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Apoidea of the Tatra Mountains and the adjacent area. Part I. *Colletidae, Andrenidae, Halictidae, Melittidae, Megachilidae,* and *Anthophoridae*

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Abstract. Altogether 139 species of *Apoidea* (excluding the family *Apidae*) were recorded from the Tatras (92) and from the sub-Tatra zone (47). Their occurrence is restricted above all to warm places and the presence of food plants and suitable sites for nesting. 27 (19.5%) species are montane, north-montane, north-central-European, and Euro-Siberian elements. 70 (50%) are xerothermic species. The species live only in the warmest places and are relicts of the warmer post glacial period, when meso-climatic conditions prevailed here, enabling them to spread. Similarly, a few of their highest localities are relict ones.

Key words: *Colletidae, Andrenidae, Halictidae, Melittidae, Megachilidae* and *Anthophoridae*, Tatra Mts

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I. INTRODUCTION

Investigations on the *Apoidea* fauna of the Polish Tatras and the adjacent area were initiated by WIERZEJSKI (1868, 1874), then continued by ŚNIEŻEK(1910), NOSKIEWICZ (1920), DYLEWSKA (1958), and in Czechoslovakia by MOCSÁRY (1918), BALTHASAR (1952), and BELÁKOVÁ (1980). Altogether, from the Tatras and from the sub-Tatra zone these authors reported 108 *Apoidea* species including 83 belonging to the families discussed in the present paper. The remaining 25 species constitute representatives of the family *Apidae*, which will be described in Part II of this monograph.

In his paper dealing with the *Aculeata* of the Polish Tatras NOSKIEWICZ (1920) determined several altitudinal limits of distribution of particular species paying special attention to the altitude 1150 m, above which he was able to record only single species.

In summing up the data on the *Apoidea* of the High Carpathians DYLEWSKA (1970) revealed that the upper limits of the altitudinal distribution of the *Apoidea* were connected with the climatic zones distinguished by HESS (1965). Moreover, the author found that their sensitivity to climatic conditions limits their places of nesting and flying to the warmest localities. Such localities are to be found on northwestern and northern edges of glades or forest clearing as well as in their central parts, and above the timber line on south or southeastern slopes, in places sheltered from the north and west by unevan terrain. TOMANEK (1952) in his work on the microclimate of forest clearings in our latitude showed that the warmest and best isolated places with the lowest precipitation and shortes period of snow cover were indeed situated on the northwestern and northern margins and the middle of forest clearings.

The present studies on the *Apoidea* fauna of the Tatras were carried out over the whole area of this mountain range and in the sub-Tatra zone in the period from 1967-1988. The author collected 2006 specimens of the family *Apoidea* (except the family *Apidae*). Besides, the author made use of the collections of J. ZABŁOCKI, J. FUDAKOWSKI, A. WIERZEJSKI, J. ŚNIEŻEK, P. ŁOZIŃSKI, O. RADOSZKOWSKI and Z. MIREK kept at the Institute of Systematics and Evolution of Animals of the Polish Academy of Sciences in Cracow. In elaborating of these collections she found only some of the specimens published by WIERZEJSKI (1868, 1884) and ŚNIEŻEK (1910), these having been identified anew by J. NOSKIEWICZ. The author was also able to establish that NOSKIEWICZ's collection from the Tatras and sub-Tatra zone, kept in the Museum of the University of Wrocław, is incomplete. Particularly important was the finding in this collection of one specimen of *Lasioglossum cupromicans* whose presence in the Tatras might have been questioned. A.W. EBMER identified this specimen as well as the part of the present author's material from the genus *Lassioglossum*, which is given in the list of species.

The author wishes to express her sincere thanks to A.W. EBMER as well as to W. CELARY , who examined the Wrocław collection and searched for her the material gathered by NOSKIEWICZ in the Tatras and sub-Tatra zone. She is also grateful to Mrs L. BIELECKA and Mrs L. SWAT for making the calculations in the tables of the present paper.

