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THE GENUS *TROLLIUS* L.
A taxonomical study

Edited by
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Memoriae Benedicti Dybowski,

ex patria exulati, regionum Siberiae et Kamczatkae investigatoris celeberrimi, hominum in his regionibus habitantium adiutoris et amici, de scientia ac Polonia optime meriti, hunc laborem dedicatum esse voluit

auctor

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INTRODUCTION

The denomination *Trollius* as generic name was introduced for the first time by Linnaeus in 1753 (*Species Plantarum*), but the name itself was known much earlier.

Conrad Gesner used the expression "*Trollius flos*" as early as 1555, taking it from the folk name "Trollblumen" common in Switzerland (Stearn, 1941).

In the 16th and 17th cent. *Trollius europaeus* was considered *Ranunculus* or *Helleborus*. Dodonaeus calls it "*Ranunculus flore globoso*" (Dodonaeus, Antverpia, 1583, icon. p. 427). Camerarius mentions "*Ranunculus 6*" (Camerarius, Frankfurt am Main, 1611, icon. p. 199) and Bauhin uses the complicated name "*Ranunculus montanus Aconiti folio flore globoso*" (Bauhinus, Basilea 1671, p. 182). Linnaeus himself in the 4th edition of "*Genera Plantarum*" of 1752 does not yet establish the genus *Trollius*, but classifies it to *Helleborus* and quotes as synonyms *Trollius* Riv. and *Helleboro-Ranunculus* Boerh. (Boerhaave). *T. asiaticus* was also mentioned as *Ranunculus asiaticus* (Lepech. Reisen. III. 40. ex Index Kewensis), and *Trollius ranunculinus* occurring in the Caucasus was at first called *Helleborus ranunculinus* Smith (Pl. Icon. ined. 2, t. 37, 1790).

The two earliest known species, *T. europaeus* and *T. asiaticus* were described by Linnaeus in 1753 (*Species Plantarum*, 556, 557). The latest discovered and established species are *T. afghanicus* Hedge et Wandalbo (1963) from the mountains of north Afghanistan and *T. apertus* (Perf.) Igosh. from the north Ural Mts. (Igoshina, 1968). In the course of the 19th and first half of the 20th cent. numerous new species, subspecies, varieties and forms have been described. Many of these names proved to be synonyms.

To date about 30 species are known; the only American species *T. laxus* was described as early as the beginning of the 19th cent. (Sa-

lisbury, 1807), and *T. europaeus*, the only species from Central and Western Europe was quoted by numerous authors under various names, e.g.: *T. grandiflorus* Tausch., *T. germanicus* Wender, *T. viridiflorus* Schur etc.

The majority of *Trollius* species occur in Asia, and they became known as the flora of this continent was gradually elaborated. Mostly new *Trollius* taxons were described on the area where the given author carried on his investigations or when local floras were elaborated, e.g. *T. pumilus* Don (Prodr. Fl. nepal. 1825); *T. chinensis* Bunge (Enum, Plant. Chin. bor. 1831; Hultén, 1928a), etc.

Owing to the lack of precision of these first descriptions, and the very cursory knowledge of the few representatives of *Trollius*, many a time the same taxon was described by several authors under different names. For instance *T. ranunculinus* (Smith) Stearn was known as *T. patulus* Salisb., *T. caucasicus* Stev. and *T. somcheticus* C. Koch. The newly detected species, on the contrary, were searched for by botanists on quite different distant areas. The above mentioned Caucasian species *T. patulus* described in 1807 was later reported from Siberia, Kamchatka, Altai, Tien-Shan Mts., and even from the Himalayas and Yunnan Mts. (De Candolle, 1824; Regel and Tiling, 1858; Busch, 1901; Ulbrich, 1922 and others).

All this information concerning *Trollius* was very fragmentary. Even more accurate and extensive elaborations dealt only with species from certain regions, and did not comprise the entire genus. Here should be mentioned the valuable paper by Brühl "Description of new and rare Indian Plants" (1896) which gives an exact analysis of the *Trollius* taxons from the Himalaya and South China Mts. illustrated by detailed drawings. Finet and Gagnepain gave descriptions and a key to six Asiatic species in "Flore de l'Asie Orientale" (1904). The Far East *Trollius* species including Japan have been elaborated by Miyabe (1943). This work gives very accurate descriptions and a key for determinations of species, drawings and an extensive index of Japanese literature concerning the genus *Trollius*.

The first general review of all the *Trollius* taxons known at the time was made by Huth in 1892. This publication, however, introduced nothing new, it only reported information given by various authors together with their mistakes.

Only as late as 1924 did Schipczinsky undertake an endeavour of elaborating the entire genus *Trollius*. He gave a discriminating analysis of the morphological characteristics and their variability, distinguished several new species and advanced his own phylogenetic concepts. He was, however, unable to elaborate the entire genus since the material from America was lacking and he had but few specimens from the Himalayas, South China, Japan and Kashmir. Schipczinsky

was well acquainted with the problem as a whole and aware of the deficiencies. Nevertheless his work is extremely valuable as the first and only monographic elaboration of the genus *Trollius*.

In his elaboration of the family *Ranunculaceae* Prantl (Engler and Prantl, 1891) divided the genus *Trollius* into three sections: 1. *Calathodes* Hook. — without honey leaves, 2. *Eutrollius* — with honey leaves, a yellow perianth and papillae on the stigma, and 3. *Hegemone* — with honey leaves, a lilac perianth and glabrous stigma. From among these, *Calathodes* Hooker f. et Thomson has long been treated as a separate genus, although related to *Trollius*. As reported by Tamura (1966), *Calathodes* is closer related to *Megaleranthis* and *Caltha* than to *Trollius*. To the section *Hegemone* only one species was classified — *Trollius lilacinus*, whereas the remaining species of *Trollius* were comprised in the section *Eutrollius*. This classification may be found in contemporary floras (Flora SSSR, 1937; Flora Europaea, 1964). In the present work this classification has been changed and the details are given in the discussion of the section *Acaulitrollius* and the species *T. lilacinus*.

Classification of the genus *Trollius* always brought up many difficulties. The variability of the morphological characters within is generally continuous. Most species are not strictly differentiated and there exist transitional forms between them. This great diversity of forms and variability of the morphological characters were the cause of numerous taxonomical misunderstandings; it was difficult in some cases to establish with which species we are dealing, since it was not known which description is exact. The widest divergencies concern the species from the Far East elaborated by Russian authors (Schipczinsky, 1923, 1924; Flora SSSR, 1937; Komarov, 1929 and others), by Japanese authors (Kitagawa, 1939; Miyabe, 1943; Ohwi, 1965) and by Hultén (1928a). All these authors based their descriptions on specimen material, on doubtlessly different morphological characters therefore in a sense their observations were accurate, but unfortunately, these characters are not constant, therefore classification of species based on them is not reliable in practice. As Brühl (1896) and Schipczinsky (1924) remark with reason, in the classification of *Trollius* the whole set of various characters should be taken into account, instead of relying on one or only a few of them.

The synonymy of *Trollius* taxons is also very involved. Usually the synonyms correspond to one another only partly, since the particular authors based their descriptions on a limited material and took into account only some features. In this way numerous taxons came into existence which only partly corresponded to one another in the descriptions, whereas in reality they concern the same species.

The experiments of the present author conducted for more than ten years on the genus *Trollius* were undertaken chiefly from the evolutionary

aspect. It was hoped that in this so plastic and little stabilized group it will be possible to trace back the steps of establishment of the morphological characters which lead to the differentiation of new taxonomic units, and consequently to the arising of new species. In this connection accurate observations on the variability of *Trollius* were indispensable. For this purpose the author undertook extensive studies in the herbaria of Leningrad, Edinburgh, Kew and the British Museum and availed herself of numerous herbaria borrowed from other botanical centres. A total of about 7000 herbarium sheets were inspected of which 845 are quoted in the present work. These herbarium studies gave a certain picture of the morphology of the genus *Trollius* as a whole, and made at the same time possible a critical appraisal of all the pertinent taxonomical works published to date and of the classification used therein.

Accurate analysis of the morphological characters within the entire genus indicated greater or smaller similarities between certain species. It was possible to distinguish certain groups of taxons closer related and generally geographically interconnected. In this way these natural groups could be established as sections. Morphological observations in great detail in confrontation with the relevant literature, prompted the author to elaborate a taxonomical review of the entire genus. She is, however, aware of the numerous shortcomings of this work. The herbarium specimens established as type specimens have not always been available. In the case of certain taxons, appropriate material was not at the author's disposal so as to allow definitive conclusions. The problem of the rank of a given taxon frequently remains open or is proposed for discussion, none the less, it is the author's hope that these deficiencies will be supplemented in the future by botanists disposing of the necessary material, and that this work will be a help to them.

The present division into sections is mainly based on the morphological similarity of the plants. Particular attention was devoted to the structure of the honey leaves. It is true that their morphology is variable as are all the other characters of the genus *Trollius*, but for some species, and even entire sections this feature is most typical and stable. Three basic types of honey leaves are distinguished: 1 — minute, thickened and glittering leaves spatulate or oval with a spherical nectary pit, typical for the section *Pumilotrollius* and *Yunnanotrollius*; 2 — elongated, flat, thin and mat, not thickened, with nectary pit in the form of a flat pocket, characteristic of the section *Longipetala*; 3 — honey leaves with intermediate characters as compared with the preceding groups, occurring in representatives of the remaining sections.

In the separation into sections, the geographical distribution of the taxons was also taken into account. Since most of the *Trollius* species readily cross with one another and give a fertile progeny (author's own observations), the possibility of contact between the particular taxons

is of high importance in the process of speciation. Taxons passing gradually one into another occur mostly on the same areas or in adjacent regions, and are no doubt closely related.

In the separation of the genus *Trollius* into sections the present author has tried to group together the taxons most closely related, in the hope that this will help to gain a better knowledge of this plant group and to classify them. Practical results will demonstrate in how far this end has been achieved.

Of the two keys included at the beginning, the first serves for distinguishing the sections, and the second for determining directly the *Trollius* species. The second key is arranged with a view to the species which have characteristic distinct features and are easy to identify; such species, however, are not numerous. Most of them do not exhibit such distinctive morphological characters and in these cases the assignment of a given specimen to the appropriate section will greatly facilitate its classification. Certain difficulties may arise in the case of specimens belonging to the section *Trollius*, *Insulaetrollius* and *Laxotrollius* since some of them are very similar. In such circumstances the site of natural occurrence of these plants is decisive.

List of herbaria quoted in text

BG	Botanical Museum, Bergen
BM	British Museum (Natural History), London
BP	Museum of Natural History, Budapest
BPH	Herbarium Universitatis Horticulturae Budapest
BRNU	Botanical Institute and Herbarium of Masarykian University, Brno
E	Royal Botanic Garden, Edinburgh
K	Royal Botanic Gardens, Kew
KRA	Herbarium Instituti et Horti Botanici Universitatis Jagiellonicae Cracoviensis, Cracow
KRAM	Herbarium Instituti Botanici Academiae Scienciarum Poloniae, Cracow
LBL	Herbarium Universitatis Mariae Curie-Skłodowska, Lublin
LE	Herbarium Instituti Botanici Academiae Scienciarum URSS, Leningrad
LE Univ.	Herbarium of the Leningrad University, Leningrad
LINN	The Linnean Society of London, London
POZ	Zakład Systematyki i Geografii Roślin Uniwersytetu im. A. Mickiewicza, Poznań
PR	National Museum, Botanical Department, Praha-Pruhonice
PRC	Herbarium Instituti Botanici Universitatis Carolinae, Praha
TRN	Katedra Systematyki i Geografii Roślin Uniwersytetu im. Kopernika w Toruniu, Toruń
W	Naturhistorisches Museum, Wien
WA	Zakład Systematyki i Geografii Roślin Uniwersytetu Warszawskiego, Warsaw
WRSŁ	Herbarium Instituti Botanici Universitatis Wratislaviensis, Wrocław

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MORPHOLOGICAL DESCRIPTION OF THE GENUS *TROLLIUS* L. AND ITS TAXONOMY

All species of *Trollius* are perennial herbs. The underground part of the plants consists of a well developed adventitious root system. The roots are relatively thick, and are frequently referred to by botanists as rhizomes. The mountain species, particularly, have a very strong root system, for instance *T. acaulis*, *T. lilacinus*, *T. pumilus* and others.

The aerial parts of *Trollius* consist of basal leaves and shoots terminating in flowers. The shoots may be single, unbranched with one flower at the top or branched with 2-7 apical flowers. Some species have leafless shoots (e.g. in the section *Pumilotrollius*), others may have 1-7 leaves on the stem. The size of the plants varies from small ones, about 5 cm high at the period of flowering (e.g. some species of the section *Pumilotrollius*), to large vigorous plants exceeding 1 m in height. In the period of flowering growth is not inhibited: the flower stem elongates so that in the period of fruiting the stem may be from several to 30 cm longer than at the time of blooming. The base of the stem is

covered with sheaths and fibres of the old leaf sheaths remaining from the preceding vegetation period. These protective elements are particularly long and dense in alpine species. The shoot has distinct grooves running in loose spirals along its length in the number of about ten.

The basal and cauline leaves show spiral phyllotaxy; the basal and lower cauline leaves are stalked, the upper ones sessile or almost so. In some species characteristic and distinctly veined leaf sheaths are seen up to 4 cm long. The sessile leaves frequently have rounded membranous ears at their base (e.g. sec. *Acaulitrollius*). In some alpine species the first basal leaves may have the form of an elongated leaf sheaths, the next one having developed blades, but with immediate transition of the sheath into the lamina; only the further leaves produce petioles between the sheath and the blade (e.g. *T. vaginatus*, *T. acaulis*, *T. lilacinus* and others). The leaf laminae are palmately 3-, 5- and sometimes 7-sected, divided into rhomboidal or obovate segments. The shape of the segments varies from narrow and elongated to almost circular (obovatus Nos 46 - 49; angulato-obovatus Nos 64 - 67)*. The lamine outline is usually reniform, semicircular (transverse ovatus No. 43); it may also be broadly ovate (transverse late ovatus Nos 41, 42) or triangular (triangularis Nos 78, 79) in dependence on the shape of the segments. The middle segment of the laminae is usually wider and three-lobate. The lateral segments frequently have one much deeper sinus; transitional stages may even be found from 3-sected to 5- or 7-sected leaves. The leaf segments are generally lobed to various degrees. These lobes may be of varying width, acute or obtuse. Some species have leaves exceptionally deep dissected into narrow lobes (e.g. *T. pumilus*, *T. ranunculinus* f. *tenuisecta*). In other species the leaf segments are not lobed, the segments are wide and obovate (late obovatus No. 49), their edges may even overlap (e.g. *T. yunnanensis*, *T. dschungaricus*). The leaf laminae may be thin and slender or somewhat thicker and leathery. In the genus *Trollius* the leaves are greatly diversified and their variability is often of continuous character. Even within one species all transitional stages may be found from leaves deeply dissected and extremely delicate to those with non-dissected segments, thick and even leathery. In many species specimens occur with extremely different leaves together with a whole series of transitional forms (e.g. *T. europaeus*, *T. asiaticus*, *T. ranunculinus*, *T. laxus* and others). The laminae of cauline leaves are similar to those of the basal ones, only they generally become smaller up along the stem and consist of a smaller number of segments. The apical cauline leaves resemble frequently somewhat the perianth leaves. They may be partly yellow and similar in shape to the outer perianth leaves.

* After "Terminology of simple symmetrical plane shapes (Chart 1)", Taxon, 9 (5): 145 - 156, 1962.

The flowers of *Trollius* consist of numerous carpels and stamens, honey leaves and perianth leaves. All these elements are arranged spirally and their number is variable. The perianth is not differentiated into a calyx and corolla and consists of leaves of the tepala type and honey leaves. Some species exceptionally have five leaves in the perianth, but specimens with six and more leaves may occur as well. The perianth leaves have been described by various authors as sepala, or petala, and the honey leaves as nectaria or petala, and these terms may be found in the literature concerning *Trollius*. For the sake of simplification these terms are also applied by the present author (Doroszewska, 1970).

In *Trollius* species there are 5 - 30 perianth leaves and their number is usually variable. Their colour is as a rule yellow or orange, exceptionally white in *T. latus* and *T. afghanicus* and light lilac in *T. lilacinus*. The perianth leaves are elliptical in outline (ellipticus Nos 3 - 5), obovate (obovatus Nos 47 - 51) or angulate-obovate (angulato-obovatus Nos 64 - 66). In some species they are completely flat (e.g. *T. pumilus*), in others concave and spoon-shaped to various degrees. The shape of the flower depends on their arrangement and shape. Thus *Trollius* flowers may be completely flat (e.g. *T. pumilus*) or have the shape of a shallower or deeper bowl (e.g. *T. chinensis*, *T. ledebouri*, *T. ranunculinus*) or even globose in the shape of a partly open or completely closed sphere (*T. europaeus*). The length of the perianth leaves varies generally within the limits of 10 - 30 mm, and so does the width. If the perianth contains only five leaves they are more or less similar and of the same width. When, however, the perianth consists of numerous leaves, the widest ones lie on the periphery, and nearer the middle they gradually become narrower. At the same time the outermost leaves are generally shorter than those in the middle of flower and may sometimes be green and indented at the apex. Such perianth leaves resemble the upper cauline ones. In the genus *Trollius* transitional forms occur between cauline and perianth leaves.

The honey leaves in *Trollius* are flat and elongated ("flat type or epeltate" acc. to Tamura, 1965) and unguiculate. Above the unguis the leaf widens into a blade at the base of which lies the nectary pit. The honey leaves are orange coloured, as a rule darker than the perianth leaves. Only in some species both types of leaves are of the same colour (e.g. *T. chinensis*, *T. asiaticus*). The morphology of the honey leaves of *Trollius* is variable, and is an important taxonomic trait in this genus. These leaves may be minute, shorter than the stamens and hidden in the flower. In other species they are more or less as long as the stamens or even a little longer; they may also be much longer than the perianth and stick out of it giving the flowers a specific form (e.g. *T. chinensis*). The length of the honey leaves in the genus *Trollius* varies from 2 to 40 mm.

The blade of the honey leaves may be oval, spatular or pear-shaped, more or less elongated, linear or widening gradually upwards. The apex may be rounded or tapering gradually upwards and pointed. Some species have greatly thickened convex and glittering blades (sect. *Pumilotrollius* and *Yunnanotrollius*), others are only slightly thickened and shining (sect. *Trollius*). In some species the honey leaves are completely flat, mat and not thickened (sect. *Longipetala*).

The nectary pits in the genus *Trollius* are spherical or flattened and pocket-like. Between the spherical and the pocket-like pit there exist transitional forms.

The numerous stamina in *Trollius* are usually yellow or orange coloured; the anthers are 2 - 6 mm long.

The stigmata are also yellow or orange, exceptionally in *T. altaicus* dark purple, and in some specimens of *T. yunnanensis* white or light green. The stigmata lie along the style and reach almost to the ovary on the side of its ventral suture. More or less numerous papillae occur on the stigma. In *T. lilacinus* the stigma is free of papillae.

The fruits of *Trollius* consist of a head of follicles; on one head there may be from 5 to about 50 of them. During ripening of the fruits the styles are not shed, but dry up transforming to beaks on the follicles, which may have a length of 0.5 - 8.0 mm. The length and shape of the beaks is also a taxonomic trait.

The follicles contain up to nine fully developed seeds, but generally there are less, about four. The seeds are black or dark brown, oval, 1 - 2 mm long.

Nearly all species of *Trollius* flower in spring; some earlier in the end of April, others later in June. The alpine species with a later vegetation period flower in July and even as late as August.

The genus *Trollius* occurs on the northern hemisphere in the moderate and cold zone.

In the classification of the family *Ranunculaceae* given by T a m u r a (1966) the genus *Trollius* is assigned to the tribe *Trollieae* Langlet and subfamily *Helleboroideae* Hutchinson. The genus is divided in the present work into seven new sections:

Sections	Species
PUMILOTROLLIUS	<i>T. pumilus</i> Don.
	<i>T. micranthus</i> Hand.-Mazz.
	<i>T. ranunculoides</i> Hemsl.
	<i>T. vaginatus</i> Hand.-Mazz.
	<i>T. farreri</i> Stapf
	<i>T. sikkimensis</i> (Brühl) grad. nov. et comb. nov.
	<i>T. bhotanicus</i> (Brühl) Mukerjee

YUNNANOTROLLIUS *T. yunnanensis* (Franch.) Ulbr.
 ssp. *yunnanensis*
 ssp. *anemonifolius* (Brühl) comb. nov.
T. papavereus Schipcz.
T. citrinus Miyabe

ACAULITROLLIUS *T. acaulis* Lindl.
 T. lilacinus Bge
 T. afghanicus Hedge et Wandelbo

LONGIPETALA *T. asiaticus* L.
 T. ledebouri Rchb.
 T. chinensis Bge
 T. hondoensis Nakai
 T. macropetalus F. Schm.
 T. sibiricus Schipcz.
 T. kytmanovii Reverd.

TROLLIUS *T. europaeus* L.
 T. apertus (Perf.) Igosh.
 T. altaicus C. A. M.
 T. dschungaricus Reg.
 T. ranunculinus (Smith) Stearn

INSULAETROLLIUS *T. riederianus* Fisch. et Mey.
 T. pulcher Makino
 T. membranostylis Hultén
 T. chartosepalus Schipcz.
 T. schipczinskii Miyabe

LAXOTROLLIUS *T. laxis* Salisb.

Type of the genus: *Trollius europaeus* L.

Keys to the sections of the genus *Trollius* and their species

Key to sections

1. Honey leaves 7 - 40 mm long, elongated narrow; blade flat, thin, not thickened and mat, similar to the outer perianth leaves and mostly of the same orange colour (*T. sibiricus* exceptionally sulphur yellow)

sect. *Longipetala*

1. Honey leaves up to 13 mm long, always orange coloured and darker than the perianth leaves, however, differing from them by their structure; blades thickened and glittering . . .

2

2. Honey leaves always widened, oval or spatulate, blades thickened cushion-like, convex and glittering. Nectary pits spherical and distended. Generally five perianth leaves, exceptionally up to eight. Alpine plants from the Himalayas and South China Mts. 3
2. Honey leaves linear, spatulate or pear-shaped, blades less thickened and glittering. Nectary pit in the form of a shallow pocket or somewhat distended. Perianth leaves 5 - 20. Plants from other territories 4
3. Small plants, 5 - 30 cm high, flowers 2.0 - 4.0 cm in diameter, honey leaves 2 - 7 mm long. Stems mostly bearing one flower and leafless, leaves if present deeply dissected
sect. *Pumilotrollius*
3. Larger plants, 30 - 80 cm high, flowers 3.0 - 7.0 cm in diameter. Honey leaves 6 - 14 mm long with groove leading to nectary pit. Shoots mostly branched and foliated, lamina rather thick, three-lobed, with entire undissected segments
sect. *Yunnanotrollius*
4. Plants from the North American continent
sect. *Laxotrollius*
4. Plants from Asia or Europe 5
5. Flowers white, light grey or light lilac, if yellow the follicles have beaks 7 - 8 mm long
sect. *Acaulitrollius*
5. Flowers yellow or orange coloured, beaks on follicles do not exceed 6.0 mm in length 6
6. Plants from Okhotsk-Japan-Kamchatka region. Honey leaves 2 - 12 mm long, linear, widened or pear-shaped; blade frequently widened at base and trough-like
sect. *Insulaetrollius*
6. Plants from other Asiatic, European and Caucasian regions. Honey leaves 6 - 14 mm long, linear or rounded at apex or spatulate. Blades never widened at base do not form trough
sect. *Trollius*

Key to species

1. Stigma and style dark purple
T. altaicus
1. Stigma and style yellow, orange or greenish 2
2. Perianth leaves light lilac or light grey
T. lilacinus
2. Perianth leaves of some other colour 3
3. Plants from the North American continent
T. laxus

3. Plants from Asia or Europe 4
4. Perianth leaves white, flower up to 3 cm in diameter and flat
T. afghanicus
4. Perianth leaves of various yellow or orange hues, size of flowers varies 5
5. Flowers globose or almost subglobose 6
5. Flowers open, flat or bowl-shaped 7
6. Honey leaves $\pm$ linear, 8 - 12 mm long (Japan)
T. pulcher
6. Honey leaves in upper part spatulate, 7 - 11 mm long: Europe, West Siberia
T. europaeus
7. Beaks on follicles 6 - 8 mm (or styles in flowers 5 - 7 mm) long distinctly split at apex
T. acaulis
7. Beaks on follicles (or styles in flowers) up to 5 mm long not split at apex or splitting hardly noticeable 8
8. Honey leaves flat, thin, mat, similar to perianth leaves but narrow with nectary pit flat and pocket-like 9
8. Honey leaves thickened and glittering, distinctly different from perianth leaves, always darker and shorter than the latter; nectary pit globose, or shallow, pocket-like 15
9. Honey leaves distinctly longer than those of the perianth and sticking out from them upwards, 20 - 40 mm long 10
9. Honey leaves equal in length to perianth leaves or shorter, not exceeding in length 20 mm 11
10. Honey leaves $\pm$ linear, gradually tapering upwards, pointed at apex, 20 - 35 mm long (Fig. 9 j - m)
T. chinensis
10. Honey leaves rather lanceolate, wide and pointed at apex, 25 - 40 mm in length (Fig. 9 i)
T. macropetalus
11. Honey leaves $\pm$ equal to perianth leaves in length, 12 - 20 mm long, 1.0 - 1.5 mm wide 12
11. Honey leaves usually shorter than those of the perianth, up to 12 mm long and 1.0 - 2.0 mm wide 14
12. Perianth leaves 10 - 20, bright orange coloured like the honey leaves, the latter usually widening in their upper part 1.5 - 5.0 mm wide (Fig. 8 a - g)
T. asiaticus
12. About 10 (13) perianth leaves. Honey leaves linear, rounded at apex, up to 2.0 mm wide, generally somewhat darker than perianth 13

13. Japanese endemite from the Honshu Island
T. hondoensis
13. Plants common in the Far East, in Northern Mongolia and Siberia, North Korea and China. Reported from Japan only from the Hokkaido Island
T. ledebouri
14. Honey leaves 7 - 12 mm long, more or less equal in length to stamina, flowers sulphur-yellow of yellow-orange (Fig. 9 a - f)
T. sibiricus
14. Honey leaves 10 - 12 mm long, 1.5 to 2 times longer than stamina, flowers light orange or orange (Fig. 8 i)
T. kytmanovii
15. Only 3 - 4 honey leaves, staminodia resembling stamina present
T. bhotanicus
15. Honey leaves 10 or more, staminodia absent 16
16. Honey leaves 6 - 13 mm long, widening into oval blade greatly thickened and convex. Nectary pit globose distended, above it the leaf margins bent upwards form a trough . . . 17
16. Honey leaves $\pm$ linear or ligulate, if widened into thickened convex blade smaller up to 7.5 mm long, without trough above nectary pit 19
17. Flowers lemon-yellow, honey leaves 10 - 13 mm long with slight stricture at about half of blade length (Fig. 3 j, k). Japan
T. citrinus
17. Flowers light orange or yellow, honey leaves with oval blade without constriction 18
18. Shoots branched, flowers light orange 4.0 - 8.0 cm in diameter, honey leaves 8 - 13 mm long (Fig. 3 a)
T. yunnanensis
18. Shoots usually unbranched, flowers yellow 3.0 - 4.5 cm in diameter, honey leaves 6 - 8 mm long (Fig. 3 b)
T. papavereus
19. Honey leaves $\pm$ linear or ligulate, slightly thickened, 7 - 14 mm long, nectary pit in depression or shallow pocket-like 28
19. Honey leaves distinctly distended into thickened blade, 2.0 - 7.5 mm long, nectary pit globose 20
20. Small plants, up to 30 cm high at time of fruiting, shoots generally single not foliated or with 1, exceptionally 2 - 3 cauline leaves; 5 - 8 perianth leaves 22
20. Larger plants, more vigorous up to 70 cm high, up to five cauline leaves on shoot, 5 - 20 perianth leaves (Far East) . . 21
21. Honey leaves 2.0 - 4.0 mm long, anthers on stamina up to 21

2 mm long. 5 - 20 perianth leaves, beaks frequently winged (Fig. 14 h - k)

T. membranostylis

21. Honey leaves 5.0 - 7.5 mm long, anthers 2 - 3 mm long, 10 - 13 perianth leaves, beaks never winged (Fig. 14 l - o)

T. schipczinskii

22. Perianth leaves 5. After drying they look like paper; style $\pm$ equal in length to ovary; beaks on follicles long, thin, straight (Chukot Peninsula)

T. chartosepalus

22. Perianth leaves 5 - 8, after drying they do not look like paper, style shorter than ovary, beaks on follicles 2 mm long, bent outwards (Himalayas, South China) 23
23. Honey leaves 2.0 - 3.5 mm long 24
23. Honey leaves 4.0 - 7.0 mm long 25
24. Flowers 1.2 - 2.0 cm in diameter, plants slender $\pm$ 24 cm high, leaf segments dissected into narrow lobes, rounded at apex, beaks on follicles thin, bent hook-like (Fig. 1 y, z)

T. micranthus

24. Flowers 2.0 - 2.7 cm in diameter, plants up to 15 cm high rather massive, leaf segments not dissected into lobes, sharp toothed, follicle beaks straight (Pl. IV)

T. sikkimensis

25. Honey leaves with distinctly round or rounded blade, vegetative leaves never whitish on under side 26
25. Blade of honey leaves oval, if rounded vegetative leaves whitish underneath 27
26. Vegetative leaves with distinct leaf sheath 1 - 3 cm long, after drying becomes brown; leaf segments dissected into narrow (1 mm) acute lobes (Pl. II)

T. vaginatus

26. Vegetative leaves without or with sheath 1 cm long, leaf segments not dissected in so narrow lobes, generally 3-lobed, with rounded or sharp teeth on leaf margins; plants slender, do not turn brown after drying (Pl. III)

T. farreri

27. Blade of honey leaves oval, vegetative leaves with poorly delineated sheaths, green underneath (Fig. 1 e - i)

T. pumilus

27. Blade of honey leaves oval or rounded, vegetative leaves with distinct sheaths, their laminae whitish underneath (Fig. 1 j - l)

T. ranunculoides

28. Honey leaves 8 - 12 mm long with blade widening at base,

nectary pit in trough-like depression

T. riederianus

28. Blade of honey leaves never widened at base without through-like depression; nectary pit in the shape of a shallow pocket 29
29. Honey leaves $\pm$ linear, blunt, 7-11 mm long 30
29. Honey leaves ligulate, 11-14 mm long (Northern Ural)

T. apertus

30. Plants from Caucasus

T. ranunculinus

30. Plants from mountains of Central Asia

T. dschungaricus

SECTION: *PUMILOTROLLIUS*, sect. nov.

Syn.: Sect. *Eutrollius* Prantl in Engler u. Prantl, Nat. Pflanzenf. III, 2: 56 (1891), p.p.

Small plants up to 30 cm high. Shoots with mostly one flower and leafless, exceptionally two-flowered with 1-3 cauline leaves. Leaf laminae 1-4 cm in diameter, 5- or 3-sected. Leaf segments of varying morphology, in most species dissected into narrow lobes. Flowers yellow, flat, 1.2-4.0 cm in diameter, five perianth leaves, exceptionally up to eight. Honey leaves 2-7 mm long with thickened convex glittering blades. Nectary pit globular, at a 0.5-2.0 mm height from the base of the honey leaf. In head 5-18 follicles 1.0-2.0 cm long with beaks.

To this section the following species are classified: *T. pumilus* Don; *T. micranthus* Hand.-Mazz.; *T. ranunculoides* Hemsl.; *T. vaginatus* Hand.-Mazz.; *T. farreri* Stapf; *T. sikkimensis* (Brühl) grad. nov. et comb. nov.; *T. bhotanicus* (Brühl) Mukerjee.

Section type: *T. pumilus* Don.

Key

1. Honey leaves about 10-12; plants 5-30 cm high 2
1. Honey leaves reduced to 3-4, instead of them stamen-like staminodia; plants 30-40 cm high
- T. bhotanicus*
2. Honey leaves 2.0-3.5 mm long 3
2. Honey leaves 4.0-7.0 mm long 4
3. Flowers 1.2-2.0 cm in diameter; plants slender, 17-24 cm high; leaf segments dissected into narrow lobes
- T. micranthus*
3. Flowers 2.0-2.7 cm in diameter, plants up to 15 cm high; leaf segments not dissected into lobes, sharply dentate (Pl. IV)
- T. sikkimensis*

4. Blade of honey leaves round (Fig. 1 m - r),
leaves never whitish on underside 5
4. Blade of honey leaves oval (Fig. 1 e - l), if rounded, the leaf
lamina whitish underneath 6
5. Leaves with distinct sheath 1-3 cm long, leaf segments
dissected into narrow (1 mm) lobes, acute, turn brown after
drying (Pl. II)

T. vaginatus

5. Leaves without or with sheath up to 1.0 cm long, leaf seg-
ments not so deeply dissected, mostly 3-lobed, with rounded
or sharp teeth; slender plants, not turning brown after drying
(Pl. III)

T. farreri

6. Honey leaves oval (Fig. 1 e - i). Leaf sheaths hardly distin-
guishable, leaves green underneath (Pl. I)

T. pumilus

6. Honey leaves oval or rounded (Fig. 1 j - l). Leaves with dis-
tinct sheaths, leaf lamina whitish underneath

T. ranunculoides

Trollius pumilus Don

D. Don, Prod. Fl. nepal. 195 (1825); J. D. Hooker et T. Thomson. Fl. Indica 1: 41 (1855); J. D. Hooker, Fl. Brit. India 1: 22 (1872); Handel-Mazetti, Acta Horti Gotoburg. 13: 41 (1940); Hara, Fl. East. Himalaya 92 (1966).

Syn.: *T. pumilus* Don ssp. *geranifolius* Brühl, Ann. Roy. Bot. Gard. Calc. 5: 88 (1896); *T. pumilus* Don var. *pinnatifidus* Schipcz. Bull. Jard. Bot. Rep. Russe 23: 68 (1924); *T. gammieanus* Stapf, Bot. Mag. (London) 152 (1928); *T. geranifolius* (Brühl) Mukerjee, Bull. Bot. Surv. Ind. 2: 106 (1960).

lc.: Brühl, Ann. Roy. Bot. Gard. Calc. 5, Pl. 113 fig. 1, 2 f, g, 3, 5 c, 6, 7 b (1896); Doroszevska, Acta Soc. Bot. Pol. 39, Pl. I a, II a, IV c, f, Fig. 1 a (1970).

Type: Herb. Ind. Or. Hook. fil. et Thomson, leg. R. Strachey et J. W. Winterbottom, Kumaon, Burjee Kang Pap 13000, (BM).

In period of flowering the shoot length is generally 10-20 cm, in the fruiting period it reaches 30 cm. Shoots oneflowered, leafless or with 1-3 cauline leaves. Basal leaves stalked, lamina 1-4 cm in diameter, 3- or 5-sected; leaf segments deeply dissected into narrow lobes, apiculate. Lower cauline leaves stalked, upper ones almost sessile, sheath hardly distinguishable; laminae the same as in basal leaves (Pl. I).

Flowers open, flat, 2.0-3.5 cm in diameter, with faint pleasant scent. Perianth leaves 5, exceptionally 6, leaves broadly-oval or obovate, 14-22 mm long, 4-8 mm wide; in one flower all leaves are more or less similar. Leaf apex may be elongated and apiculate, rounded or

truncate with minute dentation or sometimes with incisions (Fig. 1 a - d); perianth leaves yellow (Canary yellow 2)*, frequently greenish on their dorsal side or tinted with red; in some herbarium specimens the entire dorsal side of the leaves is dark red or purple; the flower stalks are often also reddish then. Perianth leaves sometimes not deciduous but persistent.

About 12 honey leaves, generally 5.0 mm (4.5 - 7.0 mm) long, elongated, widening into oval blade tapering towards apex; the blade thickened, convex, glittering orange (Saffron yellow 7); nectary pit deep, distended, globular at a height of 1.0 - 2.0 mm, unguis straight. Stigmas yellow.

Fruits: 8 - 18 follicles in head, 10 - 13 mm long; beak 1.0 - 2.0 mm long, straight, strong, bent outwards at base (Pl. I). In follicle 4 - 9 seeds ca. 1.5 mm long, oval, black. Flowers in June, July, $2n = 16$.

Distribution: Himalayas and East Tibet; Nepal, Bhutan, India: provinces Assam, Sikkim; North Burma (Kachin State); China, provinces: Yunnan, Szechwan and Kansu (Nan-Shan Mts.). Alpine species occurring at height of 4 000 - 5 000 m a.s.l., on meadows in damp places, sometimes close to patches of melting snow (Fig. 2 p. 31).

Specimens examined:

Cultivated plants: H/10, H/74, H/76 — from Botanic Garden in Warsaw.

Herbarium specimens:

G. H. Cave: (1.9.1919), East Himalaya, Yampung (E). — R. E. Cooper: 838 (1913), Himalaya, Chaigu, Sikkim (E). — L. Dhwaj: 451 (1930), Flora of Nepal, Money Dara, 13000 - 14000 ft. (BM, E); 237 (1929), Flora of Nepal, loc. Soongoorey, 13000' (BM). — I. F. Duthie: (1900), W. Himalaya, Ralam Valley, 24136 (K); 12697, Central Kansu, Lien-hoa-shan (K); 19595, Lat. $28^{\circ}18' - 99^{\circ}10'$ (K); 21228, Lat. $27^{\circ}48'N - \text{long } 101^{\circ}$ (E, K); 23205, S. W. Tibet, Prov. Tsarung, Mt. west of the Kaakerpo (K). — G. Forrest: 30014 (1931), Yunnan (E); Lat. $28^{\circ}72'$, loc. on the Beima Shan (E); Lat. $27^{\circ}30' - \text{Long. } 98^{\circ}36'$, N. W. Yunnan, Mekong-Selvin divide (E) Lat. $28^{\circ}40'N$, — Long $98^{\circ}15'$, E., Yunnan (K, E). — Handel-Mazzetti: 9626 (1916), Yunnan, river Landsang-dijang (Mekong) et Lu-dijang (Salween) $28^{\circ}4'$ (E). — C. R. Ching: 151 (1923), Dar Pan near Sining (E). — Herb. Hookerianum 1867, India, Kuman-Baril Kang (K.). — R. Lepcha: 1096 (12.8.13) East Himalaya, Yampung (E). — F. Ludlow, G. Sherrieff: 404 (1933), N. E. Bhuthan (BM); 593 (1934), Sakden Gamrichu, E. Bhutan (BM). — F. Ludlow, G. Sherrieff, G. Taylor: 5006 (1938), China, Prov. Kongbo, Songla, $29^{\circ}35'N - 94^{\circ}43'E$ (E). — F. Ludlow, G. Sherrieff, J. H. Hicks: 19792 (1949), Bhutan, Jiula (BM); 21140 (1949), N. E. Bhutan, Shingbe (Me La), (BM). — Cap. F. Kingdon-Ward: 1933, Loc. Shinden Gompa: Nagong (K). — O. Palunin: 262 (1949), Central Nepal on route Tanget (BM). — R. S. Rac: Flora of Sikkim 955, Sikkim (WA). — Bis Raw: 2125 (1933), distr. Kumaon, west Almora, Piradi Glacier (E). — J. F. Rock: S. E. Tibet, Province of Tsarung (K); (1932) Prov. Tsarung, Mt. west of the Kaakerpo, Dakerta and Yundshi (E); (1932), Yunnan, Mt. of Nakela, east of Yuragan, Mekong-Salwin divide

* Colour of flowers and their parts is given in the present paper only for cultivated specimens according to the "Horticultural colour chart" (1938).

(E, BM); Mt. of Motung of the Yangtze-Mekong (E); (1932) Yunnan, Pei-ma, Mekong-Yangtze divide (BM).—L. Sherriff: 593 (3.7.1934), Sakken (India) (E).—K. Sharma: E 362 (1932), Flora of Nepal, Aderey (E, BM).—C. Wigram: (25.9.1927), Flora of Nepal (E).—T. T. Yu: (1938) Mekong-Salwin Divide, Sewalongba (E).—Herb. L. A. Waddell: (21.7.1891), Tibet N. W., Chumbi below Ghuaha (K).—Auct. ign.: (25.6.1919) Tibet: Rel de Tchet (E).

T. pumilus Don is the earliest known species of this section. As reported by Stapf (1928) Don's description was based on the collection of Hooker from Sikkim and Kumaon. The range of this species is much wider, comprising beside the Himalayas the mountains of north-west China (Fig. 2). The habitus of *T. pumilus* as well as certain characters of the leaf lamina and flowers are variable, but the honey leaves are characteristic (Fig. 1 e-i). Brühl who distinguished within the species *T. pumilus* a number of taxons of lower rank says: "To judge from Don's description, his *T. pumilus* is identical with my subspecies *geranifolius*" (Brühl, 1896, p. 88). On this basis the ssp. *geranifolius* Brühl was accepted as a synonym of *T. pumilus*. In connection with this name *T. pumilus* Don cannot be considered as synonymous to *T. pumilus* Don ssp. *normalis* Brühl var. *sikkimensis* Brühl, as given by Handel-Mazzetti (1939-1940) and Mukerjee (1960), since these are separate taxons. The precise drawings in Brühl's work (1896, pl. 113) make it easier to distinguish them.

Stapf (1928) distinguishing in his key the new species *T. gamnienus* Stapf did not give its accurate description. According to him *T. gamnienus* differs from *T. pumilus* mainly by its upper cauline leaf on thin and long petiole reaching frequently up to the level of the flower. Such specimens are as a rule somewhat slenderer and more branched, their leaves have laminae less sharply ended and resemble somewhat those of *T. micranthus*. The difference, however, between *T. pumilus* and *T. gamnienus* is not distinct, there exist many intermediate forms and the variability of the above characters is continuous. The honey leaves of *T. gamnienus* are identical as those of *T. pumilus*. There seem to be no grounds for establishing a separate species.

Although *T. pumilus* is an alpine plant, it grows well on lowland, flowers and fructifies profusely. It is cultivated frequently in rock gardens as a decorative plant.

Trollius micranthus Hand.-Mazz.

Handel-Mazzetti, Symb. sin. 7,1: 268 (1931).

Ic.: Ibid. Tab. VI. Abb. 1.

Type: n. v.

Plants similar to *T. pumilus* but more slender and smaller. Fruiting shoots 16-24 cm high, mostly leafless, sometimes one cauline leaf de-

Fig. 1. Some flower elements of the section *Pumilotrollius* (perianth leaves life-size, honey leaves, stamens and follicle $2 \times$ life-size)

T. pumilus: a, e—H/10; b—Nepal, leg. Sharma 362 (E); c, d—E. Himalaya, Yampuihg, leg. Lepcha, 1096 (E); f—China, Yangtze-Mekong, leg. Rock (1923) (E); g—China, prov. Kongbo, leg. Ludlow, Sherriff, Taylor, 5006 (E); h—Yunnan, leg. Forrest, 30014 (E); i—Nepal, leg. Shrama, E 362 (E)

T. ranunculoides: j—S. W. Szechwan, leg. Forrest, 21228 (E); k—S. W. Kansu, leg. Rock et Forrest, 12354 (E); l—W. Kansu, leg. Prudom, 696 (K)

T. farreri: m—China, Kansu, leg. Farrer et Prudom, 519 (E); n—E. Tibet, leg. Rock, 14220 (E)
T. vaginatus: o—N. W. Yunnan, leg. Kingdom-Ward, 4209 (E); p—Central Bhutan, leg. Ludlow et Sherriff, 3291 (BM); r—S. W. Szechwan, leg. Rock, 17664 (E)

T. sikkimensis: s—W. Nepal, leg. Stainton, 4334 (E); t—E. Bhutan, leg. Ludlow et Sherriff, 593 (E); u—leg. Ludlow, Sherriff, Taylor, 7194 (BM); v—Tibet, Lhasa, leg. Ludlow, Sherriff, 11064 (E); w—ibid., 9585 (E)

T. micranthus: x, y, z—S. E. Tibet, prov. Kongbo, leg. Ludlow, Sherriff, Taylor, 5273 (E)

velops on the lower part of the stem. Basal leaves stalked, lamina 1.0-3.5 cm in diameter, 3- or 5-sected; segments incised into lobes rounded at ends, middle segment broad-ovate, three-sected.

Flowers small, flat, 1.2-2.0 cm in diameter, yellow, after drying sometimes reddish.

Perianth leaves five, oval, at apex often minutely dentate (Fig. 1 x). Honey leaves 2-3 mm long, somewhat shorter than filaments of stamina, orange-coloured, blade oval, their habitus resembles that of the honey leaves of *T. pumilus*, but they are smaller. Nectary pit round, at a height of 0.5 mm.

Follicles not numerous, about 7 (5-10) in head; their length with beak is 7-10 mm, length of beak 1.0-1.5 mm. Follicles relatively wide, rounded at apex, their width amounts mostly to one half their length. Beak thin, curved hookwise outwards (Fig. 1 y, z). Morphology of follicle characteristic for this taxon, distinctly different than in remaining species of the section *Pumilotrollius*.

Distribution: China, provinces: North-West Yunnan, Kongbo, Kansu; upper Burma, north part near the border of Yunnan. In mountains at a height of 4 000 m a.s.l.

Herbarium specimens examined: Handel-Mazzetti: 1851 (1916), Prov. Yunnan bor. occid.: fines Tibeto-Birmanicus inter fluvis Lu-dijang (Salveen) et Dijon-diy, Mont. Gomba-la supra Tachamnotong (E, LE).—Ludlow, Scherriff, Taylor: 5273 (1938), South East Tibet, prov. Kongbo, lat. 29°59'E (E).—Cap. Kingdon-Ward: 9692, 9831 (1930-31), Burma, Tibet Frontier, lat. 28°20'N-97°40' (E, BM).

T. micranthus is closely related to *T. pumilus*. Flower stalks and petioles thin and elongated, honey leaves and flowers much smaller than in *T. pumilus*. Characteristic for *T. micranthus* are the wide oval follicles with thin beaks recurved. No other taxon of the section *Pumilotrollius* has such follicles.

The above given characters are sufficiently pronounced for establishing this species, although intermediate forms between it and *T. pumilus* exist. Perhaps it should rather be considered as a subspecies of *T. pumilus* than as a separate species. The available herbarium material was too scarce to allow a change of the rank of this taxon.

Trollius ranunculoides Hamsl.

Hemsley, Journ. Linn. Soc. Bot. 39: 301 (1893); Stapf. Bot. Mag. (London), 152 (1928); Schipczynsky, Bull. Jard. Bot. Rép. Russe, 23: 67-68 (1924).

Syn.: *T. pumilus* Don ssp. *normalis* Brühl var. *ranunculoides* (Hemsley) Brühl, Ann. Roy. Bot. Gard. Calc. 5: 83 (1896).

lc.: Brühl, Ann. Roy. Bot. Gard. Calc. 5, Pl. 113 Fig. 2 e (1896).

Type: A. E. Pratt, 560, (1890), ex Western Szechuen and Tibet Frontier, nearly Tachienlu at 9000 - 13300 feet, (K).

Plants from several to 20 cm high, at the time of fruiting may reach more than 30 cm; shoots single with or without flower, without cauline leaves or with one leaf on lower part of stem.

Basal leaves stalked with membranous widened sheaths about 1.0 cm long; laminae generally 2.0 cm (1.0 - 3.0) in diameter; 3- or 5-sected. Leaf segments 3-lobed and incised into narrow sharply ending lobes. The lobes of the segments may overlap; leaf laminae whitish underneath; cauline leaves do not differ from basal ones.

Flowers open, 2.5 - 4.5 cm in diameter, yellow, frequently turn green in drying. Five perianth leaves, exceptionally six, 10 - 22 mm long; they are ovate, broad-oval obtuse or somewhat truncate, may be minutely toothed at the apex or emarginate.

Honey leaves about 12, 5 - 7 mm long orange-coloured, elongated; blade thickened in upper part, oval, rather sharply ending or widening, nectary pit at 1.0 - 1.5 mm height (Fig. 1 j - i). About 12 follicles in head. I have not seen ripe fruits.

Distribution: China, provinces: West and South Szechwan and West Kansu. In mountains at a height of 3 000 - 4 500 m a.s.l.

Herbarium specimens examined: G. Forrest: 21228 (1922), S. W. Szechuan (E), 30014 (1931), W. China (E). — G. Forrest et J. F. Rock: 24019 (1932), S. W. Szechuan, Muli Territory, Mt. Mitzuga (K). — Potanin: (1885), China bor. (K). — Purdom: 696 (1914), West Kansu (K), S. W. of Tow River, W. Kansu (K). — J. Rock et G. Forrest: 12354 (1925), S. W. Kansu, River T'ao, (E). — McLaren: Ac 172, China, Yunnan, Tasienlu, Summit of mountain, Flowers golden, Blossom in August (E). — E. H. Wilson: 3080, Western China, alpine meadows (BM).

T. ranunculoides is most closely related to *T. pumilus*, it has, however, certain common characters with *T. vaginatus* and *T. farreri*. Leaf laminae of *T. ranunculoides*, *T. pumilus*, *T. farreri* and *T. vaginatus* are all similarly dissected. *T. ranunculoides* differs from the other three species by the white colour of the leaves underneath and the fact that the leaf segments may overlap. The leaves of *T. farreri* are thinner, generally more finely dissected and, like the entire plant more delicate than those of *T. ranunculoides*. The leaves of *T. vaginatus* are somewhat thicker and more stiff than those of *T. ranunculoides*, their lobes are longer, sharper ended with a short sharp spine; the leaf sheath is longer than in *T. ranunculoides*. In spite of these differences *T. ranunculoides* resembles greatly *T. vaginatus* in its general habitus. Some specimens have less pronounced characters or are intermediate between these two species. Classification is the more difficult because the honey leaves of *T. ranunculoides* vary in shape. They may be in some plants the same

as in *T. pumilus* (Fig. 1 i), in others more similar to those of *T. farreri* (Fig. 1 m). Honey leaves with distinctly rounded blades as those of *T. vaginatus* (Fig. 1 o - r) have not been found in *T. ranunculoides*.

It results from the morphological observations that *T. ranunculoides* is a relatively poorly differentiated species in the section *Pumilotrollius*. Its honey leaves are not uniform, they are probably a connecting link between *T. pumilus* and *T. farreri*, whereas the morphology of the vegetative leaves is intermediate between *T. pumilus* and *T. vaginatus*. Thus *T. ranunculoides* is a species in which the features of three species *T. pumilus*, *T. farreri* and *T. vaginatus* are combined.

Trollius vaginatus Hand.-Mazz.

Handel-Mazzetti, Symb. sin. 7, 1: 226 - 269 (1931)

Ic.: Ibid Tab. VI, Abb. 2.

Type: n. v.

Shoots 4 - 12 cm high with a single flower at the tip, generally with one cauline leaf, less frequently leafless or with 2 - 3 leaves (Pl. II).

Basal and cauline leaves with characteristic sheaths 2 - 3 cm long, that is about one half the length of the petiole. Sheaths widened, membranous with distinct veins. Leaf laminae round, mostly 2 cm (1 - 3) in diameter, 5- and 3-sected, divided into oval segments; segments 3-sected and incised into long narrow lobes (1 mm wide), sometimes sharply ended with a short spine. Leaves rather thick and stiff, stiffer than in *T. pumilus*; they turn brown after drying.

Flowers open, flat, 2.0 - 3.5 cm in diameter. Perianth leaves 5, exceptionally 6 - 7; yellow, sometimes greenish at tip, oval or broad-ovate in shape; after the period of flowering they often are not shed but dry up on the stalk (Pl. II). Honey leaves about 12, 4 - 5 mm long, light orange coloured, with an elongated thick obtuse blade. Nectary pit globular, placed at a height of 0.5 - 2.0 mm from the base of the honey leaf (Fig. 1 o - r). Stamina 10 - 12 mm long, anther length 2.5 - 3.0 mm. Follicles 5 - 8 in head, elongated, measuring with beak 12 mm, beak about 2.0 mm long, strong, at base recurved. Morphology of the fruits does not differ from that of *T. pumilus*.

Honey leaves distinctly different from those of *T. pumilus* (Fig. 1 e - i); vegetative leaves more stiff and more deeply dissected, with long leaf sheath. The species is easy to distinguish from *T. micranthus*. As compared with *T. sikkimensis*, *T. vaginatus* has quite different vegetative leaves, the honey leaves are of the same shape, but they differ in length (Fig. 1 s, t). *T. farreri* has quite a different habitus. Both in *T. vaginatus* and *T. farreri* the perianth leaves may be wide, almost round, and they overlap. The flowers after drying have a circular outline (Pl. II, III).

The honey leaves in *T. farreri* exhibit a morphology intermediate between *T. vaginatus* and *T. pumilus*.

