe **A** *T. bellicum* **B** *T. brachyglossum* **C** *T. cristatum* **D** *T. danubium* **E** *T. disseminatum* **F** *T. lacistophyllum* **G** *T. parnassicum* **H** *T. plumbeum* **I** *T. proximum* **J** *T. scanicum* **K** *T. tenuilobum*; probability of occurrence: very low (grey), low (green), medium (yellow), high (orange), very high (red).

of the capitulum, the shape of the terminal lobe, side lobes, and interlobes; the presence or absence of teeth on lobes and in the interlobes; the colour and hairiness of the leaves and peduncles; the colour of the flowers and achenes. Some quantitative features are also important, e.g. the number of side lobes and outer bracts. Species-specific features are best visible in the field, in numerous populations, preferably in full flowering/beginning of fruiting time (in Poland, this period begins in the second half of April in the Uplands and in the first week of May in the north and in the mountains; in Poland this period overlaps with the flowering of *Prunus spinosa*). Rainless and warm springs are favourable for field research. If spring is rainy and cold, small plants from the *Erythrosperma* section are usually overgrown by grass and other perennials; they then lose their diagnostic features and are hardly noticeable from a greater distance. In the field, it is worth noting features such as the arrangement and colour of outer bracts, the colour of petioles, and the colour and shape of the capitulum. It is crucial to carefully dry collected plants after the harvest; this makes later determination much easier. All data should be taken into consideration during determination, and the specimen should be compared both with the identification key and the description.

Key to species identification

1 Pollen grains present, and numerous **2**
– Pollen grains absent or sparse (a few grains on some stigmas) **12**
2 Achenes brown-red, purple-brown or yellowish brown-red **3**
– Achenes in another colour (without red admixture) **11**
3 Outer bracts narrowly lanceolate, without or rarely with a very narrow, barely visible hyaline margin (up to 0.05 mm broad) .... ***T. tenuilobum***
– Outer bracts lanceolate to ovate, with a clearly visible (sometimes very narrow) white hyaline margin (0.05–0.3 mm broad) **4**
4 Distal margin of the inner leaves' lateral lobes entire or with occasional teeth at lower lobes **5**
– Distal margin of the inner leaves' lateral lobes usually dentate or denticulate, rarely incised **7**
5 Outer bracts 4–6 mm long and 1.5–2.5 mm broad; regularly spreading to quite regularly arranged and recurved, corniculate .... ***T. danubium***
– Outer bracts 7–9 mm long and 2–3 mm broad **6**
6 Leaves greyish-green; capitulum light yellow, convex, outer bracts elegantly arcuate spreading, corniculate .... ***T. lacistophyllum***
– Leaves dark green; capitulum dark yellow, usually opening partly, outer bracts spreading to erect, moderately corniculate .... ***T. brachyglossum***
7 Outer bracts mostly recurved, corniculate; terminal lobe of the inner leaves usually prolate **8**
– Outer bracts differently positioned (erect, subspreading, arcuate-reflexed), with or without corniculation; terminal lobe of the inner leaves triangular or subsagitate, quite often lingulate/lobulate **10**
8 Terminal lobe of the inner leaves denticulate at the base; leaves usually with 3–4 pairs of lateral lobes .... ***T. cristatum***
– Terminal lobe of the inner leaves without teeth at the base, at most incised; leaves with up to 6 pairs of lateral lobes **9**

9 Lateral lobes of the inner leaves usually dissected; outer bracts grey-green, quite often suffused red-violet, recurved or patent...................... ***T. scanicum***
– Lateral lobes of the inner leaves narrowly triangular, acute; outer bracts usually red-violet, often regularly recurved .... ***T. bellicum***
10 Achenes red-brown, 3.5–4.1 mm long (incl. 1.0–1.4 mm long, cylindrical cone); leaves usually 3–4 times longer than wide, lateral lobes' distal margins strongly dentate and often incised...................................... ***T. disseminatum***
– Achenes yellowish light red-brown, 3–3.6 mm long (incl. 0.6–0.8 mm long, subconical cone); leaves up to 7 times longer than wide, lateral lobes' distal margins often denticulate... ***T. plumbeum***
11 Achenes pale grey-brown; outer bracts grey-green suffused with purple, loosely adpressed to obliquely spreading .... ***T. tortilobum***
– Achenes brown; outer bracts purplish green, recurved....... ***T. sandomiriense***
12 Achenes yellowish-greyish-brown..***T. dissimile***
– Achenes brown-red **13**
13 Outer bracts ovate to wide lanceolate, white hyaline margin distinct (0.1–0.2 mm broad).. ***T. parnassicum***
– Outer bracts lanceolate, hyaline margin indistinct (up to 0.05 mm broad) ... . ***T. proximum***

***Taraxacum* sect. *Erythrosperma* (H. Lindb.) Dahlst., Acta Fl. Sueciae 1: 36. 1921.**

Taraxacum [unranked] *Erythrosperma* H. Lindb., Acta Soc. Fauna Fl. Fenn. 29(9): 18. 1908. Basionym.

≡ *Taraxacum* subsect. *Erythrosperma* (H. Lindb.) Schischk. In Komarov, Fl. SSSR 29: 497. 1964.

= *Taraxacum* sect. *Dissimilia* Dahlst., Acta Florae Sueciae 1: 37. 1921. Type: *Taraxacum dissimile* Dahlst.

= *Taraxacum* sect. Fulva M. P. Christ., in Gröntved et al., Botany of Iceland 3(3): 253. 1942. Type: *Taraxacum fulvum* Raunk.

= *Taraxacum* sect. *Proxima* Doll, Wiss. Z. Univ. Rostock, Reihe Math.-Naturwiss. 17: 330. 1968. Type: *Taraxacum proximum* (Dahlst.) Raunk. (≡ *T. erythrospermum* subsp. *proximum* Dahlst.).

Type. Designated by Doll, 1974: 60; see Kirschner and Štěpánek (1987), Štěpánek and Kirschner (2012): *Taraxacum rubicundum* (Dahlst.) Dahlst. (*T. erythrospermum* subsp. *rubicundum* Dahlst.); lectotype in S, designated by Doll 1973: 19: "Stockholm, Djurgardsfrescati", 10 June 1898, Dahlstedt.

Overall description of section *Erythrosperma*

Plants mostly small to middle-sized, often forming a tunic of dried leaf leftovers. Leaves usually deeply lobed with narrow lobes and petioles. Scapes often slender, thin. Outer bracts usually small, often with cornicules. Capitulum mostly small, flowers often light yellow, sometimes golden yellow. Achenes mostly red, less often straw-coloured, strongly spinulose with a cylindrical or narrowly conical cone, narrow at the base. Plants bloom in early spring (from mid-April). Related to warm and sunlit habitats.

1. *Taraxacum bellicum* Sonck, Memoranda Soc. Fauna Fl. Fenn. 59: 1. 1983.

= *Taraxacum prunicolor* Mart.Schmid, Vašut & Oosterv., Feddes Repert. 115: 221. 2004. Type: Germany, Mittelfranken, Bayern. Erlangen, scattered sandy places under pinewood at the Erwin-Rommel-Wohnheim, Uni-Südgelände (MTB 6432/14; R 4429999 H 5493713), 1 May 2002, *M. Schmid* (holotype in M 0165146; isotypes in M 0165145, L 0538648, PRA, OL, STU, DR).

Type. Finland, Lapponia inarensis, Jnari, church village, Miesniemi (lat. 68°52'N.), 7 July 1981, *C. E. Sonck* s.n. (holotype in H 591459; isotypes in CES, H 591458, S).

Description. Plants small to middle-sized, 5–12(–15) cm tall. ***Leaves*** greenish, almost glabrous, (5–)7–15(–20) cm long and 1.5–3 cm wide, generally 3–6 times longer than wide, blades broadest in middle, with 3–5(–6) pairs of lateral lobes; lateral lobes of the inner leaves patent or slightly recurved, narrowly triangular, acute, with an entire or slightly dentate distal margin, proximal margin usually entire or with a few small teeth; lateral lobes of the outer leaves triangular, proximal margin usually entire, distal margin entire or slightly dentate; interlobes often toothed, sometimes blackish rimmed; terminal lobe of the inner leaves mostly with lingulate apex; terminal lobe of the outer and medial leaves triangular or slightly lingulate, usually packed lateral lobes below; petioles unwinged, pale purple to pale brown-purple. ***Scapes*** as long as or longer than leaves, green suffused with pale purple, hairy below capitulum. ***Capitulum*** slightly convex, 2.5–3.5 cm in diameter, dark yellow, outer strips grey brown; inner bracts greyish-green, corniculate, outer bracts usually 10–14, lanceolate, usually 6.5–9 mm long, 1–3 mm broad, usually red-violet, hyaline margin inconspicuous (up to 0.1 mm broad), regularly recurved, usually with small cornicules; stigmas yellow-greenish, yellow-green-blackish after drying, pollen present. ***Achenes*** greyish purple-brown, sparsely spinulose at the top, 3.5–4.0 mm long (incl. the 1.0–1.3 mm long, narrowly conical cone), rostrum 6.0–7.0 mm long, pappus white.

Flowering period. April (May).

Habitat. In the Polish lowlands this species occurs in a wide spectrum of habitats; mostly in dry, sandy semiruderal locations exposed to the sun, e.g. roadsides, paths in dry pine forests, sandy embankments, dry pastures, sandy paths in cemeteries (especially in Wielkopolska Lowland); plant communities with its participation are dominated by species characteristic to the *Molinio-Arrhenatheretea* and *Sedo-Scleranthetea* classes. In Podlchia (Klimaszewnica) it was reported in a pastured dry grassland with: *Achillea millefolium*, *Agrostis capillaris*, *Artemisia campestris*, *Carex caryophyllea*, *Cerstium holosteoides*, *Erophila verna*, *Galium mollugo*, *Knautia arvensis*, *Luzula campestris*, *Medicago falcata*, *Myosotis stricta*, *Pilosella officinarum*, *Plantago lanceolata*, *Ranunculus bulbosus*, *Sedum acre*, *Taraxacum* sect. *Taraxacum* and *Trifolium repens*. In south Poland, this species often grows in small enclaves on exposed rocky slopes, rock shelves and fissures, in plant communities dominated by species characteristic to classes *Sedo-Scleranthetea*, *Festuco-Brometea* and *Molinio-Arrhenatheretea*. In Kraków-Częstochowa Upland (Kraków Kostrze place) this species was noted in irregular xerothermic grassland (evolved in an old limestone excavation), together with *Achillea millefolium*, *Acinos arvensis*, *Alyssum alyssoides*, *Arenaria serpyllifolia*, *Artemisia vulgaris*, *Asperula cynanchica*, *Bromus hordeaceus*, *Centaurea stoebe*, *Dactylis glomerata*, *Echium vulgare*, *Erodium cicutarium*, *Euphorbia cyparissias*, *Festuca pratensis*, *F. rubra*, *Galium verum*, *Koeleria macrantha*, *Medicago ×varia*, *M. falcata*, *Plantago media*, *Potentilla arenaria*, *Sanguisorba minor*, *Sedum acre*, *S. sexangulare*, *Stachys recta*, *Taraxacum* sect. *Taraxacum*, *Thlaspi perfoliatum*, *Thymus kosteleckyanus*, *T. pulegioides*, *Trifolium repens*.

Somatic chromosome number. 24 (Wolanin and Musiał 2017).

General distribution. Central European species reported in the Czech Republic, Austria, Germany, Poland, Switzerland, Slovakia, Ukraine and Finland (Uhlemann 2003; Horn et al. 2004; Schmid et al. 2004; Nobis et al. 2020b). Populations from Finland are most likely of anthropogenic origin (EURO+MED 2006-onwards).

Distribution in Poland. Scattered localities, quite frequent in Podlachia, the western part of Lesser Poland and Greater Poland (Fig. 10A).

Specimens examined. BB76 – Borne Sulinowo, woj. zachodniopomorskie, 10 May 2005, *K. Rostański* (122777 KTU); **CD31** – Murzynowo Leśne, square close to shop, 52°09'17"N, 17°20'25"E, 17 April 2016, *M. Wolanin* (003506 UR); Solec, anti-flood embankment on the Warta River, 52°06'08"N, 17°19'53"E, 17 April 2016, *M. Wolanin* (003495 UR); **CD32** – Nowe Miasto nad Wartą, lawn in cemetery, 52°05'14"N, 17°23'57"E, 17 April 2016, *M. Wolanin* (003515 UR); **CD40** – Książ Wielkopolski, roadside in forest, 52°04'02"N, 17°14'44"E, 16 April 2016, *M. Wolanin* (003538 UR); **CD41** – between Radoszkowo and Chromiec, sandy embankment near disused railway track, 52°02'20"N, 17°16'30"E, 16 April 2016, *M. Wolanin* (003519 UR); **CD64** – Las Taczanowski near Ostrów Wielkopolski, 2 May 2013, *A. Czarna* (POZNB); **DA81** – Gdańsk (Stogi), roadside in pine forest, 54°22'31"N, 18°43'27"E, 7 May 2016, *M. Wolanin* (003488 UR); **DC52** – Dąbrówka, forest roadside, 52°53'42"N, 18°57'51"E, 29 April 2018, *M. Wolanin* (003446 UR); **DC52** – Wakole village vicinity, roadside in pine forest, 52°50'34"N, 18°57'07"E, 29 April 2018, *M. Wolanin* (003451 UR); **DC52** – Stare Rybitwy, roadside in pine forest, 52°50'01"N, 18°55'53"E, 29 April 2018, *M. Wolanin* (003457 UR); **DC73** – Włocławek, gap between pavement and kerb, 52°40'29"N, 19°05'12"E, 29 April 2018, *M. Wolanin* (003479 UR); **DE96** – Bystrzanowice, roadside of asphalt road No 46, 50°42'24"N, 19°30'53"E, 20 April 2016, *M. Wolanin* (003532 UR); **DF37** – Jaroszowiec near Olkusz, grassland near forest road, 12 May 1977, *H. Trzcińska-Tacik* (392532 KRAM); **DF58** – Duże Skałki, bonfire-burnt location on grassland, 50°11'19"N, 19°48'23"E, 30 April 2013, *M. Wolanin* (003345 UR); Żytnia Skała, grassland on rocks, 50°11'07"N, 19°48'05"E, 30 April 2013, *M. Wolanin* (003256 UR); Żytnia Skała, fissures in rock, 50°11'09"N,

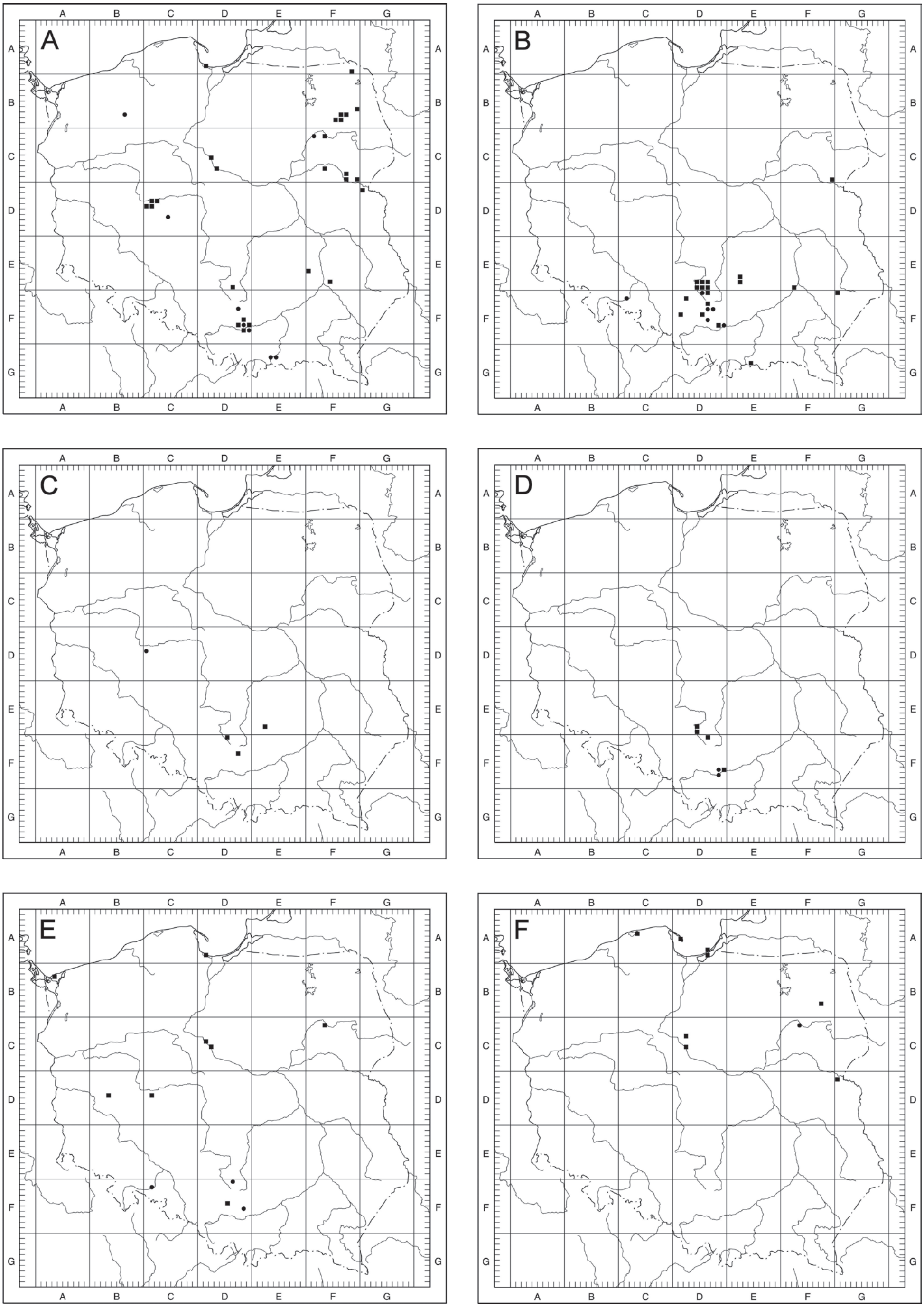

Figure 10. Distribution maps of *Taraxacum* sect. *Erythrosperma* in Poland **A** *T. bellicum* **B** *T. brachyglossum* **C** *T. cristatum* **D** *T. danubium* **E** *T. disseminatum* **F** *T. dissimile*; black square – localities recorded during field studies, black circle – other localities known from herbarium data.

Figure 11. Variation in leaf shape in *T. bellicum*; locality – Nowe Miasto nad Wartą (*M. Wolanin* 2016 UR). Scale bar: 5 cm.

19°48'04"E, 30 April 2013, *M. Wolanin* (003338 UR); Bolechowice, calcareous rocks, 1 May 1976, *H.*, *T.* & *J. Tacik* (392437, 392438, 575859 KRAM); Bolechowice, path, field road, 21 May 1976, *T. Tacik* (387575, 392460, 575854, 575893 KRAM); Dolina Kluczwody, calcareous rocks, 4 May 1957, *W. Wojewoda* (0129483 KRA); N of the village Biały Kościół, grassland on calcareous rock, 10 May 2013, *M. Nobis* (KRA); **DF67** – Czułów, grassland on rock, SW slope, 50°04'02"N, 19°41'39"E, 20 April 2015, *M. Wolanin* (003282 UR); **DF68** – Kraków (Bielany), forest clearing near road, 27 April 1975, *T. Tacik* (575853 KRAM); between Kryspinów and Bielany, sunny hill, 16 May 1976, H., *T.* & *J. Tacik* (392443 KRAM); **DF69** – Kostrze (Kraków), roadside, quarry, 50°02'18"N, 19°52'10"E, 19 April 2015, *M. Wolanin* (003295 UR), Pychowicka Górka, grassland on rocky-humus soil, 50°01'50"N, 19°53'00"E, 29 April 2013, *M. Wolanin* (003378 UR); Kraków, limestone hill near Pychowice, 8 May 1953, *T. Tacik* (575869 KRAM); Kraków (Zakrzówek), sunny hill, 5 August 1976, *T. Tacik* (392451 KRAM); Las Wolski (Kraków), calcareous rocks, 4 May 1954, *A. Jasiewicz* (437763 KRAM); Pychowice, hill, 11 May 1975, *T. Tacik* (392445 KRAM); **DF78** – Piekary (Kraków), grassland on rock, S slope, 50°00'54"N, 19°47'39"E, 19 April 2015, *M. Wolanin* (003269 UR); Tyniec Podgórki (Góra Wielkanoc), grassland on rocky-humus soil, 50°01'01"N, 19°48'55"E, 29 April 2013, *M. Wolanin* (UR 003337); Tyniec, Juranda ze Spychowa Street, calcareous rocks in former excavation, 50°00'34"N, 19°48'55"E, 29 April 2013, *M. Wolanin* (003366 UR); Piekary Tynieckie, grassland on rock, 20 April 1975, *T. Tacik* (575852 KRAM); Tyniec, hill, 14 May 1967, *J. Błaszczak* (063403 KRA); **DF79** – Kraków (Borek Fałęcki), pine forest, 7 May 1976, *T. Tacik* (392439 KRAM); Podgórki Tynieckie, sunny hill, 11 May 1976, *T. Tacik* (570163 KRAM); Podgórki Tynieckie, Biedzina hill, SW slope, 8 May 1979, *H. Trzcińska-Tacik* (601089 KRAM); **EG23** – Łącko, dry grassland close to Dunajec River, 3 May 1970, *K. Towpasz* (80794 KRA); Maszkowice n. Dunajcem, 13 May 1970, *K. Towpasz* (0123940 KRA); **EG24** – Kadcza (Kotlina Sądecka), rocky slope above road, 20 May 1970, *K. Towpasz* (80793 KRA); **FA98** – Gulbieniszki, dry grassland on SW slope of Góra Cisowa hill, 54°15'05"N, 22°54'33"E, 1 May 2018, *M. Wolanin* (003462 UR); Jeleniewo, pasture on dry rocky SW slope, 54°11'38"N, 22°54'50"E, 1 May 2018, *M. Wolanin* (003444 UR); **FB69** – Zabiele-Kolonia, sandy roadside, 53°33'30"N, 22°59'18"E, 24 April 2016, *M. Wolanin* (003526 UR); **FB76** – Klimaszewnica, sandy roadside, 53°28'50"N, 22°30'48"E, 24 April 2016, *M. Wolanin* (003524 UR); **FB77** – between Goniądz and Szafranki, dry pasture, 53°29'16"N, 22°42'30"E, 24 April 2016, *M. Wolanin* (003529 UR); Osowiec, dry sandy roadside near fort, 53°29'29"N, 22°38'20"E, 24 April 2016, *M. Wolanin* (003528 UR); **FB85** – Chrzanowo, sandy square close to excavation, 53°23'27"N, 22°21'23"E, 24 April 2016, *M. Wolanin* (003492 UR); **FB86** – Klimaszewnica, pastured grassland on sandy hill, 53°28'01"N, 22°30'07"E, 24 April 2016, *M. Wolanin* (003525 UR); **FC11** – Czartoria, hillock close to river, 8 May 2016, *T. Grużewska* (MPD); **FC13** – Piątnica (Fort Łomża), pastured grassland, 53°11'50"N, 22°06'53"E, 25 April 2016, *M. Wolanin* (003534 UR); **FC73** – Poniatowo, sandy roadside, 52°38'26"N, 22°02'44"E, 26 April 2016, *M. Wolanin* (003522, 003523 UR); Przewóz Nurski nad Bugiem, sandy roadside, 52°39'51"N, 22°17'30"E, 26 April 2016, *M. Wolanin* (003565 UR); **FC87** – Arbasy, sandy roadside, 52°30'39"N, 22°32'26"E, 26 April 2016, *M. Wolanin* (003520, 003521 UR); **FC97** – between Pustkowice and Minczew, sandy side of asphalt road, 52°27'16"N, 22°34'47"E, 26 April 2016, *M. Wolanin* (003535 UR); **FC99** – Anusin, sandy roadside at pine forest edge, 52°23'45"N, 22°53'46"E, 25 April 2016, *M. Wolanin* (003308 UR); Siemiatycze-Stacja, sandy roadside, 52°23'32"N, 22°56'10"E, 25 April 2016, *M. Wolanin* (003527 UR); **FE60** – Podgrodzie near Ćmielów, xetothermic grassland on SW slope, 50°54'24"N, 21°32'44"E, 17 April 2012, *M. Wolanin* (003396 UR); Podgrodzie near Ćmielów, xerothermic grassland on rock outcrop, 50°54'24"N,

Figure 12. *Taraxacum bellicum*; locality – between Zaklików and Lipa, 2019, photo by M. Wolanin.

21°32'44"E, 17 April 2012, *M. Wolanin*, *M. Nykiel* (003397 UR); **FE84** – between Zaklików and Lipa, sandy location at pine forest edge, 50°42'41"N, 22°04'43"E, 19 April 2019, *M. Wolanin* (003585 UR); **GD10** – Serpelice, lawn, 52°16'49"N, 23°03'01"E, 25 April 2016, *M. Wolanin* (003530 UR).

Notes. The species shows high morphological variability within leaf shape and the position and colour of outer phyllaries. This variability is evident among the populations from the Polish lowlands, often found in semi-shaded semi-ruderal and ruderal habitats such as sandy and gravely roadsides, backyards, sandy roads and paths in the forests and thickets. Features typical of the species, such as regularly recurved, red-purple, narrowly-edged outer phyllaries, or the distinct lingously elongated apex of the inner leaves terminal lobe, are well visible in specimens growing in stable, dry and full sun habitats, e.g. in sandy grasslands and rock grasslands in the south of Poland. Due to high morphological plasticity, the species can sometimes be confused with *T. scanicum*, which differs from *T. bellicum*, e.g. outer phyllaries are distinctly bordered (0.1–0.2 mm), mostly green, and the leaves' side lobes are regularly incised (Figs 11, 12).

2. *Taraxacum brachyglossum* (Dahlst.) Raunk., Dansk Exkurs.-Fl., ed. 2: 257. 1906.

Taraxacum erythrospermum subsp. *brachyglossum* Dahlst., Bot. Not., 1905: 170. 1905. Basionym.

Type. Sweden, Stockholm, Bergian Bot. Garden, sunny lawn, 4 June 1904, *H. Dahlstedt* (lectotype, selected by G. Haglund and designated by Doll 1973: 53, in S).

Description. Plants usually small-sized, 5–10 cm tall. ***Leaves*** dark green, somewhat glossy, almost glabrous or with few barely visible hairs, approximately 3–8(–10) cm long and (1–)1.5–2.5(–3.5) cm wide, usually are 3–4 times longer than wide, blades narrowly oblanceolate, usually broadest in upper 1/3, with 4–5 pairs of lateral lobes; lateral lobes opposite to remote, lateral lobes of the inner leaves narrowly triangular, recurved, the ends somewhat bent, distal margin usually entire, lower lobes slightly dentate, somewhat convex, proximal margin usually entire, often with a distinct tooth at the base; lateral lobes of the outer leaves triangular, entire, usually with a distinct tooth at the proximal margin base; interlobes usually toothed; terminal lobe of the inner leaves tripartite, often shortly lingulate and entire on the margins; terminal lobe of the outer leaves triangular or tripertite and shortly lingulate; petioles unwinged, moderately purplish. ***Scapes*** as long as or shorter than leaves, somewhat hairy. ***Capitulum*** often partially open, 1.5–2 cm, dark yellow, outer strips blackish-violet; inner bracts dark green, glaucous, usually with lumps or small cornicules; outer bracts usually 12–15, broadly lanceolate, usually 7–9 mm long, 2–3 mm broad, greyish-purple, with a narrow white hyaline margin (ca. 0.1 mm broad), spreading to erect, moderately corniculate; stigmas greyish-green, pollen present. ***Achenes*** brownish-red, spinulose above, 3.3–3.7 mm long (incl. the 0.8–1.2 mm long, narrowly conical cone), rostrum 7–9 mm long, pappus white.

Flowering period. April–May.

Habitat. Species associated mainly with thermophilic rock grasslands, occurring most often in pastured or trampled places. Moreover, this species is sometimes found in dry and sunny ruderal habitats such as railway tracks or mine slags. *T. brachyglossum* was reported in plant communities accompanied by species characteristic to the *Sedo-Scleranthetea*, *Festuco-Brometea* and *Molinio-Arrhenatheretea* classes. In Kraków-Częstochowa Upland (Olsztyn place) this species grew in a rock grassland together with *Acinos arvensis*, *Allium montanum*, *Alyssum alyssoides*, *Arenaria serpyllifolia*, *Artemisia campestris*, *Asperula cynanchica*, *Briza media*, *Carex caryophyllea*, *Centaurea stoebe*, *Dianthus carhusianorum*, *Erysimum odoratum*, *Euphorbia cyparissias*, *Helianthemum nummularium* subsp. *obscurum*, *Hypericum maculatum*, *Jovibarba sobolifera*, *Libanotis pyrenaica*, *Medicago falcata*, *Phleum phleoides*, *Pilosella officinarum*, *Pimpinella saxifraga*, *Poa compressa*, *P. pratensis*, *Potentilla arenaria*, *Sanguisorba minor*, *Sedum acre*, *S. sexangulare*, *Silene otites*, *Stachys recta*, *Teucrium botrys*, *Vincetoxicum hirundinaria*. In Pieniny Mts (Jaworki) we reported this species in a pastured rock grassland accompanied by: *Achillea millefolium*, *Arabis hirsuta*, *Arenaria serpyllifolia*, *Briza media*, *Campanula rotundifolia*, *Carex flacca*, *C. montana*, *Cerastium holosteoides*, *Convolvulus arvensis*, *Coronilla varia*, *Cruciata glabra*, *Cynosurus cristatus*, *Euphorbia cyparissias*, *Festuca rubra*, *Fragaria vesca*, *Galium mollugo*, *Geranium columbinum*, *Jovibarba sobolifera*, *Juniperus communis*, *Knautia arvensis*, *Leontodon hispidus*, *Linum catharticum*, *Lolium perenne*, *Lotus corniculatus*, *Medicago falcata*, *M. lupulina*, *Phleum pratense*, *Pilosella officinarum*, *Pimpinella saxifraga*, *Plantago lanceolata*, *P. media*, *Potentilla neumanniana*, *Prunella vulgaris*, *Prunus spinosa*, *Ranunculus polyanthemos*, *Salvia verticillata*, *Sanguisorba minor*, *Sedum acre*, *Taraxacum parnassicum*, *Thymus pulegioides*.

Somatic chromosome number. 24 (Małecka 1969; Wolanin and Musiał 2017).

General distribution. Widely distributed European species reported in France, Ireland, Great Britain, Italy, Switzerland, Belgium, the Netherlands, Germany, Denmark, Austria, Croatia, Poland, Norway, Finland, Sweden, Romania, Croatia, Moldova, Ukraine and Estonia (Marklund 1938; Van Soest 1967; Doll 1973b; Tutin et al. 1976; Tacik 1980; Fedorov 1989; Mosyakin and Fedoronchuk 1999; Nikolić 2000; Uhlemann 2003; Wendt and Øllgaard 2015).

Distribution in Poland. Scattered localities in S Poland, quite frequent in W part of Lesser Poland (Fig. 10B).

Specimens examined. CF11 – Nysa (Śląsk), May 1849, *M. Winkler* (WRSL); **DE84** – Kusięta, grassland on rock (path), 50°46'06"N, 19°16'16"E, 13 April 2014, *M. Wolanin* (003395 UR); Kusięta, grassland on rock, 50°46'03"N, 19°16'15"E, 12 April 2016, *M. Wolanin* (003486 UR); Olsztyn (Góra Zamkowa), grassland on rock outcrop, NW exposure, 50°44'55"N, 19°16'30"E, 13 April 2014, *M. Wolanin* (003360, 003454 UR); Olsztyn, grassland on rock, 50°44'55"N, 19°16'36"E, 12 April 2016, *M. Wolanin* (003487 UR); Olsztyn near Częstochowa, Góra Brodła hill, grassland on rock, 26 April 1975, *B. Baczyńska*, *I. Fibich* (017332, 117445 KTU); **DE85** – between Olsztyn and Przymiłowice, grassland on rock, 50°45'10"N, 19°17'05"E, 13 April 2014, *M. Wolanin* (003419, 003316 UR); Przymiłowice, grassland on rock, E slope, 50°45'22"N, 19°18'14"E, 13 April 2014, *M. Wolanin* (003317 UR); Przymiłowice, sandy road, 50°45'19"N, 19°17'48"E, 13 April 2014, *M. Wolanin* (003303 UR); **DE86** – Łutowiec near Mirów, grassland on the SW slope of a calcareous rock, 50°47'40"N, 19°27'19"E, 14 April 2014, *M. Wolanin* (003390 UR); **DE94** – Góra Sfinks hill, grassland on rock, 50°44'15"N, 19°16'17"E, 12 April 2016, *M. Wolanin* (003497 UR); **DE95** – Suliszowice, grassland on SW slope of calcareous rock, 50°40'19"N, 19°21'24"E, 13 April 2014, *M. Wolanin* (003290 UR); **DE96** – Bystrzanowice, parking lot close to road No 46, 50°42'25"N, 19°31'03"E, 20 April 2016, *M. Wolanin* (003413 UR); **DF05** – Przewodziszowice, grassland, 1983, *D. Kospanik* (037425 KTU); Żarki near Częstochowa, pine forest, 1994, *G. Pompa* (058136 KTU); **DF06** – Kroczyce, grassland on SW slope, 50°34'18"N, 19°31'47"E, 1 May 2013, *M. Wolanin* (003264 UR); Góra Zborów (Kroczyce), grassland on rock, 50°34'21"N, 19°31'49"E, 1 May 2021, *M. Wolanin* (003589 UR); Łutowiec, grassland on NW slope below calcareous outcrop, 50°37'42"N, 19°27'15"E, 14 April 2014, *M. Wolanin* (003361 UR); Mirów, grassland below calcareous rock, E slope, 50°36'51"N, 19°28'34"E, 14 April 2014, *M. Wolanin* (003377 UR); Mirów, path near castle, 50°36'53"N, 19°28'51"E, 14 April 2014, *M. Wolanin* (003389 UR); Rzędkowice, path on S slope of calcareous rock,

Figure 13. Variation in leaf shape in *T. brachyglossum*; locality – Kusięta (*M. Wolanin* 2016 UR). Scale bar: 5 cm.

50°34'31"N, 19°29'07"E, 14 April 2014, *M. Wolanin* (003403 UR); Kroczyce, path on SW slope, 50°34'20"N, 19°31'48"E, 1 May 2013, *M. Wolanin* (003277 UR); close to Jaskinia Głęboka near Kroczyce, old excavation, 50°34'31"N, 19°31'26"E, 1 May 2021, *M. Wolanin* (003588 UR); **DF12** – Miasteczko Śląskie, ruderal square close to railway track, 50°29'14"N, 18°55'14"E, 3 May 2016, *M. Wolanin* (003491 UR); **DF26** – Podzamcze (Ogrodzieniec), to the left of the castle, fissure in calcareous rock, 50°27'15"N, 19°33'03"E, 1 May 2013, *M. Wolanin* (003339 UR); Ryczów (Kolonia Podzamcze), calcareous rock, fissure in NW side, 50°27'05"N, 19°33'14"E, 12 April 2014, *M. Wolanin* (003408 UR); Centuria near Ogrodzieniec, sandy road between

Figure 14. *Taraxacum brachyglossum*; locality – Kusięta, 2016, photo by M. Wolanin.

pines, 6 June 1975, *T. Tacik* (570164, 570165 KRAM); **DF36** – Pustynia Błędowska, 29 April 1977, *H. Trzcińska-Tacik* (392440 KRAM); **DF37** – near the village Klucze, sandy roadside, 23 May 1955, *T. Tacik* (392459 KRAM); **DF41** – Ruda Śląska, on top of mine dump, 50°15'33"N, 18°50'25"E, 2 May 2016, *M. Wolanin* (003499 UR); **DF45** – Sosnowiec (Maczki), sandy roadside, 50°15'29"N, 19°17'08"E, 2 May 2016, *M. Wolanin* (003490 UR); Sosnowiec Maczki, between railway tracks, 28 August 1979, *A. Sendek* (027734 KTU); Sosnowiec Maczki, sandy square in the valley of the B. Przemsza, 9 May 1978, *A. Sendek* (034398 KTU); **DF56** – North of the Trzebinia (near the Myślachowice village), sandy location at pine forest edge, 27 April 1952, *T. Tacik* (575844 KRAM); **DF68** – Nielepice, fissures on top of calcareous rock, 50°06'20"N, 19°42'23"E, 12 April 2014, *M. Wolanin* (003407 UR); **DF69** – Krzemionki Dębnickie, dry grassy slopes, 8 May 1925, *Zabłocki* (169651 KRAM); Las Wolski, Przegorzały, calcareous rocks, 4 May 1954, *T. Tacik* (439037 KRAM); **EE72** – Miedzianka hill near Chęciny, grassland on rock, 50°50'47"N, 20°21'37"E, 11 April 2016, *M. Wolanin* (003485, 003496, 003540, 003542, 003561 UR); **EE82** – Grząby Bolmińskie, field road, 50°48'59"N, 20°21'17"E, 22 April 2016, *M. Wolanin* (003409 UR); **EG34** – Jaworki (Pieniny), pastured grassland on rock outcrop, 49°24'16"N, 20°32'36"E, 10 April 2014, *M. Wolanin* (003344 UR); Jaworki (Pieniny), pastured grassland on calcareous rock outcrop, 49°24'15"N, 20°32'37"E, 10 April 2014, *M. Wolanin* (003340 UR); Jaworki, grassland on rock, SE slope, 49°24'19"N, 20°32'37"E, 10 April 2014, *M. Wolanin* (003284 UR); **FC99** – Olendry, 52°23'07"N, 22°56'01"E, 25 April 2016, *M. Wolanin* (003541 UR); **FE92** – Kamień Łukawski, path on SE slope, 50°41'04"N, 21°47'10"E, 23 April 2016, *M. Wolanin* (003550 UR); Kamień Łukawski, path on loess slope, 50°41'04"N, 21°47'10"E, 19 April 2019, *M. Wolanin* (003584 UR); **GF00** – Szozdy, sandy road near railway track, 50°34'40"N, 22°56'11"E, 13 April 2019, *M. Wolanin* (003579, 003582 UR).

Notes. Species distinguished by dark green leaves with side lobes narrowly triangle and bent downwards, outer phyllaries relatively wide, greyish-purple, narrowly bordered, and often a fully flowering capitulum partly-opening and dark yellow. Species morphologically variable; in specimens found in very dry, rocky habitats, the side lobes of the tripartite terminal lobe are very often positioned upwards, which often helps in their identification (Figs 13, 14).

3. *Taraxacum cristatum* Kirschner, Štěpánek &Vašut, Preslia 77: 204. 2005.

[*T. cristatum* Kirschner & Štěpánek, nomen, in Chán et al. 2001: 151 et in Kirschner et al. 2002: 692].

Type. Slovaciamerid.-orientalis, opp. Rožňava, pagus Krásnohorské Podhradie (Krasznahorkaváralja): in graminosis siccis prope viam ad ruinam castelli Krásna Hôrka, 1 May 2004, *R.J. Vašut*, *M. Vašutová* (holotype in PRA; isotypes in OL, PRC, herbarium R. J. Vašut).

Description. Plants usually small, 5–10 cm tall. ***Leaves*** (pale) green, almost glabrous, approximately (3–)5–10 cm long and (1–)2–2.5(–3.5) cm wide, usually 4–5 times longer than wide, blades eliptical or oblanceolate, with 3–4 pairs of lateral lobes; lateral lobes mostly opposite; lateral lobes of the inner leaves narrowly triangular, falcate, with a dentate, convex distal margin, proximal margin entire or with a few teeth; lateral lobes of the outer leaves triangular, entire or somewhat denticulate at the distal margin; interlobes narrow and long, undulate or denticulate, often dark maculate; terminal lobe of the inner leaves prolate, lingulate and denticulate at the base; terminal lobe of the outer leaves triangular, prolate, undulate at the base; petioles unwinged, reddish-purple, almost glabrous. ***Scapes*** as long as or slightly longer than leaves, almost glabrous or with few barely visible hairs. ***Capitulum*** convex, 2–2.5 cm in diameter, yellow, outer strips greyish-brown-purple; inner bracts greyish-green, often suffused with purple at the ends, corniculate; outer bracts usually 9–11, lanceolate, usually 6–8 mm long, 1.5–2 mm broad, pale green, suffused pale red-purple, with a white hyaline margin (0.05–0.1 mm broad), recurved and corniculate; stigmas olive-greyish, pollen present. ***Achenes*** purplish-brown, with thin spinules in the upper part, 3.5–4.0 mm long (incl. the 0.8–1.1(–1.3) mm long, narrowly conical pyramid), rostrum 5.5–7.1 mm long, pappus white.

Figure 15. Variation in leaf shape in *T. cristatum*; locality – Grząby Bolmińskie (*M. Wolanin* 2016 UR). Scale bar: 5 cm.

Flowering period. April (May).

Habitat. In Bogucin and Grząby Bolmińskie we noted this species on field roads and paths among overgrown calcareous rock grasslands; in Przewodziszowice (Kraków-Częstochowa Upland) on the sandy dry roadside. In plant communities accompanied by *T. cristatum* we noted the species characteristic to the *Festuco-Brometea*, *Molinio-Arrhenatheretea*, *Sedo-Scleranthetea* and *Trifolio-Geranietea sanguinei* classes. In the largest population of this species (Kraków-Czestochowa Upland, Bogucin place), it grew together with *Achillea millefolium*, *Arrhenatherum elatius*, *Asperula cynanchica*, *Carex hirta*, *C. praecox*, *C. spicata*, *Cerastium arvense*, *C. semidecandrum*, *Convolvulus arvensis*, *Coronilla varia*, *Dianthus cartusianorum*, *Erysimum odoratum*, *Euphorbia cyparissias*, *Festuca rubra*, *Fragaria vesca*, *Hypericum perforatum*, *Knautia arvensis*, *Libanotis pyrenaica*, *Lotus corniculatus*, *Medicago falcata*, *Phleum phleoides*, *Pilosella officinarum*, *Plantago lanceolata*, *Poa compressa*, *P. pratensis*, *Potentilla arenaria*, *Ranunculus bulbosus*, *Sanguisorba minor*, *Scabiosa ochroleuca*, *Sedum acre*, *Silene nutans*, *Thymus pulegioides*, *Trifolium repens*, *Veronica chamaedrys*, *Viola tricolor*.

Somatic chromosome number. 24 (Wolanin and Musiał 2017).

General distribution. Central European species, reported in Austria, the Czech Republic, Poland, Slovakia and Hungary (Vašut et al. 2005).

Distribution in Poland. Species very rare, found so far in Lesser and Greater Poland (Fig. 10C).

Specimens examined. CD40 – Książ Wielkopolski, false acacia forest in N part of town, "Torfica", 2000, *A. Czarna* (POZNB); **DF05** – Przewodziszowice, dry roadside, 50°38'23"N, 19°23'24"E, 12 April 2016, *M. Wolanin* (003543, 003580 UR); **DF37** – Bogucin Mały, grassland on calcareous rock outcrop, SW exposition, 50°18'29"N, 19°34'16"E, 12 April 2014, *M. Wolanin* (003292 UR); **EE82** – Grząby Bolmińskie, field road, 50°48'46"N, 20°21'44"E, 22 April 2016, *M. Wolanin* (003305 UR).

Figure 16. *Taraxacum cristatum*; locality – Grząby Bolmińskie, 2016, photo by M. Wolanin.

Notes. Species belonging to the *Scanicum* group, similar to the rest of the species from this group, with an asymmetrically incised terminal lobe. However, compared to *T. bellicum* and *T. scanicum*, the terminal lobe in *T. cristatum* is much more denticulate, as is the distal margin of the side lobes. *T. cristatum* may sometimes closely resemble *T. plumbeum* (especially individuals of *T. plumbeum* growing in extremely dry, rocky habitats), but it differs from it in its purple-brown achenes and lower number of pairs of side lobes (3–4) (Figs 15, 16).

4. ***Taraxacum danubium*** A. J. Richards, Acta Fac. Rerum Nat. Univ. Comen., Bot. 18: 108. 1970.

≡ *Taraxacum austriacum* var. *danubium* (A. J. Richards) Doll, Feddes Repert. 84: 21. 1973.