II. DESCRIPTION OF THE AREA

The Tatras are the highest mountain range of the West Carpathians (KONDRACKI 1978). Their main ridge is 52 km long, while their width is about 16 km, three parts being distinguished: the High Tatras, Belanské Tatras, and West Tatras. The High Tatras are built of granite and characterized by a large number of peaks of over 2490 m (fig. 1), the highest of them, Mt. Gerlachovska, reaching 2656 m. The remaining parts of the Tatras are built chiefly of limestone, only some sectors of the West Tatras being also of granite. The highest peak of the West Tatras, Mt. Bystra, is 2250 m in altitude. The Belanské Tatras are formed of the massifs of Mts Havran and Muran, the higher of which reaches 2151 m.

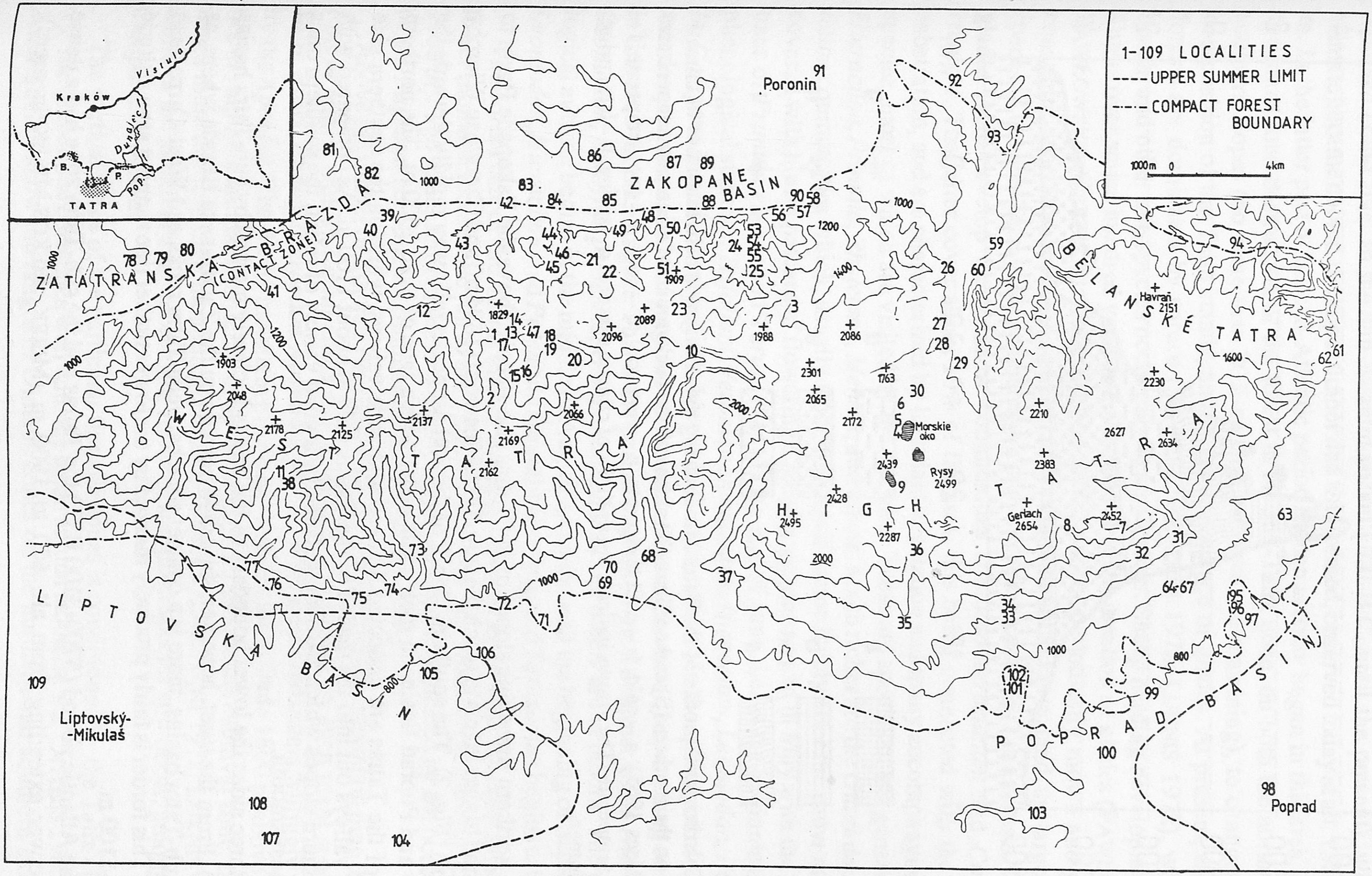

Fig. 1. Schematic map of the Tatra Mts showing the situation of localities (1-109) where the specimens were collected (see pp. 195-196) on the background of altitudes and main geographical units. Top left: situation of the Tatra Mts and other discussed regions (B – Mt Babia Góra, P – Pieniny Mts, Pop – Poprad River).