Most similar to *T. vaginatus* is *T. ranunculoides*. Although its leaf sheaths are not so long and the leaf lamina whitish underneath, the general habitus is very similar. The habitus of *T. ranunculoides* is in the main intermediate between that of *T. vaginatus* and *T. pumilus*.

Distribution: China, provinces: North-West Yunnan, and South-West Szechwan; India, Central Bhutan (only one specimen reported, Ludlow et Sherriff 3291). In mountains at a height of 3 000 - 4 250 m a.s.l. on calcareous soil and damp meadows.

Herbarium specimens examined: G. Forrest 10796 (1913), Yunnan, Mt. Changhei lat. 27°33' (E); 12557 (1914), Yunnan, Mt. Changhei lat. 27°30' (E); 16633 (1918) (E); 30014 (1931), Yunnan (E).—F. Ludlow et G. Sherriff: 3291 (1937), Central Bhutan, Black Mountain, Dunshinggang (E, BM).—T. Kingdom-Ward: 4209 (1911), N. W. Yunnan (E).—J. F. Rock: 9959 (1923), Yunnan, Mt. Peimshan, Mekong-Yangtze, between Atuntze and Pungtzera (E, W); 9698 (1923), Yunnan, Mt. Habashan (E); 17664 (1929), S. W. Szechwan, China, Minya-Kouka, east of Yulong Hsi (E, K); 14220 (1926), E. Tibet, alp. region between Radja and Jupar (K).

T. vaginatus is a rather well differentiated taxon of the section *Pumilotrollius*. The herbarium material inspected is too scarce for establishing the geographical range of this species more exactly. It would seem, however, that it does not occupy extensive areas.

The most characteristic features of *T. vaginatus* are: small dimensions of the plant, long leaf sheath (2 - 3 cm), honey leaves with rounded blade and vegetative leaves turning brown after drying. Identification of this species should not cause difficulties.

Trollius farreri Stapf

Stapf, Bot. Mag. (London) 152: Sub. t. 9143 (1928); Handel-Mazzetti, Acta Horti Gotoburg. 13: 41 (1939 - 1940).

Syn.: *T. pumilus* Don, in Maksimovich, Fl. Tangutica 16 - 17 (1889) *T. pumilus* Don ssp. *normalis* Brühl var. *kansuensis* Brühl et var. *tangutica* Brühl, Ann. Roy. Bot. Gard. Calc. 5: 88 (1896); *T. pumilus* Don var. *alpinus* Ulbr. (p. p.) ex Handel-Mazzetti, Acta Horti Gotoburg. 13: 41 (1939 - 1940); *T. pumilus* Don var. *lobatus* Schipcz. f. *minor* Schipcz. et f. *maior* Schipcz., Bull. Jard. Bot. Rep. Russe 23: 68 (1924); *T. kansuensis* (Brühl) Mukerjee, Bull. Bot. Surv. Ind. 2: 106 (1960).

Ic.: Brühl, Ann. Roy. Bot. Gard. Calc. 5: Pl. 113, fig. 2 c d (1896).

Type: Prudom, s. n. (1910), Shensi. Tai pei shan (K).

Plants small 5.0 - 20.0 cm high, shoots thin with one flower at tip; in lower part of shoot 1 - 2 cauline leaves, stem sometimes leafless (Pl. III).

Basal leaves with thin petioles, laminae generally 1.5 - 2.0 cm in diameter, 3-sected, leaf segments 3-lobed, with more or less sharp or blunt teeth. Cauline leaves with distended membraneous sheaths 0.5 - 1.0 cm long; laminae the same as in basal leaves.

Flowers open, flat, 2.0 - 3.0 cm in diameter. Five to six perianth leaves 10 - 15 cm long, yellow, frequently at tip or outside purple injected, some herbarium specimens have entire leaves dark purple outside (e.g. Rock 1300, K). The shape of perianth leaves variable. They may be rhomboidal with rather sharp apex or ovate, oval and very broad-oval, almost round. Flowers with such wide perianth leaves have a circular outline. The rhomboidal leaves give the flowers a stellate shape. These differences are particularly well visible in dry herbarium material (Pl. III).

Honey leaves 4.0 - 4.5 mm long, yellow or light orange, elongated, in upper part widened in to oval or somewhat rounded blade (Fig. 1 m, n). The blade is less rounded as in *T. vaginatus* or *T. sikkimensis*; in general the morphology of the honey leaves is intermediate between those of *T. pumilus* and *T. vaginatus* (Fig. 1 e - i, o - r). Nectary pit globular, at a height of about 1.0 mm. Fruits similar to those of *T. pumilus*. Flowers in June and July.

Distribution: China, provinces: Kansu (terra Tangutorum), North Szechwan; according to Mukerjee (1960) also India: Assam in mountains at 3 000 - 4 000 m a.s.l. (Fig. 2 p. 31).

Herbarium specimens examined: R. Farrer: 137, China, Kansu, very abundant in all the turf of the Da-Tung Alpe from 9 - 14000 feet. Flowering in July in the valleys, in June on the heights (E). — R. Farrer et W. Purdom: 519 (1914), China, Kansu. 10 — 13000 ft. height turf of the Da-Tung (E). — W. P. Fang: (1928), Szechwan, Sungpan-Hsien (E); 4092, Schechuen, Sungpan-Hsien (E). — Abbe E. Licent: 4626, W. Kansu, Kin-tsiang-tan, (K). — Purdom: (1914) Kest Kansu (K); (1910) Shensi. Tai pei shan (K). — Przewalski: (1873), China, Kansu, Terra Tangutorum (E, LE, K); (1872 - 1880), China occid, Terra Tangutorum, prov.: Kansu (K, LE); (1884), Tibet bor. (K). — J. F. Rock: 12606 (1925), SW Kansu, T'ao River basin (E, K); 13002 (1925), S. W. Kansu, Uper Tebbu Country (E, K); 13976 (1926), E. Tibet, Radja Yellow River (E); 14220 (1926), E. Tibet, alpine region between Radja-Juper ranga (E, K); E. Tibet, S. Radja alt, 10500 - 13000 ft (LE). — H. Smith: 2597 (1922), Prov. Sze-chuan, reg. bor. Swug-Pan (BM).

T. farreri is one of the small species belonging to the section *Pumilotrollius*. At first the plants belonging here were denoted as *T. pumilus* and they are mostly found in herbaria under this name. Part of them was later classified as *T. farreri*, after the species had been described by Stapf in 1928. Their classification is not easy on account of the variability of the plants which involves not only the flowers but the leaf lamina. The perianth leaves are rhomboidal or broad-oval, giving the flowers varying shapes (Pl. III). A similar variability in the shape of the

perianth leaves was found in *T. sikkimensis* and some specimens of *T. pumilus*. The laminae of *T. farreri* are small, the dentation on the segments may be sharp or rounded. According to this difference Brühl described two varieties of *T. pumilus* Don ssp. *normalis* Brühl: var. *kansuensis* and var. *tangutica* (Brühl, 1896, Pl. 113, fig. 2 c, d). These differences are, however, so slight and so unsettled that it is not possible to distinguish new taxonomic units on this basis. Handel-Mazzetti (1939 - 1940) considered them as synonyms of *T. farreri* and this view has been adopted in the present work. *T. farreri* samples collected by Farrer (Pl. III b) have laminae deeper dissected than on Brühl's drawings (1896, Pl. 113, fig. 2 c, d), they are more similar to the leaves of *T. pumilus*. The honey leaves of *T. farreri* are not all identical, and have sometimes more or less rounded blades (Fig. 1 m, n). They show characters intermediate between *T. pumilus* and *T. vaginatus* (Fig. 1 e-i, o-r). *T. farreri* occurs mainly in the mountains of the Kansu province and in North Szechwan (Fig. 2), where probably it originated.

Fig. 2. Distribution of some species of the section *Pumilotrollius* according to the herbarium material

1 — *T. pumilus*; 2 — *T. farreri*; 3 — *T. sikkimensis*

It is possible that in this part of the South China Mts. there exist numerous populations of *Trollius* differing from one another by some slight details in the structure of the lamina. Brühl (1896) distinguished on this area within *T. pumilus* Don ssp. *normalis* two varieties: var. *tangutica* and var. *kansuensis*. Both these names are mentioned in the present work among the synonyms of *T. farreri*. Mukerjee (1960) raised the var. *kansuensis* Brühl to the rank of species *T. kansuensis* (Brühl) Mukerjee; according to the latter author this species occurs also in Assam in India. *T. farreri* Stapf, however, is the name for the species used earlier than *T. kansuensis*, therefore, according to the rules of the International Code of Botanical Nomenclature the former name is valid.

Trollius sikkimensis (Brühl) grad nov. et comb. nov.

Syn.: *T. pumilus* Don *normalis* Brühl var. *sikkimensis* Brühl, Ann. Roy. Bot. Gard. Calc. 5: 88 (1896), *T. pumilus* Don var. *semifissus* Schipcz. f. *minor* Schipcz., Bull. Jard. Bot. Russe 23: 68 (1924).

lc.: Brühl, Ann. Roy. Bot. Gard. Calc. 5, Pl. 133, fig. 2 a, 2 b, 4, 5 a, 7 a (1896).

Type: Hook. fil., Sikkim, 15 - 17000' ex Brühl p. 88, 1896 (Herb. Calc. ?), n. v.

Plants small 5 - 15 cm high, stalk with one flower, leafless, sometimes with one cauline leaf in lower part. Basal leaves have 5-cm petioles with elongated poorly delineated sheath. Laminae 1.0 - 2 cm in diameter, 3- and 5-sected. Leaf segments wide, rhomboidal-oval, sharp dentate (Pl. IV).

Flowers open, flat, 2.0 - 2.7 cm in diameter, yellow. Perianth leaves 5, exceptionally 6, 10 - 13 mm long, ovate, broad-ovate or rhomboidal (Fig. 1 v, w). Sometimes they are not shed and dry up on the shoot. Honey leaves about ten, yellow, 3.0 - 3.5 mm long, elongated, widening at the tip into roundish thickened blade. Nectary pit round, at a height of 0.5 mm from the base of honey leaf (Fig. 1 s, t).

About ten follicles in head, ca 10 mm long (2 mm beak including); beak straight, bent somewhat outwards, recurved; follicles the same as in *T. pumilus*.

Distribution: Bhutan, Nepal, India (provinces: Assam, Sikkim), and South-West China: in mountains at height of 3 500 - 5 000 m a.s.l. (Fig. 2 p. 31).

Herbarium specimens examined: G. H. Cave: (28.8.1947) Sikkim: Ihonahk, alt. 15000' (E, BM). — R. E. Cooper: 4074 (1915), Flora of Bhutan, Champa, Pumthang (BM). — Cap. L. Dhwoj: 392 (1930), Flora of Nepal, Chaker (BM, E). — Herb. Ow. Hook. f. et Thomson: Sikkim (E). — Capt. F. Kingdon-Ward: 11682 (1935), Flora of Assam, Luguthang (BM). — R. Lepcha: 1087, East Himalaya, Damphibhir, alt. 14000' (E); 466 (1912), East Himalaya, Chumdari (E). — F. Ludlow et G. Sherrieff: 1617 (1936), S. Tibet, Yarup, Tsari-Chu (E); 593 (1934), Flora of

E. Bhutan: Sakden (E); 9585 (1943), Fl. of Tibet: Hills N. of Lhasa, 13000 ft. (E); 9612 (1943), Fl. of Tibet: Dechen Dzong, 3 days west of Lhasa (E); 11064 (1944) Fl. of Tibet: Reting 60 miles N. of Lhasa (E); Flora of Bhutan (1949): 16273, Pangte La, Paro Chu (E); 16334, Thimbu Chu, Pake Dzong above Naha (E); 18988, Pangotang, Bumthang La (E); 20677, Shingbe Me La, N. E. Bhutan (E).—F. Ludlow, G. Sherriff, G. Taylor: (1938) (BM); 3823, 28°57'—93°53' (BM); 4257, lat. N. 29°01'—long. E. 93°17' (BM); 6386 lat. N. 28°25'—long. E. 93°01' (BM); 7194, lat. N. 28°59'—long. E. 93°28', alt. 10500 ft. (BM).—Smith et Cave: 1852, Fl. of Sikkim, Lhonak (BM).—J. D. A. Stainton: 4334 (1963), West Nepal: Phoksumdo Khola, 29°8' N.—82°96' E, 15000 ft. (E).—F. Spencer Champan: 405 (6.8.1936), Tibet, loc. Phariw Tuna (K).—Mt. Everest 1922 Exped.: 21, S. Raphu, Tibet (K).—Mt. Everest 1924 Exped.: 258, coll. Major R. W. G. Hingston, Ronoghar Valley (K).—Mt. Everest 1933 Exped.: 120, loc. Beloro Kongra-la, Longphu-Chu (K).—Tibet Frontier Commission 1903: 134, Phari Plani (K).—Auct. ign.: 2240, Tibet, Melong Gumpa (K); 5702, W. Himalaya, Kongbo Peri, alt. 14000' (E, K); Sikkim (LE); Sikkim, Kuen-lun, Mt. Karagaj-ky (LE).

The most characteristic feature of *T. sikkimensis* are: small dimensions of the entire plant, honey leaves ca 3.0 mm long with blade rounded in its upper part, vegetative leaves with segments not dissected into lobes, only rather sharp dentate. Owing to these characters *T. sikkimensis* is the species in the section differing most from *T. pumilus* Don. It is a well differentiated taxon with rather constant morphological features. This characteristic morphology and the definite geographical range prompted the present author to raise this taxon to the rank of species.

T. sikkimensis is related to the *T. pumilus* var. *kansuensis* and *tangutica* (synonyms of *T. farreri* Stapf) described by Brühl (1896), but these varieties occur in China in the provinces Kansu and Szechwan and are probably small local forms.

Trollius bhotanicus (Brühl) Mukerjee sub "*bhotanica*"

Mukerjee, Bull. Bot. Surv. Ind. 2. 106 (1960).

Syn.: *T. pumilus* Don. ssp. *normalis* Brühl var. *bhotanica* Brühl, Ann. Roy. Bot. Gard. Calc. 5: 88 (1896).

lc.: Brühl, Ann. Roy. Bot. Gard. Calc. 5, Pl. 113, fig. 5 d (1896).

Type: King's coll., Chumbi, at Do-tha; Herb. Calc. (ex Brühl 1896, p. 88) n. v.

Description after Brühl (1896, p. 88): "stem 30 to 40 cm high, one-flowered, leafless or rarely with one leaf towards the base: leaves as in α (α =var. *sikkimensis* Brühl: leaves with numerous serratures—Chumbi, at Do-tha; K. s coll.)".

Further in text on the same page: "Of great interest in connection with the real nature of so-called petals is the occurrence in var. *bhotanica* of undoubted staminodes, consisting of filaments of varying lengths and

an ellipsoidal empty terminal pouch; the number of so-called petals is then reduced to three or four (see Fig. 5 d)".

Distribution: East Himalayas (Mukerjee, 1960).

This taxon described by Brühl (1896) as a variety of *T. pumilus* has a oneflowered stalk and leaves similar to those of *T. sikkimensis*. Characteristic for it is the occurrence in the flowers of special staminodia. The number of normal honey leaves is reduced to 3 or 4, instead of them staminodia appear closely related to stamens by their morphology. Similarly as stamens they consist of a shorter or longer filament on which an oval empty pouch is attached (Brühl, Pl. 113, fig. 5 d). According to Brühl, the occurrence of this kind of staminodia confirms the hypothesis of Prantl that the honey leaves of *Trollius*, as in other *Ranunculaceae*, arose from stamens. Brühl described them from the King's collections in the herbarium of Calcutta. Mukerjee (1960), on the basis of the data of King and Brühl raised this taxon to the rank of species, but he did not give any description. The taxon can be finally classified after a sufficient amount of material has been studied. Above all, it would be necessary to study the original collection of King in the above mentioned herbarium. Herbarium specimens of this taxon is not known to the present author.

Discussion of the section *Pumilotrollius*

The section consists of several more or less distinct species occurring in the Central and Eastern Himalayas, in East Tibet and in the mountains of South-West China (Fig. 18). Some of these species have a wider range as for instance *T. pumilus* and *T. ranunculoides*; others as e.g. *T. farreri* and *T. sikkimensis* have a restricted local range. Most species of the section occur on the same territory, and intermediate forms between them may be found. The first known species of this section was *T. pumilus* described by Don in 1825. At first all the plants of the section *Pumilotrollius* were denoted by this name. Even *T. acaulis* found in Kashmir was at first described by Royle (1839) as *T. pumilus*. Brühl (1896) was the first to call attention to the high morphological variability within *T. pumilus*, and he divided this species into three subspecies and numerous varieties. Although Brühl classified *T. yunnanensis* to the varieties of *T. pumilus*, his work is very valuable since it gives a picture of the morphological variability of this plant group, and the precise drawings included facilitate identification of the taxons (Brühl, Pl. 113, 1896). Of the three subspecies distinguished by him within *T. pumilus* the first ssp. *anemonifolius* Brühl is a synonym of *T. yunnanensis* (Franch.) Ulbr. ssp. *anemonifolius* (Brühl) comb. nov.; the second ssp. *geranifolius* Brühl is a synonym of *T. pumilus* Don; the third ssp. *normalis* Brühl was divided by the same author into a number of varieties: *sikkimensis*,

bhotanica, *yunnanensis*, *ranunculoides*, *kansuensis* and *tangutica*. Later authors (Schipczinsky, 1924; Stapf 1928; Handel-Mazzetti, 1931, 1939-1940; Mukerjee, 1960) treated these taxons in different ways. The varieties *tangutica* Brühl and *kansuensis* Brühl were considered by Handel-Mazzetti (1939-1940) as synonyms of *T. farreri* Stapf; this agrees well with the observations of the present author. Brühl's variety *ranunculoides* is a synonym of the species *T. ranunculoides* Hemsley described in 1893. This taxon has been raised once more to the rank of species (Schipczinsky, 1924; Stapf, 1928). According to the present author's own observations, *T. ranunculoides* is relatively little differentiated and closely related to *T. pumilus* and *T. vaginatus*. *T. pumilus* ssp. *normalis* var. *yunnanensis* Brühl is a synonym of *T. yunnanensis* (Franch.) Ulbr., and *T. pumilus* ssp. *normalis* var. *bhotanica* Brühl was established by Mukerjee (1960) as a separate species *T. bhotanica* Mukerjee.

The present author has established *T. pumilus* ssp. *normalis* var. *sikkimensis* Brühl as a separate species — *T. sikkimensis* (Brühl) comb. nov., since this taxon differs most morphologically from the others and is the most uniform one in the entire section *Pumilotrollius*. Handel-Mazzetti (1939-1940) and also Mukerjee (1960) considered the variety *sikkimensis* Brühl as the synonym of *T. pumilus*. According to Brühl (1896), however, the ssp. *geranifolius* Brühl established by him is completely identical with the original description of *T. pumilus* given by Don (1925), therefore the var. *sikkimensis* Brühl cannot be their synonym. The morphology of ssp. *geranifolius* and var. *sikkimensis* differs so widely that there is no doubt that they should be treated as separate taxons. In the present work var. *sikkimensis* is established as a separate species, whereas ssp. *geranifolius* is considered a synonym of *T. pumilus*. The new species *T. gamnaneanus* established by Stapf (1928) is also treated here as a synonym of *T. pumilus*. According to Mukerjee (1960) *T. gamnaneanus* is a synonym of *T. pumilus* ssp. *geranifolius* Brühl.

Of the two species described by Handel-Mazzetti (1931), *T. vaginatus* is a morphologically well differentiated separate species, whereas *T. micranthus* is related to *T. pumilus*. In the present work both these taxons have been left in the rank of species.

The particular species of the section *Pumilotrollius* differ from one another by their general habitus, dimensions, shape and size of the honey leaves and the vegetative leaf structure. In general in the genus *Trollius* the shape of the laminae is widely diversified and this variability is usually continuous. In the section *Pumilotrollius* the morphology of the leaves is in most species sufficiently constant to be taken into account as a taxonomic feature. The most distinctly separate and uniform in this group is *T. sikkimensis*, and the most poorly differentiated *T. ranunculoides*.

Syn.: Sect., *Eutrollius* Prantl in Engler u. Prantl, Nat. Pflanzenf. III, 2: 56 (1891), p.p.

Shoots mostly branched, foliated, 30 - 80 cm high. Leaves 3-sected, segments not incised into lobes, rather thick. Flowers flat or almost flat, 3 - 7 cm in diameter. Perianth leaves five, exceptionally 6 - 8, light orange. Honey leaves orange, 6 - 13 mm long, elongated, in upper part widened into a thickened blade, convex and glistening. In the lower part the edges of the leaf are rolled upwards forming a characteristic trough running down to the nectary pit. Nectary pit globular. Unguis bent outwards.

To this section are classified: *T. yunnanensis* (Franch.) Ulbr. ssp. *yunnanensis* with the forms: f. *yunnanensis*, f. *ubra* Stapf and f. *eupetala* Stapf as well as ssp. *anemonifolius* (Brühl) comb. nov.; *T. papavereus* Schipcz; *T. citrinus* Miyabe.

Section type: *T. yunnanensis* (Franch.) Ulbr.

Key

1. Perianth leaves numerous (more than 8), flowers double
T. yunnanensis ssp. *yunnanensis* f. *ubra*
1. Perianth leaves 5 - 8 2
2. Shoot mostly single, not branched, honey leaves 6 - 8 mm long, flowers yellow, 3.0 - 4.5 cm in diameter
T. papavereus
2. Shoots branched, honey leaves more than 8 mm long, (exceptionally 8), flowers 4 cm or more in diameter 3
3. Honey leaves narrow, almost linear 13 - 17 mm long, longer than stamina (Fig. 3 d - f), blade outlined very poorly, flowers 6.0 - 8.5 cm in diameter
T. yunnanensis ssp. *yunnanensis* f. *eupetala*
3. Honey leaves with distinct blade, ovally elongated, ca. 10 mm (8 - 13) long, more or less equal to stamina in length 4
4. Flowers lemon-yellow, honey leaves 10 - 13 mm long with slight constriction $\pm$ at mid length, tip of blade rather sharp (Fig. 3 j, k); occurs on the Hokkaido Island (Japan)
T. citrinus
4. Flowers light orange, honey leaves with oval elongated blade without constriction, tip of blade rounded (Fig. 3 a); South-West China 5
5. Leaf laminae distinctly triangular in outline, leaf segments rhomboidal or rhomboidal-oval, 3-lobed dentate
T. yunnanensis ssp. *yunnanensis* f. *yunnanensis*

5. Laminae rounded in outline, leaf segment very broad, round-oval, mostly overlapping, rounded; leaf edge sinuous or with broad dentation

T. yunnanensis ssp. *anemonifolius*

Trollius yunnanensis (Franch.) Ulbr. ssp. *yunnanensis* f. *yunnanensis*

Ulbrich E. in Fedde Rep. sp. nov. Beih. 12: 368 (1922); Stapf, Bot. Mag. (London) 152 (1928).

Syn.: *T. pumilus* Don var. *yunnanensis* Franch., Pl. Delavay. 23 (1889); *T. pumilus* Don ssp. *normalis* F. B. var. *yunnanensis* Brühl, Ann. Roy. Bot. Gard. Calc. 5: 88 (1896); *T. yunnanensis* Schipcz., Not. Syst. Herb. Horti. Bot. Petrop., 4 ed. 2: 9-10 (1923) et Bull. Jard. Bot. Rep. Russe 23: 66 (1924), p.p.; *T. buddae* Schipcz. *ibid.* p.p.; *T. saniculaefolius* Lévillé, Bull. Acad. Geog. Bot. 25: 43 (1915) et Cat. Pl. Yunnan, 227 (1917) vidi Lauener et Green (1961).

lc.: Stapf, Bot. Mag. (London) 152, tab. 9143 (1928); Handel-Mazzetti, Naturbilder aus Südwest China, fig. 39, 43, 44 (1927).

Type: Delavay 80 (1883), Prov. Yunnan, Mnt. Hee-chan-men supra Lankong (hol. K; iso. LE).

Plants 30-60 cm high, shoots straight, single or branched, mostly 1-3-flowered, foliated (Pl. V).

Basal leaves petiolated, lamina 3-sected. Leaf segments rhomboidal or oval ending sharply. Upper part of the middle segment 3-lobed, lateral segments also 3-lobed or with one deeper incision half way down segment. Leaves toothed or broad-toothed. Lamina 4-10 cm in diameter. Cauline leaves 1-4, similar to basal ones, mostly smaller, only sometimes equal or even larger than the latter. Cauline leaves with membranous sheaths 1.5 cm long, lower leaves stalked, upper ones sessile.

Flowers 4.0-6.0 cm in diameter, almost flat or slightly concave in the form of a shallow bowl with a very light pleasant scent.

Perianth leaves 5, exceptionally 6-8; ovate, frequently truncate or shallow emarginate, sometimes fine dentate at tip; leaf length generally ca. 24 mm (18-30), width 13-20 mm; in one flower all leaves more or less of the same width, light orange-coloured (Lemon yellow 4).

Honey leaves 8-17, 8-13 mm long (mostly ca. 10 mm) orange-coloured (Tangerine orange 9), oval elongated in shape, rounded at tip; blade thickened, glittering, convex. In lower part blade edges bent upwards form a kind of trough leading to the nectary pit. Blade width 1.0-2.5 mm, mostly 2 mm. Nectary pit at a height of 1.0-2.5 mm, round, greatly distended; unguis bent back. These details of honey leaves structure may be observed only on living material. They are very characteristic for *T. yunnanensis* and not found in representatives of other sections (Fig. 3 a).

Fig. 3. Some flower elements and the fruits of the section *Yunnanotrollius*
(a - i — 2 × life-size)

- T. yunnanensis* ssp. *yunnanensis*: a — H/134, f. *yunnanensis*, g — Yunnan, Isekon, leg. Morbeiz, 70/1912 (K); h — Lonkong, leg. Delavay, 95 (K); i — Yunnan, leg. Forrest, 14835 (K)
T. yunnanensis ssp. *yunnanensis* f. *eupetala*: d — Jangtse-Mekong, 281 (E); e — Yunnan, Mekong-Salwin Div., Sila, leg. Yü, 22472 (E); f — *ibid.*, 23183 (E)
T. papavereus: b — H/160
T. stenopetalus (syn. *T. papavereus*): c — leg. Forrest, 28768 (E);
T. citrinus: j, k — acc. to Miyabe (1943) Fig. 3 A, B

Stamina 8 - 12 mm long (including anthers 2.0 - 3.0 mm), more or less equal in length to honey leaves, their filaments yellow. Stigmata of living plants (No. H/134) white or very light green, differing by this from other *Trollius* species. This character, unfortunately, cannot be observed on herbarium material. Fruits: 14 - 30 follicles in heads, length of follicle with beak 11 - 16 mm, beak length 1.5 - 3.5 mm. Most frequent shape of

fruits shown in Figure 4. Beaks mostly rather massive, straight, at base slightly recurved, sometimes much thinner and straight or of intermediate shape (col. Rock, 22418, E). There also may be long thin beaks curled hook-like at ends outwards or inwards (Fig. 3 g-l). Seeds oval, black, ca. 2 mm long. Flowering June, July, $2n=16$.

Fig. 4. Fruits (life-size)

a — *Trollius yunnanensis* ssp. *yunnanensis* No. H/134; b — *T. papavereus* No. H/160

Distribution: China: provinces Yunnan and Szechwan; upper Burma, north-east near border of Yunnan. In mountains at a height of 3 000 - 4 200 m a.s.l. (Fig. 5, p. 43).

Specimens examined:

Cultivated: H/134 from the Botanical Garden in Warsaw; H/90 bred from seeds received from the Botanical Garden in Greifswald; H/91 bred from seeds received from the Royal Botanic Garden, Edinburgh.

Herbarium specimens: Delavay: 95, Mnte Hee-chan-men, Lankong (K); 935 (1884), M. Hee-chan-men, Lankong, alt. 3000 (LE). — G. N. Potanin: (1893), Prov. Szechuan, urbs Da-dsian-lu (Tachienlu) (LE). — J. A. Soulie: 1266 (1893), Tibet orient., Esekon (K). — P. Kingdon-Ward: 19566 (1950), India, Tha-Chu Valley alt. 10 - 12000' (E, K). — W. E. Evans: 1164, 1865 (1920), Chimili Pass alt. 12 - 12500' (E). — H. D. McLaren: B. 166 (1933), Western Yunnan (K). — T. T. Yü: 19808, 20612 (1938), Lungtzhamura, Upper Kinkiang Valley (E). — Kuan et Wang: 267 (1963), Szechuan, Kangting (K). — C. Schneider: 1794 (1914), Yunnan, Lichiang (K); 3450 (1916), Yunnan, inter Yungpeting et Lichiang (K). — Fr. Ducloux: 4096 (1906) (K). — G. Forrest: 1342 (1906), Lichiang Range lat. 27°15' (K); 5828 (1910), Yunnan lat. 27°20' (K); 7021 (1910), Yunnan, Easater Flank of Lichiang Range, Lat. 25°40' (E, K); 3828 (1910) Easter Flank of Lichiang Range, 27°90' (E); 14258 (1917 - 19), Yunnan, lat. 28°12' N., alt. 10000' (K); 14835 (1917 - 19), Yunnan (K); 26887, 26°24' N - 98°48' E (E). — P. Morbeiz: 70 (1912), Yunnan, Isecon (K) — J. F. Rock: (1932) 22330, Prov. Tsarung, Mt. of Tjonatong, Upper Salwin Riv. (K); 23864, SW Szechuan, Mt. Stiga, Yalang Riv. north of Karadi (K); 22418, Prov. Tsarung, Mt. Wulila east of Salwin Riv. (K); 24409, SW Szechuan, Mt. Siga (Siga-Szar) (BM); 24841, Yunnan (Yu-lung-shan) Mt. Satse (BM); 4341 (1922), China, Yunnan, Yangtze watershed, western slopes of Likiang Snow Range alt. 12 - 13000 ft. (W).

T. yunnanensis has been described almost simultaneously by two different authors. Schipczinsky (1923) when writing his "Generis Trollii species novae et restituendae" did not know Ulbrich's description (1922) published a year earlier. What is more, both these authors not only gave this taxon the same specific name, but quoted among others the same herbarium specimen — Delavay 80.

Numerous specimens of *T. yunnanensis* were earlier described as *T. patulus* Salisb., and they may be found in herbaria under this name. *T. patulus* Salisb. [syn. *T. ranunculinus* (Smith.) Stearn] is a Caucasian species differing distinctly from *T. yunnanensis*. In spite of the high morphological variability of both these species no relation can be traced between them.

In *T. yunnanensis* the variability of leaf morphology is high, whereas the flowers are quite uniform. The general scheme of the leaf lamina is as a rule the same in all specimens. The laminae are 3-sected, sometimes the incisions in the lateral segments are so deep that the leaf may be considered as 5-sected. The segments may be 3-lobed, but they never are divided into narrow lobes. Variable are the width and shape of the leaf segments. Typical specimens of *T. yunnanensis* ssp. *yunnanensis* have rhomboidal or rhomboidal-oval segments. In the typical *T. yunnanensis* ssp. *anemonifolius* the segments are broadly oval or roundish in outline. Between these extreme forms there is a number of intermediate ones. Both Ulbrich and Schipchinsky did not distinguish these extreme forms as separate taxons. On the other hand, Brühl (1896) described them as different taxons of lower rank, and Stapf (1928) considered them as two related species. In the present work they are treated as subspecies within the limits of the wide variability of *T. yunnanensis*.

Some specimens of *T. buddae* Schipcz. are considered synonyms of *T. yunnanensis* ssp. *yunnanensis* (for further details see the discussion of this section).

The flowers of *T. yunnanensis* ssp. *yunnanensis* and ssp. *anemonifolius* show no differences and have the same honey leaves characteristic for this species.

Trollius yunnanensis (Franch.) Ulbr. ssp. *yunnanensis* f. *ubra* Stapf

Stapf, Bot. Mag. (London) 152 (1928); Handel-Mazzetti, Symb. sin. 7: 266 - 269 (1931 - 1933).

Type: G. Forrest, 4227 (1910), Yunnan, Eastern flank Lichiang range, lat. 27°35' (K).

As reported by Stapf (1928) this form has, instead of five, as many as nine perianth leaves or more. Leaves intermediate in shape between the perianth (sepala) and honey leaves (nectaria) may occur in the perianth.

From among the specimens inspected some flowers had as many as 30 perianth leaves and looked double. They were determined as *T. patulus* Salisb. fl. pleno (e.g. col. Forrest 15242 (1917), 12909 (1914), E). Intermediate leaves between the perianth and honey leaves were found in the specimen from J. F. Rock's collection 5302 (1922) (E).

Distribution: South-West China (provinces Yunnan and North-West Szechwan). As reported by Handel-Mazzetti (1931 - 1933), this form grows in North-West Yunnan on wet meadows and in light coniferous and mixed forests at a height of 2 950 - 3 100 m a.s.l.

Herbarium specimens examined: J. F. Rock: 5304 (1922) Yunnan, S. W. Szechuan. Between Likiang-Younging and Youngpel (E, W). — P. Morbeiz: (1907), NW Yunnan (K). — G. Forrest: 4227, 6111 (1910), Easter Flank Lichiang Range, lat. 27°35', 27°33' (K); 15242 (1917), Yunnan (BM, E); 12909 (1914), Yunnan, Kari Pass — Mekong kat. 27°40' (E); Yunnan, Lichiang Range lat. 27°45' (E); 6227, Likiang Range, lat. 27°35' (BM).

Trollius yunnanensis (Franch.) Ulbr. ssp. *yunnanensis*
f. *eupetala* Stapf

Stapf, Bot. Mag. (London) 152 (1928); Handel-Mazzetti, Symb. sin. 7, 1: 266 - 269 (1931 - 1933).

Type: T. Monbeig (1905), Yunnan, Tsekou (K).

Honey leaves 13 - 17 mm long, 1 - 2 mm wide, narrow, almost linear, with slight widening in upper part, Nectary pit at a height of 2 - 4 mm (Fig. 3 d - f). Flowers mostly large, 7.0 - 8.5 cm in diameter. Other characters do not differ from those of *T. yunnanensis* ssp. *yunnanensis* f. *yunnanensis*.

Stapf (1928) describes the form *eupetala* as a mutant differing from *T. yunnanensis* by very long honey leaves, much longer than the stamina so that they change the appearance of the flowers.

Distribution: China, province Yunnan.

Herbarium specimens examined: G. Forrest: 281 (1904), Jangtze-Mekong, Cari Pasa 28° alt. 1200' (E). — J. T. Monbeig: (1907), N. W. Yunnan (E). — J. F. Rock: 23146 (1932), Yunnan, South Tibet, Tsarung Border, Western Range of Mekong on Kaakerpo, Dokerla and Tsarung alt. 13000' (E). — J. F. Rock: 4766 (1922) — Yangtze watershed, Prefectural Distr. of Likiang, eastern slopes of Likiang Snow Range (W). — T. T. Yü: 22141, 22472, 23183 (1938), Yunnan, Mekong-Salwin Divide, Sila, alt. 3800 m (E). — H(2254)61 Cult. in Hort. Bot. Reg. Kew in 1961 (K).

Trollius yunnanensis (Franch.) Ulbr.
ssp. *anemonifolius* (Brühl) comb. nov.

Syn.: *T. pumilus* Don. ssp. *anemonifolius* Brühl, Ann. Roy. Bot. Gard. Calc. 5: 87 - 88 (1896), (basonym); *T. anemonifolius* (Brühl) Stapf, Bot. Mag. (London) 152 (1928); *T. yunnanensis* (Franch.) Ulbr., Fedde Rep. sp. nov. Beih., 12: 368 (1922) p.p.; *T. yunnanensis* Schipcz., Not. syst. Herb. Horti. Bot. Petrop. 4 ed 2: 9 - 10 (1923); Bull. Jard. Bot. Rep. Russe 23: 66 (1924), p.p.

lc.: Brühl, Ann. Roy. Bot. Gard. Calc. 5: Pl. 113, fig. 2 k (1896); Stapf, Bot. Mag. (London) 152: tab. 9143 (1928).

Type: A. E. Pratt 676 (1890), Tachienlau, alt. 9000 - 13500 ft., (K; E syn.).

General habitus the same as in ssp. *yunnanensis*, but plants larger, more vigorous with more numerous and larger leaves. Height up to 80 cm. Laminae more or less round in outline. Like in ssp. *yunnanensis* they are 3-sected, but their segments are roundish-oval and may be so wide as to overlap; leaf margins dentate or sinuous; diameter of basal leaf lamina reaches 12 cm or even more. Cauline leaves similar to basal ones. Sometimes, however, specimens are found in which the laminae have narrower not overlapping segments (Brühl, 1896, Pl. 113, fig. 2 k). Specimens also occur with leaves of intermediate form between those of ssp. *yunnanensis* and ssp. *anemonifolius*.

The flowers of ssp. *anemonifolius* are the same as in ssp. *yunnanensis*, but as a rule larger, up to 7 cm in diameter. The perianth and honey leaves do not differ from the same organs in ssp. *yunnanensis*. Sometimes flowers may be found with a larger number of perianth leaves like in f. *ubra* Stapf. The fruits are diverse like in ssp. *yunnanensis* and may have beaks of various shapes.

Distribution: China, provinces Yunnan and Szechwan. In the mountains at alpine level (Fig. 5 p. 43).

Fig. 5. Distribution of some taxa of the section *Yunnanotrollius* according to the herbarium material

1 — *T. yunnanensis* ssp. *yunnanensis*; 2 — *T. yunnanensis* ssp. *anemonifolius*; 3 — *T. papavereus*

Herbarium specimens examined: R. Cunningham: (1924), Szechuan, Tatsienlu (E). — G. Forrest: 6111 (1910) Lichiang lat. $27^{\circ}35' N$, alt. 11000' (BM). — McLaren: 81 (1933), Yunnan, Mt. Wei-Hsi (E). — Ludlow et Sherriff: (13117), S. E. Tibet near Showa Dzong, Pome. — A. E. Pratt: 681 (1890) Tachienlu (K). — J. F. Rock: 22418, 23268, 24409, 24507 (1932), Yunnan, west of the Mekong-Selwin, Wei-hsi (E); Wuli-la east of the river Selwin, south of the Alulaka (E); 22737 Fuchuan range, west of the Mekong-Selwin divide and west of Wei-hsi (K); 23146 (1932), S. E. Tibet, Tsarung Border, western range on Kaakerpo Dokerla (K). — H. Smith: 10611 (1934), Sikang: Kangting (Tachienlu) distr. Yülingkong-Yachiagan Mis. (BM). — H. Stevens: 450 (1929), Szechwan, Baurong to Tachienlu, Via Handjoha (BM). — J. A. Soulie: 831 (1893), Tibet oriental, Ta-t sien-lou, Principauté de Kiala (LE).

Brühl (1896) who first distinguished this taxon mentions in his description Pratt's specimen 676. Ulbrich (1922) bases his description of *T. yunnanensis*, among others on the specimens of Pratt 681 and 676. Both these specimens have a leaf morphology typical for ssp. *anemonifolius*, and later the specimen 676 was established as the type specimen of *T. anemonifolius* (Brühl) Stapf. Thus, the same specimen 676 of

Pratt (1890) was first determined as *T. pumilus* ssp. *anemonifolius* Brühl, then as *T. yunnanensis* (Franch.) Ulbr. and finally as *T. anemonifolius* (Brühl) Stapf. It may be concluded there from that Ulbrich assumed a wider range of variability of the species *T. yunnanensis* and classified to it individuals with characters typical for the ssp. *anemonifolius*. Neither did Schipczinsky separate specimens with broad round laminae. In his description of *T. yunnanensis* he quotes the specimen of Saulie (831, 1893) with leaves typical for ssp. *anemonifolius*. Stapf (1928), the author of the species *T. anemonifolius* says that this form seems genetically stabilized and has a definite geographical range; it is at the same time so closely related to *T. yunnanensis* that if taxonomic definitions are applied in a wider sense, this species may be considered as *T. yunnanensis* since there is no distinct difference between them. Stapf's remarks are correct, *T. anemonifolius* is not definitely separated from *T. yunnanensis*. There exist in nature numerous individuals closely related to one of these forms (e.g. the specimen from the Herb. E. col. J. Kingston-Ward 1000').

It seems, therefore, reasonable not to treat this taxon as a separate species, but at most as a subspecies of *T. yunnanensis* with which it is linked by numerous intermediate forms.

Trollius papavereus Schipcz. emend.

Schipczinsky, Not. syst. Herb. Horti Bot. Petrop. 4 ed. 2: 10-11 (1923); Bull. Jard. Bot. Rep. Russe 23: 68 (1924).

Syn.: *T. stenopetalus* Stapf, Bot. Mag. (London) 152: (1928) p.p.; *T. buddae* Schipcz., Not. syst. Herb. Horti Bot. Petrop., 4 ed. 2. 10 (1923), p.p.

Type: Beresowsky, 18 VII 1893, China, prov. Szechwan borealis: Ta-zao-pin (LE).

Plants 20-40 cm high, at fruiting time may reach 60 cm. Shoots mostly one-flowered with 1-3 cauline leaves.

Basal leaves stalked, lamina 3-sected 3-8 cm in diameter. The leaf segments rhomboidal, broad-rhomboidal or oval, mostly 3-lobed. On lateral segment one incision may be deeper so that they are bisected. Leaf margin with wide dentation. Upper cauline leaves sessile, lower ones stalked with characteristic leaf sheath about 2 cm long. The sheath is membraneous with well visible veins and greatly distended. Cauline leaves smaller, sometimes equal to basal ones and of similar structure.

Flowers single, 3.0-4.5 cm in diameter, completely flat and open; in general smaller than in *T. yunnanensis* they rather resemble those of *T. pumilus*. Perianth leaves 5-6, broad-oval, rounded or flattened at tip, 12-20 mm long, yellow (Aureolin 3); they do not turn green when dried. Honey leaves 6-8 mm long, somewhat shorter than stamina, orange-

coloured (Saffron yellow 7), elongated with blade widened, oval in upper part; blade cushion-like thickened, glittering 1.0 - 1.5 mm wide; nectary pit at a height of 1.0 - 2.0 mm, round, somewhat distended. In general the character of the honey leaves of *T. papavereus* are intermediate between *T. yunnanensis* and *T. pumilus*; they have not so distinct trough characteristic for *T. yunnanensis* (Fig. 3 a, b). Follicles numerous, 20 - 60 in head, 8.0 - 12.5 mm long together with beak, beak length 2.0 - 2.5 mm. The beak massive, straight, at base slightly bent outwards. Shape and size of the follicles similar as in *T. yunnanensis* (Fig. 3 h, i). In one of the bred specimens (H/160) the follicles were exceptionally numerous and lay on the somewhat elongated receptaculum giving the head a special shape (Fig. 4 b). Fruits of this type have not been found among the herbarium specimens of *T. papavereus* or in other *Trollius* species. The material concerning *T. papavereus*, however, was very scarce and mostly without fruits. If it would be found that such heads as in the specimen H/160, appear in mature this would be a trait characteristic for this taxon. $2n=16$.

Distribution: China, provinces Yunnan and Szechwan; North-East Burma near border of Yunnan. In mountains at a height of 3 000 - 4 000 m a.s.l. (Fig. 5 p. 43).

Specimens examined:

Cultivated: H/160 bred from seeds obtained from the Botanical Garden at Rostock.

Herbarium specimens: H. Smith: 3523 (1922), prov. Sche-chuan, bor: San-cha-trii (BM). — Auct. ign. Field. 6918, 6979, Frontier Tibet and Burma, Senighu Wang, lat. $28^{\circ}8' - 97^{\circ}24' E$ (K). — J. F. Rock: 18088 (1929) South western Szechwan, China, Mts of Kulu alt. 4000 (BM); 16476 (1928), SW Schechuan, Mt of Kulu, east of Muli Gomba (E). — G. Forrest: 2342, lat. $27^{\circ}15'$, alt. 10 - 11000 ft (E); 28768, 30643 (1931) (E). — McLaren: 39, 64 (1934), Yunnan: Yung Ning (E).

In the description of *T. papavereus*, Schipczinsky (1923) mentions that the species is intermediate between *T. buddae* and *T. yunnanensis*. Actually specimens of *T. papavereus* represent traits of two different species, *T. pumilus* and *T. yunnanensis*. As a rule the flowers of *T. papavereus* resemble rather those of *T. pumilus*, and the leaves — those of *T. yunnanensis*. Some specimens, e.g. H/160 have flowers identical to those of *T. pumilus*, others, (e.g. col. McLaren 39, 64) have flowers closer related to *T. yunnanensis*.

The leaves are generally of the type of *T. yunnanensis*, their segments may be narrower or rhomboidal or somewhat broader, oval and rounded, resembling those of ssp. *anemonifolius*.

Although *T. papavereus* is as regards its morphology not uniform, the present writer have decided to leave this taxon in the rank of species; it constitutes a plant group connecting two different sections, and is pro-

bably an important phylogenetic link. *T. papavereus* has been classified to the section *Yunnanotrollius*, because it is closer related with *T. yunnanensis*.

The description of *T. papavereus* given here is much more extensive as compared with that of Schipczinsky (1923). The latter author based his report on scarce material and could not take into account the variability of this taxon. In the Herbarium of Leningrad the present author found only one specimen, the name of which had been changed by Schipczinsky from *T. patulus* to *T. papavereus*. It was the only specimen of Beresowsky which he quoted. The plant is exceptionally small with one cauline leaf and it has been so described by Schipchinsky. A typical representative of *T. papavereus* is the herbarium specimen of H. Smith 3524 (1922). According to the Schipczinsky's view (1923, 1924) accepted in the present paper. *T. papavereus* is an intermediate species between *T. pumilus* and *T. yunnanensis*. Part of the specimens of *T. stenopetalus* Stapf corresponding morphologically to those of *T. papavereus* have classified to this species. *T. stenopetalus* Stapf has, namely, small yellow flowers with honey leaves narrower than in *T. yunnanensis*, and they closely resemble those of *T. papavereus* (Fig. 3 b, c). Stearn (1941) called attention to the fact that when Stapf (1928) published his key to the *Trollius* species, he did not yet know the work of Schipczinsky (1923), therefore *T. stenopetalus* Stapf is probably a synonym of *T. buddae* Schipcz. This is quite true: Schipczinsky in his description of *T. buddae* quotes the herbarium sheet (Farges 1265, 1893) which is the type specimen of *T. stenopetalus*. It results therefrom that both Stapf and Schipczinsky had in mind the same taxon. In view of this, in the present work a part of the specimens of *T. buddae* are considered as synonymous to *T. papavereus* and classified to this species.

Trollius citrinus Miyabe

Miyabe, Acta Phyt. Geobot. 13: 15 - 16, Fig. 3 (1943); Ohwi, Flora of Japan, p. 459 (1965).

Type: Is. Hokkaido, prov. Hidaka, 1852 m; Herb. Hokkaido Imp. Univ.; n. v.

Description after Miyabe (1943): "*Herba perennis, florens ca. 50 cm. alta, caule vulgo ramoso basi vaginis latis membranaceis obtecto. Folia radicalia 3 - 4, longe petiolata, laminis 7 cm. longis 15 cm. latis ambitu reniformibus palmato-trisectis, foliolis mediis rhomboideo-ovatis breve petiolatis trifidis 7 cm. longis 5 cm. latis, lobis laciniatoserratis, foliolis lateralibus profunde bipartitis, partitionibus foliolo medio subconformibus. Folia caulina 3, radicalibus conformia, sed paulo minora atque inferiora breve petiolata, petiolis 5 cm. longa, superiora subsessilia basi vaginata.*"

Flores 5 - 6 cm. in diam. laete citrini; sepalis 5 patentibus, obovato-rotundatis, subrotundatis, obovato-ellipticus vel oblongo-ellipticis, apice subdenticulatis; petalis 10 - 13 mm. longis luteis versus apicem aurantiacis, lineari-spathulatis obtusis vel subacutis apice recurvatis margine reflexis itaque navicellatis, apud nectarostigma saccatis et angulis 130° - 150° inflexis; antheris 4,5 mm. longis; stylis rectis vel paulo recurvis sub anthesi 2 - 2,5 mm. longis. (Fig. 3 j k).

Hab. Hokkaido. Prov. Hidaka: on the shoulder of 1852 m. peak, situated about 4 km. south of Mt. Esaoman-tottabetsu (Y. Tochinal & B. Ishida, VIII, 2, 1934 — the type in the Herb. Hokkaido Imp. Univ.); the plant transplanted in the Botanic Garden, Hokk. Imp. Univ., Sapporo (K. Miyabe, VI, 9, 1943, VII, 12, 1943) Distrib. Endemic".

Distribution: Japanese endemite, the Hokkaido Island, province Hidaka in mountains at height of 1852 m a.s.l.

As reported by Miyabe, the most characteristic characters of this species are the light lemon-yellow flowers, and the spatulate honey leaves bent outwards to form a trough running to the nectary pit which is round, distended, with unguis bent back. Honey leaves of this form, typical for *T. citrinus* Miyabe (Fig. 3 j, k), are not found in any Japanese *Trollius* species. On the other hand, they have a distinct resemblance to the honey leaves of *T. yunnanensis* which also have a trough running to the nectary pit, a distended pit, and bent leaf unguis. On the basis of the data of Miyabe (1943), *T. citrinus* has been included by the present author to the section *Yunnanotrollius*. She have, however, not seen the specimens of *T. citrinus* and the structure of the honey leaves can only be established precisely on living material.

Ohwi (1965) says that *T. citrinus* may be only a variety of *T. riederianus* var. *japonicus* with which it occurs together; the matter requires further study. On Miyabe's drawings the honey leaves of *T. riederianus* and *T. japonicus* are very similar and quite different from those of *T. citrinus* (Miyabe, 1943, Fig. 1 F, 2 A, Fig. 3 A, B).

Discussion of section *Yunnanotrollius*

To the section *Yunnanotrollius* belong taxons occupying relatively small areas in the mountains of South-West China, mainly in the provinces Yunnan, Szechwan and neighbouring areas (Fig. 18). Only *T. citrinus* Miyabe is a Japanese endemite and grows on the Hokkaido Island.

When including *T. citrinus* into the section *Yunnanotrollius*, the present author based her decision on the drawings of the honey leaves given by Miyabe (1943, Fig. 3 J, K). Honey leaves of this type are not found in any other *Trollius* species, they resemble solely those of *T. yunnanensis*. These data have to be verified on living material which was not available.

The type species of the section is *T. yunnanensis* (Franch.) Ulbr. This species has flowers with a small number of perianth leaves and characteristic honey leaves not found in the representatives of other sections. The vegetative leaves of *T. yunnanensis* exhibit a high variability, but their segments are never incised or divided into narrow lobes as in many other species of *Trollius*. Basing mainly on the differences in the structure of the leaves, Stapf (1928) distinguished the new species *T. anemonifolius*. In the present paper the rank of this taxon has been lowered to subspecies, since it linked by numerous intermediate forms with *T. yunnanensis*. It probably is a taxon which is in the course of differentiation.

Of the two forms of *T. yunnanensis* ssp. *yunnanensis* reported, f. *ubra* is an example of spontaneous arising in nature of flowers with an increased number of elements known as double flowers; the form *eupetala*, on the other hand differs completely from the remaining representatives of the section *Yunnanotrollius* by the length and shape of its honey leaves. This type of honey leaves never occurs in any other taxons of *Trollius*, they may, however, be found in some hybrids. The hybrids F_1 of *T. pumilus* or *T. yunnanensis* with species having flat long, linear honey leaves like those found in the section *Longipetala* (e.g. *T. chinensis*, *T. asiaticus*, *T. ledebouri*) have honey leaves of the type of those of the form *eupetala*. The sterile hybrids F_1 of *T. chinensis* $\times$ *T. yunnanensis* obtained by the author (Doroszewska, 1970) had flowers quite similar to those of the form *eupetala*. It is possible that f. *eupetala* is of hybrid origin. The length of the honey leaves in these plants varies widely, even within one and the same flower. This kind of variation is characteristic for some interspecific hybrids of *Trollius* (unpublished observations of the author).

Further changes concern the species *T. stenopetalus* Stapf and *T. buddae* Schipcz. The descriptions of these two species are very similar and probably pertain to the same taxon. The species *T. buddae* Schipcz. raised many doubts. Schipczinsky himself (1923) mentioned that *T. buddae* is closely related to *T. yunnanensis*, only less vigorous. In his description of *T. yunnanensis* Schipcz. he quotes among others herbarium specimens, the morphological structure of which is typical for *T. yunnanensis* ssp. *anemonifolius*. Since ssp. *anemonifolius* is much more vigorous than ssp. *yunnanensis*, it would seem that the specimens of *T. buddae* correspond in general to the morphology of *T. yunnanensis* ssp. *yunnanensis*. Handel-Mazzetti (1931-1933) enumerating the specimens of *T. buddae* Schipcz. from Kansu writes that the habitus of these plants resembles that of *T. pumilus*, and that it also corresponds to *T. buddae* Schipcz. Thus this author was not sure with what taxon he was dealing.

