Acta zool. cracov. 35(3): 509-564, Kraków, 29 Jan. 1993

Apoidea (except *Apidae*) on the northern slopes of the Hohe Tauern Mts

Mirosława DYLEWSKA

Received: 12 Nov. 1990
Accepted for publication: 22 Apr. 1991

DYLEWSKA M. 1993. *Apoidea* (except *Apidae*) on the northern slopes of the Hohe Tauern Mts. Acta zool. cracov. 35(3): 509-564.

Abstract. Ninety-five apoidean species (except *Apidae*) have been identified from the northern slopes of the Hohe Tauern Mts. In these mountains a distinct faunistic boundary (1400 m) extends about 200 m above the boundary of summer in the climatic sense of the word and about 70% of the apoidean species do not go beyond it. They include all the submediterranean and south central European and most of the summer species. The highest-lying sites of the fauna under study, except *Andrena rogenhofferi*, occur close to the upper boundary of late spring in the climatic sense (potential timber-line) at an altitude of about 2100 m. In the Tatra Mts these two faunistic boundaries run about 500 m lower, however, they remain there in the same relation to the climatic boundaries as in the Hohe Tauern Mts.

Key words: *Colletidae*, *Halictidae*, *Andrenidae*, *Megachilidae*, *Anthophoridae*, Hohe Tauern.

Mirosława DYLEWSKA, Institute of Systematics and Evolution of Animals, Polish Academy of Sciences, Sławkowska 17, 31-016 Kraków, Poland.

I. INTRODUCTION

Eighteen species of the *Apoidea* (except *Apidae*) have hitherto been found on the northern slopes of the Hohe Tauern Mts. GIRAUD (1861) collected *Apoidea* in the region of the Gastein Valley. During their excursion into the area of the Shepherds Glacier in 1872 F. MORAWITZ from St. Petersburg and van ROGENHOFFER from Vienna for the first time caught *Andrena rogenhofferi* (MORAWITZ, 1872), which is known exclusively from the Alps. SCHLETTERER (1887) published some data about the *Apoidea* from the Glockner region; however they have not been included in this paper, for it cannot be established from which slopes (northern or southern) and at what altitude they were gathered. Moreover, all the species given by that author were also found by other investigators. On the other hand FRANZ (1943, 1949) presented detailed documentation for his materials. EBMER (1988) has lately reported the occurrence of five species of the family *Halictidae* in the region of Bad Hofgastein.

The objective of my work was to investigate in detail the Apoidean fauna (except *Apidae*) in three valleys (Gastein, Rauris and Fusch) and their surroundings on the northern slopes of the Hohe Tauern Mts and in the summit area of Grossglockner. Not only was such a study expected to answer the question how many species lived in that region but also to show differences in specific composition between the plant zones and what factors are decisive as regards the possibility for particular species to live at various altitudes above sea level.

A "Pax Christi" grant enabled me to carry out field work and in this connection I wish to express my gratitude to Ms L. GLAZER and Ms A. GLAZER, of the Viennese office of this Foundation. Both in the university circles of Salzburg and Vienna and in the Hohe Tauern area I met with enormous friendliness and assistance in organizing my study, gathering literature and meteorological data, identifying plants etc. It is unfeasible here to name all to whom I owe my thanks, but I must not omit some of them. These are Prof. E. ADAM, Dr A. SÄNGER, Prof. A. AICHCHORN, P. ANDREAS, W. EBMER and Dr N. WINDING. The Scientific Society at Badgastein and Salzburg University arranged accomodation for me at the Gastein-Tauernregion Forschungsinstitut at Badgestein. From the Institute of Meteorology in Vienna through the mediation of the Institute of Meteorology in Salzburg I recived the computer excerpts of meteorological data from five weather stations in the study area. I wish to express my heartfelt thanks to Ms T. SCHMATZBERGER from Neunkirchen and Mr and Mrs SCHERER and ZIMBACHER from Bucheben in the Rauris Valley. I also thank Dr N. WINDIG from Salzburg and Prof. B. PIERONEK, Dr A. KOSIOR, Assist. Prof. T. KAŹMIERCZAK from Kraków for help in collecting materials and Doc. R. KAŹMIERCZAKOWA for plant determination. I am greatly indebted to Prof. A. KOTARBA and Assist. Prof. M. KOTARBOWA of the Institute of Geography, P.A.Scs for consultations on the morphology of the Hohe Tauern Mts, to assist. Prof. T. NIEDŹWIEDŹ of the Institute of Meteorology, P.A.Scs for consultations on climatology, to Prof. J. PAWŁOWSKI of the Institute of Systematics and Evolution of Animals, P.A.Scs on zoogeography and Prof. J. WŁODEK of the Laboratory of Water Biology, P.A.Scs on statistics.

II. CHARACTERISTICS OF THE STUDY AREA

The northern slopes of the Hohe Tauern are crossed from west to east by the meridionally extending Grossal, Gastein, Rauris, Fusch and Kaprun Valleys. They are about 30 km long each. The main ridge of the Hohe Tauern is characterized by the presence of eminences exceeding 3000 m a.s.l. The highest peak, Grossglockner, reaches 3797 m. The river Salsach makes the north border of the Hohe Tauern. The Gastein and Rauris Valleys, included in this study, are hanging valleys; their mouth edges rise to a height of 900 m above the Salsach Valley. The bottoms of these valleys are flat with steep eminences exceeding 2000 m in altitude on both sides. Another valley examined, the Fusch Valley, is widely opened. The transversal valleys, such as Kötschachtal and Angertal, open into the Gastein Valley and Geissbachtal, Krumltal and Sedlwinkltal, into the Rauris Valley. Grossglocknerstrasse begins in the Fusch Valley, whose southward extension is the Ferleiten Valley. In the Rauris Valley transversal moraines occur at altitudes of 1100 and 1200 m, providing favourable conditions for bees on their southern slopes.

The main ridge of the Hohe Tauern is built of granite rocks, but limestone outcrops happen here too (FRANZ 1943). In the lower portions of the northern slopes the mosaic of acid and basic rocks is still richer.

Up to an altitude of about 1000 m the bottoms of the valleys are occupied by meadows, pastures, greens or golf-courses and they are cultivated by modern methods including chemicalization: they are frequently wet. Higher, pastures extend up to an altitude of 2000 m.

At the present time the three line runs at altitudes between 1600 and 1800 m (GRÜNDING 1962, STÜBER 1967, FRANZ 1943); it has been artificially lowered, mainly by cattle pasturing. In the 15th and 16th centuries the Alpine forests were subjected to mass felling three times and thoroughly destroyed. On the northern slopes of the Hohe Tauern the potential tree line lies at an altitude of 2100-2200 m. Today this line is marked by single spruces. The deforested areas are being grown ower by alders ("Guerle"), which are pioneer plants here and which I observed in large areas up to 2000 m. In succession they are followed by spruces, which now occupy the areas previously overgrown by firs.

The lower montane tier, called also "the beech-fir tier", with beeches, firs and spruces growing in it, spreads from 700 to 1400 m. On the northern slopes of the Hohe Tauern beech grows up to an altitude of 1600 m. The upper montane tier extends to about 1800 m and is dominated by spruce with an admixture of larch increasing by the tree line. The subalpine tier, characterized by larch and stone-pine woods and dwarf mountain pine, spreads upwards to about 2000 m. Stone-pines have been destroyed in the Rauris valley and in the Grossglockner region. *Rhododendron*, *Salix* and *Vacinium* area, among others, typical plants that accompany the woods. I found the lowest stands of *Rhododendron* at about 1300 m, whereas *Vaccinium* is rare in the Hohe Tauern in comparison with the Tatras, where it overgrows large areas. Next comes the alpine tier, divided into two subtiers: the subtier of dwarf shrubs and that of grassland. The first of them reaches an altitude of 2500 m in the Hohe Tauern and its upper boundary coincides with the upper range of *Rhododendron* and *Calluna vulgaris*. The grassland subtier spreads to an altitude of 2600 m and is characterized by the occurrence of *Saxifraga caesia*, *Primula* and *Aconitum*, visited by high-alpine bumblebees (*Bombus*). *Andrena rogenfofferi* was collected from the alpine tier. The subnival tier of the Hohe Tauern ranges from 2600 to 2800 m. Some species of the genera *Saxifraga* and *Silene* (e.g. *S. acaulis*) as well as *Soldanella pusilla*, *Potentilla frigida*, *Salix retusa*, *S. reticulata* and others bear flowers even in this tier. The bumblebees *Bombus alpinus* and *B. lapponicus* have been recorded from here (FRANZ 1943).

Some sites of steppe plant species, which are relict species in this region, were also observed at an altitude of about 1000 m in the valleys under study (GAMS 1936).

III. CLIMATIC CONDITIONS

The data describing the climate of the study area in the years 1881 to 1900, listed by FRANZ (1943), indicate that summer in the climatic sense of the word[1)] occurs here even as high as 950 m in Rauris, whereas it was not observed at Badgastein, Kolm and Saigurn,

[1)] Thermal summer – period with the mean daily air temperature above 15°C;
thermal late spring – period with the mean daily air temperature above 10°C;
thermal spring – period with the mean daily air temperature above 5°C.

Numbers of days with mean daily temperatures from 5 to 10°C, 10 to 15°C,
on the basis of the data from several meteorological

Month	Hofgastein 850 m 1985-1986					Rauris 945 m 1982-1985					Bad Gastein 1100 m 1982-1985				
	5-10°	10-15°	15-20°	20-25°	total	5-10°	10-15°	15-20°	20-25°	total	5-10°	10-15°	15-20°	20-25°	total
Apr.	14.0	6.0	0.2		20.2	14.0	3.8			17.8	11.5	9.0			20.5
May	8.0	19.0	4.0		31.0	11.0	15.5	1.8		28.3	10.5	15.5	2.0		28.0
June	3.0	17.0	8.0	2.0	30.0	3.5	15.8	10.7		30.0	6.2	12.8	11.0		30.0
July	1.0	8.5	20.0	1.5	31.0	1.7	10.5	17.3	1.5	31.0	1.3	8.1	18.3	3.3	31.0
Aug.	1.0	12.0	18.0		31.0	3.2	17.3	10.0	0.5	31.0	2.0	12.3	16.5	0.2	31.0
Sep.	6.0	17.0	7.0		30.0	10.0	18.0	2.0		30.0	6.5	17.0	6.5		30.0
Oct.	18.0	7.5	0.5		26.0	19.2	7.8			27.0	18.5	8.0	0.2		26.7
total	51.0	87.0	57.7	3.5	199.2	62.6	88.7	41.8	2.0	195.1	156.5	82.7	54.5	3.5	197.2

and so at altitudes ranging from 1100 to 1600 m. In these last places late spring merges into early autumn. On the other hand, at Zirmseehöhe (2464 m) early spring passes directly into late autumn. In Table I I have summarized the meteorological data obtained from the Institute of Meteorology and Geodynamics in Vienna and ZIMBACHER's meteorological records from Bucheben in the study period (1982-1987). It may be ascertained on the basis of these data that summer in the climatic sense occurs as high as Bucheben and Badgastein (1100 m) and that its upper boundary lies probably at an altitude of about 1200 m. Similarly, thermal late spring reaches as high as 2036 m at Mooseboden and its upper boundary occurs at about 2100 m.

The data obtained from FRANZ's (1943) paper and from the Institute of Meteorology and Geodynamics in Vienna permit me to represent the climate variation with altitude by a line in the graph in Fig. 1, which shows that in 1881-1900 thermal summer in the study area terminated at an altitude of about 1000 m, late spring at that of 1700 m and spring at 2470 m. According to the data from 1982-1987, the respective altitudes are 1150, 2000 and 2800 m. Hence, it may be stated that in the study period it was on the average warmer than in the last decade of the 19th century. It should however be noted that in 1984 the mean July temperatures were considerably lower than the mean calculated from a number of years, namely, they were 14.0°C at Rauris, 14.4°C at Bad Hofgastein and 13.7°C at Badgastein and so in the places where the mean values obtained from the period of 1982-1987 point out the occurrence of thermal summer. At Mooseboden and Schmittenhöhe, in spite of the occurence of late spring in the study period, the mean July temperatures

Table I

15 to 20°C and 20 to 25°C in particular months in which the *Apoidea* emerge, stations on the northern slopes of the Hohe Tauern

Bucheben 1100 m 1982-1985					Schmiettenhohe 1973 m 1984-1985					Mooseboden 2036 m 1982-1986				
5-10°	10-15°	15-20°	20-25°	total	5-10°	10-15°	15-20°	20-25°	total	5-10°	10-15°	15-20°	20-25°	total
6.2	1.2			7.4	0.5				0.5	1.5				1.5
11.8	14.3	0.5		26.6	12.0	1.5			13.5	11.5				11.5
6.2	15.5	8.3		30.0	12.5	5.0			17.5	12.5	9.0			21.5
1.7	10.8	17.0	1.5	31.0	10.5	11.0	4.0		25.5	9.5	12.0	5.0		26.5
3.2	17.3	10.0	0.5	31.0	15.0	9.5	3.5		28.0	16.5	10.0	1.0		27.5
10.3	17.5	1.7		29.5	9.0	10.5	0.5		20.0	9.5	10.5			20.0
18.2	3.5			21.7	12.0	4.0			16.0	11.0	3.0			14.0
57.6	80.1	37.5	2.0	177.2	71.5	41.5	8.0		121.0	72.0	44.5	6.0		122.5

in 1984 were, respectively, 7.9° and 8.7°C. The presence of such thermal anomalies as in 1984 is not indifferent to the life of bees.

IV. METHODS

The present investigation consisted in catching practically all the *Apoidea* specimens observed (except *Apidae*). Catches were repeated at the same localities, chiefly in wooded regions, 3-4 times during a vegetation season. The repetition of catches, at the same locality was necessary, because particular species characterize themselves by limited periods of emergence, lasting about 2 months. There are therefore early-spring, late-spring and summer bees and generations II and III.

Since the *Apoidea* (except *Apidae*) most frequently occurred in warmest places, the localities had to be sought with the help of a map, visual appraisal of the area and persistent penetration of all the previously selected places if possible.

I carried out my field investigation from autumn 1982 throughout 1987 for one to three months yearly. In 1982 I collected bees only for 10 days in the Rauris Valley. The investigation necessarily took a long time because of the vast study area and changeable weather in the Hohe Tauern (long cool periods, preventing bees from flying). I conducted this investigation at altitudes ranging from 700 to 2150 m. Owing to the limitation of time, I was unable to search the lower part of the alpine tier and for this reason in this paper I have made use of the results obtained by FRANZ (1943, 1949) in the Grossglockner region.

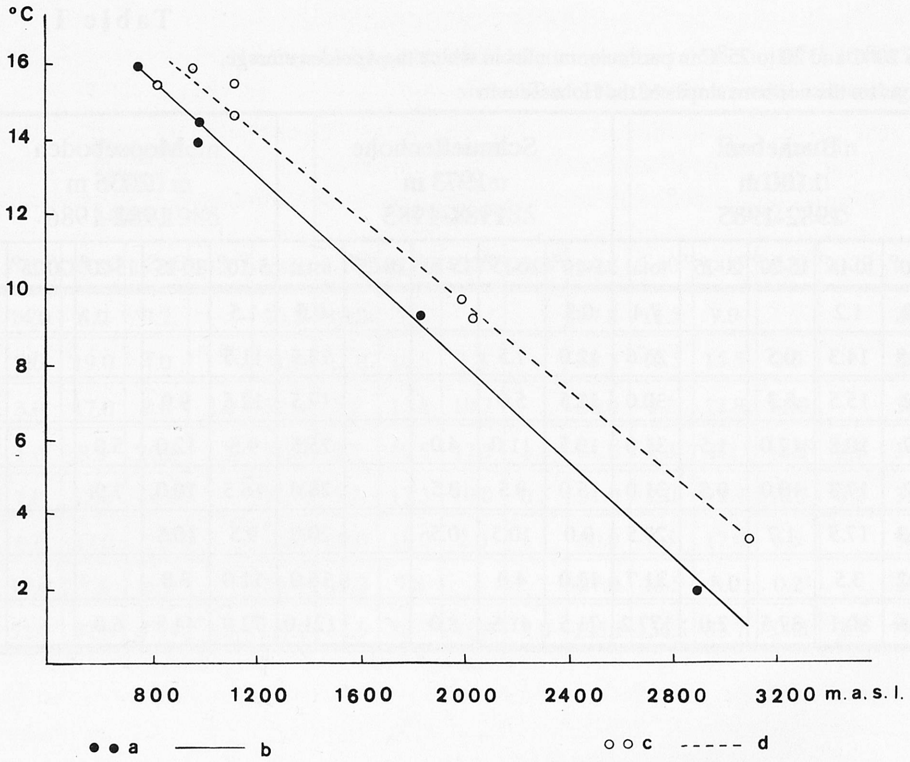

Fig. 1. The relationship between mean July temperature and altitude a.s.l. on nothern slopes of the Hohe Tauern in 1881-1900 (R = 0.999) and 1982-1987 (r = 0.994). a – data from 1881-1900, b – major axis for the data from 1881-1900, c – data from 1982-1987, d – major axis for the data from 1982-1987.

In determining insects and working on my materials I used the latest monographs devoted to particular genera, namely, *Hylaeus* (DATHE 1980), *Halictus* and *Lasioglossum* (EBMER 1969, 1970, 1974, 1975, 1988), *Andrena* (DYLEWSKA 1987). Besides, I availed myself of works by SCHMIEDEKNECHT (1930), STOECKHERT (1933) and WESTRICH (1989).

The names of plants are established in accordance with Flora Europaea (TUTIN et al. 1964-1980). During my study I also used the guide Kleine Flora des Landes Salzburg by LAEDER and REITER (1959).

I divide the area covered by the present study into several zones:

Zone I, which includes places where I found steppe plant species,

Zone II, embracing the sites ranging from about 700 to 1000 m a.s.l.,

Zone III, reaching to the upper boundary of the lower montane tier,

Zone IV, extending from 1400 to about 1800 m,

Zone V includes the subalpine tier (1800 – about 2100 m) and

Zone VI the lower part of the alpine tier (up to 2500 m).

V. LIST OF SPECIES [1)]

Particular species have been presented according to the following scheme:

Current No. Full Latin name. Zone No (Roman numeral). Name of locality, date, number and sex of specimens, plant genus or species if the insect was caught on flower, name of entomologist who collected or determined the speciemens (lack of name indicates that they were collected and determined by the author); name of the next locality ... [and so on].

Some of the above mentioned data may be lacking in the case of specimens coming from the collection not gathered by me or in the case of species in the papers written by the authors mentioned in the introduction. In these cases the names of collections or authors are given.

Colletidae

1. *Hylaeus difformis* EVERSMANN, 1852

I. Kötschachtal 25 July 1985, ♀ on *Campanula* sp.

III. Ritterkopf 1400 m, 1 July 1984, ♀ on *Potentilla erecta*.

2. *Hylaeus communis* NYLANDRER, 1852

I. Kötschachtal 24 July 1985, ♀.

3. *Hylaeus hyalinatus* SMITH, 1842

III. Steinalm 1150-1300 m 27 June 1985, ♂ and 5 July 1986, 3 ♂♂.

Halictidae[2)]

4. *Halictus rubicundus* CHRIST, 1791

I. Kötschachtal 16 May 1986, ♀ on *Taraxacum* sp. Rauriser-Höhe 13 May 1986, ♀ on *Taraxacum* sp.

II. Dorfgastein 26 May 1987, ♀ on *Taraxacum* sp.; Seidlwinkltal 13 June 1984, ♀ on *Taraxacum* sp. and 22 Sep. 1983, ♂ on *Leontodon*; Fuschtal 19 May 1987, 4 ♀♀ on *Prunus padus*; Rauris 26 May 1986, 5 ♀♀ on *Taraxacum* sp. and 25 June 1986, ♀ on *Anthylis vulneraria* ssp. *alpestris.*

III. Bucheben 4-26 May 1986, 11 ♀♀ on *Salix* sp. *Padus avium*, *Taraxacum* sp. and 7-25 June 1986, 11 ♀♀ on *Berberis vulgaris*, *Frangula alnus* and 1 July 1984, 3 ♀♀ 11 ♂♂ on *Rubus idaeus*, *Anthylis vulneraria* ssp. *alpestris*, *Leontodon* sp. and 12 July 1984, 2 ♀♀ on *Trifolium* sp.; Steinalm 20 and 27 June 1984, 7 ♀♀ on *Leontodon* sp.; Raurisertal

---

[1)] The list of species contains no species from the family *Melittidae*, becouse no members of this family have been found.

[2)] FRANZ (1949) reported *Lasioglossum quadrinotatum* (KIRBY, 1802) and *Duphoures vulgaris* SCHENK, 1861 from the Hohe Tauern. EBMER (1988) did not corroborated the occurrence of these species in that region. As a result I did not include them in the list.

(Steinbruch, 1200 m) 4 and 7 May 1985, 2 ♀♀ on *Tussilago farfara* and 20 June 1986, 2 ♀♀ on *Leontodon* sp.; Kitzsteinalm (1300 m) 20 June 1984, ♀.

IV. Ritterkar (1850-1950 m) 11 July 1984, 2 ♀♀ on *Salix* sp.; Stanzscharte (1970 m) 8 July 1984, ♀ on *Dryas octopetala* leg. A. KOSIOR.

5. *Halictus tumulorum* (LINNAEUS, 1758)

I. Rauriserhöhe 13 May 1986, ♀ on *Taraxacum* sp., det. EBMER.

6. *Lasioglossum leucozonium* (SCHRANK, 1781)

II. Bad Hofgastein, 800 m (EBMER 1988).

7. *Lasioglossum zonulum* (SMITH, 1848)

II. Bad Hofgastein, 800 m (EBMER 1988).

8. *Lasioglossum costulatum* (KRICHBAUMER, 1873)

III. Bucheben 1 July 1985, ♂ on *Leontodon* sp.

9. *Lasioglossum laevigatum* (KIRBY, 1802)

I. Rauriserhöhe 2 May 1986, 3 ♀♀ on *Salix* sp.

III. Bucheben 3 and 19 June 1986, 2 ♀♀ on *Berberis vulgaris* and *Lotus corniculatus*.

10. *Lasioglossum calceatum* (SCOPOLI, 1763)

I. Rauriserhöhe 2-16 May 1986, 15 ♀♀ on *Salix* sp., *Taraxacum* sp.; Kötschachtal 2 May 1987, 3 ♀♀ on *Salix* sp. and 14-16 May 1986, 10 ♀♀ on *Taraxacum* sp. and 30 June 1986, 2 ♀♀ on *Leontodon* sp. and 24 July 1985, 3 ♀♀.