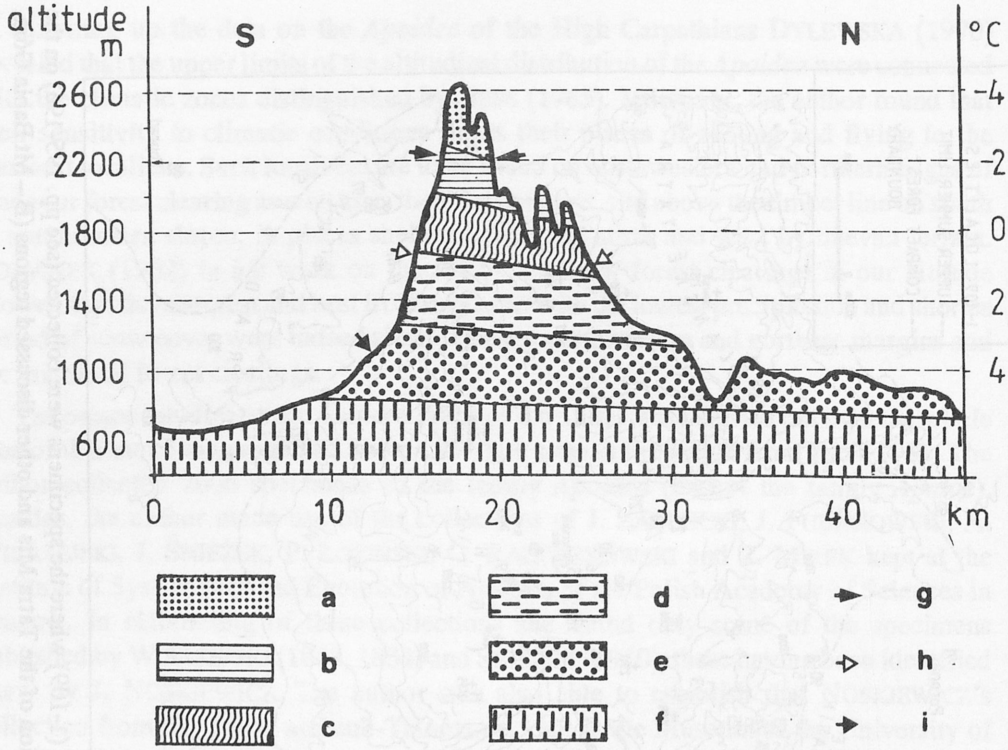

Fig. 2. Overheighted profile of the Tatra Mts showing the differences between limits of climatic zones on the southern (S) and northern (N) slopes on the background of mean year temperatures (acc. Hees 1965): a – cold, b – cold temperate, c – very cool, d – cool, e – cool temperate, f – warm temperate. The arrows indicate upper limits of climate seasons: g – spring, h – late spring, i – summer.

The northern limestone slopes of the Tatras rise steeply above the Zakopane Basin to higher and higher levels to reach the summits of Giewont (1894 m) and Czerwone Wierchy (2123 m) (Fig. 2). The southern slopes of the highest peaks fall away rapidly towards the Liptów and Poprad Basins in rock walls many with a face of even 2000 m. The northern slopes of the Tatras are dissected by deep and wide valleys, while on the southern side narrow valleys out into the massif of the Tatras only at about 1100 m. As compared with the northern slopes which are distinguished by a great variety of relief, the southern ones are almost smooth.

On three sides the lower boundary of the Tatras is clearly marked by sub-Tatra basins (Fig. 1). From the west, however, the range borders on the Zatatranska Brazda where, as in the sub-Tatra basins, there is a contact zone between Tatra rocks and West-Carpathian flysch. This forder is fairly precisely marked by the lower timber line running at an altitude of 900-1100 m.

In the Atlantic period (5700-3100 B.C.) the Tatras and the sub-Tatra zone had a dense forest cover extending from alt. 600 to 1900 m (MIREK, PIĘKOS-MIREK in press).