According to the description of Schipczinsky (1923) *T. buddae*

differs from *T. yunnanensis* by the following characters: the cauline leaves much larger than the basal ones, honey leaves linear and somewhat longer (12 mm); in drying the plants, and particularly the flowers, of *T. buddae* do not turn green in contrast to *T. yunnanensis*. Beaks on the follicles of *T. buddae* are straight and bent at the base outwards — in *T. yunnanensis* quite straight. The shoots of *T. buddae* do not elongate in the course of flowering. The last three characters reported by Schipczinsky cannot be considered as distinguishing features. In all *Trollius* species the flower stalks in the period of flowering and fruiting grow and elongate considerably; it is doubtful whether the plants of *T. buddae* would be an exception. In herbaria numerous typical specimens of *T. yunnanensis* may be found which turned green after drying, as well as such which did not. Follicles with straight beaks bent at base are typical for *T. yunnanensis* (Fig. 4 a), they are found much more frequently than those with quite straight beaks (Fig. 3 g, h). Narrower honey leaves and smaller flowers are typical not only for *T. buddae*, but for *T. stenopetalus* Stapf which differs mainly by these characters from *T. yunnanensis*. Such specimens have been classified in the present paper to *T. papavereus*.

In some specimens of *T. yunnanensis* the laminae of the cauline leaves may actually be larger than those of the basal ones, but this feature is not always distinct. Moreover, specimens with larger cauline leaves have mostly honey leaves the same as *T. yunnanensis* in disagreement with the description of *T. buddae*. From observations and analysis of the herbarium material it results that there are no grounds to treat *T. buddae* as a separate species, the morphological characters of this group of plants are too variable and unstabilized. It would seem better to adapt taxonomical units with a wider range of variability than to preserve the classification of insufficiently differentiated species. Therefore, certain specimens of *T. buddae* and *T. stenopetalus* have been classified here *T. yunnanensis* ssp. *yunnanensis*, and others to *T. papavereus*.

The latter species combines characters of *T. yunnanensis* and *T. pumilus*. The range of *T. pumilus* is partially sympatric with that of *T. yunnanensis*. Both species grow at more or less the same height in the mountains of South-West China, and their crossing is quite possible in natural conditions. As demonstrated in the author's experiments (Doroszewska, 1970), F_1 hybrids of *T. pumilus* $\times$ *T. yunnanensis* are partially fertile and an F_2 generation can be obtained. Some herbarium specimens greatly resemble these artificially obtained hybrids (e.g. in the Ludlow and Sherriff collection 12539, 13117, 13826, 15215, BM), and they probably originate from natural crosses. Notwithstanding these probable hybrids, there occur in the Yunnan Mts. plants with characters of both *T. pumilus* and *T. yunnanensis* which do not resemble the hybrids of these species. Such an example is *T. papavereus* Schipcz. It

would seem that this species does not originate from a cross, but has survived on this territory since the differentiation of the primary *Trollius* populations. The morphological structure of *T. papavereus* would, thus, be primary and not secondary as compared with that of *T. pumilus* and *T. yunnanensis*.

In general the entire section *Yunnanotrollius* is rather variable. It includes only few distinct taxons and numerous specimens the classification of which is difficult, although they no doubt belong to this section. A more precise elaboration of the section *Yunnanotrollius* on the basis of natural populations may still bring many a surprise and demonstrate that the approach of the present author was not correct in many cases. Such investigations would be interesting since the group *T. yunnanensis* belongs doubtlessly to the primary representatives of the genus *Trollius*, and the Yunnan Mts. are one of the foci where new taxons arise.

SECTION: *ACAULITROLLIUS* sect. nov.

Syn.: sect. *Eutrollius* Prantl p.p. and sect. *Hegemone* Bunge, in Engler u. Prantl, *Naturl. Pflanzenf.* III, 2: 56 (1891).

Small alpine plants reaching at time of flowering 25 cm in height; shoots unbranched with single flower, cauline leaves 1-3. They generally flower before the development of basal leaves. Leaf sheaths well developed up to 4 cm long, lamina finely dissected. First basal leaves frequently have laminae directly on leaf sheaths, and only the next ones are stalked. Flowers yellow, white or light lilac. Perianth leaves eight or more, exceptionally less to five; these leaves generally persist and dry up on the shoot. Honey leaves thickened 4-8 mm long with nectary pit in the shape of a shallow pocket.

To this section are classified: *T. acaulis* Lindl., *T. lilacinus* Bge and *T. afghanicus* Hedge et Wandelbo.

Section type: *T. acaulis* Lindl.

The section *Acaulitrollius* was established on the basis of quite different morphological characters than those of the section *Hegemone* Bunge; its type species is *T. acaulis*. With the name of the section *Hegemone* are connected definite characters so the preservation of the old name for the newly established section would cause confusion (see details in the discussion of *T. lilacinus*).

Key

1. Flowers yellow, follicle beaks 6-8 mm long	<i>T. acaulis</i>
1. Flowers of other colours, beaks up to 3 mm long	2

2. Flowers white, honey leaves 3.5 - 5.5 mm long (Fig. 6 s)

T. afghanicus

2. Flowers light lilac or light grey, honey leaves 5 - 7 mm long
(Fig. 6 b, c, Pl. VII)

T. lilacinus

Trollius acaulis Lindl.

Lindley, Edward. Bot. Reg. 56 (1842); Hooker et Thomson, Fl. Indica 1: 41 (1855); J. D. Hooker, Fl. Brit. India 1: 22 (1872); Huth, Helios 9, 1: 6 (1892); Schipczinsky, Bull. Jard. Bot. Rep. Russe, 23: 64 (1924); Mukerjee, Bull. Bot. Surv. India, 2: 106 (1960).

Syn.: *T. pumilus* Royle (non Don) Illustr. Bot. Himal. Fl. Cashmere 1, 49 (1839).

lc.: Brühl, Ann. Roy. Bot. Gard. Calc., 5 Pl. 113, fig. 5 d (1896); Finet et Gagnepain, Bull. Soc. Bot. France 51, 4: Pl. IV, 2 (1904); Bhandari and Kapil, Beitr. Biol. Pflanzen, 40: 115, Fig. 1 (1964).

Type: n. v.

Plants at first low, at the period of flowering 6 - 25 cm high; later shoot elongates up to 40 cm and more. The shoot is surrounded at base by a dense bunch of remains from previous year's leaves and by sheaths. Shoots with single flowers at tip and 1 - 3 cauline leaves sessile or almost sessile; these leaves with large, wide sheaths 1 - 3 cm long surrounding the shoot. The sheaths of the upper leaves sometimes with rounded ears. The flowers and the cauline leaves develop before the basal leaves, therefore in the period of flowering the shoot of *T. acaulis* is surrounded at its base by leaf sheaths up to a 5 cm long, (Pl. VI).

In later vegetation periods basal leaves also develop, the shoot elongates and the whole plant grows vigorously. Basal leaves with sheaths 3 - 4 cm long, membraneous and distinctly veined. Leaf laminae 3- and 5-sected, 3 - 5 cm in diameter; their segments oval-rhomboidal, deeper or less dissected into narrow lobes, with rather sharp tips or rounded.

Flowers open stellate, 3.5 - 5.0 cm in diameter. Perianth leaves generally 8 (5 - 9), yellow, leaf blades ovally elongated or rhomboidal and relatively narrow, 17 - 27 mm long, generally 10 (7 - 16) mm wide (Fig. 6 o). After blooming season they are not always shed and may dry up on shoot. Honey leaves 12 - 16, 6 - 8 mm long, orange-coloured. Shape of leaves rather varied: oval, more or less linear, sometimes spatulate, rounded at tip. Lobe thickened and somewhat convex. Some honey leaves with a slight constriction are pear-shaped (Fig. 6 e - j). Even in the same flower honey leaves of different shapes may be found. Nectary pit a height of 1.0 mm, in the shape of a shallow pocket. Stamina ca. 9 mm long, including 4 mm anthers, elongated, yellow. In flower 10 - 16 pistils; styles and stigmata 5 - 7 mm long, straight, at tip curved hook-like outwards. In some specimens a narrow membraneous wing is visible

along style down to ovary. Mature follicles 16 - 25 mm long including 6 - 8 mm beaks. The latter are strong, straight or bent outwards or inwards; split at tip characteristically (Fig. 6 n) they give dried specimens the impression of a hook. According to the bending back of the beaks, the fruit heads have different shapes (Fig. 6 p, r). $2n = 16$.

Remark: in the Kew Herbarium collection the present author found one exceptionally large specimen (Punjab, Himalaya, Herb. of the East India Co. No. 52). The height of the fructifying plant was 70 cm, the shoots were very thick and the follicles reached 25 mm in length, whereas the beaks were 7 - 8 mm long as in other plants. Since no more such large plants were found, this specimen has been treated as an exception, and its dimensions are not taken into account in the description of *T. acaulis*.

Distribution: The centre of the range of this plant lies in the mountains of Kashmir. In North India *T. acaulis* is also found in the western part of the Himalayas reaching eastwards of the Kumaon and Garhwal regions. The western border of its range runs in the mountains of North Pakistan, in the basin of the Indus river (Fig. 7). *T. acaulis* is an alpine plant found at heights above 3 000 m a.s.l.; it occurs on alpine meadows and mossfields reaching to the patches of melting snow.

Herbarium specimens examined: N. L. Bor: Flora of Lahul, (29.5.1941), loc. Dlanale, alt. 11700' (E); Flora of Lahul, (11.6.1941), Rangoha Gab. 14500' (E). — C. B. Clarke: (20.7.1876), Kashmir — Tragboll 10400' (K). — J. R. Drummond: (1888), distr. Kulu (BM); (1902), Mahagansu Pass 13000' (BM). — C. B. Clarke: Kashmir, Trajtal, 29305 (BM). — J. F. Duthie: (3.7.1883), N. W. India, Damdar Valley 13 - 14000' (E); (1895), Kashmir, Kajrag range, alt. 11 - 13000' (E); (1892), 11325 (BM); (1896), N. W. Himalaya, Flora od Bashahar, Kampingra (K); (1896), India, Punjab (K); W. Himalaya, Nila Kagan — Barri Kagan, (K); W. Himalaya, Sarul Kagan — Huzara Kagan (K); (1892), Kashmir above Gulmark (LE). — Herb. East India Company: 52, Distr. at the Royal Gardens Kew (1864), Himalaya, Punjab (K). — Herb. Hook.: (1871), N. W. India, Kisletwar, alt. 13000' (E). — K. C. Jain et R. C. Bharadwaja: (18.6.1950), India, Kulu Valley, Pulga (W). — J. H. Lace: f. 1577, N. W. Himalayas, alt. 12000', Flora of Chamba State (E); f. 955 (1891), Bacher State, Kumpingra 11000 - 13000' (E). — F. Ludlow: 45 (1939), Flora of Kashmir, Montes Nullah, Bringhi Valley (BM). — F. Ludlow et G. Sherrieff: 8130 (1940), Kashmir, loc. Mohanmarg, Sind Valley, alt. 10000' (BM, E); 9144 (1943), Kashmir, Bamaj Nullah, Keshtwar (BM); 1464 (25.7.35), Barai Valley, Keshmgava (E); 7403 (6.7.1939), Flora of India, Punjab, Simla Hill States, Dhaola Dhar Range, Rupia Pass (E). — D. McVean: (1960), Flora of N. W. Pakistan, Kaghan Hazara, alt. 11000' (E). — E. Parkinson: (16.7.1934), loc. Kutu, Punjab, Parbatti Valley above Swajni, alt. 12500' (E). — T. A. Rao: (26.6.1959), Flora of Kashmir 9717, Pissu Chati-seslinag, alt. 4000 m (WA). — Ch. Shankat: 45 (1954), Plants of Kagan, Valley-Hazara distr. (BM). — G. Sherrieff: (1939), India, Punjab, Simla Hill States, Dhaola Dhar Range, Rupin Pass, $31^{\circ}22' - 78^{\circ}09'$ (BM). — R. R. Steward et E. Nasir: (1952), Plants of Poonch, Arad Kashmir (BM). — R. Strachey et J. E. Winterbottom: Pindurea, Himalaya, alt. 12500' (LE). — major S. M. Toppin: 751 (1918), ex Chitral, Bromalu, alt. 12500' (K).

Fig. 6. Some flower elements and fruits of the section *Acaulitrollius* (perianth leaves and follicles in heads life-size; honey leaves, stamina and single follicles $2 \times$ life-size)

T. lilacinus: a, b — Chinense Turkestan, Tian-Shan, leg. Ludlow, 691 (E); c — Turkestan, Trans-Ilian Ala-tau, leg. Sokalsky, 339, (BM); d — Alatau, leg. Karelin et Kriloff, 1160 (BM)

T. acaulis: e — N. W. Himalaya, Chomba State, leg. Lace, f. 1577 (E); f — Bacher State, Kumpigra, leg. Lace, f. 955 (E); g — Kutu, Punjab, leg. Parkinson (1934) (E); h — Keshmagava, leg. Ludlow et Sherriff, 1464 (E); i — India, Punjab, Simila Hill State, leg. Ludlow et Sherriff, 7403 (E); j — Kashmir, Mohanmarg, 8130 (BM); k — Bacher State, Kumpigra, leg. Lace, f. 955 (E); l — Kashmir, Trajtal, leg. Clarke (BM); m — N. W. India, Kislawater, Herb. Hook., (E); n — *ibid.*, top of follicle beak; o — Beacher State, Kumpigra, leg. Lace, f. 955 (E); p — leg. Duthie, 11325 (BM); r — Kashmir, Trajtal, leg. Clarke, (BM)

T. afghanicus: s, t — Afghanistan, prov. Parvan, leg. Hedge et Wandelbo (E)

The first information on this species is reported by Royle (1839) who says that in the Kashmir specimens of *T. pumilus* may be found resembling in appearance *T. patulus*. It was neither the one or the other, but a separate species described as late as 1842 by Lindley under the name *T. acaulis*. More details concerning this species are given by Hooker and Thomson (1855), Hooker (1872), Finet and Gagnepain (1904) and Schipczinsky (1924).

T. acaulis is a distinctly differentiated species. No intermediate forms between it and other *Trollius* species have been detected. Its most characteristic features are: the general habitus of the plant which comes into flower before forming basal leaves, the presence of long membranous leaf sheaths, the flower in the shape of a star, and follicles with exceptionally long beaks (7-8 mm) split at the end, and a rather varied morphology of the honey leaves.

The characteristic shape of the *T. acaulis* flower is due to the perianth leaves relatively narrow and flat which hardly overlap and lie in one plane. Beaks as long as on the follicles of *T. acaulis* are not found in any other *Trollius* species. Schipczinsky (1924) mentions that the beaks in *T. acaulis* are only 4.5 mm long. Probably on the herbarium specimens inspected by him they must have been broken. Otherwise he would certainly have noticed the characteristic splitting well visible at the end of the beaks. On the material inspected by the present author in spite of the wide differences in the length of the follicles (16-25 mm), the beak length was constant amounting to 7-8 mm (Fig. 6 k-m). Hooker (1872) mentions in his description that the style in *T. acaulis* is winged. In some flowers actually membranous narrow wings may be noted running down the style to the ovary. This character, however, is difficult to observe on herbarium material.

The geographical range of *T. acaulis* extends in the mountains of Kashmir where no other *Trollius* species occurs. The nearest neighbouring species are: in the west — *T. afghanicus* known from the mountains of North Afghanistan, in the north — *T. lilacinus* in the Pamirs, and *T. pumilus* in the Western Himalayas in the east. *T. pumilus* like other species of the section *Pumilotrollius* differs distinctly from *T. acaulis* and shows no relationships. *T. afghanicus* and *T. lilacinus* belong to the same section as *T. acaulis* and exhibit a number of common features characteristic for the section *Acaulitrollius*. Morphologically *T. lilacinus* is most closely related to *T. acaulis*. These two species have similar honey leaves, pistils with winged styles, the latter feature being more pronounced in *T. lilacinus*; perianth leaves rhomboidal in shape and a similar general habitus at the time of flowering when the basal leaves are not yet developed. The close relationship of these two species is beyond doubt. Brühl as early as 1896 wrote that the resemblance

between *T. lilacinus* and the typical specimens of *T. acaulis* is noteworthy.

A certain resemblance to *T. acaulis* may also be found in specimens of *T. ranunculinus* (Smith) Stearn. This species occurring in the Caucasus Mts. is rather variable. In plants from the province Van in East Turkey follicles with a long split beak similar to those of *T. acaulis* have been found (Fig. 12 a - c). Also the honey leaves of *T. ranunculinus* are in some specimens similar to those of *T. acaulis* (Fig. 11 k), although as a rule in *T. ranunculinus* they are more elongated and linear (Fig. 11 j, l). Some specimens of *T. ranunculinus* flower like *T. acaulis* before the development of basal leaves. These common characters indicate certain phylogenetic connections between these two species.

A certain similarity to *T. acaulis* may also be found in *T. dschungaricus* and *T. altaicus* as regards the honey leaves. The geographical distribution of these species also indicates some connections of these species with the section *Acaulitrollius*, although they greatly differ by their general habitus and other morphological features. Finally, certain common characters link *T. acaulis* with the American species *T. laxus*. Brühl (1896) mentions that in some American forms of *T. laxus* the honey leaves are similar as in *T. acaulis*, and he considers that these species are related with one another by a number of intermediate forms. Actually, the morphology of the honey leaves in *T. laxus* is highly variable, and some of them have shapes similar to those in *T. acaulis* (Fig. 16 c).

Trollius lilacinus Bge

Bunge, Verz. Pfl. Alt. 33 (1835); Maximowicz, Enum. Plant. Mong. 24 - 25 (1889); Huth, Helios 9, 1: 6 (1892); Finet et Gagnepain, Bull. Soc. Bot. France 51: 394 (1904); Schipczinsky, Bull. Jard. Bot. Rep. Russe 23: 64 (1924); Krylov, Fl. Sib. Occiden. 5: 1123 - 1124 (1931); Malyshev, Fl. alpsajan. 124 (1965); Illjust. opred. rast. Kazakhst. 1: 365 - 367 (1969).

Syn.: *T. lilacinus* Bge var. *micrantha* Winkl. et Kom. ex Schipczinsky (1924); *Hegemone lilacina* Bge ex Ledebour, Fl. Ross. 1 (1842); Krylov, Fl. Alt. 34 (1901); Fl. SSSR, VII: 53 - 54 (1937); Fl. Kazakhst. IV: 15 - 16 (1961); Volodina in Introd. dekorativ. rast. Sibiri 45 - 48 (1968); *T. micrantha* (Winkl. et Kom.) A. But., Fl. Uzbek. 2: 439 (1953); Fl. Kazakhst. IV: 16 (1961).

lc.: Brühl, Ann. Roy. Bot. Gard. Calc. 5, Pl. 113, fig. 8i, 9f (1896); Finet et Gagnepain, Bull. Soc. Bot. France 51, 4, Pl. IV, 1 (1904); Fl. Kazakhst. IV, Tab. II 8 (1961); Illjust. opred. rast. Kazakhst. 1, Tab. 62, Fig. 3 (1969); Volodina, Introd. dekorativ. rast. Sibiri, 47, (1968).

Type: Altay, in Leningrad (acc. to Fl. SSSR, 7: 54, 1937), n. v.

Shoot height at the time of flowering usually 5 - 25 cm, at the period fruiting up to 30 - 40 cm. Flower stalks single with one flower at tip, surrounded at base by remains of previous year leaves and leaf sheaths.

Cauline leaves 2-3, upper ones sessile with widening leaf sheath embracing stem, frequently forming ears. Flower stems develop mostly before the basal leaves. At this stage the general habitus of *T. lilacinus* is very similar to that of *T. acaulis*. Later basal leaves develop and after flowering the plant grows vigorously. Basal leaves with wide sheaths up to 4 cm long; the sheaths are distinctly veined. Laminae 2-5 cm in diameter 3- or 5-sected, their segments broad-oval and may overlap; these segments are three-lobed and dissected into narrow lobes, rounded at apex or broadly pointed.

Flowers open, 2-4.5 cm in diameter, light lilac-coloured. Perianth leaves mostly 15-20 (3-30), light lilac, after drying light grey, whitish; sometimes these leaves are injected with red. Length of perianth leaves 12-22 mm, width variable; outermost leaves widest, gradually narrower towards centre; oval or rhomboidal in shape (Fig. 6 a), flat; after flowering they are not shed but dry up on the shoot.

Honey leaves yellow-greenish about 10-15 in number, 5-7 mm long with three branching veins on blade; leaf shape varies: the apex may be rounded or sharper, the blade oval spatulate or with a slight constriction (Fig. 6 b, c). Nectary pit at base of blade at a height of 0.5-1.0 mm from base in the shape of a shallow pocket. Stamina somewhat longer than nectary leaves, 8-9 mm long including anthers 3 mm long. Pistils numerous, ending by a cushion-like stigma; stigma glabrous without papillae; sometimes with wings descending on both sides of style down to ovary. Ripe follicles 8-10 mm long including 2-3-mm beak; beaks strong, straight or slightly bent back at base (Fig. 6 d). Seeds black glittering, ca. 2 mm long, oval; flowers June-July.

Distribution. U.S.S.R.: Central Asia and Western Siberia; Western China (acc. to Fl. Kazakhstan 1961) and North-West Mongolia (Krylov, 1901).

The range of *T. lilacinus* extends mainly in the mountains from south-west to north-east beginning with the Pamirs through Tien-Shan, the upper basin of the Amu Darya and Syr Darya, Dschungaric Alai and Altai (Fig. 7).

It grows in the alpine zone at a height of 2 200-4 000 m a.s.l. on damp meadows, mossfields, on banks of streams, on the tundra close to melting snow; it has a short vegetation period, and starts developing in spring under snow (Volodina, 1968). It is a psychrophyte (Kumina, 1960 p. 427).

Herbarium specimens examined: V. A. Abramov: (1905), Zap. Tian-Shan, pereval Terek-Bela sistema (WA).—Bunge et Fisher: 4, 15, 16, Altaj (LE).—Karelin et Kriloff: 1160 (1841) Ala-tau ad fontes fl. Lepsa (BM).—N. Kozhevnikova, N. Trulevich: (31. 7. 1964), Vnutrennii Tian-Shan, Araelskie syrty, Dno doliny reki Arabel, okolo sneshnogo zavalu (W).—F. Michlmayr:

Fig. 7. Distribution of the species of the section *Acaulitrollius* according to the herbarium material

1 — *T. acaulis*; 2 — *T. lilacinus*; 3 — *T. afghanicus*

(Ende 7. 1967), Russland, Transalai-Gebirge, Azuktasch-Nebental, ca. 4000 m, Blüte blaulich-weiss (W). — N. M. Przewalski: (1871), Mongolia occidentalis (E, LE). — A. Richter: (1847), Songarei, Alatau (LE, PRC). — Schrenk: Flora Songarica (PR). — N. D. Sokalskii: 339 (1931) Zailinskii Ala-tai, Semirch. obl., Vernenskii okrug (KRA). — N. D. Sokalsky: 339 (1907), Flora of Turkestan, Trans-Ilian Ala-tau, obl. Semirch., Vernenskii okrug. (LE, BM). — V. D. Sokolovskii: (31. 5. 1907), Zailinskii Alatau, Semirech. obl. Varnenskii okrug (LE, E). — F. Ludlow: 691 (1930), Chinense Turkestan, Tian-Shan, Idgalong 9500' (E). — V. L. Komarov: Turkestan, Flora Savarschanica, Mura pass alt. 9000' (K).

In the herbaria of Leningrad, Kew and Edinburgh the specimens from following sites was inspected: Flora Ilinensis, fontis fl. Tekes (LE); Ala-tai, Khreb. Tierskii Kadzhi-San, ez. Issuk-kul 1 (LE); Reion Kegen, oz. Issuk-kul, 1 (LE); Mt. Kashgar (K); In Montis prope Wernoje (K); Kirgizya, bass. r-ki Sarygzas (22.7.1965)

ex Horti Inst. Bot. Acad. Sci. Armeniae (E); Khreb. Narymskii, Semirech. obl. (LE); Khreb. Aleksandriiski (Kara-tau) (LE); Zap. Ten-Shan, Alaiski Khreb. (LE); Fergana, distr. Margelan, (Frunze) (LE); Pamir N, Bor-Doba (LE); Khreb. Gissarskii (Hissar) (LE); Pamir S. Kili-kal 900' (LE).

The first description of *T. lilacinus* was published by Bunge in 1835, but the author must have had some doubts as to the apurtenance of this taxon to the genus *Trollius* since Ledebour (1842) reports it under the name "*Hegemone lilacina* Bunge in litt". As characteristic features for the genus *Hegemone* Ledebour (1842, p. 73) he enumerates: "calyx petaloides, regularis, poly (15 - 20) sepalus, persistens"; it means sepals not shed immediately after flowering. Prantl (Engler and Prantl, 1891) divided the genus *Trollius* into three sections: I. *Calathodes* Hook. f. et Thoms., II. *Eutrollius* Prantl and III. *Hegemone* Bunge. *Calathodes* Hooker f. et Thomson is at present considered by taxonomists once more as a separate genus. The section *Hegemone* included only one species — *T. lilacinus* Bge (syn. *Hegemone lilacina* Bge), and the section *Eutrollius* all the remaining species of the genus *Trollius*.

It results from the descriptions that the main features distinguishing the sections *Eutrollius* and *Hegemone* are as follows:

1. Perianth dried up after flowering and preserved in the course of fruiting (*Hegemone*) or shed (*Eutrollius*).

2. Perianth leaves lilac (*Hegemone*) or yellow, orange, exceptionally white (*Eutrollius*).

3. Stigma glabrous "eglandulosa" (*Hegemone*) or covered with papillae "glandulosa" (*Eutrollius*).

Actually the perianth leaves of *T. lilacinus* are not shed immediately after flowering, but dry up slowly and are still on the stem at the time of fruit ripening. This character is found not only in *T. lilacinus*. Brühl (1896) found persistent perianth leaves in *T. pumilus* Don. ssp. *geranifolius* Brühl and in some specimens of *T. acaulis*. According to this author, this character is of no taxonomic value, and a new genus or even species cannot be established on its basis. The present author found unshed perianth leaves also on specimens of *T. afghanicus*, *T. latus* and in species of the section *Pumilotrollius*, *Yunnanotrollius* and others. These observations confirm the statement of Brühl (1896) that this character has no taxonomic value.

Since no living specimens of *T. lilacinus* were available to the present author, she could only evaluate the colour of the flowers according to the literature (in herbaria the colour is greatly changed). The colour "lilacinus" denotes according to Stearn (1967, p. 458): "pale dull violet, mixed a little with white, but with more red in it and nearer purple than lavendulaceus which has more blue and is near violet, both being greyed and light". Flora SSSR (1937, p. 51) gives the colour of the flowers in this taxon as light lilac turning grey after flowering. Accord-

ing to T a m u r a (1966, p. 21) the colour of the perianth leaves in *Hegemone* is white or reddish ("sepals white or purplish, persistent"). Purplish means "becoming purple = purpurascens" (S t e a r n, 1967, p. 492).

It results from the above quoted literature that the flowers of *T. lilacinus* may be light lilac-coloured, light grey, whitish or with a reddish hue. A reddish colour of the perianth leaves is found in representatives of the section *Pumilotrollius*, whereas *T. afghanicus* and *T. laxus* have white flowers. Thus, *T. lilacinus* is not the only species which does not have yellow flowers typical for the genus *Trollius*. White flowering specimens of *T. laxus* have been treated by some authors as a variety (*T. laxus* Salisb. var. *albiflorus* Gray), by others as an independent species *T. albiflorus* (Gray) Rydb., in no case, however, did the rank of the established taxon exceed the rank of species. The different colour of *T. lilacinus* flowers should be treated in the same way.

The last difference concerns the occurrence of papillae on the stigma. On dry herbarium material this feature could not be established with accuracy. Observations on living specimens of other *Trollius* species showed, on the other hand, that some of them had numerous distinct papillae on the stigma, and others but few and they were hardly distinguishable. This character should be studied in detail on living specimens of *T. lilacinus*, although these differences do not seem to be of high taxonomic importance. According to Br ü h l (1896, p. 87): "The only character by which it is possible to distinguish *T. lilacinus* from all the other species of *Trollius* is the absence of glandular papillae on the pistils, a character which, however, is hardly of sufficient value to make it a subspecies as is done by P r a n t l".

There are, however, certain differences in the morphology of the stigma. In living *Trollius* specimens from the species available to the present author it could be shown that the stigma is not at the apex of the pistil. It descends along the style on the side of the ventral suture and generally reaches down to the ovary. Species with a long style and long beaks on the follicle have the stigma longer than the species with short styles and beaks, in which the stigma is shorter. In *T. pumilus*, however, the stigma with but few papillae reaches only half way down the style.

To sum up, *T. lilacinus* differs from the remaining species of the genus by the lilac colour of the flowers and a somewhat different structure of the stigma, however, in the present author's opinion these differences give no grounds to classify this species to a different section. On the contrary, the high morphological similarity of *T. lilacinus* and *T. acaulis* is evidence of a close relationship between these two species, thus indicating a close link of *T. lilacinus* with the genus *Trollius*. After analyzing the particular characters it may be stated that the morphological differences between the section *Eutrollius* and *Hegemone* are not

very distinct, and T a m u r a is right when he writes (1966, p. 20): "So it may be better that *Hegemone* is treated as a specialized condition of *Trollius*".

In view of the foregoing considerations the present author has decided to include *T. lilacinus* into the section *Acaulitrollius* since it shows doubtlessly the closest relation to *T. acaulis*.

Trollius afghanicus Hedge et Wandelbo

Hedge and Wandelbo, Arbok Univ. Bergen, Mat.-Naturv. Serie 18: 27 - 28 (1963).

Ic.: Ibid. p. 27, fig. 21 (holo. BG), p. 28, fig. 22.

Type: Hedge et Wandelbo, W. 5435 (22 July 1962), Afghanistan. Prov. Parvan: Panjshir valley, west side of Aujuman pass, near stream, 3800 m, flowers white (iso. E; holo. BG).

Plants with shoots 25 cm high, at time of flowering 10 - 15 cm long. One-flower stems with 1 - 3 cauline leaves. Basal leaves stalked 4 - 7 cm long, laminae 3 - 5 cm in diameter, 5-sected; leaf segments rhomboidal, dissected into longer or shorter lobes, rounded at apex. Cauline leaves sessile or almost so with membranous sheaths embracing stem; sheaths distinctly veined; lamina of upper cauline leaves with a lower number of segments, and smaller.

Flowers up to 3 cm in diameter, flat, open and white. Perianth leaves 9 - 10, 10 - 14 mm long, width varying (5.5 - 13.0 mm). Outermost leaves broadest, towards centre gradually narrower; shape oval or rhomboidal; they persist after flowering and dry on the shoot close to the developing follicles (Hedge and Wandelbo, 1963, Fig. 21).

Honey leaves about 10, ca. 4.0 mm (3.5 - 5.5) long, 1.0 - 1.5 mm wide, with distinct widened blade set on a short unguis; blade thickened, rounded at apex or with shallow indentation in middle; on blade three veins branching upwards, central vein reaches to indentation at apex. Nectary pit in funnel-shaped depression in the form of a shallow pocket at the height of 0.5 mm (Fig. 6 s). Stamina numerous, longer than honey leaves, 6.5 - 8.0 mm long including anther length 1.5 - 2.5 mm. Follicles 14 - 20 in head, 7.5 - 3.0 mm long including the beak length 1.5 - 3.0 mm, 3.5 - 4.0 mm broad; beaks straight, strong, at base slightly bent outwards (Fig. 6 t).

Distribution: North Afghanistan, provinces Parvan and Takhar. In mountains at a height of ca. 4 000 m a.s.l.

Herbarium specimens examined: Hedge et Wandelbo: W. 5435 (1962), Afghanistan, Prov. Parvan: Panjshir valley, west side of Aujuman pass, near stream, 3800 m, flowers white, (E, iso.). — D. Podlach: 11822 (1965), Nordost Afghanistan, prov.: Takhar, Khost-o Freng, oberstes Echani-Tal, 4000 m (E).

This species recently discovered in the mountains of North Afghanistan is so far known only from two sites situated at a considerable distance from one another (Fig. 7). It is yet too early to speak of its range. Neither can much be said as regards its morphological variability. Nevertheless it is very interesting one. It no doubt constitutes a distinct taxonomic unit not only in view of the white colour of the flowers, but above all because of the characteristic honey leaves (Fig. 6 s). Similar ones have only been found in some specimens of *T. laxus* from North America and in *T. membranostylis* and *T. chartosepalus* from the section *Insulaetrollius*, occurring in South-East Asia (Fig. 14 h - k). Specimens of *T. laxus* var. *albiflorus* from the Rocky Mountains also have white flowers. The foregoing are the only cases with white flowers known to date in the genus *Trollius*.

In the mountains of North Afghanistan no other representatives of *Trollius* have been found so far. The nearest neighbours of *T. afghanicus* are: *T. acaulis* in the Kashmir and *T. lilacinus* and *T. dschungaricus* growing in the Pamirs. These species have much larger honey leaves, but in some specimens these leaves may be found similar in shape to those of *T. afghanicus*.

The perianth leaves of *T. afghanicus* are mostly of rhomboidal shape like those of *T. lilacinus*, and similarly as the latter they persist rather long after flowering (Hedge and Wandelbo, 1963, Fig. 21). This feature however, is found quite frequently in many other species of *Trollius* and cannot be considered as taxonomically important.

The follicles of *T. afghanicus* resemble those of *T. lilacinus*, *T. dschungaricus* and of many other *Trollius* species; but they differ from those of *T. acaulis* (Fig. 6 t). It was not possible to ascertain on dry material whether the stigmata of *T. afghanicus* are glabrous like in *T. lilacinus* or covered with papillae characteristic for the genus *Trollius*.

Discussion of the section *Acaulitrollius*

To the section *Acaulitrollius* belong plants occurring on the neighbouring mountain territories of Central Asia: in the Western Himalaya Mts., the Kashmir, in North Afghanistan, the Pamirs, Tien-Shan and the Altai Mts. From among the species of this section only *T. lilacinus* reaches for north; the remainig two species do not go beyond the Pamirs (Fig. 7). The mountains of Pamirs, Kashmir and of the North Afghanistan constitute no doubt the centre of the range of occurrence. It is the region where only representatives of the section *Acaulitrollius* grow. In the Western Himalayas *T. pumilus* specimens may also be found, but they are completely different from *T. acaulis* occurring there. In the Tien-Shan and Altai Mts. *T. asiaticus*, *T. altaicus* and *T. dschungaricus* are common, the latter is also known from the north Pamirs.

The Section *Longipetala* to which *T. asiaticus* belongs is quite different from the section *Acaulitrollius*, whereas *T. altaicus* and *T. dschungaricus* show certain relationships with the latter section. These species have a type of honey leaves similar to those of *T. acaulis* and *T. lilacinus* and a number of other common characters. There also exist some doubtless morphological links between the section *Acaulitrollius* and *T. ranunculinus* which like *T. altaicus* and *T. dschungaricus* belong to the section *Trollius*. For instance some specimens of *T. ranunculinus* from the Southern Caucasus have honey leaves and fruits similar to those of *T. acaulis*.

Many features characteristic for the section *Acaulitrollius* may also be found in specimens of *T. chartosepalus* and *T. membranostylis* growing in the region of Kamchatka and the Okhotsk Sea, and belonging to the section *Insulaetrollius* as well as among the representatives of the species *T. laxus* occurring in North America. This concerns such characters as the general developmental rhythm, the structure of the honey leaves, the wings on the follicles, etc. In spite of these similarities, however, intermediate forms are lacking between the section *Acaulitrollius* and other sections of the genus.

The Pamirs and Kashmir belong like Yunnan to the natural reserves of the ancient Tertiary flora, and it is possible that the species growing in this area may have preserved some primary features. There is no doubt that *T. acaulis*, *T. lilacinus* and *T. afghanicus* belong to the group of the oldest known *Trollius* species. The morphology of each of them is relatively uniform, and does not show the wide variability characteristic for most *Trollius* taxons. No intermediate forms exist between them, a fact quite exceptional and hardly ever noted in this genus. These three species differ so widely from one another that the section *Acaulitrollius* may seem an artificial unit.

Closer analysis, however, indicates a distinct relationship between these species. First of all they have a common environment and developmental rhythm. They grow in the highest parts of the mountains close to the melting snow and glaciers. In spring they shoot out with single flower stems ended by a single bud at the tip which comes into flower before the basal leaves develop. The general habitus of the plants at this stage is very characteristic: the shoot is surrounded at the base only by nerves of old leaves and sheaths. The first basal leaves may have no petioles, their laminae grow directly from the leaf sheaths. The cauline leaves have always distinctly veined sheaths, and the upper ones from characteristic ears. The perianth leaves are numerous, exceptionally only five in number; they are usually rhomboidal, they dry up on the shoot and persist still at the time of fruiting. The honey leaves are small, up to 8 mm long with a thickened blade. The shape of the latter varies, but the nectary pit has always the shape of a shallow pocket. The

pistils are frequently winged with a white membrane descending down the style onto the ovary.

Comparison shows the greatest similarity between *T. acaulis* and *T. lilacinus*. As regards *T. afghanicus*, but little can be said since this species is still insufficiently known. Although its honey leaves are different than in the other two species, the fruits and leaves are the same as in *T. lilacinus*. It is probable that when more extensive material will be examined, many new interesting details will be found.

SECTION: LONGIPETALA sect. nov.

Syn.: Sect. *Eutrollius* Prantl in Engler u. Prantl, Nat. Pflanzenf. III, 2: 56 (1891) p.p.

Plants 10 - 100 cm high; shoots erect, foliated, mostly branched, flowers one or more. Leaf laminae 4 - 12 cm in diameter, 5- or 3-sected, their segments of diverse morphology. Flowers in the form of bowls; perianth leaves 5 - 20, brilliant orange-coloured, exceptionally lighter-coloured, yellow in *T. sibiricus*. Characteristic honey leaves elongated, narrow with flat blade, not thickened, mat, and thin, like the perianth leaves, frequently also of the same colour. The length of the leaves varies from shorter ones than the stamens and hidden in the perianth to long ones, somewhat exceeding the length of the perianth and sticking out. Nectary pit in the shape of a flat pocket. The morphology of the honey leaves is the main feature differentiating the particular taxons of this section.

In this section are included the following species: *T. asiaticus* L., *T. ledebouri* Rchb., *T. chinensis* Bge, *T. hondoensis* Nakai, *T. macropetalus* F. Schm., *T. sibiricus* Schipcz., *T. kytmanovii* Reverd.

Section type: *T. asiaticus* L.

Key

1. Honey leaves distinctly longer than perianth leaves, sometimes twice their length, 20 - 40 mm long	2
1. Honey leaves more or less equal in length to perianth leaves or shorter, not exceeding 20 mm	3
2. Honey leaves almost linear, gradually tapering upwards and ending sharply, 20 - 35 mm long (Fig. 9 j - m)	
	<i>T. chinensis</i>
2. Honey leaves more lancet-shaped, broad and sharply ended 25 - 40 mm long (Fig. 9 i)	
	<i>T. macropetalus</i>
3. Honey leaves more or less equal to perianth leaves, 12 - 20 mm long, 1.0 - 5.0 mm broad	4

3. Honey leaves mostly shorter than perianth leaves, not exceeding 12 mm in length, 1.0 - 2.0 mm broad 6
4. Perianth leaves 10 - 20, honey leaves widening upwards 1.5 - 5.0 mm broad, brilliantly orange-coloured, like perianth leaves (Fig. 8 a - g).

T. asiaticus

4. Perianth leaves generally not more than 10 (13), honey leaves linear, rounded at tip and not wider than 2.0 mm, usually somewhat darker than perianth leaves 5
5. Occurs only in Japan on the Honshu Island (Fig. 9 g, h)

T. hondoensis

5. Occurs in Siberia, in the Far East, in Northern Mongolia, Northern Korea and China. Reported from Japan only from the Hokkaido Island (Miyabe 1943) (Fig. 8 j, k, l)

T. ledebouri

6. Honey leaves 7 - 12 mm long, equal to stamina or somewhat shorter or longer, flowers sulphur-yellow or yellow-orange (Fig. 9 a - f)

T. sibiricus

6. Honey leaves 10 - 12 mm long, that is 1.5 - 2.0 times longer than stamina, flowers light orange or orange (Fig. 8 i)

T. kytmanovii

Trollius asiaticus L.

Linnaeus, Sp. Pl. No 557, (1753); De Candolle, Prod. Syst. Nat., 1: 46 (1824); Ledebour, Fl. Alt. 2: 301 (1830); Ledebour, Fl. Ross., 1: 73 (1842); Turczaninow, Fl. baical-dahur., 1: 62 - 64, (1842); Maximowicz, Prim. Fl. Amur., 22 (1859); Maximowicz, Enum. Pl. Mong., 25 (1889); Finet et Gagnepain, Bull. Soc. Bot. Fran., 4: 369 (1904); Krylov, Fl. Sib. Occid., 1121, (1931); Schipczinsky, Bull. Jard. Bot. Rep. Russe, 23: 70 (1924); Fl. SSSR, VII (1937); Fl. Transbaical., 4: 344 (1941); Popov, Fl. Sred. Sibiri, 1: 228 - 229 (1957); Fl. Kazakhst., IV: 15 (1961); Popov et Bussik, Consp. fl. lit. Baical, 67 (1966); Malyshev, Fl. alp. sajan., 124 (1965); Voroshilov, Fl. sovet. Dal. Vost., 193 (1966).

Syn.: *T. sertiflorus* Salisbury, Trans. Linn. Soc. 8: 303 (1807).

IC.: Curt, Bot. Mag., 7, tab. 235, (1793); Brühl, Ann. Roy. Bot. Gard. Calc. 5, Pl. 113, fig. 8 l - n, 9 g, h, i, k (1896); Volodina, Introd. dekorat. rast. Sibiri, 51 (1968); Doroszevska, Acta Soc. Bot. Pol. 39, Pl. IIB, IVd, Fig. 1 f (1970).

Type: Herbarium of Linnaeus No 716, 2; LINN.

Shoots single or branched with 1 - 3 flowers, 20 - 80 cm high, foliate. Basal leaves with petioles two or three times the length of the leaf laminae, laminae 4 - 12 cm in diameter; lamina 5- parted; its rhomboidal 3-lobed segments dissected into sharply ending lobes. Leaves variable, on some specimens may have more oval, less dissected segments with

dentated border. Leaf laminae moderately stiff, sometimes leathery. Cauline leaves 2-5, lower ones petiolated, upper ones sessile or semi-sessile; their laminae similar to those of basal leaves, only their size diminishes upwards along the stem and they are composed of a smaller number of segments.

Flowers open, 3.0-5.0 cm in diameter in the form of a shallow bowl, odourless (Pl. VIII a, b). Perianth leaves 10-20, oval or obovate, 14-24 mm long, their width varies: they are wider on the periphery and narrower towards the centre of the flower; the leaves are slightly bent, brilliantly orange-coloured (Tangerine orange 9, Orpiment orange 10).

Honey leaves 20-40, elongated, blade thin not thickened, similar to the perianth leaves and mostly of the same orange colour. Length of the leaves 12.0-18.0 mm, exceptionally more; width 1.5-5.0 mm; shape highly variable: mostly the leaves widen gradually upwards, they are rounded at tips, may be more rhomboidal (Fig. 8 e), oval (Fig. 8 b-g) or almost linear (Fig. 8 a, f). Even in the same flower honey leaves may be found differing greatly in shape and width (Fig. 8 a, c). Nectary pit in the form of flat pocket, at a height of 1.5-3.0 mm.

Stamina 8.0-12.0 mm, including anthers 2.5-4.0 mm long. Stigmata yellow (saffron yellow 7). Follicles 14-50 in head, 7.0-12.0 mm long, including 1.0-4.0 mm beaks. Beaks straight or slightly curved inwards at end, or the whole beak is straight and inclined outwards. Seeds black, shining, oval, ca. 1.5 mm long. Flowers May-June. $2n = 16$. Cultivated as ornamental plant.

Distribution: U.S.S.R.: Arctic Siberia, western part of Siberia: Obshk, Verkhne-Tobolskh, Irtysh and Altai regions; Eastern Siberia: Yenisei, Angara-Sayania, Dauria regions and part of western Lena-Kolyumia region; Central Asia: Dzungarian-Tarbagatai regions and eastern part of Balkhash and Tien-Shan regions. Northern Mongolia and North-Western China.

T. asiaticus occupies extensive areas of North-Western and Central Asia. Its range reaches from the mountains of north and central Ural through Western Siberia and the Central Siberian Upland to the Lena river. In the Arctic it extends to the coast of the Kara Sea. It has been found on the Yamal and Gydan Peninsulas, the coast of the Ob Bay; on the North Siberian Lowland and in the lower course of the Lena river. The southern limit of the range are the Western Tien Shan, Altai, Chantai and Chantai Mts. in Northern Mongolia. In the east *T. asiaticus* occurs in the catchment area of the upper Amur. The limit of the range here are probably the Borshchovochne Mts. and the Vitim and Lena rivers (Fig. 10).

The range of *T. asiaticus* is given only in outline; its detailed el-

Fig. 8. Honey leaves and stamens of some species of the section *Longipetala* (2 × life-size)

T. asiaticus: a — type, Herb. Linn. No. 716,2 (LINN); b — Sibiria ad fl. Bierjosa, Herb. Hance, 19209 (BM); c — Sibiria, r-n Tomsk, leg. Chinina (1964) (K); d — Altai, leg. Czekanowski et Müller (1873) (BM); e — H/3; f — H/5; g — H/12; h — Gub. Irkuck, Angara, leg. Malcev (1919) (KRA)
T. kytmanovii: i — distr. Krasnoyarsk, leg. Ermolaev (KRA)
T. ledebouri: j — M-tes Bureje, leg. Karo (K); k — Dahuria, leg. Karo, 128a (BM); l — H/4

boration may bring certain changes. So may a more precise analysis of the taxons of the entire section *Longipetala*. The data concerning the

distribution of *T. asiaticus* include also a number of unclear points. It is long reported in the literature that *T. asiaticus* occurs in the north-eastern part of the European area of the U.S.S.R. namely in the eastern part of the Dwina-Pechora and Volga-Kama regions. Flora SSSR (1937, p. 49). In the herbaria, however, I have found no specimens of *T. asiaticus* from this territory. It seems doubtful whether this species passes over the Ural Mts. to the west. As reported by Igoshina (1968), *T. asiaticus* occurs in the Northern Ural only in the eastern part of the mountains.

According to Krylov (1931), in Western Siberia the range of *T. asiaticus* is disrupted into two areas separated from one another. The smaller western area comprises the polar-arctic part of the Tobolsk district and the eastern part of the Perm district. *T. asiaticus* grows there on the slopes of the Northern Ural, on the coast of the Kara Sea and on the Yamal Peninsula. This area is separated from the larger eastern range by the West Siberian Lowland. A review of herbarium material points to the existence of numerous sites between these two distribution centres. In the north between the estuary of the Ob river and that of the Yenisei the range is not disrupted and joins through the Central Siberian Upland the mountains of South Siberia.

The collection of Limpricht (No. 576, No. 2455) originates from the province Tschili (Hopeh) in China. This site is exceptionally far advanced to the east.

T. asiaticus has a very wide and varied geographical range from the sea coast in the north to the mountains of Central Asia in the south. It occurs in various vegetal zones: in the Arctic on the tundra, in the zone of forests and forest-steppe, on meadows, on forest clearings in clear forests and brushwood; in the mountains it may reach the subalpine and lower parts of the alpine zones. As reported by Malyshev (1965, p. 124), in East Sayan *T. asiaticus* reaches up to a height of 2400 m a.s.l. and is found there on meadows next to patches of melting snow.

Specimens examined:

Cultivated: H/3 — from the Botanical Garden in Warsaw, H/4 — from Mongolia, the environs of Ulan Bator; H/12 — grown from seeds received from the Botanical Garden in Leningrad.

Herbarium specimens: H. W. Avnell, 4. VI. 1876, Sibiria, r-n Tomsk, E. — N. W. Blagoweschtschensky, 1908, Gub. Enisseisk, Iter Tschuno-Angarensis, LE. — N. A. Chinina, 1964, r-n Tomsk, u d. Kalarovo, K. — A. Czekanowski, F. Müller, 1873, Altaj, ad Inferiorem Tunguskam, BM, LE. — Herb. H. F. Hance, Reced. 1887, Syberia oc. ad fl. Bierjosa, No. 19202, BM. — E. A. Hibbert, 15. V. 1965, Ulan Bator, 6 miles north, alt. 1500 m. K. — Karelin et Kirilloff, 1841, Alatau ad fl. Sarchan, BM. — F. Karo, Mai 1888, Kajske Gory am Angara Flusse bei Irkutsk, Bergwiesen Gebüsche, W, PRC; 1883, 1886, pod Janisiejskiem, WA. — N. Klopotov, No. 95, No. 460 (1908), Altaj, Tomska gub., Biiskii uezd, LE,

WA. — Komarov, 1902, Gub. Irkutsk, Gory Sayan, r. Irkut i Oka, K. — P. Krylov, No 1203a, (1902), Sibiria, Prov. Tomsk, LE, WA. — Limpricht, No 576, 3. VII. 12, Tschili: Hsiao-Wu-tai-schan, WRS�; No 2455, 9. VII. 15, China, Tschili: Wang-ping-hsien, Bo hua schan (2000 - 2400 m), WRS�. — N. Malcev, 31. V. 1910, Flora Irkuckoi Gub., na o-v r. Angary, KRA. — F. N. Meyer, No 771, 1911, So-Siberia, Altaï, Ak-selenau, K. — G. N. Potonin, 1877, locus: Mongolia borealis, Changai, E. — M. P. Price, No 265a, 1910, Mongolia, Kushalv, Nirchinski Distr., K; No 262a, Kutschaban, K. — N. M. Przewalski, 1871, Mongolia australis, E. — H. F. Ridley, Ex Herb. Hongkong No 499, 1908 - 10, Plants Sining Prefecture, Kansuh, K. — G. Sherriff, 1949, Flora of Tibet, Lhasa: Depung Monastery, BM. — Turcz., Irkutia, KRA. — Ex Herb. Inst. Bot. Ac. Sc. URSS, Centralnyi Sayan, sl. Arnskoie, K.

In the Leningrad herbarium the material from the following sites was inspected: Omskaya obl., Berezovskii u.; Malyi Yamal, Buchta; Obsk. Guba; Bass. zaliva Gyda — Yamal, Gydanskaya Tundra; P-v. Yamal 70°; 71°18'; 70°58' × 78°53'; Novosibirskaya obl., r-n Moshkovskii; gory Chansben; Tomsk, okr. Bogorodskii na Obi; Dolina Obi, okr. Molchnova; Tomsk, Marymskii krai, u. Koznetsk; okr. Biisk (Altai) r. Chuya; u. Biiskii, r. Karakol; u. Zameinogorskii; oz-o Teletzkoe; Steppe Kulundinenses; okr. Biiskii, r-n Chernogo Anuya; Krasnoyarskii krai, r. Chunya, u. Minusinskii; u. Kanskii; Turuchanskii krai na Enisee; Krasnoyarsk, r. Katanga; Bassein r. Khety; Eniseisk, s. Dudinskoe; gub. Tomsk, Bogotol, u. Mariynsk; r-n Abakan; Tubinskaya obl., Sayan; Sayan, Munku-Sardyk; u. Kirenskii; Bassein r. Angara; Kosaya Step; u. Vercholenskii; r-n Kumskii, bass. r-ki Kumy.

T. asiaticus is one of the two earliest known *Trollius* species distinguished by Linnaeus himself (1753). In his description of *T. asiaticus* this author states that the site of occurrence of this species is Sibiria and Cappadocia. This information concerned two different taxons. Later authors (Ledebour, 1830; Maximowicz, 1859; Schipczinsky, 1924; Krylov, 1931 and others) retained the name *T. asiaticus* for the Siberian plants, while those from the Caucasus were established as a separate species under the name *T. ranunculinus* (Smith) Stearn (syn. *T. patulus* Salisb.).

T. asiaticus occurs in Siberia. It has long been considered as a species arousing no doubts "vid stoikii" acc. to Schipczinsky, 1924). More precise observations, however, indicate that: 1) there is a high variability within *T. asiaticus*. This concerns in the first place the morphology of the honey leaves, flowers and vegetative leaves; 2) in the sites where the range of *T. asiaticus* meets other *Trollius* species there occur numerous intermediate forms. Many of them are natural hybrids, others may be of nonhybrid origin.