II. Rauris 19-26 May 1986, 12 ♀♀ on *Prunus* sp. and *Taraxacum* sp. and 16 Sep. 1983, on ♂ *Hieracium* sp.; Fusch 3 May 1986, ♀ on *Tussilago farfara*; Fuschtal 15 May 1987, 2 ♀♀ on *Prunus padus*; Seidlwinkltal 6 May 1986, 2 ♀♀ on *Tussilago farfara* and 13 June 1984, ♀ on *Taraxacum* sp. and 22 Sep. 1983, 4 ♀♀ 11 ♂♂ on *Hieracium* sp.

III. Hundsdorf 15 May 1987, 10 ♀♀ on *Salix* sp.; Bucheben 11-26 May 1986, 9 ♀♀ on *Tussilago farfara*, *Salix* sp., *Taraxacum* sp., *Prunus* sp. and 7 and 15 June 1986, 4 ♀♀ on *Berberis vulgaris*, *Leontodon* sp. and 1 July 1985, ♀ 2 ♂♂ on *Leontodon* sp. and 1-10 July 1986, 2 ♀♀ ♂ on *Leontodon* sp.; Steinalm 26 and 29 May 1986, 2 ♀♀ and 7 June 1986, 2 ♀♀ on *Salix sp.* and 27 June 1984, ♀ on *Hieracium* sp. and 4 Aug. 1985, ♀ on *Leontodon* sp.; Seidlwinkltal 14 June 1984, ♀ and 8 June 1986, ♀ on *Tussilago farfara*; Raurisertal 7 May 1985, ♀ on *Tussilago farfara*; Gruberalm 11 June 1986, 2 ♀♀ on *Lotus corniculatus*; Kitzstein 20 May 1987, ♀ on *Tussilago farfara* and 20 June 1984, ♀ on *Hieracium* sp.; Krumltal 12 June 1986, ♀ on *Taraxacum* sp.; Ritterkopf (1400-1500 m) 7-8 May 1985, 2 ♀♀ and 16 June 1984; ♀. Ferleitental 27 May 1986, ♀ on *Taraxacum* sp.

IV. Feldereralm 17 June 1986, ♀ on *Salix* sp.; Couloir under Feldereralm 5 July 1986, ♀ on *Salix* sp.

V. Ritterkar (1850-1950 m) 11 and 16 July 1984, 3 ♀♀ on *Salix* sp.

11. *Lasioglossum albipes* (FABRICIUS, 1781)

I. Rauriserhöhe 2 May 1986, 2 ♀♀ on *Salix* sp.; Kötschachtal 15-16 May 1986, 3 ♀♀ on *Taraxacum* sp. and 2 May 1987, 6 ♀♀ on *Petasites* sp. and *Salix* sp. and 30 June 1986, ♀ on *Leontodon* sp. and 24 July 1986, ♀.

II. Rauris 26 May 1986, 10 ♀♀ on *Taraxacum* sp. and 16 Sep. 1983, ♀ 7 ♂♂. Fusch 3 May 1986, ♀ on *Tussilago farfara*. Seidlwinkltal 13 June 1984, 6 ♀♀ on *Taraxacum* sp. and 11 Sep. 1983, ♀ 2 ♂♂. Badbruck 9 May 1987, ♀ on *Salix* sp.

III. Bucheben 11-26 May 1986, 10 ♀♀ on *Salix* and *Taraxacum* sp. and 15-25 June 1986, 23 ♀♀ on *Berberis vulgaris*, *Frangula alnius*, *Leontodon* sp., *Rubus idaeus* and 12 July 1984, ♀ on *Trifolium* sp. and 1 and 10 July 1985, 2 ♀♀ 2 ♂♂ on *Leontodon* sp.; Raurisertal (1200 m) 7 May 1986, ♀ on *Tussilago farfara* and 11 and 26 June 1986, ♀ on *Potentilla* sp. and 3 July 1986, ♀ on *Veronica chamaedris* and 20 and 25 May 1986, 2 ♀♀ and 7 and 26 June 1986, 8 ♀♀ on *Potentilla aurea*, *Taraxacum* sp., *Hieracium* sp. and 5 July 1986, ♀ *Leontodon* sp. and 12 July 1986, ♀ on *Leontodon glabratum*, leg. A. KOSIOR and 4 Aug. 1985, 2 ♀♀ ♂ on *Leontodon* sp.; Kitzsteinalm 26 June 1987, 2 ♀♀ on *Tussilago farfara* and 1 July 1986, 2 ♀♀ on *Leontodon* sp.; Ritterkopf 5 May 1986, 2 ♀♀ and 16 June 1984, 4 ♀♀ on *Taraxacum* sp. and *Hieracium* sp. and 1 July 1984, 10 ♀♀ on *Hieracium* sp. and *Potentilla erecta*.; Krumltal 20 Sep. 1983, 3 ♀♀ 5♂♂. Gruberalm 12 June 1986, 5 ♀♀ on *Lotus corniculatus*.; Seidlwinkltal 14 June 1984, ♀ on *Hippocrepis* sp. and 11 and 16 June 1986, 2 ♀♀ on *Taraxacum* sp.; Kötschachtal 14 July 1984 (1200 m) ♀ on *Hieracium* sp. and 25 July 1985, ♀.; Ferleitental 27 May 1986, 14 ♀♀ on *Taraxacum* sp.

IV. Feldereralm 17 June 1986, 2 ♀♀.

V. Ritterkar (1850-1950 m) 11 July 1984, 4 ♀♀ on *Salix* sp.; Grubereck (2010 m), ♀ on *Leontodon hispidus*, leg. A. KOSIOR.

12. *Lasioglossum laticeps* (SCHENCK, 1868)

II. Kitzstein (1000 m a.s.l.) 26 May 1986, 3 ♀♀ on *Tussilago farfara*.

III. Bucheben 4 May 1986, 3 ♀♀ on *Salix* sp.; Raurisertal (1200 m) 20 June 1986, 2 ♀♀ on *Potentilla erecta*.

13 *Lasioglossum fulvicorne* (KIRBY, 1802)

Note. In the Hohe Tauern I collected only females, which may belong to the species *L. fulvicorne* and *L. subfulvicorne*. In order to discriminate these two species for certain it is necessary to capture males (EBMER 1974). However, acc. to EBMER (in litt.), the two species should have been distinguished from each other on the basis of their head dimensions, even though the use of this single character leaves some specimens unidentified. The author counted the doubtful individuals of *L. subfulvicorne*, whose presence in the Hohe Tauern (Bad Hofgastein) was reported by EBMER (1988).

I. Rauriserhöhe 2 and 5 May 1986, 6 ♀♀ on *Salix* sp. and *Tussilago farfara*.; Kötschachtal 16 May 1986, ♀ on *Taraxacum* sp. and 24 July 1985, ♀.

II. Rauris 26 May 1986, ♀ on *Taraxacum* sp.; Seidlwinkltal 14 and 19 June 1984, 2 ♀♀.

III. Bucheben 4-19 May 1986, 19 ♀♀ on *Salix* sp. and *Prunus* sp. and 16 and 25 May 1986, 4 ♀♀ on *Prunus* sp., *Potentilla erecta*, *Berberis vulgaris* and *Leontodon* sp.; Raurisertal

(1200 m) 5 May 1986, ♀ on *Tussilago farfara*; Steinalm 7 June 1986, 2 ♀♀ on *Salix* sp.; Ritterkopf (1400 m) 5 May 1986, 2 ♀♀ on *Tussilago farfara*; Ferlaitental 27 May 1986, ♀ on *Taraxacum* sp.

14. *Lasioglossum subfulvicorne austriacum* EBMER, 1974

I. Kötschachtal 16 May 1986, 3 ♀♀ on *Taraxacum* sp.; Rauriserhöhe 2-12 May 1986, 10 ♀♀ on *Salix* sp. and *Tussilago farfara*.

II. Seidlwinkltal 19 June 1984, ♀ and 24 May 1987, ♀ on *Taraxacum* sp.; Weinersberg (1000 m) 26 May 1987, ♀ on *Tussilago farfara*.

III. Bucheben 4-19 May 1986, 5 ♀♀ on *Salix* sp., *Berberis* sp. and *Prunus* sp.; Steinalm 7 June 1986, 2 ♀♀ on *Salix* sp. and 5 July 1984, ♀; Kitzsteinalm (1300 m) 20 June 1984, ♀ on *Hieracium* sp.; Krumltal 17 June 1984, ♀; Ritterkopf (1400 m) 2 and 5 May 1986, 11 ♀♀ on *Tussilago farfara* and 16 June 1984, 2 ♀♀ on *Potentilla erecta* and *Taraxacum* sp.; Ferlaitental 27 May 1986, 2 ♀♀ on *Taraxacum* sp.

IV. Krumltal (1600-1700 m) 17 June 1984, ♀ on *Taraxacum* sp. and 12 June 1986, ♀ on *Taraxacum* sp.; Sieglitztal (1700 m) 29 July 1986, ♀ on *Leontodon*; Schlossalm bei Bad Gestein (1600-1800 m) (EBMER 1988).

15. *Lasioglossum fratellum* (PEREZ, 1903)

I. Rauriserhöhe 2 May 1986, ♀ on *Salix*; Kötschachtal 2 May 1987, 26 ♀♀ on *Tussilago farfara* and *Salix* sp. and 15-16 May 1986, 8 ♀♀ on *Taraxacum* sp. and 24 July 1985, 4 ♀♀.

II. Rauris 26 May 1986, 2 ♀♀ on *Taraxacum* sp.; Weinersberg near Hof Gastein 26 May 1987 (1000 m), 6 ♀♀ on *Tussilago farfara*; Seidlwinkltal 13 June 1984, 3 ♀♀ on *Taraxacum* sp. and 6 May 1985, ♀ on *Tussilago farfara* and 22 Sep. 1982, ♀ on *Hieracium*.

III. Bucheben 4-13 May 1986, 9 ♀♀ on *Salix* sp. and *Potentilla erecta* and 14 June 1984, ♀ and 10 June 1986, ♀ on *Taraxacum* sp.; Seidlwinktal (1100-1300 m) 14 June 1984, 2 ♀♀ on *Taraxacum* sp.; Krumltal 12 and 17 June 1986, 3 ♀♀ on *Taraxacum* sp.; Raurisertal (1200 m) 7 May 1985, 7 ♀♀ on *Tussilago farfara*; Steinalm 20 May 1986, 2 ♀♀ on *Potentilla*; Kitzsteinalm (1300 m) 20 June 1984, ♀ and 26 May 1987, 2 ♀♀; Astenschmiede 11 June 1984, ♀ on *Taraxacum* sp.; Gruberalm 12 June 1986 ♀, on *Lotus corniculatus*; Förstllehen 5 May 1986, 17 ♀♀ on *Tussilago farfara* and 17 June 1984, ♀ on *Hieracium* sp.; Böckstein 9 May 1987, ♀ on *Salix* sp.; Seidlwinkltal, 17 Aug. 1937, ♀ (FRANZ 1943).

IV. Sieglitztal (1700 m) 29 July 1986, ♀ on *Rosa* sp.; Hochalm 7 July 1984, 3 ♀♀ on *Potentilla erecta* and *Rubus idaeus*.

V. Stubnerkogel (1900 m) 19 June 1984, ♀ on *Vaccinium myrtillus*; Reissreich (2000 m) 7 July 1984, ♀.

16. *Lasioglossum alpigenum* (DALLA TORRE, 1877)

II. Rauris 26 May 1986, ♀ on *Taraxacum* sp., det. EBMER.

III. Krumltal 20 May 1985, ♂, det. EBMER.

17. *Lasioglossum cupromicans tirolense* (BLÜTHGEN, 1944)

III. Ritterkopf (1300-1400 m) 1 July 1984, ♀ det. EBMER; Raurisertal (1200 m) 7 May 1986, 2 ♀♀ on *Potentilla erecta* det. EBMER.

18. *Lasioglossum morio* (FABRICIUS, 1793)

II. Bad Hofgastein 900-1000 m (EBMER 1988).

III. Kotschachtal 16 May 1986, ♀ on *Taraxacum* sp. det. EBMER.

19. *Lasioglossum leucopum* (KIRBY, 1802)

II. Seidlwinkltal (900-1000 m) ♀. Rauris 16 Sep. 1983, ♀ 2 ♂♂ det. EBMER.

III. Ferlaitental (FRANZ 1943)

20. *Lasioglossum bavaricum* (BLÜTHGEN, 1930)

II. Kötschachtal 1200 m, 23 June 1984, 2 ♀♀.

III. Bucheben 25 May 1986, ♀ on *Taraxacum* sp.; Ritterkopf (1300-1400 m) 1 July 1984, 2 ♀♀ on *Potentilla erecta*.

IV. Hochalm 7 July 1984, ♀ on *Potentilla erecta*; Gamskarkogel slope 1850 m, ♀. Grubereck S-slope 1820 m, ♀.

21. *Lasioglossum rufitarse* (ZETTERSTEDT, 1838)

I. Kötschachtal 24 July 1986, ♀; Rauriserhöhe 13 May 1986, ♀ on *Taraxacum* sp.

II. Bad Hofgastein, 900-1000 m (EBMER 1988); Seidlwinkltal 22 Sep. 1982, ♂ det. EBMER; Rauris 26 May 1986, ♀ on *Taraxacum* sp.

III. Kötschachtal 20 and 23 June 1984, 2 ♀♀; Bucheben 4 May 1986, 2 ♀♀ on *Salix* sp. and 25 June 1986, ♀ on *Rubus idaeus*; Kitzstein (1300 m) 26 May 1987, ♀ on *Tussilago farfara*.

22. *Dufourea alpina* MORAWITZ, 1865

III. Kötschachtal 23 June 1984, ♂; Förstllehen near Bodenhaus, ♀ on *Potentilla erecta*.

IV. Feldereralm (1650 m) 6 July 1986, 2 ♂♂ on *Potentilla erecta*.

V. Hüttenkogel (1820 m) 28 July 1986, ♀ on *Campanula barbatula* leg. A. KOSIOR.

23. *Dufourea dentiventris* (NYLANDER, 1848)

I. Kötschachtal 22 July 1986, ♂ on *Campanula cochlearifolia*.

III. Couloir under Feldereralm (1450 m) 5 July 1986, ♂.

24. *Dufourea paradoxa* (MORAWITZ, 1867)

IV. Siglitztal (1700 m) 27 and 29 July 1985, 2 ♀♀ on *Potentilla* sp. and *Hieracium* sp.

V. "Glocknerstrasse im Pasterzenvorfeld" 4 Aug. 1944, ♂ (FRANZ 1949); "Glocknerstrasse zwischen Glocknerhaus und Senfleben Glocknerhaus" (2000-2100 m) 16 July 1986, ♀ 2 ♂♂ on *Hieracium*.

25. *Sphaecodes monilicornis* (KIRBY, 1802)

III. Bucheben 12 July 1984, ♀ on *Anthylis vulneraria* ssp. *alpestris*; Seidlwinkltal (1100-1400 m), ♀ on *Taraxacum officinale*.

26. *Sphaecodes ferruginatus* v. HAGENS, 1882

III. Seidlwinkltal (1100-1500 m) 14 June 1984, 2 ♀♀ on *Taraxacum* sp., *Potentilla erecta* and *Hippocrepis communis*; Raurisertal (1200 m) 20 June 1986, ♀ on *Potentilla erecta*.

Andrenidae[1)]

27. *Andrena tibialis* (KIRBY, 1802)

I. Kötschachtal 15 and 16 May 1986, 5 ♂♂ on *Taraxacum* sp.

II. Rauris 24 May 1987, ♀ on *Viola tricolor*; Fuschtal 19 May 1987, 2 ♂♂ on *Salix* sp.

III. Ferlaitental 27 May 1986, ♀ on *Taraxacum* sp.; Kitzsteinalm (1250 m) 26 May 1987, ♀ on *Salix* sp. Seidlwinkltal 6 May 1985, ♀ on *Anemone ranunculoides*; Bucheben 10 May 1984, ♀ on *Taraxacum* sp. and 10-25 May 1986, 13 ♀♀ and 2 ♂♂ on *Taraxacum* sp., *Salix* sp., *Berberis vulgaris* and *Prunus* sp. and 7 June 1984, ♀ on *Berberis vulgaris* and 7 June 1986, ♀ on *Berberis vulgaris*; Steinalm (1400 m) 7 June 1986, ♀ on *Salix* sp.; Krumltal 25 May 1987, 6 ♀♀ on *Salix* sp. and *Petasites* sp. and 17 June 1984, 3 ♀♀ on *Salix* sp.

IV. Feldereralm (1500 m) 17 May 1986, ♀.

28. *Andrena haemorrhoa* (FABRICIUS, 1781)

I. Kötschachtal 15 and 16 May 1986, 16 ♀♀ and 35 ♂♂ on *Taraxacum* sp. and 2 May 1987, 26 ♂♂ on *Salix* sp. and *Petasites* sp. and 23 June 1984, ♀; Rauriserhöhe 2 May 1986, 8 ♂♂ on *Salix* sp.

II. Bad Bruck 9 May 1987, ♂ on *Salix* sp. Raurisertal 2 May 1986, ♂ on *Salix* sp.; Weinberg 20 June 1986, 10 ♀♀ and ♂ on *Berberis vulgaris*; Seidlwinkltal 6 May 1985, 2 ♀♀ and ♂ on *Salix* sp. and *Tussilago farfara* and 24 May 1987, 3 ♀♀ and 4 ♂♂ on *Taraxacum* sp. and 13 June 1984, 2♀♀; Rauris 26 May 1986, ♀ on *Taraxacum* sp.

III. Seidlwinkltal (1400 m) 24 May 1987, 3 ♂♂ on *Padus avium* and *Taraxacum* sp. and 28 Apr. 1986, ♂ on *Salix* sp.; Kitzsteinalm (1250 m) 26 May 1987, 4 ♀♀ and 5 ♂♂ on *Salix* sp. and 20 June 1984, 2 ♀♀ on *Hieracium* sp.; Bucheben 10 May 1984, 3 ♀♀ on *Ribes* sp. and 3-29 May 1986, 17 ♀♀ and 60 ♂♂ on *Tussilago farfara*, *Salix* sp., *Prunus* sp. and *Taraxacum* sp. and 13 June 1984, 2 ♀♀ on *Hieracium* sp. and 12-25 June 1986, 59 ♀♀ and 16 ♂♂ on *Berberis vulgaris*, *Frangula alnus*, *Rubus idaeus*; Steinalm 15 and 20 May 1986, ♀ and 7 ♂♂ on *Cerasius* sp. and 1 and 7 June 1986, 12 ♀♀ on *Salix* sp.; Raurisertal (1200 m) 11 June 1984, ♀ on *Taraxacum* sp. and 20 June 1986, 2 ♀♀ on *Lotus corniculatus* and *Leontodon* sp.; Bad Gastein 30 Apr. 1987, ♂ on *Salix* sp.; Krumltal 16 June 1984, ♀ and 17 ♂♂ on *Salix* sp.; Weinberg (1100-1200 m) 26 May 1987, 4 ♀♀ on *Taraxacum* sp.; Frohalm 5 July 1986, ♀; Ferlaitental 27 May 1986, ♀ on *Taraxacum* sp.; Förstlehen (1400 m) 16 June 1984, 2 ♀♀.

IV. Kar below Feldereralm (1500 m) 5 July 1984, 14 ♀♀ on *Salix* sp. and *Taraxacum* sp.; Feldereralm (1600-1700 m) 17 June 1986, 6 ♀♀ on *Salix* sp. and 6 July 1986, ♀ on *Dryas octopetala* and 21 July 1984, ♀ on *Potentilla* sp.; Stubnerkogel above Bad Gestein 27 June 1986, ♂ on *Lotus corniculatus*.

---

1) FRANZ (1949) recorded two females of *Andrena distinguenda* SCHENK, 1871 from Zone V. This is a Submediterranean species, probably wrongly determined. I have not entered it in the list.

V. Ritterkar (1850-1950 m) 11 and 14 July 1984, 8 ♀♀ on *Salix* sp.

29. *Andrena gravida* IMHOFF, 1832

I. Rauriserhöhe 2 May 1986, ♀ on *Salix* sp.

30. *Andrena hattorfiana* (FABRICIUS, 1775)

I. Geisbachtal 13 July 1984, 2 ♀♀ on *Knautia arvensis*; Kötschachtal 30 June 1986, ♀ on *Knautia arvensis* and 23 June 1984, ♀ and ♂ on *Knautia arvensis* and 13 and 16 July 1984, 3 ♀♀ on *Knautia arvensis*.

III. Bucheben 22 July 1984, ♀ on *Knautia arvensis* and 1 July 1985, 3 ♀♀ on *Knautia arvensis*; Steinalm 4 Aug. 1985, ♀ on *Knautia arvensis*; Fröstlehen above Bodenhaus (1350 m) 18 July 1984, ♀ on *Knautia arvensis*.

31. *Andrena cineraria* (LINNAEUS, 1758)

I. Rauriserhöhe 2 May 1986, 2 ♀♀ and on *Salix* sp.; Bad Fusch 3 May 1986, ♀ and 2 ♂♂ on *Salix* sp.

32. *Andrena thoracica* (FABRICIUS, 1775)

III. Bucheben 12 June 1986, 2 ♂♂ on *Berberis vulgaris* and *Lotus corniculatus*.

33. *Andrena nigroaenea* (KIRBY, 1802)

I. Kötschachtal 15 May 1986, 2 ♂♂ on *Taraxacum* sp.

II. Seidlwinkltal 26 May 1985, ♀ on *Siringa* sp.

III. Hundsdorf 15 May 1987, ♀ on *Sonchus* sp.; Bucheben 7 and 19 June 1986, ♀ and 2 ♂♂ on *Berberis vulgaris* and *Frangula alnus*.