Type. Slovakia, Devínská Kobyla u Bratislavy, 1 May 1968, *A. J. Richards* (holotype in OXF).

Description. Plants usually small, up to 10(–12) cm tall. ***Leaves*** greyish-green, dull, sparsely hairy, approximately 3–5(–7) cm long and (1–)1.5–2.5 cm wide, usually 3–4 times longer than wide, blades oblanceolate, usually broadest in upper 1/3, with 3–4 pairs of lateral lobes; lateral lobes opposite to remote; lateral lobes of the inner leaves patent, with a wide abruptly narrowed base and generally slightly widening at the apex, entire or with a few small teeth at the margin; lateral lobes of the outer leaves recurved and obtuse at the apex, entire or occasionally with a few small teeth at the margin; interlobes often with teeth; terminal lobe of the inner leaves triangular, often with a distinct short and obtuse tip; terminal lobe of the outer leaves triangular, obtuse; petioles narrowly winged, pale purplish. ***Scapes*** as long as or slightly longer than leaves, reddish-purplish, sparsely hairy in the upper part. ***Capitulum*** convex, yellow, 2–3 cm in diameter, ligules with greyish brown-red stripes; inner bracts greyish-green, corniculate; outer bracts usually 10–14, lanceolate, usually 4–6 mm long, 1.5–2.5 mm broad, greyish-green, quite often suffused purple, with a white hyaline margin 0.1(–0.2) mm broad, regularly spreading to quite regularly arranged and recurved, 4–6 mm long, 1.5–2.5 mm broad, corniculate; stigmas greyish-green, pollen present. ***Achenes*** dark brown-red, achene body densely spinulose above, 3.3–3.8 mm long (incl. the 0.7–1.0 mm long, narrowly conical cone).

Flowering period. April (May).

Habitat. In Poland, this species was observed only in grasslands and crevices of calcareous rocks. Plant communities associated with *T. danubium* were dominated by species characteristic to the *Sedo-Scleranthetea* and *Festuco-Brometea* classes. In Kraków-Częstochowa Upland (Olsztyn place) it was noted as growing together with *Allium montanum*, *Anthyllis vulneraria*, *Arabis hirsuta*, *Arrhenatherum elatius*, *Artemisia campestris*, *Asperula cynanchica*, *Briza media*, *Carex caryophyllea*, *Centaurea stoebe*, *Cerastium arvense*, *C. semidecandrum*, *Coronilla varia*, *Dactylis glomerata*, *Dianthus carthusianorum*, *Erysimum odoratum*, *Euphorbia cyparissias*, *Fragaria viridis*, *Galium mollugo*, *Helianthemum nummularium* subsp. *obscurum*, *Juniperus communis*, *Luzula campestris*, *Medicago falcata*, *Phleum phleoides*, *Pilosella officinarum*, *Plantago lanceolata*, *P. media*, *Poa compressa*, *P. pratensis*, *Polygala comosa*, *Potentilla arenaria*, *Ranunculus bulbosus*, *Rhamnus cathartica*, *Sanguisorba minor*, *Scabiosa ochroleuca*, *Sedum acre*, *S. sexangulare*, *Silene nutans*, *S. vulgaris*, *Thymus pulegioides*, *Veronica spicata*, *Vincetoxicum hirundinaria*.

Somatic chromosome number. 24 (Wolanin and Musiał 2018).

General distribution. Central European species reported in the Czech Republic, Hungary, Austria, Slovakia, North-Eastern Germany and Poland (Uhlemann 2003; Trávníček et al. 2010; Wolanin and Musiał 2018; Štěpánek and Kirschner 2023).

Distribution in Poland. Very rare, so far only found in the western part of Lesser Poland (Fig. 10D).

Specimens examined. DE84 – Olsztyn, rock close to castle, 50°44'59"N, 19°16'47"E, 13 April 2014, *M. Wolanin* (003453); **DE94** – Góra Sfinks, grassland on rock, 50°44'15"N, 19°16'17"E, 12 April 2016, *M. Wolanin* (003483 UR); **DF06** – Mirów, grassland below castle (S slope), 50°36'50"N, 19°28'30"E, 14 April 2014, *M. Wolanin* (003469 UR); **DF68** – between Kryspinów and Bielanany, limestone hill, 16 May 1976, *H.*, *T.* & *J. Tacik* (387573 KRAM); **DF69** – Kostrze (Kraków), grassland on rock, 50°02'19"N, 19°52'09"E, 19 April 2015, *M. Wolanin* (003460 UR); Pychowicka Górka, grassland on rock, 50°01'50"N, 19°53'00"E,

Figure 17. Variation in leaf shape in *T. danubium*; locality – Olsztyn (*M. Wolanin* 2016 UR). Scale bar: 5 cm.

29 April 2013, *M. Wolanin* (003464 UR); Pychowicka Górka, grassland on rock, 50°01'53"N, 19°52'48"E, 29 April 2013, *M. Wolanin* (003445 UR); Skały Twardowskiego, grassland on rock, 50°02'27"N, 19°54'15"E, 29 April 2013, *M. Wolanin* (003448 UR); Kostrze near Kraków, 27 April 1954, *W. Kurek*, *A. Jasiewicz* (439049 KRAM); Las Wolski, Przegorzały, calcareous rocks, 4 May 1954, *T. Tacik* (439037 KRAM); between Skotniki and Pychowice in the vicinity of Kraków, on dry hills, 22 May 1938, *J. Lilop* (036160, 036161 KRAM); on the Kostrze–Pychowice route, dry limestone hills, 27 April 1957, *H. Trzcińska-Tacik* (0378960 KRA); Pychowice near Kraków, calcareous rocks, 27 April 1954, *A. Jasiewicz* (155140 KRA); Pychowice, pasture, 23 April 1951, *K. Szczepanek* (111697 KRA); Pychowice, hillock, *J. Staszkiewicz* (407038 KRAM); behind Pychowice, limestone hillocks, 8 May 1953, *T. Tacik* (387179, 387571 KRAM); **DF78** – Podgórki Tynieckie, hill above water hole, 29 May 1975, *T. Tacik* (387181, 387182 KRAM); Podgórki Tynieckie, limestone hillock, 27 April 1951, *T. Tacik* (387180 KRAM); Tyniec, hillock, 14 May 1967, *J. Błaszczak* (063403 KRA).

Notes. Species quite small, with sparsely hairy and dull leaves, usually narrow interlobes and side lobes patent or slightly bent, often a little bloated near the ends. Juvenile specimens of *T. danubium* often have poorly split leaves in the upper part, which makes them similar to *T. parnassicum*, but due to the presence of pollen, the leaves of *T. danubium* are hairy and its outer phyllaries longer and wider,

Figure 18. *Taraxacum danubium*; locality – Olsztyn, 2016, photo by M. Wolanin.

and therefore these two species can be easily distinguished. In the populations of *T. danubium* observed in Poland, the vast majority were young individuals with small rosettes with leaves shaped similarly to the external leaves of several-year-old specimens (Figs 17, 18).

5. ***Taraxacum disseminatum*** **G.E.Haglund, Svensk Bot. Tidskr. 41: 85. 1947.**

Type. Sweden, Göteborg, 9 May 1943, *T. A. Borgvall* (holotype in S).

Description. Plants middle to quite large-sized, 5–15(–20) cm tall. ***Leaves*** greyish-green, sparsely hairy on the upper side, approximately (5–)7–12(–15) cm long and (1.5)2–3(–4.0) cm wide, usually 3–4 times longer than wide, blades elliptical to oblanceolate, with 3–4(–6) pairs of lateral lobes; lateral lobes opposite to remote; lateral lobes of the inner leaves triangular, broad at the base, with a convex, strongly dentate and often incised distal margin, proximal margin usually entire or with a few teeth; lateral lobes of the outer leaves triangular, uniform, broad and short, with strong teeth at often incised and convex distal margin, proximal margin usually entire and slightly concave; interlobes narrow; terminal lobe of the inner leaves triangular, somewhat elongate, sometimes lingulate, denticulate on the upper margins; terminal lobe of the outer leaves triangular, subacute, entire or with a large tooth on the upper margins; petioles unwinged, purple. ***Scapes*** as long as or longer than leaves, sparsely hairy, especially under the capitulum, their lower parts usually purple in colour. ***Capitulum*** convex, 2.5–4.0 cm in diameter, yellow, medium dense, outer strips grey-purple; inner bracts dark grey-green, pruinose; outer bracts usually 9–12, lanceolate, usually 6–10 mm long, 2–3.5 mm broad, grey-green, with a distinct white hyaline margin (0.1–0.3 mm broad), arcuate-reflexed, without or with a small corniculum; stigmas dark, greyish-green, pollen present. ***Achenes*** red-brown, with thin and long spinules in the upper part, 3.5–4.2 mm long (incl. the 1.0–1.4 mm long, cylindrical pyramid), rostrum 7–9 mm long, pappus white.

Flowering period. April–May.

Habitat. Mostly sunny, termophilic-ruderal places such as roadsides, pastures, forest edges and paths. In Wielkopolska Lowland (Chwałkowo Kościelne) we noted this species at the edge of a pine-oak grove accompanied by *Adoxa moschatellina*, *Capsella bursa-pastoris*, *Geranium pusillum*, *Stellaria media*, *Taraxacum proximum*, *Veronica hederifolia* s.l. In Podlachia (Piątnica) we found this species in a pastured dry sandy grassland together with *Achillea millefolium*, *Artemisia campestris*, *Cerastium semidecandrum*, *Echium vulgare*, *Festuca rubra*, *Galium mollugo*, *Pimpinella saxifraga*, *Plantago media*, *Potentilla arenaria*, *P. argentea*, *Salvia verticillata*, *Sedum acre*, *Taraxacum bellicum*, *Trifolium repens*.

Somatic chromosome number. 24 (Wolanin and Musiał 2017).

General distribution. Central, Western and Northern Europe species, reported from France, Switzerland, Austria, Germany, the Netherlands, Denmark, the Czech Republic, Poland, Finland, Norway, Sweden and Hungary (Van Soest 1967, 1969; Doll 1973b; Tacik 1980; Kerguélen 1993; Lundevall and Øllgaard 1999; Uhlemann 2003; Głowacki et al. 2004; Trávníček et al. 2010; Wendt and Øllgaard 2015). This species is probably not native to Great Britain (Sell and Murrell 2006; EURO+MED 2006-onwards).

Distribution in Poland. Scattered localities, rare (Fig. 10E).

Specimens examined. AB23 – Międzyzdroje, lawn, 53°56'10"N, 14°27'24"E, 30 April 2017, *M. Wolanin* (003261 UR), **BD43** – Kebłowo, ruderal area near cemetery fence, 52°03'06"N, 16°06'34"E, 19 April 2016, *M. Wolanin* (003326 UR); **CD41** –

Chwałkowo Kościelne, roadside in forest, 51°59'41"N, 17°18'12"E, 16 April 2016, *M. Wolanin* (003327 UR); **CF11** – Nysa (Śląsk), May 1849, *M. Winkler* (WRSL); **DA81** – Gdańsk (Stogi), roadside in forest, 54°22'15"N, 18°43'06"E, 7 May 2016, *M. Wolanin*

Figure 19. Variation in leaf shape in *T. disseminatum*; locality – Chwałkowo Kościelne (*M. Wolanin* 2016 UR). Scale bar: 5 cm.

(003313 UR); **DC41** – Sąsieczno, pine forest edge, 52°57'03"N, 18°50'38"E; 29 April 2018, *M. Wolanin* (003471 UR); **DC52** – between Wakole and Dąbrówka, roadside in pine forest, 52°51'40"N, 18°58'09"E, 29 April 2018, *M. Wolanin* (003450 UR); **DF06** – Czarny Kamień near Moczydło, distr. Żarki, 29 May 1976, *A. Sendek* (12513 KTU); **DF45** – Sosnowiec Maczki, roadside at pine forest edge, 50°15'34"N, 19°17'07"E, 2 May 2016, *M. Wolanin* (003300 UR); **DF58** – Bolechowice, below calcareous rock, 21 May 1976, *T. Tacik* (575895 KRAM); **FC13** – Piątnica (Fort Łomża), pastured grassland, 53°11'50"N, 22°06'53"E, 25 April 2016, *M. Wolanin* (003274, 003287, 003567 UR).

Notes. Plant quite large with a medium dense capitulum (particularly visible in the peripheral part of the inflorescence) up to 4 cm in diameter. Leaves broad with a rather large triangular terminal lobe. The terminal lobe edge is strongly lobed and serrated in the base part. Outer bracts with significant wide hyaline margin. Species distinct and easy to recognise, although not very common, and usually populations are not numerous (Figs 19, 20).

Figure 20. *Taraxacum disseminatum*; locality – Chwałkowo Kościelne, 2016, photo by M. Wolanin.

6. *Taraxacum dissimile* Dahlst., Ark. Bot. 10(11): 8. 1911.

Type. Sweden, Gothenburg archipelago, Branno, seashore, 19 May 1910, *Th. Lange* (lectotype in TURA [sheet No. I, middle specimen], designated by Lundevall and Øllgaard 1999: 78; isolectotype in TURA [sheets No. 2 and 3]).

Description. Plants small to middle-sized, 5–12 cm tall. ***Leaves*** greyish-green, sparsely hairy on the upper side, approximately 5–10(–12) cm long and (1–)2.0–3.0(–4.0) cm wide, usually 4–5 times longer than wide, blades oblanceolate, usually broadest in upper 1/4, with 3–4 pairs of lateral lobes; lateral lobes opposite to remote; lateral lobes of the inner leaves triangular, straight or a little recurved, broad at the base, with an entire or slightly denticulate, straight or somewhat convex distal margin, proximal margin usually entire; lateral lobes of the outer leaves triangular, entire or somewhat denticulate at the distal margin; interlobes usually winged and flat, sometimes crisped, green or blackish coloured; terminal lobe distinct, triangular, often incised, entire or denticulate on the upper sides; petioles unwinged, purple. ***Scapes*** as long as or shorter than leaves, sparsely hairy below the capitulum. ***Capitulum*** convex, 3.0–3.5 cm in diameter, yellow, medium dense, outer strips greyish-red; inner bracts dark green, somewhat pruinose; outer bracts usually 12–16, lanceolate, usually 7–8 mm long, 2.5–3.5 mm broad, grey-green suffused pruinose, with a distinct white hyaline margin (0.2–0.5 mm broad), recurved and corniculate; stigmas blackish, pollen absent or very poorly developed (up to a few grains on the stigma). ***Achenes*** yellowish-greyish-brown, 3.6–4.2 mm long (incl. the 0.9–1.2 mm long, cylindrical cone), rostrum 8–9 mm long, pappus white.

Flowering period. (April) May.

Habitat. Species observed in dry, sandy, semiruderal places such as pastures, lawns and forest road edges. On the coast of the Baltic Sea (between Krynica Morska and Piaski), we noted this species on the forest roadside together with *Achillea millefolium*, *Arabidopsis thaliana*, *Carex ovalis*, *C. praecox*, *Cerastium holosteoides*, *C. semidecandrum*, *Equisetum arvense*, *Erophila verna*, *Festuca rubra*, *Luzula campestris*, *Plantago lanceolata*, *Poa pratensis*, *Potentilla argentea*, *Ranunculus bulbosus*, *Veronica arvensis*, *Vicia lathyroides*.

Somatic chromosome number. 24 (Wolanin and Musiał 2017).

General distribution. Central, North and East Europe; species reported in Germany, the Netherlands, Denmark, Poland, Norway, Sweden, Finland, Ukraine, Belarus, Lithuania, Latvia, Estonia, Central and Northwest European Russia (Van Soest 1967; Tutin et al. 1976; Fedorov 1989; Lundevall and Øllgaard 1999; Mosyakin and Fedoronchuk 1999; Øllgaard et al. 2000; Wendt and Øllgaard 2015). This species is probably not native to Belgium (Lambinon et al. 2004; EURO+MED 2006-onwards).

Distribution in Poland. Scattered localities in north-eastern Poland, quite rare (Fig. 10F).

Specimens examined. CA43 – Łeba, dry lawn, 54°46'05"N, 17°35'28"E, 3 May 2019, *M. Wolanin* (003572 UR); Łeba, dune, 54°46'05"N, 17°34'05"E, 1 May 2017, *M. Wolanin* (003265, 003278 UR); **DA51** – Hel, Leśna street, lawn, 54°36'05"N, 18°49'16"E, 9 May 2016, *M. Wolanin* (003324 UR); **DA76** – Piaski, sandy roadside, 54°25'12"N, 19°34'04"E, 10 May 2016, *M. Wolanin* (003307 UR); **DA86** – between Krynica Morska and Piaski, sandy roadside in forest, 54°24'21"N, 19°31'44"E, 10 May

2016, *M. Wolanin* (003281 UR); **DC32** – vicinity of the village Golub-Dobrzyń, roadside near Okonin lake, 53°04'27"N, 18°57'40"E, 29 April 2018, *M. Wolanin* (003477 UR); **DC52** – between Wakole and Dąbrówka, roadside in pine forest, 52°51'40"N, 18°58'09"E, 29 April 2018, *M. Wolanin* (003447 UR); **FB77** – Osowiec, dry pasture close to fort, 53°29'25"N, 22°38'32"E, 24 April 2016, *M. Wolanin* (003255, 003268 UR); **FC13** – Stara Łomża, roadside, 17 May 1998, *Z. Głowacki* (527696 KRAM); **GD10** – Serpelice, lawn, 52°16'49"N, 23°03'01"E, 25 April 2016, *M. Wolanin* (003294 UR).

Notes. This species belongs to the *Dissimilia* group due to its yellowish-greyish-brown achenes, sharply outlined, triangular-sagittate and incised terminal lobe. Outer phyllaries are large, grey-green, pruinose with a wide hyaline border. The plant is dark in colour with dark stigmas and quite bright outer phyllaries, which makes it conspicuous in the field. Pollen is not present (Figs 21, 22).

Figure 21. Variation in leaf shape in *T. dissimile*; locality – between Krynica Morska and Piaski (*M. Wolanin* 2016 UR). Scale bar: 5 cm.

Figure 22. *Taraxacum dissimile*; locality – Osowiec, 2016, photo by M. Wolanin.

7. *Taraxacum lacistophyllum* (Dahlst.) Raunk., Dansk Exkurs.-Fl., ed. 2: 257. 1906.

Taraxacum erythrospermum subsp. *lacistophyllum* Dahlst., Bot. Not., 1905: 153, 168. 1905. Basionym.

Type. Sweden, Ostergotland, Linkoping, Magistratshagcn, 4 June 1889, *H. Dahlstedt* (lectotype in S [bottom specimen], designated by Lundevall and Øllgaard 1999: 81; isolectotype in S).

Description. Plants small to middle-sized, 10–15(–20) cm tall. ***Leaves*** greyish-green, almost glabrous or with few barely visible hairs, approximately (5–)8–12(–15) cm long and (1.5–)2.0–3.0(–4.0) cm wide, usually 3–5 times longer than wide, blades elliptical, with 4–6 pairs of lateral lobes; lateral lobes opposite to remote; lateral lobes of the inner leaves patent and falcate, with a mostly entire or (at lower-positioned lobes) slightly denticulate distal margin, proximal margin usually entire; lateral lobes of the outer leaves triangular, with a mostly entire, convex distal margin; interlobes often crisped; terminal lobe of the inner leaves tripartite, subsagittate, with a somewhat elongated apex, mostly entire at the margins; terminal lobe of the outer leaves triangular, subacute; petioles narrow, unwinged, purple. ***Scapes*** as long as or longer than leaves, somewhat hairy, especially just under the capitulum. ***Capitulum*** convex, 3.5–4.0 cm in diameter, light yellow, outer strips grey-purple; inner bracts dark, greyish-green, pruinose, corniculate; outer bracts usually 12–14, lanceolate, usually 7–9 mm long, 2–2.5 mm broad, greyish-green/violet, pruinose with a white hyaline margin (0.05–0.1 mm broad), spreading-arcuate and corniculate; stigmas greyish-green, pollen present. ***Achenes*** brown-red, with long spinules in the upper part, (3.5–)3.8–4.1(–4.3) mm long (incl. the 0.7–1.0(–1.2) mm long, cylindrical cone), rostrum 6–8 mm long, pappus white.

Flowering period. April–May.

Habitat. Species most often found in semiruderal locations, such as sandy and sunny edges of pine forests, paths, cliffs; less often in ruderal habitats (concrete promenades, walls). On the coast of the Baltic Sea (Gdańsk) we noted this species on the edge of a sandy forest road, accompanied by *Achillea millefolium*, *Agrostis capillaris*, *Alliaria petiolata*, *Anthriscus sylvestris*, *Artemisia vulgaris*, *Berteroa incana*, *Hypericum maculatum*, *Melandrium album*, *Plantago major*, *Potentilla argentea*, *Tanacetum vulgare*, *Tragopogon pratensis*.

Somatic chromosome number. 24 (Wolanin and Musiał 2017), 25 (Małecka 1969).

General distribution. Central, Western and Northern Europe. Species reported from Portugal, Spain, France, Great Britain, Ireland, Corsica, Italy, Switzerland, Belgium, the Netherlands, Denmark, Germany, the Czech Republic, Hungary, Norway, Sweden, Finland, Poland, Latvia and Lithuania (Van Soest 1957, 1967; Doll 1973b; Tacik 1980; Fedorov 1989; Richards 1992; Dudman and Richards 1997; Lundevall and Øllgaard 1999; Uhlemann 2003; Trávníček et al. 2010; Wendt and Øllgaard 2015).

Distribution in Poland. Species noted only in Pomerania, chiefly on the coast of the Baltic Sea (Fig. 23A).

Specimens examined. AB47 – vicinity of Unibórz, roadside ditch edge (edge of pine forest), 53°48'49"N, 15°04'53"E, 30 April 2017, *M. Wolanin* (003417 UR); **AC32** – vicinity of Chojna, roadside, 17 May 2015, *B. Kurnicki* (SZUB); **BA76** – Darłówkowo, pine forest edge, 54°26'32"N, 16°23'22"E, 1 May 2017, *M. Wolanin* (003401 UR); **CA38** – Jastrzębia Góra, lawn, 54°49'52"N, 18°17'42"E, 9 May 2016, *M. Wolanin* (003400 UR); Rozewie, sandy roadside close to lighthouse, 54°49'49"N, 18°19'57"E, 9 May 2016, *M. Wolanin* (003262 UR); 1,5 km E of Rozewie, cliff, 30 May 1969, Stasiak (152/03 UGDA); W of Chłapowska Valley outlet, loose scrubs of Hippophae, 25 June 1970, *W. Chojnacki* (153/04 UGDA); **CA39** – Władysławowo, lawn close to parking lot in forest, 54°47'19"N, 18°25'40"E, 9 May 2016, *M. Wolanin* (003301 UR); **CA43** – Łeba, dry lawn near amusement park, 54°46'05"N, 17°35'28"E, 3 May 2019, *M. Wolanin* (003574 UR); Łeba, clearing in pine forest, 54°45'49"N, 17°32'31"E, 2 May 2019, *M. Wolanin* (003577 UR); **DA40** – Jastrania, grassy path near parking lot in forest, 54°42'49"N, 18°38'15"E, 9 May 2016, *M. Wolanin* (003354 UR); **DA51** – Hel, Leśna street, sandy roadside in forest, 54°36'08"N, 18°48'55"E, 9 May 2016, *M. Wolanin* (003330 UR); Hel, Leśna street, pine scrub edge, 54°36'09"N, 18°48'49"E, 9 May 2016, *M. Wolanin* (003382 UR); Hel, meadow close to weather station, 8 May 1997, *K. Błaszkiewicz* (058185, 058190 KTU); Hel, dunes close to

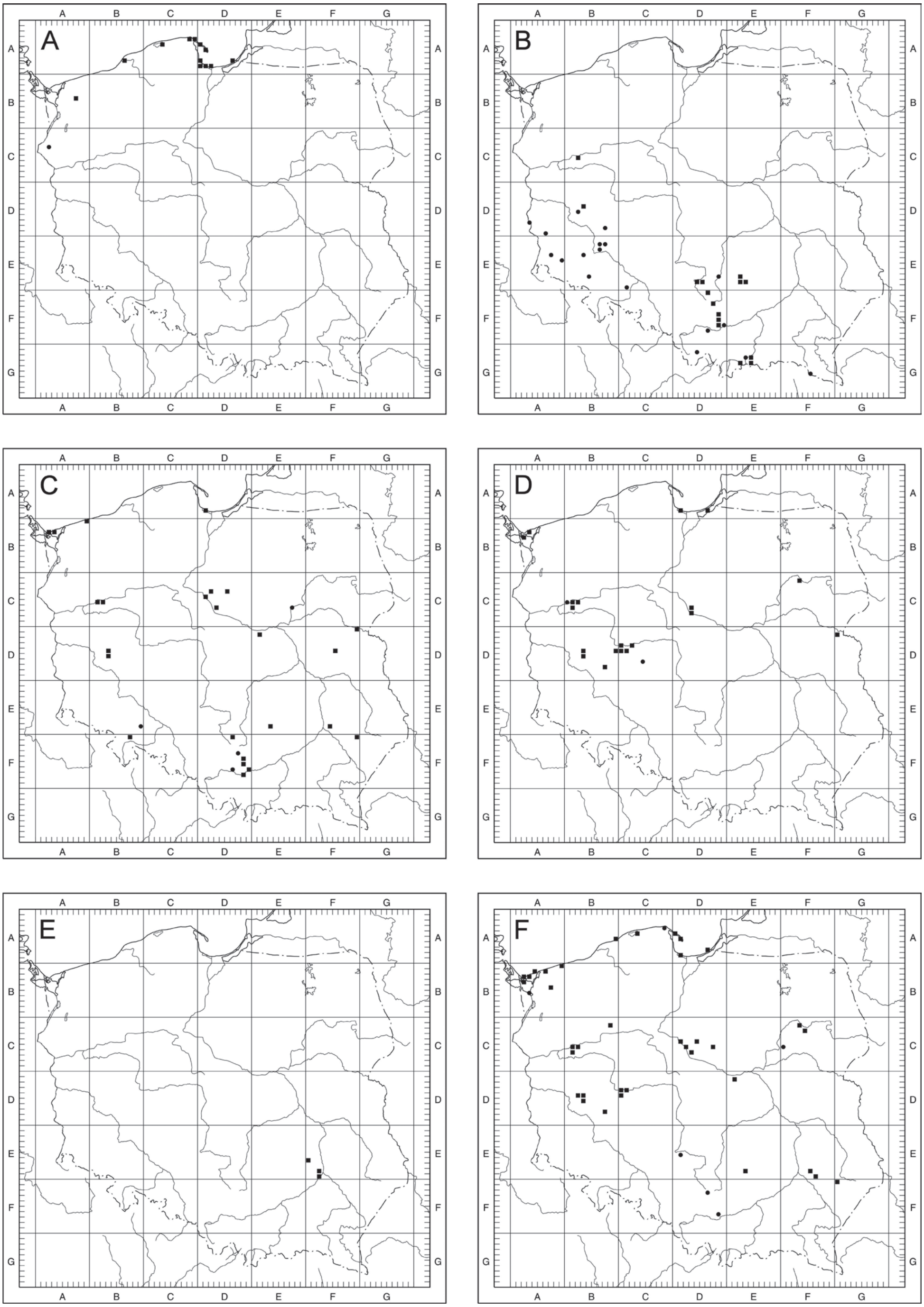

Figure 23. Distribution maps of *Taraxacum* sect. *Erythrosperma* in Poland **A** *T. lacistophyllum* **B** *T. parnassicum* **C** *T. plumbeum* **D** *T. proximum* **E** *T. sandomiriense* **F** *T. scanicum*; black square – localities recorded during field studies, black circle – other localities known from herbarium data.

Figure 24. Variation in leaf shape in *T. lacistophyllum*; locality – Jastrania (*M. Wolanin* 2016 UR). Scale bar: 5 cm.

weather station, 8 May 1997, *H. Øllgaard* (527654 KRAM); **DA70** – Sopot, fissure in stone wall along promenade, 54°27'24"N, 18°33'44"E, 8 May 2016, *M. Wolanin* (003318 UR); Sopot, neglected lawn in park, 54°27'08"N, 18°33'49"E, 8 May 2016, *M. Wolanin* (003386 UR); **DA76** – Piaski, sandy roadside, 54°25'11"N, 19°34'00"E,

Figure 25. *Taraxacum lacistophyllum*; locality – Hel, 2016, photo by M. Wolanin.

10 May 2016, *M. Wolanin* (003373 UR); **DA80** – Gdańsk (Roland pleasure ground), lawn on sandy soil, 54°24'45"N, 18°36'17"E, 8 May 2016, *M. Wolanin* (003328, 003329 UR); Gdańsk (Roland pleasure ground), lawn on sandy soil, 54°24'44"N, 18°36'28"E, 8 May 2016, *M. Wolanin* (003314 UR); Gdańsk (Westerplatte), gap in pavement, 54°24'23"N, 18°40'34"E, 7 May 2016, *M. Wolanin* (003372, 003398

UR); **DA81** – Gdańsk Stogi, along path in light pine forest, 54°22'24"N, 18°43'37"E, 7 May 2016, *M. Wolanin* (003288 UR); **DA82** – Świbno, sandy roadside in forest, 54°20'16"N, 18°56'12"E, 10 May 2016, *M. Wolanin* (003275, 003355 UR).

Notes. Plant charming, gentle, with tasteful capitulum up to 4 cm in diameter, light yellow ligules, outer bracts spreading-arcuate, greyish-green/violet, pruinose. Leaves regularly lobed, side lobes most often falcate and interlobes often crisped. Species easy to recognise (morphological features of the leaves are highly visible, even for specimens growing in unusual places) (Figs 24, 25).

8. *Taraxacum parnassicum* Dahlst., Acta Horti Berg. 9: 29. 1926.

= *Taraxacum silesiacum* Dahlst. ex G. E. Hagl., Bot. Not. 500. 1938. Type: Poland, Slask (Silesia, Schlesien), Legnica (Liegnitz), (Callier, Fl. Sielesiaca Exsicc. No. 1224) – cult. in Sweden, Stockholm, bergian Bot. Garden 6, 3 June 1904, *H. Dahlstedt* (holotype in S; isotype in S).

Type. Greece, Parnassos 1921 G. Samuelson – cult. In Hort. Bot. Upsaliensis, 22 May 1924, *G. Samuelson* (lectotype S, designated by Lundevall and Øllgaard 1999: 125; isolectotypes in S and BM).

Description. Plants small, up to 5–10 cm tall. ***Leaves*** pure green, almost glabrous, approximately 3–5(–8) cm long and 1–2 cm wide, usually 3–4(–5) times longer than wide, blades oblanceolate to narrowly oblanceolate, usually broadest in upper 1/3, with 4–5(–7) pairs of lateral lobes; lateral lobes mostly opposite (to remote); lateral lobes of the inner leaves triangular, slightly recurved, with a somewhat convex, entire or barely toothed distal margin, proximal margin usually entire; lateral lobes of the outer leaves triangular, crowded, entire or with a few teeth at the distal margin; interlobes often narrow, with a solitary tooth; terminal lobe of the inner leaves tripartite, with a short subacute tip, entire on the margins; terminal lobe of the outer leaves triangular; petioles unwinged, purple. ***Scapes*** as long as or shorter than leaves, somewhat hairy, especially under the involucres. ***Capitulum*** flat or convex, dense, 2.0–2.5 cm in diameter, light yellow, outer strips purple; inner bracts green, pruinose, corniculate; outer bracts usually 9–12, ovate to wide lanceolate, usually 5–6 mm long, 1.5–2.5 mm broad, greyish-green, suffused purple, with a white hyaline margin (0.1–0.2 mm broad), erect at the base, recurved at apex, somewhat corniculate; stigmas dark, greyish-green, pollen absent or very poorly developed (up to a few grains on the stigma). ***Achenes*** brown-red, with relatively short spinules in the upper part, (3–)3.5–4.1(–4.3) mm long (incl. the 0.7–1.1 mm long, cylindrical or slightly conical cone), rostrum 5–8.5 mm long, pappus white.

Flowering period. April–May.

Habitat. In the south of Poland, *T. parnassicum* usually grows in thermophilic grasslands on limestone rocks (most often in trampled or eroded places) and in rock crevices. In the north, this species was recorded in sandy grasslands and on a dry lawn.

Plant communities with the participation of *T. parnassicum* are dominated by species characteristic to the *Festuco-Brometea*, *Molinio-Arrhenatheretea*, *Sedo-Scleranthetea* and *Trifolio-Geranietea sanguinei* classes. In Kraków-Częstochowa Upland (Kusięta) we observed this species in a grassland on limestone rocks together with *Alyssum alyssoides*, *Arenaria serpyllifolia*, *Arrhenatherum elatius*, *Artemisia campestris*, *Asperula cynanchica*, *Carex caryophyllea*, *Centaurea stoebe*, *Cerastium arvense*, *C. semidecandrum*, *Convolvulus arvensis*, *Coronilla varia*, *Erophila verna*, *Euphorbia cyparissias*, *Festuca rubra*, *Helianthemum nummularium* subsp. *obscurum*, *Hypericum maculatum*, *Medicago falcata*, *Papaver argemone*, *Phleum phleoides*, *Plantago lanceolata*, *P. media*, *Poa pratensis*, *Potentilla arenaria*, *Ranunculus bulbosus*, *Sanguisorba minor*, *Silene nutans*, *S. vulgaris*, *Stachys recta*, *Teucrium botrys*, *Thymus pulegioides*, *Trifolium montanum*, *Veronica arvensis*, *V. spicata*, *Vincetoxicum hirundinaria*. In Pieniny Mts (Jaworki) we noted this species in a pastured rock grassland accompanied by *Acinos arvensis*, *Agrostis capillaris*, *Alchemilla glaucescens*, *Anthyllis vulneraria*, *Arabis hirsuta*, *Arenaria serpyllifolia*, *Botrychium lunaria*, *Briza media*, *Bupleurum falcatum*, *Calamagrostis varia*, *Carex flacca*, *C. transsilvanica*, *Cerastium holosteoides*, *Cotoneaster integerrimus*, *Cruciata glabra*, *Euphorbia cyparissias*, *Festuca pallens*, *F. pratensis*, *Fragaria vesca*, *Galium mollugo*, *Hypericum perforatum*, *Jovibarba sobolifera*, *Leontodon hispidus*, *Leucanthemum vulgare*, *Medicago falcata*, *M. lupulina*, *Phleum pratense*, *Pilosella officinarum*, *Plantago media*, *Polygala comosa*, *Potentilla neumanniana*, *Ranunculus polyanthemos*, *Salvia verticillata*, *Sanguisorba minor*, *Sedum acre*, *Silene nutans*, *Thymus pulegioides*, *Verbascum nigrum*.

Somatic chromosome number. 24 (Wolanin and Musiał 2017), 26 (Małecka 1969).

General distribution. Widespread European species reported in France, Ireland, Great Britain, Corsica, Italy, Switzerland, Belgium, the Netherlands, Germany, Denmark, Austria, Germany, the Czech Republic, Poland, Slovakia, Hungary, Ukraine, Romania, Bulgaria, Montenegro, Croatia, Greece and Macedonia. In Sweden, this plant is a naturalised alien (Rohlena 1942; Van Soest 1967; Doll 1973b; Tacik 1980; Gamisans 1985; Dostál 1989; Mosyakin and Fedoronchuk 1999; Uhlemann 2003; Conti et al. 2005; Trávníček et al. 2010; Dimopoulos et al. 2013; Wendt and Øllgaard 2015).

Distribution in Poland. Scattered localities in southern and western Poland, frequent only in the western part of Lesser Poland (Fig. 23B).

Specimens examined. AD73 – Zasieki distr. Lubsko, roadside, 28 July 1972, *E. Kozioł* (32319 WRSL); **AD96** – Iłowa Żagańska distr. Żary, sandy roadside, 10 June 1971, *E. Kozioł* (34605 WRSL); **AE37** – Nowogrodziec distr. Bolesławiec, railway embankment close to cement plant, 18 May 1972, *E. Kozioł* (WRSL 32322); Nowogrodziec distr. Bolesławiec, slope of railway embankment E of city, 18 May 1972, *E. Kozioł* (34556 WRSL); **AE49** – Lwówek Śl., sunny hill W of city, 3 May 1972 *E. Kozioł* (32323 WRSL); Lwówek Śląski, sunny hill, opposite school, 1 km W of city, 30 April 1972, *E. Kozioł* (35454 WRSL); **BC52** – Stare Bielice, sandy roadside of asphalt road, 52°50'57"N, 15°55'04"E, 18 April 2016, *M. Wolanin* (003322 UR); **BD43** – Kębłowo, cemetery lawn, 52°03'04"N, 16°06'41"E, 19 April 2016, *M. Wolanin* (003517 UR); **BD52** – Sterlicz near Sława Śl., sandy roadside, 10 June 1976, *E. Kozioł*

(WRSL); **BD87** – Bojanowo, green square, 10 June 1893, *C. Scholz* (WRSL); **BE16** – Gródek. Distr. Wołów, sandy hillock, 26 April 1972, *E. Kozioł* (211472 KRAM); **BE17** – Gródek near Strupina, sandy hillock, 3 May 1972, *E. Kozioł* (32321 WRSL); **BE26** – Grotki distr. Wołów, hillock on eastern edge of village, 15 May 1965, *Z. Głowacki* (31773 WRSL); **BE33** – Legnica, tournament place, 24 May 1895, *Callier* (WRSL); **BE74** – Świebodzice, 12 May 1955, (...) (281375 KRAM); **CE91** – Grodków, gravel pit, 3 May 1972, *E. Kozioł* (0388441, 0388442 KRA); **DE78** – Maluszyn, dry roadside, 27 April 2010, *M. Bielecki* (0396279 KRA); **DE84** – Kusięta, grassland on rock, 50°46'06"N, 19°16'16"E, 13 April 2014, *M. Wolanin* (003347 UR); Olsztyn, Góra Zamkowa, grassland on rock outcrop (NW slope), 50°44'55"N, 19°16'30"E, 13 April 2014, *M. Wolanin* (003297 UR); Olsztyn, grassland on rock, 50°44'55"N, 19°16'36"E, 12 April 2016, *M. Wolanin* (003487 UR); **DE85** – between Olsztyn and Przymiłowice, grassland on rock (SW exposure), 50°45'10"N, 19°17'05"E, 13 April 2014, *M. Wolanin* (003348 UR); **DF06** – Kroczyce, path on calcareous rocks, 50°34'20"N, 19°31'49"E, 12 April 2016, *M. Wolanin* (003502 UR); Kroczyce, path on SW slope, 50°34'20"N, 19°31'48"E, 1 May 2013, *M. Wolanin* (003277 UR); Mirów, grassland on rocks overgrown by shrubs, 50°36'53"N, 19°28'51"E, 1 May 2021, *M. Wolanin* (003597 UR); **DF27** – Żelazko, grassland on rock, SW slope, 50°25'14"N, 19°34'25"E, 12 April 2014, *M. Wolanin* (003349 UR); **DF48** – Gotkowice, xerothermic grassland, SW slope, 50°13'39"N, 19°43'31"E, 30 April 2013, *M. Wolanin* (003379 UR); Jerzmanowice, fissures on top of rock, 50°12'36"N, 19°45'19"E, 30 April 2013, *M. Wolanin* (003387 UR); Sąspów near Ojców, fissure in rock, near school, 50°13'21"N, 19°46'17"E, 21 April 2015, *M. Wolanin* (003310 UR); between Ojców and Grodzisko, calcareous rocks, 26 May 1929, *B. Pawłowski* (117613 KRA); between Ojców and Grodzisko, grassy slope, 26 May 1929, *B. Pawłowski* (189646 KRAM); Ojców, 27 July 1929, K. Piech (169652 KRAM); **DF58** – Bębło, grassland at the base of rock on SW slope, 50°10'51"N, 19°47'18"E, 30 April 2013, *M. Wolanin* (003406 UR); Duże Skałki, rocky paths, fissures in rocks, 50°11'20"N, 19°48'23"E, 30 April 2013, *M. Wolanin* (003414 UR); Słoneczne Skały, rock crumbs, SW rock side, 50°12'09"N, 19°45'51"E, 30 April 2013, *M. Wolanin* (003258 UR); Bolechowice, rocks in Bolechowice Ravine, 6 May 1948, *H. Błaszczyk* (113891 KRA); Bolechowice, path, 21 May 1975, *T. Tacik* (392462 KRAM); Bolechowice Valley, 6 May 1948, *Pogan* (0238571 KRA); **DF68** – Nielepice, grassland on S slope of calcareous rock, 50°06'13"N, 19°43'07"E, 12 April 2014, *M. Wolanin* (003271 UR); Bielany near Kraków, 24 April 1954, *Turnau* (0155143 KRA); between Kryspinów and Bielany, limestone hillock, 16 May 1976, *H.*, *T.* & *J. Tacik* (387574 KRAM); Skała Kmity, fissure in rock, 24 April 1991, *A. Woszczenko* (403319 KRAM); **DF69** – Las Wolski near Kraków, 24 April 1954, *Gromczakiewicz* (0155142 KRA); **DF76** – Grochowiec near Ryczów, 22 May 1926, *A. Kozłowska* (242483 KRAM); **DG14** – Grojec near Żywiec, grassland, 9 June 2000, *K. Nowak* (562018 KRAM); **EE72** – Miedzianka Hill near Chęciny, grassland on SE rock slope, 50°50'47"N, 20°21'37"E, 11 April 2016, *M. Wolanin* (003511 UR); **EE82** – Grząby Bolmińskie, field road, 50°48'46"N, 20°21'44"E, 22 April 2016, *M. Wolanin* (003321, 003388 UR); **EE83** – Sosnówka Hill, fissures in calcareous rocks, 50°48'32"N, 20°25'54"E, 18 April 2012, *M. Wolanin* (003405 UR); **EG23** – Łącko, dry grassland close to Dunajec River, 3 May 1970, *K. Towpasz* (80794 KRA); **EG24** – Czerszlowe Skałki (Pieniny Mts.), grassland on SW rock slope, 49°32'54"N, 20°32'34"E, 10 April 2014, *M. Wolanin* (003368 UR); **EG32** – "Pod Kirą" (Pieniny National Park), rock near road from Czorsztyn to Sromowce, 49°25'04"N, 20°20'36"E, 9 April 2014, *M. Wolanin* (003367 UR); Wżar Hill (Gorce Mts.), grassland on rock, E side, 22 April 1966, *H. Trzcińska-Tacik* (092621 KRAM); Wżar, rocks, 22 April 1966, *A. Zielińska* (063790 KRA); **EG34** – Jaworki, grassland on SE rock slope, 49°24'19"N, 20°32'37"E, 10 April 2014, *M. Wolanin* (003284 UR); **FG55** – Łupków, dry slope at altitude of 610 m asl, 2 May 1961, *A. Jasiewicz* (018948, 437761 KRAM).

Notes. Plant usually small. Leaves with 4–7 pairs of uniform lateral lobes and narrow interlobes, side lobe distal margin often convex and entire. Capitulum small, with light yellow ligules, no pollen or only rarely a few poorly developed grains present. Fruit with relatively short spinules. Species not very morphologically variable, easy to recognise, charming (Figs 26, 27).

Figure 26. Variation in leaf shape in *T. parnassicum*; locality – Duże Skałki (*M. Wolanin* 2016 UR). Scale bar: 5 cm.

Figure 27. *Taraxacum parnassicum*; locality – Jaworki, 2014, photo by M. Wolanin.

9. *Taraxacum plumbeum* Dahlst. Ark. Bot. 10(6): 2. 1911.

= *Taraxacum franconicum* Sahlin, Ber. Bayer. Bot. Ges. 55: 49. 1984. Type: Germany, Bayern, Südosthang des Hessekberges, Gem. Röckingen, Verbandsgemeinde Hesselberg, Krs. Ansbach, (MTB 6929/1), mit Malmschotter befestigter Weg im Opalinuston, June 1983, *E. J. Krach* (holotype in M 0152765; isotype in S 05-8711).

Type. Sweden, Gotland, Visby, the old harbour, 6 June 1909, *H. Dahlstedt* (lectotype in S, designated by Doll 1973: 123; isolectotypes in S).