Artificial crosses F_1 of *T. asiaticus* with *T. altaicus*, *T. europaeus*, *T. ledebouri* and *T. chinensis* are partly fertile (author's own experiments). Thus, *T. asiaticus* is capable of crosses with other species, which can produce fertile progeny. Through multiple crossing a number of individuals may arise intermediate between the parent plants. An interesting example of these processes in nature are the hybrids of *T. asiaticus* and *T. europaeus* described from the Northern Ural by Igoshina

(1968). As reported by this author, the hybrid populations in the eastern part of these mountains are closer to *T. asiaticus*, whereas further to the west there appear more and more traits of *T. europaeus*. These hybrids were denoted as *T. europaeus* L. var. *apertus* Perf. Lately they have been established as a new species *T. apertus* (Perf.) Igoshina (1968).

Krylov (1931) has reported on natural crosses between *T. asiaticus* and *T. altaicus* occurring in the Altai Mts. The intermediate specimens between *T. altaicus* and *T. asiaticus* found by Malyshev (1965) in east Sayan should also be considered as natural hybrids; these two species are morphologically very diverse, they have quite a different type of honey leaves and nothing indicates any close relationship between them (Fig. 8 a - g, Fig. 11 a - e). On the other hand, in the case of intermediate forms between *T. asiaticus* and *T. chinensis*, *T. ledebouri* and *T. sibiricus* matters are not so simple. These species are morphologically related, their honey leaves are usually of the same type and only differ by their length, and this trait is rather variable. It is probable that the above enumerated species are not distinct from one another, their separation is not clear-cut.

The honey leaves of *T. asiaticus* are in nature not at all uniform, ranging from broad almost oval to almost linear (Fig. 8 a - g). Even in one and the same flower there may be wide variations (Fig. 8 c).

Huth (1892), mainly on the basis of differences in the number of perianth leaves and the shape of the honey leaves, reports three varieties of *T. asiaticus*: 1. var. *typicus* — with honey leaves “latioribus subspatulatis”, which would correspond to those with blades widening towards the tip (Fig. 8 b, c); 2. var. *stenopetalus* — with linear honey leaves; 3. var. *parviflorus* — minute plants with honey leaves “oblongo-spatulatis”, thus of a shape intermediate between the two preceding ones.

Schipcizinsky (1924) says that in the eastern part of the Irkutsk district, specimens of *T. asiaticus* may be found with narrower honey leaves. According to the data of Reverdatto (1943), the typical *T. asiaticus* with widened honey leaves occurs mostly in Western Siberia to the west of the Yenisei river. East of the Yenisei it passes through the Sayan Mts., but on this territory it changes to a form with narrower honey leaves ca. 3 mm wide (*T. asiaticus* L. var. *orientalis* Reverd.). In the eastern part of the Krasnoyarsk district, east of the Yenisei river, Reverdatto (1943) found populations with linear honey leaves 1.5 - 2.0 mm wide and described them as a new species — *T. kytmanovii* Reverd.

All the living specimens of *T. asiaticus* brought from the Ulan Bator region and reared in the Botanical Garden in Warsaw had linear honey leaves (Fig. 8 f). All specimens of *T. asiaticus* collected in Northern Mongolia in the environs of Ulan Bator included in the Herbarium in Leningrad have the same linear honey leaves. No wonder, therefore, that

Schipc z i n s k y changed their name to *T. ledebouri*. Hibbert also determined the plants collected near Ulan Bator as *T. ledebouri* (No. 74, 1965 Herb. Kew.) or as *T. asiaticus*.

Thus, plants from the same territory, not differing practically from one another were once classified as *T. asiaticus*, and another time as *T. ledebouri*. It may be concluded therefrom that the plants from Northern Mongolia should be more precisely elaborated. The question also arises whether there is in nature a distinct difference between *T. asiaticus* and *T. ledebouri*. As a rule *T. ledebouri* has less perianth leaves (5 - 10), linear honey leaves, whereas *T. asiaticus* has 10 - 20 perianth leaves and honey leaves widening towards the tip. Specimens of *T. ledebouri* may be found, however, with 12 and 13 perianth leaves (H u t h, 1892; M i y a b e, 1943 and author's own observations), and the width of the honey leaves in *T. asiaticus* varies widely. In this situation the limits of variability of the characters of *T. asiaticus* should be established. This, however, will only be possible after elaboration of the entire group of related taxons of this section. For this purpose an extensive comparative material is necessary, not only from herbaria, but living, from natural sites. The present author did not have the possibility of carrying out studies of this type, therefore, she does not consider the classification of the *T. asiaticus* group as definitive. It is also impossible to decide in how far the establishment of certain lower taxons is correct, since they cannot be considered separately from the problem as a whole. To these taxons belong: *T. asiaticus*, L. var. *orientalis* Reverd. and *T. asiaticus* L. var. *affinis* Reg. (1961). The latter variety characterized by an incision at the tip of the honey leaves has also been reported as a synonym of *T. chinensis* Bge (H u t h 1892) or even as *T. chinensis* var. *affinis*.

T. asiaticus has as a rule honey leaves bent slightly arc-like and erect. From among the plants cultivated in the Botanical Garden in Warsaw specimen No. H/12 had strongly arched honey leaves forming a closed sphere what gave the flowers a different shape (Pl. VIII b). Such honey leaves have not been found in other representatives of *T. asiaticus* or in any other *Trollius* species. It is only possible to observe this trait on living material.

The fruits of *T. asiaticus* have beaks of varying length (1.0 - 4.5 mm), Schipc z i n s k y (1924) reports for this species a beak length of 0.5 mm; such short beaks are seen very rarely.

T. asiaticus is highly variable not only as regards the morphology of the flowers, but also of the vegetative leaves. Most *T. asiaticus* specimens have soft leaves with segments dissected into narrower or broader lobes. *T. chinensis*, *T. europaeus* and many other species have similar leaves. Those of specimens from Arctic Siberia and the Yamal Peninsula are smaller, stiffer and not so deeply dissected (I g o s h i n a, 1968). On the other hand, the specimen collected by P r z e w a l s k i (1871, Herb. E) in Mon-

golia had quite an exceptional foliage. Its leaves were thick, stiff and leathery, with deeply incised dentation, ending sharply by hard prickles at their tips. They rather resembled the leaves of *Eryngium* than those of *Trollius*. This specimen must have originated probably from dry areas; similar hard and leathery leaves, though not to so high a degree, were found on some specimens of *T. ranunculinus* from Turkey.

T. asiaticus has characteristic brilliantly orange-coloured flowers with numerous perianth leaves (Pl. VIII a, b). Owing to these colourful flowers it has long aroused interest as a decorative plant (Luchnik, 1951). The content of coloured substances and alkaloids in its flowers has been investigated. The aim of these studies was to utilise *T. asiaticus* as a source of natural yellow dyes for use in foodstuffs industry (Fedorov and Nikitin, 1961). This species has also been described as an example of gradual passing of cauline leaves to perianth leaves (Fedorov, Nikitin and Pankova, 1950).

Trollius ledebouri Rchb.

Reichenbach, Pl. crit., 3: 63 (1825); Ledebour, Fl. Ross., 1: 73 (1842); Regel et Tiling, Fl. ajan., 38 (1858); Komarov, Fl. Manchzh. 2: 238 (1950); Schipczinsky, Bull. Jard. Bot. Rep. Russe, 23: 69 (1924); Fl. SSSR, VII: 47 (1937); Kitagawa, Lineam. Fl. Mansh., 228 (1939); Miyabe, Acta Phyt. Geob., 13: 8 (1943); Fl. Transbaical. 4: 344-345 (1941); Popov, Fl. Sred. Sibiri, 1: 229 (1957); Malyshev, Fl. alp. sajan., 123 (1965); Popov et Bussik, Consp. fl. lit. Baical, 67 (1966); Voroshilov, Fl. sovet. Dal. Vost., 193 (1966).

Syn.: *T. Ledebouri* Rchb. var. *genuinus* Regel et Tiling, Fl. ajan., 38, (1858); *T. Ledebouri* Rchb. var. *polysepalus* Regel et Tiling, Fl. ajan., 38 (1858); Miyabe, Acta Phyt. Geob., 13: 8 (1943); *T. Ledebouri* Rchb. β -*parviflorus* Huth, Helios, 9, 1: 3-4 (1892); *T. Ledebouri* Rchb. var. *pulcher* M. Popov, Fl. Sred. Sibiri, 1: 229 (1957); *T. asiaticus* var. *Ledebouri* Maxim., Enum. Pl. Mong., 25 (1889); *T. patulus* Salisb. var. *Ledebouri* Finet et Gagnepain, Bull. Soc. Bot. France, 4: 395 (1904).

Icon.: Reichenbach, Icon. t. 272, f. 435; Brühl, Ann. Roy. Bot. Gard. Calc., 5, Pl. 113 fig. 9, 1 (1896); Fl. Transbaical., 4: 345, fig. 177 (1941); Popov et Bussik, Consp. fl. lit. Baical, 69, fig. 6 (1966); Doroszevska, Acta Soc. Bot. Pol., 39, Pl. III, b, Fig. 1 (1970).

Type: in Berlin (acc. to Fl. SSSR, VII: 48, 1937) n. v.

Shoots erect, single or branched, 40-100 cm high. One to four flowers, flower stems elongate during fruiting (Pl. IX).

Basal leaves petiolated, their laminae 5- or 3-sected, lobes rhomboidal or more oval, dissected into narrower or broader lobes, ending sharply with edges irregularly dentate. Morphology of the leaf laminae rather variable, specimens may be found with leathery leaves; their segments are not lobed, at most shallowly dissected and rounded. Cauline leaves 2-5, the lower ones petiolated, upper ones have short petioles or are sessile,

their laminae are similar to those of the basal leaves, becoming smaller up along the stem. Leaf laminae 6-12 cm in diameter.

Flowers open in the form of a shallow bowl, 3-5 cm in diameter, odourless (Pl. VIII c). Perianth leaves generally 6-8 (5-13), broad-oval and slightly bent, 14-25 mm long, golden-orange (Tangerine orange 9, Orpiment orange 10).

Honey leaves about 10-15, mostly by $1/3$ or $1/2$ longer than stamina and somewhat shorter than the perianth leaves. Their length varies from 12 to 20 mm; width 1.0-2.0 mm; they are elongated, linear, rounded at apex, with a small incision at tip sometimes (Miyabe, 1943, Fig. I, C), orange-coloured (Tangerine orange 9, Orpiment orange 10). Stamina ca. 10 mm long including length of anthers 2.5-4.0 mm (Fig. 8 j-l). Stigmata yellow, slightly inclined outwards. Follicles ca. 15 in head or more; length of follicle with beak 7-11 mm, including 1-3-mm beak. Beaks straight, outward bent. Seeds mostly 2-4 in follicle. Flowers in June-July. $2n = 16$.

Distribution: U.S.R.R.: Eastern Siberia: The Daurian region and the southern part of Lena-Kolyma region; Far East: the region Zeya-Bureya and Ussuri, the eastern part of East Sayan (Malyshev, 1965). North-Eastern China, North Korea and North Mongolia. According to Miyabe (1943 p. 8), *T. ledebouri* is also found on the Hokkaido Island, whereas Ohwi (1965) does not report this species from Japan.

In general *T. ledebouri* occurs mainly in the catchment of the middle and upper Amur, its range extends from the Baikal Lake to the Sea of Japan. It grows on damp meadows, in clear forests and brushwood, in the mountains at the alpine level and in the lower parts of mountains as well as on lowland (Fig. 10).

Specimens examined:

Cultivated: H/4 grown from seeds received from the Botanical Garden in Warsaw.

Herbarium specimens: N. Ghili, No 80 China Weichang, K.—E. A. Hibbert, No 74, 11.VI.1965, 10 km West from Ulan Bator, K.—F. Karo, *Plantae Dahuricae*: No 128a, 128b, (1889), Nertschinsk in Bargwälder, W, K, BM; No 128 (1892), Nerczyńsk, WA; Nertschinsk (1895) E.—F. Karo, *Plantae Amuricae et Zeaënsae*: (1900) Zajskaia Pristan, WA; Zajskaia Pristan am Zeaflusse, Zea auf nassen Wiesen, W; (1903), Blagowieszczensk, Mokre polany, WA; 1898 (27) im Amurgebiete, WA; (1905), Mandžuria, Amur—circa Sachalien, K; Montes Bureje, K, LE. Maximowicz, 1859, Amur—Ust. Strelka, K.—A. K. Schindler, *Plantae Sinensis* No 91, Coll. Berol. No 221, Juli 1905, Po-hua-shan, WRSL, K, (coll. as *T. asiaticus*).—V. Siplivinskii, 1964, Buryatiya, Barguzinskii Chrebet, K.

Reichenbach (1825) in his description of *T. ledebouri* mentions as characteristic for this species "5 sepala, 10-12 petala" longer than the stamina. Regel and Tiling (1858) supplement this information; according to them *T. ledebouri* may have 5-10 perianth leaves and the

honey leaves are by $1/3$ to $1/2$ longer than the stamina. These authors distinguish: "lusus 1 — *gamineus*: sepalis 5" and "lusus 2 — *polysepalus*: sepalis 5 - 10". They mention as the site of occurrence of this taxon: "Siberia baikalensis, Davuria" and the environs of Irkutsk.

K o m a r o v (1950), in his description of the Manchurian flora, does not distinguish *T. ledebouri* from *T. chinensis* Bge, and quotes the latter specific name as a synonym of *T. ledebouri*. Still more confusion was caused by the species named *T. macropetalus* F. Schm. also reported as *T. ledebouri* var. *macropetalus* Reg. This taxon is closely related to *T. chinensis* Bge. In more recent publications *T. chinensis* Bge and *T. ledebouri* Rchb. are treated as two distinct species (S c h i p c z i n s k y, 1924; Flora SSSR, 1937; Kitagawa, 1939; Voroshilov, 1966).

After S c h i p c z i n s k y (1924, p. 69) in *T. ledebouri* the length of the honey leaves is a variable character, and in dependence on this length the specimens may be similar to *T. chinensis* Bge or closer related to *T. sibiricus*. Actually in nature there are individuals with intermediate characters, the classification of which is difficult. Another species still closer related to *T. ledebouri* is *T. asiaticus*. Maximowicz (1899a) was the first to consider *T. ledebouri* as a variety of *T. asiaticus*. Huth (1892), after studying the collections of Czekanowski and Poliakov from Eastern Siberia, calls attention to the fact that *T. ledebouri* has sometimes 12 or even 14 perianth leaves and is related to *T. asiaticus*. In nature intermediate forms are known between these two species, e.g. in Eastern Sayan (M a l y s c h e v 1965), from the region of Kulyk, i.e. at the southern end of the Baikal Lake (P o p o v, 1957). It results from the literature that particularly *T. asiaticus* var. *orientalis* Reverd. found from the Sayan Mts. to the Transbaikal region (R e v e r d a t t o, 1943), thus, with a range sympatric to that of *T. ledebouri*, is closely related to the latter species. When reviewing herbarium collections one finds numerous specimens with intermediate characters, difficult to classify. But the greatest doubts arise in the case of *T. asiaticus* specimens from Northern Mongolia since these plants have linear honey leaves not differing in any detail from those of *T. ledebouri*. A living *T. asiaticus* specimen brought from the environs of Ulan Bator, No. H/5 has also such honey leaves (Fig. 8 f). On herbarium sheets from North Mongolia specimens from the same region of Ulan Bator may be seen morphologically undistinguishable and identified as *T. ledebouri* or *T. asiaticus*. As seen classification of these plants aroused doubts. The review of herbarium material shows that plants from North Mongolia are morphologically rather uniform, but their classification should be decided on the basis of a more extensive comparative material.

In general, *T. ledebouri* is a species with variable morphology of vegetative leaves, and varying length of honey leaves. The colour of flowers may also be various. It is related by intermediate forms with *T. asiaticus*,

T. sibiricus and *T. chinensis*. Its geographical range is largely sympatric with that of these species. Its relationships with *T. asiaticus* is the closest.

Trollius chinensis Bge

Bunge, Enum. plant. Chin. bor. 3 (1831); Maximowicz, Primit. Fl. amur. 22 (1859); Schipczinsky, Bull. Jard. Bot. Rep. Russe 23: 69 (1924); Fl. SSSR, VII: 47 (1937); Voroshilov, Fl. Sovet. Dal. Vost. 193 (1966); Kitagawa, Lineam. Fl. Mansh. 228 (1939); Finet et Gagnepain, Bull. Soc. Bot. France, 4: 396 (1904).

Syn.: *T. asiaticus* L. var. *chinensis* Maxim., Enum. Pl. Mongol. 25 (1889); Kitagawa, Lineam. Fl. Mansh. 228 (1939).

Ic.: Bot. Mag. 140:8565 (1914); Brühl, Ann. Roy. Bot. Gard. Calc. 5, Pl. 113, fig. 9 m (1896); Doroszevska, Acta Soc. Bot. Pol. 34, Pl. Ia, Fig. 4a, 5a (1965); Acta Soc. Bot. Pol. 39, Pl. IVa, Fig. 1i (1970).

Type: China, prov. Shansi (in Leningrad acc. to Fl. SSSR, 7: 47, 1937), n. v.

Shoots erect, profusely branched, with several flowers at end, 50 - 120 cm high. Basal leaves with petioles up to 30 cm long, 5-, less frequently, 3-lobed; lobes elongated rhomboidal, middle lobe 3-sected, frequently the lateral lobes also dissected into smaller lobes mostly ending sharply at tip. Leaf laminae 6 - 12 cm in diameter. Cauline leaves 3 - 7, lower ones petiolated and upper ones sessile or almost so. The morphology of the leaf laminae is the same as that of the basal leaves only they decrease in size upwards along the stem and are composed of a smaller number of segments (Pl. X).

Flowers 4 - 6 cm in diameter in the form of a shallow bowl from which long honey leaves stand out giving the flowers a particularly ornamental shape (Pl. VIII d). Flowers odourless. Perianth leaves 5 - 8, in garden varieties up to 17, lighter or darker orange-coloured (Carmine orange 8, Orpiment orange 9); perianth leaves somewhat concave, broad-oval, decreasing in width towards the centre of the flower, ca. 22 (13 - 30) mm long.

Honey leaves about 20, of the same colour as the perianth leaves or somewhat darker (Tangerine orange 9, Orpiment orange 10), usually ca. 30 (20 - 35) mm long. These leaves continue to grow during flowering and in some specimens their length may reach almost 4 cm; they are almost twice the length of the perianth leaves; 1.7 - 3.0 mm wide; the honey leaves linear, tapering towards tip and ending sharply. They are completely flat, the blade is not thickened. Nectary pit in the shape of a flat pocket at a height of 1.5 - 3.0 mm from below (Fig. 9 j - m).

Stamina 13 - 20 mm long, including the anther length 2.5 - 4.5 mm; such variability range was observed within one flower. Stigmata yellow. Follicles in head 12 - 40, 6.0 - 14.0 mm long including beak length 1.5 - 4.5 mm. Fruit morphology highly variable. Beak may be straight, long

Fig. 9. Some flower elements of the section *Longipetala* (perianth leaves life-size, honey leaves and stamens $2 \times$ life-size)

T. sibiricus: a — Sibiria ad Lenam prope Kirensk, Herb. Hance (BM); b — Subalpium ad Baicalem, leg. Turczaninow (1834) (K); c — Dahuria in alpe Chamar, leg. Turczaninow (BM); d, e — Dahuria leg. Krascheninnikow, 1500 (LE); f — ad fl. Aldan, auct. ign. (1835) (LE)
T. hondoensis: g — Honshu, prov. Shinano, leg. Murata, 5917, (KRA); h — Honshu, prov. Omi, leg. Nakai, 5406 (KRA)

T. macropetalus: i — acc. to Miyabe, Fig. 1 A (1943)

T. chinensis: j — H/89; k — Itaria, Herb. Hance (1887) (BM); l — China, prov. Shansi, leg. Lao Chin, 8119 (BM); m — H/66

and erect or short, strong and bent outwards. In one follicle 3-7 seeds. They are dark brown, mat, oval, 1.5-2.0 mm long. Flowers in June-July. $2n = 16$. Cultivated in gardens as ornamental plant.

Distribution: U.S.S.R. (Far East, Zee-Bureya and Ussuri regions); North-East China. The range comprises mainly the middle and lower catchment of the Amur river, in the east it reaches to the Japanese Sea coast, in the south it occurs in the environs of Peking up to the Pohay Bay of the Yellow Sea. Flora SSSR (1937) mentions the occurrence of *T. chinensis* also in Japan, and Voroshilov (1966) enumerates also the Sakhalin. The most recent description of Japanese flora (Ohwi, 1965) does not include this species. According to Miyabe (1943, p. 7) it is *T. macropetalus* F. Schm. and not *T. chinensis* Bge that occurs on the Sakhalin.

T. chinensis grows on fertile damp meadows, in damp forests on clearings and in brushwood, on the lowland and on the lower mountain levels.

Specimens examined:

Cultivated: H/25, H/66 from the Botanical Garden in Warsaw; H/95 from a natural site.

Herbarium specimens: P. H. Dorsett, J. W. Dorsett, 2. VII. 1925, Locus: Plants of Manchuria, E.—W. Y. Hsia, No H. 2023, loc. Pohaushan, Kopei, alt. 1900, E.—Lao Chin, 6. VII. 1925, No 8119, Plantae Sinensis, locus: Shansi centr: Lu-yah-shan, in prato alpino, E, BM.—Yang, 24. VI. 1955, No K. 1576, Locus: Hopei, Wang-ping, E.—F. N. Chen, No 103, 1914, Loc.: Kirin, BM.—Fronson, Itaria, Herb. H. F. Hance Recd. 1887, No 1123, BM.—Bretschneider, 1881, Herb. F. B. Forbes, Mts. West of Peking, BM.—H. E. M. James, 1886, Journey from Mukden to Kirin, between Tung-che-shien and Mäor Shan, Yaloo Riv., K; Lao-yen Ling, Mukden, K.—Abbè E. Licent, Ordos Ja Keon, No 6677, K; No 569, 1914, North China, Youngmongsham, Makapou, Shansi, BM.—W. Purdon, 1909, North Chili, Nei-chang (Mai-Chang), K.—V. H. Voroshilov, No 5087, Primorskii krai, Slavyanskii raion, bliz seleniya Sunutinka, Gorno-taeznaya stanciya, shirokolistvennyi les, KRAM.—Auct. ign., Tehaly: mont. de Tati, No 1032, K.

The flowers of *T. chinensis* are the most showy of all *Trollius* species and the plant is cultivated as an ornamental plant not only in Asia, but also in Europe and America. Although it has been known and cultivated long, it is diversely classified.

In general this species resembles *T. asiaticus* by its brilliant orange colour of flowers and the narrow long honey leaves. Maximowicz (1889a) treated this taxon as a variety (*T. asiaticus* var. *chinensis*), and the Index Kewensis mentions *T. chinensis* Bge in general as a synonym of *T. asiaticus* (author's name not given). In nature *T. chinensis* has mostly 7-10 perianth leaves, in garden specimens they may be much more numerous. This probably is the result of selection by gardeners with the aim of obtaining most decorative flowers.

K o m a r o v in the Flora of Manchuria (1950) treats *T. chinensis* Bge as a synonym of *T. ledebouri* Reich. In later elaborations *T. chinensis* was distinguished from *T. ledebouri* (S c h i p c z i n s k y, 1924; Flora SSSR, 1937; V o r o s h i l o v 1966). In the Flora SSSR (1937) *T. chinensis* is given as the synonym of *T. ledebouri* var. *macropetalus* Reg. According to this, S c h i p c z i n s k y has classified the numerous specimens collected on the coast of Southern Manchuria as *T. ledebouri* var. *macropetalus* Reg. to *T. chinensis* Bge. On the other hand, N a k a i (1928) and M i y a b e (1943) consider *T. ledebouri* var. *macropetalus* Reg. as a separate species; according to them, this taxon is synonymous with *T. macropetalus* F. Schm, and with *T. chinensis* (non Bunge) Maxim. and Schipcz. in Flora SSSR.

It would result therefrom that the descriptions of *T. chinensis* given by M a x i m o w i c z (1859) and S c h i p c z i n s k y do not agree with that of B u n g e (1831). The first descriptions, however, both of B u n g e and of M a x i m o w i c z are not accurate, and give no ground to treat *T. chinensis* reported by S c h i p c z i n s k y (1924; Flora SSSR, 1937) as a different species. This author used as base collections from China and Manchuria, and the type of *T. chinensis* Bge from China, province Shansi in the Leningrad Herbarium is quoted by him.

T. chinensis has linear honey leaves, not wider than 3 mm, tapering gradually upwards and sharply ending (Fig. 9 j-m), whereas *T. macropetalus* has more lancet-like leaves wider at the base up to ca. 4/5 of its length (Fig. 9 i). It is possible that the differences in the shape of the honey leaves are not as distinct as on the drawing and specimens may occur with intermediate morphology. Some specimens from north Ussuri determined as *T. macropetalus* do not practically differ from *T. chinensis*. It would seem necessary to compare more extensive material and establish whether *T. macropetalus* F. Schm. is actually a different species than *T. chinensis* Bge.

T. chinensis was also sometimes confused with *T. asiaticus* and *T. ledebouri*. Among typical specimens of the above named species there occur plants with intermediate characters, and their classification is difficult. The cause of this is the wide variability of these species as well as the occurrence of natural hybrids. These species, namely, easily cross with one another giving a fertile progeny (author's own observations). For instance the herbarium specimen from Herb. Kew, Leg. W. H a n c o c k (1888) in Peking Mt., has on the same label the inscription *T. asiaticus* and *T. chinensis*; the author must have had difficulties in classifying it. The plant rather resembles *T. chinensis*. The specimen (herbarium sheet No. 521 leg. P. T. W a n g 1931), described as *T. asiaticus*, actually resembles rather *T. chinensis*. It is possible that the above mentioned specimens are natural hybrids; many such examples may be quoted.

Trollius hondoensis Nakai

Nakai, Bot. Mag. Tokyo, 42: 8 (1928); Makino and Nemoto, Fl. Jap. ed. 2, 343 (1931) ex Miyabe 1943; Miyabe, Acta Phyt. Geobot. 13: 7 (1943); Ohwi, Fl. Japan, 459 (1965).

Syn.: *T. ledebouri* var. *macropetalus* sensu auct. Japan, non Regel, ex Ohwi 1965.

Ic.: Miyabe, Acta Phyt. Geobot. 13, Fig. 1 B (1943).

Type: n. v.

Plants up to 1 m high. Shoots usually single or branched, foliated. Basal leaves on petioles 6-12 cm long, 3- or 5-sected; their lobes rhomboidal-elliptic or oval, middle one wider and 3-sected, the lateral ones 2- or 3-sected; lobe edges irregularly dissected, sharply dentate. Leaf laminae on upper surface darker green, lighter underneath. Cauline leaves 4-7; lower ones petiolated, upper ones with short petioles or sessile, provided with leaf sheaths; cauline leaves similar to basal ones, diminishing in size up the stem.

Flowers open, 2.5-4.5 cm in diameter. Perianth leaves 5-7, 15-22 mm long, broad-elliptic or rounded, gold-coloured. Honey leaves 8-18, elongated, linear, not very sharply ending (subulato-linear, apice sensim angustata), 12-20 mm in length, 1-2 mm broad; longer than stamens and somewhat shorter than perianth leaves, gold-orange. Nectary pit at a height of about 3 mm from base (Fig. 9 g, h). Stamens numerous, ca. 10 mm long, anthers ca. 3-4 mm long. Follicles numerous in heads, ca. 10 mm long, beaks straight 2.5-4.0 mm long. Flowers June-August.

Distribution: Japan, Honshu; provinces: Shinano, Mino, Omi (Nakai 1928, Miyabe 1943). The plants occur on damp mountain meadows, especially along streams in the alpine zone on the Honshu Island (Ohwi, 1965).

Herbarium specimens examined: G. Nakai, No. 5406, (1951), Japan, prov. Omi: Mt. Jbuki, KRAM; G. Murata, 30.VII.1952, No. 5917, Plantae Japonicae, Hab. Prov. Shinano: Kirigamine north of Suwa, KRA.

T. hondoensis belongs to the section *Longipetala* and is most closely related to *T. ledebouri* and *T. chinensis*. All these species have rather similar honey leaves, and generally a low number of perianth leaves (Fig. 8 j-l, Fig. 9 g, h, l, m).

Japanese authors (Nakai, 1928; Miyabe, 1943; Ohwi, 1965) consistently consider *T. hondoensis* as a separate species occurring on the Honshu Island. If *T. hondoensis*, however, is an endemite of the Honshu Island, it cannot at the same time be synonymous to *T. asiaticus* var. *ledebouri* Maxim. (Nakai, 1928; Miyabe, 1943; Ohwi, 1965), since

the description by Maximowicz concerns plants from Mongolia, Manchuria, Turkestan and China, and not from Japan (Maximowicz, 1889a).

Trollius macropetalus F. Schm.

Fr. Schmidt, Reise Amurl., 88 (1868); Nakai, Bot. Mag. Tokyo 42: 9 (1928); Makino and Nemeto, Fl. Jap. ed. 2, 343 (1931) ex Miyabe (1943); Kitagawa, Lineam. Fl. Mansh., 229 (1930), Miyabe, Acta Phyt. Geobot. 13: 7 (1943).

Syn.: *T. Ledebouri* var. *macropetalus* Reg. Fl. Uss. 8 (1861); Fr. Schmidt, Fl. Sachal. 105 (1868); Kitagawa, Lineam. Fl. Mansh., 229 (1939); *T. Ledebouri* (non Reichb.) Sugawara, III. Fl. Saghal., 875 (1939) ex Miyabe (1943).

lc.: Miyabe, Acta Phyt. Geobot. 13, Fig. 1 A (1943); Fl. Korei, 1: 89 (1956).

Type: n. v.

Plants 40-90 cm high, shoots single or branched, foliated; flowers 1-3, seldom single. Basal leaves petiolate, 5- or 3-sected; lobes rhomboidal deeply incised into unequal lobes ending sharply. Cauline leaves 1-4, lower ones petiolated, upper ones sessile or almost so, their laminae are similar to those of basal leaves, their size decreases up the stem.

Flowers open, large, up to 5 cm in diameter. Perianth leaves 5-10, broad-oval, but little bent, gold-orange-coloured. Honey leaves ca. 20, erect, 25-40 mm in length, longer than perianth leaves, linear-oblan-ceolate, and sharp pointed, dark orange. Nectary pit at a height of 4-5 mm in the form of a pocket. Follicles numerous, straight ca. 5 mm long.

Distribution: U.S.S.R., Far East: coastal provinces in the Okhotsk and Ussuri regions, South Sakhalin and North Korea.

The relation of this species to *T. chinensis* Bge is variously evaluated. The greatest differences are noted between the opinions of Russian and Japanese authors. Flora SSSR (1937) treats *T. ledebouri* var. *macropetalus* Reg. as a synonym of *T. chinensis* Bge., and *T. ledebouri* var. *macropetalus* F. Schm. as synonym of *T. japonicus* Miq. Japanese authors, on the other hand (Nakai, 1928; Kitagawa, 1939; Miyabe, 1943) consider both the above named varieties of *T. ledebouri* as one taxon synonymous to *T. macropetalus* F. Schm. and also to *T. chinensis* (non Bunge) Maxim. and Schipcz., Flora SSSR (1937). In the latest Japanese papers *T. japonicus* is treated as a Japanese endemite occurring solely on the Hokkaido and Honshu Islands, and having nothing in common with *T. macropetalus* which occurs on the Sakhalin and in the coastal regions of the Okhotsk Sea (Miyabe, 1943; Ohwi, 1965).

In the present work *T. japonicus* is treated according to the opinion of Japanese authors, and *T. chinensis* Bge as a separate species. Descriptions of *T. chinensis* given by Maximowicz (1859) and Schip-

czinsky (Flora SSSR, 1937) refer to the same taxon described for the first time by Bunge (1831).

T. macropetalus F. Schm. is morphologically very similar to *T. chinensis* Bge. Although the *T. chinensis* specimens from China have honey leaves narrower than those of *T. macropetalus* from the Sakhalin (Fig. 9 i-l), in nature these differences may be less pronounced if more extensive material is compared. These two species are very similar, and their geographical ranges are largely sympatric. It is not clear to the present author whether *T. macropetalus* F. Schm. and *T. chinensis* Bge are two separate species or whether it is one variable taxon. The latter hypothesis seems to me more probable.

Trollius sibiricus Schipcz.

Schipczinsky, Not. Syst. Herb. Horti Bot. Petrop., 4, ed. 2: 11-12 (1923); Bull. Jar. Bot. Rep. Russe, 23: 69-70 (1924); Fl. SSSR, VII: 48 (1937); Fl. Transbaikalia, 4: 345 (1941); Popov, Fl. Sred. Sibiri, 1: 229-30 (1957); Popov et Bussik, Consp. fl. lit. Baical, 68 (1966).

Syn.: *T. patulus* (non Salisb.) Ledeb., Fl. Ross. 1: 73 (1842); *T. dahuricus* Turcz., Exsicc., Herb. K.

Type: in Leningrad (acc. to Fl. SSSR, VII, 1937), n. v.

Shoots erect, mostly single, rarely branched 10-70 cm high, with one flower usually, exceptionally with 2-3. Basal leaves 3-5 on petioles up to 20 cm long, 5-sected; their laminae consist of relatively narrow segments of rhomboidal-elongated shape, these segments are 3-sected, deeper or shallower incised into small lobes and sharply ended. The diameter of the leaf laminae mostly 5-8 cm. As compared with *T. ledebouri*, the leaves of *T. sibiricus* are generally deeper and more densely dissected and smaller. Cauline leaves 2-5: sessile or only upper ones sessile, and lower ones petiolate frequently have sheaths. The laminae of cauline leaves are similar to those of the basal ones but they gradually decrease in size up the stem (Pl. XI).

Flowers open, 1.5-4.0 cm in diameter; smaller flowers may be seen in arctic regions. Perianth leaves 5-12, sulphur-yellow or orange-yellow; various-shaped: broad-oval, oval-elongated or more rhomboidal (Fig. 9 a).

Honey leaves linear, rounded at tip, generally 8-10 mm long, exceptionally 7-12; width ca. 1.0 mm; these leaves may be shorter than, equal to or somewhat longer than the stamina and generally distinctly shorter than the perianth leaves; they are of the same colour as the latter or somewhat darker. Nectary pit at a height of 1.0-2.0 mm from leaf base in the shape of a shallow pocket. Stamina 6-10 mm long including 2-3-mm anthers (Fig. 9 a-f). Stigmata yellow. Follicles in heads more or less numerous, sometimes only two in head. Their length with beak

7-13 mm (beak ca. 2 mm). Beaks thin, straight or bent out- or inwards. Seeds very dark brown, almost black, shining. Flowers June - August.

Distribution: U.S.S.R., East Siberia: Lena-Kolyma and Dauria regions; Far East: regions of Okhotsk and Udscoe. It occurs mainly in the catchment of the Lena river and in Dauria. It grows on wet and moist meadows, in moist forests and brushwood on the lowland and on lower parts of mountains (Fig. 10).

Fig. 10. Distribution of some species of the section *Longipetala* according to the herbarium material

1 — *T. asiaticus*; 2 — *T. sibiricus*; 3 — *T. ledebouri*; 4 — *T. chinensis*

Herbarium specimens examined: Czekanowski, 1875, Olenok ad Lenam, K, LE. — Fokina, 25 maja 1961, Ja ASSR, Olenkii r-n, p. Verchnee Dzege, LE. — Herb. H. F. Hance, Recd. 1887, Sibiria Orientalis, ad Lenam prope Kirensk, No 19286, BM. — E. I. Kabanov, 28 maja 1907, Territ. Transbaical. distr. Bargusin, LE. — W. Kleinberg, No 59, No 64, 5. VII. 1925, Plantae Jacutenses, bassin r. Aldana, LE. — M. Korotkii, Z. Lebedeva, No 94, 1914, Iter Transbaical-

ense, ad fl. Dshirgam, LE.—I. M. Krascheninnikov, No 1500, 18. VI. 1909, Iter dahuricum ad f. Arguny, LE.—No 693, 28. VII. 1909. Nerchinsko-Zavodskii okrug, bass. r. Arguni, LE.—Maximowicz, 1. VI. 1859, Schilna, LE.—G. Melvil, No 702, 1. VIII. 1928, Plantae Jacuticae Aldanenses, LE.—P. V. Olenin, No 56, 1. VII. 1902, Jakutsk. obl., Jakutsk. okr., Amginskaya Sloboda, na p. Amyu, prit. r. Aldana, LE.—Pavlovsky, Sibiria orient., ad fl. Utschur, LE.—Th. W. Sokolow, 10. VI. 1912, Iter Ajano-Nelkanense, LE.—N. Turczaninow, Dahuria, In alpe Chamar, BM.—Turczaninow, 1834, Subalpium ad Baicalem, K.—Auct. ign., deter. Schipczinsky, In humidis ad fl. Aldan 1835, LE.

T. sibiricus is morphologically closely related to *T. ledebouri*, and Schipczinsky (1923, p. 12) in his description lists the traits distinguishing these two species. At the same time, in the first description of *T. sibiricus* Schipczinsky reports a very wide range of occurrence comprising the following provinces: "Sibiria orientalis: prov. Enissei, prov. Irkutsk, prov. Transbaical, prov. Iakutsk, peninsula Kamchatka, insula Bering, ins. Cuprea". On the other hand, in Flora SSSR (1937, p. 48), this range is less extensive not including Kamchatka and the Komandor Islands. Later Russian floras when mentioning *T. sibiricus* base on the description of Schipczinsky (Flora Transbaicalica, 1941; Popov, 1957; Popov and Bussik, 1966). Popov (1957), however, believes that the occurrence of *T. sibiricus* in the Angoro-Sayan region as recorded in the Flora SSSR (1937 p. 48), and also in the Khamar-Doban region of the Transbaical (Flora Transbaicalica, 1941, p. 345), is doubtful. According to him it is not hybrids of *T. sibiricus* × *T. asiaticus* that occur in Khamar-Doban, but a special variety of *T. ledebouri* (var. *pulcher*) which may be of hybrid origin.

The discrepancies in the classification of plants from Dauria involve also *T. dahuricus* Turcz. Some authors consider it as a synonym of *T. ledebouri* Rchb. (Komarov, 1950; Popov, 1957), others mention it as a synonym of *T. sibiricus* (Schipczinsky 1924, p. 72; Flora Transbaicalica, 1941, p. 345). In the Kew herbarium there is a specimen of *T. dahuricus* Turcz. established as type and collected by Turczaninow in 1834 near the Baikal. This plant has linear honey leaves 7 mm long, more or less equal to the stamina in length (Fig. 9 b), follicles with straight beaks about 2 mm long. Since the plant corresponds in all to *T. sibiricus* Schipcz., the present author considers these two taxons as synonymous.

Still wider discrepancies in classification occur as regards plants from the territory of Kamchatka. Hultén in the Flora of Kamchatka (1928a, p. 27) believes the name *T. sibiricus* to be a synonym of *T. riederianus* Fisch. et Mey. and Komarov (1929) confirms this opinion.

Formally, between the description of *T. sibiricus* given by Schipczinsky and that of *T. riederianus* Fisch. et Mey. by Hultén there are discrepancies. Hultén (1928a) states that in *T. riederianus* the

number of perianth leaves is nearly always 5 as in the first description of this species (Fischer and Meyer 1837), whereas Schipczinsky in his description of *T. sibiricus* gives the number of perianth leaves as ca. 10 (5-12). Besides, Schipczinsky in Flora SSSR (1937) does not mention *T. sibiricus* from Kamchatka or the Komandor Islands.

It should be assumed that *T. sibiricus* Schipcz. and *T. riederianus* Fisch. et Mey., according to the description of Hultén, are two distinct taxons. Their geographical ranges seem to be completely allopatric or at most they may contact in Okhotsk region. Morphologically they are rather similar and many a time they have been determined at first as *T. patulus* (Ledebour, 1842; Regel and Tiling, 1858; Huth, 1892). As correctly suggested by Hultén (1928a, p. 99), *T. riederianus* belongs to the group of Japanese species *T. sibiricus*, on the other hand, is connected with East Siberia and belongs to the section *Longipetala*. The honey leaves of both these species are more or less equal in length to the stamina, but differ from one another in structure; more details are given in the description of *T. riederianus*.

T. sibiricus is most closely related to *T. ledebouri* and *T. kytmanovii*. The honey leaves are of the same type: linear, differing only in length, but this character is variable and there may exist intermediate forms. As compared with *T. ledebouri*, the vegetative leaves of *T. sibiricus* are smaller, with narrower lobes and more deeply dissected. *T. sibiricus* differs from *T. kytmanovii* also by the colour of its flowers which are, light yellow in contrast to those of *T. kytmanovii* of a brilliant orange colour. The stamina of *T. kytmanovii* are almost one half shorter than the honey leaves, and those of *T. sibiricus* are more or less of equal length with them.

It results from the my owns observations that *T. patulus* Salisb. var. *sibiricus* Reg. et Til. cannot be a synonym of *T. sibiricus* Schipcz., as suggested by Schipczinsky (1923). She had the opportunity of seeing the specimens collected by Tiling in the Ayan Mts. and determined by him as *T. patulus* Salisb var. *sibiricus* and compare them with specimens from Yakutia and Transbaikalia determined by Schipczinsky as *T. sibiricus* (Herb. LE). All specimens of *T. sibiricus* have linear honey leaves 7-12 mm long (Fig. 9 a-f), whereas the *T. patulus* var. *sibiricus* specimens from the Ayan Mts. have quite different honey leaves. They are 3 mm long, thickened, spatulate or pear-shaped. Similar honey leaves may be seen in the *Trollius* specimen collected in the Ayan Mts. by Bogdanovich (1897, Herb LE; Fig. 14 h). There is no doubt that the plants from Ayan belong to a different taxon than *T. sibiricus*, although their general habitus is similar (Pl. XI, XIV). Such a type of honey leaves is found in *T. chartosepalus* Schipcz. and *T. membranostylis* Hultén. In the present work these plants have been assigned to the latter species.

Trollius kytmanovii Reverd.

Reverdatto, Animad, Syst. Herb. Krylov. Univ. Tomsk 1 - 2 (1943).

Type: Herb. Univ. Tomsk, n.v.

Description of *T. kytmanovii* Reverd. ex Reverdatto (1943, p. 1): "Caulis 15 - 30 (40) cm. alt. Folia *T. asiatici* sed minores. Flores solitaria 1,5 - 2,8 cm in diam. Sepala 9 - 12, aurantiaca vel pallide aurantiaca 9 - 15 (20) mm longa. Petala intense-aurantiaca, linearia, 10 - 12 mm longa et 1,0 - 1,5 mm lata, 1 1/2 - 2-plo staminibus longiora, apice angusta, acuminata vel rotundata.

Affinis *T. sibirico* (Reg. et Til.) Schipcz. sed patalis staminibus 1 1/2 - 2-plo longioribus bene differt.

Habitat: Prov. Krasnojarsk, Distr. Evenkiensis. In valle fl. Vivi 65° l.s. et 67 1/3° l.or., 1.VIII.1935, leg. Grachov. In valle flum. Koczeczumo circa pag. Tura, 68 1/2° l.s. et 72° l.or., 9.VII.35, leg. V. Natschokin. In valle fl. Tuba con fl. Janissej, 54° l.s. et 61 1/2 or. in prato, 28.VI.1939 leg. Kojdalova et Melnikova.

var. *occidentalis* m. Flores magni 3 1/2 - 4,0 cm in diam. Sepala 10 - 15. Petala linearia, 2 mm lata".

Distribution: U.S.S.R.: Western Siberia. In the eastern part of the Krasnoyarsk district, west up to the Yenisei river in the forest and forest-steppe zones (Reverdatto 1943).

Herbarium specimens examined: A. P. Ermolaev, distr. Krasnoyarsk, 18.V.1919, KRA.

This new species described from the Krasnoyarsk district differs from the *T. asiaticus* occurring on this territory. As reported by Reverdatto (1943), of the 70 plants collected from various sites east of the Yenisei river, 34 belonged to *T. kytmanovii* and the rest to *T. asiaticus*. Isolated single sites of *T. kytmanovii* were also found to the west of the river. According to this author, typical *T. asiaticus* occurs only in the western part of the Krasnoyarsk district, and hardly passes to the east beyond the Yenisei. In the eastern part of the Krasnoyarsk region it gradually is supplanted by *T. kytmanovii*, and still further to the east by *T. sibiricus* Schipcz. and *T. ledebouri* Rchb. Closely related to *T. kytmanovii* is *T. asiaticus* L. var. *orientalis* Reverdatto, established by this author in West Sayan. This variety has honey leaves only 3 mm wide and is as if an intermediate form between *T. asiaticus* and *T. kytmanovii* (Reverdatto, 1943).

The above observations of this author are very interesting and should be further elaborated. It is a pity that there is no further mention of these taxons in more recent Russian floras.

There is no doubt that *T. kytmanovii* distinctly differs morpholo-

gically from the typical *T. asiaticus*, above all by the shape and dimensions of the honey leaves. It is not quite clear, however, whether it is equally easy to distinguish *T. kytmanovii* from *T. sibiricus* and *T. ledebouri* which have a rather variable length of honey leaves (Schipczinsky, 1924, p. 69 - 70; Komarov, 1950, and author's own observations).

Further observations will show whether the range of *T. kytmanovii* is limited solely to the eastern part of the Krasnoyarsk district, and separate from the range of *T. sibiricus*, or whether both these taxons are related, not only morphologically but territorially.

Discussion of section *Longipetala*

The section *Longipetala* is characterised by a special structure of the honey leaves, not found in other sections. The species belonging to other *Trollius* sections have always thickened honey leaves, convex, glistening and of darker colour than the perianth leaves. They are, moreover, minute, hidden in the perianth, at most somewhat longer than the stamina. In the section *Longipetala* the honey leaves are never like this. Their blades are uniformly thin, flat and mat, similar to the perianth leaves, frequently also of the same colour. These honey leaves differ from the perianth ones only by their narrow elongated shape and by the nectary pit, which has the shape of a flat pocket and is never distended as is taxons of other *Trollius* sections. Some species of the section *Longipetala* have exceptionally long honey leaves: equal to the perianth leaves or even much longer, sticking out high above the perianth. Such long honey leaves are not found in the remaining sections of this genus. In general the morphology of the honey leaves in the section *Longipetala* differs markedly from that of all other *Trollius* taxons and differs completely from that in the sections *Pumilotrollius* and *Yunnanotrollius*. Owing to the brilliant colour of the flowers and the long leaves, some species of the section *Longipetala* as for instance *T. chinensis* and *T. asiaticus* are valued as ornamental plants. No other section has such showy flowers.

The section *Longipetala* occupies extensive area of Northern and Central Asia, from the Ural to Japan, and from the Arctic to the mountains of Central Asia, North Mongolia and China (Fig. 18). The ranges of the particular species are partly or largely sympatric on this territory (Fig. 10). *T. hondoensis*, a Japanese endemite, is an exception. The most extensive areas are occupied by *T. asiaticus* which is a highly variable species. According to Reverdatto (1943), the species of this section gradually pass from one into another starting from the west towards the east: *T. asiaticus* var. *orientalis*, *T. kytmanovii* and further *T. sibiricus*. This observation of Reverdatto seems founded and indicates the

lines of gradual differentiation of the taxon. It is only uncertain whether this process occurred from the west to the east or rather inversely.

Beside the typical representatives of the species, in nature numerous specimens may be found with intermediate characters constituting intermediate forms between these species. In many cases these specimens are of hybrid origin. They readily cross with one another giving a fertile progeny, (author's own unpublished observations). These intermediate forms constitute a link between the particular species so that the latter cannot be definitively established. Consequently, their classification is very difficult. In many cases it is hard to establish the limit between two species. The comparative list of the main morphological characters of the species given below, illustrates the situation (Table 1). It is seen that between some species the differences are not clear-cut. Therefore the key to the section *Longipetala* placed at the beginning is not fully satisfactory and many sometimes fail in practice.

One of the main morphological character differentiating the particular taxons is the length of the honey leaves. This character, however, is variable, and even within one species there may be wide differences. It results from experiments, that in *Trollius* this trait is polygenic and exhibits a continuous variability (Doroszewska, 1965, 1970). Other taxonomically important traits such as the number of perianth leaves, the length and shape of the beaks, the leaf lamina morphology, etc. may also be variable. In this group there are no contrasting character on which generally keys are based. There usually are only slight quantitative differences in the particular traits.

Therefore, the entire group *Longipetala* still requires further accurate and detailed elaboration. In the first place the range of variation of the particular species should be established and referred to their distribution. Observations performed in the field on natural living populations may result in somewhat different conclusions than the study of herbarium material. On the basis of more precise investigations it may be possible to decide whether all the above mentioned taxons of the section *Longipetala* are independent species of the same rank, e.g. *T. chinensis* and *T. macropetalus*, *T. asiaticus* from northern Mongolia and *T. ledebouri*.

The present study was based on too fragmentary herbarium material to allow a final solution of the problem. The author is sure that a more accurate elaboration of this group will bring many changes, and in the future its classification may differ from the present one. It is not excluded that it may prove more reasonable to introduce here a collective species. The solution of these problems is left to botanists working on the areas belonging to the range of the section *Longipetala* to whom living natural populations are available.

Remark. In 1969 the paper by Egorova and Siplivinsky

Table 1
List of most important morphological characters of the species of the *Longipetala* section

Species	Perianth leaves		Honey leaves		Ratio of honey leaf length to stamen length	Follicle length mm	Beak length mm
	number	colour	length mm	width mm			
<i>T. chinensis</i>	8-8(17)	bright orange	20-35	1.5-25	$\pm 2:1$	6.0-14.0	1.5-5.0
<i>T. macropetalus</i>	5-10	gold orange	25-40	2.0-4.0	$\pm 2:1$	—	± 5.0
<i>T. hondoensis</i>	5-7	gold orange	12-20	1.0-2.0	$\pm 1:1.5$	± 10.0	2.5-4.0
<i>T. ledebouri</i>	5-8(13)	bright orange	12-20	1.0-2.0	$\pm 1:1.3-1.5$	7.0-11.0	1.0-3.0
		gold orange					
<i>T. asiaticus</i>	10-20	bright orange	12-20	1.5-50	$\pm 1:1.5$	7.0-12.0	1.0-4.0
<i>T. kytmanovii</i>	9-12	bright orange	10-12	1.0-2.0	$\pm 1:1.5-2.0$	—	—
<i>T. sibiricus</i>	5-12	sulphur-yellow	7-12	0.8-1.2	$\pm 1:1$	9.0-13.0	± 1.0
		orange-yellow					

appeared dealing with floristic novelties from the environs of the Baikal Lake. These authors reported from this territory two *Trollius* taxons of the section *Longipetala*: *T. asiaticus* L. ssp. *affinis* (Regel) Egor. et Sipl. (syn.: *T. asiaticus* γ *affinis* Regel, *T. asiaticus* var. *orientalis* Reverd.) and *T. stenopetalus* (Regel) Egor. et Spil. (syn.: *T. asiaticus* a *stenopetalus* Regel, *T. kytmanovii* var. *occidentalis* Reverd.; *T. ledebouri* var. *pulcher* M. Pop.). A definitive conclusion as to these taxons will be possible after a through elaboration of the entire section *Longipetala* as already mentioned above.

SECTION: *TROLLIUS* sect. nov.

Syn.: Sect. *Eutrollius* Prantl in Engler u. Prantl, Nat. Pflanzenf. III, 2: 56 (1891), p.p.

Plants 15 - 100 cm high, shoots usually branched, foliated with 1 - 3 flowers at tip. Leaves mostly 5-sected, their segments of various forms. Flowers yellow or light orange, open in the shape of a bowl, more spherical, or even closed. Honey leaves 6.0 - 14.0 mm long, elongated, rounded at tip; blade somewhat thickened and convex, linear or somewhat widened, orange-coloured and rather shiny. Nectary pits with depression in the form of a shallow pocket. Perianth leaves 5 - 20. Numerous follicles in head.

The following species are classified to this section: *T. europaeus* L. var. *europaeus* and var. *transsilvanicus* (Schur) Bl., *T. apertus* (Perf.) Igosh., *T. altaicus* C.A.M. var. *altaicus* and var. *sajanensis* Malyshev, *T. dschungaricus* Reg. and *T. ranunculinus* (Smith) Stearn.

Section type: *T. europaeus* L.