IV. Stubnerkogel above Bad Gastein (1770 m) 29 June 1986, ♂.

34. *Andrena ovatula* (KIRBY, 1802)

I. Kötschachtal 23 June 1984, ♂ on *Hieracium* sp.

III. Förstlehen (1400 m) 18 July 1984, ♀ on *Hieracium* sp.; Steinalm 7 June 1986, ♂ on *Taraxacum* sp.

V. Sternscharte (2050 m) 5 July 1986, ♂ leg. A. KOSIOR.

35. *Andrena similis* SMITH, 1849

I. Rauriserhöhe 13 May 1986, ♀ on *Taraxacum* sp.

III. Bucheben 15 June 1986, ♀.

36. *Andrena lathyri* ALFKEN, 1899

III. Bucheben 10 June 1984, ♂ on *Anthylis vulneraria* ssp. *alpestris*.

37. *Andrena intermedia* THOMSON, 1872

I. Kötschachtal 20 and 23 June 1984, 2 ♀♀ and 3 ♂♂.

II. Weinberg 20 June 1984, ♀ on *Berberis vulgaris*.

III. Kötschachtal 26 June 1986, ♀ on *Rubus idaeus*; Bucheben 19-26 May 1986, ♀ and 8 ♂♂ on *Anthylis vulneraria* ssp. *alpestris* and *Prunus* sp. and 10-14 June 1984, 2 ♀♀ and 24 ♂♂ on *Anthylis vulneraria* ssp. *alpestris* and 12-25 June 1986, 3 ♀♀ and 76 ♂♂ on *Anthylis vulneraria* ssp. *alpestris*, *Trifolium* sp. and *Lotus corniculatus* and 12 July 1984, ♂ on *Lotus* *corniculatus* leg. A. KOSIOR and 12-21 July 1984, 2 ♀♀ and 38 ♂♂ on *Anthylis vulneraria* ssp. *alpestris*, *Lotus corniculatus* and *Lupinus* sp.; Raurisertal (Steinbruch) 20-25 June 1986, 2 ♀♀ and 19 ♂♂ on *Trifolium* sp. and *Lotus corniculatus* and 23 July 1984, ♂; Steinalm 27 June 1984, ♀ on *Lotus corniculatus* and 7 June 1986, 4 ♂♂ on *Salix* sp. and *Hyppocrepis comosa* and 4 Aug. 1985, ♀ on *Trifolium rubrum*; Kitzsteinalm 20 June 1984, ♀ and 8 ♂♂ on *Lotus corniculatus* and 1 July 1986, ♀ and ♂ on *Lotus corniculatus*; Karalm 11 June 1986, 4 ♀♀ on *Lotus corniculatus*; Förstllehen 16 June 1984, 2 ♀♀ and 8 ♂♂ on *Lotus corniculatus* and *Hieracium* sp. and 18 June 1984, ♀ on *Hieracium* sp. and 1 July 1984, ♀ and 3 ♂♂ on *Lotus corniculatus*; Bad Gastein 27 June 1986, ♂ on *Potentilla* sp. and 18 July 1984, ♀ on *Sinapis* sp; Bellevue-Alm (1300 m) 1 July 1984, 2 ♂♂ on *Lupinus* sp.; Ob. Wetzalm (1350 m) 29 June 1986, 9 ♂♂ on *Lotus corniculatus*; Karalm 11 June 1986, 4 ♀♀ on *Lotus corniculatus*.

IV. Feldereralm 6 July 1986, 4 ♂♂ on *Lotus corniculatus*.

V. Ritterkar (1800 m) 1 July 1984, 4 ♂♂ on *Dryas octopetala* leg. B. PIERONEK.

38. *Andrena barbilabris* (KIRBY, 1802)

I. Kötschachtal 16 May 1986, ♀ on *Taraxacum* sp. and 2 May 1987, 5 ♀♀ on *Petasites* sp.

II. Seidlwinkltal (950-1100 m) 13 June 1984, 3 ♀♀ on *Taraxacum* sp. and 11 June 1986, ♀ on *Taraxacum* sp. Kitzsteinalm 26 May 1987, ♀ on *Salix* sp.

III. Bucheben 11 May 1986, ♀ on *Salix* sp. and 7 and 16 June 1986, ♀ and ♂ on *Frangula alnus* and 12 July 1984, ♀ on *Anthylis vulneraria* ssp. *alpestris*; Steinalm 7 June 1986, ♀ on *Salix* sp.; Kötschachtal 23 June 1984, ♀.

IV. Under Feldereralm (1500 m) 17 June 1986, ♀ on *Salix* sp.

39. *Andrena denticulata* (KIRBY, 1802)

I. Kötschachtal 24 July 1985, ♂.

III. Steinalm 4 Aug. 1985, ♀ on *Thymus* sp. and 30 Aug. 1985, ♂ on *Thymus pulegioides*.

40. *Andrena semilaevis* PÉREZ, 1903

I. Rauriserhöhe (978 m) 13 May 1986, ♀ on *Taraxacum* sp.; Kötschachtal 16 July 1984, ♀ on *Hieracium* sp.

II. Weinersberg (1000 m) 26 May 1987, ♂ on *Tussilago farfara*; Karalm 11 June 1986, ♂ on *Lotus corniculatus*.

III. Bucheben 13 and 26 May 1986, ♀ and ♂ on *Potentilla erecta* and 27 June 1984, ♀; Fröstllehen above Bodenhaus (1400 m) ♀ on *Potentilla erecta*; Astenschmiede in Raurisertal (1200 m) 11 June 1984, ♂ on *Taraxacum* sp.; Ferleitental 27 May 1986, ♂ on *Taraxacum* sp.

41. *Andrena subopaca* NYLANDER, 1848

II. Rauris 16 May 1986, ♀ on *Taraxacum* sp.; Seidlwinkltal 13 June 1984, 2 ♀♀ on *Taraxacum* sp.

III. Kötschachtal 26 June 1986, ♀ on *Rubus idaeus*; Angertal (1280 m) 29 July 1986, ♀ on *Potentilla erecta* leg. A. KOSIOR; Seidlwinkltal (1100-1400 m) 14 June 1984, ♀ on *Taraxacum* sp. and (1400 m) 23 July 1984, ♀; Steinalm (1150-1300 m), 2 ♀♀ on *Potentilla erecta*; Fröstllehen above Bucheben 1-18 July 1987, 4 ♀♀ on *Potentilla erecta* and 16 June 1984, ♀ on *Potentilla erecta*; Ferleitental 27 May 1986, 3 ♀♀ on *Taraxacum* sp.

IV. Feldereralm (1600 m) 6 July 1986, ♀ on *Potentilla aurea*; Above Filzeralm (1800 m) 10 July 1984, 4 ♀♀ on *Potentilla aurea*; Durchgangalm (1750 m) 10 July 1984, ♀ on *Potentilla aurea*; Sportgastein (1600 m) 27 July 1985, 2 ♀♀ on *Potentilla aurea*.

42. *Andrena falsifica* PERKINS, 1915

I. Kötschachtal 14 May 1986, ♀ on *Taraxacum* sp.

II. Seidlwinkltal (1000 m) 13 June 1984, ♂ on *Taraxacum* sp.

III. Kötschachtal (1200 m) 20 June 1984, ♀; Bucheben 10 and 27 June 1984, ♀ and ♂ on *Taraxacum* sp. and 12 and 20 May 1986, 2 ♀♀ and 2 ♂♂ on *Potentilla erecta* and 19 June 1986, ♀; Förstllehen above Bodenhaus (1300-1500 m) 16 June 1984, 7 ♀♀ and ♂ on *Potentilla erecta* and ♀ on *Hieracium* sp. and 2 July 1984, 4 ♀♀ on *Potentilla erecta*.

43. *Andrena coitana* (KIRBY, 1802)

I. Kötschachtal 30 June 1986, ♀ on *Leontodon* sp. and 24-25 July 1985, 4 ♀♀ on *Centaurea* sp. and 2 ♂♂ and 16 July 1984, ♀ and ♂ on *Hieracium* sp.

III. Raurisertal (Steinbruch – 1200 m) 23 July 1984, ♀; Seidlwinkltal (1400 m) 23 July 1984, ♀ on *Hieracium* sp.; Bucheben 1 July 1985, 8 ♀♀ and 3 ♂♂ on *Rosa* sp. and *Leontodon* sp. and 10 July 1986, 3 ♀♀ on *Leontodon* sp.; Steinalm 4 Aug. 1985, 4 ♀♀ on *Leontodon* sp.; Fröstllehen (1350-1450 m) 18 and 23 July 1984, 6 ♀♀ on *Hieracium* sp.; Frohalm (1470 m) 22 Aug. 1985, ♀ on *Hieracium* sp. and (1350 m) 29 Aug. 1985, ♀ leg. A. KOSIOR; Badgastein (1280 m) 7 Sep. 1985, 2 ♀♀ on *Leontodon autumnalis* leg. T. KAŹMIERCZAK; Karalm 12 June 1986, ♀ on *Lotus corniculatus*.

IV. Ritterkopf (1600 m) 15 July 1986, 2 ♀♀ on *Leontodon* sp.; Sieglitztal (1700 m) 27 July 1985, ♂ on *Potentilla* sp. and 29 July 1986, 2 ♀♀ on *Rosa* sp.; Salsenalm (1700 m) 29 July 1985, ♂.

V. "An der Glocknerstrasse zwischen Kaisereck und Guttal 5 Aug. 1943, ♀, ♂" (FRANZ 1949).

44. *Andrena lapponica* ZETTERSTEDT, 1838

I. Kötschachtal 2 May 1987, 4 ♂♂ on *Salix* sp.

II. Seidlwinkltal 6 May 1985, ♀ on *Salix* sp. and 17 June 1984, ♀ on *Taraxacum* sp.

III. Bucheben 19 May 1986, 2 ♂♂ on *Prunus* sp.; Raurisertal (1200-1400 m) 5 May 1986, ♀ and 11 May 1984, ♀ on *Taraxacum* sp.; Krumltal (1400 m) 17 June 1986, ♀ on *Salix* sp.; Karalm 11 June 1986, ♀ on *Lotus corniculatus*.

IV. Sieglitztal 19 July 1986, ♀; Hochalm (1750 m) 7 July 1984, 2 ♀♀ on *Vaccinium myrtillus*; Sieglitztal (1700 m) 22 July 1986, 3 ♀♀ on *Rosa* sp.; Below Feldereralm (1500 m) 17 June 1986, ♀ on *Salix* sp.; Feldereralm (1630 m) 3 July 1986, ♀ on *Rhododendron ferruginatus*; Sportgastein (1700 m) 18 July 1984, ♀ on *Hieracium* sp.; Durchgangalm (1750 m) 10 July 1984, ♀.

V. Stubnerkogel (1900 m) Western slope 19 June 1984, 4 ♀♀ on *Vaccinium myrtillus*; Schlossalm (2200 m) S-slope 3 July 1986, ♀ on *Rhododendron* sp. leg. N. WINDING.

45. *Andrena helvola* (LINNAEUS, 1758)

I. Rauriserhöhe 2 May 1986, 4 ♂♂ on *Salix* sp.

II. Fusch 3 May 1986, ♀ on *Tussilago farfara*.

III. Raurisertal 7 May 1986, ♀; Bucheben 4-21 May 1986, 17 ♀♀ and 20 ♂♂ on *Salix* sp., *Ribes* sp. *Taraxacum* sp., *Prunus* sp. and *Frangula alnus* and 1 July 1985, ♀ on *Rosa* sp.; Steinalm (1400 m) 7 June 1986, ♀ on *Salix* sp.; Weinersberg (1100 m) 20 May 1984, 10 ♀♀ on *Berberis vulgaris*; Hundsdorf 19 May 1986, ♀ on *Salix* sp.; Kötschachtal 26 May 1986, ♀ on *Rubus idaeus*.

46. *Andrena clarkella* (KIRBY, 1802)

I. Kötschachtal 13 July 1984, ♀.

II. Fuschtal (800 m) 19 May 1987, 2 ♀♀ on *Salix* sp. and *Prunus padus*.

III. Seidlwinkltal 24 May 1987, ♀ on *Salix* sp.; Bucheben 11 and 28 May 1986, 2 ♀♀ on *Salix* sp.; Krumltal (1250 m) 25 May 1987, 7 ♀♀ on *Salix* sp. and *Petasites albus*; Böckstein 9 May 1987, 2 ♀♀ on *Salix* sp.; below Feldereralm 27 June 1984, ♀ on *Salix* sp.

47. *Andrena praecox* (SCOPOLI, 1763)

I. Rauriserhöhe 2 May 1986, 31 ♀♀ and ♂ on *Salix* sp.; Kötschachtal 7-11 May 1985, 17 ♀♀ on *Salix* sp.

II. Fuschtal (800 m) 19 May 1987, 2 ♀♀ on *Salix* sp. and *Prunus padus*; Bad Bruck 9 May 1987, 3 ♀♀ on *Salix* sp.

III. Bucheben 3-19 May 1986, 17 ♀♀ and ♂ on *Salix* sp. and *Prunus* sp. and 7 June 1986, 2 ♀♀ on *Salix* sp. and 28 Apr. 1986, 9 ♀♀ on *Salix* sp.; Steinalm (1400 m) 7 June 1986, 2 ♀♀ on *Salix* sp.; Kitzsteinalm (1250 m) 26 May 1987, ♀ on *Salix* sp.; Böckstein 9 May 1987, ♀ on *Salix* sp.; Kötschachtal 16 June 1986, ♀ on *Rubus idaeus*; Scheidegg (1450 m) May 1987, 2 ♀♀ on *Salix* sp.; Hundsdorf 15 May 1987, 27 ♀♀ on *Sonchus* sp.

48. *Andrena apicata* SMITH, 1847

I. Rauriserhöhe 2 May 1986, 2 ♀♀ on *Salix* sp.; Kötschachtal 2 May 1987, ♀ on *Salix* sp. and 15 May 1986, ♀ on *Taraxacum* sp.

II. Fuschtal (800 m) 19 May 1987, ♀ on *Salix* sp.; Seidlwinkltal (1100 m) 24 May 1987, ♀ on *Salix* sp.

III. Hundsdorf 15 May 1987, ♀ on *Sonchus* sp.; Bucheben 11-28 May 1986, 13 ♀♀ on *Salix* sp., *Taraxacum* sp., *Berberis vulgaris* and *Prunus* sp.; Steinalm (1400 m) 7 May 1986, 2 ♀♀ on *Salix* sp. and 27 June 1984, on *Rhododendron* sp.

49. *Andrena rogenhofferi* MORAWITZ, 1872

III. Kötschachtal 2 May 1987, 4 ♂♂ on *Salix* sp.; Bucheben 19 May 1988, ♂ on *Salix* sp. and 7-16 June 1986, ♀ and 7 ♂♂ on *Berberis vulgaris* and *Frangula alnus*; Steinalm (1400 m) 7 June 1986, 2 ♀♀ and ♂ on *Salix* sp.; Fröstllehen (1400 m) 5 May 1986, ♂ on *Tussilago farfara*; Ferletental 27 June 1986, ♀.

IV. Feldereralm (1550 m) 7 June 1986, ♀ 17 June 1986, ♀ on *Salix* sp. and 15 and 17 July 1986, 7 ♀♀ on *Rhododendron ferruginatus*; Ritterkopfhang (1500-1600 m) 1 July 1984, ♀.

V. Bei Margaritzensee (2000 m) 16 July 1986, ♀ on *Rhododendron ferruginatus*; Schlossalm (2110 m) 16 July 1986, ♀ on *Rhododendron* sp. and 1 July 1986, 3 ♀♀ on *Salix* sp. and (2150 m) 2 July 1986, ♀ on *Saxifraga oppositifolia* leg. N. WINDING.

50. *Andrena fucata* SMITH, 1847

III. Bucheben 16 June 1986, ♀ and 12 July 1984, ♀ on *Rosa* sp.; Kötschachtal (1100 m) 26 June 1986, ♀ on *Rubus idaeus*.

51. *Andrena jakobi* PERKINS, 1921

II. Bad Bruck 9 May 1987, ♂ on *Salix* sp.

III. Bucheben 7-19 May 1986, 4 ♂♂ on *Salix* sp. and *Ribes* sp. and 7-26 June 1986, ♀ and 6 ♂♂ on *Berberis vulgaris* and *Frangula alnus*; Steinalm (1300 m) 10 May 1984, ♂ on *Cerasus* sp. and 20 May 1986, ♂ on *Cerasus* sp.; Kötschachtal (1200-1300 m) 20 June 1986, ♀ and 23 June 1984, ♀ and ♂.

IV. Feldereralm (1650 m) 8 July 1984, ♀ .

52. *Andrena humilis* IMHOFF, 1832

I. Kötschachtal 20 June 1986, ♀ on *Leontodon* sp.

II. Seidlwinkltal (950-1000 m) 13 June 1984, ♀ and ♂ on *Taraxacum* sp.

III. Bucheben 25 June 1986, ♀ on *Leontodon* sp.; Steinalm (1300 m) 7 July 1986, ♀ on *Taraxacum* sp. and 23 and 27 June 1984, 3 ♀♀ on *Leontodon* sp.; Raurisertal (Astenschmiede – 1200 m) 11 June 1984, 2 ♀♀ and 2 ♂♂ on *Taraxacum* sp. and 23 July 1984, 2 ♀♀ on *Hieracium* sp.; Fröstllehen (1400 m) 16 June 1984, ♀ and 2 ♂♂ on *Taraxacum* sp.; Kitzstein (1300 m) 20 June 1984, ♂ on *Hypochoeris uniflora*.

53. *Andrena bicolor* FABRICIUS, 1775

I. Kötschachtal 2 May 1987, 3 ♀♀ on *Tussilago farfara* and 24 and 25 July 1985, 2 ♀♀ on *Campanula* sp. and *Leontodon* sp.; Bad Fusch 5 May 1986, ♂ on *Petasites albus*.

II. Weinersberg (1000 m) 25 May 1987, ♀ on *Tussilago farfara* and 20 June 1984, ♀ on *Berberis* sp.; Fusch 3 May 1986, ♀ on *Tussilago farfara*; Fuschtal (800 m) 19 May 1987, ♀ on *Prunus padus*; Raurisertal 7 May 1985, ♀ on *Tussilago farfara*; Seidlwinkltal 6 May 1985, ♀ and 2 ♂♂ on *Tussilago farfara*.

III. Bucheben 4 May 1986, ♂ on *Salix* sp. and 12 July 1984, ♀ on *Leontodon* sp.; Seidlwinkltal 24 May 1987, 3 ♀♀ on *Salix* sp. and 13 June 1984, 2 ♀♀ on *Hieracium* sp.; Kitzsteinalm (1250 m) 26 May 1987, 5 ♀♀ on *Salix* sp.; Scheidegg (1400 m) 24 May 1987, ♀ on *Prunus padus*.

IV. Ritterkopf (1600 m) 15 July 1986, ♀ on *Leontodon* sp.

54. *Andrena ruficrus* NYLANDER, 1848

I. Rauriserhöhe 20 May 1986, ♀ on *Taraxacum* sp.

II. Rauris 26 May 1986, ♀ on *Taraxacum* sp.; Seidlwinkltal 6 May 1985, ♀ and ♂ on *Tussilago farfara* and 13 June 1984, ♀ on *Taraxacum* sp. and 25 June 1986, ♀ on *Syringa vulgaris*.

III. Bucheben 4-25 May 1986, 3 ♀♀ and ♂ on *Salix* sp., *Tussilago farfara* and *Taraxacum* sp.; Seidlwinkltal (1100-1300 m) 14 May 1984, ♀ on *Taraxacum* sp.; Krumltal (1400 m) 17 June 1984, 7 ♀♀ on *Salix* sp.; Steinalm (1400 m) 7 June 1986, 3 ♀♀ on *Salix* sp.; Ritterkopfslope (1400 m) 16 June 1984, ♀.

IV. Below Feldereralm (1500 m) 27 June 1984, 13 ♀♀ on *Salix* sp. and 11 July 1984, ♀ on *Salix* sp.

V. Ritterkar (1880-1990 m) 12 and 19 July 1984, 3 ♀♀ on *Salix* sp.

55. *Panurgus banksianus* (KIRBY, 1802)

I. Kötschachtal (1100 m) 24 July 1986, ♀.

III. Bucheben 1 and 7 July 1985, 2 ♂♂ on *Leontodon* sp. and 11-12 July 1985, ♀ and 29 ♂♂ on *Anthylis vulneraria* ssp. *alpestris*, *Lotus corniculatus* and *Ranunculus* sp. and 4 July 1986, 3 ♂♂ on *Ranunculus acris* leg. A. KOSIOR; Steinalm (1350 m) 3 July 1986, ♀; Belevue-Alm (1200 m) 29 June 1986, 3 ♂♂ on *Ranunculus acris*.

IV. Tauernhaus in Seidlwinkltal 15 July 1986, ♀ on *Hieracium* sp.

V. Slope above Frohalm (1700-2000 m) 4 July 1986, 3 ♂♂ on *Ranunculus acris* leg. A. KOSIOR.

56. *Panurginus montanus* GIRAUD, 1861

III. "In Bergen von Gastein", loc. typ. GIRAUD, 1861; Badgastein (1100 m) 27 July 1986, 5 ♀♀ and 2 ♂♂ on *Potentilla aurea*; Kötschachtal (1200 m) 23 June 1984, ♀; Bucheben 25-26 June 1986, 6 ♀♀ on *Potentilla erecta* and 10 July 1986, ♀ on *Leontodon* sp.; Steinalm (1250-1300 m) 7 June 1986, 2 ♀♀ and ♂ on *Potentilla aurea* and 5 July 1986, ♀; Raurisertal (1200 m) 20 June 1986, 7 ♀♀ and 4 ♂♂ on *Potentilla erecta* and 23 July 1984, ♀ on *Hieracium* sp.; Förstllehen (1350 m) 18 July 1984, ♀ on *Potentilla erecta*; Kitzstein (1300 m) 20 June 1984, ♂.