Description. Plants small to middle-sized, 5–10(–15) cm tall. ***Leaves*** dark green, dull, sparsely hairy, approximately 5–12 cm long and 1.5–2.5(–3.0) cm wide, usually 5–7 times longer than wide, blades narrowly elliptical to narrowly oblanceolate, with 4–6 pairs of lateral lobes; lateral lobes opposite to remote; lateral lobes of the inner leaves narrowly triangular, usually falcate, acute, with a somewhat convex, often denticulate distal margin, proximal margin usually entire, concave; lateral lobes of the outer leaves triangular, distinctly falcate, with an entire or denticulate distal margin; interlobes often long and narrow, plicate and denticulate, blackish rimmed; terminal lobe of the inner leaves with lingulate apex, denticulate margins and/or incised at the base; terminal lobe of the outer leaves often small, triangular/subsagitate, quite often with short, subacute apical lobule; petioles unwinged or narrowly winged, purple, hairy at base. ***Scapes*** usually as long as leaves and hairy. ***Capitulum*** convex, 2.5–3.0 cm in diameter, yellow, outer strips grey-purple; inner bracts glaucous greyish-green, pruinose; outer bracts usually 9–12, ovate to lanceolate, usually 6–7(–8) mm long, 2.0–2.5(–3.0) mm broad, greyish-green, suffused red-purple at the apex, with a white hyaline margin, (0.5)–0.1(–0.2) mm broad, erect to subspreading, corniculate; stigmas olive-green, pollen present. ***Achenes*** yellowish light red-brown, often with relatively short spinules in the upper part, 3–3.6 mm long (incl. the 0.6–0.8 mm long, subconical cone), rostrum 8–9 mm long, pappus white.

Flowering period. April–May.

Habitat. Rocky grasslands (in trampled or eroded areas), dry sandy roadsides. In Kraków-Częstochowa Upland (Kraków Kostrze place) *T. plumbeum* grew on a rocky dry roadside together with *Arenaria serpyllifolia*, *Briza media*, *Bromus hordeaceus*, *Dianthus deltoides*, *D. carthusianorum*, *Euphorbia cyparissias*, *Festuca pratensis*, *Fragaria vesca*, *Medicago falcata*, *M. lupulina*, *Plantago lanceolata*, *P. major*, *Poa pratensis*, *Potentilla arenaria*, *Trifolium repens*, *Veroncia arvensis*. In Wielkopolska Lowland (Stare Bielice place) we noticed this species on the sandy roadside, accompanied by *Achillea millefolium*, *Artemisia campestris*, *Cerastium semidecandrum*, *Elymus repens*, *Festuca rubra*, *Lamium purpureum*, *Medicago falcata*, *Plantago lanceolata*, *P. major*, *Potentilla argentea*, *Rosa canina*, *Rumex acetosa*, *Sedum sexangulare*, *Taraxacum proximum*, *Tragopogon pratensis*.

Somatic chromosome number. 24 (Wolanin and Musiał 2017).

General distribution. Switzerland, Italy, Austria, Germany, the Czech Republic, Poland, Ukraine, Slovakia, Denmark (Van Soest 1967; Tacik 1980; Lundevall and Øllgaard 1999; Uhlemann 2003; Vašut 2003; Conti et al. 2005; Trávníček et al. 2010; Nobis et al. 2020b).

Distribution in Poland. Scattered localities in northern and southern Poland, moderately frequent (Fig. 23C).

Specimens examined. **AB09** – Dźwirzyno, lawn on sandy soil, 54°09'45"N, 15°25'59"E, 2 May 2017, *M. Wolanin* (003358, 003369 UR); **AB22** – Warszów, ditch at forest edge, 53°53'40"N, 14°18'54"E, 30 April 2017, *M. Wolanin* (003334, 003350 UR); **AB23** – Międzyzdroje, klomb, 53°56'04"N, 14°27'13"E, 30 April 2017, *M. Wolanin* (003333, 003335 UR); **BC51** – Drezdenko, lawn close to cemetery fence, 52°50'06"N, 15°49'19"E, 18 April 2016, *M. Wolanin* (003285 UR); **BC52** – Stare Bielice, sandy roadside, 52°50'57"N, 15°55'04"E, 18 April 2016, *M. Wolanin* (003298 UR); **BD43** – Kębłowo, lawn in cemetery, 52°03'04"N, 16°06'40"E, 19 April 2016, *M. Wolanin* (003380 UR); between Kębłowo and Świętno, dry field road side, 52°02'34"N, 16°05'24"E, 19 April 2016, *M. Wolanin* (003259 UR); **BD53** – Kaszczor, lawn in cemetery, 51°57'19"N, 16°10'01"E, 19 April 2016, *M. Wolanin* (003563 UR); **BE89** – Strzelin: (...) near Wyszonowice, 23 May 1942, *E. Schalow* (WRSL); **BF07** – Stolec distr. Ząbkowice Śląskie, paths near calcareous rock, 50°35'49"N, 16°52'26"E, 18 April 2017, *M. Wolanin* (003443 UR); Stolec distr. Ząbkowice Śląskie, limestone hill near Stolec, roadside, 04 June 1972, *E. Kozioł* (34508 WRSL); **DC32** – vicinity of Golub-Dobrzyń, roadside close to Okonin Lake, 53°04'27"N, 18°57'40"E, 29 April 2018, *M. Wolanin* (003476 UR); **DC35** – Rypin (Bukowa street 7), lawn, 53°04'17"N, 19°25'11"E, 28 April 2018, *M. Wolanin* (003452 UR); **DC41** – Sąsieczno, pine forest edge, 52°57'03"N, 18°50'38"E; 29 April 2018, *M. Wolanin* (003471 UR); **DC63** – Winduga near Włocławek, roadside in pine forest, 52°43'18"N, 19°01'17"E, 29 April 2018, *M. Wolanin* (003459 UR); **DF06** – Kroczyce, path on calcareous rock, 50°34'20"N, 19°31'49"E, 12 April 2016, *M. Wolanin* (003502 UR); Rzędkowice, path on S slope of calcareous rock, 50°34'31"N, 19°29'07"E, 14 April 2014, *M. Wolanin* (003403 UR); Mirów, grassland on rocks overgrown by shrubs, 50°36'53"N, 19°28'51"E, 1 May 2021, *M. Wolanin* (003596 UR); **DF37** – Klucze, sandy roadside, 15 June 1953, *T. Tacik* (570166 KRAM); **DF48** – Sąspów near Ojców, sunny W slope near church, 50°13'24"N, 19°46'19"E, 21 April 2015, *M. Wolanin* (003404 UR); **DF58** – Słoneczne Skały, rock crumbs at rock base, on SW side of rock, 50°12'09"N, 19°45'51"E, 30 April 2013, *M. Wolanin* (003258 UR); Bolechowice, calcareous rocks, 1 May 1976, *H.*, *T.* & *J. Tacik* (388114 KRAM); Dolina Kluczwody, rocky cliff, 24 April 1977, *H. Trzcińska-Tacik* (388109, 575842 KRAM); Ojców, calcareous rocks near Ciemna Cave (near the path), 3 May 1952, *A. Jasiewicz* (439041 KRAM); **DF66** – Wygiełzów near Chrzanów, grassland near military bunker, 19 May 1975, *T. Tacik* (387559 KRAM); **DF69** – Kraków (Kostrze), roadside, 50°02'08"N, 19°51'58"E, 12 April 2016, *M. Wolanin* (003498 UR); Pychowicka Górka, grassland on rocky-humus soil, 50°01'53"N, 19°52'48"E, 29 April 2013, *M. Wolanin* (003445 UR); Pychowicka Górka, grassland on rock, 50°01'50"N, 19°53'00"E, 29 April 2013, *M. Wolanin* (003464 UR); Pychowice, sunny hillock, 11 May 1975, *T. Tacik* (392447 KRAM); **DF78** – Tyniec Podgórki (Góra Wielkanoc), path on rocky-humus soil, 50°01'02"N, 19°48'57"E, 29 April 2013, *M. Wolanin* (003320 UR); Skawina, sandy square near road, 5 May 1976, *H. Trzecińska-Tacik* (388116 KRAM); **EC67** – Pawłówek near Pułtusk, grassland, 8 May 2015, *J. Marciniuk*, *P. Marciniuk* (Herb. J&P Marciniuk); Szygłówek near Pułtusk, grassland near pine forest, 8 May 2015, *J. Marciniuk*, *P. Marciniuk* (Herb. J&P Marciniuk); **ED11** – Młodzieszyn, pine forest edge, 52°19'00"N, 20°12'23"E, 28 April 2018, *M. Wolanin* (003456 UR); **EE83** – Góra Zalejowa, fissure in rock, 50°49'07"N, 20°27'30"E, 20 April 2016, *M. Wolanin* (003415 UR); **FD09** – Bużka, sandy roadside, 52°21'27"N, 22°53'56"E, 25 April 2016, *M. Wolanin* (003272 UR); Kózki, pastured grassland near Kózki reserve, 52°21'39"N, 22°52'10"E, 25 April 2016, *M. Wolanin* (003311 UR); **FD45** – between Biardy and Grezówka-Kolonia, field road hardened with crushed concrete, 52°00'36"N, 22°18'33"E, 27 April 2016, *M. Wolanin* (003533 UR); **FE84** – between Zaklików and Lipa, sandy square at pine forest edge, 50°42'34"N, 22°04'39"E, 19 April 2019, *M. Wolanin* (003583 UR); **FF09** – Wola Mała, sandy square at pine forest edge, 50°32'50"N, 22°45'48"E, 13 April 2019, *M. Wolanin* (003581 UR).

Notes. Plant very variable in morphology, which can cause problems in determination where achenes are absent. In the Polish lowlands, we noted this species mainly in dry and warm semi-ruderal habitats (usually on sandy soils), and the specimens were relatively homogeneous in their morphological features, such as: leaves with quite wide, entire or slightly toothed side lobes and suberect or patent outer phyllaries. In upland areas, in rock grasslands, the species show greater variability of morphology compared to lowland populations. In general, side lobes are narrower, more numerous and slightly more serrated, interlobia are wider and incised, and outer phyllaries are narrower and more recurved. Specimens growing in extremely dry and rocky habitats, usually with strongly dissected leaves, may resemble *T. tenuilobum*, however the terminal lobe in *T. plumbeum* has a slightly different shape, with a tongue-shaped apex slightly incised on both sides in the base, and much smaller teeth and lobules in the interlobes in relation to the side lobes. The yellowish light red-brown hue of the achenes is a very useful diagnostic feature typical of *T. plumbeum* (Figs 28, 29).

Figure 28. Variation in leaf shape in *T. plumbeum*; locality – Kraków Kostrze (*M. Wolanin* 2016 UR). Scale bar: 5 cm.

Figure 29. *Taraxacum plumbeum*; locality – between Zaklików and Lipa, 2019, photo by M. Wolanin.

10. *Taraxacum proximum* (Dahlst.) Raunk., Dansk Exkurs.-Fl., ed. 2: 258. 1906.

Taraxacum erythrospermum subsp. *proximum* Dahlst., Bot. Not. 1905: 165. 1905. Basionym.

= *Taraxacum attenuatum* Brenner, Meddeland. Soc. Fauna Fl. Fenn. 32: 114. 1906. Type: Finland, Nylandia, Ingå (Inkoo), Svartbäck, dry hill, 17 August 1905, *M. Brenner* (lectotype in H 660607, designated by Lundevall and Øllgaard 1999: 60).

Type. Sweden, Stockholm, Djurgårdsfrescati, under oaks, 5 June 1903, *H. Dahlstedt* (lectotype in S [lower plant], selected G. Haglund and designated by Doll 1973: 74).

Description. Plants small to middle-sized, 10–20(–30) cm tall. ***Leaves*** greyish-green, almost glabrous, approximately 7–15(–25) cm long and 2–4 cm wide, usually 3–4 times longer than wide; leaf blade elliptical, regularly lobate, with 4–8 pairs of lateral lobes; lateral lobes opposite to remote; lateral lobes of the inner leaves triangular, acute, patent, with a regularly dentate, slightly convex distal margin, proximal margin usually entire; lateral lobes of the outer leaves triangular, usually toothed at the distal margin; interlobes often short, blade often toothed in lower part of leaf; terminal lobe subacute or subsaginate, quite often with elongate apex; petioles unwinged, purplish. ***Scapes*** as long as or longer than leaves, somewhat hairy. ***Capitulum*** convex, 2.5–3.0 cm in diameter, greenish-yellow, with numerous tubular inner flowers, outer strips purple-brownish; inner bracts greyish-green, with lumps or small cornicules; outer bracts usually 11–14, lanceolate, usually 7–9 mm long, 2–3.0 mm broad, bright greyish-green suffused with purple, narrowly bordered (up to 0.05 broad), recurved, with lumps or small cornicules; stigmas greyish-green, pollen absent or very poorly developed (up to a few grains on the stigma). ***Achenes*** reddish-brown, narrow, with erect thin spinules in the upper part, 3.5–4.1(–4.5) mm long (incl. the 0.8–1.1(–1.4) mm long, cylindrical cone), rostrum (6–)7–8(–8.5) mm long, pappus white.

Flowering period. April–May.

Habitat. Sandy grasslands, dry sandy roadsides, lawns. In plant communities with the participation of *T. proximum*, we reported a significant presence of species characteristic to the *Molinio-Arrhenatheretea* and *Sedo-Scleranthetea* classes. Moreover, species characteristic to the class *Galio-Urticenea* and antropophytes appeared quite often. In Wielkopolska Lowland (Olsza place) we noted this species growing on sandy field roads together with *Achillea millefolium*, *Anthemis arvensis*, *Calamagrostis epigejos*, *Capsella bursa-pastoris*, *Cerastium holosteoides*, *Erophila verna*, *Festuca rubra*, *Plantago major*, *Potentilla argentea*, *Stellaria media*, *Taraxacum* sect. *Taraxacum*, *Trifolium repens*, *Veronica hederifolia* s.l., *Viola arvensis*.

Somatic chromosome number. 24 (Wolanin and Musiał 2017).

General distribution. Widespread European species reported from France, Great Britain, Iceland, Switzerland, Belgium, the Netherlands, Austria, Germany, Denmark, the Czech Republic, Poland, Hungary, Slovakia, Moldova, Bulgaria, Ukraine, Norway, Finland, Sweden, Lithuania, Latvia, Estonia and European Russia (Van Soest 1957, 1967; Doll 1973b; Tacik 1980; Dostál 1989; Fedorov 1989; Lundevall and Øllgaard 1999; Mosyakin and Fedoronchuk 1999; Uhlemann 2003; Vašut 2003; Trávníček et al. 2010; Wendt and Øllgaard 2015).

Distribution in Poland. Scattered localities in northern Poland, quite frequent in Greater Poland (Fig. 23D).

Specimens examined. AB23 – Międzyzdroje, lawn on sandy soil, 53°56'15"N, 14°27'30"E, 30 April 2017, *M. Wolanin* (003267 UR); **AB32** – W of Przybór, parking lot in forest, 53°52'39"N, 14°18'37"E, 30 April 2017, *M. Wolanin* (003254 UR); **BC50** – Gościm, cemetery, 6 May 2013, *A. Czarna* (POZNB); **BC51** – Drezdenko, lawn near cemetery, 52°50'12"N, 15°49'31"E, 18 April 2016, *M. Wolanin* (003363 UR); Drezdenko, lawn, 52°50'11"N, 15°49'19"E, 18 April 2016, *M. Wolanin* (003362 UR); Drezdenko, neglected place near cemetery fence, 52°50'06"N, 15°49'19"E, 18 April 2016, *M. Wolanin* (003392 UR); **BC52** – Chełst, lawn in cemetery, 52°49'27"N, 15°57'35"E, 18 April 2016, *M. Wolanin* (003420 UR); Stare Bielice, sandy roadside near asphalt road, 52°50'57"N, 15°55'04"E, 18 April 2016, *M. Wolanin* (003393 UR); Kwiejce, old cemetery in forest, 6 May 2013, *A. Czarna* (POZNB); **BC61** – Sowia

Góra, young pine forest edge, 52°42'01"N, 15°50'42"E, 18 April 2016, *M. Wolanin* (003551 UR); **BD43** – Kębłowo, ruderal area near cemetery fence, 52°03'06"N, 16°06'35"E, 19 April 2016, *M. Wolanin* (003394 UR); **BD49** – Olsza, sandy field road, 52°04'21"N, 17°05'54"E, 17 April 2016, *M. Wolanin* (003503 UR); **BD53** – Kaszczor, lawn in cemetery, 51°57'19"N, 16°10'01"E, 19 April 2016, *M. Wolanin* (003364, 003563 UR); **BD77** – Bojanowo, Półwiejska street 12, gap between pavement and kerb, 51°42'36"N, 16°44'53"E, 19 April 2016, *M. Wolanin* (003516 UR); **CD30** – Majdany, sandy roadside in pine forest, 52°08'02"N, 17°10'58"E, 17 April 2016, *M. Wolanin* (003504 UR); Zaniemyśl, cemetery lawn, 52°09'01"N, 17°10'09"E, 17 April 2016, *M. Wolanin* (003505 UR); **CD32** – Nowe Miasto nad Wartą, cemetery lawn, 52°05'14"N, 17°23'57"E, 17 April 2016, *M. Wolanin* (003549 UR); **CD40** – Błażejewo, parking lot hardened with slag close to cemetery, 52°00'01"N, 17°08'41"E, 18 April 2016, *M. Wolanin* (003365 UR); Jarosławki, sandy place at forest edge, 52°03'09"N, 17°10'17"E, 16 April 2016, *M. Wolanin* (003411 UR); Kiełczynek, sandy roadside, 52°04'16"N, 17°12'43"E, *M. Wolanin* (003412 UR); Kiełczynek, lawn, 52°03'57"N, 17°13'57"E, 16 April 2016, *M. Wolanin* (003341 UR); Książ Wielkopolski, roadside in forest, 52°04'02"N, 17°14'47"E, 16 April 2016, *M.*

Figure 30. Variation in leaf shape in *T. proximum*; locality – Zaniemyśl (*M. Wolanin* 2016 UR). Scale bar: 5 cm.

Wolanin (003513 UR); Książ Wielkopolski, sandy grassland in cemetery, 52°03'55"N, 17°14'10"E, 16 April 2016, *M. Wolanin* (003280, 003306 UR); **CD41** – Chwałkowo Kościelne, roadside in forest, 51°59'41"N, 17°18'12"E, 16 April 2016, *M. Wolanin* (003410, 003512 UR); between Radoszkowo and Chromiec, sandy embankment near closed railway track, 52°02'20"N, 17°16'30"E, 16 April 2016, *M. Wolanin* (003343 UR); Radoszkowo, young pine forest edge, 52°02'18"N, 17°16'06"E, 16 April 2016, *M. Wolanin* (003293 UR); **CD64** – Taczanowski Forest near Ostrów Wielkopolski, 11 May 2012, *A. Czarna* (POZNB); **DA81** – Gdańsk (Stogi), scrub edge, 54°22'24"N, 18°43'41"E, 7 May 2016, *M. Wolanin* (003376, 003391 UR); Krynica Morska, sandy roadside, 54°23'35"N, 19°28'46"E, 10 May 2016, *M. Wolanin* (003375 UR); **DC63** – Winduga near Włocławek, roadside in pine forest, 52°43'18"N, 19°01'17"E, 29 April 2018, *M. Wolanin* (003461 UR); **DC73** – Włocławek, lawn, 52°40'29"N, 19°05'12"E, 29 April 2018, *M. Wolanin* (003480 UR); **FC13** – Piątnica (Fort Łomża), pastured grassland, 53°11'50"N, 22°06'52"E, 25 April 2016, *M. Wolanin* (003342 UR); **GD10** – Serpelice, lawn, 52°16'49"N, 23°03'01"E, 25 April 2016, *M. Wolanin* (003294 UR).

Notes. *T. proximum* is distinguished by elongated leaves with quite numerous side lobes (4–8 pairs) that are uniform, triangular-deltate, entire to denticulate. The capitulum is small (2–3 cm), convex, with numerous greenish-yellowish tubular ligules. Pollen absent. Achenes slender, reddish-brown (Figs 30, 31).

Figure 31. *Taraxacum proximum*; locality – Drezdenko, 2016, photo by M. Wolanin.

11. *Taraxacum sandomiriense* Wolanin, Phytotaxa 375(2): 159. 2018.

Type. Poland, Kamień Łukawski, path on the edge of the loess slope (near the reserve), 50°41'N, 21°47'E, 6 May 2013, *M. Wolanin* (holotype KRA 476861; isotype KRA 476862).

Description. Plants small to middle-sized, 6–10(–12) cm tall. ***Leaves*** greyish-green, dull, hairy on the upper side, approximately (3–)5–10(–15) cm long and 1–2.5 cm wide, usually 3–5 times longer than wide, blades narrowly oblanceolate, usually broadest in upper 1/3, with 6(–7) pairs of lateral lobes; lateral lobes opposite to remote; lateral lobes of the inner leaves narrowly triangular, patent, with an entire or slightly dentate, somewhat convex distal margin, proximal margin usually entire or with a few small teeth; lateral lobes of the outer leaves triangular, entire or with a few teeth at the distal margin; interlobes often toothed; terminal lobe of the inner leaves tripartite, mostly lingulate and entire on the margins; terminal lobe of the outer leaves triangular; petioles unwinged, pale purple, hairy. ***Scapes*** as long as or longer than leaves, hairy, especially just under the capitulum. ***Capitulum*** convex, 2.5–3.0 cm in diameter, yellow, outer strips grey-violet; inner bracts greyish-green, corniculate; outer bracts usually 10–14, lanceolate, usually 5–7 mm long, 2–2.5 mm broad, purplish green, with a distinct white hyaline margin (0.1–0.2 mm broad), recurved and strongly corniculate; stigmas greyish-yellow, pollen present. ***Achenes*** brown, with thin spinules in the upper part, 3.4–4.0 mm long (incl. the 0.8–1.2 mm long, narrowly conical pyramid) and (0.7–)0.8(–0.9) mm broad, rostrum 8.5–10 mm long, pappus white.

Flowering period. April (May).

Habitat. Rocky and loess slopes of river valleys with south-western exposure, in plant phytocenoses dominated by species characteristic to the *Festuco-Brometea* classes, usually in eroded or trampled areas. In Kamienna river valley (Sandomierz Upland, Gałkowice-Ocin place) this species was noted on the path and accompanied by *Achillea millefolium*, *Alyssum alyssoides*, *Bromus inermis*, *Campanula sibirica*, *Centaurea scabiosa*, *Clinopodium vulgare*, *Cornus sanguinea*, *Dactylis glomerata*, *Dianthus carthusianorum*, *Euphorbia cyparissias*, *Falcaria vulgaris*, *Festuca rupicola*, *F. trachyphylla*, *Fragaria vesca*, *Galium verum*, *Hypericum maculatum*, *Inula hirta*, *Juniperus communis*, *Koeleria macrantha*, *Leucanthemum vulgare*, *Linaria vulgaris*, *Medicago falcata*, *Peucedanum oreoselinum*, *Phleum phleoides*, *Plantago media*, *Poa pratensis*, *Polygala comosa*, *Potentilla arenaria*, *Prunus spinosa*, *Pyrus pyraster*, *Rosa canina*, *R. dumalis*, *R. rubiginosa*, *Salvia pratensis*, *Scabiosa ochroleuca*, *Stachys recta*, *Thymus marschallianus*, *Ulmus minor*.

Somatic chromosome number. 24 (Wolanin et al. 2018).

General distribution. Poland.

Distribution in Poland. Species very rare, found only around Sandomierz (Wolanin et al. 2018; Fig. 23E).

Specimens examined. FE60 – Podgrodzie near Ćmielów, xerothermic grassland on rock outcrop, 50°54'24"N, 21°32'44"E, 17 April 2012, *M. Wolanin*, *M. Nykiel* (003431 UR); Podgrodzie, xerothermic grassland on rock outcrop, 50°54'24"N, 21°32'44"E, 13 April 2017, *M. Wolanin*, *M. N. Wolanin* (003421, 003422 UR); **FE82** – Gałkowice-Ocin,

Figure 32. Variation in leaf shape in *T. sandomiriense*; locality – Podgrodzie (*M. Wolanin* 2012 UR). Scale bar: 5 cm.

Figure 33. *Taraxacum sandomiriense*; locality – Podgrodzie, 2012, photo by M. Wolanin.

xerothermic grassland on SW slope, 50°44'43"N, 21°43'52"E, 17 April 2012, *M. Wolanin*, *M. Nykiel* (003442 UR); **FE92** – Kamień Łukawski, path on edge of loess slope near reserve, 50°41'04"N, 21°47'09"E, 6 May 2013, *M. Wolanin* (476861, 476862 KRA); Sandomierz (Strzelecka Hill), loess slope, 10 May 1924, *A. Kozłowska* (76947 KRA).

Notes. A distinct species with noticeably hairy leaves, purplish-green outer bracts with distinct white hyaline margin, recurved and strongly corniculate. Achenes are brown, with slender spinules in the upper part (Figs 32, 33).

12. *Taraxacum scanicum* Dahlst., Ark. Bot. 10(11): 21. 1911.

Type. Sweden, Skåne, Lund, the garden of the infectious-diseases hospital, 21 May 1910, *E. L. Ekman* (lectotype in S [upper specimen], designated by Lundevall and Øllgaard 1999: 143).

Description. Plants small to middle-sized, 10–20(–25) cm tall. ***Leaves*** dark green, almost glabrous, approximately (5–)7–12(–15) cm long and (1–)1.5–3(–4) cm wide, usually 6–7 times longer than wide, blades narrowly oblanceolate, usually broadest in upper 1/3, with (3–)4–6 pairs of lateral lobes, midribs often purple-brownish; lateral lobes opposite to remote; lateral lobes of the inner leaves usually dissected and toothed at the distal margin, slightly recurved, proximal margin usually entire; lateral lobes of the outer leaves triangular, usually toothed or/and incised at the distal margin; interlobes not or slightly crisped, often toothed only at the upper part of the leaf blade; terminal lobe of the inner leaves elongate with a protracted apex, quite often incised at the base; terminal lobe of the outer leaves with obtuse apical lobule; petioles unwinged, purple. ***Scapes*** as long as or longer than leaves, hairy, especially under the capitulum, often suffused purple-brownish. ***Capitulum*** convex, 3.0–3.5 cm in diameter, yellow, outer strips red-grey; inner bracts dark, glaucous greyish-green, somewhat pruinose, with or without a small lump; outer bracts usually 10–15, widely lanceolate, usually 7–9 mm long, 1.5–3.0 mm broad, grey-green, quite often suffused red-violet, with a narrow white hyaline margin (0.1–0.2 mm broad), recurved or patent, usually with small cornicules; stigmas dark greyish-green, pollen present. ***Achenes*** brown-red, with slender spinules in the upper part, 3.5–4.1 mm long (incl. the 0.8–1.2 mm long cone), rostrum (6.5–)7–8 mm long, pappus white.

Flowering period. April–May.

Habitat. Pine forest edges, forest clearings, paths, roadsides, most often in sunny, dry and sandy places. Plant communities participated by *T. scanicum* were dominated most often by species typical of sandy grasslands (*Sedo-Scleranthetea* class). In Wielkopolska Lowland (Ługi place) we recorded this species on a dry sandy roadside together with *Achillea millefolium*, *Anthemis arvensis*, *Artemisia campestris*, *A. vulgaris*, *Berteroa incana*, *Erophila verna*, *Helichrysum arenarium*, *Plantago lanceolata*, *P. major*, *Poa annua*, *Potentilla argentea*, *Sedum acre*, *Taraxacum* sect. *Taraxacum*, *Veronica arvensis*.

Somatic chromosome number. 24 (Grzesiuk et al. 2008; Wolanin and Musiał 2017), 25 (Małecka 1967, 1969).

General distribution. Widespread European species reported from France, Great Britain, Italy, Croatia, Switzerland, Belgium, the Netherlands, Germany, Austria, Denmark, Hungary, the Czech Republic, Poland, Norway, Sweden, Finland, Moldova, Crimea, Ukraine, Lithuania, Latvia, Estonia and European Russia (Van Soest 1957, 1967; Doll 1973b; Tacik 1980; Fedorov 1989; Lundevall and Øllgaard 1999; Mosyakin and Fedoronchuk 1999; Uhlemann 2003; Głowacki et al. 2004; Trávníček et al. 2010; Wendt and Øllgaard 2015; Nobis et al. 2020b).

Distribution in Poland. Scattered localities mainly in northern Poland, quite frequent (Fig. 23F).

Specimens examined. AB09 – Dźwirzyno, lawn on sandy soil, 54°09'45"N, 15°25'59"E, 2 May 2017, *M. Wolanin* (003273 UR); Grybowo, roadside ditch edge, 54°09'51"N, 15°28'21"E, 2 May 2017, *M. Wolanin* (003299 UR); **AB14** – Międzywodzie, roadside in forest, 54°00'35"N, 14°41'41"E, 30 April 2017, *M. Wolanin* (003331 UR); **AB16** – Pustkowo, pine forest edge, 54°04'08"N, 14°58'05"E, 2 May 2017, *M. Wolanin* (003312 UR); **AB22** – Przytór, roadside near pine forest edge, 53°53'25"N, 14°20'13"E, 30 April 2017, *M. Wolanin* (003351 UR); Warszów, roadside ditch near forest edge, 53°53'40"N, 14°18'54"E, 30 April 2017, *M. Wolanin* (003356 UR); **AB23** – Międzyzdroje, lawn on sandy soil, 53°56'15"N, 14°27'30"E, 30 April 2017, *M. Wolanin* (003353 UR); Międzyzdroje, lawn near beach entrance, 53°56'00"N, 14°26'59"E, 30 April 2017, *M. Wolanin* (003352 UR); Międzyzdroje, lawn, 53°56'10"N, 14°27'24"E, 30 April 2017, *M. Wolanin* (003332 UR); **AB32** – Ognica, sandy roadside, 53°52'47"N, 14°17'05"E, 30 April 2017, *M. Wolanin* (003319 UR); **AB47** – vicinity of Unibórz, roadside at pine forest edge, 53°48'48"N, 15°04'57"E, 30 April 2017, *M. Wolanin* (003371 UR); **AB53** – Trzebież, distr. Police, psammophilous grassland, 14 May 1999, *Z. Głowacki* (527640 KRAM); **BA59** – Ustka, sandy square in pine forest, 54°35'15"N, 16°52'48"E, 1 May 2017, *M. Wolanin* (003286 UR); Ustka, sandy roadside, 54°35'17"N, 16°53'07"E, 1 May 2017, *M. Wolanin* (003260 UR); **BC18** – Piła, sandy roadside, 53°09'01"N, 16°47'24"E, 29 April 2017, *M. Wolanin* (003357, 003370 UR); **BC51** – Drezdenko, ruderal square in cemetery, 52°50'07"N, 15°49'25"E, 18 April 2016, *M. Wolanin* (003494 UR); **BC52** – Chełst, cemetery lawn, 52°49'17"N, 15°57'35"E, 18 April 2016, *M. Wolanin* (003544 UR); **BC61** – Sowia Góra, roadside No 160, 52°41'55"N, 15°50'41"E, 18 April 2016, *M. Wolanin* (003493 UR); **BD42** – Świętno, roadside, 52°00'29"N, 16°03'29"E, 19 April 2016, *M. Wolanin* (003518 UR); **BD43** – Kębłowo, ruderal area close to cemetery fence, 52°03'06"N, 16°06'35"E, 19 April 2016, *M. Wolanin* (003381 UR); **BD53** – Kaszczor, cemetery lawn, 51°57'20"N, 16°10'01"E, 19 April 2016, *M. Wolanin* (003384 UR); **BD77** – Bojanowo, Półwiejska street 12, gap between pavement and kerb, 51°42'36"N, 16°44'53"E, 19 April 2016, *M. Wolanin* (003385 UR); **CA38** – W of Chłapowska Valley outlet, cliff slope, 25 June 1970, *W. Chojnacki* (153/01 UGDA); **CA43** – Łeba, along path in pine forest, 54°46'13"N, 17°35'28"E, 3 May 2019, *M. Wolanin* (003573 UR); Łeba, clearing in pine forest, 54°45'49"N, 17°32'31"E, 2 May 2019, *M. Wolanin* (003576 UR); **CD30** – Majdany, sandy roadside in pine forest, 52°08'02"N, 17°10'58"E, 17 April 2016, *M. Wolanin* (003508

Figure 34. Variation in leaf shape in *T. scanicum*; locality – Gdańsk Stogi (*M. Wolanin* 2016 UR). Scale bar: 5 cm.

UR); Zaniemyśl, cemetery lawn, 52°09'01"N, 17°10'09"E, 17 April 2016, *M. Wolanin* (003509 UR); **CD31** – Murzynowo Leśne, sandy square close to shop, 52°09'17"N, 17°20'25"E, 17 April 2016, *M. Wolanin* (003507 UR); **CD40** – Błażejewo, sandy grassland in cemetery, 52°00'01"N, 17°08'37"E, 18 April 2016, *M. Wolanin* (003383 UR); Jarosławki, sandy roadside at pine forest edge, 52°03'07"N, 17°10'22"E, 16 April 2016, *M. Wolanin* (003416 UR); Kiełczynek, lawn, 52°04'11"N, 17°12'49"E, 16 April 2016, *M. Wolanin* (003418 UR); Książ Wielkopolski, roadside in forest, 52°04'02"N, 17°14'44"E, 16 April 2016, *M. Wolanin* (003537 UR); Ługi, sandy roadside, 51°59'17"N, 17°11'13"E, 16 April 2016, *M. Wolanin* (003536 UR); **DA40** – Jastrania, gap between pavement and kerb, 54°42'49"N, 18°38'17"E, 9 May 2016, *M. Wolanin* (003555 UR); **DA51** – Hel (Leśna street), sandy square at pine forest edge, 54°36'08"N, 18°48'55"E, 8 May 2016, *M. Wolanin* (003501 UR); Hel, meadow close to church, 8 May 1997, *K. Błaszkiewicz* (058153 KTU); **DA76** – Piaski, sandy roadside, 54°25'11"N, 19°34'00"E, 10 May 2016, *M. Wolanin* (003402 UR); **DA81** – Gdańsk (Stogi), path in light pine forest, 54°22'24"N, 18°43'38"E, 7 May 2016, *M. Wolanin* (003399, 003556 UR); **DC41** – Sąsieczno, pine forest edge, 52°57'03"N, 18°50'38"E, 29 April 2018, *M. Wolanin* (003472 UR); **DC44** – vicinity of Adamów, dry square on pine forest edge, 52°56'52"N, 19°17'45"E, 29 April 2018, *M. Wolanin* (003478 UR); **DC52** – Dąbrówka, roadside in forest, 52°53'42"N, 18°57'51"E, 29 April 2018, *M. Wolanin* (003470 UR); between Wakole and Dąbrówka, roadside in pine forest, 52°51'40"N, 18°58'09"E, 29 April 2018, *M. Wolanin* (003449 UR); **DC57** – Borkowo Kościelne near Sierpc, cemetery lawn, 52°50'53"N, 19°42'39"E, 28

Figure 35. *Taraxacum scanicum*; locality – Drezdenko, 2016, photo by M. Wolanin.

April 2018, *M. Wolanin* (003455 UR); **DC63** – Rachcinek, dry roadside, 52°44'23"N, 19°01'15"E, 29 April 2018, *M. Wolanin* (003458 UR); **DE51** – St. Genowefa Hill, distr. Wieluń, 12 June 1965, *H. Błaszczyk* (94960 KRA); **DF26** – Ogrodzieniec near Zawiercie, calcareous rocks, 21 May 1965, *A. Jasiewicz* (439038 KRAM); **DF68** – between Kryspinów and Bielany, sunny hillock, 16 May 1976, *H.*, *T.* & *J. Tacik* (392442 KRAM); **ED11** – Młodzieszyn, pine forest edge, 52°19'00"N, 20°12'23"E, 28 April 2018, *M. Wolanin* (003474, 003475 UR); **EE83** – Zalejowa Mt., fissure in rock, 50°49'07"N, 20°27'30"E, 20 April 2016, *M. Wolanin* (003558 UR); **FC13** – Piątnica (Fort Łomża), pastured grassland, 53°11'50"N, 22°06'53"E, 25 April 2016, *M. Wolanin* (003374, 003567 UR); **FC24** – Zbrzeźnica, sandy bank close to road No 63, 53°02'23"N, 22°09'57"E, 22 April 2016, *M. Wolanin* (003531 UR); Wygoda, sandy bank close to road No 63, 53°04'59"N, 22°08'42"E, 22 April 2016, *M. Wolanin* (003559 UR); **FC50** – Kobylin distr. Goworowo, grassland close to road, 19 May 1992, *Z. Głowacki* (0386425 KRA); **FE85** – Łysaków – Kolonia, sandy roadside close to pine forest edge, 50°45'23"N, 22°07'29"E, 19 April 2019, *M. Wolanin* (003586 UR); **FE96** – Domostawa, scrub on sandy soil, near S19 road parking lot, 50°37'14"N, 22°17'14"E, 22 April 2018, *M. Wolanin* (003463, 003465, 003466 UR); **GF00** – Tereszpol (Zygmunty), sandy path in pine forest, 50°33'56"N, 22°53'56"E, 2 May 2018, *M. Wolanin* (003467 UR).

Notes. Plants with narrow leaves. Lobes tend to be dissected and petioles suffused purple. Outer bracts grey-green with white hyaline margin, often lightly suffused red-violet, recurved or patent. Fully flowering capitulum convex, yellow, sigmas dark. Fruits brown-red, deeply coloured (Figs 34, 35).

13. *Taraxacum tenuilobum* (Dahlst.) Dahlst., Acta Fl. Sueciae 1: 47, 50, 85. 1921.

Taraxacum erythrospermum subsp. *tenuilobum* Dahlst., Bot. Not., 1905: 167. 1905. Basionym.

Type. Sweden, Dalsland, Mo, Ojersbyn, on rock, 24 May 1901, *P.A. Larsson* (lectotype in S, designated by G. Haglund in Doll 1973: 86; isolectotype in S).

Description. Plants small to middle-sized, (5–)10–15 cm tall. ***Leaves*** grey-green, almost glabrous or with few barely visible hairs, approximately (5–)7–12(–15) cm long and (1.5–)2.5–3.5(–4) cm wide, usually 4–5 times longer than wide, blades narrowly oblanceolate, usually broadest in upper 1/3, with 3–7 pairs of lateral lobes; lateral lobes opposite to remote; lateral lobes of the inner leaves strongly dissected, somewhat recurved and twisted, quite often slightly widening at the apex, often with parallel small and acute lobes at the distal margin base; lateral lobes of the outer leaves narrowly triangular, slightly recurved or patent, quite often incised or toothed at the distal margin base; interlobes long, often lobulate; terminal lobe of the inner leaves elongate with a protracted apex; terminal lobe of the outer leaves tripartite-subsagitate, quite often with the apical lobule slightly widening at the apex; petioles unwinged, purple. ***Scapes*** as long as or shorter than leaves, hairy, especially just under the capitulum. ***Capitulum*** convex, 2.5–3.5 cm in diameter, yellow, outer strips grey-violet; inner bracts greyish-green, often with small lumps; outer bracts usually 10–15, narrowly lanceolate, usually 6–8 mm long, 1.5–2 mm broad, bright greyish-green, suffused with violet, faintly bordered (up to 0.05 broad), arcuate, without corniculation or sometimes with small cornicules; stigmas dark greyish-green, pollen present. ***Achenes*** red-brown, in the upper part with slender spinules, 3.5–4.0 mm long (incl. the 0.8–1.1 mm long, cylindrical cone), rostrum 6–7 mm long, pappus white.

Flowering period. April–May.

Habitat. In the northern part of Poland, this species grows most often in dry and sandy habitats, such as sandy grasslands, roadsides of forest roads, edges of pine forests, paths, cliffs, dunes, and lawns. In southern Poland, we noticed this species most often in rock grasslands (in eroding and trampled areas). Plant communities with the participation of *T. tenuilobum* were predominated by species typical to the *Festuco-Brometea* (especially in S Poland) and *Sedo-Scleranthetea* classes. In Świętokrzyskie Mts (Miedzianka place) we noted this species in rocky grassland growing together with *Allium montanum*, *Arenaria serpyllifolia*, *Artemisia campestris*, *Camelina microcarpa* subsp. *sylvestris*, *Campanula sibirica*, *Centaurea stoebe*, *Cerastium semidecandrum*, *Dianthus carthusianorum*, *Euphorbia cyparissias*, *Galium mollugo*, *Holosteum umbellatum*, *Medicago falcata*, *Plantago media*, *Poa compressa*, *P. pratensis*, *Potentilla argentea*, *Ranunculus bulbosus*, *Salvia pratensis*, *Sanguisorba minor*, *Sedum acre*, *Silene nutans*, *Stachys recta*, *Thymus pulegioides*, *Verbascum nigrum*, *Vincetoxicum hirundinaria*, *Viola arvensis*. On the coast of the Baltic Sea (Łeba place) we observed these species on the sandy edge of the pine forest, accompanied by *Carex arenaria*, *Cerastium semidecandrum*, *Erophila verna*, *Potentilla argentea*, *Vicia lathyroides*.

Somatic chromosome number. 24 (Wolanin and Musiał 2017), 25 (Małecka 1969).

General distribution. Mainly NE part of Europe. Species reported from Switzerland, Germany, the Netherlands, Denmark, Poland, Sweden, Norway, Crimea, Moldova, Ukraine, Latvia, Estonia and European Russia (Van Soest 1969; Tutin et al. 1976; Tacik 1980; Fedorov 1989; Lundevall and Øllgaard 1999; Mosyakin and Fedoronchuk 1999; Uhlemann 2003; Wendt and Øllgaard 2015).

Distribution in Poland. Localities grouped in 4 separate areas in northern and southern Poland; quite frequent only in Podlachia and on the coast of the Baltic Sea (Fig. 36A).

Specimens examined. BA59 – Ustka, path, 54°35'25"N, 16°53'07"E, 1 May 2017, *M. Wolanin* (003309 UR); **BA76** – Darłówko, sands, 54°26'45"N, 16°23'41"E, 1 May 2017, *M. Wolanin* (003323 UR); **BA84** – Łazy, path in pine forest, 54°18'16"N, 16°11'16"E, 1 May 2017, *M. Wolanin* (003346 UR); **CA38** – 1,5 km E of Rozewie, cliff, 30 May 1961, *Monk/Mark* (152/2 UGDA); **CA43** – Łeba, path in pine forest, 54°46'05"N, 17°34'06"E, 1 May 2017, *M. Wolanin* (003336 UR); **DA60** – south of Babie Doły, cliff, 12 May 1970, *W. Chojnacki* (153/01 UGDA); **DA70** – Sopot, lawn near promenade, 54°27'26"N, 18°33'43"E, 8 May 2016, *M. Wolanin* (003296 UR); **DA80** – Wisłoujście (Gdańsk), lawn, 54°23'37"N, 18°40'36"E, 7 May 2016, *M. Wolanin* (003552 UR); **DA82** – Świbno, sandy roadside in forest, 54°20'18"N, 18°56'12"E, 10 May 2016, *M. Wolanin* (003283 UR), **DB60** – near Jaszczerek, sandy roadside, 53°37'02"N, 18°35'16"E, 1 May 2019, *M. Wolanin* (003575 UR), **DF06** –

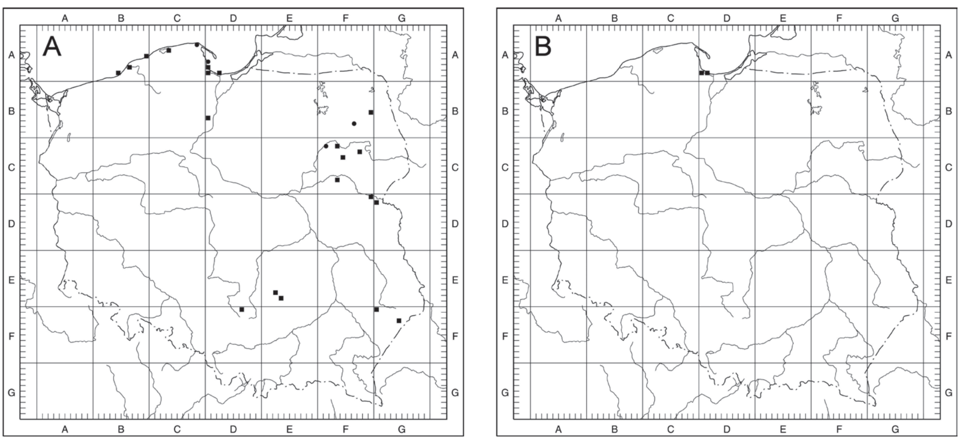

Figure 36. Distribution maps of *Taraxacum* sect. *Erythrosperma* in Poland **A** *T. tenuilobum* **B** *T. tortilobum*; black square – localities recorded during field studies, black circle – other localities known from herbarium data.