Key

1. Stigmata dark purple	<i>T. altaicus</i> var. <i>altaicus</i>
1. Stigmata yellow, orange or green	2
2. Flowers globose or almost so	3
2. Flowers flat, bowl-shaped or semispherical	4
3. Beaks on follicles 3 - 6 mm long	<i>T. europaeus</i> var. <i>transsilvanicus</i>
3. Beaks on follicles 0.5 - 2.5 mm long	<i>T. europaeus</i> var. <i>europaeus</i>
4. Plants from Caucasus Mts. U.S.S.R., Turkey or North-West Iran	<i>T. ranunculinus</i>

4. Plants from mountains of central Asia or Siberia 5
5. Plants from Pamir-Alai, Tien-Shan
T. dschungaricus
5. Plants from Eeast Sayan
T. altaicus var. *sajanensis*

Trollius europaeus L. var. *europaeus*

Linnaeus, Sp. Pl. 1: 557, No 716, 1 (1753); De Candolle, Reg. veget., 1: 112 (1818); Prod. Syst. nat. 1: 45 (1824); Korzhinskii, Fl. Vost. Evrop. Ross. 106-107 (1892); Ledebour, Fl. Ross. 1: 73 (1842); Bubani, Fl. Pyren., 2: 381 (1901); Hegi, Illustr. Fl. Mittel-Europa 3: 459-60 (1912); Cadavall, Fl. Catalunya 1: 44 (1913-15); Lindman, Svensk Fanerogamfl. 277 (1926); Hayek, Prod. Fl. penins. Balcan. 1: 300 (1927); Krylov, Fl. Sib. Occident. 5: 1120-21 (1931); Coste, Fl. descrip. illustr. France 1: 44 (1937); Perfilov, Fl. sever. Kraya 2, 3: 111-112 (1936); Fl. SSSR, VII: 45 (1937); Szafer, Kulczyński, Pawłowski, Rośl. Polskie, 163 (1953); Fl. Murman. Obl. 3: 262 (1956).

Syn.: *T. europaeus* L. ssp. *europaeus*, Fl. Europ. 1: 210 (1964); Karolyi and Pocs, Acta Paed. Agr. 6: 374 (1968); *T. europaeus* L. var. *demissorum* Borb., Geogr. enum. pl. Comit. Castrif., 244 (1887); Jávorka, Fl. Hung. 352 (1924); R. Soó, Syst. geobot. Fl. Veget. Hung. 2: 30 (1966); Karolyi and Pócs, Acta Paed. Agri. 6: 374 (1968); *T. europaeus* L. var. *genuinus* Huth, Helios 9, 1: 2 (1892); *T. europaeus* L. ssp. *globosus* (Lam.) Dom. ex Dostal, Květena ČSR, 182 (1950); *T. europaeus* L. var. *humilis* (Crantz) DC, Prod. Syst. nat. 1: 45 (1824); *T. europaeus* L. var. *napellifolius* (Roep.) DC, ibid.; *T. europaeus* L. var. *typicus* Beck f. *latisectus* Beck, ex Hegi (1912); *T. europaeus* L. var. *viridis* (Mielichh.) Huth, Helios 9, 1: 2 (1892); *T. europaeus* L. var. *vulgaris* Roep., Flora, 3: 105 (1820); *T. altissimus* Crantz ex Wenderoth, Flora, 1: 578 (1818), Huth (1892); *T. aureus* Tausch, Flora, 22, 11: 173 (1839); *T. chloranthus* Hausm. ex Hegi (1912); *T. germanicus* Wender. Schrift Marb. 2: 217 (1831); *T. globosus* Lam. ex Ind. Kew; *T. grandiflorus* Hort., Tausch in Flora, 22, 11: 173 (1839); *T. humilis* Crantz ex De Candolle, Prod. Syst. nat. 1: 45 (1824); *T. medius* Wender., Flora, 1: 578 (1818); *T. minimus* Wender., Flora, 1: 579 (1818); *T. montanus* Salisb. ex Ind. Kew.; *T. napellifolius* Roep., Flora, 3: 105 (1820); *T. rotundiflorus* Stokes, Bot. Mat. Med., 3: 270 (1812); *T. sphaericus* Salisb., Trans. Linn. Soc., 8: 302 (1807); *T. tauricus* Hort. in Wenderoth, Flora 1: 579 (1818); *T. viridiflorus* Schur, Enum. pl. Transs. 26 (1866); *T. viridis* Mielichh., Flora, 22: 492 (1839).

Ic.: Dodonaeus, p. 427 (1583); Camerarius, p. 199 (1611); Pancovius, Herbarium, fig. 413 (1673); Icon. Rchb. germ. 3, T. 102, fig. 4713; Hegi, Illustr. Fl. Mittel-Europa, 3, (1912) Taf. 110, Fig. 3, Fig. 638f; Jávorka, Icon. Fl. Hung., 157, fig. 1244 s (1934); Stojanov and Stefanov, Fl. Bulg. 441, Fig. 481 (1948); Szafer, Kulczyński, Pawłowski, Rośl. Polskie, 162, fig. 343 (1953); Maevskii, Fl. sred. pol. evrop. chas. SSSR, 70, ris. 18 (1954).

Type: Herbarium of Linneus No 716, 1, LINN.

Shoots erect 15-90 cm high, foliated, frequently unbranched with only one flower at tip or branched with 2-3 flowers, exceptionally 4-6 flowers.

Basal leaves with petioles several times longer than lamina dia-

Fig. 11. Honey leaves and stamens of the species of the section *Trollius*
(2 × life-size)

- T. altaicus*: a — H/133; b — Kirgizya, Ferganskii Chreb. (K); c — Kazakhstan, Kirgizskii Chreb., leg. Fisjun, 4406 (K); d — Tian-Shan and Pamir, leg. Appelton, 630 (K); e — Trans-Iliian Ala-tau, leg. Sokalsky, 180 (BM)
- T. dschungaricus*: f — H/22; g — iter Turcestanicum, fl. Ili, leg. Regel (1878) (E); h — Terskei Ala-tau, leg. Medvedeva et al. 144, (BM); i — Turkestanica, leg. Regel (1879) (K)
- T. ranunculinus*: j — H/82; k — Turkey, Prov. Coruh, leg. Davis, D. 29981 (E); l — Caucasus, Ossetia, leg. Brothers (1893) (K)
- T. europaeus*: m — *T. giganteus* Hort., n — H/54, o — H/55, p — H/96, r — H/39, s — H/16, t — H/23

meter; laminae 5-, less frequently 3-sected, 5 - 12 cm in diameter, leaf segments rhomboidal or oval, usually 3-lobed and dissected into narrower lobes with sharply dentate edge; lateral segments of leaf lamina frequently have one deeper indentation and are 2-sected. Shape of leaf laminae variable. Some specimens have leaves with broader segments, oval or almost undissected into lobes with a wavy edge. A number of intermediate forms may also be found (Fig. 12 m - s).

Cauline leaves 3 - 7, mostly sessile or semisessile, lowest leaf generally petiolate: higher situated ones decrease gradually in size, they have less segments and the latter become narrower. Often at the beginning of flowering the upper cauline leaves are concentrated right underneath the flower forming a ruffle. In the course of the flowering and fruiting period the flower stem elongates carrying the flowers further away from the leaves like in *T. ranunculinus*.

Flower diameter 1.5 - 5.0 cm with very weak pleasant odour. Strongly bent perianth leaves give the shape of a closed or almost closed sphere (Pl. XII d); exceptionally flowers widely open in the form of a hemisphere; small flowers of small plants, particularly, are sometimes open with almost flat perianth leaves. Perianth leaves 9 - 19 in number, yellow (Aureolin 3); the outermost leaves broad-oval or rounded, these situated towards the centre gradually narrower and more elongated; 14 - 30 mm long, the outermost ones are sometimes dissected at the tip into rather deep dents and greenish.

Honey laves about 10 (8 - 17), 6.5 - 11.0 mm long; they are equal in length to the stamina or shorter; their blade is widened in its upper part spade-like, 1.0 - 2.0 mm broad, rounded at apex, triangular or almost flat with a slight indentation (Fig. 11 m - t). This upper part of the blade is slightly thickened glittering, light orange (Saffron yellow 7). Nectary pit at a height of 1.0 - 3.5 mm from leaf base, globose, somewhat distended. Stamina numerous, yellow, 9 - 14 mm long including anther length 2.5 - 4.0 mm.

Follicles 12 - 60 in heads, follicle length 4.5 - 11.0 mm (includes beaks 0.5 - 2.5 mm long), this amounting to about twice their width. There are 1 - 4 seeds in follicle. They are black glistening, oval about 1.0 mm long; only a low per cent of them germinates. Flowers May - June. $2n = 16$. *T. europaeus* is cultivated in gardens as a decorative plant.

Distribution: Europe and West Siberia.

T. europaeus var. *europaeus* is found in almost all European countries, from the polar zone to the Mediterranean region. It has not been reported from Greece, Turkey and Portugal (Sampaio, 1947); in Southern Europe it grows only in the mountains. In the U.S.S.R. it occurs in its entire European part with the exception of Crimea and the southern part of the lower Don and the lower Volga regions; in Western

Siberia it grows in the western part of the Obsk region. Numerous sites of *T. europaeus* from Western Siberia are reported by Krylov (1931).

T. europaeus var. *europaeus* is found in the mountains up to the alpine level; it grows on damp meadows, rocks and coombs, on open areas between dwarf mountain pine, on the banks of streams and the edge of forests, on clearings and in clear brushwood. On the Central European Lowland it may be found on damp meadows, in clear mixed or deciduous forests, frequently in clear oak woods. In the north *T. europaeus* also grows on the tundra and in birch brushwood; it is known from the Kolguyev Island.

As reported by Hegi (1912). *T. europaeus* is not found in the north-western part of the Central European Lowland; since it, however, occurs on the adjacent territories, it is possible that it has been exterminated there.

Specimens examined:

Field observations: Numerous investigations and measurements of natural *Trollius* populations on the Polish Lowland (Białowieża, Suwałki region, Mazurian region, the environs of Miechów) and also in the mountains (Polish and Slovakian Tatra, Gorce, Bieszczady, Sudetes and Karkonosze) carried out by the author.

Cultivated: H/15, H/16, H/18, H/47, H/48, H/49, H/54, H/55, H/57, H/58 from Białowieża: H/96—from a natural site in the environs of Moscow; H/172 from a natural site in Austria-Styria Nordl. Kalkalpen, Admonter Kaibling 1510 m a.s.l.

Herbarium specimens:

Western Europe: J. Ball: (1881), Valesiae alpina in Combe de l'Arolla (E).—Herb. G. A. Baulener: (1916), France, Puy de Dôme (BM).—Herb. C. Billot: Vosges (E).—G. v. Beck: (27.5.1896), Lichtenstein, Wiesen bei Rothenboden (PRC).—R. K. Brummitt: 61 341 (21.5.1921), Kirkendbrightshire, v. c. 73. Wooden banks of Shirmers Burn by east shore of Loch Ken, 3 miles south east of New Galloway (W).—Costa, Herb. Willkommii, Pyreneje Catal. prope Pegnera (BM).—D. M. Henderson: (14. June 1948), Flora of Scotland, Killin, Perthshire, alt. 1000 ft. (BRNU).—T. K. Hulme: (8. 1959), Loch Awe, Agryllshire (W).—Herb. M. Heard: (1921), Pyrenees Orientales, Tech Valley (BM).—J. Hutchinson, J. R. Matthews, L. A. Riley: (1922), Flora Pyrenaica, Port d'Orsau byond Gabas, 5800 ft. (E).—C. C. Lacaita: (1933), Mts Pyreneés, meadows of Sangué nr. gavnarnie, 5314 (BM).—Lejeune et Courtois: Belgia, 1961/5813 (W).—R. D. Meikle: (19. 4. 1953), Scotland, Perth near Lowers (K).—C. Pearson: (21. 6. 46), Lough Melvin, Leitrim and Fermanagh, near edge of islet E. end of lake (W).—M. Price: (1820), Wales (E, K).—R. L. Reager: (29. 6. 1900), Ireland, Bibervy Island (K).—E. Reverchon: (1886), Plants de France, Alpes Maritimes (E).—R. Reverchon et A. Dreber: (1900), Basses-Alpes (E).—F. Sennen: (1926), Plantes de Cerdagne (KRA).—Herb. R. J. Shuttleworth rec. 1877, Pyrenees Espagnoles, Compedons (BM).—J. T. Syme: (June 1850), Edinburgh, W. Brothnik Castle (POZ).—J. de Puyfol: (20. Jun 1886), Aveyron, prairies a Vanzac, alt. 760 m (PRC).—Herb. F. Tempsky: (20 Juni 1868), Marais du Gollet de 10. Roihotte roll. Ozanow (PRC); (7. 1898), Hisp. Perrania de Cuenca (PRC); Gaturage de montagne (Montagnes Egaturages) (PRC); Environs de La

Grave (Hautes-Alpes) (PRC); Praires de la vallée de la Moselotte (Vosges), rec. par S. Perrin (PRC).—C. C. Townsend: (15. 4. 47), Inverness Shire, Loch Be-nevean (K).—F. Weber: (1886) Aveyron, France, 750 à Vaurac (PR).—A. J. Wilmott: (13. 6. 1927), Iter Hispanicum Province of Leon, above the Puerto de Ponton (BM).—Auct. ign.: (may 1873), Prés alpiere, Mt. Pyrenées (K); Y. S., E. S. 43 (1966), Flora of Andorra, Cartales D'Encanp Mut. (BM).

Scandinavian countries: C. G. Alm: Torne Lappmark, Lake Torneträsk, Lat. 68° - 68°34', Long. 18° - 20°30' (BM); Norrbotten: Tärendö, 3099 (BM).—Anderssen: (1858), Stockholm (E).—Błoński: (1906), Norwegia, Nordcap (WA).—Churchdown: 26 (1965), Arctic Finland, Long. 23°18'E Lat. 68°34'N (BM).—G. E. Croot: 3 (1912), Lycksele Lappmark, 65°55'N - 16°15'E (BM).—N. J. Fellman: (1863), Lapponia, Tetrina (BM).—H. Fröding: (Juni 1890), Värmland, N. Råda (W); (1895), Prov. Vermlandia, N. Råda (KRA).—J. G. Gunnarsson: (1912), Åsele Lappmark, Åsele (BM).—R. F. Harrison: A-42 (1949), Norway, Lake Balvatnit (BM).—L. Heikkinen: (4. 6. 1961), Fennia: Kn. Kajaani. Hauhola. 64°14'N (PRC); Kn. Kajaani. Petäisenniska, 64°14', Damp meadow (WA, E).—P. S. Jakela (26. 5. 1963), Prov. Ostrobothnia borealis, Kiiminki, In nemore ad paedium rusticum nomine Puirava in fundo calcareo cop. Ad lat. bor. c. 65°05' (W); Prov. PP. Par. Kiimiki, ad lat. bor. c. 65°10' (WA).—H. D. Jordan: 62 (1938), Arctic Norway, Lakse Fjord area, Head of Star fjord (BM).—C. Lagerheim: (1841), Västergötland: Tubbetorp, emellan Skara och Axevalla (W).—S. Laegaard et Petersen: (9. 6. 1965), Jutlandia, Kasted Mose, W of Aarhus, in open wood with humid soil, *Salix pentandra*, *S. aurita*, *S. aucuparia* dominating (W); 117 (1965), Jutlandia, lat. 56°10' (BM).—J. E. Lundquist: (1894), Smolandia, Grenna (WA).—T. Lillefosse: (16. 6. 1921), Plantae Norvegicae, distr. Oslo, Hordaland, Hordanger (BRNU); (1940) Norway, Hordoland, Hordanger, Strandeharns (BM).—Y. Mäkinen: (1954), Finnish Plants, Inari Lapland, Ustjaki, Karigasniemi (BM).—I. Montell: (17. 6. 21), Lapponia Kemensis, in pratis ad pagnum Murniv Kyrkaky, ad lat. bar. c. 68° (W); (17. 6. 21), Lapponia Kemensis, ad lat. bor. c. 68° (BRNU).—A. Pihl: (20. 6. 1888), Skåne, Broby (W).—Salvaton: (1830), Flora Fennica, prov. Tarastland (E).—A. Środoń: (7. 7. 1957), Norwegia pln., Tromsø, Lanes, w zaroślach brzozowych (KRAM); (4. 8. 1957), Norwegia pln., Troms Fylke, Flöia, N. ok. 200 m npm. las brzozowy (KRAM).—H. Smith: (1923/25), Torne Lappmark, Juckasjärvi sh. ca. 500 m (E); Fennia 64°14' N. (E); (1956), Suecia, Upland: Vöddö (BM).—A. W. Trethewy: (1922), S. Trondhein Rados (BM); Guldalen (BM).—W. Uhlemann: (1890), loc. Västergötland, Mölnlycke (E).—H. Weimarck: (8. 6. 1938), Skane: Örkeneds, Draget (BRNU).—Herb. C. G. Westerlund: (15. 6. 1903), Väster-götland: Alingsås (W).—Auct. ign.: Vermlandia, Vestrogothia, Toarp (BRNU).

Central Europe and Balkan Peninsula: A. Baldacci: (1900), Iter Albanicum Septimum (K, BM).—Balfours: (1858), Switzerland, Grimzeb (E).—W. C. Barton: (1921), Italy, Cortina, l'Ampezzo 4800' (BM).—Herb. Beck: (5 Juli 1893), Salzburg, Wildbad Gastein, Stubnerkogel 2200 m (PRC).—R. Behusch: (Juli 1897), Schweiz, Henthal bei Berninahäusern, Ober Engadin (WRSL).—M. O. Boggiani: (26 Giug. 1912), Fl. Verbano-Lepontica, Valle Formazza, Prati tra Fracchie e la foresta delle Casse (W); (28. Luglie 1913), Fl. Verbano-Lapontica, Valle Formazza, Sentiero per C. Ghighelo, boscaglie di alnobetule, 1750 - 2000 m (W, BM).—A. Boros: (31. aug. 1920), Fl. Hung., Comit. Szabolos. Inpratis humi-dis ad Bátorliget prope Nyirbátor, alt. ca. 140 m sm (BPH); (14. jul. 1923), Austria Inferior. Ad margines silvarum ad limites paludum prope Millerbach, alt. ca 800 msm (BPH); (6. aug. 1942), Fl. Hung., Comit. Csik. In pratis humidis ad rivos Ro-mán- et Bakta-patak pr. Gyeryóremete, alt. ca 700 msm (BPH); (2. aug. 1942), Fl.

Hung., Comit. Csik. In ripa Fluvii Maros infra pag. Marosfő. alt. ca 800 msm (BPH); (17 jul. 1942), Fl. Hung., Comit. Máramaros. In pratis montis Vrf. Prislopu supra pag. Borsabánya, alt. ca 800-1000 msm (BPH); (17 jun. 1943), Fl. Hung., Comit. Csik. In pratis humidis ad rivos Borzont prope Gyergyóalfalu, al. ca 780 msm (BPH).—Herb. J. Briquet: (1885), In montis Brezen alt. 1600 m (WA).—G. Bünauf: Fl. v. Oster. Ung., Frafoi: Weg nach Chorspitze (TRN); (26. 5. 1896), Westpreussen, Kreis Marienwerder, Waldschlucht bei Gr. Wessel Münsterwalder Fort (TRN).—A. Chiarugi, R. Corradi, R. Bavazzano: (4. Luglio 1956), Lombardia, La Brianza, Lago di Pusiano (Erba) m 258 (W).—G. Cufodontis: (20. 5. 1912), Iulische Alpen, Krain, Crna prst (W).—E. Chareżyńska: (20. 7. 60), Lublin, Zemborzyce Lubelskie, łąki w dolinie Bystrzycy (LBL).—M. Chmielewski: (24. 5. 1959), Lubelszczyzna, Klemensów koło Szczepieszyna, wilgotne łąki (LBL).—A. Degen: (25. 6. 1901), Pl. Hung., Comit. Csik. In monte Vöröskő supra Tölgyes (BP).—K. Domin: (8. 1914), Austria super., Alpes: in rupibus calcareis montis Pyrrgas prope opp. Windischgarsten 2100 msm (PRC).—J. Dostál, F. A. Novák: (28. 5. 1939), Bohemia: merid. in pratis paludosis apud piscinam prope pag. Chraštíčky situ sept. ab. opp. Mirotice, alt. 550 msm (PRC).—A. Ejsmond: (1885), Pow. Płock, okolice Bielska, miejscowość Goślice (WA).—W. Fertsch: (10. 8. 1965), Pow. Oborniki, Uścisko—Mokre łąki wśród pól (POZ).—D. Fijałkowski: (30. 5. 1961), Lubelszczyzna, Wolwinów k. Chełma, łąka węglanowa (LBL); (1. 10. 1962), Lublin, przy płocie na ul. Zachodniej k. Cukrowni (LBL).—E. J. A. Godeceau: (1894), Suisse, Mauvoisy val or Bagnes (BM).—Gürtler: (17. juli 1937), Transsilvania, distr. Năsăud. In pratis sub alpinis montis Corongisul mic Mtium Rodnensium, solo calcareo alt. cca 1500 msm (BP).—Heiland: (1897), Prowinz Brandenburg bei Tangersdorf (WA).—Gusulac et Topa: (28. 6. 1927), Romania, Distr. Câmpulung, góry Runc 700 m (BRNU).—E. Hejný: (12. 5. 1940), Sev. Morava: vřla louka pod silnici z Bohuslavic do Hvozda u Konice, asi 420 m. n. m. (PRC).—J. Hempel: (1868), Lubelszczyzna, Tuchowicz pow. Łukowski (LBL).—J. Heško: (1900), Braslav (PRC); (6. 1898), Hungaria, Brasso (BRNU).—A. Jastrzębska: (14. 5. 64), Lubelszczyzna, Wierzbie k. Zamościa (LBL).—J. Kiss: 31. 5. 1901), Transsilvania, In pratis montanis Szénafu prope opp. Kolozsvár (W).—R. Kobendza: (May 1927), Młociny pod Warszawą, las wilgotny (WA); Okolice Włocławka nad Wisłą (WA); (1924), Łąki pod Kampinosem (WA).—Kwieciński: (1891), Lubelskie, pow. Włodawa, Hańsk (WA).—H. Koporska: (5. 1922), Świdnik, Łąki nad Bystrzycą (LBL).—W. Korczewski: (15. 5. 1922), Duszniczki (POZ).—B. Kotula: (26. 5. 1877), Przemyśl, Kamieniołom Ostrowski (KRAM); Flora Tiroliae, Płaskowyż Secfeld z kier. NNW, 1130 m (KRAM).—F. Krawiec: (2. 6. 29), Promno, las mieszany nad jez. Dębiec (POZ); (20. 6. 1938), Pomorze, nadl. Dębowe nad Wisłą, las mieszany na płn. od Kozielca (POZ).—Kümmerle: (25. 6. 1911), Comit. Lika-Krbava Croatiae, Montes Velebit: in pratis subalpinis montis Crni vrh supra Iablanac alt. 1500 m (BP); (25. 6. 1910), Montes Velebit: in monte Goli vrh supra Iablanac, alt. 1670 m (BP).—E. Lemke: (13. 6. 1894), Ostpreussen, Kr. Heohrunen, Ebenau (TRN).—K. Łapczyński: Okolice Warszawy, Wólka Radzyńska (WA).—R. P. Murray: (1886), Switzerland, Monte Generoso-Ticino (BM).—Olszańska: (29. 5. 59), Kartuzy, Góra Zamkowa (TRN).—Paczoski: (5. 7. 1929), Bośnia, łąka śródleśna górską na Biełońnicy, Babin-dół (POZ).—B. Pawłowski: (1924), Alpy Szwajcarskie, "Les Valajnes", na pld. od Zernez, 1600 m (KRA).—F. Pax: (7. 8. 1896), Rodnaer Alpen, Bergwiesen um Kirlibaba, Kalk, 1200 m (BP); (13. 8. 1900), Ceahlauin der Moldau, Bergwiesen am Kloster Duraü, Kalk, 1000 m (BP); (12. 8. 04), Moldau: Brosteni-Barnar, Verfu Verdele, Glimmerschefer 1500 m, Bergwiesen (BP); (14. 8. 1906), Fl. moldavica, Feuchte Wiesen bei Javor Lesului an der Tarnita, Kalk, 1210 m (BP); (4. 8.

08), Bukovina, Bergwiesen am Berge Eva bei Pozorita (BP).—Payot: (1858), Suisse, Paturages alpestres, St. Aubin, Canton de Neuchâtel (PRC).—M. Pluchost: (1938), R. S. orientalis, Rachov, Mnt. Krasovsky (PR).—T. Pócs: (3. 8. 1960), Carpat orient., Gyergyói Medence. In pratis prope pag. Borzont, alt. 750 - 800 m (BP); (17. VII. 1955), In Carpat orient., in montibus Hargita. In pratis montis Nyintetö, supra pag. Csikmadaras, alt. ca. 1100 m (BP).—H. Preuss: (6. 1904), Fl. Prov. Westpreussen, Kreis Pr. Stargard (TRN).—M. Protiva: (30. 5. 1943), Středni Čechy, okolí Mělnika, 185 m (PRC).—K. Richter: (20. 6. 1891), Flora Carinthiaca, in jugo Predil. (PRC, W).—L. Rossi: Flora Croatica 6367, In pratis montis Risnjak (ZA); Fl. Croat. 12428, Velebit: In monte Zurkovac ad Krasno (26. 6. 1896) (ZA); Fl. Croat. 15270, Velebit: Lubenovačka viata 1471 m ad Alau (27. 7. 1907) (ZA).—L. Rzeszotko: (7. 6. 1958), Olechowce, w pobliżu Białej Góry, pow. Sanok (LBL).—Schiffnez (20. 5. 1886), Feuchte Wiesen bei Hadkowička n. Praha (PRC).—A. Schüller, Al. Borza: (7. 1913), Fl. Transsilv. Götzenburg (BP).—A. Schüller, W. Wangerin: (1912), Flora von Siebenbürgen, Fundort: Comit. Sceben, in pratis subalpinis montis Götzenberg alt. ca. 1000 m (TRN).—R. J. Shuttleworth: (1877), Helvetia, Bors au pied du Pir Padella près de Samaden (BM); (1878), Apeninis (BM).—A. K. Siemionow: (1887), Okolice Płocka, w lesie (WA).—S. Śliwińska: (14. 6. 1957), Lubelszczyzna, Stryjów pow. Krasnystaw, suchy płat łąki (LBL).—A. Sterneek: (Ende Juli 1900), Fl. Tiroliae aust., Gröduerthal: Umgebung von St. Ulrich (PRC).—Straube: (1861), Westpreussen, Kreis Elbing, Fundort: Schönmoor (TRN).—L. Thaisz: (14. Jun. 1907), Fl. Hung., In catena montis "Hargitta" supra pagum Bethlenfalva, Com. Udvarhely (BP).—G. Thring: H. 965/34, Voralpen (K).—Treffer: (25. 5. 01), Tirol, Wiesen feuchten Stellen um Kutlach 1000 - 2000 m (W).—J. Trzebiński: (5. 1898), Królestwo Polskie, Garwolin, zarośla leśne, bagniska (KRAM).—A. Wangerin: (8. Juli 1925), Flora von Tirol, Vent im Oetzal, Matten bei Raofen (TRN); (25. Juli 1930), Flora von Wallis, Matte an der linken Seite des Täschtales unterhalb der Täschalp bei Zermatt, bei ca 2100 m (TRN).—E. Werdermann et D. Meyer: 31 (25. 7. 1956), Dolomiten, Col. de Cuc 2400 m (K).—L. Vajda: (15. jun. 1936), Transsilvania meridionali-orientalis, in monte comit Brasso, in pratis alpinis, alt. cca 1700 m (BP).—J. Vepřek: 266, 280 (1943), Kutna Hora (PRC).—N. Vyhodcevski: (15. 6. 1955), Mt. Vitosha, in pratis alpinis humidis prope Aleko, ad cca 1700 m (W).—E. Zádor: (6. jul. 1942), Fl. Hung., Borszék-Erdei tisztáson, 1000 m (BP).—Żmuda: 180. 6 (19. 8. 1909), Łysogóry: Łysa Góra, pow. Kielce, na łące Bielnik licznie, kwitnie w czerwcu (KRAM); Łysogóry, Trzcinka, pow. Kielce, mokre łąki, kwitnie w sierpniu (KRAM).—H. Żerny: (24. Juli 1919), Nord Tirol, Uppige subalpine Wiesen in Stevisbachtal bei St. Anton am Arlberg (W).

Eastern Europe: S. Arefev: Flora Verchoturskago uezda, Permskoj gub., g. Verchoturse (WA).—K. Baecker: (17. 5. 1928), Podborce koło Lwowa, na torfiastej łące (Mąd.).—Brazaitis: Litwa, Łotwiany (KRAM).—A. Chorschkov 902 (1900), Prov. Mosqua, distr. Zwenigorod, in silvaticis pg. Darjino (Wa, LE).—K. Domin, M. Dejl: (7. 1930), Rossia Subcarpatica: montes Svidovec ad declivia montis Tatulska (PRC).—K. Drymmer: 1881, Hanuszyszki, gub. Kowieńska (WA).—H. W. Feilden: (1895), Kolguiev (K, BM).—W. Grochowski: Okolice Dorpatu (WA).—L. Gruner (1860), Dorpat (BM).—M. Kotov, T. Omeltzuk: (12. 7. 1957), Czernovickaja Olb., okr. c. Shepot, Kutscoe lesnich., v elovom lesu na polyane (PRC).—M. B. Kondratowicz: Okolice Grodna, m. Hoża (WA).—M. Łańcucka: (29. 7. 1939), Karpaty Wschodnie, Gorgany, Symela 1750 m (KRAM).—J. Mądalski: 2639 (12. 8. 1930), Czarno-Hora, na ścianie Breskuła (Mąd.).—A. Mochlińska: (1893), Kiwirce, pow.

Łuck (WA).—J. Nevola: (Julio 1922), Podkarpacka Ruś, Hoverla 1800 m (BRNU).—J. Paczoski: (16. 8. 1897), Szarki na Podolu, pow. Łatyczewski (KRAM); Okolice Kijowa (LE).—B. Pawłowski: (1934), Carpati Orient., M-tes Czywczynenses, Kamień pod Pertuczynem, wys. 1465 m (KRA); (1935), Carpati Orient., Czarnohora (KRA); (1934), Carpati Orientalis, Góry Ludowe (KRA).—R. Pohle: (1902), Insula Kolgujew (K, LE).—M. Poyarkiva: (16. 6. 1941), Leningradsk obl. Oranienb., r-nk zap. ot g. Cerchnie Cenki, elovii les, po polyanam (W)—Z. Pietkiewicz: (1910), gub. Kijów, p. Wasylków, wieś Stepanowska (WA).—E. Radoniówna: (1894), Lithuania, Hołenty, distr. Wilkomierz, po łąkach (KRA), BM, LE).—W. J. Reinthal: (1927), Estonia, Vorumaa, parish of Põlva, not far from Voru (KRA).—P. W. Sherrin: (1917), Kola Peninsula (BM).—A. Śledziński: (14. 8. 1860), Borszczów ku Balińcom (KRAM); (14. 5. 1879), pow. Zaleszczyki, Wieszanki w Nagórzanach (KRAM); (20. 7. 1879), Wierzbiatyn pow. Buczański (KRAM); (24. 5. 80), Kamionka Mała, pow. Kołomyjski (KRAM); Pospolity po lasach koło Tarnopola (KRAM).—R. Sobkiewicz: (14. 5. 1875), Żytomierz (KRAM); (4. 6. 1877), Żytomierz, okolice (KRAM).—A. Środoń: (25. 7. 1934), Karpaty Wschodnie, Hlystowaty, łąka nad potokiem dzielącym Hlystowaty od Prełuk (KRAM).—W. Szafer: (1908), Danczerz w paśmie Czarnej Hory (KRA); (30. 5. 1909), lasy oknińskie w Miodoborach (KRAM).—Straube: Ostpreussen, Aweiden b. Königsberg (TRN).—Szubert: (1826), Litwa, Ząbki (WA).—St. Trzebiński: (6. 1930), Wilno, las (LBL).—M. Twardowska: (5. 1903), Korzeniów pow. Pińsk (KRAM).—J. Wodzińska: (1911), Gub. Mińsk, pow. Słuck, Bobownia (KRA).—D. F. Wołoszczak: Lithuania, Hołenty koło Wilkomierza (LE).—Auct. ign.: J. B. B.: (7. 5. 1911), Brzeg Wołynia, łąka koło nadpłetwieńskiej dębiny w Lesienicach pod Lwowem (KRA, BRNU, UW, Mąd.).

Note: For *T. europaeus* var. *europaeus* and var. *transsilvanicus* only those herbarium sheets are quoted on which it was possible to distinguish with certainty the above named varieties; these specimens constitute only a small part of the material collected.

Trollius europaeus L. var. *transsilvanicus* (Schur) Bł.

Blocki, Oest. Bot. Zeitschr. 31: 149 (1881); Zapalowicz, Consp. Fl. Galiciae crit. 2: 189 (1908); Fl. Rep. Pop. Romane 2: 412 (1953); Szafer, Kulczyński, Pawłowski, Rośl. Polskie 163 (1953).

Syn.: *T. transsilvanicus* Schur, Enum. pl. Transs. 26 (1866); *T. europaeus* L. ssp. *transsilvanicus* (Schur) Jávorka, Fl. Hung. 325 (1924-1925); Fl. Europ. 1: 210 (1964); Karolyi and Pócs, Acta Acad. Paed. Agr. 6: 377 (1968); *T. europaeus* L. ssp. *transsilvanicus* (Schur) Dom. ex Dostal, Kvetena ČSR 182 (1950); *T. Tatrae* Borb., Ost. Bot. Zeitschr. 42: 421 (1891) *T. europaeus* L. var. *Tatrae* Borb., Geogr. atque enum. plant. Comit. Cast. Hung. 244 (1887); *T. europaeus* L. ssp. *Tatrae* (Borb.) Pócs et Balogh in Karolyi and Pócs, Acta Acad. Paed. Agr. 6: 377 (1968).

Ic.: Stojanov and Stefanov, Fl. Blg. 44 a, Fig. 481 (1948); Karolyi and Pócs, Acta Paed. Agr. 6: 378 Fig. 29, 30 c d (1968).

T. europaeus var. *transsilvanicus* differs from *T. europaeus* var. *europaeus* by longer styles in the flowers and longer beaks on the follicles (Fig. 12 j). These beaks are straight or bent back, 3-5 mm in length,

reaching sometimes even 6 mm. Frequently *T. europaeus* var. *transsilvanicus* specimens growing in the mountains at the alpine level on exposed slopes are small, 10–20 cm high, with unbranched shoots and one flower at the tip; the perianth is small and half open, its outer leaves are almost flat and rhomboidal. Specimens, however, growing on less exposed sites and at lower mountains levels or in the foothills reach larger dimensions and their general habitus does not differ from that of *T. europaeus* var. *europaeus*. They have large spherical flowers, the perianth leaves are oval and concave. $2n = 16$.

Distribution: Central Europe, in the Carpathian Mts. and on the Transsylvanian Upland, in the Sudetes and Erz. Mts., in the Bohemian basin on the Bohemian-Moravian Upland and in the Eastern Alps and their foothills, and in the Dinaric Alps. *T. europaeus* var. *transsilvanicus* grows mainly in the mountains but may also be found on the lowland, for instance in Poland in the environs of Cracow and Miechów.

Specimens examined:

Field observations: in the Polish and Slovakian Tatra, Gorce, Bieszczady, the Tatra foothills and in the Sudetes and Karkonosze.

Cultivated: H/7—brought from the Gorce (Turbacz meadow); H/11—from Bieszczady (Krzemień slopes); H/13—Polish Tatra (Morskie Oko); H/23—Polish Tatra (Czerwone Wierchy); H/26 and H/27—Bieszczady (Polonina Wetlińska); H/39 and H/40—Lipny Dół (reservation near Miechow, H/166—Sudetes (environs of Duszniki).

Herbarium specimens: Central Europe and the Balkan Peninsula: A. Boros: (15 jul. 1933), Comit. Szepes. In pratis ad fluv. Poprad sub monte Baba prope Lucivna, alt. ca. 740 m (BPH); (17 jul. 1933), Comit. Bereg. in pratis montanis silvarum apertis Voscescat vrch pr. Volóc, alt. ca 1000 m (BHP).—Bieniarz: 99.231, Załęże (KRAM).—F. Čouka: (23. 6. 1911), Morawy, Vyškov, u dolí Horě Velké (BRNU).—H. Czeczott: (5. 8.), Tatry Zachodnie, Czerwone Wierchy od strony S pod Krzesanicą w *Juncetum* czy *Luzuletum* (KRAM).—Cieciura: (23. 6. 1965), pow. Kłodzko, m. Kuklin, łąka przy strumieniu z płn. w. strony wsi (Mąd.).—J. Daska: (22. 7. 1920), Slovakia: Vysoké Tatry, Sedlo Kopa 1756 m (PRC).—M. Deyl: (1940), Bohemia boreo-orientn., Česov, Česovské valy (PR); (1952), Silesia septentrionalis: Montes vysoké Jeseníky 1300 m (PR); Bujači, Tatry (PR).—R. Doležal: (5. 1933), Brno, u Račic, 380 m (BRNU); Brno, u Jedlůwnic udolí Rakovce, 440 m (BRNU); (11. 8. 1927), Moravy, na louce u Sucheko Ždarna (BRNU).—Dörfler: Austria Inferior, ad Wöglérin prope Kaltenleutgeben, 500 m (E).—J. Dostal: (30. 8. 1928), Liptovské Hale, k. Dolního Plesa Rohacskeho (PRC); (5. 8. 1933), Montes Tatry, Giewont, alt. 1600 m (PRC); Bohemia septentr.: distr. Teplice-Sanor, pratis humidis apud opp. Přistavky, 200 msm (PRC).—K. Drymer: (1890), Podlězyce pod Sieradzem (WA).—B. Gustawicz: (7. 1880), Pieniny, Polana Huta nad Dunajcem (KRAM).—A. Hayek: (1908), Stiria media, ad viscum Grasehuh prope pagnum Stainz, 350 m (BM, E).—A. Hrabětova: (16. 5. 1936), Česk Budejovice, u potoka Lomnica (BRNU); (1950), Slovakia, Nizke Tatry, montis Dumbir (BRNU).—D. Hryby: (Juli 1911), N. W. Ungarns, Hohe Tatra, Poggersee (BRNU).—W. Jabłoński: (20. 5. 1856), Łagiewniki (KRAM).—Wł. Jabłonowski: (5. 1865), Łąki łagiewnickie, okolice Krakowa (KRAM).—P. Jávorka: (23. aug. 1955), Fl. Hung., Veszprém-m: Ta-

polcafiő, Ilka-pusztá, a Kalapács-ermenten, lápos reten tömegesen (BP).—Fr. Jirásek: (10. 5. 1934), Moravia Centr.: Brno, f. Říčka, pagnum Ochoz, ca 350 m (BRNU); Moravia Centr.: Brno ad pagnum Jedovnice, ca 480 m (KRA).—Jlmar: (24. 8. 1958), Tatry, Czerwone Wierchy, Małołączniak (BRNU); (25. 8. 1958), Tatry Liptovské, dol. Tomanova, 1685 m (BRNU).—I. Klustersky: (1943), Boh. Orient., Rovenský Rybník ad Česká Skalice (PR); (1949), Bohemia septentrionalis, montis Pustý Zámek, okolo Doupov, 650 - 700 m (PR).—E. Kuźniewski: (23. 7. 1965), pow. Kłodzko, m. Leśna, łąka nad strumieniem pod lasem na płd. w. od wsi (Mąd.).—W. Kulczyński: (maj 1875), Las Krzyżkowicki (KRAM).—B. Kropaczek: (1902), Tatry, przy wejściu na Polski Grzebień (KRA).—Maly: (18. 6. 1908), Bośnia, Romanija Polonina, Javorcu dol. ca 1300 m (BRNU).—Łapczyński: (1881), Tatry, Czerwony Wierch (WA).—J. Maďalski: 6159 (29. 8. 1934), Rumunia, Góry Bardowskie, na stromym stoku połoniny Pelesta na wsch. ramieniu Budyjowskiej M. ok. 1520 m (Mąd.); L. 15885 (31. 5. 1952), Góry Sowie, Brzeźnica, pow. Ząbkowice Śl., na łączce na płn. skraju lasu w pobliżu koty 372, na płd. zach. od wsi (Mąd.); L. 17118 (17. 6. 1954), Św. Katarzyna, pow. Kielce, na mokrych łąkach nad Czarną Wodą wśród lasów jodłowo-sosnowych (Mąd.); L. 20152 (10. 7. 1958), Hrabušice, pow. Spišská Nová Ves (Mąd.).—F. Nábělek: (15. 5. 1904), Dol. Rakousy: Höllental b. Pagerback (BRNU).—A. Oborny: (27. 5. 1880), Flora von Mähren, Wiesen am Schimberger, Fichte bei Schönwald-Fraun (BRNU).—B. Pawłowski: (1925), Tatry, przełęcz Mały Giewont, wys. 1700 m (KRA).—H. Piotrowska: (23. 6. 1954), Tatry, Małołączniak (POZ).—K. Povli: Rumunia—Buczacz, Valea Polesy (BRNU).—T. Pócs: (11. 5. 1960), Hungaria occ.: Göcsej. In pratis pr. pg. Nova (BPH).—J. Podepera: (1893), Mł. Bolesław, louka pod Chlumem (BRNU).—Rudski: (16. 7. 1930), Šarplanina: mt. Orman, ca 2000 m (BRNU).—L. Simonkai: (14. jul. 1908), in pratis inter Poprad et Batiszfalu (BP); in pratis secundo fluv. Poprad inter Poprad et Batiszfalu (BP).—J. Šmarda: (29. 5. 1957), Tatranská Kotlina, Tatry, 650 m (BRNU).—M. Smejkal: (30. 5. 1958), Slovakia, Poprad, supra pagum Primovce, distr. Levoca; (26. 5. 1964), Slovakia, Poprad (BRNU).—P. Sillinger: (30. 7. 1930), Nizke Tatry, Krakova Hala, porosty kosodreviny, 1600 m (PRC): (1. 6. 1931), Nizke Tatry, Kráľova Lehota, louky v údolí Čierneho Váha, 700 m (PRC).—K. Stejskal: (22. 7. 1909), Velký Kotel w Krkonoších (PRC).—J. Suza: (14. 6. 1960), Slovakia, montis m. Glac, ca 900 m (BRNU); (7. 6. 1914), Moravy, Ferdinansko u Vyškova (BRNU).—J. Schneider: (13. 7. 1903), Niederösterreich, nördl. Kalkalpen, Schneeberg, Krummbachgraben (W).—P. Thompson: (7. 1932), N. W. Jugoslawia, Flora of Bośnia 141, loc. Trescavia Planina (K).—K. Vandaz: (1910), Bosnia (PR).—I. Vitoušek: (12. 8. 1902), Upolin Zapadni, Bělohrad, na louce (BRNU).—Z. Wędzicha: (1952), Śląsk Dolny, pow. Kłodzko, Zieleniec koło Dusznik (WA); (8. 6. 1952), Pratum silvaticum in Zieleniec ad Duszniki apud Kłodzko (Mąd., WRSL).—Herb. Zahlbruckner: Obersteyer im Thale bei m. Steyerhof (PRC); Obersteyer, auf feuchtem Wald und Bergwiesen in Grass (PRC).

T. europaeus is common on almost the whole territory of Europe and is the earliest known and described species of the genus *Trollius*. It is mentioned as early as in prints of the 16th and 17th cent., although many a time these first authors denoted *T. europaeus* as *Ranunculus* or *Helleborus* (Gesner, 1555; Dodonaeus, 1583; Pancovius, 1673). It was finally Linnaeus who gave a formal description of *T. europaeus* and is the author of this species as well as of the genus *Trollius*.

Later, among the representatives of *T. europaeus* numerous new

Fig. 12. Fruits and leaves of *Trollius ranunculinus* and *T. europaeus* (single fol-
licles 2 × life-size, follicles in heads and middle segments of the basal leaves
life-size)

T. ranunculinus: a, b—Turkey, Prov. Hakkari, Kara Dag, leg. Davis, 24357 (E); c—Turkey,
Prov. Van, leg. Davis, 45907 (E); d, e—Turkey, Prov. Coruh, leg. Davis, 30349, (E); f, g—
Turkey Prov. Kars-Kisir, leg. Davis, 30557 (E)

T. europaeus: i—H/54, j—H/23; k—Bavaria, leg. Puchtler (1906) (E); l—Pyrenees Mts (1873),
auct. ign. (K); m—Switzerland, leg. Balfour (1858) (E); n—Subalpinis Carinthia, Herb. Bal-
four (E); o, p—Walia, leg. Price (1820) (E); r, s—Västergötland, leg. Uhlemann (1890) (E)

taxons were distinguished and described as species, subspecies, varieties and forms. The pertinent literature is extensive and the discussion of all these papers would take too much space. In general, in the establishment of these new taxons the differences in the dimensions of the entire plants and in the leaf, flower and fruit structure were taken into account. For instance, particularly small specimens have been several times described as *T. humilis* Cranz, *T. europaeus* L. var. *humilis* (Cranz) DC, and also as *T. minimus* Wender. *T. napellifolius* Roep. established by Roepert (1820) had deeply incised leaf laminae, however, those of *T. europaeus* may be dissected in various degrees. It is seen on more extensive material that this character is continuously variable like in other *Trollius* species (Fig. 12 m - s).

The specimens with particularly large flowers cultivated in gardens were named *T. grandiflorus* hort. or *T. tauricus* hort; on the other hand, specimens with greenish flowers were described as species *T. viridiflorus* Schur, *T. viridis* Mielichh, and *T. chloranthus* Hausm. The observations concerning these species are not accurate, since well developed flowers of *T. europaeus* are always of a relatively uniform yellow colour close to Auroeolin 3 according to the "Horticultural Colour Chart". Some specimens may, therefore, have only perianth leaves greenish injected, and the perianth not opened yet in the bud may frequently be green.

In some flowers the perianth outermost leaves are dentate. These minute differences were also taken into account; for instance Zapalowicz (1908) described such specimens as forms of *T. europaeus* L. f. *lobatus* and f. *denticulatus*. *Trollius* plants frequently have leaves of a form intermediate between cauline and perianth leaves. They may even be dentate and sometimes partly yellow and partly green. This has been observed not only in *T. europaeus* (Roivainen, 1936), but also in *T. asiaticus* and other species (Fedorov, Nikitin and Pankova, 1950, and the author's own observations).

The follicles of *T. europaeus* have various shapes and beaks of various length. Populations with longer beaks occur mainly in the Balkan, Carpathian and Tatra Mts. in the Sudetes and Eastern Alps. Specimens from Transsilvania (Roumania) were described by Schur (1866) as *T. transsilvanicus* Schur, and Borbás (1887) established in the Tatra Mts. *T. tatrae* Borb. On the basis of differences in the length of the style and beaks, Zapalowicz (1908) reported three more forms of *T. europaeus* L.: f. *longirostris*, f. *brevirostris* and f. *microstylis*.

Many such examples as those given above may be quoted. They point to the variability of the morphological characters in *T. europaeus*; it appears at the same time that even small insignificant morphological differences have given grounds to the establishment of new taxons. The above mentioned characters are too variable to have any taxonomic importance. Therefore, most of the taxons established have been treated

later as synonyms of *T. europaeus*. Only the difference in beak length is a relatively constant character connected with definite areas. Contemporary floras include within *T. europaeus* lower taxonomic units, differing from one another mainly by the length of the style and beak.

Some authors distinguish, besides representatives of *T. europaeus* with short beaks, also specimens with beaks 4-5 mm long giving them the name *T. europaeus* ssp. *transsilvanicus* or var. *transsilvanicus*. These taxons are treated as synonyms of *T. transsilvanicus* Schur and *T. Tatrae* Borb. (Błocki, 1881; Hayek, 1927; Dostal, 1950; Flora Republicii Populare Romana, 1953; Szafer, Kulczyński and Pawłowski 1953; Flora Europaea, 1964).

Other authors like Jávorka (1924-1925) and Soó (1966) establish a third taxon with medium-sized beaks ca. 3 mm long. It has been described by Borbás (1887) as *T. europaeus* L. var. *demissorum* Borb.

Karolyi and Pócs (1968) report four subspecies of *T. europaeus* L.: ssp. *europaeus*, ssp. *demissorum* (Borb.) Jáv., ssp. *transsilvanicus* (Schur) Simk and ssp. *tatrae* (Borb.) Pócs et Balogh. Specimens of ssp. *tatrae* distinctly differ from those of ssp. *transsilvanicus* by the shape of their follicles and beaks (Karolyi and Pócs, 1968, Fig. 29, 30).

The present author has observed numerous natural populations of *T. europaeus* in Poland, performed some experiments on plants cultivated in gardens and studied extensive herbarium material. It results from these studies that the beak length in *T. europaeus* is variable ranging from 0.5-6.0 mm. This character depends on the action of numerous polygenes. In crosses of *T. europaeus* var. *europaeus* (beaks 1.0 mm) with *europaeus* var. *transsilvanicus* (beaks 5.0 mm) the F_1 progeny had beaks ca. 3.0 mm long, and in the F_2 specimens the beaks varied in length between 0.5 and 5.0 mm. It would result from these observations that the beak length is a character with continuous variability. Herbarium material gives the same picture. Although *T. europaeus* populations with long beaks occur mostly in the mountains of central Europe, they also descend onto the lowland. On the same areas specimens may be found with short beaks or of intermediate length, and there is no clear-cut difference between them.

On the illustrations presenting the four subspecies of *T. europaeus* given by Karolyi and Pócs (1968, Fig. 27-30), the differences in the morphology of the follicles are very distinct. Most specimens from the Tatra actually have follicles like those on the drawing by the above mentioned authors for ssp. *tatrae*, but such specimens may be found not only in the Tatra, but also in other areas. In herbarium material, specimens with fruits typical for ssp. *demissorum* and ssp. *transsilvanicus* (Karolyi and Pócs, 1968, Fig. 28-30), are relatively rare. Most plants have follicles of intermediate form.

It should be also taken into account that in other *Trollius* species

a high variability is noted in the form of the fruits, for instance in *T. ranunculinus*, thus, this character has no taxonomic value.

In this situation it seems reasonable to distinguish only populations with long and short beaks, but in the rank of variety and not of subspecies. The establishment of the difference between these taxons is a relative matter. Flora Europaea (1964) gives for ssp. *europaeus* stigmata up to 3.0 mm long and for ssp. *transsilvanicus* 3.0 - 5.0 mm long. This is acceptable if no third taxon with an intermediate beak length is distinguished. For the var. *europaeus* it is given here a beak length of 0.5 - 2.5 mm, but actually in the typical *T. europaeus* var. *europaeus* the length of the beaks should not exceed 2 mm. This problem will be elaborated in more detail in a separate publication.

Trollius apertus (Perf.) Igosh.

Igoshina, Bot. Journ. USSR 53, 6: 779 - 94 (1968).

Syn.: *T. uralensis* Gorodkov (Herb. LE); Fl. Europ. 1: 210 (1964); *T. europaeus* L. var. *apertus* Perfilev, Fl. Sever. Kraya, 2, 3: 112 (1936); *T. apertus* Perf. (Herb. Inst. Biolog. Ssyktyvkar ex Igoshina, 1968).

lc.: Igoshina, Bot. Journ. USSR 53, 6, Ris. 1 (3, 4, 8), Ris. 2 (2), Ris. 3. (1968).

Type: A. Tolmatchev, ad flumen Krassnaja, in insula Vajgacz, 17 Aug. 1934; Herb. Ssyktyvkarensi; ex Igoshina 1968; n. v.

Description according to Igoshina (1968, p. 793): „*Radix fibrillosa, fibrillis uniformibus; caules 1-2, simplices, glabri, 40-60 cm alti; folia radicalia pauca, caule quadruplo breviora, glabra, lamina orbiculari, 6-7 cm lata, in lacinias 5 rhombes, ad trientem vel medium bis incisas, margine dentibus inaequilongis, brevibus obtusatis, rarius acutatis ornatas, saepium sibi invicem adhaerentes (f. latisecta), rarius and 2-3 mm remota (f. angustisecta), fissa; folia caulina pauca, 1-2 inferiora petiolis abbreviatis praedita, lamina ei foliorum radicalium simili, superiora sessilia, lamina in segmenta 2-3 oblonga dissecta; flores 1-2, globosi, verticaliter vix applanati, 3,5-4,0 cm in diam., semiaperti; sepala 13-15, exteriora late obovata vel orbicularia, 18-20 mm longa, 20-22 mm lata, interiora ovalia vel anguste obovata, 18-20 mm longa, 11-12 mm lata, citrina, intense lutea vel pallide aurantiaca; petala (nectaria) oblonga, 11-14 mm longa, in quadrante vel triente superiore ad 1.2-2.2 mm dilatata et apice obtuse cuneiformia, deorsum ad 0,7 mm sensim angustata, in unguem 1.5 mm longum, 0,5 latum abeuntia, in quadrante superiore aurantiaco-rubra, infra flava, unguebus flavidis; nectaria canaliculata, glabra, supra unguem sita; stamina numerosa, pallide flava (filamentis interdum vix aurantiacis), matura 8-9 mm longa, petalis breviora vel rarius eis subaequilonga, antheris maturis and 2 mm longis; fructus e folliculis numerosis capitatum congestis constans.*

In partibus polaribus, subpolaribus et raro borealibus montium uralensium, in promontoriis occidentalibus, in parte orientali tundrae Bolschезemel'skaja dictas et in insula Vajgacz, in pratibus montium inundatis et subnivalibus, in salicetis tundrarum, in silvis collucatis herbosis.