However, within this forest there were open spaces (windfalls and landslides) where the *Apoidea* could live. In the sub-Atlantic period (300 B.C. until the present), when the climate became cooler, the upper timber line was formed, observed today at alt. 1550-1650 m. In the latter part of the sub-Atlantic period human activity began in this area, leading to almost total destruction of the forest in the sub-Tatra zone, on both the northern and southern slopes (no more than 20% of their previous are remaining), to changes in the composition of the Tatra stands, and to the appearance of glades. At present, the Tatra forests are dominated by spruce (SZAFER, ZARZYCKI 1972, LUKNIŠ 1972), while fir, beech, and other tree species occur only in small areas. Sheep herding developing in the Tatras over seven hundred years has contributed to the creation of glades (PAWŁOWSKI, PAWŁOWSKA, ZARZYCKI 1960, LUKNIŠ 1972) which, periodically mown and grazed, constitute, apart from the small areas of cultivated fields and built-up land, the largest open speces in the sub-Tatra zone and occupy a considerable area in the Tatra forests. In these glades there develop the meadow communities *Gladiolo-agrostietum* and *Cirsietum rivulare*. The latter cover about 10% of the area, this being connected with the humid substratum, and are characterized by luxuriant vegetation and many accompanying plant species, most of which are visited by the *Apoidea*. These are species of the genera *Salix, Hieracium, Primula, Phyteuma, Mentha*, and others. Much richer are the *Gladiolo-Agrostetum* communities which, usually from mid-April, immediately after the snow melt, are covered with bluish patches of flowering *Crocus scepusiensis* and in May with the yellow ones of *Primula elatior* and *Taraxacum*. At the end of June, i.e. at the beginning of the phenological summer, *Trifolium, Veronica chamaedris, Hieracium, Leontodon, Potentilla, Campanula*, and others begin to bloom in these meadows. In the early part of July the meadows have reached full growth and should be mown. However, hay-making continues in this area till mid-August. This is the period of phenological summer when *Hieracium, Leontodon, Lathyrus pratensis, Campanula patula*, and others are in bloom. The phenological autumn begins in the middle of August and lasts until the beginning of September. *Leontodon, Hieracium*, and *Potentilla* are still flowering, and *Taraxacum* begins to bloom.

The forest belt of the Tatras and of the adjacent area is divided into two zones: the lower montane forest zone (up to alt. 1200 m) and upper montane forest zone (up to about 1600 m). The upper limit of the lower montane forest zone is indicated by the occurrence of the *Fagetum carpaticum* community (PAWŁOWSKI 1956).

Above the timber line there extends the subalpine zone of dwarf mountain pine thickets *Pinion mughi* with *Pinus montana* ssp. *mughus* accompanied by such plant species as *Salix, Ribes, Padus, Hieracium, Aconitum firmum, Vaccinium* and others willingly visited by the *Apoidea*. The dwarf mountain pine zone reaches the altitude 1800 m above which lies the alpine zone and from 2250 m up to the highes summits the subnival zone. In these zones there develop high montain grasslands (SZAFER, ZARZYCKI 1972, LUKNIŠ 1972), while in the subnival zone more than 100 vascular plant species still occur, among them *Campanulla alpina*.

The vertical range of the particular floristic zones is conditioned by the Tatra climate, e.g. the timber line correlates well with the mean annual isotherm + 2^{o}C (HESS 1965). Fig. 2 and Table I show the ranges of climatic zones on the northern and southern slopes of the Tatras and Table I indicates additionally their ranges in the valleys. As can be seen from Fig.2 and Table I, the limits of climatic zones on southern slopes run higher by about 100 m than those on norhern ones. In the Tatra valleys the observed differences depend upon their width. Thus, in narrow valleys the limits are lowered by about 300 m as compared with the slopes, but in wide ones by no more than 150 m. Also the upper limits of climatological seasons run at different altitudes according to the slope aspect (KONČEK 1974). Climatic summer, in which the number of days with on average daily temperature above 15°C is at least 15, occurs on southern slopes up to an altitude of about 1000 m (Fig. 1). On the northern side of the Tatras and sub-Tatra zone there is no climatic summer, and its upper limit is beyond the investigated area. The upper limit of climatic late spring, when the number of days with an average daily temperature above 10°C is at least 15, runs at a similiar altitude on the two slopes (±1600–1650 m), also in lower part of sub-alpine zone. Climatic spring with an average daily temperature of least 5°C ends in the upper limit of the alpine zone (±2200 m).