Figure 37. Variation in leaf shape in *T. tenuilobum*; locality – Kroczyce (*M. Wolanin* 2016 UR). Scale bar: 5 cm.

Kroczyce, grassland and paths on calceolus rock (SW slope), 50°34'18"N, 19°31'47"E, 1 May 2013, *M. Wolanin* (003359 UR); Podlesice, rock close to cave, grassland on rock, 50°34'30"N, 19°31'32"E, 1 May 2021, *M. Wolanin* (003593 UR); Mirów, grassland on rock overgrown by shrubs, 50°36'53"N, 19°28'51"E, 1 May 2021, *M. Wolanin* (003595 UR); **EE72** – Miedzianka hill, grassland on rock, 50°50'49"N, 20°21'32"E, 11 April 2016, *M. Wolanin* (003514 UR); **EE83** – Sosnówka hill, grassland on rock, 50°48'24"N, 20°26'15"E, 11 April 2016, *M. Wolanin* (003500 UR); **FB59** – between Wrotki and Mogielnica, dry pasture, 53°39'45"N, 22°58'11"E, 24 April 2016, *M. Wolanin* (003270 UR); **FB76** – Sośnia, dunes on pasture, 8 May 2003, *Z. Głowacki* (0388261 KRA); **FC11** – Czartoria, hillock close to river, 8 May 2016, *T. Grużewska* (MPD); **FC13** – Piątnica (Fort Łomża), pastured sandy grassland, 53°11'48"N, 22°07'00"E, 24 April 2016, *M. Wolanin* (003539 UR); **FC27** – Truskolasy-Lachy, stoned field road close to old excavation, 53°02'23"N, 22°42'11"E, 2 May 2018, *M. Wolanin* (003481); **FC34** – Zbrzeźnica, psammophilous grassland, 53°01'24"N, 22°10'11"E, 26 April 2016, *M. Wolanin* (003546 UR); **FC73** – Borowe nad Bugiem, Bug river sandy terrace, 52°40'22"N, 22°00'41"E, 26 April 2016, *M. Wolanin* (003545 UR); **FD09** – Bużka, sandy roadside, 52°21'26"N, 22°53'55"E, 25 April 2016, *M. Wolanin* (003484 UR); **GD10** – Serpelice, lawn, 52°16'49"N, 23°03'01"E, 25 April 2016, *M. Wolanin* (003257 UR); **GF00** – Tereszpol near Biłgoraj, lawn, 50°33'13"N, 22°55'54"E, 25 April 2016, *M. Wolanin* (003468 UR); **GF24** – Bełżec, grassland on closed railway track, 50°22'45"N, 23°26'51"E, 18 April 2019, *M. Wolanin* (003587 UR).

Notes. Plant with distinct, strongly incised and narrow side lobes, and tongue-shaped terminal lobe apex. Outer phyllaries are narrowly lanceolate, arcuate, faintly bordered. Juvenile plants can be confused with *T. scanicum*, which has significantly less dissected side lobes, and the outer bracts of which are wider (with distinct hyaline margin, 0.1–0.2 mm broad), recurved or patent (Figs 37, 38).

Figure 38. *Taraxacum tenuilobum*; locality – Łeba, 2017, photo by M. Wolanin.

14. *Taraxacum tortilobum* Florstr., Acta Soc. Fauna Fl. Fenn. 39(4): 11. 1915.

Type. Finland, Satakunta, Pori (Bjomeborg), Rafso (Reposaari), the cemetery area, 8 June 1911, *B. Florstrom* (lectotype H 068135, designated by Doll 1973: 49; isolectotype in H 202526, 202527, 202538, 202541-202543 and in S).

Description. Plants small to middle-sized, up to 15(–20) cm tall. ***Leaves*** greyish-green to light green, sparsely hairy, approximately (5–)7–10(–14) cm long and (1.5–)2–3(–4.5) cm wide, usually 3–5 times longer than wide, blades elliptical to oblanceolate, with 4–6 pairs of lateral lobes; lateral lobes opposite to remote; lateral lobes of the inner leaves patent or recurved, widened at the base, crisped, with numerous filiform teeth at the distal and proximal margins, usually curled at the apex; lateral lobes of the outer leaves triangular, entire or with a few filiform teeth at margins; interlobes frequently dentate; terminal lobe of the inner leaves tripartite with an elongate tongue-shaped tip; terminal lobe of the outer leaves triangular or tripartite, often with a tongue-shaped tip; petioles narrowly winged, pale purplish-red. ***Scapes*** as long as or longer than leaves, somewhat hairy, green or suffused pale purplish-red. ***Capitulum*** convex, 3–4 cm in diameter, pale yellow, outer strips grey-purple; inner bracts greyish-green, corniculate; outer bracts usually 12–14, ovate to lanceolate, usually 6–7(–8) mm long and (–1.5)2–3 mm broad, grey-green, suffused with purple, with a white hyaline margin 0.1–0.2 mm broad, loosely adpressed to obliquely spreading, purple at apex, corniculate; stigmas grey-purple, pollen present. ***Achenes*** pale grey-brown, achene body spinulose above, 4.7–5.3 mm long (incl. the 1.4–1.9 mm long, narrowly conical cone); for specimens growing in full light achene measurements are 4–4.4 mm (incl. the 0.9–1.3 mm long cone).

Flowering period. (April) May.

Habitat. Sandy pine forest edges, dry lawns, scrubs. On the coast of the Baltic Sea (Gdańsk Stogi) we noticed this species on a sandy path at the edge of a pine–false acacia forest (growing together with *Elymus repens*) and on the scrub edge, accompanied by *Ballota nigra*, *Dactylis glomerata*, *Erigeron annuus*, *Ficaria verna*, *Geranium pusillum*, *G. robertianum*, *Lamium purpureum*, *Poa nemoralis*, *P. pratensis*, *Stellaria media*, *Taraxacum proximum*, *Veronica hederifolia* s.l.

Somatic chromosome number. 24 (Wolanin and Musiał 2018).

General distribution. Widespread European species reported from Spain, Great Britain, France, Corsica, Italy, Switzerland, Germany, Belgium, the Netherlands, Germany, Denmark, Poland, Sweden, Finland, Ukraine, Latvia, Estonia (Van Soest 1967; Richards 1969; Adema et al. 1982; Lundevall and Øllgaard 1999; Mosyakin and Fedoronchuk 1999; Uhlemann 2003; Wendt and Øllgaard 2015; Wolanin and Musiał 2018).

Distribution in Poland. Species scarce, noted only in Gdańsk (Baltic Sea seashore) (Fig. 36B).

Specimens examined. DA80 – Gdańsk, Roland pleasure ground, lawn on sandy ground, 54°24'45"N, 18°36'18"E, 08.05.2016, *M. Wolanin* (003289 UR); **DA81** – Gdańsk (Stogi), sandy place on pine forest edge (along concrete walkway), 54°22'27"N, 18°43'40"E, 7 May 2016, *M. Wolanin* (003263, 003276, 003302 UR); Gdańsk (Stogi), sands, 54°22'08"N, 18°43'31"E, 8 May 2016, *M. Wolanin* (003315 UR).

Figure 39. Variation in leaf shape in *T. tortilobum*; locality – Gdańsk Stogi (*M. Wolanin* 2016 UR). Scale bar: 5 cm.

Notes. Species included in the *Dissimilia* group, easily identified by a combination of pale grey-brown achenes, leaves strongly crisped, lateral lobes often toothed and curled, outer phyllaries loosely adpressed to obliquely spreading (Figs 39, 40).

Figure 40. *Taraxacum tortilobum*; locality – Gdańsk Stogi, 2016, photo by M. Wolanin.

Species not confirmed in Poland

Based on the literature data, 25 *Taraxacum* species from the section *Erythrosperma* have been reported from Poland to date (Table 1). However, the presence of 10 species listed by Tacik (1980), i.e.: *T. austriacum* Soest (=*T. erythrospermum* Andrz. & Besser), *T. brunneum* Soest, *T. laetiforme* Dahlst. (=*T. discretum* H. Øllg.), *T. falcatum* Brenner, *T. fulvum* Raunk., *T. gracillimum* Soest, *T. laetum* (Dahlst.) Dahlst., *T. leptocarpum* Saarsoo, *T. marginatum* Dahlst., *T. simile* Raunk, and included in successive editions of the checklist (Mirek et al. 1995, 2002, 2020), were not confirmed during the revision of the herbarium materials. All of the above-mentioned species had been misidentified with other species. Moreover, the occurrence of the species was also not confirmed during the field studies. It is worth mentioning that, with the exception of *T. erythrospermum*, all of these species are also absent in the neighbouring countries/regions (eastern Germany, Czech Republic) (Uhlemann 2003; Trávníček et al. 2010). The specimens of *T. erythrospermum* collected in the vicinity of Kraków (Tacik 1980) were misidentified and actually belonged to *T. danubium* (Wolanin and Musiał 2018). In 2005, Vašut et al. (2005) reported the presence of *T. maricum* in Solec, however, their determination of the specimens was uncertain. During field studies, we could not confirm the presence of *T. maricum* in Solec, despite intensive field penetration at the locality. Thus, in the face of the lack of additional herbarium material of this species from Poland, we decided to exclude it from the list.

Threats

Using the IUCN (2022) threat categories, most of the investigated species (*T. bellicum*, *T. brachyglossum*, *T. lacistophyllum*, *T. plumbeum*, *T. proximum*, *T. scanicum*, *T. tenuilobum*) should be considered as of least concern (LC) in Poland. The species listed above are rare in Poland, growing in large dispersion (*T. bellicum*, *T. brachyglossum*, *T. plumbeum*, *T. scanicum*, *T. tenuilobum*), the others (*T. lacistophyllum*, *T. proximum*) occur more regionally, often abundantly, in semi-ruderal habitats (Fig. 41A–C). One gets the impression that human activity causes them more benefits than harm, for example, in Wielkopolska Lowland, *T. scanicum*, *T. proximum*, *T. plumbeum*, *T. bellicum* grow on intensively trampled paths, on roadsides or even in cemeteries. We also included the rarer plants (*T. disseminatum*, *T. dissimile*) in this category, due to the relatively large area of occurrence and the lack of noticeable factors that could threaten them at present. *T. parnassicum* is considered a species near to threat (NT) due to its close relation to specific, rare habitats and observed unfavourable habitat transformations that clearly threaten this species, e.g. xerothermic rock grasslands overgrowing due to lack of grazing (Fig. 41D). A significant part of the private property limestone rocks in the Kraków-Częstochowa Upland is also successively fenced, which definitely accelerates the overgrowing by shrubs due to the lack of touristic exploration. In the Lower Silesia, many localities of *T. parnassicum* reported in the nineteenth and second half of the twentieth century are now most likely historical, which may have been caused by the intensification of agriculture in this area and secondary succession in closed sand mines. *T. tortilobum* is classified as a vulnerable species (VU) due to very small and limited populations (the species was found only in Gdańsk). *T. danubium* should be recognised as an endangered species (EN) due to its limited range in Poland, a very low number of sites and very significant fluctuations observed in the number of mature individuals. It seems that a significant factor preserving this species in the largest localities (Olsztyn, Skały Twardowskiego in Kraków) is their being recreational destinations (Fig. 41E). *T. cristatum* should be considered critically endangered (CR) in Poland due to the extremely low number of its localities, small populations and the observed decline in the number of individuals. The same risk category (CR) was assigned to *T. sandomiriense* due to the extremely small number of sites and mature plants within them as well as the tendency for its habitats to decline (very rare and specific to this species; Fig. 41F).

Figure 41. Habitats of dandelions of the sect. *Erythrosperma* in various parts of Poland **A** *Taraxacum plumbeum* on sandy roadside in Dźwirzyno, 2016 **B** *T. lacistophyllum* on dry lawn in Jastrzębia Góra, 2016 **C** dry rocky SW slope in Jeleniewo – habitat of *T. bellicum*, 2018 **D** xerothermic grassland in Jaworki (Pieniny Mts) – habitat of *T. parnassicum*, 2015 **E** limestone rocks in Olsztyn – habitat of *T. danubium*, *T. parnassicum* and *T. brachyglossum*, 2020 **F** rocky grassland in Podgrodzie – habitat of *T. sandomiriense* and *T. bellicum*, 2018, photos by M. Wolanin.

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Supplementary material 1

Genetic distance between *Taraxacum* genotypes

Authors: Mateusz Wolanin, Ewelina Klichowska, Iwona Jedrzejczyk, Monika Rewers, Marcin Nobis

Data type: genetic

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A new species of *Liparis* (Orchidaceae, Epidendroideae, Malaxidinae) from the Bosque de Protección Alto Mayo, San Martín, Peru

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Abstract

Liparis altomayoënsis **sp. nov.** is described, illustrated, and tentatively assigned to the Neotropical section *Decumbentes* on the basis of its branching, prostrate rhizomes and upright stems bearing several leaves. Vegetatively, the new species is distinguished by its short, upward stems bearing 3–6 leaves, these with undulate, translucent margins and reticulate, prominent veining on the upper surface. Florally, it is distinctive in the labellum with fleshy basal one-half provided with a central, rounded cavity limited on each side by a prominent, bilobulate ridge and apically by a lunate ridge, and membranaceous, trilobulate apical one-half deflexed ca. 90°. In contrast with other species of section *Decumbentes*, in which fruit formation is infrequent, in *L. altomayoënsis* a high proportion (~50–100%) of flowers develop into a fruit; in some flowers the pollinaria rotate and contact the stigma, apparently resulting in at least facultative self-pollination. The main differences among the six species of *L.* section *Decumbentes* hitherto known are contrasted in a dichotomous key. The new species is known only from three populations located in the Bosque de Protección Alto Mayo, on the Amazonian slope of the Andes in northeastern Peru but appears to be under no foreseeable threats.

Keywords

Andean cloud forest, high fruit set, labellum, self-pollination

Resumen

Liparis altomayoënsis **sp. nov.** es descrita, ilustrada y asignada tentativamente a la sección neotropical *Decumbentes* con base en sus rizomas postrados, ramificados y tallos ascendentes portando varias hojas. Vegetativamente, la nueva especie se distingue por sus tallos ascendentes cortos con 3–6 hojas, éstas con márgenes undulados, translúcidos y venación reticulada prominente en la superficie superior. Floralmente, es distintivo su labelo con la mitad basal carnosa, provista de una cavidad central redondeada que está limitada a cada lado por una cresta bilobulada prominente y apicalmente por una cresta lunada, y la mitad apical del labelo membranácea, trilobulada y deflexa ca. 90°. En contraste con otras especies de la sección *Decumbentes*, en las que la producción de frutos es infrecuente, en *L. altomayoënsis* una alta proporción (~50–100%) de las flores produce fruto; en algunas flores los polinarios rotan y contactan el estigma, aparentemente resultando en autopolinización al menos facultativa. Las diferencias principales entre las seis especies de *L.* sección *Decumbentes* conocidas hasta ahora se contrastan en una clave dicotómica. La nueva especie se conoce solamente de tres poblaciones localizadas en el Bosque de Protección Alto Mayo, en la vertiente amazónica de los Andes en el noreste de Perú, pero no parece estar sujeta a amenazas previsibles.

Palabras clave

Alta producción de frutos, autopolinización, bosque nublado andino, labelo

Introduction

The genus *Liparis* Rich. consists of about 320 epiphytic and geophytic species and is widely distributed in tropical, subtropical, and temperate regions of the Old and New Worlds, being distinguished from other members of Malaxidinae mainly by the elongate column with an apical, incumbent anther (Ridley 1886; Cribb et al. 2005). Although several molecular phylogenetic studies have shown that *Liparis* is polyphyletic (Cameron 2005; Tang et al. 2015; Li et al. 2020; Ya et al. 2021; Wang et al. 2022), such studies have been strongly biased towards tropical/subtropical Asian taxa. Many Neotropical species have not yet been included in molecular analyses, and much work remains to be done to attain a clear picture of generic limits and relationships in this region. Meanwhile, the morphology-based sectional classification proposed by Garay and Romero-González (1999) provides a framework for taxonomic discussion and comparison of morphologically discrete groups.

Liparis section *Decumbentes* Garay & G.A.Romero is endemic to the Neotropics and distinctive in the decumbent, creeping stems with distichously arranged leaves (Garay and Romero-González 1999; Fig. 1). This poorly known group is restricted to Andean cloud forests from Venezuela south to Bolivia, and included five species, two of them only recently described from Peru (Damián et al. 2020; Salazar et al. 2022).

In this work, we propose an additional species tentatively assignable to *Liparis* section *Decumbentes*, discovered during fieldwork conducted as part of our ongoing orchid inventory of the Bosque de Protección Alto Mayo, San Martín, Peru (BPAM; J. D. Edquén et al. in prep.). The new species is described and illustrated, and the features permitting to distinguish the currently known six members of *Liparis* section *Decumbentes* are compared in a dichotomous key.

Materials and methods

Live plants were studied *in situ* and photographed with a digital camera (Nikon 850, Nikon Corporation, Tokyo, Japan) provided with a 60 mm AF Micro Nikkor lens (Nikon). Leaves and flowers preserved in ethanol 70% were examined and photographed under a stereomicroscope (Stemi SV 6, Carl Zeiss Mikroskopie, Jena, Germany) using a cell phone (iPhone 11, Apple Inc., Cupertino, USA). All images were processed for plate preparation with ADOBE PHOTOSHOP v. 24.0.1 (Adobe Inc., San Jose, USA). Three specimens from different locales were pressed and deposited in the herbarium of the Universidad Nacional Toribio Rodríguez de Mendoza, Chachapoyas, Peru (KUELAP); one of them was designated as the holotype. Measurements were made on the pressed specimen and the alcohol-preserved specimens. Our material was compared with the protologues and additional literature, types, and records of types of all previously described species of New World *Liparis*, especially those belonging to section *Decumbentes*, to which our material shows similarities. The collections of several major herbaria in Peru and abroad were studied, including AMES, AMO, CUZ, F, GH, HOXA, K, KUELAP, MEXU, MO, MOL, NY, QCE, QCNE, UFV, US, and USM (herbarium acronyms according to Thiers 2022). The new species was compared on morphological grounds to other members of section *Decumbentes* and the main differences were incorporated into a key to the six hitherto recognized species belonging to this section.

Taxonomic treatment

***Liparis altomayoënsis* Salazar & Edquén, sp. nov.**
urn:lsid:ipni.org:names:77317365-1
Figs 1, 2

Type. Peru. Departamento San Martín: Provincia Rioja, distrito Pardo Miguel Naranjos, sector Venceremos, camino al terreno del Sr. Roner Espinal Gómez, 5°41'10.68"S, 77°45'19.17"W, 1756 m a.s.l., 15 June 2022, *J. D. Edquén 6111* (holotype: KUELAP 002579!).

Diagnosis. *Liparis altomayoënsis* is characterized by the short prostrate rhizomes and upright stems (to 5 and 8 cm long, respectively); 3–6 spirally arranged leaves per stem; leaves petiolate, the blades with strongly undulate, translucent margins and reticulate veining prominent on the upper surface and sunken on the underside. The labellum is slightly wider than long, its base provided at each side with a fleshy, rounded, channeled, erect lobule forming a tunnel with the lower half of the column; basal one-half of labellum provided with a central, rounded cavity limited on each side by a prominent, bilobulate ridge and apically by a lunate ridge; apical one-half of labellum membranaceous, trilobulate, deflexed ca. 90°. (Figs 1F–H, 2C–E).

Description. Terrestrial, decumbent, glabrous ***herb*** 5–15 cm tall including the inflorescence. ***Roots*** scarce, dull white, glabrous, arising from the rhizome, up to 15 mm long, ca. 0.5 mm in diameter. ***Rhizome*** (prostrate portion of the stems) branching, terete, greenish white, each branch formed by several (up to 10) internodes, 2–5 cm long, 2–3 mm in diameter, partially covered by brownish remains of cataphylls; upright portion of the stem 3.5–8 cm long, 2.5–3.5 mm in diameter, formed by 4–6 internodes, these nearly completely covered by the leaf sheaths. ***Leaves*** [2–]3–6 per stem, arranged into a spiral, petiolate; petiole (4–)10–14 × 3–5 mm, semi-tubular, obliquely sheathing the internode; blade 10–25 × 7–15 mm, ovate, acute to shortly acuminate, margins strongly undulate, translucent, 5–7 main parallel veins and several transverse ones, all veins conspicuously raised on the upper surface and slightly sunken on the underside, excepting the slightly prominent central vein; upper surface glossy dark green, lower surface opaque olive green. ***Inflorescence*** terminal, 4–7 cm long; peduncle 20–26 mm long, 1–1.5 mm in diameter, with several longitudinal low keels; raceme 2–6 cm long, moderately lax, with 7–20 flowers opening in succession, but most can be open at a time. ***Floral bracts*** shorter than the ovaries, divergent from the rachis at flowering, patent at fruiting stage, pale green, lanceolate, acute, 5–7 × 1.3–1.5 mm. ***Ovary*** spreading, pedicellate, narrowly obconical, convex dorsally, flat ventrally, slightly 3-angled, 6–6.6 mm long, 1–1.2 mm wide above the middle; about one half of the length corresponds to the twisted pedicel. ***Flowers*** resupinate, pale green with a wine–colored ridge at each side of the central cavity of the labellum. ***Sepals*** spreading, with revolute margins, 1-veined; lateral sepals obliquely elliptic, rounded, 3.6–3.7 × 1.6–1.7 mm, dorsal sepal linear–lanceolate, rounded and slightly calyptrate at apex, 4–4.1 × 1.2–1.3 mm. ***Petals*** spreading, incurved, linear, slightly falcate, rounded, 4–4.2 × 0.5–0.6 mm. ***Labellum*** 2.6–2.7 mm total length, 2.7–2.8 mm total width when spread out, sessile, 7-veined, in natural position its basal one-half diverging ca. 60° from the column and the apical one-half in turn deflexed ca. 90°; base provided at each side with a fleshy, rounded, channeled, erect lobule forming a tunnel with the lower half of the column; disc fleshy, deeply concave, provided at each side of the cavity with a obliquely triangular, retrorse, rounded lobe ca. 1 × 0.8 mm, which has an erect ridge projected towards the apex into an acute, narrowly triangular lobule ca. 0.2 × 0.1 mm; cavity limited apically by a transverse, lunate, rounded to obtuse fleshy ridge; apex membranaceous, trilobulate, the lobules rounded, mid-lobule ca. 0.3 × 0.2 mm, lateral lobules much shorter, deflexed in natural position. ***Column*** semiterete, clavate, slightly arcuate, lacking auricles, whitish green below the middle, dark green with purplish suffusion near the apex, 1.6–1.8 × 0.7–0.8 mm. ***Anther*** apical, incumbent, transverse to the main column axis, whitish, cordiform, emarginate, 2-celled with each cavity partially subdivided in two, ca. 0.2 × 0.4 mm. ***Pollinaria*** 2, each consisting of 2 fused pollinia, yellow, obliquely ovoid, granulose, 0.3–0.4 × ca. 0.2 mm. ***Capsule*** ascending, ellipsoid, with 6 low longitudinal ribs, to 5 × 3.5 mm plus a filiform pedicel ca. 4.5 mm long, when mature yellowish brown.

Phenology. Flowering recorded in June and July. Capsules in different stages of development were observed from June to October. Mature, empty dehiscent capsules from the previous year's flowering were observed in mid-May.

Distribution and habitat. Known only from sector Venceremos of the BPAM. Terrestrial, in deep leaf mold on steep slopes with wet montane cloud forest on a

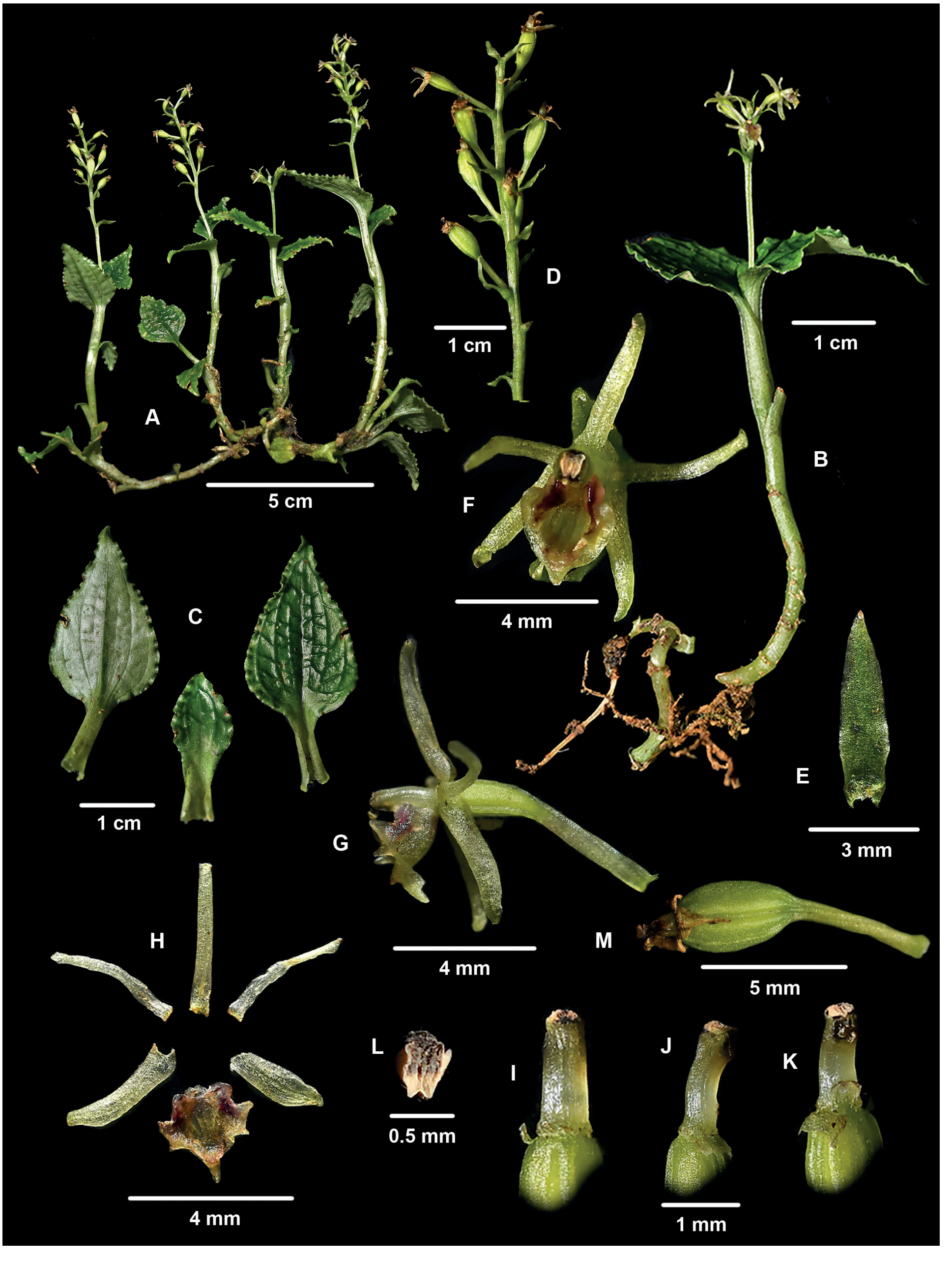

Figure 1. *Liparis altomayoënsis* (from *Edquén 6111*) **A** habit **B** flowering stem **C** leaves **D** infructescence **E** floral bract **F** flower from front **G** flower from side **H** perianth dissection **I** column, dorsal view **J** column, lateral view **K** column, ventral view **L** anther **M** developing capsule.

steep tepui (table mountain) slope dominated by dwarfed trees of *Clusia* L. (Clusiaceae), *Meriania* Sw., *Miconia* Mart. (Melastomataceae) and stands of *Chusquea* Kunth (Poaceae), at 1750–2160 m a.s.l.

Etymology. The specific epithet refers to the Bosque de Protección Alto Mayo, the protected natural area in northeastern Peru where this species was discovered.

Taxonomic notes. We tentatively include the new species in *Liparis* section *Decumbentes* because of its branching, prostrate rhizomes and upright stems bearing several leaves (Fig. 1A, B). However, in many other respects it differs from the five previously known species of the section, and its systematic position will have to be revised when material suitable for molecular analysis is available. Vegetatively, *L. altomayoënsis* differs from all other species of section *Decumbentes* in its comparatively short, upward stems bearing only a few (3–6) spirally arranged leaves with strongly undulate, translucent margins and reticulate veining, with the veins prominent on the upper surface and sunken on the underside (Fig. 1C). Florally, the most distinguishing feature of the new species is the unusual morphology of the labellum, which is slightly wider than long. The basal one-half of the labellum is fleshy, diverges from the column about 60° and has a retrose lobe on each side and a central, rounded cavity limited on each side and the apex by prominent ridges; the apical one-half of the labellum is membranaceous, deflexed ca. 90° with respect to the basal one-half, and 3-lobulate (Fig. 1F, G). The lateral labellum ridges consist of a proximal, retrorse, obtuse lobule and a forwardly projecting, narrowly triangular distal lobule. The apical ridge limiting the cavity is unlobed, lunate, and rounded or obtuse. The column is semiterete, clavate, slightly arcuate, lacking auricles and the anther is terminal, transverse to the main axis of the column (Fig. 1E, I–K). The features allowing for the distinction of the six species hitherto known of *L.* section *Decumbentes* are highlighted in the key (see below).

Reproductive biology. Unlike other species of *Liparis* section *Decumbentes*, in which fruit production seems to be very rare (cf. Damián et al. 2020; Salazar et al. 2022), a surprisingly high percentage (~50–100%) of flowers of the plants of *L. altomayoënsis* we examined were developing into a fruit (Figs 1A, B, 2A). Such high frequency of fruit formation is similar to that recorded in self-pollinating populations of other, distantly related species of *Liparis*, such as eastern Asian *L. kumokiri* F.Maek. of section *Liparis* (Oh et al. 2001). We were unable to verify in the field possible evidence of self-pollination, but we could not remove the pollinaria of several fresh flowers examined and photographed *in situ*, and subsequent examination of the columns of six alcohol-preserved flowers under a stereomicroscope revealed that, in two of them, the two pollinaria were in contact with the stigmatic cavity, as if they had rotated downwards with the rostellum acting as a sort of hinge (Fig. 2B). A similar rotation of the pollinaria to contact the stigma has been suggested as a mechanism of self-pollination, probably promoted by the dislodgement of the anther by raindrops, in other species of *Liparis* such as *L. loeselii* (L.) Rich. in eastern North America (Catling 1980) and *L. kumokiri* in Japan (Suetsugu 2019). Facultative autonomous self-pollination resulting from rotation of the pollinarium such that the pollinia contact the stigma has been recorded in some populations of species of other Epidendroideae genera, such as *Eulophia alta* (L.) Fawc. & Rendle (Goss 1973; G.A. Salazar, pers. obs.), *Eulophia maculata* (Lindl.) Rchb.f. (as *Oeceoclades maculata* (Lindl.) Lindl.; Aguiar et al. 2012: fig. 4), and various species of *Corallorhiza* Gagn. (Catling 1990 and references therein; Freudenstein 1997; G. A. Salazar pers. obs.). Hence, there is a possibility that at least some of the many capsules observed in *L. altomayoënsis* may have resulted from

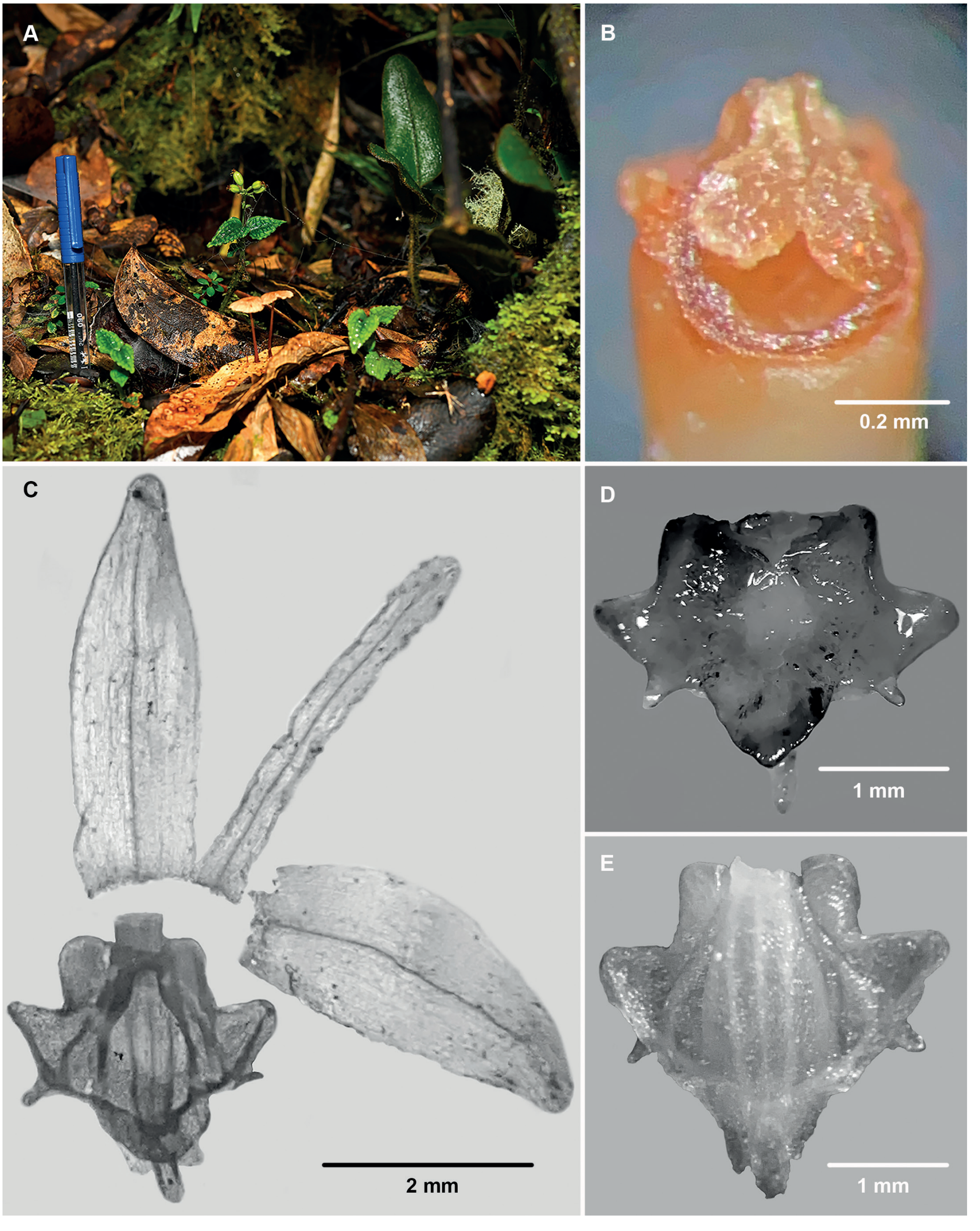

Figure 2. *Liparis altomayoënsis* (from *Edquén 6111*) **A** plants in habitat (the pen serves as size reference) **B** column apex from below showing the two pollinaria on the stigmatic cavity **C** dissection of the perianth **D** labellum, ventral view **E** labellum, dorsal view.

self-pollination by the spontaneous rotation of the pollinaria. However, in fresh flowers of *L. altomayoënsis* the labellum is distinctive glossy, especially the raised borders of the basal cavity and the bottom of the cavity itself, suggesting nectar mimicking, as proposed for other *Liparis* having a glossy central band along the labellum (Oh et al. 2001). We were unable to verify whether the cavity contains nectar, which has been shown to be present at least in small quantities in some species of *Liparis* (Margońska et al. 2019; Suetsugu 2019). The presence of nectar or a nectar-mimicking glossy surface are suggestive of visitation and probable cross-pollination mediated by insects. At the present time, it is not clear whether the high fruit set observed in *L. altomayoënsis* is the result of self-pollination, pollinator-mediated cross pollination, or both, and the factors underlying its high success in setting fruit will have to be clarified by carefully designed field and laboratory experiments.

Conservation assessment. The BPAM was established in 1987 by the Peruvian government to protect the water sources for agriculture, industrial use, and human consumption in the valley of the Upper Mayo River, as well as to conserve the fauna and flora (Servicio Nacional de Áreas Naturales Protegidas por el Estado 2023). It encompasses 182,000 ha of rugged mountainous terrain on the eastern (Amazonian) slope of the Andes in the northwestern portion of the Department San Martín and adjacent areas of Departments Amazonas and Loreto (ca. 5.4°–6.2°S, 77.2–77.8°W), covering an elevation interval from ca. 900 to 3800 m a.s.l. The vegetation includes wet lower montane forest, montane rain/cloud forest, and high-elevation grassland. *Liparis altomayoënsis* is known only from three stands (populations) of various dozen plants located on the northwestern portion of the BPAM (sector Venceremos) on a steep tepui slope. There were no signs of human alteration or potential risk factors to the populations, which are under legal protection within the BPAM. Moreover, there are large expanses of potentially suitable habitat that remain to be explored, which suggests that this species is not an immediate conservation concern, as long as its habitat remains unaltered.

Additional specimens examined. Peru. As the type locality, 5°42'41.55"S, 77°44'19.54"W, 2090 m a.s.l., 17 May 2022, *J. D. Edquén 6101* (KUELAP!); as the type locality, 5°42'42.73"S, 77°44'31.99"W, 2160 m a.s.l., 4 July 2022, *J. D. Edquén 6421* (KUELAP!).

Key to the species of *Liparis* section *Decumbentes*

1 Labellum saddle-shaped, i.e., strongly convex with the lateral margins downcurved, distal margins laciniate, apex projected into a narrowly triangular lobule .... ***L. inaudita* Salazar, Edquén & D.Trujillo**

– Labellum not saddle-shaped, at most slightly convex without downcurved margins, concave or strongly revolute, distal margins entire or erose, apex rounded, shallowly emarginate, apiculate, mucronate or 3-lobulate, if prominently apiculate then the margins entire (not laciniate) **2**

2 Labellum strongly revolute, when spread out abruptly expanded from a short cuneate base, about two times wider than long, transversely oblong–flabellate, apex apiculate .... ***L. laticuneata* C.Schweinf.**

– Labellum not strongly revolute, when spread out variously shaped but never abruptly expanded from a short cuneate base, longer than wide or only slightly wider than long, apex shallowly emarginate with a small apicule in the sinus or 3-lobulate **3**

3 Labellum deeply concave, the concavity limited at each side and towards the apex by prominent, fleshy ridges, lateral ridges retrorse, projected forwardly into a narrowly triangular lobule, apical ridge lunate, obtuse, labellum apex 3-lobulate ....***L. altomayoënsis* Salazar & Edquén**

– Labellum flat, slightly convex or slightly concave, without ridges whatsoever, labellum apex not 3-lobulate..**4**

4 Leaves sessile; labellum slightly convex, when spread out ovate–elliptic, apex and base rounded.......................***L. sessilis* Damián, Salazar & Rimarachín**

– Leaves petiolate; labellum flat or slightly concave, when spread out obovate, pandurate, or ovate–rhombic, apex obtuse or shallowly emarginate, mucronate, base cordate..**5**

5 Flowers with pale green sepals and petals, and red purple labellum; labellum ovate–rhombic, obtuse; column slender above a thick base, strongly arcuate, about four times as long as wide or longer .... ***L. crispifolia* Rchb.f.**

– Flowers entirely green with a darker green central stripe on the labellum; labellum obovate or pandurate, shallowly emarginate, the sinus apiculate; column thick throughout, slightly arcuate, about 2.5 times longer than wide.... .... ***L. brachystalix* Rchb.f.**

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CHECKLIST

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Checklist of the diatoms (Bacillariophyta) from Lake Naivasha, Kenya, with some historical notes

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Abstract
Lake Naivasha is one of only two large freshwater lakes in the Eastern Rift Valley of Kenya, East Africa. Together with its satellite lakes Crescent Island Crater, Oloidien and Sonachi, it comprises a great variety of pelagic and benthic habitats for aquatic biota, and its sediment record represents a unique archive of past climate change and long-term ecosystem dynamics in equatorial East Africa. This is particularly so because local paleoenvironmental reconstructions can be checked against historical data on the composition of aquatic fauna and flora collected in Lake Naivasha since the early 20th century. Some of the most prominent biological proxies for reconstructing past changes in lakes are diatoms (Bacillariophyta), a group of unicellular autotrophic eukaryotes of which the siliceous skeletons (valves) preserve well in lake sediments and are good indicators for, among others, climate-driven changes in salinity. However, diatom taxonomy and species concepts have changed a lot in recent decades, making it sometimes difficult for non-taxonomists to know which species are concerned in different published studies. This paper provides the currently accepted taxonomic names of the 310 specific and infraspecific diatom taxa reported from Lake Naivasha and its satellite lakes to date, together with their synonyms used in literature concerning these lakes as well as other, commonly used synonyms. Further, a short overview is given of the history of diatom research conducted on materials from Lake Naivasha and its satellite lakes. The present checklist may facilitate the identification and interpretation aspects of future diatom studies on the wider Lake Naivasha ecosystem and on other East African lakes that are less well studied.

Keywords
biodiversity, Crescent Island Crater, East Africa, Lake Oloidien, Lake Sonachi

Introduction

Lake Naivasha is located at about 1885 m a.s.l. (above sea level) in the central valley of the Eastern (Gregory) Rift in Kenya between 0°43'08"S and 0°49'57"S and between 36°16'54"E and 36°25'46"E (Fig. 1). With a surface area fluctuating around 135 km^2, Lake Naivasha is, besides Lake Baringo, the only large freshwater lake in Kenya's portion of the Eastern Rift Valley, and consequently an important source of freshwater in the rift-valley region. It has two smaller satellite lakes, which, depending on the lake level, can be confluent with it or separated by a narrow sill: Lake Oloidien with a surface area of 5.1 km^2 at its southwestern corner, and Crescent Island Crater (1.9 km^2) along its eastern shore. Its third satellite lake is Lake Sonachi, also referred to as Crater Lake (e.g., Rich 1932) or Green Crater Lake (e.g., Damnati et al. 1991), is a very small saline crater lake (0.14 km^2) situated to the west and receiving underground water supply from the main basin of Lake Naivasha (MacIntyre and Melack 1982; Verschuren 1999a).

While the main basin of Lake Naivasha is hydrologically open, fed by the Malewa and Karati Rivers in the east and the Gilgil River in the north, and groundwater outflow to the south and the southeast, Lake Oloidien is hydrologically closed (Gaudet and Melack 1981; Verschuren et al. 2000b). Without its own river inflow, this lake depends on local rainfall and either direct confluence or subsurface inflow from Lake Naivasha (Verschuren et al. 1999a, 2000b). Crescent Island Crater Lake is hydrologically open through its direct confluence with the main lake. Only during periods of severe lowstands, when the connection with the main lake is fully interrupted, does it become a hydrologically closed system (Verschuren 2001; Van der Meeren et al. 2019).

During lake highstands, such as first recorded in 1897 but also the present-day situation after two episodes of strong transgression in 2011, 2012 and 2020, Lake Oloidien is broadly confluent with Naivasha and contains fresh water. However, when separated from Lake Naivasha during lake lowstands, it develops higher salinity because it then depends on local rainfall and subsurface inflow, while water losses are almost entirely due to evaporation (Verschuren et al. 2000b). Lake Sonachi is normally a strongly saline-alkaline ('soda') lake, but substantial changes in salinity during past episodes of wetter and drier climate conditions have also been reported in historical times (Verschuren et al. 1999a). This implies that freshwater as as well as inland saline communities of aquatic biota, among others of diatoms, can be found in the lakes of this aquatic system, making Lake Naivasha and its satellite lakes ideal for paleolimnological research involving both climate reconstruction and long-term ecological dynamics (Verschuren et al. 1999a, b, 2000a, 2000b; Mergeay et al. 2011; Van der Meeren et al. 2019; Van der Meeren and Verschuren 2021).