Typus specimina ad flumen Krassnaja, in insula Vajgacz, 17 Aug. 1934 a A. Tolmatchev collecta, in Herbario Ssyktyvkarensi conservanda.

Affinitas. T. europaeo L. et T. asiatico L. proximus, sed a specie prima floribus semiapertis, petalis quam stamina vulgo longioribus, oblongis, in quadrante vel triente superiore dilatatis et apice angustatis, sepalis haud raro pallide aurantiacis differt est, a specie secunda petalis quam sepala brevioribus, sepalis saepium luteis distinguitur". 2n = 16.

Distribution: U.S.S.R. Northern Ural, in polar, subpolar and boreal zones. An exact map of the distribution of *T. apertus* is included in the work of Igoshina (1968).

The geographical ranges of only two *Trollius* species reach to the Northern Ural: of *T. europaeus* and *T. asiaticus*, taxons with a distinctly different morphology. On this territory numerous *Trollius* specimens have been found differing from both these species, but with a number of intermediate characters between them. They were first described as *T. europaeus* L. var. *apertus* Perf. In herbarium collections specimens have been preserved which Perfilev named *T. apertus* (Herb. Ssyktyvkar.) as a separate species. Also Gorodkov considered his *Trollius* collection from the Northern Ural as a new species and named it *T. uralensis* (Harb. LE), but neither the first nor the second author published a description of these species newly established by them. It was Igoshina (1968) who gave an accurate description of this taxon as *T. apertus* preserving for it the rank of species.

The investigations of Igoshina on natural *Trollius* populations performed in the Northern Ural demonstrated that *T. apertus* is derived from a cross. In general the morphology of these plants is intermediate between *T. europaeus* and *T. asiaticus*, but it is not uniform and there are wide differences between the particular populations. In the western part of the Northern Ural the *Trollius* populations have more characters in common with *T. europaeus*, whereas in the eastern part of this range they are closer related to *T. asiaticus*. As reported by Igoshina, *T. asiaticus* migrated to the Ural region from the mountains of Southern Siberia. This was possible after recession of the glaciers from Western Siberia (Zyryansk glaciation). After occupying the northern basin *T. asiaticus* descended on the lowland and migrated to the north along the Yenisei river valley. It reached the Yamal Peninsula, and advanced further in western direction. *T. europaeus* arrived to the Northern Ural from Europe, thus from the west or from the Southern Ural. The two

species met in the Northern Ural Mts., and the newly arising hybrids found there appropriate conditions of life. At present, *T. apertus* populations prevail on subalpine meadows and on the tundra of the Northern Ural, while *T. europaeus* occurs mainly on the foothill meadows of the western part of the range and in forest and forest-steppe regions of the mountains. Typical *T. asiaticus* is mainly found on the eastern side of the mountains (Igoshina, 1968).

The present author's observations on the morphology of the plants from Northern Ural performed in the BIN Herbarium in Leningrad agree completely with the data of Igoshina. The artificially obtained hybrids *T. asiaticus* $\times$ *T. europaeus* were as a rule similar to *T. apertus*; they had open flowers and honey leaves similar to those of *T. apertus* (Igoshina, 1968, Ris. 2 (2)). F_1 hybrids in these crosses were but little fertile, but it was possible to obtain an F_2 generation as well as the progeny of the recessive cross $F_1 \times T. asiaticus$; the latter hybrids were very close to *T. asiaticus* (author's unpublished experiments). The results of the above mentioned experiments fully confirm the hypothesis of Igoshina concerning the hybrid origin of *T. apertus*.

The differences in the population of *T. apertus* in the eastern and western part of the Ural mentioned by Igoshina indicate no doubt that we are dealing here with the phenomenon of introgression (introgressive hybridization according to E. Anderson, 1949). The new taxon, therefore, is not isolated from its parent species, and consequently, its differentiation is not complete. This arouses doubts whether in this situation its rank is not too elevated, and whether it should be treated as a new species. At first sight it would seem better to leave it as *T. europaeus* var. *apertus*. It should, however, be taken into account that it does not exhibit a distinct prevalence of morphological characters of one of the parent species, what would justify its treatment as a subspecies or variety of one of them. Therefore, these plants may be treated only as hybrids or considered as an independent species still in the course of formation. In the present study the latter eventuality has been adopted.

Other cases are known in the genus *Trollius* when the given species has characters intermediate in relation to two other species, e.g. in the sections *Longipetala*, *Pumilotrollius* and others. Thus, the example of *T. apertus* does not stand alone. In those others cases, however, we are dealing with closely related species within one section. *T. apertus*, however, combines not only traits of two species, but also of two completely different sections. In the present work *T. apertus* has classified to the section *Trollius* because its honey leaves are different from these in the *Longipetala* section to which *T. asiaticus* belongs. Honey leaves of this type may be found in the section *Trollius*.

C. A. Meyer, Verz. Pfl. 200 (1831); Ledebour, Fl. Ross. 1: 73 (1842); Huth, Helios, 9, 1: 3 (1892); Krylov, Fl. Alt. 1: 33 (1901); Krylov, Fl. Sib. Occident. 5: 1122-23 (1931); Schipczinsky, Bull. Jard. Bot. Rep. Russe 23: 67 (1924); Fl. SSSR, VII: 45 (1937); Fl. Uzbek. II: 436 (1953); Fl. Kazakhst. IV: 14-15 (1961); Malyshev, Fl. alp. sajan. 123-24 (1965); Illjust. opred. rast. Kazakhst. 1: 365 (1969).

Syn.: *T. caucasicus* (non Stev.) Ledebour, Fl. Alt. 2: 301 (1830).

Ic.: Ledebour, Ic. Pl. Fl. Ross. 4, Tab. 345 (1833); Fl. Kazakhst. IV, Tab. II, 10 a (1961); Brühl, Ann. Roy. Bot. Gard. Calc. 5, Pl. 113, Fig. 80, 9 n (1896); Doroszewska, Acta Soc. Bot. Pol. 39, Fig. 1 b (1970).

Type: Altai (in Leningrad acc. to Fl. SSSR, VII: 45 (1937) n.v.

Shoots straight, erect, branched or single with 1-3 flowers at tip. During flowering 15-60 cm, at the time of fruiting up to 80-100 cm long.

Basal leaves petiolate up to 30 cm long, 5-sected of highly variable shape. Most plants have thin leaves with ovally elongated segments dissected into lobes (e.g. Fisiyum, 1961, LE), some specimens have exceptionally narrow and elongated segments (e.g. H/133; Popov, 1936, E). The leaf segments may also be broad-oval, leathery, broadly dentate on edges and not dissected into narrow lobes (e.g. Titov, 1915, E; Sokalski 180, BM, E). Cauline leaves 2-4, lower ones on petioles up to 10 cm long, upper ones sessile or almost so; their laminae are similar to those of the basal leaves, but their size decreases up the stem. Frequently they are provided with leaf sheaths; the sheaths at the sessile leaves have rounded ears.

Flowers open with well visible dark stigmata in the centre (Pl. XII a) frequently distinctly protogynous. While the stigmata are already mature, the perianth leaves still are in the initial stage of development: minute and green; they gradually mature and take on an orange hue. Fully developed flowers are golden-yellow or orange (Safron yellow 7, Cadmium orange 8 or Tangerine orange 9) they have the shape of bowls, exceptionally they may be spherical and closed (Pl. XII a, b); they are 3-6 cm in diameter and odourless.

Perianth leaves generally 10-15, exceptionally more or less down to five; 13-28 mm long; outermost leaves wide ovate or cordiform, those closer to the centre narrow and oval; the tips are sometimes minutely dentate and greenish.

Honey leaves usually 10-12; 6-11 mm long, 1.0-2.3 mm wide of variable shape: linear rounded at tip or with slight indentation (Fig. 11 b, c), spatulate (Fig. 11 a, d) or pear-like elongated (Fig. 11 e); blades thickened, convex, glistering, brilliant orange-coloured (Tangerine orange 9,

Orpiment orange 10). Nectary pit in the form of shallow pocket somewhat distended, at a height of 1.0 - 3.0 mm from base; unguis may be somewhat deflected from leaf axis. Stamina equal to honey leaves or nearly so (Fig. 11 a - e), 8 - 14 mm long including anther length 3 - 4 mm. Pistils numerous with dark purple stigmata (Oxblood red 00823 (3), this colour descends to the ovary.

Note: *T. altaicus* C.A.M. var. *sajanensis* Malyshev has yellow stigmata.

Follicles in head 12 - 30, 12 - 17 mm long including beak length 1 - 3 mm, sometimes exceptionally 4 mm; beaks straight, sometimes slightly inclined inwards. Seeds in follicle on the average 4 - 5, oval, black. Flowers June - July. $2n = 16$. Cultivated as ornamental plant.

Distribution: U.S.S.R., Central Asia: northern part of Pamir-Alai region; regions: Syr-Daria, Thien-Shan, Hungarian-Tarbagatai, Balkhash; Western Siberia: Altai region; Eastern Siberia: North-West Agara-Sayan and south Lena-Kolyma regions; North-West China (Thien-Shan); Western Mongolia.

The geographical range of *T. altaicus* extends in the mountains of Central Asia and Siberia from south-west to the north-east beginning from the Pamir-Alai through Tien-Shan, Dshungaric Mts., Altai, West Sayan, East Sayan, Stanovoi Mts. up to eastern part of the Stanovoi range. The range of *T. altaicus* extends in its major part on the territory of the U.S.S.R., it encroaches on the territory of China in the Tien-Shan Mts. and of Mongolia in the Mongol Alai (Fig. 13).

Specimens examined:

Cultivated: H/20 grown from seeds collected in the Altai mountains and received from the Altai Botanical garden in 1963; H/97 received from Hortus Botanicus Principalis Acad. Sci. U.S.S.R., Moscow; H/133 — grown from seeds received from the Botanical Garden Moskwa Ostankino.

Herbarium specimens: H. Appelton: 630 (1906), Pamir and Tian-Schan (K). — V. Fisjum: 4406, Kazachstania, jugum Kirghizicum, in angustis fl. Tschibindy, in declivibus septentrionali-orientalibus, in pratis subalpinis altiherbosis (K, BM, W, KRA, E). — Karelin et Kriloff: 57 (1840), in mt. Tarbagatai, mt. Aktschanly (K, BM, LE). — O. Knorring et Z. Minkwitz: 269 (1911), ad distr. Andishan, Ferganskaya obl. (WA). — M. Popov: (9. 6. 1936), locus: Zailinskij Alataj, Karakastek (E). — Schrenk: Songarei (LE, PRC). — P. Smirnow: (19. 7. 1930), Altaj merid. In pratis aloinis montium Narynensium ad fontes fl. Ak-bulak pr. pag. Katon-Karagaj, ca 2200 m. s. m. (PRC). — N. D. Sokalski: 180, Turkestan, Zailiiskii Alatai, Semirechinskaya obl., Vernienskii okrug (E, BM). — Sokolovskaya: Kuraiskii Chrb. 2300 m. (LE Univ.). — Titov: (1915), obl. Semirech., Chrebet Aleksandrovskii (LE, E). — Auct. ign. Ex Herb. Inst. Bot. Ac. Sci. URSS, 1965, Kirgizya, Ferganskii Chrebet, erchovya reki Jassy (K). — Auct. ign. Ex Herb. Inst. Ac. Sci. URSS, 1965, Kirgizya, Ferganskii Chrebet, uroch. Chartash (K).

In the Leningrad herbarium collection of *T. altaicus* from the following sites was inspected: North Kazakhstan, Ulutai; R-ka Kizir, Obl. Semipalatinsk, u. Zai-

Fig. 13. Distribution of the species of the section *Trollius* according to the herbarium material
 1 — *T. altaicus*; 2 — *T. dschungaricus*; 3 — *T. ranunculinus*; 4 — *T. europaeus*

sancki; Terra Kareliniana, Dschillkaragai; Chreb. Dzhungarskii Ala-tai; R-n Bien-Aksuiskii (Aksui); Gory Chu-Ilinskie, r-ion Kurgaya; Taldy Kurganskogo uezda; Talasskii Ala-tai; Auli-atinskii uezd, (Auli-ata); Tian-shan, zap. Syr.-Darii-skii obl.; Turkestan, Terekei-Alatai; Obl. Frunzenskaya, r-n Chuiskii-Chu; Terskii Ala-tai; distr. Osch, Pszewalsk; Zap. Tian-shan, Chreb. Chatkalskii; Irkuckaya obl., Chamar-Daban, 52°9' - 101°42'; r-n Tunkinskii, Sayan, 51°55' - 101°47'.

Even before Meyer published in 1831 his description of *T. altaicus*, earlier mentions of this plant may be found in the "Flora altaica" of Ledebour (1830). The latter author describes plants found in the Altai under the name *T. caucasicus*, he notes, however that the Altai specimens differ from the Caucasian ones by purple stigmata. The latter have been reported consistently by all later authors (Huth, 1892; Krylov 1901; Schipczinsky, 1924 and others) as the most constant and characteristic trait of *T. altaicus*. In no other taxon have stigmata of this colour been found, all other taxons have greenish, yellow or orange stigmata. Thus, the purple stigmata of *T. altaicus* seemed to be the most typical and reliable character until Malyshev (1965) established in East Sayan the variety *T. altaicus* var. *sajanensis* with yellow stigmata. Thus, this distinct character convenient for classification proved unreliable.

Another new detail as regards *T. altaicus* is the breeding of specimens with spherical closed flowers by the author of the present study. They were grown from seeds collected on a natural site in the Altai Mts. They differed from typical *T. altaicus* specimens only by the globose shape of the flowers (Pl. XII b). Such a type of flowers is found in *T. europaeus* in Europe and *T. pulcher* in Japan, but it has so far never been noted in any other *Trollius* taxon. *T. altaicus* specimens with globose flowers occur doubtlessly in natural populations in the Altai Mts. They are probably rare since they have not been reported in the literature. This character may, however, be observed only on living specimens and is not distinguishable on herbarium material.

Besides the two above mentioned details, other morphological traits of *T. altaicus* are highly variable. Above all the vegetative leaves which may be soft with narrower or wider segments and dissected more or less into lobes. The leaves of *T. altaicus* may also be thick, leathery with undissected segments, like the leaves of *T. dschungaricus* or of *T. yunnanensis*. Neither is the colour of the flowers uniform — yellow or orange; finally the honey leaves are greatly varied (Fig. 11 a - e). They may be broader than 1.0 mm as reported by Malyshev (1965). Such leaves are found in *T. dschungaricus* (Fig. 11 f - i). These two species are very similar and probably closely related. The morphology of *T. dschungaricus* is much more uniform than that of *T. altaicus* and it seems to be within the limits of variability of the latter species. The geographical range of *T. dschungaricus* is also much more restricted and lies more to the south

than that of *T. altaicus*. In many cases the only character differentiating these two species was the red colour of the stigmata in *T. altaicus*, and if we exclude this trait, the distinction between these species is very doubtful.

T. altaicus and *T. dschungaricus* are related with *T. lilacinus* and *T. acaulis* as well as with *T. ranunculinus* occurring on the Caucasus. This is indicated firstly by the honey leaves very similar in these three plant groups and also by a number of other characters. The fruits of *T. altaicus* and *T. dschungaricus* are identical and very similar to those of *T. lilacinus*. Similar follicles may also be found on some specimens of *T. ranunculinus*, although this species is characterized by an exceptionally high variability of its fruits.

Trollius altaicus C.A.M. var. *sajanensis* Malyshev

Malyshev, Fl. alp. sajan. 123 (1965).

Type: Malyshev, 1963 r. Tubota (Sajan Orient.), Herb. im. M. G. Popova, Irkuck (acc. to Malyshev, 1965), n. v.

As reported by Malyshev the specimens of *T. altaicus* from Sayan differ from the ones from Altai in that their stigmata and styles are yellowish and not dark purple ("stylis flavidis differt"). There are no other morphological differences between them.

Distribution: U.S.S.R.: East Sayan, at a height of 1450 - 2600 m a.s.l. Malyshev reports numerous sites and gives a map (Malyshev 123 - 124, map 26, 1, 1965).

T. altaicus specimens cultivated in the Botanical Garden in Warsaw had dark purple stigmata (Oxblood red 00823/3), but there may be differences in the intensity of this hue. In interspecific crosses between *T. altaicus* and *T. asiaticus*, *T. europaeus*, *T. ledebouri* and others, the F_1 individuals always had red stigmata, but lighter than in *T. altaicus*. The colour of stigmata in the F_2 generation varied widely: from various red hues, darker or lighter to hardly noticeable traces of this colour at the tips of the stigma. This was due to quantitative differences in the amount of the coloured substances and these differences are unstable and hardly perceptible. Classification could be done only roughly and not precisely. From the experiments performed it results that the colour of the purple stigmata in *T. altaicus* is a polygenic character (author's own unpublished observation). Slight mutations in natural populations may lead to the appearance of plants with light red or even yellowish stigmata as found by Malyshev. On the other hand, it not excluded that specimens of the var. *sajanensis* are of hybrid origin. They may have arisen in natural hybrid populations as the result of manifold

crossing with species having yellow stigmata as for instance *T. ledebouri*, and a gradual elimination of the genes conditioning a purple colour of the stigma. Malyshev (1965) found in the south-eastern part of Eastern Sayan numerous intermediate forms between *T. altaicus* and *T. asiaticus* and *T. ledebouri*. These forms are probably natural hybrids. Experiments of the present author demonstrated that the above named species readily cross with one another giving fertile hybrids. Krylov (1901) found natural hybrids of *T. altaicus* $\times$ *T. asiaticus* in the Altai Mts. Thus a natural flow of genes between these taxons is possible on areas where their ranges are sympatric as in the southern part of East Sayan. The natural selection of a *T. altaicus* var. *sajanensis* population with yellow stigmata may have been the result of such an introgression.

Trollius dschungaricus Reg.

Regel, Acta Horti Petrop. 7, Suppl. ad fasc. VII: 383 (1880); Huth, Helios, 9, 1: 3 (1892); Schipczinsky, Bull. Jard. Bot. Rep. Russe, 23: 66-67 (1924); Fl. SSSR, VII: 44 (1937); Fl. Kazakhst., IV: 14 (1961); Illjust. opred. rast. Kazakhst., 1: 365-66 (1969).

Syn.: *T. europaeus* L. var. *songairicus* Reg., Bull. Soc. Nat. Mosc. 43, 1: 243 (1870); Maximowicz, Enum. Plant. Mong., 24 (1889).

Ic.: Fl. SSSR, VII, Tabl. V, 2 (1937); Fl. Kazakhst. IV, Tab. II, 9 (1961); Illjust. opred. rast. Kazakhst., 1: 367, Tabl. 62 fig. 2 (1969); Doroszevska, Acta Soc. Bot. Pol., Fig. 1 e, (1970).

Type: A. Regel, 1879, Turkestan, Herb. Horti Petrop. (izo K, holo. LE).

Shoots straight, erect, at the time of flowering 5-40 cm long, may reach during fruiting a length of 60 or even 70 cm. Shoots single or branched with 1-3 flowers. Cauline leaves 2-4, lower ones petiolate, upper ones sessile, mostly with sheaths; lower cauline leaves may have 3 cm long sheaths, those of sessile leaves with characteristic rounded ears.

Basal leaves develop with the shoot, their laminae 3-7 cm in diameter are generally thickened and leathery; 3- or 5-sected with broad-oval or ovate segments, broadly dentate on edge. The segments may be shallowly 3-lobed but they are not dissected into narrow lobes. Cauline leaves resemble the basal ones only they diminish in size up the stem. Besides these leaves typical for *T. dschungaricus* specimens, may be found others with thin and deeply incised segments.

Flowers open in the shape of a shallow bowl, 3.5-6.0 cm in diameter, odourless. Perianth leaves flat, about 10 (5-20), 13-26 mm long oval or rhomboidal of various width; intensely yellow or light orange (Saffron yellow 7, Cadmium orange 8) sometimes reddish outside.

Honey leaves about 10, 7-10 mm long, 1-2 mm wide, elongated,

usually linear, rounded at tip or with small incision (Fig. 11 i, h), sometimes spatulate (Fig. 11 f, g); blade thickened convex and glistening; orange-coloured (Tangerine orange 9). Nectary pit at a height of 1.0 - 2.5 mm from base of leaf in the shape of a shallow pocket, somewhat distended; the unguis may be somewhat inclined away from the leaf axis (Fig. 11 f). Stamina equal to or not much longer than honey leaves, 8 - 12 mm long including anther length 2.5 - 4.0 mm. Pistils numerous with yellow stigmata.

Follicles 10 - 30 in head, 10 - 12 mm long including beak 1.5 - 2.5 mm long, straight or bent outwards. Seeds oval. ca. 2 mm long dark brown. Flowers June - July. $2n = 16$.

Distribution: Central Asia: Pamir-Alai, Syr-Daria submontane, Tien-Shan regions; West China (Tien-Shan).

The geographical range of *T. dschungaricus* includes mainly the North Pamirs, Pamir-Alai and the Western and Central Tien-Shan (Fig. 13).

Specimens examined:

Cultivated: H/22 grown in the Botanical Garden in Warsaw from seeds received from Hort. Bot. Princip. Acad. Sci. U.R.S.S. in Moscow.

Herbarium specimens: W. I. Lipski: 851 (1909), Zailinskii Altai, Semirechinskaya obl., Vernenskii okrug (WA, LE).—F. Ludlow: 684, Chinense Turkestan, Tien-Shan: Kurdai valley (E).—N. Kozhevnikova, N. Trulevich: (12. 7. 1960), Kirgiziya, Vnutrenni Tian-Shan, Sklony odnogo iz uvalov grebnya, juzhnee Paterbaschika (W).—L. N. Medvedeva, L. P. Markova et al.: 144 (1950), Terskii Alatai, r-ka Baiamkol (BM).—Ex Herb. W. W. Moldenhauera: Semirechinskaya obl. (BM).—A. Regel: (1878), Iter Turcestanicum, fl. Ili, alt. 5700' (E); (1879), Turkestan, Ex Herb. Horti Petropolitani (K).—R. J. Roshevitz: 467, 727 (1908), Centralny Tian-Shan, distr. Prshewalsk (WA).—Sokolovskaya, Strelkova: (1947), Alatai Terckii, r-ka Baian-kol; Chibinskii gornyi massiv (LE Univ.).—In herbaria of Kew and Leningrad the collection of *T. dschungaricus* from the following sites was inspected: Kirgiziya, Chreb. Ferganskii, r-ka Jassy (K); Chr. Aleksandryjskii 9000 ft. (LE); Semirechinskaya obl., Dzharkentskii ui., r-ka Tekes (LE); Terskii Alatai (LE); Zailinskii Alatai, Aman-Dzhan (LE); Aleksandryiskii Chrb., Assa-Thal (LE); Kirgiskii Chredb. (LE); Gub. Fergana, Margelan, u. Osh (LE); Turkestan, r-ka Kara-su (LE); Pamir (LE); oz. Issyk-Kul (LE); Turkestan, Changai (LE); Mongolia pln. Tian-Shan (LE).

T. dschungaricus has been described by Regel (1870) at first as a variety of *T. europaeus* under the name *T. europaeus* L. var. *songaricus* Reg. Later Regel (1880) established this taxon as an independent species *T. dschungaricus* Reg. The first description is rather inaccurate, the author based it on the plants reared in the Botanic Garden in Leningrad from seeds which he had collected in Turkestan.

Schipcizinsky (1924) gives a more accurate description of this species, and still more details may be found in Flora SSSR (1937).

The geographical range of *T. dschungaricus* is relatively small, sympatric with *T. lilacinus* and *T. altaicus* and partly with *T. asiaticus*. Mor-

phologically *T. dschungaricus* is closest to *T. altaicus*. The latter is rather highly variable, whereas *T. dschungaricus* is rather uniform. The honey leaves of *T. dschungaricus* are very similar to those of *T. altaicus* and differentiation of these two species on the basis of this character, as stated by Malyshev (1965), may be unreliable (Fig. 11 a - i).

Honey leaves of a similar type are also found in *T. lilacinus*, *T. acaulis* and also in *T. ranunculinus* (Fig. 6 b, c; e - j; Fig. 11 j - l). Moreover the follicles of *T. lilacinus* closely resemble those of *T. dschungaricus* and *T. altaicus*. The morphology of the fruits of these species is relatively uniform. The above mentioned similarities indicate a certain relationship between *T. dschungaricus* and the section *Acaulitrollius* and with the *T. ranunculinus* occurring on the Caucasus Mts.

Derivation of *T. dschungaricus* from *T. yunnanensis* suggested by Schipczinsky (1924, p. 61) does not seem probable. These two species are not so closely related. They have a different type of honey leaves (Fig. 3 a). The nectary pits of *T. yunnanensis* are globose and greatly distended, whereas in *T. dschungaricus* they form a shallow pocket and do not have the trough leading to the nectary pit so characteristic for *T. yunnanensis*. Further differences concern the shape of the fruits and the perianth leaves. In the comparison of *T. dschungaricus* and *T. yunnanensis*, the differences in the morphology of the flowers and fruits are more significant than the similarity of the leaf laminae. It seems probable that *T. dschungaricus* originates rather from the Pamirs. Evidence of this would seem to be the numerous common character with the species of the section *Acaulitrollius* as well as the geographical range.

Trollius ranunculinus (Smith) Stearn

Stearn. Journ. Bot. 79: 188 - 191 (1941); Davis, Cullen, Coode, Fl. Turkey, 1: 105 (1965).

Syn.: *Helleborus ranunculinus* Smith, Pl. Icon. ined. 2, t. 37 (1790); *T. patulus* Salisbury, Trans. Linn. Soc. 8: 303 (1807); De Candolle, Prod. Syst. Nat. 1: 46 (1824); Regel et Tiling, Fl. ajan. 33 - 38 (1858); Huth, Helios, 9, 1: 4 - 5 (1892); Bush in Fl. cauc. crit., 3,3: 18 - 21 (1901); Finet et Gagnepain, Bull. Soc. Bot. France, 4: 394 - 95 (1904); Schipczinsky, Bull. Jard. Bot. Rep. Russe, 23: 64 - 65 (1924); Fl. SSSR, VII: 46 (1937); Grossgeim, Fl. Kavkaza, 4: 14 (1950); Fl. Armenii, I: 127 (1954); *T. patulus* Salisb. var. *caucasica* Trautv. A.H.P., IV, 2: 344; *T. caucasicus* Steven, Mem. Soc. Nat. Mosc. 3: 265 (1812); Meyer, Verzeich. Pflantz. 200 (1831); Busch, in Fl. cauc. crit. 3,3: 18 - 21 (1901); Grossgeim, Fl. Kavkaza, 2: 92 (1930); *T. somcheticus* C. Koch, Linnaea 15: 247 (1841); Ruprecht, Fl. Caucasi, Pars 1 (1859).

Ic.: Smith, Pl. Icon. ined. n. 37 (1790); Doroszevska, Acta Soc. Bot. Pol. 39 Fig. 1 j (1970).

Type: n. v.

Shoots erect, branched, with 1 - 4 flowers, less frequently single

shoots with one flower. At the beginning of flowering usually 20 - 40 cm long, reach at the time of fruiting 70 cm, but some specimens are much smaller. As a rule the flower stems are profusely branched and develop simultaneously with the basal leaves. Exceptionally plants may be found flowering before the development of these leaves. These specimens are small, 10 - 15 cm high, with a one-flowered unbranched shoot. At this stage the plants resemble in their general habitus *T. acaulis* (e.g. Davis' collection from Turkey D. 11962 and D. 29981, E).

Cauline leaves 2 - 4 the lowest one usually petiolate and the remaining ones sessile or almost so, at first concentrated right under the flower, forming a characteristic ruff; these leaves have rounded, ears surrounding the petiole. Basal leaves petiolate, laminae 3 - 11 cm in diameter, 5-sected. In some specimens the petiolated leaves have widened sheaths 3 - 2 cm long and distinctly veined. The general habitus of the plants varies, and the leaves are also highly variable. Most plants have soft laminae 5-sected with segments dissected into narrower or broader lobes. There may also occur thick leathery leaves with rounded segments not dissected into lobes (e.g. Holmberg, 795, W) as well as specimens with thin delicate leaves deeply incised (e.g. L. Mlokoshevich, 8.V.1913). Also plants may be found with laminae very deeply incised and rather stiff (e.g. Davis D. 24357). The plants with leaves deeply dissected into lobes up to 3 mm wide have been established as the form *tenuisecta*; there are numerous intermediate specimens between this form and plants with nondissected laminae.

Flowers open in the form of a bowl (Pl. XII c) 3.0 - 5.5 cm in diameter, odourless. Perianth leaves 5 - 16, 13 - 28 mm long of varying width, the outermost ones cordiform broad-oval, narrower towards the centre, slightly bent; yellow or orange-coloured (Aureolin 3, Lemon yellow 4, Buttercup yellow 5, Indian yellow 6) Honey leaves usually ca. 10 - 12, 7 - 11 mm long, 1.0 - 1.7 mm wide, elongated, linear and rounded at tip (Fig. 11 j, l), sometimes their blade is slightly widened, ovals elongated or spatulate (Fig. 11 k); blade somewhat thickened and rather shining, of darker or lighter orange colour (Saffron yellow 7, Cadium orange 8, Tangerine orange 9). Nectary pit in the shape of a shallow pocket at a height of 1 - 3 mm from leaf base.

Stamina shorter, longer or equal to honey leaves, anthers 2.5 - 3.0 mm long. Pistils numerous with yellow stigmata. Follicles 10 - 25 in head, sometimes more (Fig. 12 g). Follicle length usually ca. 12 mm (7 - 20), including beak length 2.0 - 5.5 mm; beaks straight, bent outwards or inwards. The shape of the follicles and heads varies (Fig. 12 a - g). Some specimens from Turkey have beaks exceptionally long, strong and split at the tip (Fig. 12 a - c). Seeds 2 - 5 in follicle. Flowers May - June. $2n = 16$.

Forma *tenuisecta* Busch, *foliis in segmenta valde angustiora* (ad 3 mm

lata), *profundis incisa et dentata palmatisecta*. Hab.: in Transcauc. occid., in *Suania* (Busch, 1901, p. 21).

Distribution: Caucasus; western provinces of Turkey and North-Western Iran (Grossgeim, 1950, 4, map 11; Parsa, 1952).

The range of *T. ranunculinus* involves the Caucasus Mts. reaching to the north to the Fore-Caucasian region. The southern limit runs more or less in the mountains of north Eastern Turkey and North Western Iran (Kurdistan) (Fig. 13). It results from the map of the range of *Trollius* given by Meusel, Jäger and Weinert (1965, p. 155) that *T. ranunculinus* is also found in the Elburz Mts.

Specimens examined:

Cultivated: H/19 received from the Botanic Garden in Leningrad, derived from a natural site on the Caucasus; H/82 grown from seeds received from Hortus Botanicus Experimentalis Styriacus, Frohnleiten, Austria.

Herbarium specimens: E. N. Busch: (1. 8. 1929), Jugo-Osetinskaya Ekspeditsiya A. N. SSSR, Brittsatskoe ushchele, 2100-2300 m (PRC); (1935), South-Ossetian (BM) — A. H. et V. F. Brothers: (1893), Plantae Caucasus, Ossetia-Lass (K). — F. Campbell: (17. 6. 1967), 219 Flora of Caucasus, Georgia, Military Highway, rocky hillside, alt. 2400 m (K). — N. Desoulavy: (4. Jul. 1898), Caucasus, M. Kasbek, in pascuis humidis 8000' (LE, PRC). — Davis: D. 23351 (1954), Turkey, Prov. Van, distr. Hosap, Kepir Dag 2800 m (E); D. 24357 (1954), Prov. Hakkari, Kara Dag 9500' (E, BM); D. 29981 (1957), Turkey, Prov. Çoruh (E, BM); D. 30349 (1957), Turkey, Prov. Çoruh, Kordevan dag (E); D. 30557 (1957), Turkey, Prov. Kars-Kisir, 2400 m (E); D. 11962 (1962), Turkey, Prov. Trabzon, 6000' (E); D. 45907 (1966), Turkey, Prov. Van, 2600 m (E). — J. Freyn: 7112 (1894), Armenia Turcia, Gümüsane (BM). — Giuseppi: Flora of Caucasus, loc. Dangazarun valley, 7000' (K); Flora of Caucasus, Dangar oran (K). — Holmberg: 795 (1912), Iter transcaucasicum, Prov. Baku, distr. Kuba, loc. Schakh Dag, ca 2000 m (K, W). — E. A. Endaurowa: (1907), Iter caucasicum I, Prov. Kuba (WA). — R. F. Hohenacker: (1838), Georg cauc. In cacamine nudo montis Sarial (PRC). — C. B. Kac: (28. jul. 1965), Stavropolskij kraj, Karachaevo, Cherkesskaya A.O., Teberdinskii r-n, dolina r. Amanausa, na sklonach g. Sofrudisu (W). — Lipski: (1898), Mt. Casbek, alt. 8000' (LE). — L. L. Mlokoshevich: (8. 5. 1913), Flora caucasica, Pg. Tori prope Borzom, prov. Tiflis (W). — N. Sredinsky: distr. Kurinskij; r-ka Pirsagat (LE). — A. Sokolovskaya: Jugo Osetija (LE Univ.); Elbrus, r-n Terskovskii (LE Univ.).

The first information on *Trollius* on the Caucasus is given by Linnaeus (1753) who localized the species *T. asiaticus* described by himself in Siberia and the Caucasus. Later authors left the name *T. asiaticus* for plants occurring in Siberia, and those from the Caucasus and Asia Minor were given other specific names. Smith made drawings of *Trollius* specimen from Cappadocia in the collection of Tournefort and called this plant *Helleborus ranunculinus* Smith (Smith, 1790). Salisbury (1807) on the basis of Smith's work described the new species as *T. patulus* Salisb.; according to this author the plants had

5 - 6 perianth leaves and honey leaves longer than the stamen filaments. As early as 1812 Steven described from Caucasus a new species *T. caucasicus* Stev. differing from *T. patulus* Salisb. by honey leaves shorter than the stamen filaments. According to Meyer (1931) *T. caucasicus* Stev. has also straight beaks on the follicles, ("stylis rectis"), whereas the beaks of *T. patulus* specimens are bent.

Ruprecht (1859) basing on the variable shape of the beaks distinguishes among the Caucasian plants two new taxonomic units: α -*Buxbaumi* and β -*Tournefortii*, but the shape of the beaks proved in practice to be variable, and Ruprecht himself was not always able to differentiate these forms (acc. to Busch, 1901). Koch (1841) in turn described from the Caucasus a new species *T. somcheticus* C. Koch, differing by 8 leaves in the perianth. In his description Koch mentions that this new species is very similar to *T. patulus* Salisb. and *T. caucasicus* Stev. Finally Busch (1901) while elaborating the flora of the Caucasus gave a new accurate description of *T. patulus* Salisb. and called attention to its high morphological variability. He reports that the number of perianth leaves may be 5 - 10, the shape of the beaks on the follicles is widely diverse and the staminal filaments may be equal in length, longer or shorter than the honey leaves. Busch found such differences in plants from the same site growing next to each other. *T. caucasicus* Stev. and *T. somcheticus* C. Koch were considered by Busch as synonyms of *T. patulus* Salisb., their differentiation proved to be practically impossible. Lipski noted on the labels attached to herbarium specimens collected by him on the Caucasus that he cannot distinguish specimens of *T. patulus* from those of *T. caucasicus* (Lipski, 1898, LE). Busch's observations are most reliable, he based them on extensive living material collected from numerous natural sites. He demonstrated that within *T. patulus* many characters exhibit continuous variability, therefore it is impossible to establish separate species, although the morphology of the plants is greatly varied. The only form established by him with deeply dissected leaves, *T. patulus* Salisb. f. *tenuisecta* Busch is also related to plants with normal leaves by numerous intermediate specimens. Busch analyzed in detail the Caucasian plants, nevertheless he reports as the site of occurrence of *T. patulus* East Siberia, Altai and Tien-Shan, beside the Caucasus.

The description of *T. patulus* given by Salisbury was fragmentary and did not take into account the geographical range of this species. Later authors used the name *T. patulus* to denote various taxons from East and Central Asia. De Candole (1824) was one of the first to distinguish two varieties of *T. patulus*: α -*pedunculatus* growing in Siberia and β -*subinvolutus* from Cappadocia. Regel and Tilling (1858) report several varieties and forms of this species occurring on the Kamchatka, in East Siberia and the Caucasus. Similarly, Huth (1892) in

his elaboration of the genus *Trollius* mentions a number of lower rank taxons within *T. patulus* which, according to him, grow in Europe, Eastern Siberia, Chukot and Kamchatka, the Kuril Islands, Turkestan and the Caucasus. Brühl (1896, p. 87) who locates *T. laxus* also in Siberia says: "That *T. patulus* and *T. caucasicus* are nothing but varieties of *T. laxus* is pretty generally admitted". Finet and Gagnepain (1904) treat *T. patulus* Salisb. var. *genuinus* as the synonym of *T. laxus* Salisb., *T. dahuricus* Turczaninow, *T. pumilus* Don. and *T. yunnanensis* (Franchet) nomen. They adjoined therefore to the range of *T. patulus* Japan, Manchuria, China and the Eastern Himalayas. As results from the above quoted examples, for a long time the characters and range of *T. patulus* were undetermined, and treated quite arbitrarily by various authors. In time the taxons from eastern and Central Asia were established under other specific names, and the term *T. patulus* was preserved for the Caucasian plants. In herbaria up till now numerous specimens may be found belonging to different species and collected as *T. patulus* (e.g. Limpricht's collection from Yunnan, 1922, and others).

Schipcziński (1924) was the first who under the name *T. patulus* understood only the plants growing on the Caucasus and in Asia Minor. The Russian floras apply his view (Flora SSSR, 1937; Grossgeim, 1950; Flora Armenii, 1954).

Stearn (1941) restitutes to this species the epithet "*ranunculinus*" and uses the name *T. ranunculinus* (Smith) Stearn as synonym of *T. patulus* Salisb. This change is not only conform to the rules of the International Codex of Botanical Nomenclature, but is convenient since the name *ranunculinus* is associated only with the Caucasus, whereas *T. patulus* was used for other taxons from various areas, and this was a cause of confusion.

Additional misunderstandings arose owing to authors who located on the Caucasus *T. europaeus* as well (De Candolle 1818). Although Ruprecht (1859) and Busch (1901) categorically stated that *T. europaeus* does not occur on the Caucasus, this erroneous information continued to be repeated by some authors (e.g. Hegi, 1912; Meisner, 1969).

As reported by Busch (1901), Schipcziński (1924) and others, *T. ranunculinus* is morphologically highly variable, but this variability is of continuous character, thus separate taxonomical units cannot be established. The only form established by Busch f. *tenuisecta* Busch has exceptional deeply dissected leaves. Such specimens were found in Eastern Turkey with bluish-grey leaves; they are probably connected with a drier environment (Davis, D. 30351, E). The widest morphological differences are found in the plants from the Southern Caucasus and Eastern Turkey. First of all the shape of the folicles and

beaks of these plants is diverse, so the heads with fruits vary in form (Fig. 12 a - g). In general, specimens from the Northern Caucasus have smaller follicles with thinner and shorter beaks; among the plants from Turkey exceptionally large follicles with long strong beaks may be found. For instance in specimen D. 24357 the length of the follicles is 17 - 20 mm including beaks 5.0 - 5.5 mm long; the latter are thick and split at the ends (Fig. 12 a, b); these follicles resemble those of *T. acaulis*. The specimen D. 30557 from the province Kars in Turkey has follicles 18 mm long with thin straight beaks 4.0 - 5.0 mm in length (Fig. 12 g) resembling in general by their shape the follicles of *T. europaeus* ssp. *transsilvanicus* from the Tatra (Fig. 12 j).

Some specimens of *T. ranunculinus* from Turkey have a definite similarity to *T. acaulis*. Not only their fruits are similar, but also the honey leaves (Fig. 6 g, h, k, l, p, r) and the general habitus. They flower before the development of the basal leaves and have similar leaf sheaths on the stem. The plants are small and occur at higher alpine levels near melting snow (D. 29981 from the prov. Coruh and D. 11962 from the prov. Trabzon, E), i.e. in the same conditions as *T. acaulis*. The morphological similarity of some specimens of *T. ranunculinus* to *T. acaulis* indicates a relationship between these species. They probably belong to a common development line originating from the Pamirs and Kashmir from where they have migrated to the Caucasus. It may be seen from the map of the range of *Trollius* given by Meusel, Jäger and Weinert (1965, p. 155) that this genus is found in the Elburz Mts. This site might be the link joining the Pamirs with the Caucasus and would indicate expansion in this direction. Unfortunately the present author not had the opportunity of seeing specimens from the Elburz Mts.

Discussion of the section *Trollius*

To the section *Trollius* belong species with honey leaves intermediate between those of the sections *Pumilotrollius* and *Yunnanotrollius* and of the section *Longipetala*. This intermediate character concerns their structure and dimensions. The honey leaf length in the section *Trollius* is 6 - 14 mm, in *Pumilotrollius* 2 - 7 mm, in the section *Yunnanotrollius* 6 - 13 mm, and in the section *Longipetala* 7 - 40 mm. In the species of the section *Trollius* the blades of the honey leaves are thickened, convex and shining, but these traits are much less pronounced than in the sections *Pumilotrollius* and *Yunnanotrollius*. These blades are usually elongated, linear and rounded at the tip. The nectary pits of these leaves have the shape of a shallow pocket or a small pit, whereas in the section *Longipetala* the nectary pits are flat and pocket-like, and in the sections *Pumilotrollius* and *Yunnanotrollius* they are spherical.

The species of the section *Trollius* show a distinct relationship with

the section *Acaulitrollius*, and seem to originate from the region of the mountains of Central Asia: the Pamirs, Kashmir and adjacent territories. Evidence of this may be found in the common characteristics: the honey leaves of *T. altaicus*, *T. dschungaricus* and *T. ranunculinus* are similar to those of *T. acaulis* and *T. lilacinus*; the long leaf sheaths and ears round the cauline leaves characteristic for the section *Acaulitrollius* are also found in some plants of the section *Trollius*; fruits like those of *T. lilacinus* and *T. afghanicus* occur on *T. dschungaricus*, *T. altaicus*, *T. ranunculinus* and *T. europaeus*; some specimens of *T. ranunculinus* from Turkey greatly resemble *T. acaulis* (for more details see the discussion of the species *T. ranunculinus*).

The species of the section *Trollius* are territorially separated into three groups (Fig. 18). The first comprises *T. altaicus* and *T. dschungaricus*. These two species are very similar and there can be no doubt that they are closely related. Their ranges are largely sympatric, and they partly overlap the geographical range of *T. lilacinus*. *T. dschungaricus* occupies a smaller area and is morphologically more uniform than *T. altaicus*; it is at the same time closer related to the section *Acaulitrollius* (Fig. 7, 13).

T. ranunculinus occurring in the Caucasus Mts. has an almost completely isolated range which does not contact at present any other *Trollius* species. This species is very variable and its representatives from the southern Caucasus and Turkey have many traits in common with *T. acaulis* growing in the Kashmir.

To the third group belong *T. europaeus* and *T. apertus*; their geographical ranges are allopatric to the remaining species of the section. *T. europaeus* occupies vast areas in Europe and Western Siberia, whereas *T. apertus* is known only from the Northern Ural. The latter species is of hybrid origin (Igoshina, 1968). It must have arisen as the result of a cross between *T. europaeus* and *T. asiaticus*, therefore, it has many characters relating it to *T. asiaticus*. *T. europaeus* reaches farthest west of the entire genus *Trollius*; it occurs on the British Isles and in Spain.

A number of traits intermediate between the section *Longipetala* and *Yunnanotrollius* is exhibited by the sections *Trollius* and *Insulaetrollius*; some species of the two last groups are very similar. This concerns above all *T. riederianus* growing on the Kamchatka. This species has been many a time determined as *T. patulus* (i.e. syn. of *T. ranunculinus* from the Caucasus). Both these species have honey leaves of similar shape and size. The difference consists in that the honey leaves of *T. riederianus* are distinctly widened at the base of the blade and the nectary pit is distended like in the honey leaves of *T. yunnanensis*. The section *Insulaetrollius* to which *T. riederianus* belongs shows a distinct

relationship not only to the section *Acaulitrollius*, but also to the section *Yunnanotrollius*. It appears therefore, that *T. riederianus* is not as closely related with *T. ranunculinus* as it is general believed (Regel and Tilling, 1858; Huth, 1892; Busch, 1901; Hultén, 1928 and others).

SECTION: *INSULAE TROLLIUS* sect. nov.

Syn.: Sect. *Eutrollius* Prantl in Engler u. Prantl, Nat. Pflanzenf. III, 2: 56 (1891), p.p.

Plants from the Okhotsk and Chukot Peninsula regions rather small with a single flower on the stalk. Those from Kamchatka, Sakhalin, Japan, the Kuril and Komandor Islands are much more vigorous, their shoots are branched with several flowers and the leaves are 5- or 7-sected. Cauline leaves with membraneous sheaths frequently with ears.

Flowers orange-coloured. Honey leaves equal in length to stamina, somewhat shorter or longer, sometimes more than two times shorter. They are thickened, linear or widened, spatulate or pear-shaped. Nectary pit in a through-like depression, slightly distended, the blade of the honey leaf somewhat widened at this point. In some plants the beaks on the follicles may be winged.

To this section the following species are classified: *T. riederianus* Fisch. et Mey. var. *riederianus* and var. *japonicus* (Miq.) Ohwi, *T. pulcher* Makino, *T. membranostylis* Hultén, *T. chartosepalus* Schipcz. and *T. schipczinskii* Miyabe.

Section type: *T. riederianus* Fisch. et Mey

Key

1. Honey leaves equal in length to stamina, somewhat longer or a little shorter, 8 - 12 mm long 2
1. Honey leaves shorter than staminal filaments or at most equal to them, less than 8 mm long 3
2. Flowers open, flat or in the form of a very shallow bowl
T. riederianus
2. Flowers globose or almost so
T. pulcher
3. Honey leaves 5.0 - 7.5 mm long (Fig. 14 l - o), perianth leaves 10 - 13
T. schipczinski
3. Honey leaves 2.0 - 4.5 mm, exceptionally 5.0 mm long; perianth leaves 5 - 20 4

4. Honey leaves ca. 4.0 mm long and 2.0 mm broad. Perianth leaves 5, when dried they look like thin paper, Chukot Peninsula
T. chartosepalus
4. Honey leaves 2.0 - 4.5 mm long, mostly not wider than 1 mm. Perianth leaves 5 - 20, when dried do not have appearance of paper, range much wider: Okhotsk-Japan-Kamchatka region
T. membranostylis

Trollius riederianus Fisch. et Mey. var. *riederianus*

Fischer et Meyer, Index Sem. Hort. Petrop. 4: 48 (1837); Hultén, Fl. Kamtch., 2: 97 - 99 (1928); Hultén, Fl. Aleut. Isl., ed. 2, 190 (1960); Komarov, Fl. poluost. Kamch., 2: 114 (1929); Miyabe, Acta Phyt. Geobot., 13: 11 - 12 (1943); Ohwi, Fl. Jap., 459 (1965); Voroshilov, Fl. sovet. Dal. Vost., 193 (1966).

Syn.: *T. patulus* (non Salisb.) Ledeb., Fl. Ross. 1: 73 (1842); *T. patulus* var. *genuinus*, *lusus* 2-*pedunculatus* et var. *brevistylus*, *lusus* 2-*pedunculatus*, Regel. et Tiling., Fl. ajan., 33 (1858); *T. patulus* Salisb. α -*genuinus* l. *pedunculatus* et γ -*riederianus* l. *pedunculatus*, Huth, Helios, 9: 5 (1892); *T. membranostylis* sensu Miyabe (non Hultén) p.p. Acta Phyt. Geobot. 13: 9 - 11 (1943).

Ic.: Miyabe, Acta Phyt. Geobot., 13, Fig. 1 DEF, Fig. 4 D (1943).

Type: Kamchatka (in Leningrad, acc. to Fl. SSSR, VII: 50, 1937) n. v.

Shoots erect, 10 - 60 cm high, one flowered or branched with 1 - 4 flowers, foliated (Pl. XIII).

Basal leaves with petioles two or three times longer than lamina; lamina diameter 4 - 12 cm, sometimes more. Leaves 5- or even 7-sected, their segments elongated, rhomboidal or more oval, three-lobed and dissected to various degrees into narrow lobes ending sharply. Cauline leaves 2 - 5, their laminae similar to those of the basal ones, decreasing in size up along the stem and reduced; upper leaves sessile or almost so with widened membraneous sheaths surrounding stem. Specimens from the Komandor Islands have greatly widened leaf sheaths.

Flowers open, 3 - 6 cm in diameter. Perianth leaves generally 5 - 7, but there may be more 8 - 12 (e.g. Kordakov's specimen No. 58 from the Mednyi Ostrov Island), oval obovate golden-orange. Some leaves flattened at tip, sometimes with depression; flowers with such perianth leaves resemble those of *T. yunnanensis* (e.g. specimens: Pavlov's No. 201 from Kamchatka, Egorov's from the Kuril Islands, Kardakov's No. 137 from the Bering Islands). Honey leaves elongated and rounded at tip, 8 - 12 mm long, 1.0 - 1.5 mm broad, linear (Fig. 14 a - c) or somewhat spatulate (Fig. 14 d, f); blade somewhat thickened, particularly at tip, orange-coloured; at base of blade through-like depression somewhat widened. The nectary pit in it round, slightly distended; it lies at a height of 0.5 - 1.0 mm from the base of the honey leaf. Stamina 8 - 12 mm in length including anthers 2.5 - 4.0 mm long. Pistils numerous, follicles

Fig. 14. Some flower elements of the section *Insulaetrollius* (perianth leaves and fruits life-size, honey leaves and stamens $2 \times$ life-size)

T. riederianus: a — Kamczatka, leg. Dybowski (KRA); b — Kamczatka, leg. Hultén, 3877 (LE); c — Kamtschatka, leg. Pavlov, 201, (LE); d — Komandorskie o-va, o. Mednyi, leg. Grebnickii (LE); e — O-v Beringa, leg. Kardakova, 137 (LE); f — O. Urup, leg. Egorova, 2140 (LE); g — Sachalin, leg. Augustinowicz, (1880) (LE)

T. membranostylis: h — Siberia, in mont. Ajanesibus, leg. Tiling, (PRC); i — Sachalin, leg. Tolmatshev, (1953) (KRA); j — Sachalin, leg. Egorova, (1962) (LE); k — Kamchatka, leg. Novograblenov, (LE)

T. schipczinskii: l — fl. Amur ad fontes Bureje, leg. Schmidt, (1862) (LE); m — Juzhnyi Sachalin, leg. Popov (LE); n — Ins. Sagalien, leg. Faurie, 447 (LE); o — O. Sachalin, leg. Egorova, 2017 (LE)

ca. 10 mm long including beak length ca. 1.5 - 2.5 mm; beaks straight and thin. Follicle with pronounced veins. Flowers June - August. $2n = 16$.

Distribution: North-East Asia, U.S.S.R.: Kamchatka, the Komandor and Kuril Islands, Sakhalin, Okhotsk region (?). Japan: Hokkaido (acc. to Ohwi, 1965). The Aleutian Islands: Kiska (Hultén, 1937, 1960).