Table I

Dependences of height and limits of vertical plant zones upon relief in Tatra Mts (after HESS, 1965)

Plant zones	Upper limit of zone					
	North slopes			South slopes		
	slopes	broad valleys	small valleys	slopes	broad valleys	small valleys
Oats cultivation	1135	985	835	1205	1055	905
Lower mountain forest zone	1266	1181	1096	1322	1237	1152
Upper mountain forest zone	1567	1482	1397	1628	1538	1453
Subalpine zone	1750	1678	1607	1882	1810	1739
Alpine zone	1921	1849	1778	2053	1981	1910

III. METHODS

The study depended on catching practically all the observed specimens of *Apoidea* belonging to the families discussed in this part of the monograph. Catches were repeted 3-4 times in the same localities, chiefly in forest areas, duing one growing season. Repeated catches in the same localities were essential because particular species are characterized by limited times of appearence, lasting about two months (early spring, late spring, and summer bees, and II and III generations).

Because of the fact that the investigated families of *Apoidea* occur in the Tatras and sub-Tatra zone only in the warmest places (DYLEWSKA 1970), the localities had to be sought with the help of maps, visual assessment of the terrain, and persistent penetration of as many possible of the previously selected areas. The investigations were carried out in all the altitudinal zones of the Tatras.

The field studies covered 14 vegetation periods, in the years 1967-1988, and lasted each year for one to two months. Studies of long duration were essential because of the vast area they covered and the variable Tatra weather, and the associated long cold spells which prevented bees from pesing.

In the identification of insects and processing of data the author made use of recent monographs (DATHE 1980, EBMER 1969, 1970, 1974, 1975, 1988, DYLEWSKA 1987) dealing with the particular genera, namely: *Hylaeus*, *Halictus*, *Lasioglossum*, and *Andrena* as well as of works by SCHMIEDEKNECHT (1930) and STOECKHERT (1933).

In the chapter entitled: "List of species" the particular altitudinal zones are marked with Roman numericals. They are as follows:

I.	Sub-Tatra zone	- ca. 600-900 m
II.	Lower montane forest zone	- ca. 900-1200 m
III.	Upper montane forest zone	- ca. 1200-1550 m
IV.	Subalpine zone	- ca. 1550-1800 m
V.	Alpine zone	- ca. 1800-2200 m
VI.	Subnival zone	- ca. 2200-2663 m

Northern (N) and southern (S) slopes are also marked in the list of species.

Species of the families *Colletidae*, *Andrenidae*, *Halictidae*, *Megachilidae*, and *Anthophoridae* were found in zones I-IV, but they were not recorded from zones V-VI in spite of careful searching.

All the collected specimens of the investigated families were caught in 109 localities. These are presented successively with regard to the division into the above-mentioned zones (Fig. 1):

Zone IV N: 1 - Iwaniacka pass, 2 Siwe Sady slopes, 3 - slope of Mt. Kasprowe Uhrocie, 4 - Lake Morskie Oko, 5 - slope of Miedziane Mt., 6 - slope of Opalone Mt.

Zone IV S: 7 - slope of Mt. Slavkovský, 8 - Velická Val., 9 - Popradské Pleso Lake, 10 - Ticha Val., 11 - Track to Jalovské pass.

Zone III N: 12 - Hala Chochołowska meadow, 13 - slope of Mt Kominy Tylkowe, 14 - Hala Smytnia Wyżnia meadow, 15 - Hala Ornak Wyżnia meadow, 16 - Hala Ornak meadow, 17 - Ornak couloir, 18 - Żar slope, 19 - Tomanowa Val., 20 - Hala Tomanowa meadow, 21 - Hala Kondratowa meadow, 22 - Hawiarska path, 23 - Hala Kondratowa meadow, 24 - slope of Mt Kalacka Turnia, 25 - slope of Mt Boczań, 26 - Polana Rusinowa meadow, 27 - slope of Mt Wołoszyn, 28 - Wodogrzmoty Mickiewicza waterfall, 29 - road to lake Morskie Oko, 30 - Mt Opalone.