However, diatom taxonomy and species concepts have changed a lot since species description in this group of unicellular algae started in the 19th century. After a period of species lumping in the 20th century, the end of the last century saw the erection of new and restoration of many formerly described genera and species mainly due to better microscopes. Moreover, many new species were discovered, including tropical African taxa which had previously been assigned to European and/or North American

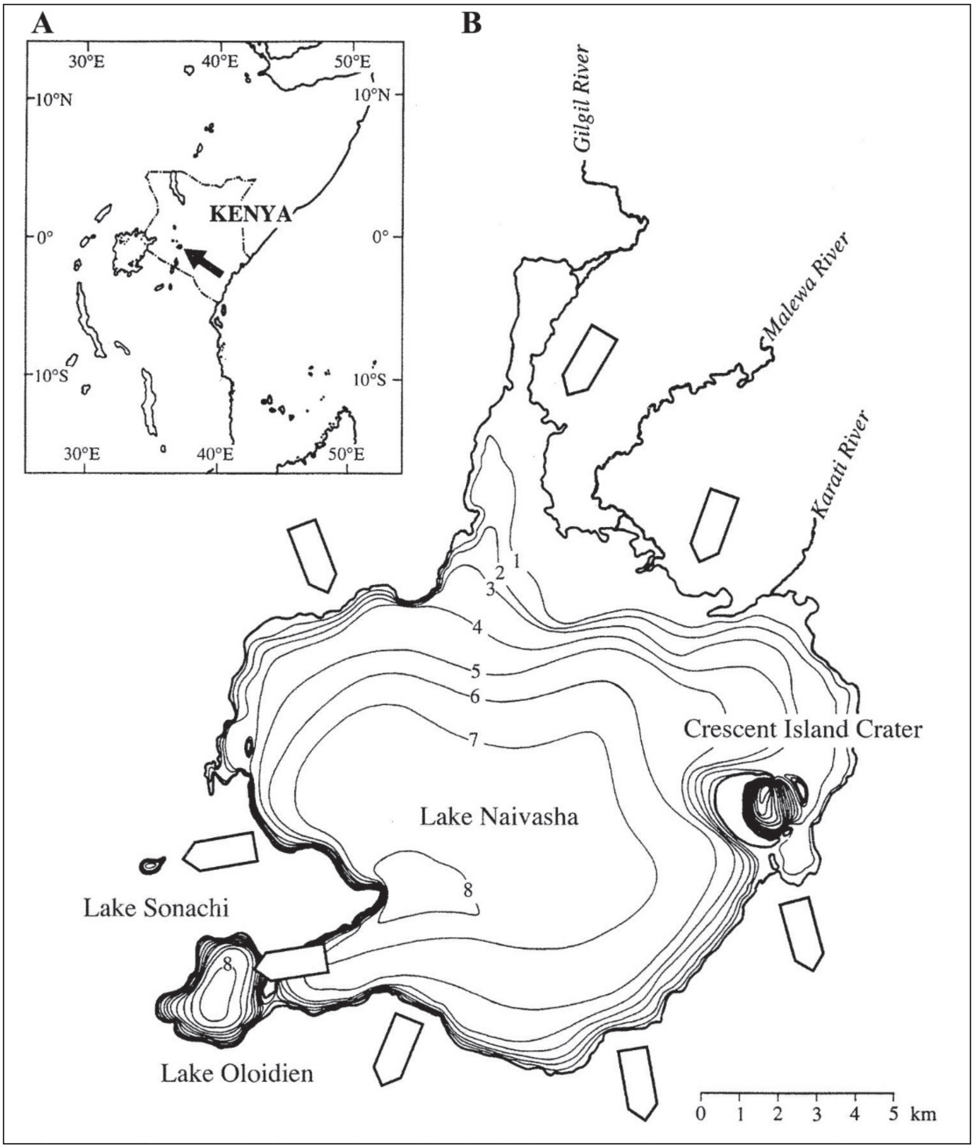

Figure 1. A location of Lake Naivasha in Kenya, East Africa **B** bathymetric map of Lake Naivasha and its satellite Lakes Oloidien, Sonachi and Crescent Island crater, relative to a lake-surface elevation of 1885.8 m above sea level. White arrows show the direction of the groundwater flow. From Verschuren et al. (2000b), as modified after Gaudet and Melack (1981) and Åse et al. (1986).

taxa due to the use of identification guides from these north-temperate regions. This makes it often very difficult for non-taxonomists to know exactly which diatom species are involved in the older and the more recent literature on Lake Naivasha. Because of the importance of Lake Naivasha in East African paleoecological and paleoclimate studies, and the fact that diatoms have proven to be good indicators (so-called 'proxies') for changes in salinity (and nutrients) and reconstruction of past environmental situations, we found it opportune to make a checklist of all the diatoms reported up to now from Lake Naivasha and its three satellite lakes. Notably, the present checklist covers both recent phytoplankton and periphytic collections as well as fossil diatom valves recovered from sediment cores. The current taxonomically accepted names are provided together with their synonyms used in different studies as well as references to the publications or materials in case of unpublished results.

Material and methods

The material used for the present checklist is twofold. On the one hand, all literature data known to us, published between 1932 and the present, among others Rich (1932), Bachmann (1938), Richardson and Richardson (1972), Gasse (1986), Verschuren et al. (1999a), Verschuren et al. (1999b), Verschuren et al. (2000a), Verschuren et al. (2000b), Cocquyt and De Wever (2002), Stoof-Leichsenring et al. (2011), Stoof-Leichsenring et al. (2012) and Owino et al. (2020). On the other hand, counts of fossil diatom assemblages carried out on sediment cores from Naivasha, Crescent Island Crater, Oloidien and Sonachi, whose results are either unpublished, or were used for publications focusing on paleoenvironmental reconstruction that did not include full species lists.

The sediment sequences covered in this paper are listed in Table 1, with citation of the publication providing the most detailed information on their collection and characteristics.

All sediment cores were recovered from an anchored boat or platform using a combination of gravity coring and piston coring, except for NS93.2-F which was recovered using freeze coring (Verschuren 1999a).

Historical overview of diatom sampling and studies in Lake Naivasha

The first reports on diatoms from Lake Naivasha and its satellite lakes date back to the 1930s. Rich (1932) investigated samples collected between 18 April and 7 July 1929 by Miss Penelope Jenkin during the Percy Sladen Expedition to Kenya's Rift Valley Lakes (Jenkin 1936). From the 13 Naivasha samples she investigated, she only reported diatoms in three samples from near the mouth of the Gilgil River at the north end of the lake. In sample number 135 (surface) and number 193 (water over *Ceratophyllum*) Rich (1932) mentioned one and three diatom taxa respectively, and 30 diatom taxa in sample number 138 (mud) of which a diatom preparation was made. Besides the 30 taxa from the main basin of Naivasha, Rich (1932) reported one diatom, *Rhopalodia ventricosa* from one of the two samples collected in Lake Sonachi (referred to as 'Crater Lake'). Rich (1933) expanded the species list of Lake Naivasha by two taxa observed in samples taken in November 1930 and February 1931.

During the "Mission scientifique de l'Omo", organized by R. Jeannel and C. Arambourg, plankton samples from some Rift Lakes in Kenya were taken by hydrobiologist

Table 1. Sediment cores from Lakes Naivasha, Crescent Island, Oloidien and Sonachi included in the checked list, with the date of coring, the core length and age, and the reference to the publication providing the most detailed information.

Core	Lake	Coring date	Core length	Core age	Reference
NC93 (NC93.1-S + NC93.1-L)	Crescent Island Crater	08/1993	8.22 m	ca. 200 AD to Present	Verschuren 2001
NS93.2-F	Sonachi	08/1993	0.37 m	ca. 1750 AD to Present	Verschuren 1999a
NM93.1-S	main basin of Naivasha	08/1993		ca. 1800 AD to Present	Verschuren 1999b
NM91.1-S	main basin of Naivasha	08/1991		ca. 1800 AD to Present	Verschuren 1996
NO91.1-S:	Oloidien	08/1991	0.92 m	ca. 1800 AD to Present	Verschuren 1999b
NC20 (NC20-3G + NC20-1P)	Crescent Island Crater	01/2022	23.0 m	ca. 7000 BP to Present	Nguyen 2022

P.A. Chappuis, at the end of this expedition on the return from the Omo Valley (Ethiopia) to Mombasa (Kenya) from where the expedition members embarked back to France (Lester 1933). From the phytoplankton sample taken in Lake Naivasha on 12 April 1933 and which contained a lot of detritus from plant remains, Bachmann (1938) reported 14 diatom taxa. From the sample taken in ‘Crater Lake’ (= Lake Sonachi), which was dominated by *Arthrospira platensis* Gomont [as *Spirulina platensis* (Gomont) Geitler], Bachmann (1938) mentioned 4 diatom species.

By the end of the 1930s, 43 diatom species and infraspecific taxa were known from Lake Naivasha, distributed among 15 genera sensu lato; for Lake Sonachi this was only 5 species, belonging to five genera. However, *Rhopalodia ventricosa* was the only species from Lake Naivasha reported by both Rich (1932) and Bachmann (1938). About thirty years later, Richardson and Richardson (1972) reported 112 diatom taxa from a 28-meter long sediment sequence from Crescent Island Crater, covering the last ca. 9000 years and obtained by combining mutiple sediment cores taken between 30 December 1960 and 2 January 1961, and analyzed at 20-cm intervals. These taxa, 96 species and 16 varieties, are distributed among 25 genera, based on the taxonomy used. Of the 96 species, 15 are referred to as “cf.” and 5 as “sp.”.

Gasse (1986) studied six phytoplankton net samples from Lake Naivasha collected by herself on 5 December 1979 and by J. Kalff on 8 February, 18 March, 19 April, 2 May and June 1980, as well as one littoral mud sample collected by herself on 5 December 1979 and two bottom samples collected by C. Barton. From Crescent Island Crater she analyzed one phytoplankton net sample and one bottom mud sample collected by herself and C. Barton respectively. Finally, Gasse (1986) reported on three samples from Lake Sonachi collected on 6 December 1979: a phytoplankton net sample, littoral mud and scrapings from dead trees. From this total of 11 samples, Gasse (1986) reported 20 genera, 70 species, more than 14 varieties, two forms, one taxon with confer (“cf.”), one taxon with affinity (“aff.”) and two unknown species (“sp.”). The exact number of varieties cannot be tracked down as it is not clear how many are included in the mentioned “and varieties”.

In the 1990s, the growing interest in climate change in East Africa and worldwide led to several coring campaigns in Lake Naivasha and its satellite lakes followed by intensive paleolimnological studies of the recovered sediment cores (Verschuren et al. 1999a, 1999b, 2000a, 2000b). Diatoms were one of the paleoecological proxies studied in a 8.22-m long composite sediment core (NC93) from Crescent Island Crater covering the last ca. 1650 years (Verschuren et al. 2000a; Van der Meeren et al. 2019), and in a shorter sediment core of 71-cm from Oloidien (NO91.1-S) covering the last ca. 200 years (Verschuren et al. 1999b, 2000b). For Lake Sonachi diatom studies were performed on 50 samples from a 37.2-cm freeze-core (NS93.2-F) collected in 1993 (Verschuren et al. 1999a). Diatoms from a sediment core taken in the main basin of Naivasha (NM93.1-S) were also investigated by one of us (CC) but these results have not been published to date.

The above mentioned paleoecological studies inspired Cocquyt and De Wever (2002) to study the epiphytic diatom communities in Lake Naivasha and its satellite lakes. For this purpose, herbarium specimens of aquatic plants collected in Lake Naivasha between 1909 and 1933, and kept in the collections of the Meise Botanic Garden (BR), were investigated: *Nymphaea caerulea* Savigny, *Potamogeton pectinatus* Linnaeus, *P. schweinfurthii* A.Bennett and *Najas horrida* A.Braun ex Magnus. Additional materials of *Nymphaea caerulea* and *Cyperus laevigatus* Linnaeus collected in 1999 in Lake Naivasha and Lake Sonachi respectively, were studied (Cocquyt and De Wever 2002).

Based on microscopic (i.e., morphological) analyses of fossil diatoms in core NSA-3 from the main basin of Lake Naivasha, Stoof-Leichsenring et al. (2011) reported 39 diatom species, while in follow-up molecular analyses these authors could identify 28 different diatom haplotypes in bulk sediment samples (Stoof-Leichsenring et al. 2012). All haplotypes that differed < 8% to a species-specific GenBank sequence (corresponding to a similarity of 92–100%) were assigned to that species. Haplotypes with a similarity below 92% to any reference sequence, were not assigned to a species, but to the respective diatom family. This implied that the genetic survey did not reveal all species morphologically identified. However, all genetic information and morphological data were highly correlated but not fully identical (Stoof-Leichsenring at al. 2012). It is clear that the African diatom flora is still not well known either morphologically or molecularly.

This brief overview of the diatom research on Lake Naivasha and its satellite lakes covers only taxonomic relevant publications for diatoms (Table 2). The numerous and important studies done on phytoplankton biomass, dynamics, chlorophyll, etc. and papers on algae other than diatoms, such as Kalff and Watson (1986), Harper et al. (1993, 2003) and Ballot et al. (2009), are not included in the present overview. However, the diatom species names mentioned in those ecological studies concern the most common diatoms, of which the taxon names can be found in this checklist either as a currently accepted name or as a synonym.

Results and discussion

Over the last decades, from the earliest start of diatom investigation of the Lake Naivasha system up to now, a total of 205 different species and infraspecific taxa have been reported: 132 from the main basin of Lake Naivasha, 123 from Crescent Island Crater, 43 from Oloidien and 15 from Sonachi (Table 2). When including unpublished studies of sediment core material this number increases to 310 (236, 149, 43 and 52 respectively) distributed over 66 genera. *Cymatopleura* and *Rhopalodia* are kept as separate genera and the species are not included in *Surirella* and *Epithemia* respectively as recently recommended (Ruck et al. 2016a, b; Cocquyt et al. 2018). However, some of the reported taxa are unidentified and referred to as "aff." (3), "cf." (38) and "sp." (14). Probably a number of these belong to already identified taxa and fall within the variability of a species, while others are potentially new to science and should be the subject of further taxonomic research.

Table 2. Overview of the number of diatom species and infraspecific taxa reported in the most important publications from Lake Naivasha and its satellite basins mentioning morphological diatom identifications.

Lake	Naivasha	Crescent Island Crater	Oloidien	Sonachi
Rich (1932)	29	-	-	1
Bachmann (1938)	14	-	-	4
Richardson and Richardson (1972)	-	102	-	-
Gasse (1986)	58	46	35	6
Verschuren et al. (1999a, b)	-	-	9	2
Verschuren et al. (2000)	-	-	8	-
Cocquyt and De Wever (2002)	39	12	-	6
Stoof-Leichsenring et al. (2011, 2012)	40	-	-	-
Owino et al. (2020)	23	-	-	-
Total number of diatom taxa	123	132	43	15

Taking into consideration only the identified species and infraspecific taxa, 7 taxa (3.4%) are considered to be endemic to tropical Africa (Sub-Saharan Africa without southern Africa), besides 4 pantropical (2.0%) and 2 taxa restricted to the African continent (1.0%). This proportion is very small compared to other tropical lakes such as Lake Tanganyika where in the northern part up to 13.1% of the reported diatoms have a distribution restricted to tropical Africa (Cocquyt 2000). However, the number of tropical African, pantropical and African diatom taxa can increase as the unidentified taxa and those referred to as "aff." and "cf." potentially are taxa with a restricted distribution. Two other remarks should also be noted, namely that it is quite possible that material from Lake Naivasha and adjacent lakes was misidentified, as often European and North American diatom floras were used, and secondly, that diatom species, originally described from tropical Africa, have erroneously been reported from other tropical regions or from temperate regions in Europe and North America. Examples of this second possibility are several *Nitzschia* species, such as *N. accommodata*, *N. confinis*, *N. latens*, *N. spiculoides*, *N. subcommunis* and *N. tarda*, all described by Hustedt (1949) from the formerly Albert National Park (Belgian Congo), nowadays the Virunga National Park in the eastern part of the Democratic Republic of the Congo and the Volcanoes National Park in Rwanda.

Molecular analysis confirmed the morphological identification of 14 of the 49 species and infraspecific taxa observed in the sediment cores studied by Stoof-Leichsenring et al. (2012). This implies that slightly more than a quarter of the observed taxa are cosmopolitan. The genetically identified species had a higher internal similarity range than those that had been found in taxonomic studies on supposedly cosmopolitan species (Abarca et al. 2014). In addition, there are very few molecular data available of African taxa to serve as a reference library. The remaining three quarters of the reported taxa comprise species with restricted distribution, such as restricted to the tropics, to Africa, or to tropical Africa. This supports our hypothesis mentioned above that the number of tropical African, African and pantropical taxa must be higher than the number obtained by the results of the distribution of taxa present in this checklist.

In the overview below, taxa are listed according to the systematics of Round et al. (1990), with some adaptations to accommodate genera described after its publication. Although this classification is not the most recent one, and major changes have already occurred on higher taxonomic level (e.g. Adl et al. 2018), we believe it gives a clear and workable reference list of the diatom taxa known from Lake Naivasha, especially because many researchers who include diatoms in their research on Lake Naivasha are not taxonomists. The classification given here includes classes, orders, families and genera. Within each family, genera are arranged alphabetically and so are the species and infra-specific taxa within the genera. The authorities are compliant with the International Plant Names Index (2022). The most current used synonyms are given, as well as the synonyms used in the published papers. For each species the literature is cited where this taxon was mentioned for Lake Naivasha and its satellite lakes in the most important publications dealing with diatom taxonomy. With regards to our own unpublished observations, reference is made to the sediment core in which the species was observed.

Checklist

Class Coscinodiscophyceae Round & R.M.Crawford, 1990
Order Thalassiosirales Glezer & Makarova, 1986
Family Thalassiosiraceae M.Lebour, 1930
Genus *Thalassiosira* Cleve, 1973

1. *Thalassiosira faurii* (Gasse) Hasle, 1978: 282, figs 61–69.

Coscinodiscus faurii Gasse nom. inval., 1975: 24, pl. 32 figs 1, 2.

Observation. Main basin: Stoof-Leichsenring et al. (2012), Cocquyt and De Wever (2002), NM91.1-S, NM93.1-S.

Crescent Island Crater: Cocquyt and De Wever (2002), NC93, NC20.

Sonachi: NS93.2-F.

Occurrence. Epiphytic, sediment core.

2. *Thalassiosira rudolfi* (H.Bachmann) Hasle, 1978: 279, figs 51–60, 65.

Coscinodiscus rudolfi H.Bachmann, 1939: 135, fig. 7. The specific epithet is *rudolfi* and not *rudolfii* because the species is named after Lake Rudolf.

Observation. Main basin: NM91.1-S, NM93.1-S.

Crescent Island Crater: Richardson and Richardson (1972), Van der Meeren et al. (2019), NC20.

Oloidien: Verschuren et al. (1999b).

Sonachi: NS93.2-F.

Occurrence. Sediment core.

Remark. Rich (1932) reported a *Coscinodiscus* sp. from bottom mud in the main basin of Naivasha, probably one of the *Thalassiosira* taxa mentioned above. In NS93.2-F from Sonachi a valve fragment of *Thalassiosira* was observed.

Class Coscinodiscophyceae Round & R.M.Crawford, 1990
Order Thalassiosirales Glezer & Makarova, 1986
Family Stephanodiscaceae Glezer & Makarova, 1986
Genus *Cyclotella* (Kützing) Brébisson, 1838

3. *Cyclotella meneghiniana* Kützing, 1844: 50, pl. 30 fig. 68.

Observation. Main basin: Gasse (1986), Stoof-Leichsenring et al. (2011), Stoof-Leichsenring et al. (2012), NM91.1-S, NM93.1-S.

Crescent Island Crater: Richardson and Richardson (1972), Gasse (1986), Cocquyt and De Wever (2002), NC93, NC20.

Oloidien: Verschuren et al. (1999b).

Sonachi: NS93.2-F.

Occurrence. Epiphytic, bottom mud, sediment core.

4. *Cyclotella* sp.

Observation. Main basin: NM91.1-S, NM93.1-S.

Crescent Island Crater: NC93.

Occurrence. Sediment core.

Genus *Cyclostephanos* Round 1987

5. *Cyclostephanos damasii* (Hustedt) Stoermer & Håkansson, 1988: 346.

Stephanodiscus damasii Hustedt, 1949: 57, pl. I figs 2–5.

Observation. Main basin: Cocquyt and De Wever (2002).

Crescent Island Crater: Richardson and Richardson (1972).

Occurrence. Epiphytic, sediment core.

6. *Cyclostephanos invisitatus* (M.H.Hohn & Hellerman) E.C.Theriot, Stoermer & Håkansson, 1988: 256, figs 18–24.

Stephanodiscus invisitatus M.H.Hohn & Hellerman, 1963: 325, pl. 1 fig. 7.

Observation. Crescent Island Crater: NC20.

Occurrence. Sediment core.

A small *Cyclostephanos* taxon was observed in the sediment core NM91.1-S taken from the main basin of Lake Naivasha, which may be identical to *Cyclostephanos invisitatus*.

Genus *Discostella* Houk & Klee, 2004

7. *Discostella pseudostelligera* (Hustedt) Houk & Klee, 2004: 223, figs 109, 110.

Cyclotella pseudostelligera Hustedt, 1939: 581, figs 1, 2.

Observation. Crescent Island Crater: NC93.

Occurrence. Sediment core.

8. *Discostella stelligera* (Cleve & Grunow) Houk & Klee, 2004: 208.

Cyclotella meneghiniana var. *stelligera* Cleve & Grunow, 1881: 22, pl. 5, fig. 63a, c.
Cyclotella stelligera (Cleve & Grunow) Van Heurck, 1882: pl. XCIV figs 22–26.

Observation. Main basin: Stoof-Leichsenring et al. (2011), Stoof-Leichsenring et al. (2012), NM91.1-S, NM93.1-S.

Crescent Island Crater: Richardson and Richardson (1972), NC93, NC20.

Occurrence. Sediment core.

Cocquyt and De Wever (2002) reported a *Cyclotella* cf. *stelligera* on herbarium material from the main basin of Lake Naivasha.

Genus *Lindavia* (Schütt) De Toni & Forti, 1900

9. *Lindavia glomerata* (H.Bachmann) Adesalu & Julius, 2017: 170.

Cyclotella glomerata H.Bachmann, 1911: 131, figs 106–108.

Observation. Main basin: Gasse (1986), NM91.1-S, NM93.1-S.

Occurrence. Plankton, sediment core.

Genus *Pantocsekiella* K.T.Kiss & Ács, 2016

10. *Pantocsekiella* cf. *comensis* (Grunow) K.T.Kiss & Ács, 2016: 65.

Cyclotella comensis Grunow, 1882: pl. 93 figs 16, 17.

Observation. Main basin: Cocquyt and De Wever (2002).
Occurrence. Epiphytic.

11. *Pantocsekiella kuetzingiana* (Thwaites) K.T.Kiss & Ács, 2016: 67.

Cyclotella kuetzingiana Thwaites, 1848: 169, pl. XI fig. D 1–5.

Observation. Main basin: Gasse (1986) (and varieties), Owino et al. (2020), NM91.1-S, NM93.1-S.
Crescent Island Crater: Richardson and Richardson (1972), NC20.
Occurrence. Plankton, bottom mud, sediment core.

12. *Pantocsekiella ocellata* (Pantocsek) K.T.Kiss & Ács, 2016: 62.

Cyclotella ocellata Pantocsek, 1901: 134, pl. IV fig. 318.

Observation. Main basin: Gasse (1986), Cocquyt and De Wever (2002), Stoof-Leichsenring et al. (2012), Owino et al. (2020), NM91.1-S, NM93.1-S.
Crescent Island Crater: Richardson and Richardson (1972), NC20, NC93.
Lake Sonachi: NS93.2-F.
Occurrence. Bottom mud, epiphytic, sediment core.

Genus *Stephanodiscus* Ehrenberg, 1845

13. *Stephanodiscus* cf. *agassizensis* Håkansson & H.J.Kling, 1989: 283, 285, figs 56–59.

Observation. Crescent Island Crater: core NC20.
Occurrence. Sediment core.

14. *Stephanodiscus astraea* (Kützing) Grunow, 1880: 114 complex.

Cyclotella astraea Kützing, 1849: 19.

Observation. Main basin: Owino et al. (2020).
Crescent Island Crater: Richardson and Richardson (1972).
Occurrence. Sediment core.

15. *Stephanodiscus* cf. *hantzschii* Grunow, 1880: 115, pl. VII fig. 131.

Observation. Crescent Island Crater: Richardson and Richardson (1972).
Main basin: NS91.1-S.
Lake Sonachi: NS93.2-F.
Occurrence. Sediment core.

16. *Stephanodiscus* cf. *minutulus* (Kützing) Cleve & Möller, 1882: 300.

Cyclotella minutula Kützing, 1844: 50.

Observation. Main basin: Cocquyt and De Wever (2002).
Crescent Island Crater: Richardson and Richardson (1972).
Occurrence. Epiphytic, sediment core.

Remark. Beside the above mentioned *Stephanodiscus* taxa, Owino et al. (2020) reported an unidentified species in a sediment core taken from the main basin of Lake Naivasha.

Class Coscinodiscophyceae Round & R.M.Crawford, 1990
Order Aulacoseirales R.M.Crawford, 1990
Family Aulacoseiraceae R.M.Crawford, 1990
Genus *Aulacoseira* Thwaites, 1848

17. *Aulacoseira agassizii* (Ostenfeld) Simonsen, 1979: 56.

Melosira agassizii Ostenfeld, 1909: 179, pl. 2 figs 18–20.

Observation. Main basin: Gasse (1986), NM93.1-S.
Crescent Island Crater: Richardson and Richardson (1972), Gasse (1986), NC93, NC20.
Occurrence. Plankton, bottom mud, sediment core.

18. *Aulacoseira alpigena* (Grunow) Krammer, 1991: 93, figs 1–15.

Melosira distans var. *alpigena* Grunow, 1882: pl. LXXXVI figs 28, 29.
Aulacoseira distans var. *alpigena* (Grunow) Simonsen, 1979: 57.

Observation. Main basin: NM93.1-S and cf. this taxon in NM91.1-S.
Crescent Island Crater: NC93.
Occurrence. Sediment core.

19. *Aulacoseira ambigua* (Grunow) Simonsen, 1979: 56.

Melosira crenulata var. *ambigua* Grunow, in Van Heruck 1882: pl. 88 figs 12–15.

Melosira ambigua (Grunow) O.Müller, 1903: 332.

Observation. Main basin: Rich (1932), Gasse (1986), Cocquyt and De Wever (2002), Stoof-Leichsenring et al. (2011), Stoof-Leichsenring et al. (2012), Owino et al. (2020), NM91.1-S, NM93.1-S.

Crescent Island Crater: Richardson and Richardson (1972), Van der Meeren et al. (2019), NC20, and cf. this taxon in NC93.

Lake Oloidien: Verschuren et al. (1999b), Verschuren et al. (2000b).

Occurrence. Plankton, epiphytic, bottom mud, sediment core.

20. *Aulacoseira distans* (Ehrenberg) Simonsen, 1979: 57.

Gaillonella distans Ehrenberg, 1836: 221, pl. III fig. 5.
Melosira distans (Ehrenberg) Kützing, 1844: 54.

Observation. Main basin: Stoof-Leichsenring et al. (2011), Stoof-Leichsenring et al. (2012).

Crescent Island Crater: Richardson and Richardson (1972).

Occurrence. Sediment core.

21. *Aulacoseira distans* var. *africana* (O.Müller) Simonsen, 1979: 57.

Melosira distans var. *africana* O.Müller, 1904: 293, pl. IV figs 32, 33.

Observation. Main basin: Stoof-Leichsenring et al. (2011), NM91.1-S, NM93.1-S.

Crescent Island Crater: NC93, NC20.

Occurrence. Sediment core.

22. *Aulacoseira* cf. *goetzeana* (O.Müller) Simonsen, 1979: 58.

Melosira goetzeana O.Müller, 1904: 290, pl. IV fig. 20.

Observation. Crescent Island Crater: NC20.

Occurrence. Sediment core.

23. *Aulacoseira granulata* (Ehrenberg) Simonsen, 1979: 58.

Gaillonella granulata Ehrenberg, 1843: 415.
Melosira granulata (Ehrenberg) Ralfs in Pritchard, 1861: 820.

Observation. Main basin: Gasse (1986), Stoof-Leichsenring et al. (2011), Stoof-Leichsenring et al. (2012), NM91.1-S, NM93.1-S.

Crescent Island Crater: Richardson and Richardson (1972), Gasse (1986), NC93, NC20.

Lake Oloidien: Verschuren et al. (1999b), Verschuren et al. (2000b).

Occurrence. Plankton, bottom mud, sediment core.

Richardson and Richardson (1972) distinguish a variety of *A. granulata*, "*A. granulata* var. (coarse variety)", which has much coarser areolae than the other valves of *A. granulata* and varieties observed in the studied sediment core materials. This taxon may be identified as *Aulacoseira* cf. *goetzeana* in core NC20.

24. *Aulacoseira granulata* var. *angustissima* (O.Müller) Simonsen, 1979: 58.

Melosira granulata var. *angustissima* O.Müller, 1899: 315.

Observation. Main basin: Gasse (1986), Stoof-Leichsenring et al. (2011), Stoof-Leichsenring et al. (2012), NM91.1-S, NM93.1-S.

Crescent Island Crater: Richardson and Richardson (1972), Gasse (1986), Van der Meeren et al. (2019), NC93, NC20.

Occurrence. Plankton, bottom mud, sediment core.

In NC93, the form *curvata* was distinguished within this taxon.

25. *Aulacoseira herzogii* (Lemmermann) Simonsen, 1979: 59.

Melosira herzogii Lemmermann, 1910: 316, figs 12, 13.

Observation. Crescent Island Crater: NC20.

Occurrence. Sediment core.

26. *Aulacoseira humilis* (A.Cleve) Genkal & Trifonova, in Trifonova and Genkal 2001: 315.

Melosira distans var. *humilis* A.Cleve, 1939: 6, fig. 1.
Aulacoseira distans var. *humilis* (A.Cleve) Gasse, 1986: 76, pl. 3 figs 1–4, 7–9.

Observation. Crescent Island Crater: NC93.

Occurrence. Sediment core.

27. *Aulacoseira italica* (Ehrenberg) Simonsen, 1979: 60.

Gaillonella italica Ehrenberg, 1838: 171, pl. 10 fig. 6.
Melosira italica (Ehrenberg) Kutzing, 1844: 55, pl. 2 fig. 6.

Observation. Main basin: Bachmann (1938).

Crescent Island Crater: in NC93 a taxon was identified as *A.* cf. *italica*.

Lake Oloidien: Verschuren et al. (1999b), Verschuren et al. (2000b).

Occurrence. Phytoplankton, sediment core.

28. *Aulacoseira italica* var. *bacilligera* (O.Müller) Gasse, 1986: 81.

Melosira italica var. *bacilligera* O.Müller, 1844: 55, pl. 2 fig. 6.

Observation. Main basin: Cocquyt and De Wever (2002).
Occurrence. Epiphytic.

29. *Aulacoseira jonensis* (Grunow) Houk & Klee, 2007: 99, pl. LXXXII figs 1–13, pl. LXXXIII figs 1–8.

Melosira granulata var. *jonensis* Grunow, 1882: pl. LXXXVII figs 23–26.
Aulacoseira granulata var. *jonensis* (Grunow) Simonsen, 1979: 58.

Observation. Crescent Island Crater: Richardson and Richardson (1972), NC93.
Occurrence. Sediment core.

30. *Aulacoseira muzzanensis* (F.Meister) Krammer, 1991: 98.

Melosira muzzanensis F.Meister, 1912: 41, 232, pl. 1 fig. 10.
Aulacoseira granulata var. *muzzanensis* (F.Meister) Simonsen, 1979: 59.

Observation. Main basin: NM91.1-S, NM93.1-S.
Crescent Island Crater: cf. this taxon in NC20.
Occurrence. Sediment core.

31. *Aulacoseira nyassensis* (O.Müller) Simonsen, 1979: 61.

Melosira nyassensis O.Müller, 1904: 285, pl. III fig. 3.
Melosira nyassensis [subsp. *devriesii*] f. *minor* O.Müller, 1904: 3287, pl. III fig. 2.

Observation. Main basin: Rich (1932), Owino et al. (2020), NM91.1-S, NM93.1-S.
Occurrence. Phytoplankton, sediment core.

32. *Aulacoseira nyassensis* var. *victoriae* (O.Müller) Simonsen, 1979: 61.

Melosira nyassensis var. *victoriae* O.Müller, in Ostenfeld 1908: 338.

Observation. Crescent Island Crater: Richardson and Richardson (1972).
Occurrence. Sediment core.
According to AlgaeBase (Guiry and Guiry 2022) the taxonomic status of this taxon requires further investigation.

33. *Aulacoseira pyxis* (O.Müller) Simonsen, 1979: 62.

Melosira pyxis O.Müller, 1904: 291, pl. IV figs 23–5.

Observation. Main basin: Rich (1932).
Occurrence. Bottom mud.

Remark. Besides the seventeen above mentioned *Aulacoseira* taxa, an unidentified species was reported in the main basin by Stoof-Leichsenring et al. (2011), Stoof-Leichsenring et al. (2012), and in NM91.1-S, NM93.1-S and NS93.2-F. In addition, Owino et al. (2020) erroneously mentioned two species with the generic name of *Aulacoseira*: *A schroidera* and *A ulna*. The latter is probably *Ulnaria ulna*. We have no idea which species is meant by the former but the most similar name is *Melosira schroederi* (Wołoszyńska 1914: 186, pl. III figs 11, 12, 14) described from Lake Victoria.

Class Coscinodiscophyceae Round & R.M.Crawford, 1990
Order Chaetocerotales Round & R.M.Crawford, 1990
Family Chaetocerotaceae Ralfs in Pritchard, 1861
Genus *Chaetoceros* Ehrenberg, 1844

34. *Chaetoceros* sp.

Observation. Main basin: Stoof-Leichsenring et al. (2011).
Lake Sonachi: NS93.2-F.
Occurrence. Sediment core.

Class Fragilariophyceae, Round
Order Fragilariales P.C.Silva, 1962
Family Fragilariaceae Greville, 1833
Genus *Belonastrum* (Lemmermann) Round & Maidana, 2001

35. *Belonastrum berolinense* (Lemmermann) Round & Maidana, 2001: 22.

Synedra berolinensis Lemmermann, 1900: 31.
Fragilaria berolinensis (Lemmermann) Lange-Bertalot, 1993: 43, pl. 134 figs 21–25.

Observation. Crescent Island Crater: Richardson and Richardson (1972), NC20.
Occurrence. Sediment core.

Genus *Fragilaria* Lyngbye, 1819

36. *Fragilaria amphicephaloides* Lange-Bertalot, 2013: 256, pl. 7 figs 7–10.

Synedra amphicephala Kützing, 1844: 64, pl. 3 fig. 12.

Fragilaria amphicephala (Kützing) Lange-Bertalot nom. illeg., 2000.

Observation. Crescent Island Crater: NC20.
Occurrence. Sediment core.

37. *Fragilaria capucina* Desmazières, 1830, no. 453.

Observation. Main basin: Stoof-Leichsenring et al. 2012, Owino et al. 2020.
Lake Oloidien: Verschuren et al. (1999b), Verschuren et al. (2000b).
Occurrence. Sediment core.

38. *Fragilaria fragilarioides* (Grunow) Cholnoky, 1963: 169, pl. 25 figs 29, 30.

Synedra rumpens var. *fragilarioides* Grunow, 1881: pl. 40 fig. 12.
Fragilaria rumpens var. *fragilarioides* (Grunow) A.Cleve, 1953: 42, fig. 352b.
Fragilaria capucina var. *fragilarioides* (Grunow) Ludwig & Flores, 1997: 58, figs 2–9.

Observation. Main basin: Cocquyt and De Wever (2002), NM91.1-S, NM93.1-S.
Crescent Island Crater: NC20.
Occurrence. Epiphytic, sediment core.

39. *Fragilaria radians* (Kützing) D.M.Williams & Round, 1987: 269.

Synedra radians Kützing, 1844: 64, pl. 14/7 figs 1–4.
Synedra acus var. *radians* (Kützing) Hustedt, 1930: 155 fig. 171.
Synedra acus f. *radians* (Kützing) Hustedt, 1957: 237.

Observation. Main basin: Cocquyt and De Wever (2002), NM91.1-S, NM93.1-S.
Crescent Island Crater: Cocquyt and De Wever (2002), Van der Meeren et al. (2019), NC20.
Occurrence. Epiphytic, sediment core.

40. *Fragilaria rumpens* (Kützing) G.W.F.Carlson, 1913: 29.

Synedra rumpens Kützing, 1844: 69, pl. 1 figs 4, 5.
Fragilaria capucina (Kützing) Lange-Bertalot ex Bukhtiyarova, 1995: 417.

Observation. Main basin: Gasse (1986), Stoof-Leichsenring et al. (2011), Stoof-Leichsenring et al. (2012).
Crescent Island Crater: Gasse (1986).
Occurrence. Plankton, bottom mud.
In NC20 an unspecified variety of this taxon was reported.

41. *Fragilaria tabulata* var. *truncata* (Greville) Lange-Bertalot, 1938: 167, fig. 1 a–g.

Echinella fasciculata var. *truncata* Greville, 1832: pl. 16 fig. 4.
Synedra vaucheriae var. *truncata* (Greville) Rabenhorst, 1864: 132.
Fragilaria vaucheriae var. *truncata* (Greville) Stoermer & Yang, 2005: 1701.

Observation. Crescent Island Crater: NC20.
Occurrence. Sediment core.

42. *Fragilaria tenera* (W.Smith) Lange-Bertalot, 1980: 746.

Synedra tenera W.Smith, 1856: 98.

Observation. Main basin: Gasse (1986), NM91.1-S, NM93.1-S.
Crescent Island Crater: NC20.
Occurrence. Plankton, bottom mud, sediment core.

43. *Fragilaria vaucheriae* (Kützing) J.B.Petersen, 1938: 167, fig. 1 a–g.

Exilaria vaucheriae Kützing, 1833: 32, fig. 38.
Synedra vaucheriae (Kützing) Kützing, 1844: 65, pl. 14 fig. 4.
Fragilaria capucina var. *vaucheriae* (Kützing) Lange-Bertalot, 1980: 747.

Observation. Crescent Island Crater: NC20.
Occurrence. Sediment core.

A unidentified *Fragilaria* sp. was observed in the sediment core NM91.1-S taken from the main basin of Lake Naivasha. However, as the diatom analysis was performed at the beginning of the 1990s before the delineation of many now accepted genera within *Fragilaria* s.l., we cannot determine the current genus of this species.

Genus *Pseudostaurosira* D.M.Williams & Round, 1988

44. *Pseudostaurosira brevistriata* (Grunow) D.M.Williams & Round, 1988: 276, figs 28–31.

Fragilaria brevistriata Grunow in Van Heurck, 1885: 157, pl. 45 fig. 32.
Staurosira brevistriata (Grunow) Grunow, 1884: 101.

Observation. Crescent Island Crater: Richardson and Richardson (1972), NC20.
Lake Sonachi: NS93.2-F.
Occurrence. Sediment core.

Genus *Punctastriata* D.M.Williams & Round, 1988

45. *Punctastriata lancettula* (Schumann) P.B.Hamilton & Siver, 2008: 363.

Fragilaria lancettula Schumann, 1867: 52, pl. 1 fig. 4.
Fragilaria pinnata var. *lancettula* (Schumann) Hustedt, 1913: pl. 297 figs 51, 59–64.
Staurosirella pinnata var. *lancettula* (Schumann) Siver, 2005: 197.

Observation. Crescent Island Crater: Richardson and Richardson (1972), NC20.
Occurrence. Sediment core.

Genus *Staurosira* Ehrenberg, 1843

46. *Staurosira binodis* (Ehrenberg) Lange-Bertalot, 2011: 260, pl. 10 figs 41–57.

Fragilaria binodis Ehrenberg, 1854: 12, pl. V:II fig. 26, pl. VI:I fig. 43, pl. X fig. 15.
Fragilaria construens f. *binodis* (Ehrenberg) Hustedt, 1957: 231.
Staurosira construens var. *binodis* (Ehrenberg) P.B.Hamilton, 1992: 29.
Pseudostaurosira construens var. *binodis* (Ehrenberg) Edlund nom. inval., 1994: 12.
Pseudostaurosira binodis (Ehrenberg) Edlund, 2001: 88.

Observation. Crescent Island Crater: Richardson and Richardson (1972).
Occurrence. Sediment core.

Richardson and Richardson (1972) mention *Fragilaria construens* var. *binodis* (Ehrenberg) Grunow. We think that they wanted to cite *Fragilaria construens* f. *binodis* (Ehrenberg) Hustedt and have erroneously put Grunow as author instead of Hustedt. That they might have meant *Fragilaria construens* var. *binodis* Stockmayer nom. inval. (Stockmayer 1909: 75) seems unlikely. Moreover, according to Guiry and Guiry (2022) "The taxonomic and/or nomenclatural status of this taxon is in some way unresolved and requires further investigation".

47. *Staurosira construens* Ehrenberg, 1843: 424.

Fragilaria construens (Ehrenberg) Grunow, 1862: 101.
Staurosira venter var. *construens* (Ehrenberg) Cleve & Möller, 1879: 270–271.

Observation. Main basin: NM93.1-S, and cf. this taxon in NM91.1-S.
Crescent Island Crater: Richardson and Richardson (1972), NC20.
Lake Sonachi: NS93.2-F.
Occurrence. Sediment core.

48. *Staurosira construens* var. *exigua* (W.Smith) H.Kobayasi, 2002: 90.

Triceratium exiguum W.Smith, 1856: 87.

Fragilaria construens var. *exigua* (W.Smith) Schulz-Danzig, 1920: 750, figs 9–16.
Fragilaria exigua (W.Smith) Lemmermann nom. illeg., 1908: 409.

Observation. Crescent Island Crater: Richardson and Richardson (1972).
Occurrence. Sediment core.

49. *Staurosira dubia* Grunow nom. inval. in Cleve & Möller, 1879: 270–271.

Fragilaria leptostauron var. *dubia* (Grunow) Hustedt nom. inval., 1931: 254, figs 668h–i.

Observation. Crescent Island Crater: Gasse (1986).
Occurrence. Bottom mud.
According to Guiry and Guiry (2022) the taxonomic or nomenclatural status (or both) of this entity is in some way unresolved and requires further investigation.

50. *Staurosira inflata* (Heiden) A.Rusanov, Ács, E.Morales & Ector, 2018: 341, figs 3, 20–25, 30–43.

Synedra inflata Heiden, 1900: 14, fig. 19.
Fragilaria heidenii Østrup, 1910: 190, pl. 5 fig. 118.

Observation. Main basin: core NM91.1-S, core NM93.1-S.
Occurrence. Sediment core.

51. *Staurosira leptostauron* (Ehrenberg) Kulikovskiy & Genkal, 2011: 363, pl. 2 figs. 1–6, pl. 8 fig. 1.

Biblarium leptostauron Ehrenberg, 1854: 106, figs. 5–8.
Staurosira leptostauron (Ehrenberg) D.M.Williams & Round, 1988: 276, figs. 22, 23.

Observation. Crescent Island Crater: NC20.
Occurrence. Sediment core.

52. *Staurosira subsalina* (Hustedt) Lange-Bertalot, 2004: 115.

Fragilaria construens var. *subsalina* Hustedt, 1925: 106, figs. 5–8.
Fragilaria construens f. *subsalina* (Hustedt) Hustedt, 1957.
Pseudostaurosira subsalina (Hustedt) E.A.Morales, 2005: 115.

Observation. Crescent Island Crater: NC20.
Lake Sonachi: NS93.2-F.
Occurrence. Sediment core.

53. *Staurosira venter* (Ehrenberg) Cleve & J.D.Möller, 1879: 242.

Fragilaria venter Ehrenberg, 1856: 87.
Fragilaria construens var. *venter* (Ehrenberg) Grunow, in Van Heurck 1881: pl. 45 figs 21b, 23, 24b, 26a, 26b.
Fragilaria construens var. *venter* (Ehrenberg) P.B.Hamilton, 1992: 29.