IV. Feldereralm (1650 m) 6 July 1986, 10 ♀♀ and 33 ♂♂ on *Potentilla aurea*; Below Feldereralm (1500 m) 5 July 1986, ♀ and 2 ♂♂ on *Ranunculus acris*; Siglitztal (1700 m) 27 and 29 July 1985, 32 ♀♀ and 9 ♂♂ on *Potentilla* sp. and *Hieracium* sp.; and 28 July 1986, ♀ and ♂ on *Hieracium* sp.; Hochalm (1750 m) 7 July 1984, 4 ♂♂ on *Potentilla erecta*; Durchgangalm (1740 m) 10 July 1984, ♀ on *Potentilla erecta*.

V. Schlossalm (2060 m) 1-2 July 1986, ♀ and 6 ♂♂ on *Potentilla erecta* and *Hieracium pilosella*; Nahe Glocknerhaus (2000-2100 m) 3 ♀♀ and ♂ on *Hieracium* sp.; Above Feldereralm (2100 m) 17 July 1986, ♂, leg. B. PIERONEK.

Megachilidae

57. *Anthidium manicatum* (LINNAEUS, 1758)

I. Kötschachtal 24-25 July 1985, 3 ♀♀ and 3 ♂♂ on *Stachys germanica*.

58. *Anthidium montanum* F. MORAWITZ, 1864

III. Ober Wetzlalm (1350 m) 29 June 1986, 5 ♂♂ on *Lotus corniculatus*; Bucheben 1 July 1985, ♂ on *Lotus corniculatus*.

59. *Chelostoma grande* NYLANDER, 1852

I. Geissbachtal (980 m) 13 Aug. 1984, ♂.

III. Geissbachtal (1370 m) 4 Aug. 1986, ♀ on *Lotus corniculatus* leg. A. KOSIOR; Bucheben 12-26 May 1986, 3 ♀♀ on *Taraxacum* sp. and 10 June 1984, ♀ and 11 and 19 June 1986, 2 ♀♀ on *Lotus corniculatus* and 26 June 1984, ♀ and 12 July 1984, 2 ♀♀ on *Lotus corniculatus* and 24 July 1985, 2 ♀♀; Steinalm (1200-1300 m) 25-26 May 1986, 5 ♀♀ and 3 ♂♂ on *Lotus corniculatus* and *Taraxacum* sp. and 7 June 1986, ♀ on *Taraxacum* sp. and 30 June 1986, 2 ♂♂ on *Potentilla* sp. and (1400 m) 7 June 1986, ♀ on *Taraxacum* sp. and 5 July 1986, ♀; Raurisertal (1200 m) 20 June 1986, ♂ on *Lotus corniculatus*; Karalm

11-12 June 1986, 6 ♀♀ on *Lotus corniculatus*; Kötschachtal (1100 m) 10 May 1986, ♂ on *Taraxacum* sp. and (1200 m) 23 June 1984 2 ♀♀ on *Knautia arvenis* and 24 July 1985, 5 ♀♀.

60. *Chelostoma maxillosum* (LINNAEUS, 1767)

III. Bucheben 26 May 1986, ♀ and ♂, 10 June 1984, ♀, 19 June 1986, ♂, 12-13 July 1984, 2 ♀♀ and 2 ♂♂ on *Anthylis vulneraria* ssp. *alpestris*; Steinalm (1300-1400 m) 2 ♀♀ and 8 ♂♂ on *Taraxacum* sp., *Lotus corniculatus* and *Potentilla* sp. and 25 May 1986, 6 ♀♀ and 30 ♂♂ and 5 July 1986, 3 ♀♀ on *Leontodon* sp. and 21 July 1986, ♂; Kötschachtal 16 May 1986, ♂ on *Taraxacum* sp. and 26 June 1986, ♀ on *Ranunculus acris*.

61. *Chelostoma nigricorne* NYLANDER, 1848

II. Rauris 19 July 1984, ♂ on *Campanula* sp.

III. Steinalm (1250 m) 5 July 1986, ♀ and 4 Aug. 1985, ♀ on *Centaurea* sp.; Kötschachtal 25-30 June 1986, 5 ♀♀ und 8 ♂♂ on *Campanula* sp., *Lupinus* sp.. *Leontodon* sp. and *Ranunculus acris*.

62. *Chelostoma florisome* (LINNAEUS, 1758)

I. Kötschachtal 25 July 1985, ♂ on *Campanula* sp.

63. *Trachusa byssina* (PANZER, 1798)

III. Raurisertal (1200 m) 18-26 July 1984, 3 ♀♀ and 6 ♂♂ on *Lotus corniculatus* and *Onobrychis viciifolia*.

64. *Megachile circumcincta* (KIRBY, 1802)

III. Bucheben 19-27 June 1986, 11 ♀♀ on *Lupinus* sp. and *Lotus corniculatus* and 2-3 July 1986, ♀ and ♂ on *Lupinus* sp. leg. A. KOSIOR and 12 July 1984, 2 ♀♀ on *Rosa* sp. and 21 July 1984, ♀ on *Lupinus* sp. and 12 Aug. 1986, ♀; Raurisertal (1200 m) 15 June 1986, ♀ and 20 June 1986, 3 ♀♀ on *Lotus corniculatus* and 3 July 1986, ♂ leg. A. KOSIOR and 23 and 25 July 1984, 7 ♀♀ on *Lotus corniculatus*; Steinalm 19 June 1986, ♂ on *Lotus corniculatus* and 5 July 1986, ♂ on *Rosa* sp. and 4 Aug. 1985, ♀.

IV. Feldereralm (1650 m) 6 July 1986, ♀ on *Lotus corniculatus*.

65. *Megachile willoughbiella* (KIRBY, 1802)

III. Bucheben 12 July 1984, ♂ on *Lotus corniculatus*. Steinalm 4 July 1985, ♀ on *Lotus corniculatus*.

66. *Megachile nigriventris* SCHENCK, 1867/1868

III. Bucheben 25 June 1986, 3 ♀♀ and ♂ on *Anthylis vulneraria* ssp. *alpestris*, *Lathyrus pratensis* and *Lupinus* sp. and 1 July 1985, ♀ and 12 and 21 July 1984, 9 ♀♀ and 2 ♂♂ on *Rosa* sp., *Lotus corniculatus*, *Anthylis vulneraria* ssp. *alpestris* and *Lupinus* sp. Raurisertal (1200 m) 25 July 1984, 2 ♀♀ and ♂ on *Lotus corniculatus*; Seidlwinkltal (1400 m) 23 July 1984, ♀ on *Anthylis vulneraria* ssp. *alpestris*; Steinalm (1250 m) 6 July 1986, ♂; Kitzsteinalm (1300 m) 1 July 1986, 4 ♀♀ and ♂ on *Lotus corniculatus*; Badgastein (1100 m) 27 June 1986, ♀ and (1200 m) 3 Aug. 1987, ♀ on *Lathyrus pratensis* leg. A. KOSIOR; Kötschachtal 25 and 30 June 1986, 5 ♀♀ on *Lupinus* sp. and *Vicia* sp.; Belevue-Alm 29 June 1986, ♀ on *Lupinus* sp.; Obere Wetzalm above Badgastein (1350 m) 28 June 1986, 2 ♀♀ and 3 ♂♂ on *Lotus corniculatus*.

67. *Megachile alpicola* ALFKEN, 1924

I. Kötschachtal 23 June 1984, ♂ on *Knautia arvensis* and 24 July 1985, ♀.

III. Steinalm (1150 m) 4 Aug. 1985, ♀ on *Centaurea* sp.; Fröstllehen (1400 m) 15 July 1986, ♀ on *Leontodon*.

68. *Osmia rufa* (LINNAEUS, 1758)

II. Fuschtal (800 m) 19 May 1987, ♂ on *Prunus padus*.

III. Bucheben 10 June 1984, ♂ and 12 July 1984, 2 ♀♀ on *Lotus corniculatus*; Böckstein 9 May 1987, ♂ on *Salix* sp.

69. *Osmia mustelina* GERSTAECKER, 1869

III. Bucheben 26 May 1986, 2 ♀♀ on *Lotus corniculatus* and 15 June 1986, ♀.

70. *Osmia nigriventris* (ZETTERSTEDT, 1838)

III. Bei Gestein (probably Badgastein) 12 specimens (GIRAUD 1861); Bucheben 25 June 1986, ♀ on *Lotus corniculatus*; Steinalm (1250 m) 26 May 1986, ♀ and (1400 m) 7 June 1986, 2 ♀♀ on *Hipochoeris uniflora*; Seidlwinkltal 23 July 1984, ♀ on *Rhododendron hirsutum*; Kitzsteinalm (1300 m) 20 June 1984, ♀ on *Lotus corniculatus*.

71. *Osmia uncinata* GERSTÄCKER, 1869

III. Kitzsteinalm (1300 m) 20 June 1984, 2 ♀♀ on *Lotus corniculatus* and *Leontodon* sp.; Karalm 11 June 1986, 2 ♀♀ on *Lotus corniculatus*.

IV. Steineralm (1600 m) 27 June 1984, ♂ on *Vaccinium myrtillus*; Feldereralm (1650 m) 6 July 1986, ♀ on *Lotus corniculatus*.

V. Glocknerhaus (2000 m) 15 July 1986, 2 ♀♀ on *Lotus corniculatus*.

72. *Osmia tuberculata* NYLANDER, 1852

III. "bains de Gastein" (GIRAUD 1861)

73. *Osmia robusta* (NYLANDER, 1848)

III. "dans les montages de Gestein" (GIRAUD 1861)

74. *Osmia lepeletieri* PÉREZ, 1879

I. Gaisbachtal 13 and 27 June 1987, 3 ♀♀ on *Echium vulgare*.

III. Bucheben 27 June 1984, ♀.

75. *Osmia adunca* (PANZER, 1798)

I. Gaisbachtal (980 m) 13 and 19 July 1984, 14 ♀♀ and 4 ♂♂ on *Echium vulgare* and 7 Aug. 1986 (1035 m), ♀ on *Echium vulgare* leg. A. KOSIOR; Kötschachtal 24 July 1985, 2 ♀♀ and 2 ♂♂.

76. *Osmia leaiana* (KIRBY, 1802)

I. Kötschachtal 16 June 1986, ♀ on *Taraxacum* sp. and 24 July 1985, 2 ♀♀.

II. Rauris (950 m) 13 July 1984, ♀ on *Calendula officinalis*.

III. Bucheben 10 June 1984, ♂ and 12 July 1984, ♀ on *Lathyrus pratensis*.

77. *Osmia coerulescens* (LINNAEUS, 1758)

II. Rauris 13 July 1984, ♀ on *Lamium maculatum*.

III. Bucheben 10 June 1984, ♀ and ♂ 26 May 1986, ♀ and 2 ♂♂.

78. *Osmia aurilenta* (PANZER, 1799)

I. Rauriserhöhe (978 m) 15 May 1986, ♀ on *Lotus corniculatus*; Kötschachtal 10 May 1986, ♂ on *Taraxacum* sp.

III. Bucheben 20 May 1986, ♂.

79. *Osmia parietina* CURTIS, 1828

III. Bucheben 20 May 1986, ♀ and 11 June 1986, ♀ on *Lotus corniculatus* and 25 June 1986, ♀ on *Lotus corniculatus*; Raurisertal (1200 m) 7 June 1985, ♀ on *Taraxacum* sp. and 20 June 1986, 2 ♀♀ on *Lotus corniculatus*; Steinalm (1300-1400 m) 20 May 1986, 2 ♂♂ on *Dryas octopetala* and 27 June 1984, ♂ on *Vaccinium myrtillus*; Fröstllehen (1300-1400 m) 1 July 1984, ♀.

80. *Osmia villosa* (SCHENCK, 1853)

I. Kötschachtal 30 June 1986, ♀ and 24 July 1985, ♀.

III. Bucheben 19 and 25 June 1986, 2 ♀♀ on *Phyteuma* sp. and 10 July 1986, ♀; Rauriserta1 (1200 m) 20 June 1986, ♀ on *Lotus corniculatus*.

IV. Gamskarkogel slope (1850 m) 22 July 1986, ♀ on *Leontodon hispidus* leg. A. KOSIOR; Grubereck southern slope (1820 m) 4 Aug. 1986, ♀ leg. A. KOSIOR.

81. *Stelis phaeoptera* (KIRBY, 1802)

I. Kötschachtal 24 July 1985, 2 ♀♀.

III. Steinalm (1200 m) 5 July 1986, 2 ♀♀ on *Rosa* sp.

82. *Stelis minuta* LEPELETIER a. SERVILLE, 1825

I. Kötschachtal 24 July 1985, ♀.

Anthophoridae

83. *Nomada marshalella* (KIRBY, 1802)

I. Rauriserhöhe 2 May 1986, ♂ on *Salix* sp.; Kötschachtal 10 June 1984, 2 ♀♀.

II. Fuschtal (800 m) 19 May 1987, ♂ on *Prunus padus*.

III. Bucheben 19 May 1986, ♀ on *Prunus padus* and ♀ on *Berberis vulgaris*.

84. *Nomada obtusifrons* NYLANDER, 1848

I. Kötschachtal 24 July 1985, ♀.

III. Steinalm 5 July 1986, ♀.

85. *Nomada braunsiana* SCHMIEDEKNECHT, 1882

III. Bucheben 12 July 1984, ♂.

86. *Nomada rhenana* F. MOTAWITZ, 1872

III. Bucheben 19 June 1986, ♂ on *Frangula alnus*.

87. *Nomada flava* PANZER, 1798

III. Bucheben 13 May 1986, ♂ on *Salix* sp.

88. *Nomada panzeri* LEPELETIER, 1841

I. Rauriserhöhe 2 May 1986, ♀ and ♂ on *Salix* sp.

III. Seidlwinkltal 14 June 1984, ♀; Bucheben 15-16 June 1986, ♀ and 3 ♂♂; Steinalm 27 June 1984, ♀; Förstllehen 1 July 1984, ♀; Karalm 11 June 1986, 4 ♀♀ on *Lotus corniculatus*; Krumltal 12 June 1986, ♀ on *Taraxacum officinale*; Ferlaitental 27 May 1986, ♀ on *Taraxacum* sp.

V. Southern slope of Margritze (1850-1950 m) 7 July 1937 (FRANZ 1943); Senfleben (1900 m) between "Guttal and Pallik" 15 July 1940, ♀ (FRANZ 1943).

89. *Nomada bifida* THOMSON, 1782

I. Rauriserhöhe 2 May 1986, ♂; Kötschachtal 16 May 1986, ♀.

III. Bucheben 4 and 8 May 1986, 3 ♂♂ on *Salix* sp.

90. *Nomada flavoguttata* (KIRBY, 1802)

III. Bucheben 2 May 1986, ♂ on *Taraxacum* sp. Förstllehen 1 July 1984, ♀ on *Potentilla erecta*. Karalm 12 June 1986, ♀ on *Lotus corniculatus*.

91. *Nomada fabriciana* (LINNAEUS, 1767)

I. Kötschachtal 2 May 1987, ♀ and ♂.

92. *Nomada succincta* PANZER, 1798

III. Bucheben 19 May 1988, ♂ on *Prunus* sp.

93. *Anthophora acervorum* (LINNAEUS, 1758)

II. Rauris 24 May 1987, ♀ on *Primula* sp.

94. *Anthophora quadrimaculata* (PANZER, 1806)

III. Bucheben 1 July 1985, ♀; Raurisertal 25 July 1984, ♀; Förstllehen (1450 m) 18 July 1984, ♂.

95. *Anthophora furcata* (PANZER 1798)

I. Kötschachtal 24-25 July 1985, 2 ♂♂ on *Stachys germanica*.

III. Bucheben 1 July 1985, ♀ and 21 July 1984, ♀ on *Lupinus* sp.

VI. FAUNISTIC ANALYSIS

1. Number of localities found

The number of localities is not the same in particular altitudinal zones distinguished and in the valleys examined (Table II). I had at my disposal data from 62 localities altogether, of which 11 (preceded with the sign "+" in the table) are quoted after the authors mentioned in the Introduction to this paper. The data referring to these 11 sites are given in the list of species.

Table II

The numbers of localities at which I collected *Apoidea* in particular valleys of the Hohe Tauern and in successive altitudinal zones

Valley	Altitudinal zone						Total
	I	II	III	IV	V	VI	
Fusch	1	2	1		1+6	+1	12
Rauris	2	3	13+1	9	2		30
Gastein	1	3+1	6	4+1	5		21
Total	4	9	21	14	14	1	63

The number of localities in Zone I is restricted to places – given by GAMS (1936) – with a relict steppe flora. That flora was found on the west-facing slopes above Hof Gastein in the Gastein Valley, on the Rauriserhöhe, situated at the ledge of the hanging of the Rauris Valley and in the Geibachtal near Rauris. In the Fusch Valley such a locality was spotted on the western slopes above Fusch. Owing to their microclimatic conditions the western exposure of the sites in the Gastein and Fusch Valleys is unfavourable to the *Apoidea* (DYLEWSKA 1991). It was therefore necessary to seek some nearly south- or nearly south-facing places with appropriate vagatation. I found places in the Kötschachtal, by the path leading to the Pöserhöhe and at Bad Fusch. The sites of Zone I lay between 950 and 1100 m a.s.l.

The small number of localities (8) discovered in Zone II and so at altitudes from 700 to 1000 m might erroneously suggest poor penetration of the area. This zone includes mainly the bottoms of the lower sections of the valleys and the bases of the surrounding elevations. The search of Zone II allowed me to find only a small number of localities. Striking was the lack of insects in the luxuriantly blooming meadows and, above all, the virtually complete lack of the genera *Bombus* and *Psithyrus* (chiefly in the Gastein Valley), and the poor emergence of *Andrena humilis* in all the valleys examined, although *Taraxacum* sp. was in rich bloom. It was particularly difficult to find sites with late-spring and summer faunas in this zone.

The largest number of localities (21) were discovered in Zone III, 13 of them in the Rauris Valley. Fourteen localities were found in Zone IV and, just as in Zone III, most of them (10) in the surroundings of the Rauris Valley; the remaining localities were in the region of the Gastein Valley. For a number of localities (6) in Zone V I am indebted to a study made by FRANZ (1943, 1949) at the Glocknerstrasse. Besides, I found 5 localities above the Gastein Valley and near Sportgastein in the Sieglitz Valley; the other localities were on the slopes in the region of the Rauris Valley and in the Grossglockner Massif, close to the "Glocknerstrasse". Altogether I had at my disposal 14 localities in the subalpine tier and one in the alpine zone.

2. Specific Composition in Particular Altitudinal Zones

I present list of species collected and the numbers of individuals in Table III. The sites at which they have been taken in the altitudinal zones are also given. The table shows that

Table III

The number of localities (l) and specimens (spm) of the early- and late-spring and summer *Apoidea* (except *Apidae*) collected in the altitudinal zones (I to VI) distinguished on the northern slopes of the Hohe Tauern

No	Species	I		II		III		IV		V		VI		Total	
		l	spm	l	spm	l	spm	l	spm	l	spm	l	spm	l	spm
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
	early-spring species														
1	*H. rubicundus*	2	2	4	13	4	50	2	3					12	68
2	*L. laevigatum*	1	3			1	2							2	5
3	*L. calceatum*	2	33	4	35	10	38	1	2	1	3			18	111
4	*L. albipes*	2	14	4	28	10	114	1	2	2	5			19	163
5	*L. fulvicorne*	2	8	2	3	5	45							9	56
6	*L. subfulvicorne*	2	13	2	3	6	25	3	4					13	45
7	*L. fratellum*	2	39	3	13	11	56	2	4	2	2			21	114
8	*L. laticeps*			1	3	2	5							3	5
9	*L. morio*			1	1	1	1							2	2
10	*L. leucopus*			2	4	1	1							3	5
11	*L. rufitarse*	2	2	3	3	3	6							8	11
12	*A. tibialis*	1	5	2	3	6	31	1	1					10	40
13	*A. haemorrhoa*	3	86	4	26	11	222	2	23	1	8			21	365
14	*A. gravida*	1	1											1	1
15	*A. cineraria*	2	6											2	6
16	*A. thoracica*					1	2							1	2
17	*A. nigroaenea*	1	2	1	1	2	4	1	1					5	8
18	*A. barbilabris*	1	6	2	5	4	7	1	1					7	19
19	*A. semilaevis*	2	2	1	1	5	7							8	10
20	*A. subopaca*			2	3	6	14	4	8					12	26
21	*A. falsifica*	1	1	1	1	3	21							5	23
22	*A. lapponica*	1	4	1	2	5	5	5	9	2	5			14	25
23	*A. helvola*	1	4	1	1	6	60							8	65
24	*A. clarkella*	1	1	1	6	5	13							7	20
25	*A. praecox*	4	49	2	5	7	62							11	116
26	*A. apicata*	2	4	3	2	2	17							7	23
27	*A. rogenhofferi*					6	19	7	10	2	6	1	1	13	36

Table III ctd.

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
28	*A. jakobi*			1	1	3	16	1	1					5	18
29	*A. bicolor*	2	6	5	7	5	14	1	1					13	28
30	*A. ruficrus*	1	1	2	5	6	16	1	14	1	3			10	39
31	*O. rufa*			1	1	2	4							3	5
32	*O. uncinata*					2	4	2	2	1	2			5	8
33	*N. marshamella*	2	3	1	1	1	2							4	6
34	*N. flava*					1	1							1	1
35	*N. panzeri*	1	2			6	13			2	2			9	17
36	*N. bifida*	2	2			1	3							3	5
37	*N. flavoguttata*					3	3							3	3
38	*N. fabriciana*	1	2											1	2
39	*N. succincta*					1	1							1	1
40	*A. acervorum*			1	1									1	1
41	*Sph. monilicornis*					2	2							2	2
42	*Sph. ferruginatus*					2	4							2	4
	late-spring species														
43	*H. communis*	1	1											1	1
44	*H. hyalinatus*					2	5							2	5
45	*L. tumulorum*	1	1											1	1
46	*L. leucozonium*			1	1									1	1
47	*L. zonulum*			1	1									1	1
48	*L. costulatum*					1	1							1	1
49	*L. cupromicans tirolense*					2	3							2	3
50	*L. bavaricum*			1	2	2	3	2	2					5	7
51	*L. alpigenum*			1	1	1	1							2	2
52	*D. alpina*					2	2	1	2	1	1			4	5
53	*D. paradoxa*							1	2	3	5			4	7
54	*A. ovatula*	1	1			2	2			1	1			4	4
55	*A. similis*	1	1			1	1							2	2
56	*A. lathyri*					1	1							1	1
57	*A. intermedia*	1	1	1	1	10	225	1	4	1	4			14	235
58	*A. fucata*					2	3							2	3
59	*A. humulis*	1	1	1	2	4	15							6	18
60	*P. montanus*					9	37	4	94	5	15			18	146
61	*Ch. nigricorne*			1	1	2	15							3	16

Table III ctd.