Zone III S: 31 - Hrebienok, 32 - above Nový Smokovec, 33 - Vyšné Hagi, 34 - above Vyšné Hagi, 35 - Štrbské Pleso lake, 36 - Mengusovska Val., 37 - Tri studničky, 38 - Žiarska Val.

Zone II N: 39 - Juranová Val., 40 - Bobrovska Val., 41 - Zverovka, 42 - Siwa Polana meadow, 43 - Chochołowska Val., 44 - Wyżnia Kira Miętusia meadow, 45 - Kościeliska Val., 46 - Polana Zahradziska meadow, 47 - Hala Smytnia Niżnia meadow, 48 - Ku Dziurze Val., 49 - Mała Łąka Val., 50 - Strążyska Val., 51 - Hala Strążyska meadow, 52 - Jatki slope, 53- Kuźnice, 54 - road to Kalatowki, 55 - Kalatowki meadow, 56 - Jaworzynka Val., 57 - Olczyska Val., 58 - Toporowa Cyhrla, 59 - Łysa Polana meadow, 60 - Biała Woda Val.

Zone II S: 61 - above Tatranská Kotlina, 62 - Tatranská Kotlina, 63 - Tatranská Lomnica, 64 - Nový Smokovec, 65 - Starý Smokovec, 66 - Horný Smokovec, 67 - Sybir, 68 - Ticha Val., 69 - Podbanské, 70 - above Podbanské, 71 - Hrdovo, 72 - slope of Mt Suchy hrádok, 73 - slope of Mt Klinovaté, 75 - Brišné, 76 - Uboč meadow, 77 - Žiarská Val.

Zone I N: 78 - near Zuberec, 79 - Blatná, 80 - Brestová, 81 - Oravice, 82 - Ticha Val., 83 - Siwa Woda Val., 84 - Kiry, 85 - Gronik Kościeliski, 86 - Palenica, 87 - Gubałówka, 88 - Zakopane, 89 - slope of Mt Antałówka, 9- - Jaszczurówka Bory, 91 - slope of Mt Galicowa Grapa, 92 - Bukowina Tatrzańska, 93 - Głodówka, 94 - Ždiar.

Zone I S: 95 - Dolný Smokovec, 96 - Pod lesom, 97 - Nová Lesná, 98 - Poprad, 99 - Gerlachov, 100 - Batižovce, 101 - Štola, 102 - Nižné Hági, 103 - Lučivna, 104 - Kralová Lechota, 105 - Pribyliná, 106 - Potočký, 107 - Liptovský Hradok, 108 - Podturen, 109 - Lučky.

The names of plants are given after SZAFER, KULCZYŃSKI, PAWŁOWSKI (1986). The names of villages given by MOCSÁRY (1918) in Hungarian are given, in the list of species, in Slovakia according to PFOHL (1931).

IV. LIST OF SPECIES

The particular species are shown according to the following scheme:

Current No. Full Latin name. Zone No: No of locality - date (Roman numericals indicate months), No and sex of specimens (♀ and ♂), plant genus or species if the insect was caught on a flower; No of the next locality - ...(and so on).

Some of the above data may be missing in the case of specimens coming from a collection not gathered by the author or in the case of those mentioned in papers by authors quoted in the introduction. In such cases the names of collections or authors are given.

Colletidae

1. *Colletes cunicularius* (LINNAEUS, 1761).

II N: 43 - 13 V 1967, ♂ on *Salix*.

2. *Colletes daviesanus* SMITH, 1846.
I N: 88 - July (ŚNIEŻEK 1910);
I S: 98 - MOCSÁRY (1918).

3. *Hylaeus gibbus* (SAUNDERS, 1850).
I N: 92 - 4 VIII 1939, ♂ leg. ZABŁOCKI.

4. *Hylaeus signatus* (PANZER, 1798).
I N: 78 - 16 VI 1972, ♂ on *Reseda lutea*.

5. *Hylaeus confusus* NYLANDER, 1848.
I N: 79 - 27 VII 1967, ♀. 82 - 29 VII 1967, ♀ on *Potentilla*;
II N: 40 - 29 VII 1967, ♀ ♂ on *Hieracium*. 58 - 1 VIII 1920, ♂ leg. NOSKIEWICZ;
II S: 69 - 19 VII 1977, ♂. 72 - 22 and 30 VII 1977, 4 ♀♀ on *Leontodon*. 75 - 23 VII 1977, ♂.