Observation. Crescent Island Crater: NC20.
Occurrence. Sediment core.

Genus *Staurosirella* D.M.Williams & Round, 1988

54. *Staurosirella africana* (Hustedt) D.M.Williams & Round, 1988: 276.

Fragilaria africana Hustedt, 149: 62, pl. 2 figs 29–34.

Observation. Crescent Island Crater: NC20.
Occurrence. Sediment core.

55. *Staurosirella pinnata* (Ehrenberg) D.M.Williams & Round, 1988: 274.

Fragilaria pinnata Ehrenberg, 1843: 415, pl. 3 figs 6, 8.
Punctastriata pinnata (Ehrenberg) D.M.Williams & Round, 1987: 278.

Observation. Main basin: Gasse (1986), NM91.1-S, NM93.1-S.
Crescent Island Crater: Richardson and Richardson (1972), NC20.
Lake Sonachi: NS93.2-F.
Occurrence. Plankton, sediment core.
In NC20 from Crescent Island, an unidentified variety of *Staurosirella pinnata* was reported.

56. *Staurosirella* sp.

Observation. Crescent Island Crater: NC20.
Occurrence. Sediment core.

Genus *Synedra* Ehrenberg, 1830

57. *Synedra cunningtonii* (Kützing) G.S.West, 1907: 151, pl. 8 fig. 4.

Observation. Main basin: NM93.1-S, and cf. this taxon in NM91.1-S.
Crescent Island Crater: Richardson and Richardson (1972), NC20.

Occurrence. Sediment core.

The observed valves of this taxon in the materials of NM93.1-S. appear morphologically closely related to *Fragilaria nanana* and *F. tenera*, especially the nearly straight valves that are only slightly constricted/deformed mid-valve.

Genus *Ulnaria* (Kützing) Compère, 2001

58. *Ulnaria acus* (Kützing) Aboal, 2003: 102.

Synedra acus Kützing, 1844: 68, pl. 15 fig. VII.
Fragilaria ulna var. *acus* (Kützing) Lange-Bertalot, 1980: 745.
Fragilaria ulna f. *acus* (Kützing) Krammer & Lange-Bertalot ,1991: 144, fig: 122: 11–13, fig. 119: 8.
Ulnaria ulna var. *acus* (Kützing) Compère nom. inval., 2003: 70, pl. 12 figs 8–10.

Observation. Main basin: Gasse (1986), Cocquyt and De Wever (2002), Stoof-Leichsenring et al. (2011), Stoof-Leichsenring et al. (2012), Owino et al. (2020), NM91.1-S, NM93.1-S.

Crescent Island Crater: Richardson and Richardson (1972), Gasse (1986), Cocquyt and De Wever (2002), NC20.

Lake Oloidien: Gasse (1986).

Occurrence. Plankton, epiphytic, bottom mud, sediment core.

59. *Ulnaria amphirhynchus* (Ehrenberg) Compère & Bukhtiyarova, 2006: 280.

Synedra amphirhynchus Ehrenberg, 1843: 425, pl. III fig. I.25.
Synedra ulna var. *amphirhynchus* (Ehrenberg) Grunow, 1862: 397.
Ulnaria ulna var. *amphirhynchus* (Ehrenberg) Aboal, 2003: 113.

Observation. Crescent Island Crater: NC20.

Occurrence. Sediment core.

60. *Ulnaria biceps* (Kützing) Compère, 2006: 281.

Synedra biceps Kützing, 1844: 66, pl. 14/18, 14/21 fig. 13.
Synedra ulna f. *biceps* (Kützing) Hustedt, 1957: 236.
Fragilaria ulna var. *bicep*s (Kützing) Compère, 1991: 214.
Fragilaria biceps (Kützing) Lange-Bertalot nom. illeg., 1993: 43, pl. 121 figs 1–5.

Observation. Crescent Island Crater: NC20

Occurrence. Sediment core.

61. *Ulnaria contracta* (Østrup) E.A.Morales & M.L.Vis, 2007: 125.

Synedra ulna var. *contracta* Østrup, 1901: 281 fig. 247.
Fragilaria ulna var. *contracta* (Østrup) Main, 1988: 96.

Observation. Crescent Island Crater: NC20.
Occurrence. Sediment core.

62. *Ulnaria danica* (Kützing) Compère & Bukhtiyarova, 2006: 281.

Synedra danica Kützing, 1844: 66, pl. 14 fig. 13.
Fragilaria ulna var. *danica* (Kützing) Kalinsky, 1982: 125.
Fragilaria danica (Kützing) Lange-Bertalot, 1996: 54, pl. 7 fig. 1, pl. 109 figs 1, 1'.
Synedra ulna var. *danica* (Kützing) Van Heurck, 1885: 151.
Synedra ulna f. *danica* (Kützing) Hustedt, 1957: 151.

Observation. Main basin: Rich (1932).
Crescent Island Crater: NC20.
Occurrence. Bottom mud, sediment core.

63. *Ulnaria delicatissima* (W.Smith) Aboal & P.C.Silva, 2004: 361.

Synedra delicatissima W.Smith, 1853: 72, pl. 12 fig. 94.
Synedra acus var. *delicatissima* (W.Smith) Rabenhorst, 1864: 136.
Fragilaria delicatissima (W.Smith) Lange-Bertalot nom. illeg., 1980: 746.

Observation. Main basin: Bachmann (1938), Stoof-Leichsenring et al. (2011), Stoof-Leichsenring et al. (2012).
Occurrence. Plankton, sediment core.

64. *Ulnaria delicatissima* var. *angustissima* (Grunow) Aboal & P.C.Silva, 2004: 361.

Synedra delicatissima var. *angustissima* Grunow, 1881: pl. XXXIX fig. 10.
Synedra acus var. *delicatissima* (Grunow) Van Heurck, 1885: 151.

Observation. Main basin: Stoof-Leichsenring et al. (2011), Stoof-Leichsenring et al. (2012).
Occurrence. Sediment core.

65. *Ulnaria nyansae* (G.S.West) D.M.Williams, 2007: 125.

Synedra nyansae G.S.West, 1907: 149, pl. 8 fig. 3.

Observation. Main basin: Owino et al. (2020).
Occurrence. Sediment core.

66. *Ulnaria ulna* (Nitzsch) Compère, 2001: 100.

Bacillaria ulna Nitzsch, 1817: 99, pl. V figs 1–10.
Synedra ulna (Nitzsch) Ehrenberg, 1832: 87.
Fragilaria ulna (Nitzsch) Lange-Bertaot, 1980: 745.

Observation. Main basin: Rich (1932), Gasse (1986), Stoof-Leichsenring et al. (2011), Stoof-Leichsenring et al. (2012), Owino et al. (2020), NM93.1-S, and cf. this taxon in NM91.1-S.

Crescent Island Crater: Richardson and Richardson (1972), Gasse (1986), NC20.

Lake Oloidien: Verschuren et al. (1999b), Verschuren et al. (2000b).

Occurrence. Plankton, bottom mud, sediment core.

67. *Ulnaria ulna* var. *spathulifera* (Grunow) Aboal, 2003: 114.

Synedra spathulifera Grunow, 1881: pl. XXXVIII fig. 4.
Synedra ulna var. *spathulifera* (Grunow) Van Heurck, 1885: 151, pl. 38 fig. 4.
Synedra ulna f. *spathulifera* (Grunow) Skabichevskij, 1960: 242, fig. 81.
Fragilaria ulna var. *spathulifera* (Grunow) Main, 1988: 96.

Observation. Crescent Island Crater: Richardson and Richardson (1972).

Occurrence. Sediment core.

Class Bacillariophyceae Haeckel, 1878
Order Eunotiales P.C.Silva, 1962
Family Eunotiaceae Kützing, 1844
Genus *Eunotia* Ehrenberg, 1837

68. *Eunotia bilunaris* (Ehrenberg) Schaarschmidt, 1880: 159.

Synedra bilunaris Ehrenberg, 1832: 87.
Eunotia lunaris var. *bilunaris* (Ehrenberg) Grunow, 1885: pl. XXXV fig. 6B.

Observation. Crescent Island Crater: core NC20.

Occurrence. Sediment core.

69. *Eunotia curvata* (Kützing) Lagerstedt, 1884: 61.

Exilaria cruvata Kützing, 1833: No 112.

Observation. Main basin: Cocquyt and DeWever (2002), NM91.1-S.

Crescent Island Crater: Gasse (1986).

Occurrence. Plankton, epiphytic.

70. *Eunotia* cf. *incisa* W.Smith ex W.Gregory, 1854: 25, pl. IV fig. 4.

Eunotia sudetica var. *incisa* (W.Smith ex W.Gregory) Manguin, 1950.

Observation. Crescent Island Crater: NC20.
Occurrence. Sediment core.

71. *Eunotia minor* (Kützing) Grunow, 1881: pl. 33 figs 20, 21.

Eunotia pectinalis var. *minor* (Kützing) Rabenhorst, 1864: 74.
Eunotia pectinalis f. *minor* (Kützing) O.Müller, 1910: 117.

Observation. Main basin: Cocquyt and De Wever (2002), NM91.1-S, NM93.1-S.
Crescent Island Crater: Gasse (1986), NC20.
Occurrence. Plankton, epiphytic, sediment core.

72. *Eunotia monodon* Ehrenberg, 1843: 414, pl. 1 fig. V.7.

Observation. Main basin: Gasse (1986).
Occurrence. Plankton, bottom mud, sediment core.

73. *Eunotia pectinalis* (Kützing) Rabenhorst, 1864: 73.

Eunotia pectinalis var. *stricta* (Rabenhorst) Van Heurck, 1881: pl. 33 fig. 18.
Eunotia pectinalis f. *elongata* Grunow, 1881: pl. 33 fig. 16 (text 1885: 143).
Eunotia pectinalis var. *impressa* O.Müller, 1898: 12.
Eunotia pectinalis [var. *minus*] f. *impressa* (O.Müller) Ant.Mayer, 1913: 63.

Observation. Main basin: Gasse (1986), Stoof-Leichsenring et al. (2012).
Crescent Island Crater: Gasse (1986).
Occurrence. Plankton, bottom mud, sediment core.
In core NC20 from Crescent Island, a *Eunotia* cf. *pectinalis* was observed.

74. *Eunotia* cf. *tenella* (Grunow) Hustedt, 1913: 287, figs 20–25.

Eunotia arcus var. *tenella* Grunow, 1881: 34, figs 5–6.

Observation. Crescent Island Crater: Richardson and Richardson (1972).
Occurrence. Sediment core.

Remark. Besides the seven above mentioned *Eunotia* taxa, an unidentified species was reported in the Crescent Island core NC20, and in the main basin core NM91.1-S and core NM93.1-S.

Class Bacillariophyceae Haeckel, 1878
Order Mastogloiales D.G.Mann, 1990
Family Mastogloiaceae Mereschkowsky, 1903
Genus *Mastogloia* Thwaites ex W.Smith, 1856

75. *Mastogloia elliptica* (C.Agardh) Cleve, 1893: pl. 185 figs 24–27.

Mastogloia dansei var. *elliptica* (C.Agardh) Grunow, 1880: pl.4 fig. 19.

Observation. Crescent Island Crater: Richardson and Richardson (1972), NC20.
Occurrence. Sediment core.

76. *Mastogloia* sp.

Observation. Lake Sonachi: core NS 92-2-F.
Occurrence. Sediment core.

Class Bacillariophyceae Haeckel, 1878
Order Cymbellales D.G.Mann, 1990
Family Rhoicospheniaceae Chen & Zhu, 1983
Genus *Rhoicosphenia* Grunow, 1860

77. *Rhoicosphenia abbreviata* (C.Agardh) Lange-Bertalot, 1980: 586, pl. 1A, 3C, D fig. 5A.

Rhoicosphenia curvata (Kützing) Grunow, 1860: 511.

Observation. Main basin: Gasse (1986).
Crescent Island Crater: Richardson and Richardson (1972), NC20.
Occurrence. Bottom mud, sediment core.

Class Bacillariophyceae Haeckel, 1878
Order Cymbellales D.G.Mann, 1990
Family Anomoeoneidaceae D.G.Mann, 1990
Genus *Anomoeoneis* Pfitzer, 1871

78. *Anomoeoneis costata* (Kützing) Hustedt, 1959: 744, fig. 1111.

Anomoeoneis sphaerophora f. *costata* (Kützing) A.M.Schmid, 1977: 321, 329; invalid.

Observation. Lake Oloidien: Gasse (1986).
Lake Sonachi: NS93.2-F.
Occurrence. Bottom mud, sediment core.

79. *Anomoeoneis sculpta* (Ehrenberg) Cleve, 1895: 6.

Anomoeoneis sphaerophora var. *sculpta* (Ehrenberg) O.Müller, 1900: 303.
Anomoeoneis sphaerophora f. *sculpta* (Ehrenberg) Krammer, 1985: 13.

Observation. Main basin: Gasse 1986, core NM91.1-S.
Lake Oloidien: Gasse (1986).
Lake Sonachi: NS93.2-F.
Occurrence. Bottom mud, sediment core.

80. *Anomoeoneis sphaerophora* Pfitzer, 1871: 77, pl. 3 fig. 10.

Observation. Main basin: Rich (1932), Gasse (1986), Cocquyt and De Wever (2002), Stoof-Leichsenring et al. (2012).
Crescent Island Crater: Richardson and Richardson (1972), NC20.
Lake Oloidien: Gasse (1986).
Lake Sonachi: NS93.2-F.
Occurrence. Epiphytic, bottom mud, sediment core.
Rich (1932) reported various forms of this taxon resembling *A. sphaerophora* f. *rostrata* O.Müller, 1900: 303, pl. XII figs. 3–9.

81. *Anomoeoneis sphaerophora* var. *guentheri*, 1900: 302, pl. 12 figs 6–9.

Anomoeoneis var. *guentheri* (O.Müller) A.Cleve, 1953: 202, fig. 1927f, invalid.

Observation. Main basin: Gasse (1986).
Lake Oloidien: Gasse (1986).
Occurrence. Bottom mud.

Class Bacillariophyceae Haeckel, 1878
Order Cymbellales D.G.Mann, 1990
Family Cymbellaceae Greville, 1833
Genus *Cymbella* C.Agardh, 1830

82. *Cymbella cistula* (Ehrenberg) O.Kirchner, 1878: 189.

Observation. Main basin: Gasse (1986), Owino et al. (2020).
Occurrence. Plankton, sediment core.
Richardson and Richardson (1972) reported a *Cymbella* cf. *cistula* from sediment core material of Crescent Island, while, Gasse (1986) mentioned this taxon as *Cymbella cistula* (Hemprich) Grunow.

83. *Cymbella cistula* var. *africana* Cholnoky, 1958: 105, pl. 1 figs 14–16.

Observation. Crescent Island Crater: core NC20.

Occurrence. Sediment core.

84. *Cymbella cymbiformis* C.Agardh, 1830: 10.

Observation. Main basin: Gasse (1986).

Occurrence. Plankton.

Gasse (1986) reported this taxon as *Cymbella cymbiformis* (Kützing) Hustedt.

85. *Cymbella kappii* (Cholnoky) Cholnoky, 1956: 61, figs 17–20.

Cymbella turgidula var. *kappii* Cholnoky, 1953: 142, figs 12–16.

Observation. Crescent Island Crater: NC20.

Occurrence. Sediment core.

86. *Cymbella lanceolata* C.Agardh, 1830: 9.

Navicula lanceolata (C.Agardh) Kützing, nom. illeg., 1844: 94, pl. 28 fig. 38, pl. 30 fig. 48.

Observation. Main basin: Rich (1932).

Occurrence. Bottom mud.

87. *Cymbella simonsenii* Krammer, 1985: 33, pl. 7 figs 1–9.

Observation. Crescent Island Crater: NC20.

Occurrence. Sediment core.

Remark. A *Cymbella* sp. was reported by Richardson and Richardson (1972), Owino et al. (2020) and Cocquyt and De Wever (2002), while Stoof-Leichsenring et al. (2012) mentioned several *Cymbella* sp. Also in core NM91.1-S, a *Cymbella* sp. was observed. However, we cannot verify if these concern *Cymbella* s.s. or *Cymbella* s.l.

Genus *Cymbopleura* (Krammer) Krammer, 1999

88. *Cymbopleura amphicephala* (Nägeli ex Kützing) Krammer, 2003: 70, pl. 91 figs 1–18, pl. 93 figs 2–8.

Cymbella amphicephala Nägeli ex Kützing, 1849: 890.

Observation. Main basin: Gasse (1986).

Occurrence. Plankton.

Genus *Encyonema* Kützing, 1834

89. *Encyonema elginense* (Krammer) D.G.Mann, 1990: 666.

Cymbella elginensis Krammer, 1980: 136, fig. 23.
Cymbella turgida W.Gregory, 1856: 5, pl. 1 fig. 18.
Encyonema turgidum (W.Gregory) Grunow, 1875: pl. 10 figs 49–53.

Observation. Main basin: Gasse (1986).
Crescent Island Crater: Gasse (1986).
Lake Oloidien: Gasse (1986).
Occurrence. Plankton, bottom mud.

90. *Encyonema gracile* Rabenhorst, 1853: 25, pl. 10.

Cymbella gracilis (Rabenhorst) Cleve, 1894: 169.

Observation. Main basin: Rich (1932).
Occurrence. Bottom mud.

91. *Encyonema mesianum* (Cholnoky) D.G.Mann, 1990: 666.

Cymbella mesiana Cholnoky, 1955: 160, figs 11, 12.

Observation. Crescent Island Crater: NC93, NC20.
Occurrence. Sediment core.

92. *Encyonema* cf. *minutum* (Hilse) D.G.Mann, 1990: 667.

Cymbella minuta Hilse, 1862: No. 1261.
Cymbella ventricosa var. *minuta* (Hilse) A.Cleve, 1955: 125, figs 1177g–i.

Observation. Main basin: NM91.1-S, NM93.1-S.
Occurrence. Sediment core.

93. *Encyonema muelleri* (Hustedt) D.G.Mann, 1990: 667.

Cymbella muelleri Hustedt, 1937: 425.
Cymbella muelleri Cholnoky nom. inval., 1953: 141.
Cymbella grossestriata var. *obtusiuscula* O.Müller, 1905: 154, pl. 1 fig. 13.

Observation. Main basin: Rich (1932), Gasse (1986), Cocquyt and De Wever (2002), Stoof-Leichsenring et al. (2011), Stoof-Leichsenring et al. (2012), NM91.1-S, NM93.1-S.

Crescent Island Crater: Richardson and Richardson (1972), Cocquyt and De Wever (2002), NC20.

Lake Oloidien: Gasse (1986).

Lake Sonachi: Cocquyt and De Wever (2002).

Occurrence. Plankton, epiphytic, bottom mud, sediment core.

94. *Encyonema neomesianum* Krammer, 1997: 5, pl. 191 figs 7–9.

Cymbella minuta var. *pseudogracilis* (Cholnoky) Reimer, 1975: 50, pl. 9 figs 1a–2b.
Encyonema minutum var. *pseudogracile* (Cholnoky) Czarnecki, 1994: 157.
Cymbella turgida var. *pseudogracilis* Cholnoky, 1958: 112; pl. 2 figs 49–50.

Observation. Crescent Island Crater: Richardson and Richardson (1972).

Occurrence. Sediment core.

95. *Encyonema neomuelleri* Krammer, 1997: 142, figs 23–27.

Observation. Crescent Island Crater: NC20.

Occurrence. Sediment core.

96. *Encyonema silesiacum* (Bleisch) D.G.Mann, 1990: 667.

Cymbella silesiaca Bleisch, 1864: No. 1802.
Cymbella minuta var. *silesiaca* (Bleisch) Reimer, 1975: 49, pl. 8 figs 7a–10b.
Cymbella ventricosa var. *silesiaca* (Bleisch) A.Cleve, 1955: 124, figs 1177d–f.

Observation. Crescent Island Crater: NC93, NC20.

Main basin: Cocquyt and De Wever (2002), NM91.1-S, NM93.1-S.

Occurrence. Epiphytic, sediment core.

97. *Encyonema ventricosum* (C.Agardh) Grunow, 1875: pl. 10 fig. 59.

Cymbella ventricosa (C.Agardh) C.Agardh, 1830: 9.

Observation. Crescent Island Crater: Gasse (1986).

Main basin: Gasse (1986).

Lake Oloidien: Gasse (1986).

Occurrence. Plankton, littoral, bottom mud.

Bachmann (1938) reported *Cymbella ventricosa* Kützing from the littoral zone of Lake Naivasha. According to Guiry and Guiry (2022) *Cymbella ventricosa* Kützing, 1844 is a nom. illeg. and the taxonomic or nomenclatural status (or both) of this entity is in some way unresolved and requires further investigation. Probably the taxon Bachmann observed is the same species as *Encyonema ventricosum* reported by Gasse (1986).

98. *Encyonema* sp.

Observation. Crescent Island Crater: NC20.
Occurrence. Sediment core.

Genus *Encyonopsis* Krammer, 1997

99. *Encyonopsis microcephala* (Grunow) Krammer, 1997: 91.

Cymbella microcephala Grunow, 1885: 63.

Observation. Crescent Island Crater: NC20.
Occurrence. Sediment core.

100. *Encyonopsis* sp.

Observation. Crescent Island Crater: NC20.
Occurrence. Sediment core.

Genus *Geissleria* Lange-Bertalot & Metzeltin, 1996

101. *Geissleria* cf. *acceptata* (Hustedt) Lange-Bertalot & Metzeltin, 1996: 64.

Navicula acceptata Hustedt, 1950: 398, pl. 38 figs 66, 67.

Observation. Crescent Island Crater: NC20.
Occurrence. Sediment core.

102. *Geissleria* cf. *decussis* (Østrup) Lange-Bertalot & Metzeltin, 1996: 65, pl. 104 fig. 2, pl. 125 figs 3–6.

Navicula decussis Østrup, 1910: 77, pl. 2 fig. 50.
Navigeia decussis (Østrup) Bukhtiyarova, 2013: 168.

Observation. Crescent Island Crater: NC20.
Occurrence. Sediment core.

103. *Geissleria pseudolagerstedtii* (Cholnoky) J.C.Taylor & Cocquyt, 2019: 1.

Navicula pseudolagerstedtii Cholnoky, 1960: 75, pl. 6 fig. 326.

Observation. Crescent Island Crater: Richardson and Richardson (1972).
Occurrence. Sediment core.

104. *Geissleria* sp.

Observation. Crescent Island Crater: NC20.
Occurrence. Sediment core.

Genus *Placoneis* Mereschkowsky, 1903

105. *Placoneis* cf. *dicephala* (Ehrenberg) Mereschkowsky, 1903: 7, pl. 1 figs 11–13, 21, 22.

Navicula dicephala Ehrenberg, 1838: 185.

Observation. Crescent Island Crater: NC20.
Occurrence. Sediment core.

106. *Placoneis* cf. *gastrum* (Ehrenberg) Mereschkowsky, 1903: 13, pl. 1 fig. 17.

Navicula gastrum (Ehrenberg) Kutzing, 1844: 94, pl. 28 fig. 56c.

Observation. Crescent Island Crater: NC20.
Occurrence. Sediment core.

107. *Placoneis hambergii* (Hustedt) Bruder, 2007: 349.

Navicula hambergii Hustedt, 1924: 562, pl. 17 fig. 2.

Observation. Crescent Island Crater: NC20.
Occurrence. Sediment core.

Class Bacillariophyceae Haeckel, 1878
Order Cymbellales D.G.Mann, 1990
Family Gomphonemataceae Kützing, 1844
Genus *Gomphonema* Ehrenberg, 1832

108. *Gomphonema acuminatum* Ehrenberg, 1832: 88.

Observation. Main basin: Owino et al. (2020).
Occurrence. Sediment core.

109. *Gomphonema acuminatum* var. *longiceps* (Ehrenberg) N.Abarca & R.Jahn, 2020: 36.

Gomphonema longiceps Ehrenberg, 1854: pl. 10/1 fig. 21.

Observation. Crescent Island Crater: Richardson and Richardson (1972).
Occurrence. Sediment core.

110. *Gomphonema affine* Kützing, 1844: 86, pl. 30 fig. 54.

Gomphonema lanceolatum var. *affine* (Kützing) A.Cleve, 1932: fig. 254c.

Observation. Crescent Island Crater: NC20.
Occurrence. Sediment core.

111. *Gomphonema* cf. *angustatum* (Kützing) Rabenhorst, 1864: 283.

Observation. Crescent Island Crater: NC20.
Occurrence. Sediment core.

112. *Gomphonema augur* Ehrenberg, 1841: 211.

Observation. Crescent Island Crater: NC20.
Occurrence. Sediment core.

113. *Gomphonema gracile* Ehrenberg, 1838: 217, pl. 18 fig. 3.

Observation. Main basin: Gasse (1986), Cocquyt and De Wever (2002), Stoof-Leichsenring et al. (2011), Stoof-Leichsenring et al. (2012), NM91.1-S.
Crescent Island Crater: Richardson and Richardson (1972), Gasse (1986), Cocquyt and De Wever (2002), NC20.
Lake Oloidien: Gasse (1986), Verschuren et al. (2000b).
Lake Sonachi: Verschuren et al. (1999a), Cocquyt and De Wever (2002), NS93.2-F.
Occurrence. Plankton, epiphytic, bottom mud, sediment core.

114. *Gomphonema gracile* f. *turris* Hustedt, 1937: 439, pl. 28 figs 14–16.

Observation. Main basin: Cocquyt and De Wever (2002).
Occurrence. Epiphytic.

115. *Gomphonema* cf. *insigne* W.Gregory, 1856: 12, pl. 1 fig. 39.

Observation. Crescent Island Crater: NC20.
Occurrence. Sediment core.

116. *Gomphonema intricatum* Kützing, 1844: 87, pl. 9 fig. 4.

Observation. Main basin: Rich (1932), Gasse (1986), Stoof-Leichsenring et al. (2012), NM91.1-S, NM93.1-S.

Crescent Island Crater: Gasse (1986), NC20.

Occurrence. Plankton, bottom mud, sediment core.

Richardson and Richardson (1972) reported *Gomphonema* cf. *intricatum* from sediment core material of Crescent Island.

117. *Gomphonema lanceolatum* Ehrenberg nom. illeg., 1843: 306, pl. II fig. 37.

Observation. Main basin: Rich (1932), Gasse (1986), Stoof-Leichsenring et al. (2012), NM91.1-S, NM93.1-S.

Crescent Island Crater: Richardson and Richardson (1972), Gasse (1986), NC20.

Lake Oloidien: Gasse (1986).

Occurrence. Plankton, bottom mud, sediment core.

Gomphonema lanceolatum has long been a very common name of a diatom taxon by which various *Gomphonema* species and multiple forms of *Gomphonema affine* were referred to (Reichardt 1999). *Gomphonema affine* is a common species of tropical and sub-tropical regions and sometimes frequently found (Reichardt 1999). For this reason, in this paper we have not put the taxon observed in Lake Naivasha and its satellite lakes in synonymy with *Gomphonema grunowii* R.M.Patrick & Reimer (1975: 131, pl. 17 fig. 6) as mentioned by Guiry in Guiry and Guiry (2022).

118. *Gomphonema naviculoides* W.Smith, 1856: 98.

Navicula gracile var. *naviculoides* (W.Smith) Grunow, 1880: pl. 24 fig. 13.

Observation. Main basin: Bachmann (1938).

Occurrence. Littoral.

119. *Gomphonema parvulum* (Kützing) Kützing, 1849: 65.

Gomphonema clavatum Ehrenberg, 1832: 88.

Observation. Main basin: Bachmann (1938), Gasse (1986), Stoof-Leichsenring et al. (2011), Stoof-Leichsenring et al. (2012), NM91.1-S, NM93.1-S.

Crescent Island Crater: Richardson and Richardson (1972), Gasse (1986), NC20.

Lake Oloidien: Gasse (1986).

Lake Sonachi: NS93.2-F.

Occurrence. Plankton, littoral, bottom mud, sediment core.

Cocquyt and De Wever (2002) reported *Gomphonema* cf. *parvulum* from epiphytic materials taken in Crescent Island, the main basin of Lake Naivasha and Lake Sonachi.

120. *Gomphonema pseudoaugur* Lange-Bertalot, 1979: 202, figs 11–165.

Observation. Main basin: Gasse (1986), Stoof-Leichsenring et al. (2011), Stoof-Leichsenring et al. (2012), NM93.1-S.

Crescent Island Crater: NC20.
Lake Oloidien: Gasse (1986).
Occurrence. Plankton, bottom mud, sediment core.
Cocquyt and De Wever (2002) reported *Gomphonema* cf. *pseudoaugur* from epiphytic materials taken in the main basin of Lake Naivasha and Lake Sonachi.

121. *Gomphonema pumilum* (Grunow) E.Reichardt & Lange-Bertalot, 1991: 528, pl. 6 figs 4–11.

Gomphonema intricatum f. *pumilum* Grunow, 1880: pl. 24 figs 35, 36.
Gomphonema intricatum var. *pumilum* A.Cleve, 1932: 99, fig. 252b.

Observation. Crescent Island Crater: Richardson and Richardson (1972), core NC20.
Occurrence. Sediment core.
Gasse (1986) reported *Gomphonema* cf. *pumilum* from bottom mud materials taken in the main basin of Lake Naivasha.

122. *Gomphonema subapicatum* F.E.Fritsch & M.F.Rich, 1929: 109, pl. 6 A, B.

Observation. Main basin: Bachmann (1938).
Occurrence. Littoral.
Bachmann (1938) remarked that the observed valves in Lake Naivasha were smaller than the dimensions given for this taxon by Fritsch & Rich (Fritsch et al. 1929).

123. *Gomphonema subclavatum* (Grunow) Grunow, 1884: 98, pl. 1 (A) fig. 13.

Observation. Main basin: Rich (1932), Bachmann (1938).
Lake Oloidien: Gasse (1986).
Occurrence. Littoral, bottom mud.

124. *Gomphonema subtile* var. *sagitta* (Schumann) Grunow, 1880: pl. 23 fig. 27.

Gomphonema sagitta Schumann, 1863: 187, pl. 9 fig. 29.

Observation. Lake Oloidien: Gasse (1986).
Occurrence. Bottom mud.

125. *Gomphonema sundaense* E.Reichardt, 2005: 129, pl. 6 figs 1–8.

Gomphonema clevei var. *javanicum* Hustedt, 1937: 441, pl. XXVII figs 6–13.

Observation. Main basin: Gasse (1986).
Occurrence. Bottom mud.

126. *Gomphonema turris* Ehrenberg, 1843: 416.

Gomphonema augur var. *turris* (Ehrenberg) Lange-Bertalot, 1985: 44, pl. 37 figs 1–7, pl. 38 figs 1–4, 8–12.
Gomphonema acuminatum var. *turris* (Ehrenberg) Wolle, 1890: pl. 28 fig. 25.

Observation. Main basin: Bachmann (1938).
Crescent Island Crater: NC20.
Occurrence. Littoral, sediment core.

127. *Gomphonema vibrio* var. *pulvinatum* (Braun ex Rabenhorst) R.Ross, 1986: 608.

Gomphonema pulvinatum Braun ex Rabenhorst, 1853: 58.
Gomphonema intricatum var. *pulvinatum* Braun ex Rabenhorst, 1853: 58.

Observation. Main basin: Cocquyt and De Wever (2002).
Occurrence. Epiphytic.

Remark. Beside the above mentioned *Gomphonema* taxa, an unidentified *Gomphonema* sp. was reported by Owino et al (2020), and some small unidentified *Gomphonema* valves were observed in cores NC20, NM91.1-S and NM93.1-S.

Genus *Gomphoneis* Cleve 1894

128. *Gomphoneis clevei* (Fricke) Gil, 1989: 267, 271, pl. 1 figs 4–12, pl. 4 figs 1–4, pl. 5 figs 1–4.

Gomphonema clevei Fricke, 1902: pl. 234 figs 44–46.

Observation. Main basin: NM93.1-S, and cf. this taxon in NM91.1-S.
Crescent Island Crater: NC20.
Occurrence. Sediment core.

Class Bacillariophyceae Haeckel, 1878
Order Cymbellales D.G.Mann, 1990
Family Cymbellales incertae sedis
Genus *Gomphonella* Rabenhorst, 1853

129. *Gomphonella olivacea* (Hornemann) Rabenhorst, 1853: 61, pl. IX fig. 1.

Gomphonema olivaceum (Hornemann) Ehrenberg, 1838: 218.

Observation. Crescent Island Crater: NC20.
Occurrence. Sediment core.

Class Bacillariophyceae Haeckel, 1878
Order Achnanthales P.C.Silva ,1962
Family Cocconeidaceae Kützing, 1844
Genus *Cocconeis* Ehrenberg, 1836

130. *Cocconeis disculus* (Schumann) Cleve, 1882: 139.

Navicula disculus Schumann, 1862: 21, fig. 23.
Navicula scutelloides var. *disculus* (Schumann) Torka, 1906: 15, fig. 3a.

Observation. Crescent Island Crater: Richardson and Richardson (1972).
Occurrence. Sediment core.

131. *Cocconeis* cf. *lineata* Ehrenberg, 1849: 301, pl. 5 (part 2) fig. 44.

Cocconeis placentula var. *lineata* (Ehrenberg) Van Heurck, 1885: 133 [Atlas pl. 30 figs 31, 32].
Cocconeis placentula f. *lineata* (Ehrenberg) Hustedt, 1957: 244.

Observation. Crescent Island Crater: NC93, NC20.
Occurrence. Sediment core.

Gasse (1986) mentioned that *Cocconeis placentula* var. *lineata* was associated with *Cocconeis placentula* in the samples studied from East Africa. However, we cannot know if this taxon was observed by Gasse (1986) in Lake Naivasha and its satellites lakes.

132. *Cocconeis placentula* Ehrenberg, 1838: 194.

Navicula pediculus var. *placentula* (Ehrenberg) Grunow, 1867: 15.

Observation. Main basin: Gasse (1986), Cocquyt and De Wever (2002), Stoof-Leichsenring et al. (2012), NM91.1-S, NM93.1-S.

Crescent Island Crater: Richardson and Richardson (1972), Gasse (1986), Cocquyt and De Wever (2002), NC93, NC20

Lake Sonachi: Gasse (1986), Cocquyt and De Wever (2002).

Occurrence. Plankton, bottom mud, sediment core.

133. *Cocconeis placentula* var. *euglypta* (Ehrenberg) Cleve, 1895: 170.

Cocconeis euglypta Ehrenberg, 1854: pl. XXXIV, pl. VI-A fig. 2.
Cocconeis placentula f. *euglypta* (Ehrenberg) Hustedt, 1957: 244.

Observation. Main basin: Rich 1932, NM91.1-S, NM93.1-S.

Crescent Island Crater: Richardson and Richardson (1972), NC93, NC20.

Occurrence. Bottom mud, sediment core.

Gasse (1986) mentioned that this variety was associated with the species in the samples studied from East Africa. However, as the variety *euglypta* is reported to be rare, we cannot know if this taxon was observed by Gasse (1986) in Lake Naivasha and its satellites lakes.

134. *Cocconeis* sp.

Observation. Crescent Island Crater: NC20.
Occurrence. Sediment core.

Class Bacillariophyceae Haeckel, 1878
Order Achnanthales P.C.Silva, 1962
Family Achnanthidiaceae D.G.Mann, 1990
Genus *Achnanthes* Bory, 1822

135. *Achnanthes* sp.

Observation. Main basin: Cocquyt and De Wever (2002).
Occurrence. Epiphytic.

Cocquyt and De Wever (2002) reported a *Achnanthes* sp. epiphytic on *Nymphaea caerulea* Savigny herbarium material collected in the main basin of Lake Naivasha. They only observed 3 valves of this taxon which was not illustrated.

The identity of the genus to which the taxon mentioned by Owino et al. (2020) as *Achnanthes* sp. belongs cannot be determined because these authors do not use the latest taxonomy in their paper.

Genus *Achnanthidium* Kützing, 1844

136. *Achnanthidium* cf. *affine* (Grunow) Czarnecki, 1994: 156.

Achnanthes affinis Grunow, 1880: 20.
Achnanthes minutissima var. *affinis* (Grunow) Lange-Bertalot, 1989: 104.

Observation. Crescent Island Crater: NC20.
Occurrence. Sediment core.

137. *Achnanthidium exiguum* var. *heterovalvata* (Krasske) Czarnecki, 1994: 157.

Achnanthes exigua var. *heterovalvata* Krasske, 1923: 193, figs 9a, 9b.
Achnanthes heterovalvata (Krasske) Frenguelli, 1942: 95, pl. 1 figs 9–10.

Observation. Main basin: Cocquyt and De Wever (2002).
Crescent Island Crater: Cocquyt and De Wever (2002).
Lake Sonachi: Cocquyt and De Wever (2002).
Occurrence. Epiphytic.

138. *Achnanthidium exile* (Kützing) Heiberg, 1863: 119.

Achnanthes exilis Kützing, 1833: no. 12.

Observation. Crescent Island Crater: NC20.
Occurrence. Sediment core.

139. *Achnanthidium minutissimum* (Kützing) Czarnecki, 1994: 157.

Achnanthes minutissima Kützing, 1833: 578, fig. 54.
Achnanthes minutissima var. *cryptocepala* Grunow, 1880: pl. XXVII figs 41–44.
Achnanthidium microcephalum Kützing, 1844: 75, pl. XIII, XIX.
Achnanthes microcephala (Kützing) Grunow, 1880: 22.
Achnanthes cryptocephala (Grunow) M.Peragallo, 1897: 4.

Observation. Main basin: Gasse (1986), Cocquyt and De Wever (2002), NM91.1-S, NM93.1-S.
Crescent Island Crater: NC20.
Lake Oloidien: Verschuren et al. (1999b), Verschuren et al. (2000b).
Lake Sonachi: Gasse (1986), NS93.2-F
Occurrence. Plankton, epiphytic, bottom mud, sediment core.

Genus *Gogorevia* Kulikovskiy, Glushchenko, Maltsev & Kociolek, 2020

140. *Gogorevia exilis* (Kützing) Kulikovskiy & Kociolek, 2020: 1610.

Achnanthes exigua Grunow, 1880: 21.
Achnanthidium exiguum (Grunow) Czarnecki, 1994: 157.

Observation. Crescent Island Crater: Richardson and Richardson (1972), NC20.
Occurrence. Sediment core.

Genus *Planothidum* Round & Bukhtiyarova, 1996

141. *Planothidum rostratum* (Østrup) Lange-Bertalot, 1999: 279.

Achnanthes rostrata Østrup, 1902: 35, pl. I fig. 11.
Achnanthes lanceolata subsp. *rostrata* (Østrup) Lange-Bertalot, 1991: 79.
Achnanthes lanceolata f. *rostrata* (Østrup) Hustedt, 1957: 251.

Observation. Crescent Island Crater: Richardson and Richardson (1972).
Occurrence. Sediment core.

142. ***Planothidum*** **sp.**

Observation. Crescent Island Crater: NC20.
Occurrence. Sediment core.

Genus *Platessa* Lange-Bertalot, 2004

143. ***Platessa*** **cf.** ***strelnikovae*** **M.D.Enache, M.Potapova & E.Morales, 2014: 240, figs 1–23.**

Observation. Crescent Island Crater: NC20.
Occurrence. Sediment core.

Class Bacillariophyceae Haeckel, 1878
Order Naviculales Bessey, 1907
Family Cavinulaceae D.G.Mann, 1990
Genus *Cavinula* KD.G.Mann & Stickle, 1844

144. ***Cavinula scutelloides*** **(W.Smith) Lange-Bertalot, 1996: 31.**

Navicula scutelloides W.Smith, 1856: 91.

Observation. Main basin: Owino et al. (2020).
Crescent Island Crater: Richardson and Richardson (1972), NC20.
Occurrence. Sediment core.

Class Bacillariophyceae Haeckel, 1878
Order Naviculales Bessey, 1907
Family Diadesmidaceae D.G.Mann, 1990
Genus *Diadesmis* Kützing, 1844

145. ***Diadesmis confervacea*** **Kützing, 1844: 109, pl. 30 fig. 8.**

Navicula confervacea (Kützing) Grunow, 1880: pl. 14 fig. 36.

Observation. Crescent Island Crater: NC20.
Occurrence. Sediment core.

Genus *Humidophila* (Lange-Bertalot & Werum) R.L.Lowe, Kociolek, J.R.Johansen, Van de Vijver, Lange-Bertalot & Kopalová, 2014

146. *Humidophila contenta* (Grunow) R.L.Lowe, Kociolek, J.R.Johansen, Van de Vijver, Lange-Bertalot & Kopalová, 2014: 357.

Navicula contenta Grunow, 1885: 109.
Diadesmis contenta (Grunow) D.G.Mann, 1990: 666.

Observation. Main basin: Cocquyt and De Wever (2002).
Lake Sonachi: NS93.2-F.
Occurrence. Epiphytic, sediment core.
Recent review of this taxon by Van de Vijver et al. (2022) has shown that often valves identified as *H. contenta* belong to a different species, namely *Humidophila simplex* (E.Reichardt) R.L.Lowe Kociolek, J.R.Johansen, Van de Vijver, Lange-Bertalot & Kopalová (2014: 359). As no photographs or drawings are available of the valves of *H. contenta* that have been sporadically observed in the main basin of Lake Naivasha and in Lake Sonachi, in future studies attention should focus on correct identification of this taxon.

Genus *Luticola* D.G.Mann, 1990

147. *Luticola mutica* (Kützing) D.G.Mann, 1990: 532, 670 figs a–c.

Navicula mutica Kützing 1844: 93, pl. 3 fig. 32.

Observation. Crescent Island Crater: Richardson and Richardson (1972), Gasse (1986), Van der Meeren et al. (2019), NC20.
Main basin: Cocquyt and De Wever (2002), Owino et al. (2020), NM91.1-S, NM93.1-S.
Lake Sonachi: NS93.2-F.
Occurrence. Plankton, epiphytic, sediment core.

Class Bacillariophyceae Haeckel, 1878
Order Naviculales Bessey, 1907
Family Amphipleuraceae Grunow, 1990
Genus *Frustulia* Rabenhorst, 1853

148. *Frustulia saxonica* Rabenhorst, 1853: 50 pl. VII fig. 1.

Frustulia rhomboides var. *saxonica* (Rabenhorst) De Toni, 1891: 277.

Observation. Lake Sonachi: Bachmann (1938), NS93.2-F.
Occurrence. Plankton, sediment core.

Class Bacillariophyceae Haeckel, 1878
Order Naviculales Bessey, 1907
Family Brachysiraceae D.G.Mann, 1990
Genus *Brachysira* Kützing, 1836

149. *Brachysira exilis* (Kützing) Round & D.G.Mann, 1981: 227.

Observation. Crescent Island Crater: NC20.
Occurrence. Sediment core.

150. *Brachysira* cf. *serians* (Brébission) Round & D.G.Mann, 1981: 227.

Anomoeoneis serians (Brébisson) Cleve, 1895: 7.

Observation. Lake Sonachi: NS93.2-F.
Occurrence. Sediment core.

Class Bacillariophyceae Haeckel, 1878
Order Naviculales Bessey, 1907
Family Neidiaceae Mereschkowsky, 1903
Genus *Neidium* Pfitzer, 1871

151. *Neidium affine* (Ehrenberg) Pfitzer, 1871: 39.

Observation. Crescent Island Crater: NC20.
Occurrence. Sediment core.

152. *Neidium iridis* (Ehrenberg) Cleve, 1894: 69.

Neidium amphigomphys (Ehrenberg) Pfitzer, 1871: 39.
Neidium iridis var. *amphigomphys* (Ehrenberg) O'Meara, 1875: 337.

Observation. Main basin: Gasse (1986).
Crescent Island Crater: Gasse (1986).
Occurrence. Plankton.

153. *Neidium productum* (W.Smith) Cleve, 1894: 69.

Observation. Crescent Island Crater: Gasse 1986.
Occurrence. Bottom mud.

154. *Neidium* sp.

Observation. Crescent Island Crater: Richardson and Richardson (1972).

Occurrence. Sediment core.

Class Bacillariophyceae Haeckel, 1878
Order Naviculales Bessey, 1907
Family Sellaphoraceae Mereschkowsky, 1902
Genus *Fallacia* Stickle & D.G.Mann, 1990

155. *Fallacia pygmaea* (Kützing) Stickle & D.G.Mann, 1990: 668.