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
62	*Ch. maxillosum*					3	60							3	60
63	*Ch. grande*	1	2			6	39							7	41
64	*O. mustellina*					1	3							1	3
65	*O. nigriventris*					3	18							3	18
66	*O. leaiana*	1	3	1	1	1	2							3	6
67	*O. cerulescens*			1	1	1	5							2	6
68	*O. aurilenta*	2	2			1	1							3	3
69	*O. tuberculata*					1	1							1	1
70	*O. parietina*					4	10							4	10
71	*O. robusta*					1	2							1	2
72	*O. villosa*	1	2			2	4	2	2					5	8
73	*M. nigriventris*					9	39							9	39
74	*A. montanum*					2	6							2	6
75	*N. rhenana*					1	1							1	1
76	*N. braunsiana*					1	1							1	1
	summer species														
77	*H. difformis*	1	1			1	1							2	2
78	*D. dentiventris*	1	1			1	1							2	2
79	*A. hattorfiana*	2	8			4	7							6	15
80	*A. denticulata*	1	1			2	2							3	3
81	*A. coitana*	1	9			6	30	3	6	1	2			11	47
82	*P. banksianus*	1	1			3	42	2	4					5	47
83	*A. manicatum*	1	6											1	6
84	*T. byssina*					1	9							1	9
85	*St. minuta*	1	1											1	1
86	*St. phaeoptera*	2	2			1	2							2	4
87	*Ch. florisomne*	1	1											1	1
88	*O. adunca*	2	23											2	23
89	*O. lepeletieri*	1	2			1	1							2	3
90	*M. circumcincta*					3	32	1	1					4	33
91	*M. willoughbiella*					2	2							2	2
92	*M. alpicola*	1	2			2	2							3	4
93	*N. obtusifrons*	1	1			1	1							2	2
94	*A. quadrimaculata*					3	3							3	3
95	*A. furcata*	1	2			1	2							2	4

in Zone I I caught 8 species which do not occur in the higher zones. These species are: *Andrena cineraria*, *Nomada fabriciana*, *Hylaeus communis*, *Lasioglossum tumulorum*, *Stelis minuta*, *Anthidium manicatum*, *Chelostoma florisomne* and *Osmia adunca*. *Lasioglossum zonulum*, *L. costulatum* and *Anthophora acervorum* have been found exclusively in Zone II. The upper boundaries of the altitudinal distribution of 20 early-spring, 23 late-spring and 12 summer species in all probability lie in Zone III. At least 18 early-spring, 7 late-spring and 3 summer species (*Panurgus banksianus*, *Andrena coitana* and *Megachile circumcincta*) live in Zone IV (upper montane tier). In Zone V (subalpine tier) I gathered 10 early-spring, 5 late-spring and one summer species (*Andrena coitana*) and only the early-sprig species *Andrena rogenhofferi* was found in Zone VI.

A total of 95 apoidean species (except *Apidae*) have been found on the northern slopes of the Hohe Tauern, including 42 early-spring, 34 late-spring and 19 summer species. All these species (95) were presented in the upper montane tier, 25 were found in Zone IV 15 in Zone V and one species in Zone VI.

In Table IV I have also presented the numbers and percentages of species from particular phenological groups in the altitudinal zones. A comparison of the data concerning Zones I and II with those for Zone III, which is considerably less devastated, shows that the percentages of late-spring and summer species are – especially in Zone II – underestimated. On the other hand, it can be seen from the comparison of the percentages of particular phenological groups in the altitudal zones that the proportion of early-spring species increases above Zone III and that of late-spring species grows from Zone I to Zone V, the largest number of these species occurring in Zone III. The percentage of summer species, compared with the other phenological groups, is the lowest and falls with increasing altitudes (from about 28 to 7% in Zone V).

Table IV

The number of species (sp) and specimens (spm) of the early-, late-spring and summer *Apoidea* (except *Apidae*) collected in the altitudinal zones (I-VI) distinguished on the northern slopes of the Hohe Tauern (recapitulation of the Table III)

Species	I		II		III		IV		V		VI		Total	
	sp	%	sp	%	sp	%	sp	%	sp	%	sp	%	sp	%
early spring	27	52.8	28	77.8	38	46.3	16	64.0	9	60.0	1	100.0	42	100.0
late spring	10	18.9	8	22.2	29	35.3	6	24.0	5	33.3	–	–	34	100.0
summer	15	28.3	–	–	15	18.4	3	12.0	1	6.7	–	–	19	100.0
total	52	100.0	36	100.0	82	100.0	25	100.0	15	100.0	1	100.0	95	100.0
specimens	spm	%	spm	%	spm	%	spm	%	spm	%	spm	%	spm	%
early spring	301	79.8	178	94.2	910	58.5	86	43.0	36	56.8	1	100.0	1512	100.0
late spring	15	4.0	11	5.8	506	32.7	106	51.6	26	40.1	–	–	664	100.0
summer	61	16.2	–	–	137	8.8	11	5.4	2	3.1	–	–	211	100.0
total	377	100.0	189	100.0	1553	100.0	203	100.0	64	100.0	1	100.0	2387	100.0

Table V

The mean numbers of *Apoidea* species falling to one locality (sp/l) in successive seasons and altitudinal zones in the Hohe Tauern

Seasons	Altitudinal zone					
	I	II	III	IV	V	VI
early spring	6.7	3.1	1.8	1.1	0.6	1
late spring	2.5	0.9	1.4	0.4	0.4	
summer	3.7		0.7	0.2	0.1	
total	13.0	4.0	3.9	1.8	1.1	1

Table V gives the mean numbers of species per locality in particular altitudinal zones for the total of species found and for individual phenological groups. The calculation of such means was expedient, because the numbers of localities in particular zones distinguished differ considerably. These means indicate a wealth of localities in Zone I and its gradual dwindling as the altitude increases, the reduction of late-spring and summer species being pronounced in Zone II.

Percentage decreasses between Zones III and IV and between Zones IV and V in the numbers of species and individuals collected is given in the Table VII, in which they are shown for absolute numbers of species collected and for the above-discussed mean numbers of species per locality (Table VII). Table VII shows that the percentage decrease calculated on the basis of the total number of species differs from the corresponding results obtained for particular phenological groups. The percentage decrease at the boundary between Zones III and IV is about 70% for the total of species and, respectively, 58, 75 and 82% for individual phenological groups. On the other hand, the percentage fall calculated on the basis of the mean numbers of species per site (Table VIII) is distinctly lower for the total of species (54%) and early-spring species (39%), while in the case of the late-spring and summer species these differences are smaller (by about 8%). The percentage fall at the boundary between zones IV and V (Tables VII and VIII) is distinctly smaller than that between Zones III and IV, the late-spring species showing a specially small percentage fall.

The foregoing analyses indicate that between Zones III and IV there is a clear faunistic boundary, which concerns the early-spring species in smaller measure and the late-spring and summer species to a very considerable extent. A further conspicuous fall in the number

Table VI

The mean numbers of apoidean specimens falling to one locality (spm/l) in successive seasons and altitudinal zones in the Hohe Tauern

Seasons	Altitudinal zone					
	I	II	III	IV	V	VI
early spring	75.2	19.8	43.3	6.1	2.6	1
late spring	3.8	1.2	24.2	7.5	1.9	
summer	15.5		6.5	0.8	0.1	
total	94.5	21.0	74.1	14.4	4.6	1

Table VII

A fall in the numbers of all the species and specimens of the *Apoidea* collected, between altitudinal Zones III and IV as well as IV and V in the Hohe Tauern, expressed in percentages, for the phenological groups distinguished

Phenological groups	Species		Specimens	
	III/IV	IV/V	III/IV	IV/V
early spring	57.9	43.8	90.5	58.1
late spring	79.3	16.7	79.4	75.2
summer	80.0	66.7	92.0	81.8
total	69.5	69.5	87.0	68.3

of species takes places between Zones IV and V; that is above all true of the early-spring and summer species and to a much smaller degree the late-spring species. The distribution of all the *Apoidea* species (excludind *Apidae*) except for one early-spring species most probably reaches its verge in Zone V.

3. Numbers of Specimens Collected

A total of 2387 *Apoidea* specimens (excepting *Apidae*) have been taken into consideration in the present study. This number comprises about 30 specimens given after other authors (see Introduction and List of Species). If the data from literature did not contain information about the number of specimens, I assumed that the author had one individual at this disposal. In consequence, my material consisted of 1512 specimens of the early-spring group, 664 of the late-spring group and 211 of the summer group.

The numbers of specimens caught and the percentages of particular phenological groups in the altitudinal zones are tabulated in Table IV. As can be seen from this table, the numbers of specimens collected in Zones I and II are distinctly lower than the numbers of specimens obtained from Zone III; they are, respectively, 377, 189 and 1553. The percentage differences between the numbers of specimens collected on Zones I-III are much greater than those between the numbers of species (52, 36, 82). There is also a

Table VIII

A fall in the mean numbers of species and specimens of the *Apoidea* falling to one locality (sp/l and spm/l) between altitudinal Zones III and IV as well as IV and V in the Hohe Tauern, expressed in percentages, for the phenological groups distinguished

Phenological groups	Species		Specimens	
	III/IV	IV/V	III/IV	IV/V
early spring	38.9	45.5	85.9	57.4
late spring	71.4	0.0	69.0	74.7
summer	71.4	50.0	87.7	87.5
total	53.8	38.9	80.6	87.8

noticeable fall in numbers between Zones III and IV and between IV and V. The percentage share of particular phenomenological groups varies with the altitudinal zone. In Zones I and II the percentages of late-spring and summer species are clearly underestimated, which brings out the high proportion of early-spring species. The percentage of summer species in Zones III-V shows a distinct fall from about 9 to 3.1%. The percentage of early-spring species in Zone III-IV keeps up approximately at the same level, with a drop in Zone IV. Starting from Zone III, the late-spring species show a remarkable increase in the percentage of specimens (in Zone IV by about 20%) and their high proportion (40%) in Zone V.

Table VI gives the mean numbers of specimens falling to one locality for particular phenological groups and for the total of specimens collected. Zones I and III appear the richest in bees, whereas Zone II is visibly poorer and most specimens caught at one locality in it belong to the early-spring species at that. From 95 to 1 specimens/locality were taken in Zones I-IV. There is a dramatic fall in numbers above Zone III.

Tables VII and VIII show the percentage fall between Zones III and IV and between IV and V, calculated from the absolute numbers of species and specimens collected and the mean numbers and specimens falling to one locality. These tables suggest that there are differences in the results computed on the two above-presented bases, but these results prove quite clearly that the quantitative decline between Zones III and IV is considerably greater than the percentage fall in the number of species. This is also true of the early-spring species (to about 90%). The smallest fall in the number of specimens is shown by the late-spring species (79%). The percentage fall in the numbers of specimens between Zones IV and V is also much greater than that in the number of species.

4. The Species Composition and Numbers of the *Apoidea* in Particular Valleys and Their Surroundings

I found 83 species (38 early-spring, 29 late-spring and 16 summer ones) in the Rauris Valley, 69 species (respectively, 34, 21 and 14) in the Gastein Valley and 25 species (21, 3 and 1) in the Fusch Valley. About 8, 4 and 2 species fall to one locality in particular valleys. Therefore, in the Rauris Valley and its surroundings not only I collected the largest number of species but also the localities in this valley were the richest in species.

The numbers of specimens of particular phenological groups in the valleys explored are as follows: in the Rauris Valley I caught 1085 specimens of the early-spring group, 510 late-spring specimens and 166 summer ones, in the Gastein Valley , respectively, 351, 137 and 42 specimens and in the Fusch Valley 84, 10 and 2 specimens. On the average, 56, 25, and 7.4 specimens fall to one locality in the successive valleys. As a result, the Rauris Valley has not only the highest number of specimens collected but also the highest number of specimens falling to one locality.

5. The Numbers and Frequencies of Species Collected in the Hohe Tauern

The numbers of collected specimens belonging to particular species range from 1 to 365. The individual species were found at 1 to 21 localities (altogether there were 63 localities). The species represented by 8 to 365 specimens collected by me are classified as "abundant" and they are qualified as "frequent" if present at 8 to 21 localities.

In Table IX I have listed the abundant species in order of number of specimens found, number of localities, and spm/locality index (ratio of the number of specimens collected

Table IX

A division of the *Apoidea* species collected in the Hohe Tauern into groups on the basis of specimens caught (spm), localities (l) and the mean numbers of specimens falling to one locality (spm/l)

No.	Species	spm	l	spm/l	%	Groups of species
1	*A. haemorrhoa*	365	21	17.4		very abundant and
2	*A. intermedia*	235	14	16.8		very frequent species
3	*L. albipes*	163	19	8.6		
4	*P. montanus*	146	18	18.1	7.4	
5	*A. praecox*	116	11	10.6		(common species)
6	*L. fratellum*	114	21	5.4		
7	*L. calceatum*	111	18	6.2		
8	*H. rubicundus*	68	12	5.8		abundant and
9	*A. helvola*	65	8	8.1		very frequent species
10	*L. fulvicorne*	56	9	6.2	4.2	(very frequent species)
11	*Ch. grande*	41	7	5.9		
12	*L. subfulvicorne*	45	13	3.5		abundant and
13	*A. coitana*	47	11	4.3		frequent species
14	*A. tibialis*	40	10	4.0		
15	*A. ruficrus*	39	10	3.9		(frequent species)
16	*M. nigriventris*	39	9	4.3		
17	*A. rogenhofferi*	36	13	2.8		
18	*A. bicolor*	28	13	2.1	12.6	
19	*A. subopaca*	26	12	3.0		
20	*A. lapponica*	25	14	1.8		
21	*N. panzeri*	17	9	1.9		
22	*L. fulvitarse*	11	8	1.4		
23	*A. semilaevis*	10	8	1.3		
24	*A. apicata*	23	7	3.3		abundant but
25	*A. falsifica*	23	5	4.6		unfrequent species
26	*A. clarkella*	20	7	2.9		
27	*A. barbilabris*	19	7	2.7		
28	*A. humilis*	18	6	3.0	8.4	
29	*A. jakobi*	18	5	3.6		(unfrequent species)
30	*A. hattorfiana*	15	6	3.2		
31	*O. parietina*	10	4	2.5		
32	*Ch. maxillosum*	60	3	20.0		abundant but
33	*P. banksianus*	47	5	9.4		very unfrequent species
34	*M. circumcincta*	33	4	8.2		
35	*O. adunca*	23	2	11.5	7.4	
36	*O. nigriventris*	18	3	6.0		(local species)
37	*Ch. nigricorne*	16	3	5.3		
38	*T. byssina*	9	1	9.0		
39-95	see Table III	1-8	1-5	1-3	60.0	not numerous and very unfrequent species (sporadical species)

to the number of sites). Species whose 1-8 specimens have been taken are regarded as not numerous and placed all together at the end of the list. They are 57 in number and form 60% of all the species in the Hohe Tauern.

In the table under discussion I have divided the abundant species into several groups in respect of the number of specimens collected, that of localities and the spm/locality ratio. These groups of species are as follows:

1) Very abundant and very frequent or common species distinguished on the basis of more than 100 specimens at 11 to 21 localities. The spm/locality ratio for these species exceeds 5.0, ranging from 5.4 to 18.1.

2) Abundant and very frequent or very frequent species are those occurring in numbers from 41 to 68 specimens at 7 to 12 localities. Like the common species the species of this group are characterized by the spm/locality ratio higher than 5. In this group I have exceptionally desisted from the established number of localities for frequent species (8) and included a species present at 7 localities because of its high spm/localty ratio reaching 5.9.

3) Species whose specimens I gathered in numbers of 10 to 47 at 8 to 14 localities are classified as abundant and frequent or frequent. The spm/locality ratio in this group is below 5, ranging from 1.4 to 4.3.

4) Abundant and rare or rare species have 10 to 23 specimens at 4 to 7 localities. Spm/locality ratio, as in the preceding group, is below 5 and ranges from 2.5 to 4.6.

5) Abundant and very rare or local species are those whose 9 to 60 specimens were collected for the most part at 1-3 localities. They are characterized by a high spm/locality ratio (above 5), ranging from 5.3 to 20.0. I found 2 species at 5 and 4 localities and in spite of this I place them in this group for their high spm/locality ratios.

The not numerous species (57) are characterized by small number of specimens (1-8) and of localities (1-5) in which they occurred and a low spm/locality ratio (1-3). I qualified them as not numerous and very rare or sporadic. They make the largest group of species recorded from the Hohe Tauern. Some other species that may still be found in this area will have to be numbered among these sporadic species.

The division of species here applied resemples that used by DOBROWOLSKI (1963) and TOMIAŁOJĆ (1990) for birds and PAWŁOWSKI (1967) for the *Coleoptera*, but is based not only on the numbers of specimens and localities, as it is in the above-mentioned authors, but also on the spm/locality ratio.

Most of the species placed in the first three groups are early-spring species. On the other hand, the very rare species belong nearly exclusively to the family *Megachilidae*, characterized by very high thermal requirements.

The division of species used by me is applicable exclusively in the lower montane tier and refers to all species but *P. montanus*, *A. rogenhofferi*, *D. alpina* and *D. paradoxa*, distributed from 1100 to 2150 m or still higher. It is so because *P. montanus* is a frequent species in the lower montane tier and a common one in higher zones, whereas *D. alpina* is sporadic species in all the zones in which it was met with (see Table III). I detected *D. paradoxa* (sporadic species) only in Zones IV and V. The remaining species known from the upper montane tier and from higher zones, here included in the groups of common (5), frequent (7), rare (2), very rare (1) and sporadic (6) species, are sporadic or very rare in higher regions (*A. haemorrhea, A. lapponica, A. ruficrus*).

VII. ZOOGEOGRAPHICAL ANALYSIS

1. Zoogeographical elements[1]

14 groups of zoogeographical elements were found on the northern slopes of the Hohe Tauern:

1) 4 Holarctic species (4.2%) : *H. rubicundus, L. zonulum, L. leucozonium, A. clarkella*

2) 11 Palearctic species (11.6%): *L. calceatum, L. albipes, L. tumulorum, A. haemorhhoa, A. cineraria, A. ovatula, A. humilis, A. thoracica, O. rufa, St. minuta, N. flavoguttata*

3) 18 West Palearctic species (18.9%): *H. communis, H. difformis, L. laticeps, L. morio, L. leucopum, L. costulatum, L. laevigatum, L. fulvicorne, L. subfulvicorne, Sph. monilicornis, A. hattorfiana, A. nigroaenea, A. bicolor, St. phaeoptera, A. manicatum, Ch. florisomne, O. caerulescens, A. acervorum*

4) 20 European species (21.1%): *H. hyalinatus, Sph. ferruginatus, A. apicata, A. similis, A. lathyri, A. intermedia, Ch. maxillosum, Ch. nigricorne, M. willoughbiella, O. uncinata, O. leaiana, T. byssina, N. flava, N. panzeri, N. bifida, N. marshamella, N. fabriciana, A. quadrimaculata, A. furcata*

5) 5 European-Caucasian species (5.3%): *A. fasifica, A. helvola, A. fucata, A. praecox, A. jakobi*

6) 6 European-Siberian species (6.3%): *A. tibialis, A. barbilabris, A. subopaca, A. denticulata, A. coitana, N. obtusifrons*

7) 4 North-Central European species (4.2%): *A. semilaevis, P. banksianus, M. circumcineta, O. parietina*

8) 9 Boreo Montane species (9.4%): *D. dentiventris, A. lapponica, A. ruficrus, L. rufitarse, L. fratellum* (Holarctic), *M. nigriventris, M. alpicola, O. tuberculata, O. nigriventris*

9) 5 Montane[2] species (5.3%): *L. cupromicans tirolense, L. bavaricum, A. montanum, O. villosa, O. lepeletieri*

10) 3 High Montane species (3.2%): *P. montanus, D. paradoxa paradoxa, D. alpina*

11) 3 Alpine species (3.2%): *L. alpigenum, Ch. grande, O. robusta*

12) 1 High Alpine species (1%): *A. rogenhofferi*

13) 1 Submediterranean species (1.1%): *O. adunca*

14) 6 South Central European species (6.3%): *A. gravida, O. aurilenta, O. mustellina N. brausiana, N. rhenana, N. succincta.*

---

[1] Division into elements after DYLEWSKA (1987).

[2] The Montane, High Montane, Alpine and High Alpine elements were distinguished to be used in an analysis of their altitudinal distribution, the Alpine ones being endemites of the Alpes.

2. The Abundance and Altitudinal Distribution of Zoogeographical Elements in the Zones Distinguished

Table X gives the numbers of species and specimens belonging to particular zoogeographical elements in the distinguished altitudinal zones. These elements are arranged in three groups. The first group is composed of widely distributed species, in the second group I included the High Montane, High Alpine, Montane, North Montane, European-Siberian and North Central European species. As can be seen from this table, the most abundant group is that of widely distributed species, with its 58 species (61.1%) and 1599 specimens collected (66.9%). There were 30 species (31.7%) and 755 specimens (31.6%) belonging to the second group of zoogeographical elements, while the third group was represented by the fewest species and specimens, respectively 7 (7.3%) and 33 (1.4%). The mean numbers of specimens falling to 1 species decrease in the same order, being successively 29, 24 and 5.

The specimens most frequently met with on the northern slopes of the Hohe Tauern belonged to the Palearctic (on the average 63 specimens per species), European-Caucasian (45), High Montane (53) and High Alpine (36) species. The least numerous were the South Central European (about 2 specimens per species), Montane (5), West Palearctic (10), and Alpine (15) elements.

On the northern slopes of the Tauern the upper range of the distribution of the elements belonging to the third group reaches 1100 m a.s.l. This refers to the South Central European species, which I caught in Zone I and on the southern slopes of the transversal moraine at Bucheben, whereas the Submediterranean species *Osmia adunca* was taken only in Zone I, namely, in the Geisbachtal near Rauris (950 m) and in the Kötschachtal on the southern slopes (1100 m). In all probability this species occurs also by the road from Hof Gastein to the Kötschachtal where *Echium vulgare* blooms. The highest sites of *Osmia adunca* hitherto known from the northern slopes of the Alps are at an altitude of about 500 m a.s.l. (WESTRICH 1989).