6. *Hylaeus annulatus* (LINNAEUS, 1758)
I N: 88 - 19 VIII 1987, ♂.
II S: 69 - 19 VII 1977, ♀ on *Digitalis lutea*. 72 - 30 VII 1977, ♀ on *Leontodon*.
III N: 19 - 20 VIII 1977, ♀ on *Potentilla*.

7. *Hylaeus cardioscapus* COCKERELL, 1924
I N: 88 - 17 VI 1969, ♀ on *Hieracium*. 89 - 20 VII 1987, 2 ♀♀ on *Stachys* and *Veronica*. 91 - 16 VII 1987, ♀ on *Campanulla patula*. 92 - 4 VIII 1987, ♂ leg. ZABŁOCKI.

8. *Hylaeus communis* NYLANDER, 1852
I N: 89 - 20 VII 1987, 7 ♀♀ on *Stachys* and *Veronica*. 91 - 16 VII 1987, ♀.

9. *Hylaeus nigritus* (FABRICIUS, 1798)
II S: 72 - 30 VII 1977, ♂.

10. *Hylaeus hyalinatus* SMITH, 1842
I N: 89 - 20 VII 1987, ♀ on *Veronica*.
I S: 95 - 26 VI 1972, ♀ on *Hieracium*. 107 - 13 IX 1979, 3 ♀♀ on *Scabiosa*. 108 - 13 IX 1979, ♀ on *Hieracium*.
II S: 69 - 19 VII 1977, ♂ on *Digitalis lutea*. 72 - 30 VII 1977, ♂. 75 - 23 VII 1977, ♀ on *Potentilla*.

11. *Hylaeus cornutus* (SMITH, 1842
II S: 63 - BALTHASAR (1952)

Andrenidae

12. *Andrena labialis* (KIRBY, 1802)
I N: 92 - 15 VI 1939, ♂ leg. ZABŁOCKI.

13. *Andrena haemorrhoa* (FABRICIUS, 1781)
I N: 83 - 14 V 1967, 3 ♀♀ and 6 ♂♂ on *Salix*. 87 - 17 V 1988, 2 ♀♀ and ♂ on *Salix*. 88 - 18 V 1988, ♂ on *Salix*. 89 - 16 and 19 V 1988, ♀ and 11 ♂♂ on *Salix*. 93 - 11 V 1967, ♂ on *Tussilago farfara*.

I S: 96 - 14 V 1975, ♀. 97 - 13 V 1975, ♂ on *Salix*. 105 - 12 and 17 V 1985, 5 ♀♀ on *Salix fragilis*. 107 - 11 V 1985, 3 ♀♀ on *Salix aurita*.
II N: 42 - 13 V 1967, 2 ♂♂ on *Salix*. 44 - 12 V 1967, ♀ and 5 ♂♂ on *Salix*. 56 - 19 VI 1970, ♂ on *Potentilla aurea*.
II S: 69 - 20 V 1985 9 ♂♂ on *Salix aurita* and near by sprigs of the *Picea excelsa*. 71 - 20 V 1985, 4 ♂♂ on *Salix aurita* and *Taraxacum officinale*. 74 - 17 V 1985, 3 ♀♀ on *Salix aurita*.
IV N: 5 - 22 VI 1970, ♀ on *Vaccinium myrtillus*.

14. *Andrena hattorfiana* (FABRICIUS, 1775)

All specimens on *Knautia arvensis*.
I N: 78 - 16 VI 1972, ♀. 84 - 31 VIII 1967, ♀. 91 - 16 VII 1987, ♀. 94 - 21 VII 1965, 5 ♀♀.
I S: 95 - 22 VI 1972, 2 ♀♀.
II S: 65 - MOCSÁRY (1918). 72 - 22 VII 1977, 3 ♀♀.

15. *Andrena schencki* MORAWITZ, 1866

I N: 78 - 16 VI 1972, ♀ on *Medicago*.

16. *Andrena rufizona* PÉREZ, 1834

I N: 91 - 16 VII 1987, ♂ on *Rosa canina* leg. MIREK.
II N: 58 - 9 VIII 1919, ♂ (NOSKIEWICZ 1920).