Navicula pygmaea Kützing, 1849: 77.
Lyrella pygmaea (Kützing) Makarova & Karayeva, 1987: 53, pl. 2 fig. 2.

Observation. Main basin: NM91.1-S, NM93.1-S.
Occurrence. Sediment core.

Class Bacillariophyceae Haeckel, 1878
Order Naviculales Bessey, 1907
Family Sellaphoraceae Mereschkowsky, 1902
Genus *Sellaphora* Mereschkowsky, 1902

156. *Sellaphora* cf. *damasii* (Hustedt) C.E.Wetzel, Ector, Van de Vijver, Compère & D.G.Mann, 2015: 226.

Navicula damasii Hustedt, 1962: 203, pl. VII fig. 1322.
Navicula subcontenta var. *africana* Hustedt, 1949: 85, pl. 4 figs 27, 28.

Observation. Crescent Island Crater: NC20.
Occurrence. Sediment core.

157. *Sellaphora nyassensis* (O.Müller) D.G.Mann, 1989: 2.

Navicula nyassensis O.Müller, 1910: 83, pl. I fig. 5.
Navicula pupula var. *nyassensis* Lange-Bertalot, 1985: 89.

Observation. Crescent Island Crater: Richardson and Richardson (1972), NC20.
Occurrence. Sediment core.

158. *Sellaphora perventralis* (Hustedt) A.Tuji, 2003: 71.

Navicula perventralis Hustedt, 1937: 241, pl. 17 figs 49–50.

Observation. Crescent Island Crater: Richardson and Richardson (1972).
Occurrence. Sediment core.

159. *Sellaphora* cf. *pseudoventralis* (Hustedt) Chudaev & Gololobova, 2015: 254, figs 17–29.

Navicula pseudoventralis Hustedt, 1953: 631, figs 12, 13.

Observation. Crescent Island Crater: NC20.
Occurrence. Sediment core.

160. *Sellaphora pupula* (Kützing) Mereschkovsky, 1902: 187, pl. 4 figs 1–5.

Navicula pupula Kützing, 1844: 93, pl. 30 fig. 40.

Observation. Main basin: Gasse (1986), Cocquyt and De Wever (2002), Stoof-Leichsenring et al. (2012), NM91.1-S, NM93.1-S.
Crescent Island Crater: Gasse (1986), Cocquyt and De Wever (2002), NC20.
Lake Oloidien: Gasse (1986).
Occurrence. Plankton, bottom mud, sediment core.

161. *Sellaphora rectangularis* (W.Gregory) Lange-Bertalot & Metzeltin, 1996: 102, pl. 25 figs 10–12, pl. 125 fig. 7.

Navicula pupula var. *rectangularis* (W.Gregory) Cleve & Grunow, 1880: 45.
Navicula pupula f. *rectangularis* (W.Gregory) Hustedt, 1961: 121, figs 1254 n–q.
Sellaphora pupula var. *rectangularis* (W.Gregory) Mereschkowsky, 1902: 191.

Observation. Main basin: NM91.1-S, NM93.1-S.
Crescent Island Crater: Richardson and Richardson (1972), NC20.
Occurrence. Sediment core.

162. *Sellaphora* cf. *seminulum* (Grunow) D.G.Mann, 1989: 2.

Navicula seminulum Grunow, 1860: 552, pl. 2 fig. 3.

Observation. Crescent Island Crater: NC20.
Occurrence. Sediment core.

163. *Sellaphora* sp.

Observation. Crescent Island Crater: NC20.
Occurrence. Sediment core.

Class Bacillariophyceae Haeckel, 1878
Order Naviculales Bessey, 1907
Family Pinnulariaceae D.G.Mann, 1990
Genus *Caloneis* Cleve, 1894

164. *Caloneis aequatorialis* Hustedt, 1921: 148, figs 5, 6.

Observation. Crescent Island Crater: NC20.
Occurrence. Sediment core.

165. *Caloneis bacillum* (Grunow) Cleve, 1894: 99.

Observation. Crescent Island Crater: NC93, NC20.
Occurrence. Sediment core.

166. *Caloneis* cf. *clevei* (Lagerstedt) Cleve, 1894: 51.

Observation. Crescent Island Crater: NC93.
Occurrence. Sediment core.

167. *Caloneis silicula* (Ehrenberg) Cleve, 1894: 51.

Observation. Crescent Island Crater: NC93, NC20.
Occurrence. Sediment core.

168. *Caloneis ventricosa* (Ehrenberg) F.Meister, 1912: 116, pl. 17 fig. 4.

Observation. Crescent Island Crater: NC20.
Occurrence. Sediment core.

Genus *Pinnularia* Ehrenberg, 1843

169. *Pinnularia acrosphaeria* W.Smith, 1853: 58, pl. XIX fig. 183.

Observation. Main basin: Rich (1932).
Occurrence. Bottom mud.

170. *Pinnularia biundulata* (O.Müller) Kulikovskiy & Genkal, 2010: 497.

Pinnularia microstauron var. *biundulata* O.Müller, 1898: 25.
Pinnularia microstauron f. *biundulata* (O.Müller) Hustedt, 1930: 320, fig. 583.

Observation. Main basin: Gasse (1986).
Occurrence. Bottom mud.

171. *Pinnularia borealis* Ehrenberg, 1843: 420, pl. 4 fig. I.5, pl. 4 fig.V.5.

Observation. Main basin: NM91.1-S, NM93.1-S.
Occurrence. Sediment core.

172. *Pinnularia borealis* var. *scalaris* (Ehrenberg) Rabenhorst, 1864: 216.

Observation. Main basin: Rich (1932).
Occurrence. Bottom mud.

173. *Pinnularia* cf. *dubitabilis* Hustedt, 1949: 105, pl. 6 figs 11–13.

Pinnularia eburnea Zanon, 1941: 49, pl. III figs 16–18.

Observation. Crescent Island Crater: Richardson and Richardson (1972).
Occurrence. Sediment core.

174. *Pinnularia gibba* (Ehrenberg) Ehrenberg, 1843: 315.

Observation. Main basin: Cocquyt and De Wever (2002).
Crescent Island Crater: Gasse (1986).
Occurrence. Plankton, epiphytic.

175. *Pinnularia gibba* var. *sancta* (Grunow ex Cleve) F.Meister, 1932: 43, fig. 140.

Observation. Main basin: Stoof-Leichsenring et al. (2012), NM93.1-S, and cf. this taxon in NM91.1-S.
Occurrence. Plankton, epiphytic.

176. *Pinnularia interrupta* W.Smith, 1853: 59, pl. 19 fig. 184.

Navicula interrupta (W.Smith) Grunow, 1860: 521.

Observation. Main basin: Rich (1932).
Occurrence. Bottom mud.

177. *Pinnularia interruptiformis* Krammer, 2000: 109, pl. 85 figs 1–9.

Pinnularia biceps f. *petersenii* R.Ross, 1947: 201, pl. 9 fig. 11.

Observation. Crescent Island Crater: NC20.
Lake Oloidien: Gasse (1986).
Occurrence. Bottom mud, sediment core.

178. *Pinnularia mesolepta* (Ehrenberg) W.Smith, 1853: 58, pl. 19 fig. 182.

Navicula mesolepta Ehrenberg, 1843: 419, pl. 4/2 fig. 4.

Observation. Main basin: Rich (1932).
Occurrence. Bottom mud.

179. *Pinnularia major* (Kützing) Rabenhorst, 1853: 42, pl. 6 fig. 5.

Observation. Main basin: Owino et al. (2020).
Crescent Island Crater: Gasse (1986).
Lake Oloidien: Gasse (1986).
Occurrence. Plankton, bottom mud, sediment core.

180. *Pinnularia subcapitata* W.Gregory, 1856: 9, pl. 1 fig. 30.

Observation. Crescent Island Crater: Gasse (1986).
Occurrence. Plankton.

181. *Pinnularia viridis* (Nitzsch) Ehrenberg, 1843: 305, 315, 385, pl. 1 fig. 7.

Observation. Main basin: Owino et al. (2020).
Occurrence. Sediment core.

Remark. Unidentified *Pinnularia* taxa are reported from Crescent Island (core NC20) and from the main basin (Cocquyt and De Wever 2002 and cores NM91.1-S and NM93.1-S.).

Class Bacillariophyceae Haeckel, 1878
Order Naviculales Bessey, 1907
Family Diploneidaceae D.G.Mann, 1990
Genus *Diploneis* Ehrenberg ex Cleve, 1894

182. *Diploneis elliptica* (Kützing) Cleve, 1894: 92.

Observation. Crescent Island Crater: NC20.
Occurrence. Sediment core.

183. *Diploneis ovalis* (Hilse) Cleve, 1891: 44, pl. 2 fig. 13.

Observation. Crescent Island Crater: Richardson and Richardson (1972).
Occurrence. Sediment core.

184. *Diploneis pseudovalis* Hustedt, 1930: 253, fig. 403.

Observation. Main basin: Stoof-Leichsenring et al. (2012).

Occurrence. Sediment core.

185. *Diploneis* sp.

Observation. Crescent Island Crater: Richardson and Richardson (1972).

Occurrence. Sediment core.

An unidentified *Diploneis* taxon was also observed in the core taken from Crescent Island Crater (core NC20) and from the main basin (core NM91.1-S.).

Class Bacillariophyceae Haeckel, 1878
Order Naviculales Bessey, 1907
Family Naviculaceae Kützing, 1844
Genus *Adlafia* Gerd Moser, Lange-Bertalot & Metzeltin, 1998

186. *Adlafia pseudomuralis* (Hustedt) J.Y.Li & Y.Z.Qi, nom. inval., 2018: 5, pl. 1 fig. 6.

Navicula pseudomuralis Hustedt, 1937: 245, pl. 19 figs 25–27.
Fallacia pseudomuralis (Hustedt) D.G.Mann, 1990: 669.

Observation. Crescent Island Crater: Gasse (1986).

Occurrence. Plankton.

Genus *Hippodonta* Lange-Bertalot, Witkowski & Metzeltin, 1996

187. *Hippodonta* cf. *costulata* (Grunow) Lange-Bertalot, Metzeltin & Witkowski, 1996: 254, pl. 1 figs 6, 7, pl. 3 fig. 5, pl. 4 figs 6–9.

Navicula costulata Grunow, 1880: 27.

Observation. Crescent Island Crater: NC20.

Occurrence. Sediment core.

Genus *Mayamaea* Lange-Bertalot, 1997

188. *Mayamaea permitis* (Hustedt) Bruder & Medlin, 2008: 327.

Navicula permitis Hustedt, 1945: 919, pl. 41 figs 8, 9.

Observation. Main basin: Gasse (1896).

Occurrence. Bottom mud.

Genus *Navicula* Bory, 1822

189. *Navicula barbarica* Hustedt, 1949: 97, pl. IV figs 14–17.

Observation. Crescent Island Crater: Richardson and Richardson (1972).
Occurrence. Sediment core.

190. *Navicula capitatoradiata* H.Germain ex Gasse, 1986: 86, pl. 19 figs 8–9.

Observation. Crescent Island Crater: core NC20.
Occurrence. Sediment core.

191. *Navicula cari* var. *cincta* (Ehrenberg) Lange-Bertalot, 1980: 37, pl. 7 figs 1–23.

Observation. Main basin: Gasse (1986).
Crescent Island Crater: Gasse (1986).
Lake Oloidien: Gasse (1986).
Occurrence. Plankton, bottom mud.

192. *Navicula cryptocephala* Kützing, 1844: 95, pl. 3 figs 20, 26.

Observation. Main basin: Gasse ((1986), Cocquyt and De Wever (2002), Stoof-Leichsenring et al. (2011), Stoof-Leichsenring et al. (2012).
Crescent Island Crater: Richardson and Richardson (1972), Gasse (1986).
Occurrence. Plankton, epiphytic, bottom mud, sediment core.

193. *Navicula cryptotenella* Lange-Bertalot, 1985: 62, pl. 18 figs 22, 23, pl. 19 figs 1–10, pl. 27 fig. 1.

Observation. Main basin: NM91.1-S, NM93.1-S.
Crescent Island Crater: NC20.
Occurrence. Sediment core.

194. *Navicula* cf. *exigua* W.Gregory nom. illeg., 1854: 99.

Observation. Main basin: NM91.1-S, NM93.1-S.
Crescent Island Crater: NC20.
Occurrence. Sediment core.

According to Guiry and Guiry (2022) the taxonomic and nomenclatural status of *Navicula exigua* is in some way unresolved and requires further investigation.

195. *Navicula* cf. *glomus* J.R.Carter, 1981: 578, pl. 13 fig. 17.

Observation. Crescent Island Crater: NC20.

Occurrence. Sediment core.

196. *Navicula minima* Grunow, 1880: pl. XIV fig. 15.

Observation. Crescent Island Crater: Richardson and Richardson (1972).

Occurrence. Sediment core.

197. *Navicula radiosa* Kützing, 1844: 91, pl. 4 fig. 23.

Navicula radiosa var. *acuta* (W.Smith) Grunow, 1860: 526.

Observation. Main basin: Rich (1932), Gasse (1986), Stoof-Leichsenring et al. (2011), Stoof-Leichsenring et al. (2012).

Crescent Island Crater: Richardson and Richardson (1972), NC20.

Occurrence. Bottom mud, sediment core.

198. *Navicula radiosa* f. *divergentissima* Manguin, 1952: 26, fig. 54.

Navicula radiosa [var. *acuta*] f. *divergentissima* Manguin, 1952: 26, fig. 54.

Observation. Crescent Island Crater: NC20.

Occurrence. Sediment core.

According to Guiry and Guiry (2022) the taxonomic status of this taxon requires further investigation.

199. *Navicula radiosafallax* Lange-Bertalot, 1993: 131, pl. 52 figs 1–3.

Navicula radiosa var. *parva* J.H.Wallace, 1960: 3, pl. 1 fig. 5.

Observation. Main basin: NM93.1-S, and cf. this taxon in NM91.1-S.

Occurrence. Sediment core.

200. *Navicula seminuloides* var. *sumatrensis* Hustedt, 1937: 239, pl. 17 figs 32, 33.

Observation. Crescent Island Crater: Richardson and Richardson (1972).

Occurrence. Sediment core.

Richardson and Richardson (1972) mentioned the name of this taxon as *Navicula seminuloides* var. *sumatrana*.

201. *Navicula rhynchocephala* Kützing, 1844: 152, pl. 30 fig. 35.

Observation. Crescent Island Crater: NC20.
Occurrence. Sediment core.

202. *Navicula rostellata* Kützing, 1844: 95, pl. 3 fig. 65.

Navicula rhynchocephala var. *rostellata* (Kützing) Cleve & Grunow, 1880: 33.
Navicula viridula var. *rostellata* (Kützing) Cleve, 1895: 15.

Observation. Crescent Island Crater: NC20.
Occurrence. Sediment core.

203. *Navicula* aff. *tenella* Brébisson ex Kützing, 1849: 74.

Navicula radiosa var. *tenella* (Brébisson ex Kützing) Van Heurck, 1885: 84.

Observation. Main basin: NM93.1-S.
Crescent Island Crater: Gasse (1986).
Occurrence. Plankton, sediment core.

204. *Navicula trivialis* Lange-Bertalot, 1980: 31, pl. 1 figs 5–9.

Observation. Main basin: NM91.1-S.
Crescent Island Crater: Richardson and Richardson (1972).
Occurrence. Sediment core.

205. *Navicula veneta* Kützing, 1844: 95, pl. 30 fig. 76.

Navicula cryptocephala var. *veneta* (Kützing) Rabenhorst, 1864: 198.
Navicula cryptocephala f. *veneta* (Kützing) Hustedt, 1957: 290.

Observation. Main basin: Cocquyt and De Wever (2002).
Crescent Island Crater: Gasse (1986).
Occurrence. Plankton, epiphytic.

206. *Navicula viridula* (Kützing) Ehrenberg, 1836: 53.

Observation. Main basin: NM91.1-S, NM93.1-S.
Crescent Island Crater: Richardson and Richardson (1972).
Occurrence. Sediment core.

207. *Navicula zanonii* Hustedt, 1949: 792, pl. 5 figs 1–5.

Observation. Main basin: Gasse (1986), NM91.1-S.

Occurrence. Bottom mud.

Remark. Owino et al. (2020) reported, besides an unidentified *Navicula*, also "*Navicula granatum*". Probably a typing error occurred as a *Navicula* with the epithet *granatum* does not exit. In core NM91.1-S, a small *Navicula* was observed. However, we do not know to which genus split off from *Navicula* s.l. this taxon currently belongs.

Genus *Navigiolum* Lange-Bertalot, Cavacini, Tagliaventi & Alfinito, 2003

208. *Navigiolum adamantiforme* (R.E.M.Archibald) J.C.Taylor & Lange-Bertalot, 2006: 177, figs 2a–k.

Navicula adamantiforme R.E.M.Archibald, 1966: 256, figs 5, 6.

Observation. Crescent Island Crater: core NC20.

Occurrence. Sediment core.

Class Bacillariophyceae Haeckel, 1878
Order Naviculales Bessey, 1907
Family Stauroneidaceae D.G.Mann, 1990
Genus *Craticula* Grunow, 1868

209. *Craticula buderi* (Hustedt) Lange-Bertalot, 2000: 101, pl. 58 fig. 3.

Navicula buderi Hustedt, 1954: 279, figs 11–15.

Observation. Lake Sonachi: NS93.2-F.

Occurrence. Sediment core.

210. *Craticula ambigua* (Ehrenberg) D.G.Mann, 1990: 666.

Navicula ambigua Ehrenberg, 1843: 417, pl. 2/2 fig. 9.
Navicula cuspidata var. *ambigua* (Ehrenberg) Kirchner, 1878: 178.

Observation. Main basin: Bachmann (1938).
Crescent Island Crater: NC93, NC20.

Occurrence. Littoral, sediment core.

211. *Craticula cuspidata* (Kützing) D.G.Mann, 1990: 666.

Navicula cuspidata (Kützing) Kützing, 1844: 94, pl. 3 figs 34, 37.

Observation. Main basin: Gasse (1986).
Lake Sonachi: NS93.2-F.
Occurrence. Plankton, sediment core.

212. *Craticula cuspidata* var. *major* (F.Meister) Czarnecki, 1994: 96.

Navicula cuspidata var. *major* F.Meister, 1912: 134, pl. 20 fig. 10.

Observation. Main basin: Rich (1932).
Occurrence. Bottom mud.

213. *Craticula elkab* (O.Müller ex O.Müller) Lange-Bertalot, Kusber & Cocquyt, 2007: 119.

Navicula elkab O.Müller ex O.Müller, 1910: 76 figs. 19–22.

Observation. Main basin: Cocquyt and De Wever (2002), Stoof-Leichsenring et al. (2011), Stoof-Leichsenring et al. (2012), NM91.1-S, NM93.1-S.
Crescent Island Crater: Richardson and Richardson (1972), Gasse (1986), Van der Meeren et al. (2019), NC20.
Lake Oloidien: Gasse (1986), Verschuren et al. (1999b), Verschuren et al. (2000b).
Lake Sonachi: Gasse (1986), Cocquyt and De Wever (2002), NS93.2-F.
Occurrence. Epiphytic, bottom mud, sediment core.

214. *Craticula halophila* (Grunow) D.G.Mann, 1990: 666.

Navicula cuspidata var. *halophila* Grunow, 1885: 100, suppl. pl. B fig. 30.
Navicula halophila (Grunow) Cleve, 1894: 109.
Navicula halophila f. *robusta* Hustedt, 1959: 401, figs. 1–3.

Observation. Main basin: Gasse (1986), Stoof-Leichsenring et al. (2012), NM91.1-S, NM93.1-S.
Lake Sonachi: Gasse (1986), NS93.2-F.
Occurrence. Plankton, bottom mud, sediment core.

215. *Craticula* aff. *minusculoides* (Hustedt) Lange-Bertalot, 2001: 115.

Navicula minusculoides Hustedt, 1942: 88, fig. 5.

Observation. Crescent Island Crater: Gasse (1986).
Occurrence. Bottom mud.

216. *Craticula molestiformis* (Hustedt) Mayama, 1999: 2.

Navicula molestiformis Hustedt, 1949: 86, pl. 5 fig. 9.
Navicula twymaniana R.E.M.Archibald, 1966: 264, figs 41–43.

Observation. Crescent Island Crater: Gasse (1986).
Occurrence. Plankton.

217. *Craticula perrotettii* Grunow, 1868: 20, pl. 1 fig. 1.

Navicula perrotettii (Grunow) Cleve, 1894: 110, pl. 3 fig. 12.

Observation. Crescent Island Crater: NC20.
Occurrence. Sediment core.

Remark. Rich (1932) reported *Navicula cuspidata* var. *major* F.Meister 1912: 134, pl. 20 fig. 10. (*Craticula cuspidata* var. *major* (Meister) Czarnecki 1994: 96) in bottom mud from the main basin of Lake Naivasha. According the Guiry and Guiry (2022) the taxonomic status of this taxon requires further investigation, but the valves observed by Rich (1932) are very probably one of the larger *Craticula* species observed in Lake Naivasha, e.g., *Craticula cuspidata* or *Craticula perrotettii*.

Genus *Dorofeyukea* Kulikovskiy, Maltsev, S.A.Andreeva, T.Ludwig & Kociolek, 2019

218. *Dorofeyukea kotschyi* (Grunow) Kulikovskiy, Kociolek, Tusset & T.Ludwig, 2019: 178, figs 5–7.

Navicula kotschyi Grunow, 1860: 538, pl. 2 fig. 12.
Luticola kotschyi (Grunow) J.C.Taylor, W.C.Harding & C.G.M.Archibald, nom. inval., 2007: 50.

Observation. Crescent Island Crater: NC20.
Occurrence. Sediment core.

Genus *Fistulifera* Lange-Bertalot, 1997

219. *Fistulifera pelliculosa* (Kützing) Lange-Bertalot, 1997: 73, figs 28–31.

Navicula pelliculosa (Kützing) Hilse, 1863: 68.

Observation. Crescent Island Crater: Gasse (1986).
Occurrence. Plankton.

Genus *Stauroneis* Ehrenberg, 1843

220. *Stauroneis phoenicenteron* (Nitzsch) Ehrenberg, 1843: 311, pl. 2 fig. 1, pl. 3 fig. 3.

Stauroneis phoenicenteron var. *genuina* Cleve 1894: 149.

Observation. Main basin: Rich (1932).
Occurrence. Bottom mud.

Class Bacillariophyceae Haeckel, 1878
Order Thalassiophysales D.G.Mann, 1990
Family Catenulaceae Mereschkowsky, 1902
Genus *Amphora* Ehrenberg ex Kützing, 1844

221. *Amphora copulata* (Kützing) Schoeman & R.E.M.Archibald, 1986: 429, figs 1–13, 30–34.

Amphora ovalis var. *libyca* (Ehrenberg) Cleve, 1895: 104 pro parte.
Amphora libyca Ehrenberg, 1841: 205 pro parte.

Observation. Main basin: Rich (1932), Cocquyt and De Wever (2002), Stoof-Leichsenring et al. (2011), Stoof-Leichsenring et al. (2012), NM91.1-S, NM93.1-S.
Crescent Island Crater: Richardson and Richardson (1972), NC20.
Occurrence. Bottom mud, sediment core
Tropical African specimens of *Amphora libyca* (Ehrenberg) Cleve, 1895: 104 (synonym: *Amphora ovalis* var. *libyca* (Ehrenberg) Cleve, 1895: 104) were often put in synonymy with *Amphora copulata*. However, further investigation of the valves observed in Lake Naivasha and its satellite lakes is needed to see if these valves belongs to a cluster of different species. The revision work of the genus *Amphora* by Levkov (2009) suggests that we may indeed be dealing here with several species, as was the case for Lake Tanganyika where many new species were described.

222. *Amphora gouwsii* Cholnoky, 1953: 352, fig. 1.

Observation. Crescent Island Crater: Richardson and Richardson (1972).
Occurrence. Sediment core.
According to Guiry and Guiry (2022) the taxonomic status of this taxon requires further investigation.

223. *Amphora ovalis* (Kützing) Kützing, 1844: 107, pl. 5 figs 35, 39.

Observation. Crescent Island Crater: Richardson and Richardson (1972), NC20.
Occurrence. Sediment core.

224. *Amphora pediculus* (Kützing) Grunow, 1875: pl. 26 fig. 99.

Amphora ovalis var. *pediculus* (Kützing) Van Heurck, 1885: 59.

Observation. Main basin: Gasse (1986).
Crescent Island Crater: Richardson and Richardson (1972).
Lake Sonachi: Gasse (1986).
Occurrence. Plankton, bottom mud, sediment core.

Remark. Owino et al. (2020) reported a *Amphora* sp., probably one of the above mentioned taxa or one of the following *Halamphora* taxa, in the sediment core of the Main basin they studied.

Genus *Halamphora* (Cleve) Mereschkowsky, 1903

225. *Halamphora thermalis* (Hustedt) Levkov, 2009: 235, pl. 108 figs 19–39, pl. 230 figs 1–6.

Amphora thermalis Hustedt, 1949: 111, pl. 11 figs 1–3.
Amphora hartii Cholnoky, 1963: 30, figs 1–3.

Observation. Lake Sonachi: NS93.2-F.
Occurrence. Sediment core.

226. *Halamphora thumensis* (Ant.Mayer) Levkov, 2009: 236, pl. 98 figs 10–20, pl. 219 fig. 6.

Amphora coffeiformis var. *thumensis* Ant.Mayer, 1919: 208, pl. 9 fig. 69.
Cymbella thumensis (Ant.Mayer) Hustedt, 1945: 938.

Observation. Crescent Island Crater: Richardson and Richardson (1972).
Occurrence. Sediment core.

227. *Halamphora veneta* (Kützing) Levkov, 2009: 242, pl. 94 figs 9–19, pl. 102 figs 17–30, pl. 217 figs 1–5, pl. 218 figs 1–5.

Amphora veneta Kützing, 1844: 108, pl. 3 fig. 25.

Observation. Main basin: Gasse (1986), Cocquyt and De Wever (2002), NM91.1-S, NM93.1-S.
Crescent Island Crater: Richardson and Richardson (1972), Gasse (1986).
Lake Oloidien: Gasse (1986).
Lake Sonachi: Gasse (1986).
Occurrence. Epiphytic, bottom mud, sediment core.

Class Bacillariophyceae Haeckel, 1878
Order Bacillariales Hendey, 1937
Family Bacillariaceae Ehrenberg, 1831
Genus *Hantzschia* Grunow, 1877

228. *Hantzschia amphioxys* (Ehrenberg) Grunow, 1880: 103.

Observation. Main basin: Gasse (1986), Cocquyt and De Wever (2002), NM91.1-S, NM93.1-S.
Crescent Island Crater: Richardson and Richardson (1972), Gasse 1986, NC20.
Lake Oloidien: Gasse (1986).
Lake Sonachi: NS93.2-F.
Occurrence. Epiphytic, bottom mud, sediment core.

229. *Hantzschia amphioxys* var. *africana* Hustedt, 1921: 131, 197, pl. 1 fig. 25.

Observation. Main basin: Gasse (1986), Cocquyt and De Wever (2002), NM93.1-S.
Crescent Island Crater: Richardson and Richardson (1972), Gasse (1986), NC20.
Lake Oloidien: Gasse (1986).
Lake Sonachi: NS93.2-F.
Occurrence. Epiphytic, bottom mud, sediment core.

Genus *Nitzschia* Hassall, 1845

230. *Nitzschia accommodata* Hustedt, 1949: 139, pl. 12 figs 27–31, 34, 35.

Observation. Crescent Island Crater: Richardson and Richardson (1972).
Occurrence. Sediment core.

231. *Nitzschia acicularis* (Kützing) W.Smith, 1853: 43, pl. 15 fig. 122.

Observation. Crescent Island Crater: NC20.
Occurrence. Sediment core.

232. *Nitzschia* cf. *adapta* Hustedt, 1949: 135, pl. XII figs 3–6.

Observation. Crescent Island Crater: Richardson and Richardson (1972), NC20.
Occurrence. Sediment core.

233. *Nitzschia amphibia* Grunow, 1862: 574, pl. 28 fig. 23.

Observation. Main basin: Gasse (1986), Cocquyt and De Wever (2002), NM91.1-S.
Crescent Island Crater: Richardson and Richardson (1972), Gasse (1986), NC20.
Lake Oloidien: Gasse (1986).

Occurrence. Plankton, bottom mud, sediment core.

234. *Nitzschia amphibia* f. *frauenfeldii* (Grunow) Lange-Bertalot, 1987: 5, pl. 37 figs 15–22.

Observation. Crescent Island Crater: NC20.

Occurrence. Sediment core.

According to Guiry and Guiry (2022) the taxonomic or nomenclatural status (or both) of this entity is in some way unresolved and requires further investigation.

235. *Nitzschia* cf. *archibaldii* Lange-Bertalot, 1980: 44, pl. 1 figs 14–18, pl. 7 figs 115–121.

Observation. Main basin: Gasse (1986).

Crescent Island Crater: Gasse (1986).

Lake Oloidien: Gasse (1986).

Lake Sonachi: NS93.2-F.

Occurrence. Plankton, bottom mud, sediment core.

236. *Nitzschia bacata* Hustedt, 1937: 485, pl. 41 figs 30–33.

Observation. Crescent Island Crater: Richardson and Richardson (1972), NC20.

Occurrence. Sediment core.

237. *Nitzschia brevissima* Grunow, 1880: 485, pl. LXVII fig. 4.

Nitzschia obtusa var. *brevissima* Grunow, 1885: 180.

Observation. Crescent Island Crater: Richardson and Richardson (1972).

Occurrence. Sediment core.

238. *Nitzschia clausii* Hantzsch, 1860: 40, pl. 6 fig. 7.

Observation. Lake Sonachi: NS93.2-F.

Occurrence. Sediment core.

239. *Nitzschia communis* Rabenhorst, 1860: no. 949.

Observation. Main basin: NM93.1-S, and cf. this taxon in NM91.1-S.

Lake Sonachi: NS93.2-F.

Occurrence. Sediment core.

240. *Nitzschia confinis* Hustedt, 1949: 145, pl. 11 figs 49–54, pl. 13 figs 84–90.

Observation. Crescent Island Crater: Richardson and Richardson (1972).
Occurrence. Sediment core.

241. *Nitzschia dissipata* (Kützing) Rabenhorst, 1860: no. 968.

Observation. Main basin: Owino et al. (2020).
Crescent Island Crater: NC20.
Occurrence. Sediment core.

242. *Nitzschia filiformis* (W.Smith) Van Heurck, 1896: 406, pl. 33 fig. 882.

Observation. Crescent Island Crater: NC20.
Occurrence. Sediment core.

243. *Nitzschia fonticola* (Grunow) Grunow, 1881: pl. LXIX figs 15–20.

Observation. Crescent Island Crater: Richardson and Richardson (1972), NC20.
Lake Sonachi: NS93.2-F.
Occurrence. Sediment core.

244. *Nitzschia fonticola* var. *pelagica* Hustedt, in A.W.F.Schmidt 1924: pl 349 figs 15–16.

Observation. Crescent Island Crater: NC20.
Occurrence. Sediment core.

245. *Nitzschia frustulum* (Kützing) Grunow, 1880: 98.

Observation. Main basin: Stoof-Leichsenring et al. (2011), Stoof-Leichsenring et al. (2012).
Crescent Island Crater: Richardson and Richardson (1972), NC20.
Lake Sonachi: NS93.2-F.
Occurrence. Sediment core.

246. *Nitzschia* aff. *frustulum* (Kützing) Grunow, 1880: 98.

Observation. Main basin: Cocquyt and De Wever (2002).
Crescent Island Crater: Gasse (1986), Cocquyt and De Wever (2002).
Occurrence. Epiphytic, bottom mud.

247. *Nitzschia frustulum* var. *perpusilla* (Rabenhorst) Van Heurck, 1885: 184.

Observation. Crescent Island Crater: Richardson and Richardson (1972).
Occurrence. Sediment core.

248. *Nitzschia goetzeana* O.Müller, 1905: 176, pl. II fig. 20.

Observation. Crescent Island Crater: Richardson and Richardson (1972).
Occurrence. Sediment core.

249. *Nitzschia gracilis* Hantzsch, 1860: 40, pl. 6 fig. 8.

Observation. Main basin: Gasse (1986), NM91.1-S, NM93.1-S.
Crescent Island Crater: Gasse (1986).
Lake Oloidien: Gasse (1986).
Occurrence. Plankton, bottom mud, sediment core.

250. *Nitzschia* cf. *inconspicua* Grunow, 1862: 579, pl. 28/12 fig. 25.

Observation. Crescent Island Crater: NC20.
Lake Sonachi: NS93.2-F.
Occurrence. Sediment core.

251. *Nitzschia* cf. *intermedia* Hantzsch ex Cleve & Grunow, 1880: 95.

Observation. Main basin: Gasse (1986), Stoof-Leichsenring et al. (2011), Stoof-Leichsenring et al. (2012), NM91.1-S, NM93.1-S.
Crescent Island Crater: Gasse (1986), NC20.
Lake Oloidien: Gasse (1986).
Lake Sonachi: NS93.2-F.
Occurrence. Plankton, bottom mud, sediment core.

252. *Nitzschia lacustris* Hustedt, 1922: 166.

Observation. Crescent Island Crater: Richardson and Richardson (1972).
Main basin: Owino et al. (2020).
Lake Oloidien: Gasse (1986).
Occurrence. Bottom mud, sediment core.

253. *Nitzschia lancettula* O.Müller, 1905: 175, pl. 2 fig. 15.

Observation. Main basin: Cocquyt and De Wever (2002).
Crescent Island Crater: Richardson and Richardson (1972), Gasse (1986), NC20.
Occurrence. Bottom mud, epiphytic, sediment core.

254. *Nitzschia latens* Hustedt, 1949: 148, pl. XII figs 30, 31.

Observation. Main basin: Cocquyt and De Wever (2002), NM93.1-S, and cf. this taxon in NM93.1-S.

Crescent Island Crater: NC20.

Lake Sonachi: NS93.2-F.

Occurrence. Epiphytic, sediment core.

255. *Nitzschia linearis* W.Smith, 1853: 39, pl. XIII fig. 110.

Observation. Main basin: Bachmann (1938), Stoof-Leichsenring et al. (2011), Stoof-Leichsenring et al. (2012), NM93.1-S, and cf. this taxon in NM91.1-S.

Crescent Island Crater: NC20.

Lake Oloidien: Gasse (1986).

Occurrence. Plankton, bottom mud, sediment core.

256. *Nitzschia* cf. *mediocris* Hustedt, 1949: 149, pl. XIII figs 21–24.

Observation. Crescent Island Crater: Richardson and Richardson (1972), NC20.

Occurrence. Sediment core.

257. *Nitzschia obtusa* W.Smith, 1853: 39, pl. XIII fig. 109.

Observation. Lake Sonachi: NS93.2-F.

Occurrence. Sediment core.

258. *Nitzschia palea* (Kützing) W.Smith, 1856: 89.

Observation. Main basin: Gasse (1986), Stoof-Leichsenring et al. (2011), Stoof-Leichsenring et al. (2012), Owino et al. (2020), NM91.1-S, NM93.1-S.

Crescent Island Crater: Richardson and Richardson (1972), Gasse (1986), Van der Meeren et al. (2019), NC20.

Lake Oloidien: Gasse (1986).

Lake Sonachi: Verschuren et al. (1999a), Verschuren et al. (2000b), NS93.2-F.

Occurrence. Plankton, bottom mud, sediment core.

259. *Nitzschia palea* var. *debilis* (Kützing) Grunow, 1880: 96.

Observation. Main basin: Gasse (1986), NM91.1-S, NM93.1-S.

Crescent Island Crater: Gasse (1986), Van der Meeren et al. (2019), NC20.

Lake Oloidien: Gasse (1986).

Lake Sonachi: NS93.2-F.

Occurrence. Plankton, bottom mud, sediment core.

260. *Nitzschia palea* var. *tenuirostris* Grunow, 1881: pl. 69 fig. 13.

Observation. Main basin: NM91.1-S, NM93.1-S.
Crescent Island Crater: NC20.
Occurrence. Sediment core.

261. *Nitzschia palea* var. *tropica* Hustedt nom. illeg., 1949: 147 pl, XIII figs 26–29.

Observation. Crescent Island Crater: NC20.
Occurrence. Sediment core.
This taxon is different from *Nitzschia palea* var. *tropica* Grunow (1880: 96) and needs further investigation.

262. *Nitzschia paleacea* (Grunow) Grunow, 1881: pl. LXVIII figs 9, 10.

Observation. Main basin: NM91.1-S, NM93.1-S.
Lake Sonachi: NS93.2-F.
Occurrence. Sediment core.

263. *Nitzschia perminuta* Grunow, 1881: pl. LXIX figs 4, 7.

Nitzschia frustulum var. *perminuta* Grunow, 1881: pl. LXVIII fig. 31.

Observation. Crescent Island Crater: Richardson and Richardson (1972).
Occurrence. Sediment core.

264. *Nitzschia* cf. *pura* Hustedt, 1954: 480, figs 70–75.

Observation. Main basin: NM91.1-S, NM93.1-S.
Crescent Island Crater: NC20.
Lake Sonachi: NS93.2-F.
Occurrence. Sediment core.

265. *Nitzschia* cf. *pusilla* Grunow, 1862: 579, pl. 28 fig. 11.

Observation. Crescent Island Crater: Van de Meeren et al. (2019).
Occurrence. Sediment core.

266. *Nitzschia recta* Hantzsch ex Rabenhorst, 1862: no. 1283.

Observation. Main basin: Owino et al.(2020), NM91.1-S, NM93.1-S.
Crescent Island Crater: NC20.
Occurrence. Sediment core.

267. ***Nitzschia rostellata*** **Hustedt, 1956: 127, figs. 69, 70.**

Observation. Main basin: NM91.1-S, NM93.1-S.
Occurrence. Sediment core.

268. ***Nitzschia sigma*** **(Kützing) W.Smith, 1853: 39, pl. XIII fig. 108.**

Observation. Main basin: NM93.1-S, and cf. this taxon in NM91.1-S.
Crescent Island Crater: NC20.
Lake Sonachi: NS93.2-F.
Occurrence. Sediment core.

269. ***Nitzschia sigmoidea*** **(Nitzsch) W.Smith, 1853: 38, pl. XIII fig. 104.**

Observation. Lake Sonachi: Bachmann (1938).
Occurrence. Plankton.

270. ***Nitzschia spiculoides*** **Hustedt, 1949: 151, pl. 13 figs 5, 6.**

Observation. Crescent Island Crater: NC20.
Occurrence. Sediment core.
Richardson and Richardson (1972) reported *Nitzschia* cf. *spiculoides* from a sediment core taken in Crescent Island.

271. ***Nitzschia subacicularis*** **Hustedt, 1938: 490, pl. 41 fig. 12.**

Observation. Main basin: Stoof-Leichsenring et al. (2011), Stoof-Leichsenring et al. (2012), Owino et al. (2020), NM91.1-S, NM93.1-S.
Crescent Island Crater: NC20.
Lake Sonachi: NS93.2-F.
Occurrence. Sediment core.
Richardson and Richardson (1972) reported *Nitzschia* cf. *subacicularis* from a sediment core taken in Crescent Island Crater.

272. ***Nitzschia subcommunis*** **Hustedt, 1949: 146, pl. XI 41 figs 55–58, pl. XIII figs 101–106.**

Observation. Crescent Island Crater: NC20.
Occurrence. Sediment core.
Richardson and Richardson (1972) reported *Nitzschia* cf. *subcommunis* from a sediment core taken in Crescent Island Crater.

273. *Nitzschia subrostrata* Hustedt, 1942: 137, figs 313–319.

Observation. Main basin: Gasse (1986), NM91.1-S, NM93.1-S.
Crescent Island Crater: Richardson and Richardson (1972), NC20.
Occurrence. Bottom mud, sediment core.

274. *Nitzschia* cf. *subrostrata* Hustedt, 1942: 137, figs 313–319.

Observation. Crescent Island Crater: Richardson and Richardson (1972).
Occurrence. Sediment core.

275. *Nitzschia tarda* Hustedt, 1949: 138, pl. XII figs 24, 25.

Observation. Crescent Island Crater: Richardson and Richardson (1972), NC20.
Occurrence. Sediment core.

276. *Nitzschia thermalis* (Ehrenberg) Auerswald, 1861: no. 1064a.

Observation. Main basin: Rich (1932), Gasse (1986).
Crescent Island Crater: NC20.
Lake Oloidien: Gasse (1986).
Occurrence. Plankton, bottom mud, sediment core.

277. *Nitzschia* cf. *tropica* Hustedt, 1949: 147, pl. XI figs 34–48.

Observation. Crescent Island Crater: Richardson and Richardson (1972).
Occurrence. Sediment core.

278. *Nitzschia vanoyei* Cholnoky, 1954: 420, figs 75–81.

Observation. Crescent Island Crater: NC20.
Occurrence. Sediment core.

Richardson and Richardson (1972) reported *Nitzschia* cf. *vanoyei* from a sediment core taken in Crescent Island Crater.

279. *Nitzschia vitrea* G.Norman, 1861: 7, pl. 2 fig. 4.

Observation. Main basin: Cocquyt and De Wever (2002), NM91.1-S, NM93.1-S.
Occurrence. Epiphytic.

Genus *Tryblionella* W.Smith, 1853

280. *Tryblionella calida* (Grunow) D.G.Mann, 1990: 678.

Nitzschia calida Grunow, 1880: 75.
Nitzschia tryblionella var. *calida* (Grunow) Van Heurck, 1885: 171.

Observation. Crescent Island Crater: NC20.
Occurrence. Sediment core.

281. *Tryblionella umbilicata* (Hustedt) D.G.Mann, 1990: 679.

Nitzschia umbilicata Hustedt, 1949: 129, pl. XI fig. 65.

Observation. Main basin: NM91.1-S, NM93.1-S.
Occurrence. Sediment core.

Class Bacillariophyceae Haeckel, 1878
Order Rhopalodiales D.G.Mann, 1990
Family Rhopalodiaceae (Karsten) Topachevs'kyi & Oksiyuk, 1960
Genus *Epithemia* Kützing, 1844

282. *Epithemia adnata* (Kützing) Brébisson, 1838: 16.

Epithemia zebra (Ehrenberg) Ehrenberg, 1838: 191, pl. 14 fig. 7.
Epithemia zebra var. *genuina* Grunow nom inval., 1862: 328.

Observation. Main basin: Gasse (1986), Cocquyt and De Wever (2002), Stoof-Leichsenring et al. (2011), Stoof-Leichsenring et al. (2012), NM91.1-S, NM93.1-S.

Crescent Island Crater: Richardson and Richardson (1972), Cocquyt and De Wever (2002), NC20.

Lake Oloidien: Gasse (1986).

Lake Sonachi: Bachmann (1938), NS93.2-F.

Occurrence. Plankton, bottom mud, sediment core.

Gasse (1986) reported also *Epithemia porcellus* Kützing, 1844 (as *Epithemia zebra* var. *porcellus* (Kützing) Grunow, 1862) and *Epithemia adnata* var. *saxonica* (Kützing) R.M.Patrick, 1975 (as *Epithemia zebra* var. *saxonica* (Kützing) Grunow, 1862) from East Africa but it cannot be deduced from the publication if these two taxa were observed in the samples from Lake Naivasha and it satellite lakes.

283. *Epithemia argus* (Ehrenberg) Kützing, 1844: 35, pl. 22 figs 55, 56.

Observation. Crescent Island Crater: Gasse (1986), core NC20.
Occurrence. Plankton, sediment core.

284. *Epithemia argus* var. *intermedia* (Hilse) Ant.Mayer, 1936: 99, pl. 6 figs 13, 14, 16, pl. 7 fig. 5.

Epithemia intermedia Hilse, 1860: 76.

Observation. Crescent Island Crater: Richardson and Richardson (1972).
Occurrence. Sediment core.

285. *Epithemia hyndmannii* W.Smith, 1850: 124.

Observation. Lake Oloidien: Gasse (1986).
Occurrence. Plankton.

286. *Epithemia porcellus* Kützing, 1844: 34, pl. 5 figs 18, 19.