Herbarium specimens examined:

Kamchatka: B. Dybowski: Kamczatka, No 3248, No 3251, KRA; (as *T. patulus*).—E. Hultén: No 3877, Syd-Kamczatka, Tolmatjovajafloden, Bolshajas flodystem, 1922, LE;—N. F. Kovalenko: No 58, 2.VIII.1930, Iter in Bolschereztzk distr. Peninsula Kamtschatka, LE;—N. V. Pavlov: No 201, 1935, Kamchatka: alpijskie luzhki na sklonach Opalskoi sopki, 600 m abs. vysoty. LE;—V. Rubinskii, No 71, 10.VI.1909, Kamchatka, LE;

Komandor Islands: B. Dybowski: 1879, Insula Cuprea, Maris Beringiani, LE; (as *T. patulus*); B. Dybowski: ins. Beringa, LE;—Grebnickii: 14.VI. 1896, Komandorskie o-va, o. Mednyi, LE;—A. I. Kardakov: No 58, 1930, o-v. Mednyi, s. Preodransenskoe, LE;—E. Kardakova: No 137, 8.VII.1929, o-v Beringa, okr. s. Negekalskogo, LE;

Kuril Islands: E. Egorova, No 1069, 1963, O. Kanashir, LE;—E. Egorova, L. Kolchanova, No 3191, 1965, O. Iturup, LE; No 2140, 1964, O. Urup, Buchta Iriny, LE;—Korotkevic, 26.VI.1954, O. Paramushir (Paramushir), LE;—Mishin, 8.VIII.1955, Kurilskie ostrova: O-v Shumshu, Bereg reki na s-vostok ot Taioamy, vozle ostatka snezhnogo zanosa, LE;

Sakhalin: Augustinowicz: 1880, Ins. Sachalin, LE; Insula Sachalin, Glen. 1861, 27 Mai, Mus. Bot. Acad. Petrop., LE; (both specimens determined as *T. patulus*).

Note: Hultén (1928a, p. 97) gives a list of numerous sites of *T. riederianus* from South Kamchatka.

T. riederianus was described for the first time from Kamchatka in 1837 by Fischer and Meyer. Nevertheless for long years specimens of this species from Kamchatka and the neighbouring islands were mostly described as numerous varieties and forms of *T. patulus* (Regel et Tiling, 1858; Huth, 1892 and others).

In 1923 Schipczinsky gave a new description of *T. riederianus* sp. *restit.*, and in 1928 Hultén while elaborating the flora of Kamchatka (Fl. Kamtch. 2: 97) reported many additional data concerning *T. riederianus* Fisch. et Mey. on the basis of the extensive material from Kamchatka. The elaborations of these two authors contain discrepancies. The description of *T. riederianus* sp. *restit.* by Schipczinsky does not agree with that of *T. riederianus* Fisch. et Mey. given by Hultén (1928a). The latter author considered *T. riederianus* sp. *restit.* Schipcz. as a synonym of the new species which he himself described under the name *T. membranostylis* Hultén. On the other hand, the new species named by Schipczinsky *T. sibiricus* Schipcz. was considered by Hultén as a synonym of *T. riederianus* Fisch. et May. Komarov (1929) adopted the classification of Hultén, adding only some supplementary information concerning the morphology of these taxons.

Flora SSSR (1937) contains the classification of Schipczinsky. These taxonomic discrepancies were due in the first place to the fact that the first description of *T. riederianus* by Fischer and Meyer was not precise enough. The second reason was the high variability of these plants which, according to Schipczinsky (1923), involves the shape of follicles and beaks, the number of perianth leaves and the length of the honey leaves, that is all the main taxonomic characters.

It results from the comparison both of herbarium materials and of descriptions that *T. riederianus* Fisch. et Mey., and *T. sibiricus* Schipcz. are two different species differing by their geographical ranges and the character of the honey leaves (for details see discussion of *T. sibiricus*). The latter belongs to the group of Asiatic species occurring mainly in the Transbaikal and Yakutian regions. On the other hand, the range of *T. riederianus* lies more to the east; this species belongs to the group of the Okhotsk-Japan-Kamchatka species of the section *Insulaetrollius*.

T. riederianus Fisch. et Mey. differs from *T. membranostylis* Hultén by a number of characters, but mainly by the length of the honey leaves. *T. riederianus* Fisch. et Mey. has honey leaves almost equal in length to the stamina, 8-12 mm long, whereas those of *T. membranostylis* do not exceed 5 mm in length and are usually shorter than the filaments of the stamina (Fig. 14 a-k). Although Hultén in his description of *T. membranostylis* does not give the dimensions of the honey leaves, he considers *T. patulus* var. *sibiricus* Reg. et Til. as a synonym of *T. membranostylis* (Hultén, 1928a, p. 99). Specimens of *T. patulus* var. *sibiricus* Reg. et Til. collected by Tiling in the Ayan Mts. have honey leaves ca. 3 mm long (Fig. 14 h). According to Komarov (1929) the honey leaves of *T. membranostylis* are ca. 4 mm long.

In his first description of *T. riederianus* sp. *restit.* in 1923 Schipczinsky gave the honey leaf length as 4 mm, and in his later reports as 5-7 mm (Schipczinsky 1924, Flora SSSR, VII, 1937). Hence the taxon described by him only partly corresponds to *T. membranostylis* Hultén and differs essentially from the specimens of *T. riederianus* Fisch. et Mey. occurring on Kamchatka.

Closely related to *T. riederianus* Fisch. et Mey. is *T. japonicus* Miq. This species is listed as a variety of *T. riederianus* Fisch. et Mey. [var. *japonicus* (Miq.) Ohwi] in the latest Japanese Flora (Ohwi, 1965). Therefore the taxon described up till now as *T. riederianus* Fisch. et Mey. should now be denoted as *T. riederianus* Fisch. et Mey. var. *riederianus*

T. riederianus Fisch. et Mey. var. *japonicus* (Miq.) Ohwi

Ohwi, Fl. Jap., 459 (1965).

Syn.: *T. japonicus* Miq., Ann. Mus. Bot. Lugd. Bat., 3: 6 (1867); Nakai, Bot. Mag. Tokyo, 42: 7 (1928) p.p.; Miyabe, Acta Phyt. Geobot., 13: 12-13 (1943);

Schipcizinsky, Bull. Jard. Bot. Rep. Russe, 23: 71 (1924), p.p.; Fl. SSSR, VII: 50-53 (1937), p.p.; *T. nishidae* Miyabe, Acta Phyt. Geobot., 13: 13-14 (1943) ex Ohwi, Fl. Jap., 459 (1965); *T. patulus* (non Salisb.) sensu auct. Japon. ex Ohwi, Fl. Jap., 459 (1965).

Note: in Miyabe's paper (1943) a full bibliography of Japanese works concerning this taxon may be found. These publications are, however, unknown to the author of the present study.

lc.: Miyabe, Acta Phyt. Geobot., 13, Fig. 2 AC, Fig. 5 AC (1943).

Type: n. v.

This variety is closely related to *T. riederianus* Fisch. et Mey. var. *riederianus* from which it differs by the following: leaves more deeply incised, beaks on follicle thin and somewhat longer, 2.5-4.0 mm long, straight or somewhat bent outwards (Miyabe, 1965, Fig. 5 AC). Honey leaves in var. *japonicus* may be somewhat widened, they usually have five nerves, whereas in var. *riederianus* they have three. There are usually five perianth leaves in var. *japonicus*, whereas var. *riederianus* may have more, up to 12. Flowers June-August (Miyabe, 1943). $2n = 16$.

Distribution: Japan; the Hokkaido Island and Central and Northern Honshu. Miyabe (1943) mentions numerous sites of occurrence on mountain meadows.

T. japonicus Miq. described in 1867 from Jezu (= Hokkaido) was treated for long years as a separate species. Some authors attributed a wider sense to this taxon, and reported its occurrence not only from Japan but also from Korea and the Kuril Islands (Nakai, 1928) as well as the Sakhalin (Flora SSSR, 1937; Voroshilov, 1966). In his elaboration of Japanese *Trollius* species Miyabe (1943) states that *T. japonicus* has not been found on the Kuril Islands, or the Sakhalin, only on Hokkaido and Honshu. From the Sakhalin a different species, *T. shipczinskii* is reported. Ohwi (1965) also mentions Honshu and Hokkaido as the only places of occurrence of *T. japonicus*. According to the opinion of the above mentioned authors the distribution of *T. japonicus* should be restricted solely to Japan (Fig. 15).

Ohwi (1965) lowered, moreover, the taxonomic rank of *T. japonicus* to the variety of *T. riederianus* Fisch. et Mey. [var. *japonicus* (Miq. Ohwi)]. At the same time he treated *T. nishidae* Miyabe as the synonym of *T. riederianus* Fisch. et Mey. var. *japonicus* (Miq.) Ohwi. The introduction of these changes seems correct since the taxons are very similar. Hultén 1928a, p. 99), was the first to state that he saw no difference between *T. japonicus* and *T. riederianus*. The present author did not dispose of any *T. japonicus* or *T. nishidae* specimens from Japan, so she had to rely on Hultén's opinion and on the latest Japanese publications (Miyabe, 1943; Ohwi, 1965). These two authors report a differ-

rent number of species from Japan. Miyabe has a tendency to giving descriptions of numerous small species, whereas Ohwi includes them into larger units which differ from one another more distinctly. The latter approach seems to me more purposeful.

Trollius pulcher Makino

Makino, Bot. Mag., Tokyo, 28: 109 (1914); Miyabe, Acta Phyt. Geobot. 13: 18-9 (1943); Ohwi, Fl. Jap., 459 (1965).

lc.: Miyabe, Acta Phyt. Geobot., 13: Fig. 2 B, 5 B (1943).

Type: T. Makino (Aug. 1903) Mt. Riishiri in Isl. Riishiri; n. v.

Description according to Makino p. 109-110 (1914): "A glabrous perennial, about 2-6 dm, high, erect, with wiry fibres of the basal portion of old stems and petioles at the base; roots tufted, fibrous, stout-filiform, with very short rootlets, nigrescent when dried. Stems few caespitose, mostly simple, terete, often stout, usually 3- rarely 2- or 4-foliate, uniflorous rarely biflorous at the top, provided with a few membranaceous sheaths at the base, attaining 9 mm across. Leaves flaccidly herbaceous, reniform in outline, attaining about 12 cm long, 19 cm broad, 3-sected into 3 primary segments, thin; segments sessile, cuneate at the base, inciso-dentate with the sharp subulate teeth; lateral segments broader, deeply 2-parted; 2-nd segments: outer one 2-parted, inner one 3-cleft; primary middle segment elliptical, 3 cleft; veins loosely anastomotic with longitudinal coarse areolae, conspicuous beneath; radical leaves few, long-petiolate, shorter than the stem; cauline leaves shortly petiolate in the lowest one, but sessile and smaller in size in the superior 2 rarely 1 or 3, the uppermost one smallest and often simpler in form; petiole sheathing towards the base. Flower golden yellow, subspheroidal, 3-5 1/2 cm across, erect, rather shortly pedunculate. Sepals many, 14-15 in number, concave, subconnivent, imbricated and assumed a subglobular form collectively, sessile, orbicular and reflexo-ascending and attaining about 2 1/2 cm long and wide in the outer ones, but narrower in the inner ones, entire but often denticulate towards the rounded apex, closely and numerously veined, membranaceous, deciduous. Petals small, several (about 5-7), shorter than stamens erect, linear-spathulate, obtuse at the apex, shortly unguiculate, entire, longitudinally several-veined, with a nectariferous faveole at the base of the lamina, about 8 1/2-10 mm long. Stamens numerous, mainly exceeding the pistils, 7-12 mm long, filament filiform, longer than the anthers; anther oblong-linear, 2 1/3 mm long. Pistils numerous, densely placed, about 4 1/2-7 mm long, sessile, erect in the central ones but ascending erect in outer ones; ovary subulato-linear, gradually attenuated into the style above, arcuate in the outer ones; style simple, erect, straight, shorter than the ovary,

obtuse at the apex, stigmatose on the ventral side vertically; ovules sub-numerous (12), sessile oval. Hab.: Prov. Kitami in Hokkaido; Mt. Riishiri in Isl. Riishiri (T. Makino, Aug. 1903)". $2n = 16$.

This Japanese species is an endemite occurring on the Hokkaido and Riishiri Islands (Makino, 1914; Ohwi, 1965). On the illustrations given by Miyabe the honey leaves of *T. pulcher* resemble those of *T. japonicus* Miq. and *T. riederianus* Fisch. et Mey. (Miyabe, 1943, Fig. 1 F, Fig. 2 AB). This similarity points to a close relationship between *T. pulcher* and *T. riederianus* and the group of taxons related to the latter. A characteristic feature distinguishing *T. pulcher* is, however, the globose shape of its flowers. The numerous perianth leaves (10 - 16 acc. to Ohwi, 1965) are concave and overlap forming a sphere or almost so like the flowers of *T. europaeus*.

The present author has not seen specimens of *T. pulcher*, but on the basis of pertinent literature and illustrations she includessit into the section *Insulaetrollius*.

Trollius membranostylis Hultén

Hultén, Fl. Kamt. 2: 99 - 100 (1928); Komarov, Fl. poluost. Kamtch. 2: 116 (1929); Miyabe, Acta Phyt. Geobot., 13: 9 - 11 (1943).

Syn.: *T. patulus* var. *sibiricus* Reg. et Til., Fl. ajan., 33 - 38 (1858); *T. americanus* Ledebour, Fl. Ross. 1: 73 (1842); *T. ochotensis* Tiling, Fl. ajan., 38 (1858); *T. riederianus* (non Fisch. et Mey.) Schipczinsky, Not. syst. Herb. Hort. Bot. Petrop., 4, ed. 2: 13 - 14 (1923) p.p.; Bull. Jard. Bot. Rep. Russe 23: 70 (1924), p.p.; Fl. SSSR, VII: 50 (1937), p.p.

Ic.: Miyabe, Acta Phyt. Geobot., 13, Fig. 4 ABC (1943).

Type: n. v.

Shoots erect up to 60 cm high, mostly unbranched, foliated with one flower at tip (Pl. XIV).

Basal leaves petiolate, laminae up to 15 cm in diameter, 3- or 5-sect-ed, dissected into narrow rhomboidal or oval segments deeply dissected into uneven dentate lobes. Cauline leaves 1 - 5, lower ones petiolate, upper ones sessile with widened sheaths surrounding stem. Laminae of cauline leaves similar to those of basal ones, diminishing in size up the stem.

Flowers open, 2.5 - 4 cm in diameter. Perianth leaves orange-yellow, 5 - 20, oval or broad-oval; broader outside and narrower towards the centre, almost flat. Honey leaves 2.0 - 4.5 mm long, shorter than filaments of stamina or almost equal to them; orange-coloured, widening towards the tip at which they are rounded, thickened, spatulate or pear-like in shape, with three nerves sometimes hardly distinguishable. Nectary pit at a height of 0.5 - 1.5 mm. Stamina 6 - 8 mm long, anthers up to 2 mm long (Fig. 14 h - k). Follicles more or less numerous in head,

Fig. 15. Distribution of the taxa of the section *Insulaetrollius*

1—*T. riederianus* var. *riederianus*—according to herbarium material and partly to literature; 2—*T. riederianus* var. *japonicus*—according to Miyabe (1943); 3—*T. pulcher*—according to Miyabe (1943); 4—*T. chartosepalus*—according to the herbarium material; 5—*T. schipczinskii*—according to the herbarium material; 6—*T. membranostylis*—according to the herbarium material and partly to literature

8–10 mm long, this including beaks ca. 2 mm long. Beaks bent outwards, hook-like with membraneous wing along dorsal suture or not winged and with straight beaks. Seed ca. 1.5 mm long with delicate pattern on surface. Flowers June–July.

Distribution: North-East Asia; U.S.S.R.: regions: Okhotsk, Udscoe, Anadyr, Kamchatka, Sakhalin; according to Miyabe (1943) also Hokkaido and the Kuril Islands. On moist forest meadows and subalpine meadows.

Herbarium specimens examined: Regions Udsch, Okhotsk and Anadyr: K. J. Bogdanovich: 25 iunia 1897, Aian, (LE), (determined as *T. patulus* Salisb. var. *sibiricus* Reg., quoted by Schipczinski (1923) as *T. riederianus*);—Tiling: Siberia, In montibus Ajanensisbus; PCR, K, (as *T. patulus* Salisb. v. *sibiricus* Reg.);—Exp. Acad. 1844, ex Herb. Acad. Petrop., locus: Udscoi, Sibir. orient. K, LE; No 782, 13.VI.26, O-v B. Santar, Maloie Ozero, Dolina Kliucha, LE; Vysokogor. fl. Dusse-Alinia, Bass. Suluka, LE; Anadyrsko-Penzhinskii r-o, Bass. r-ki Penzhiny, LE;

Kamchatka: Novogradlenov: 21.7.1927, Kamchatka, pereval Kamcheren, h = 1200 m, LE; — 21.7.1929, Kamchatka: pereval Kamcheren, Herb. Kamchatkoi fl. no. 1340, LE; (Both specimens labelled as *T. riederianus* by Komarov).

Sakhalin: A. Tolmatchev, 22.VI.1953, Insula Sachalin. In viciniis opp. Dolinsk. In herbosis elatis apud rivum in "Cholodnaja dolina", LE, E, W, KRA; — E. Egorova, 6.VII.1962, Juzhno-Sachalinskii r-n, h = 600 m, LE; (both specimens determined as *T. japonicus* Miq.).

The description of *T. membranostylis* given by Hultén (1928 a) is not very precise, but as synonyms of this species he enumerates *T. patulus* Salisb. var. *sibiricus* Reg. et Til. and *T. riederianus* (non Fisch. et Mey.). Schipcz. (1923, 1924). In these earlier sources more information on this species can be found. According to Hultén the characteristic feature of *T. membranostylis* is the presence of beaks bent outwards with membranaceous wing along the outer suture (Miyabe, 1943, Fig. 4 A). The lack of herbarium specimens with ripe fruits does not allow analysis of this character, Miyabe, however, has some reservations as to its value. According to him, this trait is not constant, even on one and the same plant follicles may be found with and without wings. Neither do winged beaks always occur together with a hook-like shape (Schipczinsky, 1923, 1924 for *T. riederianus*); these characters may occur independently from one another (Miyabe, 1943, pp. 10, 15). The specific name "membranostylis" introduced by Hultén defines precisely the morphology of the beaks, but the observations of Miyabe (1943) indicate that this trait is too variable to be of taxonomic significance. In this situation it seems indicated to include to *T. membranostylis* also those individuals which correspond in general to the description of this species, although they may have straight beaks or wingless ones.

Usually in most *Trollius* species both the length and shape of the beaks are highly variable, and it is difficult to distinguish even lower taxons according to these characters (Brühl, 1896, p. 87; Busch, 1901 and author's own observations). Winged beaks are also known in *T. acaulis* and *T. lilacinus*, species of the *Acaulitrollius* section, and also in some specimens of *T. laxus* from North America, but in these species this trait is also variable. It is not excluded that in nature populations may exist in which both the above mentioned characters occur together and are stable, up till now, however, this has not been found. One should, therefore, be rather cautious in applying the taxonomic classification on the basis of so highly variable traits. The perianth of *T. membranostylis* has usually 9 - 20 leaves, according to Hultén (1928a, p. 100), but Komarov (1929) reports 5 - 10 leaves. Thus, it seems that this character is also widely variable.

During elaboration of *T. membranostylis* the present author devoted

particular attention to the dimensions and shape of the honey leaves and their length as compared to that of the stamina, and also the length of the anthers since Hultén (1928a, p. 100) attaches much importance to the latter trait. The anther length in *T. membranostylis* actually seems to be rather constant, in none of the specimens inspected did it exceed 2 mm.

Hultén (1928a) does not give a precise description of the honey leaves or their dimensions, he only mentions that they have three nerves. According to Schipczinski's description in *T. riederianus* these leaves have one nerve and widen towards the tip. They are thickened and rounded at the tip, or spatulate or obovate. The authors observations as regards the shape of the honey leaves agree completely with this description. There are generally three nerves on these leaves, but sometimes they are hardly noticeable and there are some discrepancies as regards their dimensions of the honey leaves. Schipczinsky in his first description of *T. riederianus* of 1923 gives the honey leaf length as 4 mm and in his later work as 4-7 mm (1924, Flora SSSR, 1937). These first observations of Schipczinsky (1923) seem correct. *T. patulus* var. *sibiricus* Reg. et Til. specimens collected by Tiling from Ayan have such honey leaves ca. 3 mm long (Fig. 14 h). The description of *T. membranostylis* by Hultén was based on this taxon, therefore it may be considered as the typical species. Comparison of the length of the honey leaves of *T. patulus* Salisb. var. *sibiricus* Reg. et Til. shows that it cannot be synonymous with *T. sibiricus* Schipcz. (Schipczinsky, 1923; Flora SSSR, 1937), but is it synonymous to *T. membranostylis* Hultén (1928a). The honey leaves of the latter species are also distinctly shorter than those of *T. riederianus* Fisch. et Mey. Komarov (1929) who in general agreed to the classification of Hultén accepted for the honey leaves of *T. membranostylis* a length of ca. 4 mm. Nevertheless some specimens from Kamchatka with small pearshaped honey leaves were classified by Komarov as *T. riederianus* (Novogradlenov's collection 1929) by mistake. It is assumed in the present study that *T. membranostylis* has honey leaves not exceeding 4.5 mm in length and that plants with longer leaves must belong to other species. They may be specimens of *T. schipczinskii* from Sakhalin (Fig. 14 l-o) or hybrids.

Hultén (1928a) mentions the following areas of occurrence of *T. membranostylis*: the Okhotsk, Chukot and Kamchatka regions. Miyabe (1943) quotes further numerous specimens from the Kuril Islands and Hokkaido. The drawings of the honey leaves, however, from the latter specimens differ greatly from those of *T. membranostylis* and rather resemble those of *T. riederianus* (Miyabe 1943, Fig. 2 D).

The specimens from the Sakhalin are more vigorous, but their honey leaves are exceptionally small, hardly 2 mm long and they have dark

stigmata (Tolmatchev's, 1953 and Egorova's, 1962 collections). Colour evaluation in dry plants is, however, unreliable.

Trollius chartosepalus Schipcz.

Schipczinsky, Not. syst. Horti Bot. Petrop., 4, ed. 2: 11 (1923); Bull. Jard. Bot. Rep. Russe, 23: 71 (1924); Fl. SSSR, VII: 53 (1937).

Type: Maydell (1869), Ad brachium fl. Anadyr; LE.

Description of Schipczinsky (1923, p. 11): "*Rhizoma curtum, planta perennis, florens 5 - 15 ctm. alt., fructifera elongata ad 25 ctm. Caulis solitarius simplex mollis, basi vaginis latis membranaceis obtectus. Folia radicalia (1 - 2) petiolata, lamella eorum magna (ad 5 ctm.) ambitu rotundata 3 - 4 lobata: lobi late-rhomboides bi-vel tri-fidi, apice late crenati. Folium caulinum 1 sessile, foliis radicalibus minus, tripartitum (subminores), tempore florendi folia vix aperta et parva, fructificatione tantum folia omnino evoluta. Flores solitari ad 4 ctm. in diametro, pedicelli initio brevi ad 1 ctm. deinde longi ad 8 - 10 ctm. Sepala 5 pallide lutea vel lutea, late obovata apice eroso-crenata, in sicco tenuia papyracea. Petala spatulaeformia 4 mm, long., 2 mm, lat., aurantiaca duplo staminibus breviora: nectarostigma 1/2 mm. supra basin. Folliculi pauci (5 - 7) in stylum longum attenuati. Stylus longus germine subaequans vel superans tenuis absolute rectus. Pistillum cum stylo staminibus longius.*

Habitat in Asia orientali, peninsula Tschuktschorum. Specimina vidi: 1 — Ad brachium fl. Anadyr, 3.VI.1869 et 20.VI.1869 (Maydell); 2 — Terra Tschuktschorum, 1.VI.1869 (Maydell); 3 — In ditione fl. Anadyr, a fluvio hoc septentrionem versus ripa 3.VI.1869 (Maydell). Omnia sub nomine *T. americanus* Muhl. et Gais. var. *pentapetala* DC.

Ex affinitate *T. americanus* Muhl. et Gaissenh. differt petalis spatulaeformibus, sepalis tenuibus, pistillo cum stylo staminibus longiore".

Herbarium specimens examined: The herbarium sheets mentioned by Schipczinsky.

T. chartosepalus belongs to the group of the Okhotsk-Japan-Kamchatka taxa. It resembles most closely *T. membranostylis* Hultén (1928a) and the description of *T. riederianus* Schipcz. (1924, Flora SSSR, 1937).

As reported by Schipczinsky, the leaves of *T. chartosepalus* develop fully in the period of fructification, while at the time of flowering they only start to grow. A similar developmental rhythm is noted in some alpine species, and is particularly characteristic for *T. acaulis* and *T. lilacinus* belonging to the section *Acaulitrollius*.

The taxonomic position of *T. chartosepalus* is not quite clear. The material seen by the present author is too scarce for her to decide of

the systematic rank of this taxon. The more so, since the related species of this section are variable and classification of this entire group may raise reservations. It is not excluded that *T. chartosepalus* and *T. membranostylis* are actually closer related than it would result from descriptions and measurements of the relatively few specimens from these taxons.

Schipcziński (1923, p. 11, 1924, p. 61) traces back *T. americanus* (syn. *T. laxus*) directly from *T. chartosepalus*. His suggestion seems correct, but in a somewhat wider sense. No doubt the American *Trollius* plants derive from the group of species of the section *Insulaetrollius* to which *T. chartosepalus* belongs, but there are no grounds to derive *T. americanus* directly from *T. chartosepalus*.

Honey leaves of more or less the same dimensions and shape as in *T. chartosepalus* are found in *T. membranostylis* and also in *T. afghanicus* and some specimens of *T. laxus* in North America. This resemblance confirms the hypothesis of Schipcziński that the American *Trollius* plants originate from the group of Okhotsk-Japan-Kamchatka species. On the other hand, this points to a relationship of *T. chartosepalus* with the Pamirian group.

Trollius schipcziinskii Miyabe

Miyabe, Acta Phyt. Geobot., 13: 14 - 15 (1943).

Syn.: *T. japonicus* (non Miq.) Schipcziński, Bull. Jard. Bot. Rep. Russe, 23: 71 (1924), Fl. SSSR, VII: 50 (1937), p.p. quod. pl. Sachalin; *T. riederianus* (non Fisch. et Mey.) Schipcziński, Bull. Jard. Rep. Russe 23: 70 (1924), p.p. Fl. SSSR. VII (1937), p.p., quod. pl. Sachalin et Ochotsk.

Ic.: Miyabe, Acta Phyt. et Geobot., 13, Fig. 2D, Fig. 6 ABC (1943).

Type: Sakhalin; n. v.

Shoots erect, 30 - 70 cm high with 1 - 3 flowers. Basal leaves petiole, their laminae 5-lobed with segments dissected into longer or shorter lobes, generally sharply ended. Cauline leaves 2 - 5, similar to the basal ones, diminishing in size along the stem. Flowers open, 3 - 6 cm in diameter (Pl. XV). Perianth leaves mostly ca. 10 (10 - 13); yellow, oval or rhomboidal-oval in shape. Honey leaves generally shorter than staminal filaments or equal to them, 5.0 - 7.5 mm long, bright orange, shining, spatulate rounded at tip and thickened. Nectary pit at a height of ca. 1 mm from base of leaf, spherically distended. Stamina 7 - 10 mm long including anther length 2 - 3 mm (Fig. 14 l - o).

Follicles 8 - 20 in head, 8 - 14 mm long including beak length 2.0 - 4.0 mm. Some specimens with distinct innervation on follicles and long strong beaks of various shape. They may be bent outwards or straight (Fig. 14 m, n). Flowers June - July.

Distribution: Far East, U.S.S.R.: Sakhalin, Udschii and Okhotsk (?) regions. According to Miyabe (1943) from Okhotsk and Udschii regions to North Sakhalin and in mountains along Sakhalin southwards to Toyohara region.

Herbarium specimens examined:

Sakhalin: E. Egorova: No 2017, O. Sachalin, Makarovskii r-on, LE;—Faurie; No 447, 17 Juli 1908, Hab. Insula Sagalien, in farbides Dobuki, LE;—M. G. Popov: 22.VII.1948, Juzhnyi Sachalin, LE;—Herb. Saghalien Central Exp. Station, 2614, LE; (all labelled as *T. japonicus*).

Udschii region: F. Schmidt: 1862, Flora Amur, ad fontes Bureje, LE; (labelled as *T. riederianus*).

This species has been described from the Sakhalin in 1943 by Miyabe and named after the Russian botanist N. Schipczinsky. Miyabe himself (1943, p. 15) believed that *T. schipczinskii* is related to *T. riederianus* Schipcz. sp. restit. (non Fisch. et Mey.) with the difference that among the plants from the Sakhalin the beaks on the fruits are not winged.

According to observations of the present author the plants from the Sakhalin differ widely. Their variability concerns in the first place the honey leaves and fruits, this making classification very difficult. Plants with honey leaves equal more or less to the stamina were determined as *T. japonicus* Miq. or as *T. riederianus* Fisch. et Mey. Miyabe (1943), however, in his work on the *Trollius* species from Japan mentions that *T. japonicus* occurs only on the Hokkaido and Honshu Islands, and is not found on the Sakhalin. In the latest published Flora of Japan, Ohwi (1965) confirms the information given by Miyabe on the distribution of *T. japonicus* with the only difference that he reduces its taxonomic rank considering it as a variety of *T. riederianus*. The opinions of these Japanese authors (Miyabe, 1943; Ohwi, 1965) seems most reliable, therefore, the plants from the Sakhalin cannot remain under the name *T. japonicus* (Flora SSSR, 1937, p. 50; Voroshilov, 1966). Some of these specimens differ distinctly from *T. riederianus* Fisch. et Mey. as well as from *T. membranostylis* Hultén, they correspond to the description of *T. schipczinskii* Miyabe. The differences concern the dimensions and shape of the honey leaves (Fig. 14).

In some individuals of *T. schipczinskii* (Popov's specimen 1948) the follicles are exceptionally thick-walled with protruding innervation and long beaks (4 mm); on one and the same plant the follicles in one head have beaks bent outwards, and in another they are erect (Fig. 14 m, n). Thus the beak shape may be variable even within one individual.

Discussion of the section *Insulaetrollius*

To the section *Insulaetrollius* belong species which may be generally described as originating from the Okhotsk-Japan-Kamchatka regions.

The particular taxons of this group have narrow or wider geographical ranges, they all occur, however, in North-East Asia and are to be found on the territory of the U.S.S.R. in the regions: Anadyr, Okhotsk and Udscoe, on the Chukot and Kamchatka Peninsulas, the Sakhalin, in Japan and on the Kuril, Komandor and Aleutian Islands (Fig. 15).

These plants belonging to various taxons were determined for long years most frequently as *T. patulus* with numerous varieties (Ledebour, 1842; Regel and Tiling, 1858; Huth, 1892; Fedtschenko, 1906).

The earliest established species of this group was *T. riederianus* described in 1837, next came *T. japonicus* in 1867, *T. pulcher* in 1914, *T. chartosepalus* in 1923, *T. membranostylis* in 1928 and *T. schipczinskii* in 1943. Some of these species as for instance *T. chartosepalus* are still little known.

Owing to the high variability of these species they were differently and sometimes quite contradictorily classified by the particular authors (Schipczinsky, 1923, 1924; Flora SSSR, 1937; Hultén, 1928a; Miyabe, 1943). The details concerning the particular species are given in their descriptions. The classification here applied may also raise doubts. Some of the species classified to this section are almost unknown to the present author as for instance *T. chartosepalus* and *T. japonicus*. In the case of other species, the herbarium material studied was scarce and fragmentary. Therefore, in the elaboration of plants from the territory of Japan the author relied above all on the opinions of Japanese botanists (Miyabe, 1943; Ohwi, 1965), and as regards species from the Asiatic continent on the works of Russian botanists (Schipczinsky, 1923, 1924; Komarov, 1929).

In spite of various taxonomically doubtful points this section is a very interesting group of plants in which traits characteristic for the representatives of *Trollius* from the Pamirian section *Acaulitrollius* and Yunnan section *Yunnanotrollius* may be found.

To the characters common with the section *Acaulitrollius* belong: small thickened honey leaves spatulate or pear-shaped like in *T. afghanicus*, which are also seen in *T. chartosepalus* and *T. membranostylis* (Fig. 6 s, Fig. 14 h-l); a membranaceous wing on the beaks of some specimens of *T. lilacinus* and *T. acaulis* as well as in *T. membranostylis* and *T. chartosepalus*; membranaceous widened leaf sheaths in both groups; a similar developmental rhythm of *T. chartosepalus* and the plants from the Pamirs for which flowering before the development of basal leaves is characteristic; exceptionally thick, long and straight beaks on the fruits of some specimens as for instance *T. schipczinskii* from the Sakhalin (Popov, 1948; Miyabe, 1943, Fig. 5 C). Beaks of this type but still longer are characteristic for *T. acaulis* (Fig. 6 k-r).

The similarity between the Okhotsk-Japan-Kamchatka species and representatives of the *Yunnanotrollius* section concerns above all the structure of the honey leaves. In the former group they are small or medium-sized, but the blade is always somewhat thickened, rounded and glistening. They have a characteristic through-like depression in which the nectary pit lies. This part is usually slightly widened and the nectary pit spherical and distended. A similar through only more pronounced is seen in *T. yunnanensis* and the nectary pit of this species is more distended. In taxons of the section *Insulaetrollius* the above mentioned characters of the honey leaves are not as distinct as in *T. yunnanensis*, but their morphology shows a relationship with the latter, particularly in species with longer honey leaves as for instance *T. riederianus*. Moreover, in some specimens of *T. riederianus*, the shape, dimensions and arrangement of the perianth leaves are the same as in *T. yunnanensis* (N. V. Pavlov. No. 201, 1935, Kamchatka; E. Kardakova No. 137, Bering Island).

The above indicated similarities between the plants of the section *Insulaetrollius* and the Pamir and Yunnan sections show that plants originating from both these groups played a role in the formation of the Japanese and Kamchatka taxons. It is probable that *Trollius* reached the region of Kamchatka by two different ways. One led from the Pamirs through the mountains of Central to North-East Asia, the second from the Yunnan Mts. also in north-east direction along the sea coast; these plants must have gone as far as the Japanese Islands and further to Kamchatka. In the Okhotsk-Japan-Kamchatka region the two different groups must have met and intercrossed in time. There resulted a group of very heterogeneous taxons of the *Insulaetrollius* section, but the traits characteristic for the Pamir and *T. yunnanensis* plants have subsisted in it to this day.

SECTION: *LAXOTROLLIUS* sect. nov.

Syn.: Sect. *Eutrollius* Prantl in Engler u. Prantl, Nat. Pflanzenf. III, 2: 56 (1891), p.p.

Plants occurring in North America. Shoots 50 cm high, foliated, with one or two flowers. Leaves 5-sected with segments dissected into lobes, and with sheaths. Flowers flat, 3.0 - 4.5 cm in diameter. Perianth leaves 5 - 10, white, cream-or yellow-coloured. Honey leaves 3.5 - 7.0 mm long with thickened blades of varying shapes: linear, oval pear-shaped, frequently with incision at tip and pronounced middle nerve. Follicles numerous, ca. 10 mm long, beak length 2 - 5 mm. The morphology of the beaks is highly variable.

To the section belongs one species *T. laxus* Salisb. with two varieties — var. *laxus* and var. *albiflorus* Gray.

Section type: *T. laxus* Salisb.

Key

- 1. Perianth leaves pure white var. *albiflorus*
- 1. Perianth leaves cream-or yellow-coloured or yellow-green var. *laxus*

Trollius laxus Salisb. var. *laxus*

Salisbury, Trans. Linn. Soc. 8: 303 (1807); Pursh, Fl. Am. Sept. 2: 391 (1814); A. Gray, Man. Bot. North United States, 11 (1848); Clements et Clements, Rocky Mt. Fl., 8 (1914); Coulter, Man. Bot. Rocky Mt., 8 (1885); Harrington, Man. pl. Colorado, 13 (1954); Gleason et Cronquist, Man. vasc. plants Northeast. Unit. States and Canada, 306 (1963); Rickett, Wild Flowers U.S. I, 1: 22 (1966).

Syn.: *T. americanus* Mühlenberg, Trans. Am. Phil. Soc. 3: 172 (1793) nud.; Muhlenb. et Gaiss., in Donn. Cat. h. cant. ex Huth (1892); De Candolle, Reg. Veg. 1: 413-14 (1818), Prod. 1: 46 (1824); Hooker, Fl. bor. am. 1: 23 (1833); Ledebour, Fl. Ros., 1: 73 (1842); Regel et Tiling, Fl. ajan. p. 33 (1858); Schipczinsky, Not. syst. Herb. Horti Bot. Petrop. 4 ed. 2: 14 (1923); *T. albiflorus* (Gray) Rydberg, Mem. N.Y. Bot. Garden, 1: 152 (1900); *T. pentapetalus* (Herb. Banks) ex De Candolle (1824), nom. nud.; *T. decapetalus* (Herb. Bose) ex De Candolle (1824), nom. nud.; *T. mexicanus* (Herb. Roemer), nom. nud.; Herb. BM;

Ic.: Rickett, Wild Flowers of America, plate 108 (1953).

Type: H. E. Mühlenberg, prope Lancaster in Pennsylvania (Salisbury, 1807); n. v.

At time of flowering plants 10-30 cm and, at the period of fruiting up to 50 cm high. Shoots single with one flower or branched ones with two flowers. Some specimens bloom before development of basal leaves, the cauline leaves are then arranged immediately under the flower in a ruffle. The first basal leaves have short petioles but with sheaths up to 5 cm long. These sheaths are membranaceous, broad distinctly nerved. Further basal leaves usually have much shorter sheaths and longer petioles. Laminae 3-5-sected with rhomboidal three-lobed segments dissected into narrow lobes, ending sharply with sharp dentation on edges. In some specimens segments with rounded edges almost undissected (Pl. XVI). Diameter of leaf laminae 4-10 cm. Cauline leaves generally 3 (1-4). The lower ones are petiolated the upper ones sessile or all are sessile. Laminae usually 3-sected similar to the basal leaves; all have a distinct sheath surrounding the shoot. In sessile leaves the sheath frequently forms rounded ears (Fig. 16 y).

a

b

c

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y

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x

Flowers open, flat or in the form of shallow bowls, 3.0 - 4.5 cm in diameter. Perianth leaves 5 - 10, sometimes more; 14 - 20 mm long; oval, elongated or broad-rhomboidal; 6 - 12 mm broad (Fig. 16 a, b); light cream-coloured (Primrose yellow 601/2), light yellow or yellow. Sometimes the perianth leaves are not shed immediately after flowering but dry up and may be found on the shoot with fully developed follicles. Honey leaves ca. 15, yellow (Saffron yellow 7), their length varies from 3.5 to 7.0 mm. They are more or less the same length as the filaments of the stamina or somewhat shorter. All honey leaves are thickened and glistening; mostly with three nerves which may branch. Their shape varies widely: elongated almost linear, sometimes with a distinct central nerve and an incision at tip (Fig. 16 c, d); the blade somewhat widened, oval and rounded at tip (Fig. 16 e, f), pear-shaped with widened upper part. The latter shape is most common, and these leaves may be of various length, some have an incision at the tip (Fig. 16 g - k). If the central nerve is pronounced, it descends from the incision at the tip of the blade and across the unguis. Nectary pit in the shape of a shallow pocket at a height of 0.5 - 1.0 mm from base of leaf. Stamina 6 - 8 mm long including anther length 2 - 3 mm.

Fruits: 10 - 30 follicles in head. Length of follicles with beak 7.0 - 13.0 mm, beak length 2.0 - 5.0 mm; their shape is highly variable. The follicles may be broad, up to 1/2 of their length, with thin, quite straight beaks (Fig. 16 r, s) or bent outwards (Fig. 16 w, x). More elongated follicles may be three and even as much as four times longer than broad, their beaks are mostly shorter and thicker, straight or slightly inclined (Fig. 16 l - p). This great diversity in the morphology of the follicles gives rise to a great variety of shapes of the fruit heads (Fig. 16 r - x). Flowers May-July. $2n = 16$.

Distribution: United States of America and Canada.

The range is separated into two parts. The eastern part comprises

Fig. 16. Some flower elements and fruits of *Trollius laxus* (perianth leaves and follicles in heads life-size; honey leaves, stamina and single follicles $2 \times$ life-size):

a - Montana, leg. Jones (1909) (BM); b - West Central Colorado, leg. Baker, (22) (E); c - Kieking Horse Bake, leg. Macoun (1885) (BM); d - Rocky Mt. lat. 40 - 41°, Powell's Expl. Exp. (1868) (K); e - S. Colorado, Mt. Hesperus, leg. Baker, Earle, Tarcy, 300 (E); f - British Columbia, leg. Calder, Savile, 9935 (BM); g - Northern Rocky Mts, leg. McCalla, 2123 (K); h - British Columbia, Selkirk, leg. Schow, 47 (BM); i - S. Colorado, La Plata Mts, leg. Baker, Earle Tarcy, 288 (E); j - Alberta, leg. Ogilvie (1913) (E); k - *T. mexicanus* ex Herb. Roemer (BM); l = h; m - Yellowstone Park, leg. Nelson et Nelson (1899) (E); n - Yellowstone Park, leg. Rydberg, Bessy, 4061 (E); o - St. Mary's Lakes Mts, leg. Umbach, 81 (E); p - New York near Portageville, leg. Jonson (1927) (BM); r - Firceville, leg. Coville (1885) (K); s - British Columbia, leg. Petersein, 534 (K); t, u - S. Colorado, leg. Baker (1899), 336 (E); w - N. Montana, leg. Vreeland, 1044 (K); x - Wyoming, medicine Bow Mts, leg. Nelson, 7838 (K); y = b

the States: New Hampshire, New York, Pennsylvania, Michigan, and Virginia; mainly in the Appelachian Mts. (Rickett, 1953, 1966); Gleason and Cronquist (1963) mention moreover the states Delaware and Connecticut. The western part of the range extends along the Rocky Mountains southwards, it comprises the States: Alberta, British Columbia, Washington, Montana, Idaho, Wyoming, Utah and Colorado. The specimen of *T. laxus* in the British Museum herbarium labelled as *T. mexicanus* (Roemer's Herbarium) seems to have been found on the territory of the New Mexico State. It is quite possible that the range of *T. laxus* extends through the Rocky Mountains further south than the Colorado State (Fig. 17).

Fig. 17. Distribution of *Trollius laxus* according to the herbarium material

Specimens examined:

Cultivated: H/167 grown from seeds received from the Botanic Garden at Uppsala in 1966.

Herbarium specimens: C. F. Baker: 336 (1899), Souther Colorado near Pagosa Peak (BM, K, E); 22 (1901), Plants of West Central Colorado, Region of the Gunnison Watershed (E). — C. F. Baker, F. S. Earle, S. M. Tarcy: 288 (1899), S. Colorado, W. La Plata Mts. Slide Rock Coum., 10500 f. (E); 300 (1899), Plants of Southern Colorado, Mt. Hesperus (E). — A. J. Breitung: (July 1945), Canada, Alberta, Banff National Park, vicinity of sunshine Ski Lodge, south of Healy Creek, Wawah Ridge, Twinn Cairn and Standish Hump, alpine slopes and ridges

between 7200 - 8500' elev. (W); (11 - 15 July 1945), Canada, Alberta, Banff National Park, Vicinity of Lake Louise (W).—J. A. Calder, K. T. MacKay: 32275 (1961), Moat lake, Forbidden Plateau, 49°41' N - 125°24' (W, WA).—J. A. Calder, D. B. O. Savile: 9955 (1953), British Columbia, 17 1/2 mile s. w. Cherryville, along Monashee Road (BM); 10871 (1953), Canada, British Columbia; Mt. Revelstoke National Park. Along road to Heather Lodge, alt. 5400' (W).—J. A. Calder, I. A. Parmelee, R. L. Taylor: 18061 (1956), 52°51' N - 121°26' (W, BM).—A. Cronquist: 8069 (1955), Montana, Open, boggy, gentle slope just west of Quad Creek, atop the Beartooth Mts., 23 miles sw Red Lodge. Twp. 9 So, R. 19 E, S. 19, Elev. about 10 000 ft. (W).—G. M. Dawson: (1864), loc. Bow Riever, Rocky Monts (BM).—Fr. Coville: (1865), locus Mnd Creek, near Firuville (K).—O. Degener: 26934 (1960), Colorado, Independence Pass on Twin Lakes, Cold Water bog (W).—Custer Co: (1916), 3568 Plants of Idaho, Josephus Lakes (K); 956 Plants of Idaho, 118°20' W Long, 51°45' N Lat. (K).—A. Gary: (1836), Colorado, Utica (LE).—J. V. Haberer: 35 (1873), Swamp near Utica, Oneida county, N. Y. (PRC).—E. Hall, J. P. Harbour: (1862), Rocky Mt. Alpine Flora, lat. 39°41' (BM).—H. D. House: 17380 (1930), Flora of New York, Summit lake marsh, Springfield, Otsego county (PRC).—M. E. Jones: (1909), Flora of Montana, Spruce Belt (BM).—N. G. Jones: 34075 (1962), Colorado, Boulder Co., Wet ground, Fourth of July Canyon, alt. ca 10000 ft., above Eldora (KRA); 34208 (1962), swamp, 2 mi. below s. Yankee Doodle Lake, alt. ca 10500 ft., Gilpin Co., Colorado (KRA).—F. W. Jonson: (1927). Flora of New York, near Partageville (BM).—N. G. Jones: (1963), Colorado, Diamond Lake, North Fork of Middle Boulder Creek (LE).—Lyll: (1860), Cascade Mts. 45° N Lat (K); (1861), Fort Colville to Rocky Mts, Lat 49° N (K).—J. F. Macbride, E. B. Payson: 3513 (1916), Idaho, Cope Horn (E); 3568 (1916), Plants of Idaho, Josephus Lakes, alt. 7000 ft. (E).—W. C. McCalla: (1869), Northern Rocky Mountains, 7500 ft. (K).—J. Macoun: 64 (1885), Kicking Horse Lake (BM).—J. S. Moyer: (june 1875), Quakertown, P. A. (W).—A. Nelson, E. Nelson: (1899), 6094, Plant of Yellowstone Park, Obsidian Creek (E); 886 (1894), Flora of Wyoming, Union Pass (E); (1900), 7837, Flora of Wyoming, Medicine Bow Mts. Albany Co. (K).—H. Ogilvie: (1913), Alberta, Brit. Columbia, 52°80' - 117°30' E, 6000 ft. (E).—F. Petress: 635 (1950), Wyoming, Medicine Bow Mts., unter Picea Engelmani auf Sumpfwiesen am Lake Marie (W).—H. Petersein: 534, Selkirk Flora, Selkirk in British Columbia near 51°50' N Lat., alt. 5000' (K).—P. A. Rydberg, E. A. Bessy: 4061, 10.VIII.1897, Yellowstone Park, Lacy's Creek (E).—C. H. Show: 47 (1904), Selkirk Flora, Selkirk and Rocky Mts in British Columbia near 51°30' N Lat. (E, BM); 1905, Selkirk Flora, 118°20' E—51°45' NL (E).—R. G. Stolze: f. 501 (1965), Wyoming, Common along Bull Creek, in very wet mossy soil; roadside along Rt. 16, 20 miles east Tensleep Washakie County, Elev. 8700 ft. (W); f. 671 (1965), Wyoming, Common on sandy banks of creek, in partial shade of spruce-pine woods in Wood-rock Compground, on County Road 632, 3 miles east of U. S. Route 14, Sheridan County, Elev. 8500 ft. (W); 884 (1966), Wyoming, Meadows and limestone slops at Clay Butte, 44°56' N 109°37' W, along U. S. Route 212, 25 miles southeast of Cooke City, Montana, Elev. 2900 m (W).—R. L. Taylor, D. H. Ferguson: 3141 (1958), Canada, British Columbia, Rocky Mountains, Half a mile east of Torando Pass, 49°58' N - 114°35', Common in pine-fir alpine meadow at 7200' (W).—W. Thompson: 7409, 7410 (1913), Flora of the State of Washington, Olympic Mnts, Mt. Angeles, 5000 ft. (K).—Torr et Gray: ex Herb. Careyannum, N. America (K).—L. M. Umbach: 811, (1905), St. Mary's Lakes Mont. (E).—G. Vasey: 21 Powell's Exploring Expedition 1868, Rocky Mt., Lat. 40 - 41° (K).—F. K. Vreeland: 1044 Fl. of North Montana, Glacial Basin below Sperry Glacier, alt. 1800 - 1950 m (K).—L. Williams: 1384 (1933), Plants of Northwestern Wyoming, Teton County, Moist

hillsides in timber, Bridger Mountain, elev. 9600 ft. (PRC). — Auct. ign.: Herb. Zahlbruckner, In Virginia, Su. Enslea (PRC); *T. mexicanus*, amic. Otto (rarissimus) Herb. Roemer, Herb. R. J. Shuttleworth, Rec. 1877 (BM); British Columbia, Canyon Creek Mountains (K); South Colorado: 288, Slide Rock Canyon, W. La Plata Mts. (K); 300, Mt. Hispirus (K); Colorado, Gray's Peak (LE); British Columbia, Mt. Apex southwest of Pentincton, alt. 7500', Herb. Dep. of Agriculture, Ottawa, Canada (LE).

Trollius laxus Salisb. var. *albiflorus* Gray

A. Gray, Am. Journ. Sci II, 33: 241-2 (1862); Coulter, Man. Bot. Rocky Mt., 8 (1885); Weber, Rocky Mt. Fl., 253 (1967).

Syn.: *T. albiflorus* (Gray) Rydberg, Mem. N.Y. Bot. Garden, 1: 152 (1900); Rydberg, Fl. Rocky Mt. Ad. Pl., 304 (1922).

T. laxus var. *albiflorus* with pure white flowers differs from *T. laxus* var. *laxus* which has cream- paleyellow- greenish- or yellow-coloured flowers. No other differences have been noted between the two varieties. The general habitus and dimensions are the same. Both variable have a very characteristic morphology of the follicles and honey leaves.

Distribution: North America: Rocky Mountains, in the States: Montana, Alberta, British Columbia, Colorado. Grows in the mountains at a height of 2 000 - 3 500 m a.s.l. on meadows near snow patches, in valleys in humid places (Rydberg 1900).

Herbarium specimens examined: J. A. Calder, K. T. Mackay: 32275 (1961), Canada, British Columbia, Vancouver Island, Moat Lake, Forbidden Plateau 49°41' N, 125°24' W, Locally common at wet margin of brook at south end of Lake at 4000', flow. white (W, LE). J. A. Calder, J. A. Parmelee, R. L. Taylor: 18061 (1956), Canada, British Columbia, Yanks Peak (6242'), 6 miles north of Keithley Creek on Cariboo Lake, approx. 52°51' N 121°26' W. Common in moist openings in coniferous woods from 4800', fls white (W).

Note: Only those herbarium sheets are quoted, on the labels of which the remark is placed that the flower is white. The name on the label is not always reliable in this case since some authors did not distinguish these two varieties and treated their names as synonymous.

The first report on the occurrence of *Trollius* in North America was given by Mühlenberg in 1793. This author mentions *T. americanus* N. S. in a list of plants from the region of Lancaster, he gives, however, no description. The letters N. S. mean that the author gave the plant a new name since he could find no description in the literature which would correspond to his specimens. Also Salisbury (1807) described from the environs of Lancaster in Pennsylvania the new species under the name *T. laxus* Salisb. basing on the collection of Mühlenberg (Salisbury 1807, p. 303). Later authors (Pursh, 1814; Hooker, 1833; Gray, 1862) consider *T. americanus* Mühl. and *T. laxus* Salisb. as synonyms.

In the first descriptions already the variable number of perianth leaves was remarked. Pursh (1814) and De Candolle (1818) on the basis of herbarium material mention: α — *T. pentapetalus* (Herb. Banks) and β — *T. decapetalus* (Herb. Bose). De Candolle (1818, 1824) says that *T. americanus* is very similar to *T. laxus* and considers that this taxon originates from Pennsylvania. On the other hand, Turczaninov (1842) considers *T. americanus* var. *pentapetalus* from Dahuria in Central Asia as a synonym of the species *T. dahuricus* Turcz. which he himself describes. The same error repeated after him Ledebour (1842) and Regel and Tiling (1858). The latter authors, however, add to the description the remark that they did not find such plants in the entire flora of Russia. In spite of this, *T. laxus* is mentioned by some of the later authors from East Siberia (e.g. Brühl, 1896, p. 87).

In 1862 Gray described from the Rocky Mountains a variety with white flowers — *T. laxus* Salisb. var. *albiflorus* Gray. Rydberg (1900) raised it to the rank of species as *T. albiflorus* (Gray) Rydb. This taxon was supposed to differ from the typical *T. laxus* of Pennsylvania with yellow flowers by somewhat broader perianth leaves, vegetative leaves with broader segments and the white colour of flowers. The plants have been found in the Rocky Mountains at the alpine level near snow patches in the Montana State and in the Yellowstone National Park. It results from further observations that the plants with white flowers from the Rocky Mountains may have both wider and narrower perianth leaves and segments and leaf lobes of various width.