The decrease in the number of species between Zones III and IV is about 72% for widely distributed elements and only 51% in the case of the second group of zoogeographical elements. The decrease in the numbers of specimens from these two groups of elements is respectively, 96 and 61%. On the other hand, the decrease in numbers of species and specimens between Zones IV and V is, respectively, 33 and 35% for the widely distributed species and about 60 and 34% for the species and specimens of the second group.

3. The Abundance and Altitudinal Distribution of the Zoogeographical Elements of Particular Phenological Groups

Table X presents the numbers of species and specimens from particular zoogeographical elements for the early-spring, late-spring and summer groups collected in the zones distinguished. The zoogeographical elements are listed in the three groups discussed above. This table shows that the early-spring group is the richest both in species and specimens collected, for I have caught 31 species and 1191 specimens, but only from the group of widely distributed elements. The second group of zoogeographical elements is considerably poorer, with its 9 species and 319 specimens. The numbers of specimens

Table X

The numbers of species (sp) and specimens of the early- and late-spring *Apoidea*, belonging to the distinguished groups of zoogeographical elements in particular zones in the Hohe Tauern (the plant species arranged in the order of their bursting intoo bloom

Zones		Groups of zoogeographical elements: group A						group B								group C		
		Holarctic	Palearctic	West Palearctic	European	European Caucasian	total	European Siberian	North Central European	North Montane	Montane	High Montane	Alpine	High Alpine	total	Submediterranean	South Central European	total
(1)	(2)	(3)	(4)	(5)	(6))	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)
early spring species																		
I	sp	2	4	5	5	3	19	2	1	4					7		1	1
	spm	3	139	32	13	54	241	11	2	46					59		1	1
II	sp	2	4	8	2	4	20	3	1	4					8			
	spm	19	90	23	3	8	143	11	1	23					35			
III	sp	2	6	9	7	4	28	3	1	4				1	9		1	1
	spm	63	393	89	44	159	748	52	7	83				19	161		1	1
IV	sp	1	3	3	1	1	9	3		3				1	7			
	spm	3	27	6	2	1	39	10		27				10	47			
V	sp		3		2		5			3				1	4			
	spm		16		4		20			10				6	16			
VI	sp													1	1			
	spm													1	1			
total	sp	2	7	10	8	4	31	3	1	4				1	9		1	1
	spm	88	665	150	66	222	1191	84	10	189				36	319		2	2
	spm/sp	44.0	95.0	15.0	8.3	55.5	38.4	28.0	10.0	47.2				36.0	35.4		2.0	2.0
late spring species																		
I	sp		3	1	3		7				1		1		2		1	1
	spm		3	1	5		9				2		2		4		2	2
II	sp	2	1	1	3		7				1		1		2			
	spm	2	2	1	3		8				2		1		3			
III	sp		2	2	7	1	12		1	3	4	2	3		13		4	4
	spm		17	6	309	3	335		10	58	16	39	42		165		6	6
IV	sp				1		1				2	3			5			
	spm				4		4				4	98			102			
V	sp		1		1		2					3			3			
	spm		1		4		5					21			21			
VI	sp																	
	spm																	
total	sp	2	3	3	7	1	16		1	3	4	3	3		14		5	5
	spm	2	23	8	325	3	361		10	58	24	158	45		295		6	6
	spm/sp	1.0	7.7	2.7	46.4	3.0	22.6		10.0	19.3	6.0	52.7	15.0		21.0		1.6	1.6

Table X ctd.

(1)	(2)	(3)	(4)	(5)	(6))	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)
summer species																		
I	sp		1	5	1		7	3	1	2	1				7	1		1
	spm		1	18	2		21	11	1	3	2				17	23		23
II	sp																	
	spm																	
III	sp			3	4		7	3	2	2	1				8			
	spm			10	16		26	33	74	3	1				111			
IV	sp							1	2						3			
	spm							6	5						11			
V	sp							1							1			
	spm							2							2			
VI	sp																	
	spm																	
total	sp		1	5	4		10	3	2	2	1				7	1		1
	spm		1	28	18		47	52	80	6	3				141	23		23
	spm/sp		1.0	5.6	4.5		4.7	17.3	40.0	3.0	3.0				20.1	23.0		23.0
total																		
I	sp	2	8	11	9	3	33	6	2	6	2		1		17	1	2	3
	spm	3	143	51	20	54	271	22	3	49	4		2		80	23	3	26
II	sp	4	5	6	5	4	24	3	1	4	1		1		9			
	spm	21	92	24	6	8	151	11	1	23	2		1		38			
III	sp	2	8	14	18	4	46	6	3	9	5	2	3	1	29		5	5
	spm	63	410	105	369	162	1109	85	91	144	17	39	42	19	437		7	7
IV	sp	1	3	5	2	1	12	4	2	3	2	3		1	14			
	spm	3	27	6	6	1	43	16	5	27	4	98		10	160			
V	sp		4		3		7	1		3		3		1	8			
	spm		17		8		25	2		10		21		6	39			
VI	sp													1	1			
	spm													1	1			
total	sp	4	11	18	19	5	58	6	4	9	5	3	3	1	30	1	6	7
	spm	90	689	186	409	225	1599	136	100	253	27	158	45	36	755	23	10	33
	spm/sp	22.5	62.6	10.3	21.5	45.0	28.5	22.6	25.0	28.1	5.4	52.7	15.0	36.0	25.1	23.0	1.7	4.7

falling on the average to 1 species are similar for both groups of zoogeographical elements, being, respectively, 38 and 35.

Among the early-spring forms captured by me the most numerous were the Palearctic (on the average 95 specimens per species), European-Caucasian (55.5), Holarctic (44), North Montane (47.2), European-Siberian (28) and High Alpine (36) species. The South Central European species were single and their single specimens were caught both early and late in the spring.

Out of the widely distributed early-spring species 65% do not go above Zone III and the fall in their abundance between Zones III and IV is 95%, whereas for the second zoogeographical group these percentages are, respectively, 23 and 72%. Thus, the faunistic boundary of the early-spring species between Zones III and IV concerns the widely distributed species; nevertheless, the percentage fall in abundance is considerable for both these zoogeographical groups. Between Zones IV and V the fall in the number of species of these two groups is, respectively, 40 and 43% and in the number of specimens collected, respectively, 40 and 64%.

The numbers of widely distributed late-spring species and the species included in the second zoogeographical group are similar, for, respectively, 16 and 14 species and 361 and 295 specimens were found; the European species (about 46 specimens per species), which were much less numerous in early-spring (8), and the High Montane ones (53 specimens/species) were the most frequent among them. The remaining zoogeographical elements were less numerous (1-19 specimens).

In this phenological (late-spring) group the presence of all the Alpine and High Montane species and also most Montane species (only one summer species) is noteworthy.

In the group of widely distributed elements the fall of the number of late-spring species between Zones III and IV is considerably greater than in the case of the early-spring forms and it is 81% of the number of species and 93% of their abundances. For the second group of zoogeographical elements this fall in the late-spring species is, respectively, 62 and 40%. I have not found a percentage fall between Zones IV and V for widely distributed species, whereas for the second group of zoogeographical elements it is 40% of the number of species and 79% of that of specimens.

As regards the summer species, there were more specimens taken from the second group of zoogeographical elements than from that of widely distributed species (respectively, 141 and 47), but the number of species found is larger in the group of widely distributed species (10 against 7). The number of specimens falling to one species is therefore higher for the second group of zoogeographical elements, being 20 against 5.

The widely distributed species from the summer group do not generally go beyond Zone III. The only exception is *Megachile circumcineta*, for I found one specimen of this species at an altitude of 1550 m. Out of the second group of zoogeographical elements, *Panurgus banksianus* and *Andrena coitana* occur above Zone III (28% remain within Zone IV). The fall in abundance between Zones III and IV is 87% in this group.

It may be stated that it is mainly the early-spring species that extend above Zone III (19 out of 42) and of the late-spring species, above all, the High Montane elements (3), not many Montane ones (2 out of 4 found) and two wodely distributed forms, whereas of the summer species as rule only the North Central European and European-Siberian ones.

4. High Montane and High Alpine Species

Table X shows that the High Montane and High Alpine species occur only in Zones III (from 1100 m) – VI. On the northern slopes of the Hohe Tauern I recorded 3 High Montane species: *Panurginus montanus* (1100-2100 m), *Duforea alpina* (1200-1820 m) and *D. paradoxa* (1700-2100 m) and one High Alpine species – *Andrena rogenhofferi* (1100-2450 m). According to GUSENLEITNER (1984), *A. rogenhofferi* was reported from altitudes of 1050-2400 m in Austria. Moreover, STOECKHERT (1954) gives *A. rogenhofferi* from altitudes between 540 and 830 m from St. Gilgen near Salzburg. This locality may have been given as a result of a wrong determination or it may be of a relict nature.

The numbers of specimens of the above-mentioned species found in particular altitudinal zones are, respectively, 58, 108, 82 and 1. Hence, it might be inferred that in the upper montane tier these species find optimum conditions for development. However, only *Panurgus montanus* was collected in large numbers of individuals 37, 94 and 15) and so the foregoing inference holds water for this species.

However, we should remove the above-discussed species from our considerations on the fall in the number of species and in the abundance of *Apoidea* with the altitude growing, for only the species distributed at least starting form Zone I upwards and known from still lower sites and from lowland areas should be taken into account in them. In this approach in the case of widely distributed elements (group A) and the elements of the group B in Table X (except high montane and high alpine elements) the fall in the number of early-spring species between Zones III and IV is respectively, 68% and 25%, that of late-spring species 92% and 82% and of summer ones, 100 and 68%. The fall in abundance calculated on the basis of specimens collected from both groups of zoogeographical elements distinguished is for early-spring species, respectively, 93 and 88%, for late-spring species 99 and 97% and for summer ones 100 and 90%. The fall in the number of early-spring species between Zones III and IV is lower than that of late-spring and summer species. The fall in the number of specimens is very high in all groups and higher from the fall in the number of species. The species of the group B of zoogeographical elements are better in montan conditions than the widely distributet species. It is indicated by the falls in the number of species and of speciemens which are lower in the group B than in the group A (widely distributed elements).

VIII. ECOLOGICAL ANALYSIS

1. Influence of Climatic Conditions on Distribution

On the basis of investigations carried out in the Carpathians I pointed out (DYLEWSKA 1966, 1974, 1991) that particular *Apoidea* species nest and appear at flowers in places where they find suitable climatic conditions. In the Carpathian most species live in warmest places and are connected with microclimates; only a few species occur also in cooler places, being connected with the mesoclimate. On the other hand, most bumblebees (*Bombus* LATR., *Apidae*) are connected with the mesoclimate, for they can be met with at the flowers also in cool places. In the Carpathian I found warm places by the north-western walls of woods and in the middle of clearings. Above the tree-line and in deforested areas the surface irregularities – depressions, gullies, cirques, etc. – provide protection on the northern and western sides. In the Hohe Tauern Mts the same principles are decisive of the distribution of the *Apoidea* and their knowledge was necessary in searching for the localities.

The early-spring bees, which emerge at the beginning of climatic spring, have as a rule the lowest thermal requirements. The late-spring bees are generally characterized by higher thermal requirements and they emerge in climatic late spring, whereas the summer bees fly to the flowers starting from the beginning of climatic summer. Where no climatic summer occurs, there are generally no summer bees, either. The same may be stated for the late- and early-spring bees. I found exceptions from this rule in the sub-Tatran region and in the Tatras, namely, single individuals of summer bees and of species having high thermal requirements (e.g. Submediterranean, South Central European) above the upper boundary of climatic summer. I regarded the localities of these species as relict ones. Hence, it was very important to establish the upper boundaries of summer in the climatic sense (about 1200 m) and late spring (about 2100 m) on the northern slopes of the Hohe Tauern (see p. 545).

Above the upper boundary of climatic summer (see list of species) I collected single specimens of the summer species: widely distributed (*Andrena hattorfiana*, *Megachile willoughbiella*, *M. circumcineta* and *Antophora quadrimaculata*), one North Montane species (*Megachile alpicola*) and one European-Siberian (*Andrena denticulata*). In most cases they spread up to 200 m above the upper boundary of summer and so were encountered up to the upper boundary of the lower montane tier. Only one specimen of *M. circumcineta* was taken at an altitude of 1600 m. As in the Tatras, the localities of the avove-mentioned species may be regarded as relict ones, indicating that these bees must have arrived there in a period of milder climate.

I did not find widely-distributed late-spring bees above the upper boundary of the lower montane tier in the Hohe Tauern (all but one *Andrena intermedia*). Instead, I recorded Montane and High Montane bees (altogether 18 species – 19% of all the late-spring bees captured) from the higher montane and subalpine tiers. This might suggest that the upper boundary of climatic summer is also difficult for the late-spring bees to cross. Moreover, in the subalpine tier it is not every year that the climatic conditions correspond with late spring (see p. 512), which must exert an influence upon the reduction of the numbers of the late-spring bees, because there is a decrease in the number of flight days and in that of larval cells started. At any rate it may be claimed on the basis of the investigations made so far that the late-spring bees do not go above the boundary of climatic late spring.

The early-spring bees occur above Zone III (lower montane tier) in considerably larger numbers, as I came upon 25 species (30.5% of those known from Zone III) and only 86 specimens (9.4%) in Zone IV. The distinctly larger number of early-spring species found in Zone IV as compared with the late-spring species (respectively, 6=20.7% and 106=20.9%) may be due to their lower thermal requirements. However, the remarkable fall in abundance shows how difficult this climatic barrier (the boundary of climatic summer) is also for the early-spring species.

The potential tree-line on the nothern slopes of the Hohe Tauern (and so the boundary of the late spring in the climatic sense) is in all probability tha boundary of the altitudinal distribution of all the bees, excluding the *Apidae* and *Andrena rogengofferi*. I caught *A. rogengofferi* at an altitude of about 2100 m also on the northern slopes on a completely overcast day and at a temperature of about 14^{o}C. Therefore this *Andrena* ist most likely associated with the macroclimate, just as are the bumblebees (*Bombus* LATR.).

Table XI

Food plants visited by *Apoidea* species in the lower mountane tier (plant species arranged in the order of their bursting into bloom)

No.	Food plants	Visiting *Apoidea* species	Number of *Apoidea* species	Number of *Apoidea* specimens
(1)	(2)	(3)	(4)	(5)
1	*Salix* sp.	*Lasioglossum laevigatum* (3 ♀♀), *L. calceatum* (30 ♀♀), *L. albipes* (21 ♀♀), *L. fulvicorne* (13 ♀♀), *L. subfulvicorne* (9 ♀♀), *L. fratellum* (20♀♀), *L. rufitarse* (2 ♀♀), *Andrena tibialis* (17 ♀♀ 2 ♂♂), *A. haemorrhoa* (39 ♀♀ 37 ♂♂), *A. gravida* (♀), *A. cineraria* (3 ♀♀ 3 ♂♂), *A. barbilabris* (3 ♀♀), *A. lapponica* (2 ♀♀ 4 ♂♂), *A. helvola* (5 ♀♀ 8 ♂♂), *A. clarkella* (11 ♀♀), *A. praecox* (88 ♀♀ ♂), *A. apicata* (9 ♀♀), *A. rogenhofferi* (2 ♀♀ 6 ♂♂), *A. jakobi* (3 ♂♂), *A. bicolor* (8 ♀♀ ♂), *A. intermedia* (♂), *A. ruficrus* (14 ♀♀ 2 ♂♂), *Osmia rufa* (♂), *Nomada flava* (♂), *N. bifida* (3 ♂♂), *N. marshamella* (♂), *N. panzeri* (♀ ♂)	27	377
2	*Taraxacum* sp.	*Halictus rubicundus* (12 ♀♀), *H. tumulorum* (♀), *Lasioglossum calceatum* (29 ♀♀), *L. albipes* (45 ♀♀), *L. fulvicorne* (3 ♀♀), *L. subfulvicorne* (8 ♀♀), *L. fratellum* (♀), *L. alpigenum* (♀), *L. morio* (♀), *L bavaricum* (♀), *L. rufitarse* (2 ♀♀), *Sphaecodes monilicornis* (♀), *Sph. ferruginatus* (♀), *Andrena tibialis* (6 ♀♀ 5 ♂♂), *A. haemorrhoa* (31 ♀♀ 56 ♂♂), *A. nigroaenea* (2 ♂♂), *A. ovatula* (♂), *A. similis* (♀), *A. barbilabris* (5 ♀♀), *A. semilaevis* (2 ♂♂), *A. subopaca* (7 ♀♀), *A. falsifica* (2 ♀♀ 2 ♂♂), *A. lapponica* (2 ♀♀), *A. helvola* (5 ♀♀ 4 ♂♂), *A. apicata* (7 ♀♀), *A. humilis* (5 ♀♀ 5 ♂♂), *A. ruficrus* (5 ♀♀), *Chelostoma grande* (15 ♀♀ 4 ♂♂), *Ch. maxillosum* (♀ 3 ♂♂), *O. leaiana* (♀), *O. aurilenta* (♂), *O. parietina* (♀), *Nomada panzeri* (2 ♀♀), *N. flavoguttata* (♂)	34	288
3	*Berberis vulgaris* L.	*Halictus rubicundus* (6 ♀♀), *Lasioglossum laevigatum* (2 ♀♀), *L. albipes* (6 ♀♀), *L. fulvicorne* (♀), *L. subfulvicorne* (2 ♀♀), *Andrena tibialis* (5 ♀♀ ♂), *A. haemorrhoa* (46 ♀♀ 11 ♂♂), *A. nigroaenea* (♀ ♂), *A. helvola* (10 ♀♀), *A. apicata* (4 ♀♀), *A. rogenhofferi* (♀ 3 ♂♂), *A. jakobi* (♀ 3 ♂♂), *A. intermedia* (♀), *A. thoracica* (♂), *A. bicolor* (♀), *Nomada marshamella* (♀)	16	108
4	*Tussilago farfara* L.	*Halictus rubicundus* (2 ♀♀), *Lasioglossum laevigatum* (2 ♀♀), *L. calceatum* (8 ♀♀), *L. albipes* (4 ♀♀), *L. fulviventris* (7 ♀♀), *L. subfulviventris* (17 ♀♀), *L. fratellum* (44 ♀♀), *L. rufitarse* (♀), *Andrena haemorrhoa* (5 ♀♀ 15 ♂♂), *A. rogenhofferi* (♂), *A. ruficrus* (2 ♀♀ ♂), *A. semilaevis* (♂), *A. helvola* (♀), *A. bicolor* (7 ♀♀ 2 ♂♂)	13	118

Table XI ctd.

(1)	(2)	(3)	(4)	(5)
5	*Petasites* sp.	*Lasioglossum albipes* (3 ♀♀), *Andrena tibialis* (3 ♀♀), *A. clarkella* (3 ♀♀), *A. barbilabris* (5 ♀♀), *A. bicolor* (♂), *A. haemorrhoa* (13 ♂♂)	6	28
6	*Prunus padus* L.	*Halictus rubicundus* (4 ♀♀), *Andrena haemorrhoa* (2 ♂♂), *A. clarkella* (♀), *A. praecox* (♀), *A. bicolor* (2 ♀♀), *Osmia rufa* (♂), *Nomada marshamella* (♀ ♂), *Lasioglossum calceatum* (2 ♀♀)	8	15
7	*Sonchus* sp.	*Andrena nigroaenea* (♀), *A. praecox* (27 ♀♀), *A. apicata* (♀)	3	29
8	*Dryas octopetala* L.	*Osmia parietina* (2 ♂♂)	1	2
9	*Frangula alnus* MILLER	*Halictus rubicundus* (5 ♀♀), *Lasioglossum albipes* (6 ♀♀), *Andrena haemorrhoa* (20 ♀♀ 4 ♂♂), *A. nigroaenea* (♂), *A. barbilabris* (♂), *A. helvola* (3 ♀♀ 4 ♂♂), *A. rogenhofferi* (4 ♂♂), *A. jakobi* (3 ♂♂), *Nomada rehnana* (♂)	9	52
10	*Hypochoeris uniflora* VILL.	*Andrena humilis* (♂), *O. nigriventris* (2 ♀♀)	2	3
11	*Prunus* sp.	*Lasioglossum calceatum* (9 ♀♀), *L. fulvicorne* (10 ♀♀), *L. subfulvicorne* (♀), *Andrena tibialis* (2 ♀♀ ♂), *A. haemorrhoa* (4 ♀♀ 15 ♂♂), *A. lapponica* (2 ♂♂), *A. praecox* (8 ♀♀ ♂), *A. helvola* (3 ♀♀ 4 ♂♂), *A. apicata* (4 ♀♀), *Nomada succincta* (♀)	10	55
12	*Anemone ranunculoides* L.	*Andrena tibialis* (♀)	1	1
13	*Ribes* sp.	*Andrena helvola* (3 ♀♀ 4 ♂♂), *A. jakobi* (2 ♂♂)	2	9
14	*Primula* sp.	*Anthophora acervorum* (♀)	1	1
15	*Syringa vulgaris* L.	*Andrena nigroaenea* (♀), *A. ruficrus* (♀)	2	2
16	*Rhododendron* sp.	*Andrena apicata* (♀), *Osmia nigriventris* (♀)	2	2
17	*Vaccinium myrtillus* L.	*Osmia uncinata* (♂), *O. parietina* (♂)	2	2
18	*Lamium maculatum* L.	*Osmia coerulescens* (♀)	1	1
19	*Viola tricolor* L.	*Andrena tibialis* (♀)	1	1
20	*Sinapis* sp.	*Andrena intermedia* (♀)	1	1
21	*Lotus corniculatus* L.	*Lasioglossum laevigatum* (♀), *L. calceatum* (2 ♀♀), *L. fratellum* (♀), *Andrena haemorrhoa* (♂), *A. thoracica* (♂), *A. lapponica* (♀), *A. semilaevis* (♂), *A. intermedia* (17 ♀♀ 80 ♂♂), *A. coitana* (2 ♀♀), *Panurgus banksianus* (14 ♂♂), *Chelostoma grande* (16 ♀♀), *Ch. maxillosum* (♀ 2 ♂♂), *Osmia rufa* (2 ♀♀), *O. uncinata* (4 ♀♀), *O. aurilenta* (♀), *O. mustellina* (6 ♂♂), *O. nigriventris* (2 ♀♀), *O. parietina* (4 ♀♀), *O. villosa* (♀), *Megachile willoughbiella* ♀ ♂), *M. nigriventris* (10 ♀♀ 5 ♂♂), *M. circumcineta* (10 ♀♀), *Trachusa byssina* (2 ♀♀ 3 ♂♂), *Nomada panzeri* (4 ♀♀), *N. flavoguttata* (♀), *Anthidium montanum* (6 ♂♂)	26	203

Table XI ctd.