Epithemia zebra var. *porcellus* (Kützing) Grunow, 1862: 328, pl. 3 figs 3, 4.

Observation. Main basin: Rich (1932).
Occurrence. Bottom mud.

287. *Epithemia sorex* Kützing, 1844: 33, pl. 5/12 figs 5a–c.

Observation. Main basin: Bachmann (1938), Stoof-Leichsenring et al. (2012), NM91.1-S.
Crescent Island Crater: Richardson and Richardson (1972), NC20.
Lake Oloidien: Gasse (1986).
Occurrence. Plankton, littoral, sediment core.

288. *Epithemia turgida* (Ehrenberg) Kützing, 1844: 34, pl. 5 fig. 14.

Observation. Main basin: Rich (1932).
Crescent Island Crater: Richardson and Richardson (1972).
Occurrence. Bottom mud, sediment core.

289. *Epithemia turgida* var. *capitata* Fricke, 1904: pl. 250 fig. 7.

Observation. Main basin: Bachmann (1938).
Occurrence. Littoral.

290. *Epithemia* sp.

Observation. Crescent Island Crater: Richardson and Richardson (1972).
Occurrence. Sediment core.

Genus *Rhopalodia* O.Müller, 1895

291. *Rhopalodia gibba* (Ehrenberg) O.Müller, 1895: 65, pl. 1 figs 15–17.

Observation. Main basin: Gasse (1986), Stoof-Leichsenring et al. (2011), Stoof-Leichsenring et al. (2012), NM91.1-S, NM93.1-S.

Crescent Island Crater: Richardson and Richardson (1972), Gasse (1986), NC20.

Lake Oloidien: Gasse (1986).

Occurrence. Bottom mud, sediment core.

292. *Rhopalodia gibba* var. *ventricosa* (Kützing) H.Peragallo & M.Peragallo, 1900: 302, pl. 77 figs 3–5.

Epithemia ventricosa Kützing, 1844: 35, pl. 30 fig. 9a, b.
Rhopalodia ventricosa (Kützing) O.Müller, 1895: 65, pl. 1 figs 20, 21.

Observation. Main basin: Rich (1932).

Lake Sonachi: Rich (1932).

Occurrence. Plankton, bottom mud.

293. *Rhopalodia gibberula* Mereschkowsky, 1906: 32, fig. 19.

Observation. Main basin: Gasse (1986), Cocquyt and De Wever (2002), NM91.1-S, NM93.1-S.

Crescent Island Crater: Richardson and Richardson (1972), Cocquyt and De Wever (2002), NC20.

Lake Oloidien: Gasse (1986).

Lake Sonachi: Gasse (1986), Cocquyt and De Wever (2002), NS93.2-F.

Occurrence. Plankton, bottom mud, sediment core.

294. *Rhopalodia gibberula* var. *vanheurckii* O.Müller, 1900: 32, pl. X fig. 11, pl. XI figs 6, 7.

Observation. Crescent Island Crater: NC20.

Occurrence. Sediment core.

295. *Rhopalodia parallela* (Grunow) O.Müller, 1895: 64, pl. 1 figs 13, 14.

Epithemia gibba var. *parallela* Grunow, 1862: 327, pl. 6 fig. 7.
Epithemia parallela (Grunow) Ruck & Nakov, 2016b: 1.

Observation. Main basin: Rich (1932).

Occurrence. Bottom mud.

296. *Rhopalodia rhopala* (Ehrenberg) Hustedt, 1949: 128.

Epithemia rhopala (Ehrenberg) Cocquyt & R.Jahn, 2018: 51, figs 51–58.

Observation. Crescent Island Crater: NC20.
Occurrence. Sediment core.

297. *Rhopalodia vermicularis* O.Müller, 1895: 67, pl. I figs 34–39, pl. II figs 10, 11, 14.

Epithemia vermicularis (O.Müller) Cocquyt & R.Jahn, 2018: 50, figs 47–50.

Observation. Crescent Island Crater: Richardson and Richardson (1972).
Lake Oloidien: Gasse (1986).
Occurrence. Bottom mud, sediment core.

Class Bacillariophyceae Haeckel, 1978
Order Surirellales D.G.Mann, 1990
Family Surirellaceae Kützing, 1844
Genus *Cymatopleura* W.Smith, 1851

298. *Cymatopleura* cf. *clavata* (O.Müller) Cocquyt & R.Jahn, 2014: 413.

Cymatopleura solea var. *clavata* O.Müller, 1904: 22, fig. 1.
Surirella clavata (O.Müller) Cocquyt & R.Jahn, 2017: 98.

Observation. Main basin: Stoof-Leichsenring et al. (2011), Stoof-Leichsenring et al. (2012).
Crescent Island Crater: NC20.
Occurrence. Sediment core.

299. *Cymatopleura* cf. *elliptica* (Brébisson) W.Smith, 1851: 13, pl. 3 figs 10, 11.

Surirella elliptica Brébisson ex Kützing, 1844: 61, pl. 28 fig. 28.

Observation. Crescent Island Crater: Richardson and Richardson (1972).
Occurrence. Sediment core.

300. *Cymatopleura librile* (Ehrenberg) Ehrenberg, 1845: 139.

Cymatopleura solea (Brébisson) W.Smith, 1851: 12, pl. 3 fig. 9.
Surirella solea (Brébisson) Brébisson, 1838: 17.

Observation. Main basin: Owino et al. (2020).

Crescent Island Crater: Richardson and Richardson (1972).
Occurrence. Sediment core.

Remark. Rich (1932) reported a *Cymatopleura* sp. from bottom mud in the main basin of Lake Naivasha, probably one of the taxa mentioned above.

Genus *Iconella* Jurilj, 1949

301. *Iconella biseriata* (Brébisson) Ruck & Nakov, 2016: 1.

Surirella biseriata Brébisson, 1835: 53, pl. VII.

Observation. Main basin: Stoof-Leichsenring et al. (2011), Stoof-Leichsenring et al. (2012).
Occurrence. Sediment core.

302. *Iconella engleri* (O.Müller) Cocquyt & R.Jahn, 2017: 87.

Surirella engleri O.Müller, 1903: 28, pl. I fig. 4.
Surirella engleri f. *angustior* O.Müller, 1903: 28, pl. I fig. 5.

Observation. Main basin: Bachmann (1938), Gasse (1986).
Occurrence. Plankton.

303. *Iconella fuellebornii* (O.Müller) Cocquyt & R.Jahn, 2017: 88.

Surirella fuellebornii O.Müller, 1904: 30.

Observation. Crescent Island Crater: Richardson and Richardson (1972).
Occurrence. Sediment core.

304. *Iconella linearis* (W.Smith) Ruck & Nakov, 2016: 2.

Surirella linearis W.Smith, 1853: 31, pl. VIII fig. 58.

Observation. Main basin: Rich (1932), Owino et al. (2020), NM91.1-S, NM93.1-S.
Crescent Island Crater: NC20.
Occurrence. Bottom mud, sediment core.

305. *Iconella linearis* var. *elliptica* (O.Müller) Cocquyt & R.Jahn, 2017: 90.

Surirella linearis var. *elliptica* O.Müller, 1904: 30, pl. 1 fig. 10.

Observation. Main basin: Rich (1932).
Occurrence. Bottom mud.

306. *Iconella nervosa* (A.W.F.Schmidt) Cocquyt & R.Jahn, 2017: 93.

Surirella tenera var. *nervosa* A.W.F.Schmidt, 1875: pl. 23 figs 15–17.
Surirella nervosa (A.W.F.Schmidt) Ant.Mayer 1913: 341, pl. 23 fig. 5, pl. 28 figs 8, 9.

Observation. Crescent Island Crater: NC20.
Occurrence. Sediment core.

307. *Iconella nyassae* (O.Müller) Cocquyt & R.Jahn, 2017: 93.

Surirella nyassae O.Müller, 1904: 33, pl. II fig. 3.

Observation. Crescent Island Crater: Richardson and Richardson (1972).
Occurrence. Sediment core.

308. *Iconella* cf. *tenera* (W.Gregory) Ruck & Nakov, 2016: 2.

Surirella tenera W.Gregory, 1856: 11, pl. 1 fig. 38.

Observation. Main basin: NM93.1-S.
Sediment core.

309. *Iconella* sp.

Observation. Main basin: NM91.1-S, NM93.1-S.
Occurrence. Sediment core.

Genus *Surirella* Turpin, 1828

310. *Surirella ovalis* Brébisson, 1838: 17.

Observation. Main basin: Owino et al. (2020).
Crescent Island Crater: NC20.
Occurrence. Sediment core.

Remark. Owino et al. (2020) also reported a *Surirella* sp. but we do not know if it concerns a *Surirella sensu stricto* or a *Iconella* species.

Conclusions

The diatom flora of Lake Naivasha and its satellite lakes is highly diverse with 310 species and infraspecific taxa reported to date. This number will certainly increase as many taxa remain unidentified, and some species and infraspecific taxa were lumped when older taxonomy was used for identification. Moreover, it is well known that the more material is studied, the more species and infraspecific taxa will be observed, especially rare taxa. In addition, the present species richness is based only on morphological characteristics. Only a few studies exist at present on the molecular identity of the diatoms observed in tropical Africa. Available genetic data appears to be inadequate for most of the tropical African diatoms as shown by the results of Stoof-Leichsenring et al. (2012) where only less than 30% (14 out of the 49 species) could be more or less linked to a species present in the existing molecular library.

Extensive molecular investigation of the diatoms in Lake Naivasha and it satellite lakes, and in tropical Africa in general, would provide more information on the identity of the observed species and their endemic or cosmopolitan nature. We are convinced that the proportion of reported diatom species with a distribution restricted to tropical Africa (3.4%), to the African continent (1.0%), or to the pantropics (2.0%) based on the present checklist, will increase when molecular data of the observed taxa become available.

The checklist presented here will certainly provide a useful baseline for further diatom research in Kenya, and more generally in tropical Africa, in order to align molecular and morphological identifications.

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RESEARCH ARTICLE

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Yersinochloa nghiana, a new species (Poaceae, Bambusoideae, Bambuseae) from southern Vietnam

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Abstract

Yersinochloa nghiana **sp. nov.** from Vietnam is described and illustrated. It is found from southern Vietnam, where it occurs at an elevation of 1130 m in Braian Mountain, Di Linh District, Lam Dong Province. This new species is distinguished from a similar species, *Yersinochloa dalatensis*, by culm nodes with a thick swollen patella, culm leaf blades erect, auricles conspicuous, margins bearing long hairs, palea dorsal view showing rachilla extension and rudimentary floret at the apex and lodicules bifid at the base.

Keywords

new species, Vietnam, *Yersinochloa*

Introduction

Recently, the morphology of clambering or scrambling bamboo genera in the tribe Bambuseae Kunth ex Nees, subtribe Bambusinae J. S. Presl have been reviewed in depth (Nguyen and Tran 2012; Nguyen et al. 2013; Nguyen and Tran 2016). Seven distinct clambering or scrambling bamboo genera in Asia are currently recognised: 1) *Maclurochloa* K.M. Wong (Wong 1993); 2) *Soejatmia* K.M. Wong from the Malay Peninsula (Wong 1993); 3) *Neololeba* Widjaja from the Philippines, central and eastern Indonesian islands, New Guinea and Queensland (Widjaja 1997); 4) *Mullerochloa* K.M. Wong from northeast Australia (Wong 2005); 5) *Nianhochloa* H.N. Nguyen & V.T. Tran from southern Vietnam (Nguyen and Tran 2012); 6) *Cochinchinochloa* H.N. Nguyen & V.T. Tran from southern Vietnam (Nguyen et al. 2013) and 7) *Yersinochloa* H.N. Nguyen & V.T. Tran from southern Vietnam (Nguyen and Tran 2016). The systematics of these clambering or scrambling bamboo genera have traditionally been given by vegetative and productive characters (Nguyen and Tran 2016). One of these, *Yersinochloa* H.N. Nguyen & V.T. Tran of Vietnam, is specially characterised by pseudo-spikelets with only one perfect floret, unkeeled palea and anther apices with tiny spines (Nguyen and Tran 2016).

During our investigation of the bamboos from Braian Mountain, Di Linh District, Lam Dong Province, in southern Vietnam in December 2007, the authors found several populations of a clambering bamboo widespread and abundant through the degraded natural forest in valleys between 1100 and 1130 m a.s.l. Specimens of rhizomes, branches, culm leaves and flowers were collected and studied. We confirmed the presence of inflorescences terminating at leafy branches, pseudo-spikelets having only one perfect floret with no terminal vestigial flowers, the palea unkeeled and the anther apex bearing tiny spines, as was found in *Yersinochloa dalatensis*. However, further detailed studies differentiated this specimen from the latter by characters having culm nodes with a thick swollen patella; culm leaf blades erect, swollen at the base; auricles conspicuous, margins bearing long hairs; palea dorsal view of palea showing rachilla extension and rudimentary floret at the apex; lodicules bifid at the base (Table 1, Figs 1–3). Besides that, the species is distinguished from *Cochinchinochloa*, because it has only one perfect floret, a terminal vestigial flower absent and anther apices bearing tiny spines. Its flower is typical in *Yersinochloa*. Otherwise, the culm leaf blades of *Cochinchinochloa braiana* have embraced the entire internode, auricles triangle-shaped, while the species have only half embraced the internode. Thus, it is not close to *Cochinchinochloa braiana*. These distinctive features indicate that this bamboo is readily diagnosed as a new species.

Materials and methods

This study is based on plant material collected from Braian Mountain, Di Linh District, Lam Dong Province, in southern Vietnam. The plant specimens were deposited at DLU, VNMN and VTN-Tay Nguyen Institute for Scientific Research. Vegetative parts were measured in the field; fresh flowers were examined under a light-microscope and colour photographs were taken using a camera. Other similar species were used for critical comparison.

Taxonomic treatment

Yersinochloa nghiana **V.T.Tran, sp. nov.**
urn:lsid:ipni.org:names:77317220-1
Figs 1, 2

Diagnosis. *Yersinnochloa nghiana* is morphologically most similar to *Y. dalatensis* and *Cochinchinochloa braiana* with culms and branches scrambling or hanging over nearby vegetation or trees, lodicules 3, stamens 6, filaments free, caryopsis oblique, with a relatively thin pericarp. However, *Y. nghiana* is distinguished from *Y. dalatensis* by culm nodes with a thick swollen patella (vs. culm nodes without a thick swollen patella), culm-leaves blade erect (vs. reflexed), auricles conspicuous (vs. auricles absent). It also differs from *Cochinchinochloa braiana* in culm-leaves blade half embracing the internode (vs. culm-leaves blade embracing the entire internode), a terminal vestigial flower absent (vs. a terminal vestigal flower 1), perfect florets 1 (vs. perfect florets 2), anther apices bearing tiny spines (vs. anther absent tiny spines).

Type. Vietnam. Lam Dong Province, Di Linh District, Brain Mountain, E, 1216 m a.s.l., 11°27'25"N, 108°3'41"E, 10 Sep 2022, *V. T. Tran DLU 0463* (holotype DLU!; isotype VNMN!, VTN!).

Description. Culms and branches scrambling or hanging over nearby vegetation or trees, 5–10 m tall; internodes 40–80 cm long and 3.5–4.5 cm in diameter; when young, densely covered with appressed white hairs; culm walls 0.8–1.0 mm thick; nodes with a thick swollen patella. Branches several with middle one dominant, elongating. Culm leaves black-purplish, sheath with dense appressed white hairs on the abaxial surface; 25–28 cm long and 10–12 cm wide at base; apex 7–8 cm wide and truncate; margins

Table 1. Morphological comparisons of *Yersinochloa nghiana* V.T.Tran, sp. nov. with *Y. dalatensis* H.N. Nguyen & V.T. Tran and *Cochinchinochloa braiana* H.N. Nguyen & V.T. Tran.

Characters		*Y. dalatensis*	*Y. nghiana*	*Cochinchinochloa braiana*
Internode		culm nodes uexhibit a thick swollen patella	culm nodes with a thick swollen patella	culms nodes with a thick swollen patella
Culm leaves	culm-leaves blade	reflexed, oblong	erect, swollen at the base, tardily deciduous, only half embraced the internode	erect, tardily deciduous, inflated at the base, embraced the entire internode
	auricles	absent	conspicuous	triangle shaped
Rachilla		absent	extension and a rudimentary floret at apex	extension bearing perfect and an imperfect floret elongate at maturity
Terminal vestigial flower		absent	absent	1
Perfect florets		1	1	2
Anther apices		bearing tiny spines	bearing tiny spines	absent tiny spines
Lodicules		3	3	3

Figure 1. *Yersinochloa nghiana* V.T.Tran: **A** habitat **B** clump **C, D** shoots **E** culm leaf (dorsal view) **F, G** auricles **H** culm leaf swollen at the base **I** leafy branch **J, K** section of leafy branch **L** branches several with middle one dominant. Photos by Tran Van Tien from type locality.

Figure 2. *Yersinochloa nghiana* V.T.Tran: **A–C** inflorescence terminating at leafy branches **D, E** pseudospikelets **F, G** perfect florets **H** rachilla internode **I, J** prophyllate bud keeled **K** lemma **L** lemma (dorsal view) **M** palea with rachilla extension **N** palea (dorsal view) with rachilla extension **O** stigmas **P** lodicules **Q** stamens **R** caryopsis **S** fruit. Photos by Tran Van Tien from type locality.

Figure 3. *Yersinochloa nghiana* V.T.Tran and *Y. dalatensis* H.N. Nguyen & V.T. Tran: **A1–A3** culm leaves **A4** fertile floret with rachilla extension **A5** lodicules **A6** fruit **B1** culm leaf **B2** fertile floret without rachilla extension **B3** lodicules **B4** fruit. Photos by Tran Van Tien from type locality.

bearing dense white-brown hairs; leaf blades erect, swollen at the base, tardily deciduous, purple-black, 20–25 × 4–5 cm, abaxially with dense white hairs at the base; auricles conspicuous, 2.0–2.2 × 0.2–0.3 cm; ligule short, ca. 1 mm, entire. Leafy branches bearing 5–6 leaves, foliage leafy branches distichously arranged along its length; foliage leaf blades wedge-shaped, 25–28 × 4.0–4.5 cm, acute or cuneate-obovoid at base, glabrous; veins 15–18 pairs; sheaths with ciliate margins, auricles with dense bristles 3–5 mm long; inner ligule a low rim, ca. 1 mm; pseudo-petiole ca. 5–6 mm length. Inflorescences terminating at leafy branches, indeterminate; pseudo-spikelets typically 2.2–2.0 cm long; each subtended by a prophyllate bud, keeled, with ciliate margins, 2.0–2.2 × 0.6–0.8 mm and consisting of one glume, one perfect floret. Rachilla internode below fertile floret ca. 0.5 cm. Fertile floret 1.0–1.2 × 0.2–0.4 cm; lemma oblong lanceolate, 1.0–1.2 × 0.5–0.6 cm, veins 7–9, at apex acute with 0.2 mm long, margins and adaxial side bearing dense white cilia; palea glabrous, distally obviously grooved, dorsal view showing rachilla extension and a rudimentary floret at apex, 1.0–1.2 × 0.5–0.6 cm, acute at apex, base spirally involute; lodicules 3, obovate or oblong, acute at apex, purple, ca. 0.2–0.3 × 0.1–0.2 mm, with ciliate margins, bifid at base. Stamens 6; filaments free, 1.0–1.2 cm; anther ca. 1 mm, purple, apices bearing 3 tiny spines, ca. 1 mm. Ovary green, glabrous with a long style, 1.2–1.0 cm; stigmas 3, purple; caryopsis oblique, with a relatively thin pericarp, 0.9 –1.0 × 0.1–0.2 cm, with a long style, ca. 1.3 cm.

Distribution and habitat. *Yersinochloa nghiana* grows in degraded natural forest in valleys, but is also common along rivers and valleys, between 1100 and 1130 m a.s.l., in Braian Mountain, Di Linh District, Lam Dong Province, Vietnam.

Phenology. The plants were found flowering in December 2007. New shoots developed in June to August.

Local uses. *Yersinochloa nghiana* is of considerable importance to the local people. Its culms are used for making handicrafts and household tools.

Etymology. The new species is named in honour of Dr. Nguyen Hoang Nghia for his contributions to the bamboo research in Vietnam.

Preliminary conservation status. The species *Yersinochloa nghiana* sp. nov. is only known from a single population in Braian Mountain, Di Linh District, Lam Dong Province, Vietnam. This single population has no more than 500 mature clumps, all growing in degraded natural forests in valleys, but is also common along rivers and valleys. According to IUCN Red List Categories and Criteria (IUCN 2022), the species is classified as data deficient (DD) and it needs more surveys.

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RESEARCH ARTICLE

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Endiandra macrocarpa (Lauraceae), a new tree species from south-western China

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Abstract
Endiandra macrocarpa, a new species of *Endiandra* (Lauraceae) from Yunnan Province of south-western China, is here described and illustrated, based on morphological evidence. Compared to other *Endiandra* species occurring in south China and the adjacent regions in Indochina, this species is mainly characterised by its much larger ellipsoidal fruits (up to 11 × 6 cm), as well as glabrous branchlets and puberulent inflorescences.

Keywords
Endiandra, morphology, taxonomy, tropical montane forest, Yunnan Province

Introduction

The genus *Endiandra* R. Br. of the Lauraceae family is widely distributed from south China, Indochina, Malesia and Australia to the Pacific Islands (Rohwer 1993; Arifiani 2001; van der Werff 2001). It has approximately 100 species and its diversity is strongly centred in south-eastern Malesia and Australia (Hyland 1989; Arifiani 2001; Cussan et al. 2007). *Endiandra* was first described by Brown (1810), based on the type species from Australia, *Endiandra glauca*. The species of the genus can be characterised by alternate, penninerved leaves; axillary or terminal panicles; bisexual flowers with three 2-celled fertile stamens and unprotected fruits on pedicels (Kostermans 1957; Rohwer 1993; van der Werff 2001; Cussan et al. 2007; Li et al. 2008).

According to previous studies of wood and bark anatomy, floral morphology, taxonomy and molecular phylogeny, *Endiandra* belongs to the basal lineages of the family, in the tribe Cryptocaryeae or the *Cryptocarya* group and is closely related to *Beilschmiedia* Nees (Richter 1981; Rohwer 1993; van der Werff and Richter 1996; Rohwer 2000; Chanderbali et al. 2001; Rohwer and Rudolph 2005; Rohwer et al. 2014; Li et al. 2020; Song et al. 2020). Vegetatively, *Endiandra* is very similar to *Beilschmiedia*, only flower characters can differentiate the two genera (van der Werff 2001; Arifiani et al. 2012). Typical flowers of *Endiandra* only have three fertile stamens in the third whorl, whereas *Beilschmiedia* has nine fertile stamens (Arifiani 2001; van der Werff 2001; Arifiani et al. 2012).

Without any comprehensive revision, *Endiandra* has so far only been treated in floras or local revisions (e.g. Hyland (1989); Kochummen (1989); Arifiani (2001); Cussan et al. (2007); Li et al. (2008)). In China, there are only three recognised *Endiandra* species (two endemic) and they are distributed in Yunnan, Guangxi, Hainan and Taiwan (Li et al. 1979; Li et al. 1982; Liang et al. 1985; Li et al. 2008; Yang and Da 2008; Yu et al. 2009). During recent field surveys in south-eastern Yunnan Province, we collected an unknown Lauraceae species with very large fruits. Further morphological study suggests that this species belongs to *Endiandra* and differs from its other species distributed in south China and the adjacent regions. As a result, we here describe this species as new to science.

Materials and methods

We conducted field surveys from 2020 to 2022. Morphological characters of the new *Endiandra* species were examined in detail, based on fresh and preserved materials, as well as dried specimens. We also compared the new species with possible relatives, based on specimens from the herbaria HITBC, IBK, IBSC, KUN, PE, SYS and SZ and images of specimens available on JSTOR Global Plants (www.plants.jstor.org) and GBIF (www.gbif.org).

Results

Taxonomic treatment

Endiandra macrocarpa **D.Y.Zou, Lang Li & J.Li, sp. nov.**
urn:lsid:ipni.org:names:77317221-1
Figs 1, 2

Diagnosis. Compared to other *Endiandra* species occurring in south China and the adjacent regions in Indochina, this species is mainly characterised by its much larger ellipsoidal fruits (up to 11 × 6 cm), as well as glabrous branchlets and puberulent inflorescences.

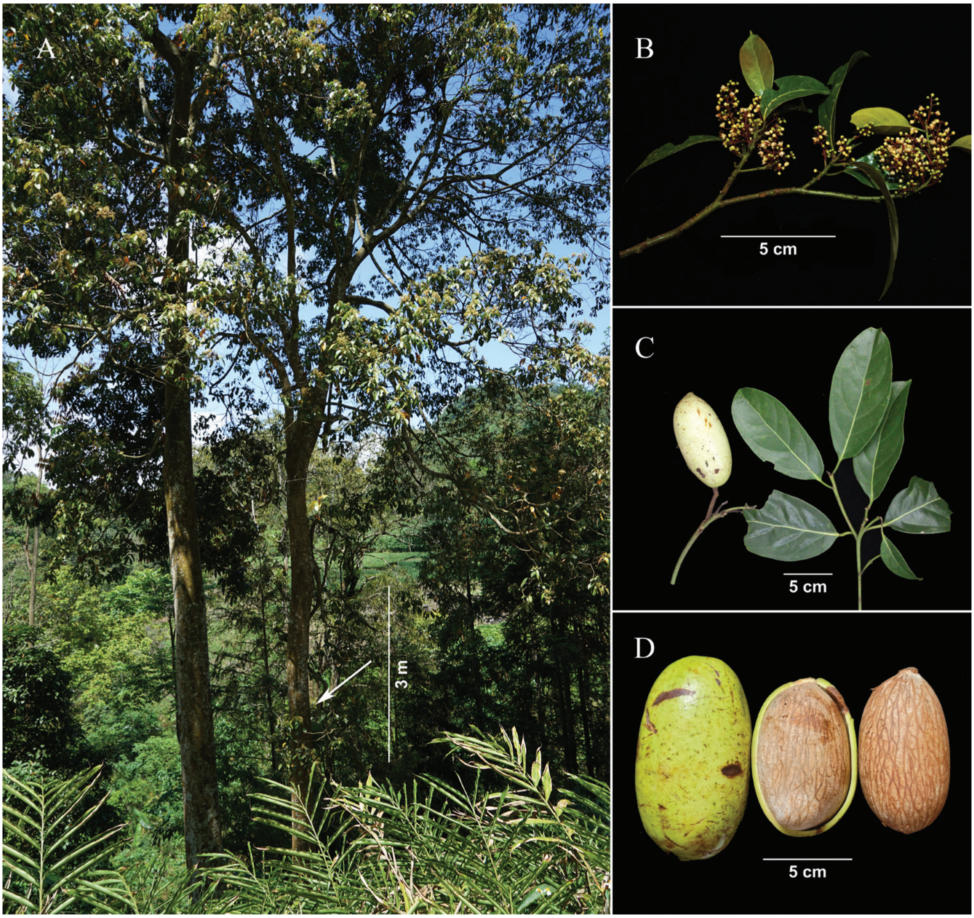

Figure 1. Morphology of *Endiandra macrocarpa* **A** tree habit **B** flowering branchlet **C** fruiting branchlet displaying immature fruit **D** mature fruits. Photographed by Lang Li and Guan-long Cao.

Type. China. Yunnan Province: Maguan County, Gulinqing Town, Houcao Village, in tropical montane forest near the village and is strongly disturbed by human activities, ca. 800 m a.s.l., 12 May 2022, flowering, *Lang Li and Dian-yang Zou, 2022028* (Holotype: HITBC!; Isotypes: HITBC!).

Description. Trees evergreen, up to 15 m tall (Fig. 1A). Bark brownish-grey. Branchlets brown, terete, with blunt ridges and striate when dry, glabrous, slightly warty. Leaves alternate; petiole 1–1.5 cm, concave-convex, glabrous; leaf blade greenish and opaque abaxially, green and shiny adaxially, elliptic or oblong-elliptic, 5–16 × 3–7 cm, thinly leathery. Mid-rib elevated on both surfaces, but rather conspicuous abaxially, lateral veins 5–8 pairs, slightly elevated abaxially, conspicuous adaxially, veins and veinlets reticulate, base cuneate to obtuse, mostly asymmetric, apex acuminate with obtuse acumen or obtuse with acute acumen. Panicle axillary, 4–8(10) cm, puberulent (Fig. 1B). Pedicels slender, 1–3 mm, thickened after anthesis. Flowers yellow, scented, ca. 3 mm. Perianth fleshy, unequal, outer ones slightly larger, broadly ovate,

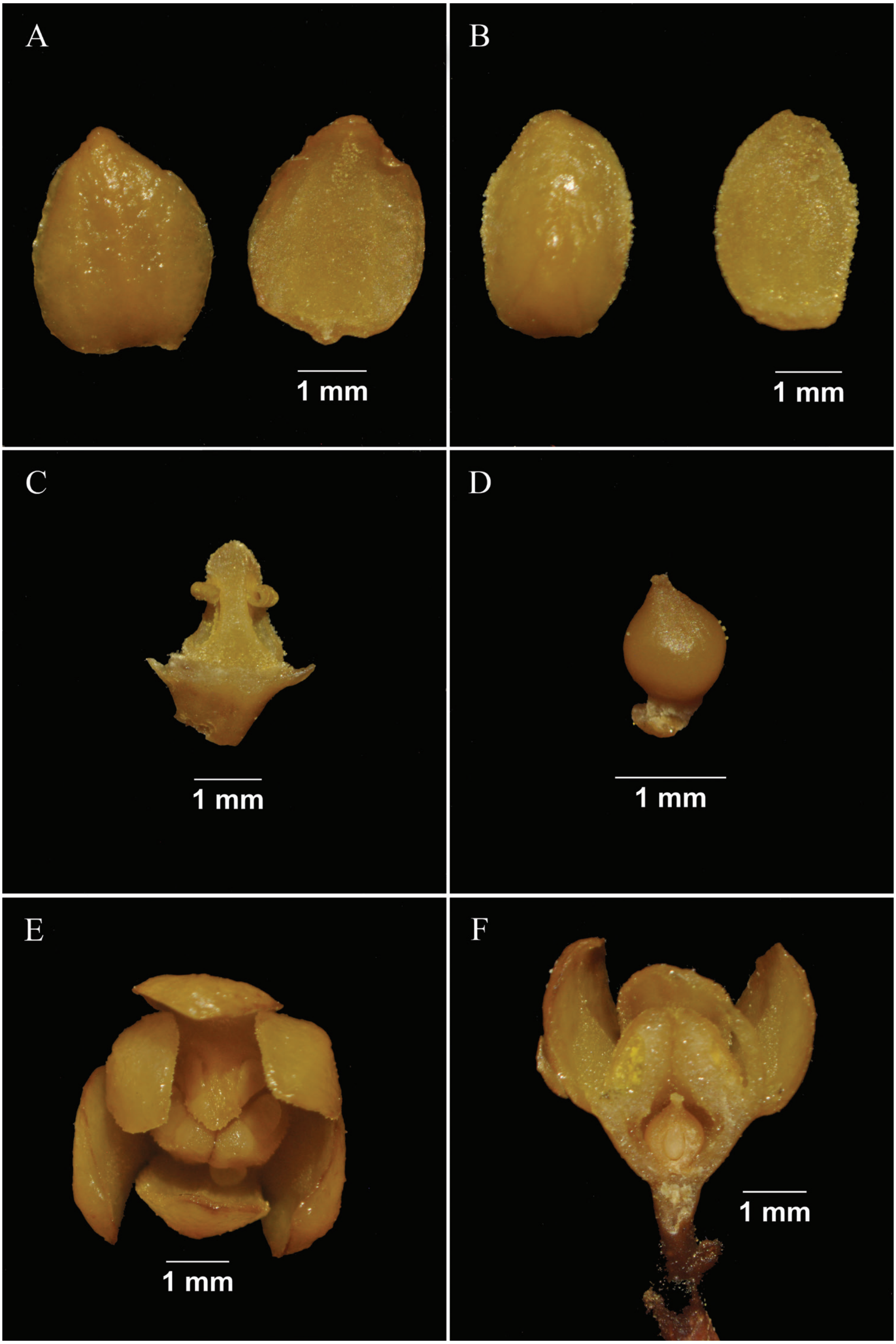

Figure 2. Morphology of a flower of *Endiandra macrocarpa*. **A** outer tepals, abaxial and adaxial side **B** inner tepals, abaxial and adaxial side **C** stamen, abaxial side **D** pistil **E** flower, top view **F** flower, longitudinal section. Photographed by Dian-yang Zou.

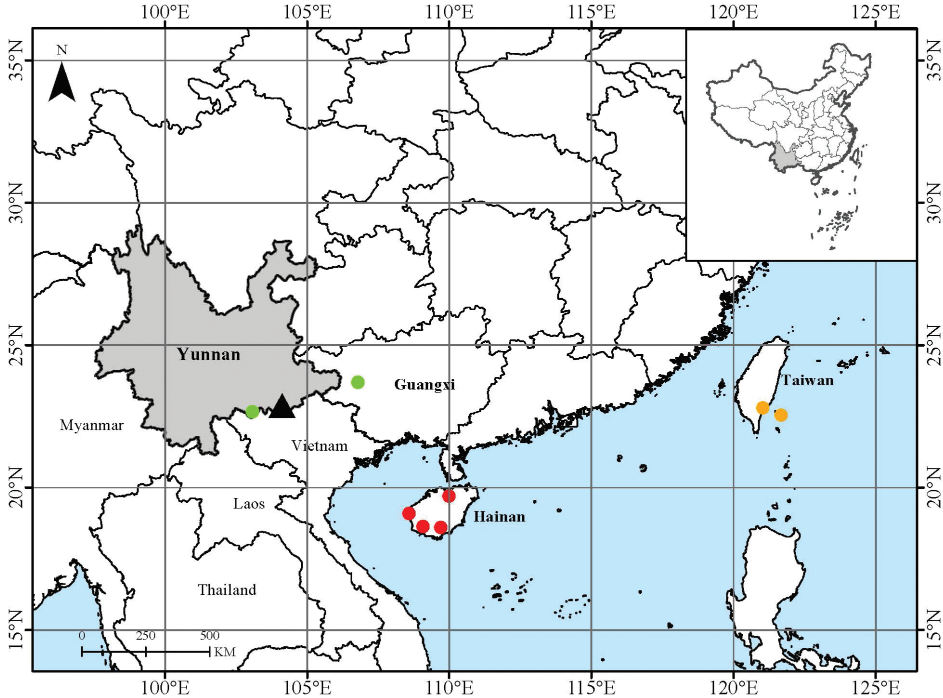

Figure 3. Distribution of *E. macrocarpa* (black triangle), *E. hainanensis* (red dot), *E. dolichocarpa* (green dot) and *E. coriacea* (yellow dot) in China.

3 × 2 mm (Fig. 2A), adaxially pilose; inner ones smaller, ovate, 2.5 × 1.8 mm, adaxially densely villous (Fig. 2B). Fertile stamens 3, triangular, ca. 2 mm, eglandular, puberulent; anthers thick, stalkless, 2-celled, cells extrorse, tightly adnate to each other; staminodes absent (Fig. 2C, E). Ovary ovoid, ca. 1.2 mm; style short; stigma punctate (Fig. 2D). Fruit ellipsoid or long ellipsoid, up to 11 × 6 cm, immature fruit green, yellow when mature, smooth, glabrous, apex bluntly apiculate (Fig. 1C, D). Seed endocarp light brown with a darker brown network of both broad and fine, slightly raised veins. Fruit stalk brown, up to 5 mm in diam. at apex, glabrous.

Phenology. Flowering from April to May and fruiting from July to October.

Distribution and habitat. Currently known only from the type locality in Maguan County, Yunnan Province, south-western China (Fig. 3). Tropical montane forest in valley, on clay loam soil mixed limestone; ca. 800 m a.s.l.

Etymology. The specific epithet "*macrocarpa*" of the new species refers to its very large fruits compared to the other species within the genus *Endiandra*.

Preliminary conservation status. Currently, *E. macrocarpa* is only known from the type locality in Maguan County, Yunnan Province, south-western China with only one mature individual. It is located in tropical montane forest near the village, which is strongly disturbed by human activities. So far, no other occurrence of this species in south-eastern Yunnan and the adjacent regions has been found or reported. Further in-depth field surveys are suggested in order to find more individuals and locations of the species. Thus, the preliminary conservation status of *E. macrocarpa* is not assessed in the present study.

Additional specimen examined. China. Yunnan Province: Maguan County, Gulinqing Town, Houcao Village, in tropical montane forest near the village, strongly disturbed by human activities, ca. 800 m a.s.l., 26 August 2020, fruiting, *Lang Li and Guan-long Cao, 2020158* (HITBC!); 25 April 2021, flowering, *Lang Li and Guan-long Cao, 2021029* (HITBC!); 28 October 2021, mature fruits, *Lang Li and Dian-yang Zou, 2021081* (HITBC!).

Discussion

South-eastern Yunnan is biogeographically located in a transitional zone from tropical Southeast Asia to subtropical East Asia (Zhu and Yan 2009). The flora of this region is suggested to be a marginal part of the tropical Asian flora, but contains more subtropical and temperate elements than other floras of the adjacent regions, for example, southern Yunnan, south-western Guangxi and northern Vietnam (Zhu and Yan 2009; Zhu 2013). As one of the world's biodiversity hotspots, south-eastern Yunnan is of extreme interest to botanists not only for its richness of primitive angiosperm taxa, such as species of Lauraceae and Magnoliaceae, but also for being a centre of plant endemism in China (Myers et al. 2000; Zhu and Yan 2009; López-Pujol et al. 2011). A recent study conducted by Zhou et al. (2023) further revealed that south-eastern Yunnan is an endemism centre of Lauraceae with significantly high species richness (SR), phylogenetic diversity (PD), corrected weighted endemism (CWE) and phylogenetic endemism (PE). Recent field surveys in this region also discovered several new endemic species of Lauraceae, for example, *Beilschmiedia turbinata* Bing Liu & Y. Yang, *Caryodaphnopsis malipoensis* Bing Liu & Y. Yang, *Phoebe hekouensis* Bing Liu, W.Y. Jin, L.N. Zhao & Y. Yang and *Phoebe jinpingensis* Bing Liu, Y. Yang, W.Y.Jin & Zhi Yang (Liu et al. 2013a, b, 2020; Yang et al. 2021).

Far away from its diversity centre in the south-eastern part of Malesia and Australia, *Endiandra* species are very rare in China. Besides the newly-discovered *E. macrocarpa*, only three recognised *Endiandra* species (two endemic) are distributed in Yunnan, Guangxi, Hainan and Taiwan (Li et al. 2008, Fig. 3). Considering the possible endemism of the new species, we firstly compared *E. macrocarpa* with the other three *Endiandra* species occurring in China, which possess much smaller fruits (detailed in Table 1). Fruits of *E. coriacea* Merr. are ovoid, up to 2 × 1 cm. Fruits of *E. hainanensis* Merr. et F.P. Metcalf ex Allen are narrowly ellipsoid, up to 3.8 × 1.4 cm. Fruits of *E. dolichocarpa* S. Lee et Y. T. Wei are cylindrical and larger, up to 8 × 2.3 cm, but still much smaller than the fruits of *E. macrocarpa*. Additionally, *E. macrocarpa* has glabrous branchlets and puberulent inflorescences, while twigs are puberulent in *E. coriacea* and panicles are glabrous in *E. hainanensis* (Li et al. 2008). We also compared *E. macrocarpa* with three other *Endiandra* species occurring in the adjacent regions of south-eastern Yunnan in Indochina, for example, Vietnam, Laos and Thailand (detailed in Table 1).

Table 1. Comparative morphology, habitat and geographic distribution of *Endiandra macrocarpa* and its possible relatives.

Morphological character	*Endiandra macrocarpa*	*Endiandra hainanensis*	*Endiandra dolichocarpa*	*Endiandra coriacea*	*Endiandra firma*	*Endiandra macrophylla*	*Endiandra rubescens*
Leaf	elliptic or oblong-elliptic, 5–16 × 3–7 cm, thinly leathery, lateral veins 5–8 pairs, petiole 1–1.5 cm, glabrous	lanceolate to oblong-elliptic, 9–15 × 3–6 cm, papery, lateral veins 6–8 pairs, petiole 1–1.5 cm, glabrous	oblong, 13–25(30) × (4)5–7.5(11) cm, leathery, lateral veins 6–8 pairs, petiole robust, up to 2 cm, glabrous	elliptic or obovate, 9–12 × 4.5–6 cm, thickly leathery, lateral veins 5 or 6 pairs, petiole 1–1.2 cm, puberulent initially, but soon glabrate	oblong-elliptic, 15–20 × 4 cm, glabrous, lateral veins 10–11 pairs, petiole 1.2 cm	elliptic to slightly obovate, 16–30 × 5–13 cm, lateral veins 8–13 pairs, petiole 1.2–2.5 cm, glabrous	elliptic, 6.5–15 × 2–7 cm, lateral veins 7–11 pairs, petiole 0.8–1.5 cm, nearly glabrous
Branchlet	glabrous	glabrous	glabrous	puberulent	–	glabrous	pubescent
Fruit	ellipsoid or long ellipsoid, up to 11 × 6 cm, yellow when mature, glabrous, apex bluntly apiculate	narrowly ellipsoid, up to 3.8 × 1.4 cm, purple-brown when mature, glabrous, obtuse at both ends	cylindrical when dry, up to 8 × 2.3 cm, black-brown when mature, glabrous, obtuse on both ends	ovoid, up to 2 × 1 cm, glabrous, base subrounded, apex acute	elliptic-ovoid, up to 6.4 cm long, quite smooth, tip rounded	ellipsoid, 4–7.5 × 1.7–2.5 cm, base obtuse	ellipsoid, green, 2–5 × 1.3–2.5 cm, base obtuse
Inflorescence	axillary, 4–8(10) cm, puberulent	axillary, 2–6 cm, few flowered, glabrate	–	axillary or terminal, up to 8 cm, few flowered, puberulent	2.5–5 cm, obscurely puberulent	axillary, 6–15 cm, with a sparse or dense, short, erect indument	axillary, 4–13 cm, with a sparse or dense, short, erect indument
Habitat	tropical montane forest in valley, on clay loam soil mixed limestone; ca. 800 m	mixed forests in valleys, thickets on open land; ca. 400–1100 m	forests; ca. 500 m.	low hill forests; ca. 20–200 m	montane rain forest on sandy loam soil; ca.100–1800 m	primary rain forest or peat swamp-forest on clay loam soil or sandy soil; ca. 50–1100 m	primary rain forest on sandy loam or acid soils along streams; ca. 20–1500 m
Distribution	SW China (Yunnan)	S China (Hainan)	SW China (Guangxi, Yunnan)	SE China (Taiwan), Philippines	Bangladesh, India, Vietnam, Malaysia, Indonesia	Thailand,Vietnam, Laos, Malaysia, Singapore, Philippines, Indonesia	Vietnam, Malaysia, Indonesia, Papua New Guinea, Australia

Note: "–" represents unknown morphological characters.

Endiandra firma Nees differs from *E. macrocarpa* by its smaller fruits with rounded tips (Hooker 1875). *Endiandra macrophylla* (Blume) Boerl. differs from *E. macrocarpa* by its smaller fruits and much larger leaves (Arifiani 2001). *Endiandra rubescens* Blume ex Miq. differs from *E. macrocarpa* by its smaller fruits and pubescent branchlets (Arifiani 2001). Species with giant fruits are uncommon in *Endiandra*. *Endiandra insignis* (F.M.Byailey) F.M.Byailey and *E. sulavesiana* Kosterm., endemic to Australia and Sulawesi, respectively, are the two *Endiandra* species that possess fruits with comparable size to those of *E. macrocarpa* (Kostermans 1955; Cussan et al. 2007). However, other fruit characters of these two species are quite different. *Endiandra insignis* has globular, ribbed fruits (6–8 × 6.5–10.1 cm) and *E. sulavesiana* has long cylindrical, ribbed fruits (up to 13 × 2.5 cm), while *E. macrocarpa* has ellipsoidal, smooth fruits (up to 11 × 6 cm). As a result, morphological evidence supports the recognition of *E. macrocarpa* as a distinct species in the genus *Endiandra*.

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