In later American Floras the classification of *Trollius* is not uniform, most authors mention only one species, but under various names. F. E. Clements and F. S. Clements (1914) mention from the Rocky Mountains only *T. laxus*, Rydberg (1922) only *T. albiflorus* (Gray) Rydb. as syn. *T. laxus* var. *albiflorus* Gray. Harrington (1954) in his description of the plants from Colorado mentions as first *T. laxus* Salisb. as synonym of *T. albiflorus* (Gray) Rydb. In "Rocky Mountain Flora" Weber (1967) mentions also only one taxon — *T. laxus* Salisb. var. *albiflorus* Gray. The above mentioned differences in the nomenclature were mainly caused by the but little pronounced differences in the colour of the flowers. The plants from the eastern States have light-yellow flowers ("flavi nec aurentiaci" according to Salisbury 1807, that is "pale-yellow" according to Stearn, 1967, p. 246), yellow (Pursh, 1814) or greenish-yellow (Gleason and Cronquist, 1963). In the Rocky Mountains, on the other hand, the plants may have yellow, pale-yellow, greenish-yellow, cream-coloured, almost white and pure white flowers. Coulter (1885) reports for *T. laxus* from the Rocky Mountains "flowers pale greenish-yellow or nearly white" and for the variety *albiflorus* "the pure white sepals"; Harrington (1954) for plants from Colorado mentions: "sepals white or cream-coloured". It re-

sults therefrom that the plants from the Rocky Mountains may have perianth leaves of various intermediate hues between white and light-yellow or greenish-yellow. This is probably due to small quantitative differences in the pigments responsible for the intensity of the yellow colour.

The differences in the colour of the flowers of *T. laxus* and *T. albiflorus* proved in practice too slight to distinguish on this basis two species. Some authors treat the plants with pure white flowers only as a variety (*T. laxus* var. *albiflorus*) as did for the first time Gray (1862). The establishment of a new taxonomic unit on the basis of so unstable a character is not advisable but acceptable at the variety level.

In descriptions of *T. laxus* attention has been mainly devoted to the colour of the flowers, whereas other morphological characters of this species are also highly variable and require a more detailed discussion. This concerns the general habitus of the plants, the leaf and fruit morphology and the shape of the honey leaves.

Some specimens of *T. laxus* flower before development of the basal leaves, the shoot is surrounded at the base with leaf sheaths and the cauline leaves form a ruffle immediately below the flower (Pl. XVI). At this stage the plants greatly resemble in general habitus *T. acaulis* which as a rule flowers before development of the leaves. This probably is true for specimens growing at high altitudes at the snow border. The difference in the general habitus of the *T. laxus* plants flowering before the development of basal leaves and the habitus with fully developed leaves is so great that they might be taken for two different taxa.

The leaves of *T. laxus* have laminae with narrower or broader segments dissected into lobes of various width; these lobes may end sharply with sharp dentation on the edges or be rounded at the tip with a wavy margin. Such differences in the morphology of leaf laminae are found in numerous other *Trollius* species, e.g. *T. asiaticus*, *T. ranunculinus*, *T. europaeus* and others. The variability of the leaf laminae is continuous with a number of intermediate forms. Although some *T. laxus* var. *albiflorus* specimens actually have leaves with broader segments than those in *T. laxus*, like those described by Rydberg (1900), specimens with narrow segments may also be found. Characteristic for this species are the leaf sheaths. Petiolated leaves have elongated sheaths, sessile cauline ones exhibit sheaths with rounded ears. Specimens may also be seen with much smaller leaf sheaths without ears. Similar sheaths are found in *T. acaulis*, *T. lilacinus* and *T. ranunculinus*, in these species rounded ears may be seen at the cauline sessile leaves.

The honey leaves of *T. laxus* show a high variability not noted in any other *Trollius* species. Their length and shape are diverse (Fig. 16 c - k). Similar linear honey leaves may be found in *T. ranunculinus* from the Caucasus and *T. riederianus* from the Kamchatka (Fig. 11 j,

Fig. 16 c); oval and spatulate honey leaves occur in *T. acaulis* and *T. lilacinus* (Fig. 6 b, c, e-l); *T. afghanicus* and *T. membranostylis* have pear-shaped leaves with an incision at the tip (Fig. 6 s, Fig. 14 h-k).

All the above named species, however, have honey leaves less variable in shape, whereas in *T. laxus* the range of variability is ever so much wider including all these forms.

The fruits of *T. laxus* also exhibit exceptional variability (Fig. 16 r-x). Regel and Tiling as early as 1858 called attention to this fact and distinguished for *T. americanus* Mühl. the forms: α -*tenuistylus* and β -*brevistylus*, it is not clear, however, on what materials they based and whether these plants originated doubtlessly from America. This high variability of the follicles of *T. laxus* is the reason why the heads with the fruits are so dissimilar and may suggest the appurtenance of the plants to various taxons.

In some other *Trollius* species the morphology of the fruits is also variable, but the differences are not so drastic as in *T. laxus*. The rather high variability of the fruits has long been known in *T. ranunculinus*; it concerned particularly the shape of the beaks; on the basis of this difference new taxonomic units have been established (Meyer, 1831; Ruprecht, 1859). This character, however, proved in practice so variable that it could have no taxonomic significance (Busch, 1901). If in *T. laxus* the fruit variability is as continuous as in *T. ranunculinus*, it can as in the latter case be of no taxonomic significance.

On account of the scarce comparative material the present author feels unable to ascertain whether a similar variability of the honey leaves and fruits occurs in the plants from the Eastern States of the U.S.A.

Analysis of the morphological characters indicates a similarity between *T. laxus* and two other *Trollius* groups. To the first belong the species from Central Asia: *T. acaulis*, *T. lilacinus* and *T. afghanicus* of the *Acaulitrollius* section. The second group includes the Okhotsk-Japan-Kamchatka species of the *Insulaetrollius* section. There is no doubt as to the relationship between *T. laxus* and the Central-Asiatic group, although these species are so remote from one another. The following common characters are evidence of this relationship: the morphological similarity of the honey leaves and fruits, the characteristic leaf sheaths frequently provided with ears, the elongated shape of the perianth leaves noted in *T. laxus*, *T. acaulis* and *T. lilacinus*, the white colour of the flowers known only in *T. laxus* and *T. afghanicus*, etc. Most numerous common traits are found between *T. laxus* and *T. acaulis*. Hooker and Thompson as early as 1855 called attention to the similarity of these two species: "*T. acaulis* is very near *T. americanus*". Later Brühl (1896, p. 87) says that the honey leaves of the American *T. laxus* speci-

mens are the same as in *T. acaulis*; he also mentions a number of other common characters for *T. laxus*, *T. acaulis* and *T. ranunculinus*.

Most of the above mentioned common traits for *T. laxus* and the species of the section *Acaulitrollius* may also be found in species belonging to the *Insulaetrollius* section. Particularly striking is the similarity of the honey leaves of *T. laxus*, *T. membranostylis*, *T. riederianus* and other species of this section. *T. chartosepalus* plants and some specimens of *T. laxus* develop flowers before the basal leaves. This development rhythm is characteristic for the plants of the *Acaulitrollius* section. The relationship of the American *Trollius* with *T. chartosepalus* and *T. riederianus* has been pointed out by Schipczinsky (1923, 1924). This author considers that *T. americanus* is derived from *T. chartosepalus* and *T. laxus* from *T. riederianus*. On account of the lack of American material Schipczinsky could not draw a precise comparison between these species, but he considered the American plants as the last member of the eastern branch of the *Trollius* species (Schipczinsky, 1923, p. 14).

The hypothesis of this author, correct in principle, should be adopted in a somewhat more extensive approach. The American representatives of the genus *Trollius* originate from the group of Okhotsk-Japan-Kamchatka taxons or from their ancestors occurring on this area.

COMPARISON OF THE TROLLIUS SECTIONS

Seven sections have been distinguished in the genus *Trollius* by the author. Three of them occur on areas which have not been covered by glaciation and these may be considered as the primary (oldest) ones. To these sections belong: *Pumilotrollius*, *Yunnanotrollius* and *Acaulitrollius*. They all include mountain plants growing at the alpine and subnival level in the mountains of Central Asia. Each of these sections has characteristic morphological traits and a relatively restricted geographical range. There are no intermediate forms between the section *Acaulitrollius* and the remaining two, and its range is completely allopatric. Between the sections *Pumilotrollius* and *Yunnanotrollius*, on the contrary, intermediate forms exist and the ranges of these section are sympatric (Fig. 18). In each of these three groups the degree of differentiation of taxons is different.

The section *Pumilotrollius* is found in the Himalays and East Tibet, mainly on the territory of India and in South-West China (Fig. 2). It is the section reaching farthest to the south, its range in the Yunnan and Himalayas reaches beyond the 30th parallel of northern geographical longitude; the distribution of the section *Yunnanotrollius* is similar. Seven small species are included in the section *Pumilotrollius*. The height

of some specimens does not exceed 5 cm, such small plants are not noted among representatives of other sections. The geographical ranges of the *Pumilotrollius* species are mostly sympatric, and intermediate forms may be found among them. Nevertheless, it is possible and justified to distinguish the particular species. In this *Trollius* group there are exceptionally distinct differences in the structure of the leaf laminae, very helpful in the classification of the species.

The section *Yunnanotrollius* occurring in the mountains of East Tibet and South China (Fig. 5) is largely sympatric with the *Pumilotrollius* section, but the morphological differences between these two groups of species are very distinct. In the *Yunnanotrollius* section only three species have been distinguished, one of which, *T. yunnanensis*, comprises two subspecies and several forms. These taxons are highly variable. Notwithstanding this, many specimens belonging to this section could not be classified to other established species. At the same time their morphological characters were so variable that they could not be grouped into any other additional taxons. As compared with the section *Pumilotrollius*, the differentiation of species in the section *Yunnanotrollius* is less advanced. *T. papavereus* belonging here has flowers similar to those of *T. pumilus* and is a link between these two sections.

The section *Acaulitrollius* occurs in Kashmir, the Pamirs, Tien-Shan Mts. and on the adjacent areas (Fig. 7). In the Eastern Himalayas it comes into contact with the section *Pumilotrollius*, and in the northern Pamirs, Tien-Shan and Altai it is sympatric with *T. dschungaricus* and *T. altaicus* belonging to the *Trollius* section, it is also to some extent sympatric with the section *Longipetala* (Fig. 18). The section *Acaulitrollius* comprises only three species. They are quite distinct and no intermediate forms exist between them. Neither are plants intermediate between these species and representatives of other sections known. This situation is exceptional for the genus *Trollius*. Nevertheless, the particular characteristic traits for this section may be found in representatives of the sections *Trollius*, *Insulaetrollius* and *Laxotrollius*. This is of great importance in evolutionary considerations; therefore, the section *Acaulitrollius* is one of the most interesting groups of the genus *Trollius*.

It may be concluded from the foregoing comparison that the differentiation of taxons in the above mentioned three sections is unequal. In *Acaulitrollius* this process seems to be most advanced and as if ended, whereas in the remaining two differentiation of new species is still probably in progress.

In all the three sections considered the flowers are open, flat or almost so, and the honey leaves small, thickened, quite different from those of the perianth. Their blades are thickened cushion-like, glistening of an orange colour darker than that of the perianth.

Extremely different is the structure of the honey leaves in the taxons

Fig. 18. Geographical ranges of the sections

1 — sect. *Pumilotrollius*; 2 — sect. *Yunnanotrollius*; 3 — sect. *Acautitrollius*; 4 — sect. *Longipetala*; 5 — sect. *Trollius*; 6 — sect. *Insulaetrollius*; 7 — sect. *Larotrollius*; 8 — Main directions of migration

of the *Longipetala* section. In this section the honey leaves are flat, elongated and mat. Their blades are neither thickened nor convex, but thin and similar to the perianth leaves, partly even of the same colour. Their nectary pit has always the shape of a flat pocket, whereas in *Pumilotrollius* and *Yunnanotrollius* plants it is spherical and distended, and in the section *Acaulitrollius* it resembles a shallow pocket. Representatives of the section *Longipetala* occur both in the mountains and on the lowland in Central and Northern Asia (Fig. 10). In the western part of Western Siberia and in Northern Ural the range of *Longipetala* is partly sympatric with *T. europaeus* and *T. apertus* belonging to the section *Trollius*. Both these sections are linked by *T. apertus*, a species which arose as the result of crossing of *T. europaeus* and *T. asiaticus*.

Also *T. altaicus* belonging to the section *Trollius* has a range largely sympatric with the *Longipetala* section since it is found in the Tien-Shan, Altai, Sayan and Stanovoi Mts. In the Far East the range of the section *Longipetala* is partly identical with that of the section *Insulaetrollius*. Both these groups are interlinked by *T. riederianus* and *T. sibiricus*, two very similar species. The section *Longipetala* does not seem to have any links with the remaining *Trollius* groups.

The particular taxons of the section *Longipetala* pass gradually into one another and are linked by intermediate forms. Their geographical ranges are generally partly sympatric. Differentiation of some species is not distinct, and their rank arouses many doubts.

The species of the remaining three sections *Trollius*, *Insulaetrollius* and *Laxotrollius* have many intermediate characters between those of *Longipetala* and the section *Pumilotrollius* and *Yunnanotrollius*. This concerns above all the structure of the honey leaves which in these groups are only somewhat thickened and glistening and have nectary pits usually in the shape of a shallow pocket or depression. These pits are never spherical or distended as in the plants of *Pumilotrollius* and *Yunnanotrollius* sections. At the same time, species of the sections *Trollius*, *Insulaetrollius* and *Laxotrollius* show a distinct morphological relationship with the section *Acaulitrollius*. In general the three above mentioned sections are much less uniform than the already discussed four others, and in each of these groups the situation is different.

The section *Trollius* includes three groups of taxons, the geographical regions of which are allopatric and rather distant from one another (Fig. 13, 18). *T. altaicus* and *T. dschungaricus* grow in the mountains of Central Asia and Siberia, *T. ranunculinus* on the Caucasus, *T. europaeus* in Europe and on the West-Siberian Lowland, and *T. apertus* in the Northern Ural. Characteristic for this group are linear honey leaves rounded at the tip, somewhat thickened and shining. Some plants, however, may have honey leaves widened and similar to those of *T. acaulis* and *T. lilacinus*. *Trollius europaeus* has also somewhat widened honey

leaves, but they rather resemble those of *T. pumilus*. From among the species of this section *T. ranunculinus* exhibits the highest variability; some specimens of this species from Eastern Turkey are related to *T. acaulis*, *T. ranunculinus* is in general also similar to *T. riederianus*.

T. europaeus differs distinctly from other species by its globose or almost spherical flowers. Although in *T. altaicus* globose flowers may also be found sometimes, but *T. altaicus* is characterized by dark purple stigmata not found in any other species. The variety *T. altaicus* var. *sajanensis* has yellow stigmata, and may easily be confused with *T. apertus* occurring in the Northern Ural. Of all the species of the *Trollius* section, however, the closest related morphologically are *T. altaicus* and *T. dschungaricus*; their ranges are partly sympatric and they are probably closely related. In general the section *Trollius* has many characters in common with the section *Acaulitrollius* as well as with some representatives of the *Insulaetrollius* section to which the above mentioned *T. riederianus* belongs.

The taxons of the section *Insulaetrollius* are distributed on the islands of the Far East, on the Kamchatka and Chukot Peninsulas, in the coastal regions of the Okhotsk Sea (Fig. 15). Two principal types of honey leaves can be distinguished in this group: small spatulate leaves or pear-shaped ones found in *T. membranostylis* and *T. chartosepalus*, and longer linear leaves like those of *T. riederianus* and *T. pulcher*. Honey leaves of intermediate character are seen in *T. schipczinskii*. Small leaves like those of the first mentioned group are found in *T. afghanicus* belonging to the section *Acaulitrollius*. The elongated leaves of *T. riederianus* resemble somewhat those of *T. yunnanensis*. Beside the honey leaves, a number of other characters point to relationships between the sections *Insulaetrollius* and the sections *Acaulitrollius* and *Yunnanotrollius*. The similarity is, however, most pronounced between the representatives of the section *Insulaetrollius* and specimens of *T. laxus* belonging to the section *Laxotrollius*.

The section *Laxotrollius* found in North America includes only one species *T. laxus* (Fig. 18). This species is highly variable, incomparably more so than the species of other sections as for instance *Insulaetrollius*. This concerns not only the colour of the flowers which may be yellow, light-yellow, greenish, cream-coloured or white, but also the fruits and honey leaves which in *T. laxus* are very diverse. Almost all types of honey leaves occurring in the section *Insulaetrollius* may be found in specimens of *T. laxus*. If we compare the sections *Insulaetrollius* and *Laxotrollius* it is seen that their division into taxons is incommensurable. The variability of the *Laxotrollius* section plants is more or less the same as in the section *Insulaetrollius*, but in the former section all the specimens have been classified to only one species, *T. laxus*, whereas in the latter section several species have been distinguished: *T. riede-*

rianus, *T. pulcher*, *T. membranostylis*, *T. chartosepalus* and *T. schipczinskii*. The variability of morphological characters in *T. laxus* is so continuous that there are no grounds for dividing this species into several taxons. Only specimens with white flowers are denoted as *T. laxus* var. *albiflorus*. In the particular taxons of *T. laxus* many features characteristic for the section *Acaulitrollius* may be found as well as others occurring in representatives of the section *Insulaetrollius*.

OBSERVATIONS ON CULTURE, CROSSES AND HYBRID FERTILITY

Some species of *Trollius* have long been cultivated as ornamental plants. Most common in gardens is *T. chinensis* which has very decorative flowers and *T. pumilus* planted in rock gardens. Both these species are easy to cultivate. *T. europaeus* is also often cultivated even as a polyploid garden form. Some authors recommend also for breeding *T. asiaticus*, *T. altaicus* and *T. lilacinus* (Luchnik, 1951; Malyshev, 1965; Volodina, 1968).

In the Botanical Garden in Warsaw numerous specimens of 15 *Trollius* taxons have been cultivated for more than ten years. Some of them originated from natural sites. These plants were used for crosses and karyological studies; at the same time note was taken of their development morphology and fertility.

It results from these observations of many years that *Trollius* does not belong to easily growing plants developing quickly and multiplying well. It is very sensitive to the environmental conditions. *Trollius* requires not only a large amount of water in the soil, but also in the air. Almost all *Trollius* plants are mesophytes and long-day plants requiring much light, they do not tolerate dry sun-heated air. Many alpine species cannot be adapted to lowland conditions, others—even if they do grow—do not flower at all. The same is true as regards specimens from the far north. Although *Trollius* is resistant to frost and hibernates well in Warsaw without being covered, many specimens die in the course of the year.

Among the numerous *Trollius* specimens partial selfsterility is frequent, and they give but few seeds. The seeds germinate poorly and usually in a low per cent (Doroszewska, 1970). The seedlings grow slowly and flower in the second year of growth. Therefore experiments with *Trollius* are tedious and require long years of work.

Various species of *Trollius* readily cross between themselves. The author has brought about more than 100 interspecific crosses, nearly always with good results. The main obstacle in crossing was the different time of flowering of some parent plants. In Warsaw the *Trollius* plants mostly flowered in May and June, but some species started earlier

than others, and it was not always possible to obtain the flowers at the same time. Some species, moreover, form only a single shoot with one flower at the tip what also makes crossing difficult.

The mean amount of seeds obtained by cross pollination was as a rule not lower than that yielded by the parent specimens after selfpollination. In some crosses the mean number of F_1 seeds was even higher than that of S_1 seeds collected from the parent plants after selfpollination. In all crosses a large part of the F_1 seeds were undeveloped and they germinated in a very low per cent. Part of the seedlings of the F_1 generation were weak and died in further culture. Nevertheless in nearly all crosses the author succeeded in bringing to the stage of flowering and fruiting at least several F_1 specimens. The fertility of the F_1 generation varied widely. In general three groups could be distinguished:

1. Crosses in which the F_1 generation fertility was about the same as that of the parents.
2. Crosses in which the F_1 generation had a reduced fertility as compared with the parent plants; it was lowered to various extents depending on the choice of the parent plants.
3. Crosses in which the F_1 hybrids were completely sterile, and even back-pollination gave no results.

To this third group belong hybrids from the crosses of *T. pumilus* and *T. yunnanensis* with representatives of other sections (Doroszevska, 1970 and unpublished observations). Taxons of the sections *Longipetala*, *Trollius* and *Insulaetrollius*, on the other hand, always gave fertile F_1 hybrids, and an F_2 generation could be produced (Doroszevska, 1965 and unpublished observations). This allowed to follow the inheritance of some morphological characters, which is very important for the understanding of the evolutionary processes occurring in the genus *Trollius*.

It results from the experimental data that the progeny of closer related species is in general more fertile. The fertility of the F_1 generation may in this way be an indicator of the phylogenetic relations between the taxons. A detailed elaboration of these problems will be the subject of another publication.

KARYOLOGICAL DATA

It results from up-to-date observations that *Trollius* specimens have mostly a diploid set of $2n = 16$ chromosomes. This has been established for more than a dozen species, mostly on specimens from natural sites (Langlet, 1932; Sokolovskaya, 1960, 1963; Sokolovskaya and Strelkova, 1948, 1960; Skalińska et al. 1959; Doroszevska, 1967, 1970 and others).

The tetraploid number of chromosomes $2n = 32$ given by Langlet (1932) for *T. americanus* Mühl. was established in a plant taken from the Botanical Garden, and not from a natural site. The tetraploid specimen of *T. europaeus* described by the author (Doroszevska, 1964) was an artificially obtained tetraploid. The triploid of 24 chromosomes as reported for *T. europaeus* by Lundegårdh (1909) seems doubtful.

It would seem that polyploids and aneuploids do not occur in nature. For the genus *Trollius* a basal number of chromosomes $x = 8$ is characteristic, and deviations from the diploid level are rare. Even under changed culture conditions the number of chromosomes remains the same (Zhukova, 1961).

Langlet (1932) distinguished in the family *Ranunculaceae* two types of chromosomes. Relatively large and long ones which he denoted as type R as in *Ranunculus*, and minute chromosomes denoted as type T as in *Thalictrum*. The genus *Trollius* has type R chromosomes.

Investigations on the karyotypes of some *Trollius* species have been performed by Kurita (1957, 1959, 1960, 1965) and Doroszevska (1967). It results from these studies that in *Trollius* the morphology of the chromosomes is relatively uniform. Within one karyotype there are no drastic differences between the chromosomes. They all are of type R, and the ratio of the length of their arms may be 1:2, 2:3, 1:3 or 1:4. In the seven *Trollius* taxons investigated by the author (Doroszevska, 1967) the chromosome dimensions varied between 3.2 and 7.9 μ , the shortest ones were found in *T. pumilus*.

The karyotypes of various *Trollius* species may be rather closely similar. They show not only a morphological resemblance but their chromosomes are also partly homologous.

In interspecific hybrids the course of meiosis in KMP of the F_1 generation is mostly quite regular. In metaphase I cells with 8 bivalents prevail, that is all chromosomes have the ability of conjugation. This phenomenon was noted in all the interspecific F_1 crosses, even in crosses in which the F_1 individuals were quite sterile, as for instance in numerous crosses with *T. pumilus* (Doroszevska, 1965, 1970). It would result therefrom that in *Trollius* the chromosomes of unrelated species conjugate with one another, and it is probable that they are at least partly homologous.

OUTLINE OF PHYLOGENY AND MIGRATION

Many *Trollius* species are not distinct and it is probable that in some groups the process of speciation is still in progress. In the genus *Trollius* most species readily cross with one another and give fertile progeny. This may sometimes lead to the arising of a new species as in the case

of *T. apertus* (Igoshina, 1968). It is suggested that the form *T. yunnanensis* ssp. *yunnanensis* f. *eupetala* is also of hybrid origin. The form *eupetala* differs widely from the remaining taxons of *T. yunnanensis* by the length and shape of the honey leaves. In no other *Trollius* taxon do such honey leaves occur, they are found, however, in some hybrids. In crosses of *T. pumilus* or *T. yunnanensis* with representatives of the section *Longipetala* the F_1 hybrids have honey leaves of the same type as those of the form *eupetala*. The cross *T. chinensis* $\times$ *T. yunnanensis* had in the F_1 generation flowers identical to those of the f. *eupetala* (author's own unpublished observations).

In general the process of differentiation of the taxons is prevented in natural populations by free crossing, thus making often the arising of new species impossible. It may, therefore, be assumed that the absence of sex barriers between numerous *Trollius* taxons is one of the main causes of poor differentiation of species in this genus. A second important factor influencing this phenomenon is the same character of morphological traits.

In the genus *Trollius* most morphological characters are conditioned by the action of numerous multiple factors. This was established for such important taxonomic traits as the height and general habitus of the plants, shape and size of leaf laminae, colour and shape of the flowers, number of perianth leaves, structure of honey leaves, morphology of fruits etc. The differences in establishment of any of these characters are largely dependent on the quantity of active polygenes. These polygenic characters give very often a picture of continuous variability. We are, therefore, dealing in the morphology of *Trollius* with slight, sometimes unnoticeable quantitative differences. This is a frequent phenomenon in nature. For instance the structure of the leaf lamina in some *Trollius* species is highly variable, from almost whole segments to deeply dissected ones. The morphological effect of the extreme forms is considerable, but the variability between them is so uniformly continuous that it is impossible to establish any limits.

Polygenecity of the characters is thus the main cause of occurrence of numerous intermediate forms between the taxons. As example of this may serve the *Longipetala* section in which one species passes gradually into another.

The results of experiments correspond fully to the pattern observed in nature. In all the artificial crosses performed, the F_1 progeny was always intermediate between the parent species. In the F_2 generation the variability of the particular traits was mostly of continuous character, and its scope frequently exceeds the parent forms (Doroszewska, 1965, 1970 and unpublished results).

In several crosses, forms existing in nature could be successfully reproduced. For instance in the F_2 generation of the *T. chinensis* $\times$ *T. euro-*

paeus cross some specimens were identical with *T. ledebouri* (Doroszewska, 1965). In this case the result of the cross does not prove solely the hybrid origin of *T. ledebouri*. This species is not related to *T. europaeus*, but is close to *T. chinensis* from which it differs mainly by the length of its honey leaves and the colour of its flowers. These are typically quantitative differences. In the F_2 generation of the above named cross, segregation of polygenes occurred resulting in individuals morphologically similar to *T. ledebouri*.

It would seem that in the genus *Trollius* the process of speciation occurred gradually through the summation of slight quantitative differences. These differences may have arisen as the result of slight mutations. Therefore, differentiation of the taxons progressed very slowly, the more so, since at certain stages it may have been neutralized by sporadic free crossing of the already differentiated taxons.

It is probable that in the genus *Trollius* two main centres of differentiated taxons existed. One of them was situated in South-West China, mainly in the Yunnan province mountains, and the second one in the Pamirs, Alai and Kashmir.

In the Yunnan area the differentiation of the primary populations ran along two main lines and gave as effect two groups of different taxons which are now found there, these are the sections *Pumilotrollius* and *Yunnanotrollius*.

Populations of *T. pumilus* type migrated from the Yunnan Mts. westwards along the Himalayan arch and spread to the north in the mountains of East Tibet as indicated by the present range of *Pumilotrollius* (Fig. 18). The presently existing morphological differences between the particular species of the section *Pumilotrollius* seem to indicate that differentiation within this group involved the following characters: The general habitus of the plants changed from rather vigorous and massive to slender, like that of the present *T. micranthus* or *T. farreri*. The shape of the honey leaves also changed; their blades are at present elongated as e.g. in *T. pumilus*, rounded as in *T. sikkimensis* or intermediate as in *T. farreri*. The widest differentiation concerned the structure of the leaf laminae, the morphology of the fruits, however, is in general similar in all species of this section with the exception of *T. micranthus* which has quite different follicles. It is difficult today to guess what were the lines of these transformations. In the entire section *Pumilotrollius*, *T. sikkimensis* is most uniform and diverse, and *T. ranunculoides* is least differentiated.

The primary populations close to *T. yunnanensis* must have partly migrated from Yunnan to the north-east and reached Japan, Sakhalin, Kamchatka and coastal regions of the Okhotsk Sea. Evidence of this may be found in the occurrence of some features typical for *T. yunnanensis* among the taxons growing on these areas. For instance the Japanese

species *T. citrinus* has honey leaves very similar to those of *T. yunnanensis*, also *T. riederianus* growing on the Kamchatka and neighbouring islands has many common characters with *T. yunnanensis*. The populations which remained in the Yunnan Mts. have at present a limited range (Fig. 18.) Their differentiation concerns mainly the general habitus of the plants and leaf morphology. In the section *Yunnanotrollius* the process of speciation is very little advanced and is probably still in progress. In this group specimens with an increased number of perianth segments may be found as for instance in *T. yunnanensis* ssp. *yunnanensis* f. *ubra*. This form is an example of spontaneous formation of double flowers in nature.

T. papavereus of the *Yunnanotrollius* section has many characters in common with *T. pumilus* and is a link between the sections *Yunnanotrollius* and *Pumilotrollius*. Although *T. papavereus* is a rather variable group it does not resemble the hybrids of *T. pumilus* and *T. yunnanensis* (Doroszevska, 1970). It is possible that this species is a relict of the old primary populations.

In the Pamir, Alai, Kashmir and on the adjacent territories numerous and diverse *Trollius* populations must have arisen. Many of them have now migrated and only three species of the section *Acaulitrollius* are to be found on this area. These species are quite distinct and well differentiated and there are no intermediate forms between them. Migration of these primary populations from the Pamirs and Kashmir occurred mainly in two directions. To the west and north-west to Asia Minor and Europe, and the second migration route led to the north-east through the mountains of Central Asia and Siberia towards the Okhotsk Sea and Kamchatka. The present distribution of the species of the *Trollius* section indicates the routes of these migrations (Fig. 18).

It is difficult today to establish the time when the first *Trollius* populations differentiated. It probably took place in the Middle or Upper Tertiary. At any rate it must have occurred before the migrations started. The expansion of *Trollius* from the Pamirs, Alai and Kashmir was probably associated with great changes in the vegetal cover of Eurasia caused by climatic changes on this area in the Tertiary. In the Miocene the territory of Afghanistan, Iran, Asia Minor and South-East Europe was covered mainly with deciduous forests of thermophilous flora (ancient Eurasian temperate forest). The climate was moist and mild, appropriate for *Trollius* vegetation. The *Trollius* populations passed through Afghanistan and Iran and reached the Caucasus and Asia Minor and further the Balkans. This must have happened before the Balkans separated from the Asiatic continent. The genus *Dactylis* followed a similar route, its populations came from the Himalayas to the Mediterranean basin through Afghanistan and Iran (Stebbins and Zohary, 1959). Its

migration may have occurred more or less in the same period as did *Trollius* migration.

The upheaval of the Iran upland and the climatic changes occurring on this area exterminated the *Trollius* populations. The Caucasian species *T. ranunculinus* is a relict remaining after this migration. Numerous specimens of this species from North-East Turkey have many traits in common with *T. acaulis*, as for instance massive fruits with exceptionally long beaks, the shape of the honey leaves, the same developmental rhythm etc. There is no doubt that *T. ranunculinus* is related to *T. acaulis*, both these species originate probably from a common ancestor. If it is true that *Trollius* plants grow in the Elburz Mts. as shown by the map given by Meusel, Jäger and Weinert (1965), this would be an additional argument confirming the north-western direction of migration.

T. europaeus is the only *Trollius* species growing in Europe and reaching so far to the west. It is probable that *T. europaeus* came to Europe from Asia Minor through the Balkans. At first it spread in the Alps, Pyrenees and Carpathians and then descended on the lowland.

The north-eastern migration led from the Pamirs and Alai over Tien-Shan, Altai, both the Sayans, the Stanovoi Mts. to the region of the Okhotsk Sea and Kamtchatka. The present distribution of *T. lilacinus*, *T. dschungaricus* and *T. altaicus* marks the direction of this way. In the latter two species a number of morphological characters may be found which relate them to the section *Acaulitrollius*. Thus, not only their geographical distribution, but also their morphology confirms that these species derive from the Pamirs and Alai; owing to their resemblance to *T. acaulis*, like *T. ranunculinus* they may be related to the same territory. On the other hand, the populations which migrated in north-east direction must have been rather similar to those which wandered to the north-west. This may be concluded from the distinct morphological similarities linking *T. altaicus* with *T. europaeus* and with *T. ranunculinus*, owing to which these species have been classified to the same sections *Trollius*.

In the Okhotsk-Japan-Kamchatka region the populations from the Yunnan met and mixed with those arriving from the Pamirs. Owing to this process the section *Insulaetrollius* arose including various taxons among which traits characteristic for *T. yunnanensis*, as well features common with the section *Acaulitrollius* may be found. For instance the shape of the honey leaves of *T. membranostylis* and *T. chartosepalus* is very similar to that of *T. afghanicus*. Winged styles, long leaf sheaths or provided with ears, and a similar developmental rhythm are also noted in representatives of the sections *Acaulitrollius* and *Insulaetrollius*. On the other hand, the flowers of some *T. riederianus* specimens are very similar to those of *T. yunnanensis*.

From the Okhotsk-Japan-Kamchatka region *Trollius* migrated furt-

her to the east and reached North America. Hultén (1928) suggests two routes by which the American plants passed and continue to pass to East Siberia, and may also wander in opposite direction. The first route leads from the Chukot Peninsula through the Bering strait to Alaska, and the second from Kamchatka over the Komandor and Aleutian Islands to the Aleutian Peninsula. It is probable that *Trollius* came to America by the latter way. It grows at present on the Komandor and Aleutian Islands (Hultén, 1937, 1960), but these plants are not of necessity relicts after the migration, *Trollius* may have been carried there much later. In North America *Trollius* migrated along the Rocky Mountains to the south and east reaching as far as the Atlantic coast. At present its range is disjuncted. In the Rocky Mountains it extends from British Columbia and Alberta in Canada to the State of New Mexico in the U.S.A. The second, smaller part of the *Trollius* range extends over several Eastern States of the U.S.A. mainly in the Appalachians, but also on the lowland (Fig. 17). It has not, however, been found on Alaska or in the Yukon State (Hultén, 1944), although it grows on the Chukot Peninsula. Notwithstanding which way *Trollius* came to North America, it is certain that it is derived from the group of taxons of the section *Insulaetrollius*. This may be concluded from the numerous characters common for both these sections.

The section *Longipetala* has been omitted in the foregoing considerations. The formation of the taxons of this group occurred probably in connection with the south-Chinese centre, however, morphological data supporting this hypothesis are lacking. Schipczinsky (1924) believes that *T. ledebouri* derives from *T. yunnanensis*. This is not excluded, but there is no morphological evidence to prove this relationship, the structure of the leaf lamina is not a sufficient argument. The present distribution of *Longipetala* seems to suggest that this *Trollius* group originates from the mountains of South China. In the section *Longipetala* a quite different type of honey leaves developed; they are long, flat and mat, of an appearance not found in other *Trollius* sections. The differences between the particular species of the section *Longipetala* concern mainly the length of the honey leaves which is a polygenic character, very variable besides. The development of these longer and longer leaves occurred probably slowly in successive steps as the result of a number of slight mutations. The honey leaves with completely different structure must have, however, arisen owing to some major evolutionary transformation which resulted in the differentiation of this *Trollius* group.

At present the section *Longipetala* occupies an enormous stretch of West and Central Siberia and the Far East (Fig. 18). It is not possible to decipher the stages of evolution and lines of migration of this group. It was no doubt a very complex process associated with climatic changes

occurring on the territory of North-East Asia in the Glacial Epoch. The successive glaciation and interglacial periods and the translocations of flora associated with them must have in some way affected the migrations of *Trollius*. Probably in these critical periods it found refuge in the mountains of Central Asia from which in time some taxons descended on the lowland.

The above given scheme of the presumed *Trollius* migration is only a greatly simplified outline. It is not possible today to reconstruct all the successive stages of migration and the morphological changes associated with them. It would seem, however, that in general the contribution to the formation of new *Trollius* taxons of the populations from the Pamir-Alai centre and Kashmir was much more larger than that of the populations from the South China Mts. Traces of traits characteristic for the section *Acaulitrollius* may be found among the taxons of the sections *Trollius*, *Insulaetrollius* and *Laxotrollius*. The characters of the section *Yunnanotrollius*, on the other hand, have but little influenced the section *Insulaetrollius* and do not appear at all in representatives of the section *Laxotrollius*.

LATIN DIAGNOSES

Sectio: PUMILOTROLLIUS sect. nov.

Syn.: Sec. *Eutrollius* Prantl in Engler et Prantl, Nat. Pflanzenf. 3,2: 56 (1891), p.p.

Plantae parvae ad 30 cm altae. Caules solito uniflori et aphylli, per raro biflori, 1 - 3 foliis caulinis praediti. Laminae in diametro 1 - 4 cm, palmatosectae vel trisectae; lobi morphologia varia, in plerisque speciebus secti in angustos lobulos. Flores lutei, plani, in diametro 1,2 - 4,0 cm, sepala 5, perraro plura usque ad 8. Specialia petala nectararia longa 2 - 7 mm cum crassa lobula, hermiosa et valde lucenti. Cavernula nectararii sphaerica, inflata in altitudine 0,5 - 2,0 mm. Folliculi in capite 5 - 8, longitudine una cum rostello 1,0 - 2,0 cm.

Sectioni adnumerantur species quae sequuntur: *Trollius pumilus* Don; *T. micronthus* Hand.-Mazz.; *T. ranunculoides* Hemsl.; *T. vaginatus* Hand.-Mazz.; *T. farreri* Stapf; *T. sikkimensis* (Brühl) grad. nov. et comb. nov.; *T. bhotanicus* (Brühl) Mukerjee.

Typus sectionis: T. pumilus Don.

Sectio: YUNNANOTROLLIUS sect. nov.

Syn.: Sec. *Eutrollius* Prantl in Engler et Prantl, Nat. Pflanzenf. 3,2: 56 (1891), p.p.

Caules solito ramosi, foliati, and 30 - 80 cm alti. Folia trisecta, fragmenta satis crassa, in lobos non secta. Flores plani vel paene plani, in diametro 3 - 7 cm. Sepala 5, perraro 6 - 8, leviter aurantiaca. Petala nectararia aurantiaca, longitudine 6 - 13 mm, oblonga, in superiore parte extensa in crassum lobulum hermiosum et splendens. In inferiore parte margines petali sursum subcinctae format specialem canaliculum descendentem in cavernulam nectararii. Cavernula nectararii sphaerica, valde inflata. Unguis ab axe petali deviatu est.

Sectioni adnumerantur species: *Trollius yunnanensis* (Franch.) Ulbr. ssp. *yunnanensis* cum formis: f. *yunnanensis*, f. *rubra* Stapf et f. *eupetala* Stapf atque ssp. *anemonifolius* (Brühl) comb. nov.; *T. papaveraceus* Schipcz.; *T. citrinus* Miaybe.

Typus sectionis: T. yunnanensis (Franch.) Ulbr.

Sectio: *ACAULITROLLIUS* sect. nov.

Syn.: Sec. *Eutrollius* Prantl p.p. et Sec. *Hegemone* Bunge, in Engler et Prantl, Nat. Pflanzenf. 3,2: 56 (1891).

Plantae parvae in montibus excelsis crescentes, tempore florendi ad 25 cm altae; caules non ramosi singulis floribus in apice, foliis caulinis 1 - 3. Florent saepe antequam folia basalia oriuntur. Prima folia basalia saepe laminas sedentes iam in vaginis foliorum ac deinde in truncis habent. Flores lutei, albi vel lilacini. Sepala 8 et plus perraro minus ad 5; hae sepala plerumque non excidunt sed in caule exsiccantur. Petala nectaria crassa, ad 4 - 8 mm longa, cavernula nectarii instar vadosi marsupii.

Sectioni adnumerantur: Trollius acaulis Lind.; T. lilacinus Bge; T. afghanicus Hedge et Waldebo.

Typus sectionis: T. acaulis Lind.

Sectio: *LONGIPETALA* sect. nov.

Syn.: Sec. *Eutrollius* Prantl in Engler et Prantl, Nat. Pflanzenf. 3,2: 56 (1891), p.p.

Plantae 10 - 100 cm altae; caules erecti, foliati, plerumque ramosi; florem unum aut paucos habent. Laminae 4 - 12 cm in diametro, palmatosectae vel trisectae; earum lobi varia morphologia. Flores instar cupulae; sepala 5 - 20 colore aurantiaco fulgentia, perraro pallidiora, lutea apud T. sibiricum. Specialia petala nectaria oblonga et angusta, quibus lobula plana, non crassa, languida neque lucentia. Lobulum illud tenue et solidum quemadmodum sepala, saepe etiam eiusdem coloris. Eorum longitudo varia; inde a brevibus et brevioribus staminibus et absconditis in perianthio usque ad longa interdum multo longiora perianthio et ex eo proiecta. Cavernula nectarii instar plani marsupii. Differentiae in morphologia petalorum nectariorum principalem indolem pro singulis taxonibus sectionis constituunt.

Sectioni adnumerantur species quae sequuntur: Trollius asiaticus L.; T. ledebouri Rchb.; T. chinensis Bge; T. hondoensis Nakai; T. macropetalus F. Schm.; T. sibiricus Schipcz.; T. kytmanovii Reverd.

Typus sectionis: T. asiaticus L.

Sectio: *TROLLIUS* sect. nov.

Syn.: Sec. *Eutrollius* Prantl in Engler et Prantl, Nat. Pflanzenf. 3,2: 56 (1891), p.p.

Plantae ad 15 - 100 cm altae, caules solito ramosi, foliati, 1 - 3 floribus in apice. Foliae praecipue palmatosectae, quarum lobi varia morphologia sunt. Flores lutei vel leviter aurantiaci, aperti instar cupulae vel magis sphaerici aut etiam clausi. Petala nectaria 6,0 - 14,0 mm longa, oblonga, ad extremum rotundata; eorum lobula paulo crassa et hermiosa, anguste

oblonga vel paulo extensa, aurantiaca vel parum splendentia. Cavernulae nectariorum instar vadosi marsupii in vadosa fovea iacent. Sepala 5 - 20. Multi folliculi in capitibus sunt.

Sectioni adnumerantur: *Trollius europaeus* L. var. *europaeus* et var. *transsilvanicus* (Schur) bl.; *T. apertus* (Perf.) Igosh.; *T. altaicus* C.A.M. var. *altaicus* et var. *sajanensis* Malyshev; *T. dschungaricus* Reg.; *T. rannunculinus* (Smith) Stearn.

Typus sectionis: *T. europaeus* L.

Sectio: INSULAETROLLIUS sect. nov.

Syn.: Sec. *Eutrollius* Prantl in Engler et Prantl, Nat. Pflanzenf. 3,2: 56 (1891), p.p.

Plantae e regione Ochock et Czukotka, sunt potius parvae, uno flore in caule. Plantae autem in regione Camschatca, Sachalin, Insulis Japonicis, Kurylicis et Komandoriensibus crescentes magis fertiles sunt, quarum caules ramosi, et paucis floribus sunt, folia palmatosecta vel septemsecta; folia caulina cum vaginis membraceis, saepe instar auriculi. Flores aurantiaci. Petala nectararia longitudine paria staminibus, ab eis paulo longiora vel breviora, nonnunquam plus duplo breviora. Hae petala crassa, anguste oblonga vel extensa, spatulata aut piriformia sunt. Cavernula nectarii in canaliculata fossula paulum inflata iacet, lobula petali ibi extensa. Apud nonnullas plants rostella folliculorum membracea atque alata sunt.

Sectioni adnumerantur species: *Trollius riederianus* Fisch. et Mey. var. *riederianus* et var. *japonicus* (Miq.) Ohwi; *T. pulcher* Makino; *T. membranostylis* Hultén; *T. chartosepalus* Schipcz.; *T. schipczinskii* Miyabe.

Typus sectionis: *T. riederianus* Fisch. et Mey.

Sectio: LAXOTROLLIUS sect. nov.

Syn.: Sec. *Eutrollius* Prantl in Engler et Prantl, Nat. Pflanzenf. 3,2: 56 (1891), p.p.

Plantae hae in America Septentrionali crescunt. Caules ad 50 cm alti, foliati, uniflori vel biflori. Folia palmata cum lobis sectis in lobula et vaginis foliatis. Flores plani in diametro 3,0 - 4,5 cm. Sepala 5 - 10, coloris albi, eburnei aut lutei. Petala nectararia longitudine 3,5 - 7,0 mm cum lobula crassa, morphologia varia: anguste oblonga, elliptica, piriformia, saepe cum incisura in apice et cum apparenti nervo mediato. Folliculi multi longitudine circa 10 mm, quorum longitudo restelli ad 2 - 5 mm. Morphologia folliculorum multifaria.

Sectio comprehendit unam speciem cum daubus varietatibus: *Trollius laxus* Salisb. var. *laxus* et var. *albiflorus* Gray.

Typus sectionis: *T. laxus* Salisb.

RODZAJ *TROLLIUS* — STUDIUM TAKSONOMICZNE

Streszczenie

Rodzaj *Trollius* obejmuje 31 gatunków, które zostały zgrupowane w 7 nowo opracowanych sekcjach. Podział ten oparty jest głównie na podobieństwie morfologicznym gatunków oraz na ich rozmieszczeniu geograficznym. Szczególną uwagę zwrócono na budowę listków miodnikowych. Podano diagnozy sekcji, opisy gatunków i odnośną literaturę. Dla większości gatunków wykonano mapy punktowe i wyznaczono zasięgi geograficzne poszczególnych sekcji. Opracowano klucze do sekcji, w obrębie każdej sekcji oraz jeden klucz ogólny.

Sekcja *Pumilotrollius* występuje w Himalajach i górach Chin Pd., zawiera ona następujące gatunki: *T. pumilus* Don, *T. micranthus* Hand.-Mazz., *T. ranunculoides* Hemsl., *T. vaginatus* Hand.-Mazz., *T. farreri* Stapf., *T. sikkimensis* (Brühl) grad.-nov. et comb. nov. i *T. bhotanicus* (Brühl) Mukerjee. (Tab. I - IV, Fig. 1, 2).

Sekcja *Yunnanotrollius* obejmuje dwa gatunki z Pd.-Zach. Chin: *T. yunnanensis* (Franch.) Ulbr. i *T. papavereus* Schipcz. oraz jeden gatunek japoński *T. citrinus* Miyabe. (Tab. V, Fig. 3, 4, 5).

Sekcja *Acaulitrollius* zawiera trzy gatunki występujące w górach Azji Środkowej: *T. acaulis* Lindl., *T. lilacinus* Bge i *T. afghanicus* Hedge et Wandelbo. (Tab. VI, VII, Fig. 6, 7).

Sekcja *Longipetala* obejmuje gatunki z Azji Środkowej i Północnej, od Uralu aż po Japonię. Są to: *T. asiaticus* L., *T. ledebouri* Rchb., *T. chinensis* Bge, *T. ho-doensis* Nakai, *T. macropetalus* F. Schm., *T. sibiricus* Schipcz. i *T. kytmanovii* Re-verd. (Tab. VIII, IX, Fig. 8 - 10).

Sekcja *Trollius* ma zasięg rozerwany; w Europie rośnie tylko *T. europaeus* L., na Uralu Północnym *T. apertus* (Perf.) Igosh., na Kaukazie *T. ranunculinus* (Smith) Stearn, a w górach Azji Środkowej *T. altaicus* CAM i *T. dschungaricus* Reg. (Tab. XII, Fig. 11 - 13).

Sekcja *Insulaetrollius* obejmuje pięć gatunków rozproszonych na terenie Azji Pn.-Wsch.: na Kamczatce, Sachalinie, Wyspach Japońskich, Kurylskich, Komandorskich i Aleutach. Są to: *T. riederianus* Fisch. et Mey., *T. pulcher* Makino, *T. membranostylis* Hultén, *T. chartosepalus* Schipcz. i *T. schipczinskii* Miyabe. (Tab. XIII - XV, Fig. 14, 15).

Sekcja *Laxotrollius* zawiera tylko jeden gatunek północnoamerykański *T. larius* Salisb., który ma wiele cech wspólnych z przedstawicielami sekcji *Insulaetrollius*. (Tab. XVI, Fig. 16, 17).

Większość cech morfologicznych gatunków *Trollius* wykazuje szeroką zmienność o charakterze ciągłym, co bardzo utrudnia klasyfikację tych roślin. Niektóre gatunki nie są od siebie wyraźnie oddzielone i istnieją między nimi liczne formy pośrednie. Dotyczy to w szczególności tych, które łatwo krzyżują się ze sobą, dają płodne potomstwo, a zasięgi ich chociaż częściowo pokrywają się.

Opierając się na podobieństwie morfologicznym cech i obecnym rozmieszczeniu gatunków, można było odczytać niektóre drogi migracji pierwotnych populacji *Trollius*. Jak można sądzić istniały dwa główne ośrodki różnicowania się taksonów *Trollius*: jeden w górach Chin Pd., drugi w górach Pamiro-Ałaju i Kaszmiru. Występujące obecnie na tych terenach sekcje *Pumilotrollius*, *Yunnanotrollius* i *Acaulitrollius* są prawdopodobnie najbardziej pierwotnymi przedstawicielami rodzaju *Trollius*.

Z gór Chin Pd. populacje pierwotne zbliżone do *T. yunnanensis* rozprzestrzeniły się częściowo w górach Himalajów i Tybetu oraz wywędrowały w kierunku północno-wschodnim, docierając do Japonii, Sachalinu, Kamczatki i rejonów Morza Ochockiego.

Ekspansja *Trollius* z gór Pamiro-Ałaju i Kaszmiru poszła głównie w dwóch kierunkach. Jeden z nich prowadził na północo-zachód do Azji Mniejszej i Europy, drugi szlak szedł na północo-wschód górami Azji Środkowej i Syberii w kierunku Kamczatki. W rejonie Morza Ochockiego i Kamczatki nastąpiło prawdopodobnie spotkanie i wymieszanie tych dwu różnych linii migracyjnych. Z tych miejsc *Trollius* poszedł dalej na wschód i dotarł do Ameryki Północnej (Fig. 18).

Do niniejszej pracy wykorzystano obszerny materiał zielnikowy; ogółem przejrano około 7000 okazów zielnikowych, z czego cytowanych w tekście jest 845 arkuszy. Ponadto dla 11 gatunków przeprowadzono obserwacje na żywym materiale, hodowanym przez kilka lat w Ogrodzie Botanicznym w Warszawie.

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PLATE I

Trollius pumilus Don No. H/10

a — herbarium specimen (1/2 life-size); b — fruits (life-size); c — flowers (life-size)

Trollius vaginatus Hand.-Mazz., herbarium specimens (life-size)

a—leg. Ludlow et Sherriff (1937) No. 3291, Central Bhutan; b—leg. Forrest (1913) No. 10796, Yunnan, Mt. Changhei

Trollius farreri Stapf., herbarium specimens

a — leg. Przewalski, (1873), China, prov. Kansu, Terra Tangutorum; b — leg. Farrer, No. 137, China, Kansu

Trollius sikkimensis (Brühl) grad. nov. et comb. nov., herbarium specimen: leg.
Ludlow et Sherriff (1943) No. 9585, Tibet, Lhasa

PLATE V

Trollius yunnanensis (Franch.) Ulbr. ssp. *yunnanensis* No. H/134 (1/2 life-size)

PLATE VI

Trollius acaulis Lind., leg. T. A. Rao (1959), Kashmir, (1/2 life-size)

Trollius lilacinus Bge, leg. V. A. Abramov, (1905), in West Tian-Shan (1/2 life-size)

Flowers of some species of the section *Longipetala*

a — *T. asiaticus* L. No. H/5; b — *T. asiaticus* L. No. H/12; c — *T. ledebouri* Rehb. No. H/4;
d — *T. chinensis* Bge No. H/95

Trollius ledebouri Rchb., leg. F. Karo (1903), Błagowieszczansk (by river Amur)

PLATE X

Trollius chinensis Bge, No. H/95

PLATE XI

Trollius sibiricus Schipcz., leg. Pavlowsky in E. Sibiriae as *T. patulus* Salisb. var. *sibiricus*, Schipczinsky has classified as *T. sibiricus*

PLATE XII

Flowers of some species of the section *Trollius*

a — *T. altaicus* C. A. M., No. H/133; b — *T. altaicus* C. A. M., No. H/20; c — *T. ranunculinus* (Smith) Stearn, No. H/82; d — *T. europaeus* L., No. H/55

PLATE XIII

Trollius riederianus Fisch. et Mey, leg. Hultén (1922), Syd-Kamtchatka No. 3377

Trollius membranostylis Hultén, leg Tiling in Ayan mountains as *T. patulus* Salisb.
 var. *sibiricus* Regel

PLATE XV

Trollius schipczinskii Miyabe, leg. E. Egorova, Sakhalin, r-n Makarovskii, No. 2017,
as *T. japonicus* Miq.

Trollius laxus Salisb., leg. R. G. Stolze (1965), Rocky Mountains, Wyoming U.S.A.
 (1/2 life-size)