(1)	(2)	(3)	(4)	(5)
22	*Anthylis vulneraria* L. subsp. *alpestris* ASCHERSON et GRAEBUER	*Halictus rubicundus* (2 ♀♀ 4 ♂♂), *Sphaecodes monilicornis* (♀), *Andrena lathyri* (♂), *A. intermedia* (5 ♀♀ 76 ♂♂), *A. barbilabris* (♀), *Panurgus banksianus* (♀ 14 ♂♂), *Chelostoma maxillosum* (2 ♀♀ 2 ♂♂), *Megachile nigriventris* (3 ♀♀ ♂)	8	113
23	*Rubus idaeus* L.	*Halictus rubicundus* (♀ 4 ♂♂), *Lasioglossum rufitarse* (♀), *L. albipes* (7 ♀♀), *Andrena haemorrhoa* (3 ♀♀), *A. intermedia* (♀), *A. subopaca* (♀), *A. helvola* (♀), *A. praecox* (♀), *A. fucata* (♀)	9	21
24	*Trifolium* sp.	*Andrena intermedia* (3 ♀♀ 34 ♂♂), *Halictus rubicundus* (2 ♀♀)	2	39
25	*Lupinus* sp.	*Andrena intermedia* (4 ♂♂), *Chelostoma nigricorne* (♀ 2 ♂♂), *Megachile circumcineta* (2 ♀♀ ♂), *Megachile nigriventris* (7 ♀♀), *Anthphora furcata* (♀)	5	18
26	*Rosa* sp.	*Andrena helvola* (♀), *A. fucata* (♀), *A. coitana* (2 ♀♀), *Megachile circumcineta* (2 ♀♀ ♂), *M. nigriventris* (3 ♀♀), *Stelis phaeoptera* (2 ♀♀)	6	12
27	*Campanula* sp.	*Hylaeus difformis* (♀), *Dufourea dentiventris* (♂), *Andrena bicolor* (♀), *Chelostoma florisomne* (♂), *Ch. nigricorne* (4 ♀♀)	5	8
28	*Ranunculus acris* L.	*Panurgus banksianus* (7 ♂♂), *Chelostoma nigricorne* (♀ 2 ♂♂)	2	10
29	*Calendula officinalis* L.	*Osmia leaiana* (♀)	1	1
30	*Centaurea* sp.	*Andrena coitana* (4 ♀♀), *Megachile alpicola* (♀)	2	5
31	*Hieracium* sp.	*Lasioglossum calceatum* (6 ♀♀ 12 ♂♂), *L. subfulvicorne* (♀), *L. fratellum* (♀), *Andrena haemorrhoa* (4 ♀♀), *A. ovatula* (♀ ♂), *A. intermedia* (♀ 2 ♂♂), *A. falsifica* (♀), *A. semilaevis* (♀), *A. coitana* (9 ♀♀ ♂), *A. bicolor* (2 ♀♀), *A. humilis* (2 ♀♀)	11	44
32	*Leontodon* sp.	*Halictus rubicundus* (4 ♀♀), *Lasioglossum costulatum* (♂), *L. fulvicorne* (♀), *L. calceatum* (5 ♀♀ 2 ♂♂), *L. albipes* (14 ♀♀ 3 ♂♂), *Andrena haemorrhoa* (♀), *A. humilis* (♀ 3 ♂♂), *A. coitana* (10 ♀♀ 5 ♂♂), *A. bicolor* (2 ♀♀), *Panurgus banksianus* (2 ♂♂), *Panurgus montanus* (♀), *Chelostoma maxillosum* (3 ♀♀), *Ch. nigricorne* (♀ 2 ♂♂), *Osmia uncinata* (♀), *Megachile alpina* (♀)	15	63
		total *Leontodon* sp. and *Hieracium* sp.	26	107
33	*Thymus* sp.	*Andrena denticulata* (♀ 2 ♂♂)	1	3
34	*Cerasius* sp.	*Andrena jakobi* (2 ♂♂)	1	2
35	*Phyteuma* sp.	*Osmia villosa* (2 ♀♀)	1	2
36	*Vicia* sp.	*Andrena tibialis* (♀), *Megachile nigriventris* (3 ♀♀)	2	4
37	*Lathyrus pratensis* L.	*Megachile nigriventris* (2 ♀♀), *Osmia leaiana* (♀)	2	3
38	*Veronica chamaedrys* L.	*Lasioglossum albipes* (♀)	1	1

Table XI ctd.

(1)	(2)	(3)	(4)	(5)
39	*Onobrychis vicifolia* SCOP.	*Trachusa byssina* (♀ 3 ♂♂)	1	4
40	*Knautia arvensis* (L./COULTER)	*Andrena hattorfiana* (10 ♀♀ 4 ♂♂), *Chelostoma grande* (2 ♀♀), *megachile alpicola* (♀)	3	14
41	*Echium vulgare* L.	*Osmia adunca* (14 ♀♀ 4 ♂♂), *O. lepeletieri* (2 ♀♀)	2	21
42	*Stachys germanica* L.	*Anthidium manicatum* (3 ♀♀ 3 ♂♂), *Anthophora furcata* (2 ♂♂)	2	8
43	*Potentilla erecta* (L.) RÄUSCHEL	*Hylaeus difformis* (♀), *Lasioglossum albipes* (5 ♀♀), *L. fulvicorne* (♀), *L. subfulvicorne* (♀), *L. fratellum* (4 ♀♀), *L. bavaricum* (♀), *Andrena subopaca* (7 ♀♀), *A. falsifica* (15 ♀♀ 3 ♂♂), *A. semilaevis* (2 ♀♀ ♂), *Panurginus montanus* (14 ♀♀ 7 ♂♂), *Dufourea alpina* (♂), *L. cupromicans* (2 ♀♀), *Sphaecodes ferruginatus* (2 ♀♀), *Nomada flavoguttata* (♀)	14	68
44	*Potentilla aurea* L.	*Panurginus montanus* (7 ♀♀ 3 ♂♂)	1	10
45	*Potentilla* sp.	*Andrena intermedia* (♀), *Chelostoma maxillosum* (2 ♂♂), *Ch. grande* (2 ♂♂), *Lasioglossum fratellum* (2 ♀♀), *L. albipes* (♀)	5	18
		total *Potentilla* L.	16	96

In the Hohe Tauern and Tatras some species of the genera *Lasioglossum* (e.g. *L. calceatum*, *L.albipes*, *l. fratellum*) and *Andrena* (e.g. *A. bicolor*) are associated with the mesoclimate, for I happened on them also in cooler places.

2. Food Plants

The food plants are listed in Tables XI and XII, in which the bees species found at the flowers and the numbers of captured specimens are also given. The most fequently visited plants in the lower montane tier (Table XI) were *Salix* sp. (27 species and 377 specimens) and *Taraxacum* sp. (respectively, 34 and 288). Out of the early-spring plants, *Tussilago farfara* (13 and 118), *Berberis vulgaris* (16 and 108), *Frangula alnus* (9 and 52) and *Prunus* sp. (10 and 55) were also often visited. The plants visited by the largest numbers of bees in late spring and summer were *Lotus corniculatus* (26 and 203), *Potentilla* L. (16 and 96), *Hieracium* sp. and *Leontodon* sp. (21 and 107) and *Anthylis vulneraria* ssp. *alpestris* (8 and 113). I collected bees from altogether 45 genera of plants in the lower montane tier. *Andrena intermedia*, *A. ovatula*, *Chelostoma grande* and the species of the genera *Megachile*, *Osmia* and *Trachusa* were associated with the *Leguminosae*. Moreover, I collected some species of the genus *Megachile* (*M. circumcineta* and *nigriventris*) from *Rosa* sp. and *M. alpicola* from *Knautia arvensis*, *Lathyrus* sp. and *Centaurea* sp. I caught some species of the genus *Osmia* on *Prunus padus* (*O. rufa*), *Rhododendron* sp. (*O. nigriventris*), *Vaccinium* sp.

Table XII

Food plants visited by *Apoidea* (excl. *Apidae*) species in the upper montane tier

No.	Food plants	Visiting *Apoidea* species	Number of *Apoidea*: species	Number of *Apoidea*: specimens
1	*Salix* sp.	*Halictus rubicundus* (2♀♀), *Lasioglossum calceatum* (5 ♀♀), *L. albipes* (4 ♀♀), *Andrena haemorrhoa* (22 ♀♀), *A. rogenhofferi* (4 ♀♀), *A. barbilabris* (♀), *A. lapponica* (♀), *A. bicolor* (♀), *A. ruficrus* (17 ♀♀)	9	57
2	*Taraxacum* sp.	*Lasioglossum subfulvicorne* (2 ♀♀), *Andrena haemorrhoa* (6 ♀♀)	2	8
3	*Dryas octopetala* L.	*Halictus rubicundus* (♀), *Andrena haemorrhoa* (♀), *A. intermedia* (4 ♂♂)	3	6
4	*Vaccinium myrtillus* L.	*Lasioglossum fratellum* (2 ♀♀), *Andrena lapponica* (6 ♀♀), *Osmia uncinata* (♂)	3	9
5	*Rhododendron* sp.	*Andrena lapponica* (2 ♀♀), *A. rogenhofferi* (9 ♀♀)	2	11
6	*Saxifraga oppositifolia* L.	*Andrena rogenhofferi* (♀)	1	1
7	*Ranunculus acris* L.	*Panurgus banksianus* (3 ♂♂), *Panurginus montanus* (♀ 2 ♂♂)	2	6
8	*Hieracium* sp.	*Andrena lapponica* (♀), *Panurgus banksianus* (♀), *Panurginus montanus* (22 ♀♀ 10 ♂♂), *Dufourea paradoxa* (2 ♀♀ 2 ♂♂)	4	38
9	*Leontodon* sp.	*Lasioglossum fulvicorne* (♀), *L. albipes* (♀), *Andrena bicolor* (♀), *A. coitana* (2 ♀♀), *Osmia villosa* (♀)	5	6
10	*Campanula barbata* L.	*Dufourea alpina* (♀)	1	1
11	*Lotus corniculatus* L.	*Andrena haemorrhoa* (♂), *A. intermedia* (3 ♂♂), *Osmia uncinata* (3 ♀♀), *Megachile circumcineta* (♀)	4	8
12	*Rubus idaeus* L.	*Lasioglossum fratellum* (♀)	1	1
13	*Rosa* sp.	*Lasioglossum fratellum* (♀), *Andrena lapponica* (3 ♀♀), *A. coitana* (2 ♀♀)	3	6
14	*Potentilla aurea* L.	*Andrena subopaca* (8 ♀♀), *Panurginus montanus* (10 ♀♀ 33 ♂♂)	2	51
15	*Potentilla erecta* (L.) RÄUSCHEL	*Lasioglossum fratellum* (2 ♀♀), *L. bavaricum* (♀), *Dufourea alpina* (♀ 2 ♂♂), *Panurginus montanus* (2 ♀♀ 8 ♂♂)	4	16
16	*Potentilla* sp.	*Andrena haemorrhoa* (♀), *A. coitana* (♂), *Panurginus montanus* (26 ♀♀ 37 ♂♂), *Dufourea paradoxa* (♀)	4	66
		total *Potentilla* sp.	8	133

(*O. uncinata* and *O. parietina*), *Lamnium maculatum* (*O. coerulescens*), *Calendula officinalis* (*O. lesiana*), *Leontodon* sp. (*O. unicata*), *Phyteuma* sp. (*O. villosa*), *Hippocrepis* sp. (*O. nigriventris*) and *Echium vulgare* (*O. adunca* and *O. lepeletieri*). I encountered some species of the genus *Chelostoma* on *Lotus corniculatus*, *Lupinus* sp., *Campanula* sp., *Potentilla* sp., *Ranunculus acris* and *Leontodon* sp. The High Montane species visited above all *Potentilla erecta*, *P. aurea* and other species of this genus. In the lower montane tier I found *Andrena rogenhofferi* on *Salix* sp. as well as *Berberis vulgaris* and the commonest late-spring species *Andrena intermedia* on *Lotus corniculatus*, *Lupinus* sp. and *Hieracium* sp.

Above 1400 m to 2150 m (Table XII) the number of plant species visited by bees, being 14, is considerably smaller than in the lower montane tier. The most numerously visited plants were *Potentilla* sp. (3 species and 133 specimens), *Salix* sp. (respectively, 9 and 53) as well as *Hieracium* sp. and *Leontodon* sp. (altogether 9 species and 44 specimens). I caught many species, such as *Andrena haemorrhoa*, *Lasioglossum calceatum* and *albipes* on *Salix* sp. and *Taraxacum* sp. and *L. fratellum* on *Vaccinium* sp., *Rosa* sp., *Rubus idaeus* and *Potentilla erecta*, as well as *L. bavaricum* on *Potentilla erecta*. The High Montane species occurred on *Hieracium* sp., *Potentilla* sp. and *Ranunculus acris*.

3. Influence of the Configuration of the Land on Distribution

The numbers of localities, specimens and species found on the northern slopes of the Hohe Tauern and in the summit region of Grossglockner were dependent mainly upon land morphology. This is why the Rauris Valley with its two transversal moraines is especially favourable for the development of bees. On the other hand, I found only single *Apoidea* at altitudes ranging from 1800 to 2100 m on detached peaks. There was much greater possibility of finding some localities in the Grossglockner Massif, where places screened from winds were considerably more numerous, for the massiveness of the terrain allows more microclimates to arise.

During my investigation in the Hohe Tauern I did not take into consideration the effect of the substratum upon the specific composition and abundance of the *Apoidea*. A study of this type carried out in the Tatras (DYLEWSKA 1991) showed that the localities in the limestone part of the Tatras are richer in both the number of species found and that of specimens collected, for I found 68 species there and 49 species in the granite part of the Tatras and the mean number of specimens taken at one locality was, respectively, 14 and 11.4.

4. Xerothermic Species

In the Hohe Tauern the Submediterranean and South Central European species are undoubtely xerothermic. Besides, a large number of summer and late-spring species are characterized by high thermal requirements and they shouls be numbered among the xerothermic forms, although they differ in they living requirements. Here belong the species associated with the *Leguminosae*, encountered only in the warmest places. In addition, some early-spring species, such as *Halictus rubicundus* and *Lasioglossum morio* have aslo high thermal requirements. It may be stated in general that above half the species collected in the Hohe Tauern have high thermal requirements and are associated with macroclimates, for I found them in the warmest places.

At their highest-lying localities all the species behave as do the xerothermic forms under hard circumstances, that is, they appear in the warmest places. The xerothermic species of the Hohe Tauern, like those in the Tatras (DYLEWSKA 1991), live at relict localities, because most probably only the apoidean species connected with the mesoclimate can spread, while the species associated with microclimates are found at single localities a long way apart. On the other hand, the species associated with the mesoclimate occur generally at a considerably larger number of localities.

IX. A COMPARISON OF THE *APOIDEA* FROM THE NORTHERN SLOPES OF THE HOHE TAUERN AND TATRAS

A comparison of the *Apoidea* from the northern slopes of the hohe Tauern and Tatras cannot be carried out unless we take into consideration the climatic conditions prevailing in various floristic zones, for the sensitivity of the *Apoidea* to temperature (DYLEWSKA 1991) is the main factor determining the altitudinal distribution of particular species. Since the tree line is related to the annual isotherm of +2^{o}C (HESS 1965), the potential tree line on the northern slopes of the hohe Tauern (2100-2200 m) may be referred to the tree line on the notrhern slopes of the Tatras (1550 m). The upper boundary of climatic summer extends at an altitude of about 700 m in the Carpathians in Poland and at that of about 1200 m in the Hohe Tauern (see p. 511) In the Tatras the upper boundary of the climatic late spring occurs somewhat above the tree line (at about 1600 m) and in the Hohe Tauern it is also near the potential tree line. Hence the difference between the ranges of the climatic zones in the two massifs is about 500 m or perhaps even nearly 600 m. On the northern side the lower boundary of the Tatras is at an altitude of about 900 m. The forest tier in the Tatra Mts has been divided into a lower part with deciduous trees (e.g. beech) and an upper part with conifers. In the Hohe Tauern the upper montane tier (from 1400 m upwards) ia characterized also by the presence of beech, while its subalpine tier comopares with the coniferous montain forest tier in the Tatras and the lower part of its alpine tier with the dwarf pine tier in the Tatras.

1. Differences in the Specific Composition

Table XIII contains a list of species collected in the Tatras and in the Hohe Tauern. The list is divided into three phenological groups: early-spring, late-spring and summer species. Moreover, in this table I give the numbers of specimens caught and localities found in particular altitudinal zones, which permits the calculation of the mean number of specimens falling to one locality; in addition, Zone I corresponds with the mixed mountain forest tier in the Tatras and the upper montane tier in the Hohe Tauern, the coniferous mountain forest tier in the Tatras (Zone II) with the subalpine tier in the Hohe Tauern and the dwarf pine tier in the Tatras (Zone III) with the lower part of the alpine tier in the Hohe Tauern. The table presents also the zoogeographical characteristics of the species and zoogeographical elements.

Table XIII suggests that there certainly is a marked similarity between the Tatras and the Hohe Tauern, since the species occurring in them are for the most part those widely distributed, Montane, North montane, European-Siberian and North Central European, known both from the Carpathians (DYLEWSKA 1991) and from the Alps (WESTRICH 1989). Furthermore, neither on the northern slopes of the Tatras nor in the corresponding

Table XIII

Specific composition and abundance of the *Apoidea* (except *Apidae*) in the altitudinal zones I-III (see p. 553) on the northern slopes of the Tatra Mts and in the zones corresponding to them in the Hohe Tauern

bees	No.	species	Tatra Mts						Hohe Tauern						Tatra	Hohe Tauern	zoogeographical element
			I		II		III		I		II		III		spm/l		
			l	spm	l	spm	l	spm	l	spm	l	spm	l	spm			
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)
early spring	1	*C. cunicularius*			1	1									1		Palearctic
	2	*H. rubicundus*							1	3						1.5	Holarctic
	3	*L. calceatum*	9	26	1	1			1	2	1	3			2.7	2.5	Palearctic
	4	*L. albipes*	13	58	6	13			1	2	2	3			3.7	1.7	Palearctic
	5	*L. fulvicorne*	3	7	1	1									2.0		West Palearctic
	6	*L. subfulvicorne*							3	4						1.3	West Palearctic
	7	*L. fratellum*	11	50	11	74	5	40	2	4	3	3			6.0	1.4	North Montane
	8	*L. leucopum*							1	1						1.0	West Palearctic
	9	*L. rufitarse*			1	1									1.0		North Montane
	10	*A. tibialis*							1	1						1.0	European-Siberian
	11	*A. haemorrhoa*	3	9	1	1			2	23	1	8			2.5	10.0	Palearctic
	12	*A. nigroaenea*							1	1						1.0	West Palearctic
	13	*A. gravida*					1	1							1.0		South Central European
	14	*A. bicolor*	4	6	5	15	1	1	1	1					2.1	1.0	West Palearctic
	15	*A. minutula*			1	2									2.0		West Palearctic
	16	*A. falsifica*	1	1	1	1									1.0		European-Caucasian
	17	*A. semilaevis*	1	1	1	5									3.0		North Central European
	18	*A. subopaca*	11	37	9	28	1	1	4	8					3.2	2.0	European-Siberian
	19	*A. praecox*	1	1											1.0		European-Caucasian
	20	*A. lapponica*	6	30	5	16	4	16	5	9	2	5			4.1	2.0	North Montane
	21	*A. rogenhofferi*							7	10	2	6	1	1		1.7	Alpine

Table XIII ctd.

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)
early spring	22	*A. apicata*	1	1											1.0		European
	23	*A. clarkella*	1	2											2.0		Holarctic
	24	*A. ruficrus*	1	2											2.0		North Montane
	25	*A. barbilabris*							1	1						1.0	European-Siberian
	26	*A. jakobi*							1	1						1.0	European-Caucasian
	27	*O. uncinata*							2	2	1	2				1.3	European
	28	*N. bifasciata fucata*					1	1							1.0		West Palearctic
	29	*N. panzeri*	4	14	2	2	3	8			2	2			3.7	1.0	European
	30	*N. leucophtalma*	1	4											4.0		European
	31	*N. fabriciana*	1	1											1.0		European
	32	*N. flavoguttata*	2	3	1	1									1.3		Palearctic
total early-spring specimens				251		162		68		103		34		1			
total early-spring species			17		15	23	7		16		8	17	1		14.2 3.4	4.6 2.2	c=8 QS=40.0%
late spring	33	*H. confusus*	1	1											1.0		Palearctic
	34	*L. leucozonius*	1	1											1.0		Holarctic
	35	*L. cupromicans*	2	2											1.0		Montane
	36	*L. bavaricum*	2	6	3	4			1	1					2.0	1.0	Montane
	37	*L. villosulum*	1	1											1.0		West Palearctic
	38	*D. alpina*							1	2	1	1				1.5	High Montane
	39	*D. paradoxa*							1	2	3	5				1.7	High Montane
	40	*A. ovatula*									1	1				1.0	Palearctic
	41	*A. intermedia*							1	4	1	4				4.0	European
	42	*A. fucata*	2	3	1	1									1.3		European-Caucasian
	43	*A. humilis*	4	10											2.5		Palearctic
	44	*P. montanus*							9	94	5	15				12.1	High Montane
	45	*Ch. maxillosum*	2	12	1	2									2.0		European
	46	*Ch. nigricorne*	1	2											2.0		European

Table XIII ctd.

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)
late spring	47	*O. villosa*	2	2					2	2					1.0	1.0	Montane
	48	*O. parietina*	1	2											2.0		North Montane
	49	*O. leaiana*	1	1											1.0		European
	50	*O. inermis*	2	2											1.0		North Montane
	51	*M. nigriventris*	1	1											1.0		North Montane
total late-spring specimens				46		7				105		26					
total late-spring species			14		3 14				6		5 7				1.9	5.0	c=2 QS=19.0%
summer	52	*H. annulatus*			1	1									1.0		North Montane
	53	*H. nigritus*	1	1											1.0		Palearctic
	54	*A. coitana*	6	11	6	21			3	6	1	2			2.7	2.0	European-Siberian
	55	*A. rufizona*	1	1											1.0		Montane
	56	*P. banksianus*	4	10			1	1	2	4					2.2	1.7	North Central European
	57	*D. vulgaris*					2	3							1.5		European
	58	*Ch. florisomne*	2	4	1	2									2.0		West Palearctic
	59	*M. circumcineta*							1	1						1.0	European
	60	*M. willoughbiella*	1	1											1.0		European
	61	*St. ornatula*	1	1											1.0		Palearctic
	62	*C. rufescens*	1	1											1.0		Palearctic
	63	*N. obtusifrons*	1	1											1.0		European-Siberian
	64	*N. similis*	1	2											2.0		European
	65	*A. furcata*	1	2											1.0		European
total summer specimens				33		27		4		11		2			1.5	0.4	c=2
total summer species			12		3		2		3		1				2.2	1.9	QS=15.4%
total specimens				331		196 596		69		216		65 282		1	3.0	3.1	c=12 QS=31.6%
total species			37		22	49	6		28		16	28	1				

part of the hohe Tauern are there as a rule any Submediterranean, Subpontic, South Central European and some other species (*Andrena gravida*, the South Central European species found in Zone III in the Tatras, should be regarded as an exception of obscure origin). On the other hand, in the Tatras and Carpathians the High Montane and High Alpine species are missing. *Bombus pyrenaeus* of the family *Apidae* is the only exception among the *Apoidea*. This notwithstanding, the similarity between the massifs under discussion calculated from the formula

$$QS = \frac{2c}{a + b} \times 100$$

where c is the number of common species and a and b represent the numbers of species from particular regions, is scarcely 31.6%. The number of species found on the northern slopes of the Hohe Tauern (27), small in comparison with that for the Tatras (49), and the small number of the common species (12) account for this result.

The similarity between the two faunas varies with the season, namely, it is the greatest in the early-spring faunas (about 40%) and decreases in the case of the late-spring and summer faunas (respectively, 19 and 15%). The list of the early-spring fauna of the two massifs contains only one species (*Andrena rogenhofferi*) which does not occur in the Carpathians. The differences between the numbers of the early-spring species in the Tatras (23) and in the Hohe Tauern (17) are not great but the number of common species is small as well. Moreover, in the Hohe Tauern I noted some species that I did not find on the northern slopes of the Tatras. These are *Halictus rubicundus*, *Lasioglossum leucopum*, *Andrena tibialis*, *A. nigroaena*, *A. ovatula*, *A. intermedia* and *Osmia uncinata*. Most of these species are characterized by high thermal requirements.

I found 14 late-spring species in the Tatras and 7 in the Hohe Tauern. Three of these last were High Montane species and absent in the Carpathians. There are great differences in the summer fauna between the two massifs. Out of the 13 species recorded from the Tatras, there were only three in the Hohe Tauern.

The ranges of the early-spring species in the Tatras seem to reach considerably higher than they do in the Hohe Tauern. I found 7 species in Zone III in the Tatras and only one in the Hohe Tauern. The differences are however only apparant. All the localities of these species in the Tatras lay in the lowest parts of the dwarf mountain pine tier and did not spread beyond the boundary of late spring in the climatic sense. Both in the Tatras and in the Hohe Tauern the range of the late-spring species terminates in Zone II and does not extended across the boundary of climatic late spring. Similarly, the summer species do not occur above the boundary of late spring, but their number in the Tatras is significant (13). All these species were represented above the upper boundary of climatic summer: most of them (8) in the lowermost parts of the mixed mountain forest tier, the remaining ones in higher zones. The summer species found in Zones II and III both in thr Tatras and in the Hohe Tauern are mainly North Montane, European-Siberian and North Central European species, whereas the other, most often widely distributed, species occur up to about 300 m above the upper boundary of summer.

2. Numbers of Specimens Caught

Differences of the numbers of specimens caught between particular phenological groups are great whether the absolute numbers or, above all, the numbers of specimens falling to one locality are compared. I caught 138 specimens of the early-spring species in the Hohe Tauern and 481 in the Tatras, the average numbers falling to one locality being, respectively, 4.6 and 14.2. All the early-spring species – I captured at least 10 specimens of each in the Tatras – were also met with in the Hohe Tauern, although mostly in much smaller numbers. *Andrena haemorrhoa* is an exception: 10 specimens of this species were reported from the Tatras and 31 from the Hohe Tauern. Besides, *Andrena rogenhofferi* and *A. ruficrus*, unknown from the Tatras, were caught in the Hohe Tauern, 17 specimens either at 10 and 2 localities, respectively.

I collected only 53 specimens of the late-spring species in the Tatras and 131 in the Hohe Tauern, in the last case that was chiefly *Panurginus montanus*, whose 111 specimens (77% of the group) I gathered. I caught 61 specimens of the summer species in the Tatras and 13 in the Hohe Tauern, altogether 112 specimens of the late-spring and summer species in the Tatras and 144 in the Hohe Tauern: the numbers of specimens falling to one locality are, respectively, 4 and 3. The treatment of these two phenological groups together is well-grounded, because the periods of their emergence is high mountains are similar.

3. A Comparison of the Apoidean Faunas of the Sub-Tatra Region and the Lower Montane Tier in the Hohe Tauern

The sub-Tatra region of the northern slopes of the Tatras (DYLEWSKA 1991) is characterized by its very rich morphology of the land. In consequence, it makes it very possible for microclimates to form. This is confirmed by the numbers of species collected (101). The sub-Tatra region in question covered an area above the upper boundary of summer from about 800 to 900 m a.s.l. This would coresspond only to a range of altitudes from 1300 to 1400 m on the northern slopes of the Hohe Tauern. In spite of that in the present comparison I have included the whole lower montane tier of the Hohe Tauern, because, for instance, the xerothermic cpecies belonging to the Mediterranean and South Central European elements reach only to an altitude of 1100 m on the northern slopes of the Hohe Tauern and to the boundary of the Tatra Mts in the sub-Tatra region (900 m).

Table XIV gives the numbers of species found in the sub-Tatra region and in the lower montane tier of the Hohe Tauern, belonging to particular zoogeographical groups, the numbers of common cpecies and shows the similarities between these faunas. It can be seen from this table that the similarity between the wholes of faunas of these regions is distinctly greater (53.3%) than between the Tatras and higher regions of the Hohe Tauern. A particularly great similarity was found in the Montane, North Montane, European-Siberian and North Central European elements, for which it approximates to 76%. In fact, it might reach 100%, since these elements are known from both the Alps and Carpathians. On the other hand, the similarity between the widely distributed species in these two massifs comes close to that of the whole faunas and is about 52%. The impoverishment of the apoidean fauna of the Hohe Tauern is best seen in this group of species, for I have recorded 74 species of this group in the sub-Tatra region and 58 in the lower montane tier of the Hohe Tauern and the number of the common species comes to 34, although the study area and the number of localities found in the Hohe Tauern were considerably greater than in the sub-Tatra region, there being 34 localities in the former area and 17 in the latter. The relatively small number of common species of the widely distributed elements (34)

Table XIV

The numbers of the *Apoidea* species belonging to the distinguished zoogeographical elements, collected in the lower montane tier on the northern slopes of the Hohe Tauern and in the sub-Tatra region

Groups of zoogeographical elements	Number of species			
	sub-Tatra region	regio montana interior in the Hohe Tauern	Number of common species	QS%
Widely distributed	74	59	34	51.1
Alpine, High Alpine, High Montane	–	6	–	–
Montane, North Montane, European-Siberian, North Central European	22	23	17	75.6
Submediterranean, Submediterranean-Siberian, South Central European	5	7	2	33.3
Total	101	95	53	54.1

is due to a large number of species represented by single specimens in both regions. And so the comparatively low similarity in widely distributed species is caused by the destruction of this fauna in the Hohe Tauern and the rarity of many species. Apart from the Alpine, High Alpine and High Montane species, which are lacking in the Polish part of the Carpathians, the thermophilous fauna (Submediterranean, South Central European and the like elements) shows the lowest level of similarity: 5% of all the species collected in the sub-Tatra region and 7% in the hohe Tauern.

4. Food Plants

The forest zones on the northern slopes of the Tatras and in higher regions of the Hohe Tauern (starting from the upper montane tier) differ significantly, mainly in degree of deforestation. Although the lower parts of the Tatras were cleared of the forest in the 19th century, they have been reforested and now dense woods cover them except for numerous but small clearings, whereas in the Hohe Tauern the forests were cleared as early as the 16th century and devastated by pasturing. Microclimates arising in the clearings in the forest zone produce suitable living conditions for bees. There are not many clearings in the Hohe Tauern. Heavy damage to the vegetation of this area has impoverished the food resources of bees.

In spite of differences in the plant cover the northern slopes of both the Tatras (DYLEWSKA 1991) and the Hohe Tauern (Tables XI and XII) have similar food plants of bees, except for *Rhododendron*, which is absent in the Tatras. Moreover, in both these massifs the same plants are visited by largest numbers of bees as well. And so the basic plants for early-spring bees are *Salix* sp. and, in addition, *Tussilago farfara*, *Petasites* sp., *Berberis vulgaris* and *Prunus* sp..*Taraxacum* sp. makes an exception in this respect: In the Tatras it competes with *Salix* sp. for the abundance of bees visiting them and in the Hohe Tauern is characterized by the exceptionally poor fauna under study. Besides the early-spring bees, *Taraxacum* sp. is also visited by some late-spring bees, e.g. *Andrena humilis*, which I did not come upon in the higher regions of the Hohe Tauern (Table XIII), whereas both in the Tatras and in the sub-Tatra region it is a common species. In both the massifs the late-spring and summer faunas were captured chiefly from *Potentilla* sp., *Hieracium* sp. and *Leontodon* sp.. The remaining late-spring and summer plants play a very insignificant role as regards the number of specimens collected; nevertheless, the presence of some species is connected with these plants. For instance, *Andrena fucata* visit *Rubus idaeus*, *Chelostoma florisomne* appears at *Campanula* sp., *Osmia inermis* at *Vaccinium* and *Andrena ovatula* and *A. intermedia* mainly at *Lotus corniculatus*. The above-mentioned species of plants, particularly *Rubus* sp. and *Vaccinium* sp., prevent a growth in the diversity of the *Apoidea* fauna in the Hohe Tauern, as compared with the Tatras. *Vaccinium* sp., *Rubus* sp., *Chamaenerion angustifolium* and other plants which attract a rich fauna of bees and bloom in masses in the Tatras are missling from the area studied in the Hohe Tauern; instead, *Rhododendron* sp., which attracts considerably fewer *Apoidea*, occurs here.

5. Influence of the Configuration of the Land

The northern slopes of the Hohe Tauern, bare in great measure after their deforestation, clearly show their expanse and greater exposure to winds, which mostly lower the air temperature and impede the flight of bees. The Tatras are characterized by their much greater massiveness and very rich land morphology. Hence, despite the severe climate they offer significantly better possibilities for nesting in microclimates than do the Hohe Tauern. For this reason on singly rising summits along the valleys (above the tree line) and on the main ridge of the Hohe Tauern there were much fewer bees than in the Grossglockner Massif. Attention should, besides, be given to the magnitude of the Alps in comparison with the Tatras, where, as I have pointed out (DYLEWSKA 1991), it was possible for bees to colonize the northern slopes by species reaching the base of the mountains from both sides, on the southern side from the Pannonian Lowland. In the Hohe Tauern the *Apoidea* most probably invaded the northern slopes only from the northern side.

X. CONCLUSIONS

1. The poverty of the apoidean fauna in the lower part of the lower montane tier (from 700 to 1000 m) on the northern slopes of the Hohe Tauern was induced by anthropopressure (destruction of the flora, chemicalization, etc.), also by orography and climate (the valley bottoms are flat, coolar than the slopes and partly wet).

2. The opulence of the fauna of the upper part of the lower montane tier (1100-1400 m) was brought about by its favourable exposures (e.g. transversal moraines in the Rauris Valley) and smaller devastation caused by anthropopressure.

3. *Osmia adunca*, the Submediterranean element, and other xerothermic species – such as *Anthidium manicatum* and *Osmia aurilenta* – found at the localities with a steppe flora, are of a relict nature in this area [1)].

4. The single localities of summer species above the boundary of climatic summer in the Hohe Tauern, just as in the Tatras, are in all probability relict localities[1)].

5. A distinct faunistic boundary extends in the upper part of the lower montane tier (1200-1400 m). About 70% of the species do not occur above it, the fall in the number of speciemens being about 90%. This boundary is accounted for by a change in the climatic conditions, namely, by the course of the upper boundary of climatic summer. On the northern side of the Tatras the boundary of summer and the faunistic boundary discussed above lie below the lower boundary of the Tatras, at respective altitudes of 700 and 900 m and so under climatic conditions resembling those on the northern slopes of the Hohe Tauern.

6. The High Montane and, at the same time, late-spring species (mainly *Panurginus montanus*), which do not occur in the Tatras, most probably occupied warm places and food plants in the upper montane and subalpine tiers earlier, still before the invasion of the remaining species (widely distributed, Montane, North Montane, etc.) and this is why the number of the late-spring species (except for the High Montane ones) caught in these zones is very small (4) compared with the number of species (14) recorded from the corresponding climatic zones in the Tatras. On the other hand, the number of speciemens of all the zoogeographical groups of late-spring species is significantly greater in the Hohe Tauern (131 – 4.5 specimens per locality) than in the corresponding zones in the Tatras (54 – 1.3 specimens per locality), which supports the foregoing conclusion.

7. The distinctly richer apoidean fauna (except *Apidae*) on the northern slopes of the Tatra Mts (I found 596 specimens of 49 species, on the average 1.2 species and 14.5 specimens per locality) than that of the Hohe Tauern (28 species, 282 specimens; respectively, 0.8 and 10.0 per locality) is due to the greater massiveness of the Tatras (and so to better conditions for the occurrence of warm places) and to a considerably smaller destruction of the natural flora.

REFERENCES

DATHE H. 1980. Die Arten der Gattung *Hylaeus* F. in Europa (*Hymenoptera*: *Apoidea*, *Colletidae*). Mitt. zool. Mus. Berlin, **56**(2): 207-294.

DOBROWOLSKI K. A. 1963. Próba analizy pojęcia "rzadki" gatunek. Ekol. Pol. B, 9, 3: 207-212.

DYLEWSKA M. 1966. The *Apoidea* of the Babia Góra Mountain. Acta zool. cracov., Kraków, **11**(5): 111-175.

DYLEWSKA M. 1974. Die Bienen (*Hymenoptera*: *Apoidea*) in den hohen Westkarpaten. Fol. Ent. Hung., Budapest, **27**(suppl.): 349-356.

---

1) In my work on these bees of the Tatra Mts (DYLEWSKA 1991) I expressed an opinion on the period (periods) from which come the above-named species found in the altitudinal zones with a mesoclimate that now makes.

DYLEWSKA M. 1987. Die Gattung *Andrena* FABRICIUS (*Andrenidae, Apoidea*) in Nord- und Mitteleuropa. Acta zool. cracov., Kraków, **30**, **12**: 359-708.

DYLEWSKA M. 1991. *Apoidea* of the Tatra Mountains and of the adjacent area. Part I. *Colletidae, Andrenidae, Halictidae, Melittidae, Megachilidae* and *Anthophoridae*. Acta zool. cracov., Kraków, **34**(1): 189-265.

EBMER A. W. 1969. Die Bienen des Genus *Halictus* LATR. s. l. im Grossraum von Linz (*Hymenoptera, Apidea*). Systematik, Biographie, Ökologie and Biologie mit Berücksichtigung aller bisher aus Mitteleuropa bekannten Arten. Teil I. Naturk. Jahrb. St., Linz: 133-183.

EBMER A. W. 1970. Die Bienen des Genus *Halictus* LATR. s. l. im Grossraum von Linz (*Hymenoptera, Apidea*). Teil II. Naturk. Jahrb. St. Linz: 19-82.

EBMER A. W. 1974. Die Bienen des Genus *Halictus* LATR. s. l. im Grossraum von Linz (*Hymenoptera, Apidea*). Nachtrag und zweiter Anhang. Naturk. Jahrb. St. Linz: 123-158.

EBMER A. W. 1975. Die Bienen des Genus *Halictus* LATR. s. l. im Grossraum von Linz (*Hymenoptera, Apidea*). Teil III. Linz. Biol. Beitr., Linz, **7**(1): 41-118.

EBMER A. W. 1988. Kritische Liste der nicht-parasitischen *Halictidae* Österreichs mit Berücksichtung aller mitteleuropäischen Arten (Insecta: *Hymenoptera*: *Apoidea*: *Halictidae*). Linz. Biol. Beitr., Linz, **20**(2): 527-711.

FRANZ H. 1943. Die Landtierwelt der mittleren Hohe Tauern. Ein Beitrag zur Tiergeographischen und -Sociologischen Erforschung der Alpen. Mit Beiträgen von. E. LINDNER (Stuttgart) and O. WETTSTEIN (Wien) sowie unter Mitwirkung zahlreicher Spezialisten. Denkschr. Akad. Wiss. Wien, math-naturw. Klasse, Wien, 107, 552 pp.

FRANZ H. 1949. Erster Nachtrag zur Landtierwelt der mittleren Hohen Tauern. Sitzungsber. Österr. Akad. Wiss. math.-naturw. Klasse, Wien, **158**: 1-77.

GAMS H. 1936. Beiträge zur Pflanzengeographishen Karte Österreichs. I. Die Vegetation des Grossglocknergebietes. Abh. Zool. Bot. Ges. Wien, **16**(2): 1-79.

GIRAUD J. 1861. Fragments entomologiques. I. Description de plusieurs *Apides* nouvelles et observations sur quelques espèces connues. Verh. Zool.-Bot. Ges. Wien, **11**: 447-470.

GRÜNDING P. 1962. Über die Vegetazionsverhältnisse der Schweiz. in: Blotzheim U. N. G. v. Die Brutvögel der Schweiz, ihre Verbreitung und Lebensweise, Aarau: 95-164.

GUSENLEITNER F. 1984. Faunistische und morphologische Angaben zu Bemerkenswerten *Andrena* – Arten aus Österreich (Insecta: *Hymenoptera*: *Apoidea*: *Andrenidae*). Linz. Biol. Beitr., Linz, **16**(2): 211-276.

HESS M. 1965. Piętra klimatyczne w Polskich Karpatach Zachodnich. Zeszyty nauk. Uniw. Jagiell., Kraków, **115**: 1-258.

LEEDER F., REITER M. 1959. Kleine Flora des Landes Salzburg. Neue Übersicht über die Farn- und Blütenpflanzen, Salzburg, 348 pp.

MORAWITZ F. 1872. Ein Beitrag zur Bienenfauna Deutschlands. Verh. zool.-bot. Ges., Wien, **22**: 355-388.

PAWŁOWSKI J. 1967. The beetles (*Coleoptera*) of Babia Góra Mt. (Polish Western Carpathians). Acta zool. cracov., Kraków, **12**(6): 419-665.

SCHLETTERER A. 1887. Die Bienen Tirols. Jber. Staatsrealschule, Wien, **12**: 1-28.

SCHMIEDEKNECHT O. 1930. Die *Hymenoptera* Nord- und Mitteleuropas mit Einschluss von England, Südschweiz und Ungarn., Jena, 712-1053 pp.

STOECKHERT F. K. 1933. Die Bienen Frankens. (Hym. Apid.). Dtsch. ent. Z., Berlin, 1932, Beiheft, 294 pp.

STOECKHERT F. K. 1954. Fauna Apoideorum Germanie. Ab. Bayer. Acad. Wiss. Math. -naturw. Kl. N. F. München **65**: 3-87.

STÜBER E. 1967. Salzburger Naturführer, Salzburg.

TOMIAŁOJĆ L. 1990. Ptaki Polski. Rozmieszczenie i liczebność. PWN Warszawa, pp. 461.

TUTIN T. G., HEYWOOD V. H., BURGES N. A., VALENTINE D. H., WALTERS S. M., WEBB D. A. (eds.) 1964. Flora europaea. I. Cambridge Univ. Press, Cambridge, ss. XXXII + 464.

TUTIN T. G., HEYWOOD V. H., BURGES N. A., MOORE D. M., VALENTINE D. H., WALTERS S. M., WEBB D. A. (eds.) 1968. Flora europaea. II. Cambridge Univ. Press, Cambridge, London, New York, Melbourne, ss. XXVII + 455.

TUTIN T. G., HEYWOOD V. H., BURGES N. A., MOORE D. M., VALENTINE D. H., WALTERS S. M., WEBB D. A. (eds.) 1972. Flora europaea. III. Cambridge Univ. Press, Cambridge, ss. XXIX + 370.

TUTIN T. G., HEYWOOD V. H., BURGES N. A., MOORE D. M., VALENTINE D. H., WALTERS S. M., WEBB D. A. (eds.) 1976. Flora europaea. IV. Cambridge Univ. Press, Cambridge, London, New York, Melbourne, ss. XXIX + 505.

TUTIN T. G., HEYWOOD V. H., BURGES N. A., MOORE D. M., VALENTINE D. H., WALTERS S. M., WEBB D. A. (eds.) 1980. Flora europaea. V. Cambridge Univ. Press, Cambridge, London, New York, New Rochelle, Melbourne, Sydney, ss. XXXVI + 452.

WESTRICH P. 1989. Die Widbienen Baden-Württembergs. Allgemeiner Tiel: Lebensräume, Verhalten, Ökologie und Schutz. Spezieller Teil: Die Gattungen und Arten. Stuttgart, 431 pp.