17. *Andrena nigroaenea* (KIRBY, 1802)

I N: 78 - 16 VI 1972, ♀ on *Reseda lutea*.
I S: 95 - 29 V 1972, 2 ♂♂ on *Potentilla aurea* and 22 VI 1972, 3 ♂♂.

18. *Andrena flavipes* PANZER, 1799

I N: 84 - 4 VIII 1968, ♀.
II S: BELÁKOVÁ (1980)

19. *Andrena gravida* IMHOFF, 1832

IV N: 2 - 5 VIII 1968, ♀ on *Leontodon*.

20. *Andrena limata* SMITH, 1853

I S: 103 - MOCSÁRY, 1918.

21. *Andrena nitida* (MÜLLER, 1775)

II S: BELÁKOVÁ (1980).

22. *Andrena cineraria* (LINNAEUS, 1758)

I N: 88 - 3 V 1908, ♀ leg. ŚNIEŻEK.

23. *Andrena combinata* (CHRIST, 1791)

I S: 95 - 22 VI 1972, ♂ and 29 V 1973, 10 ♂♂ on *Potentilla aurea*.
II S: 69 - 20 V 1985, ♂ on *Vaccinium myrtillus*.

24. *Andrena wilkella* (KIRBY, 1802)

I N: 92 - 12-24 VIII 1939, 6 ♀♀ leg. ZABŁOCKI.
I S: 95 - 22 VI 1972, ♀ and 3 ♂♂ near by branches of *Picea excelsa*.

25. *Andrena ovatula* (KIRBY, 1802)

I N: 78 - 16 VI 1972, ♀ on *Reseda lutea*. 94 - 21 VII 1965, ♀. 91 - 16 VII 1987, ♀.

I S: 95 - 22 VI 1972, 12 ♂♂. 100 - 21 IX 1979, ♀. 103 - 21 IX 1979, ♀ on *Trifolium*.

II S: 62 - 21 VI 1972, ♀ on *Hieracium*. 66 - 28 VI 1972, ♀ on *Echium vulgare*.

26 *Andrena minutula* (KIRBY, 1802)

I S: 105 - 20 VII 1977, ♀ on *Hieracium*.

II S: 63 - 21 V 1972, ♀ on *Hieracium*. 69 - 25 V 1985, 2 ♀♀ on *Salix aurita*.

III N: 20 - 8 VI 1967, 2 ♀♀ on *Potentilla aurea*.

27. *Andrena minutuloidea* PERKINS, 1914

I S: 105 - 20 VII 1977, ♀ on *Hieracium*. 109 - 23 V 1985, ♀ on *Salix fragilis*.

28. *Andrena falsifica* PERKINS, 1915

I S: 95 - 29 V 1973, 8 ♀♀ and 2 ♂♂ on *Potentilla aurea*, *Veronica chamaedris* and *Taraxacum officinale*. 97 - 30 V 1973, ♀ on *Taraxacum officinale*. 109 - 23 V 1985, ♀ on *Salix fragilis*.

II N: 47 - 16 V 1967, ♀ on *Gagea lutea*.

II S: 63 - 21 V 1973, 2 ♀♀ and m and 21 VI 1972, ♀ on *Hieracium*. 71 - 20 V 1985, 2 ♂♂ on *Taraxacum officinale*. 76 - 16 V 1985, ♀ on *Taraxacum officinale*.

III N: 19 - 5 VII 1971, ♀ on *Potentilla erecta*.

29. *Andrena semilaevis* PÉREZ, 1903

I S: 95 - 29 V 1973, ♂ on *Potentilla aurea*. 109 - 23 and 29 V 1985, ♀ and 2 ♂♂ on *Salix fragilis*.

II N: 45 - 13 V 1971, ♀.

II S: 67 - 30 V 1973, ♀. 77 - 16 V 1985, ♀ on *Salix aurita*.

III N: 21 - 18 VI 1969, 5 ♀♀ on *Potentilla erecta*.

III S: 38 - 25 VII 1977, ♀ on *Potentilla erecta*.

30. *Andrena subopaca* NYLANDER, 1848

I N: 80 - 27 VII 1967, ♂. 81 - 25 VII 1967, 2 ♀♀ on *Potentilla*. 84 - 14 V 1967, ♂ on *Tussilago farfara* and 31 VIII 1967, ♀ on *Hieracium*. 88 - 14 VII 1908, ♀ leg. ŚNIEŻEK. 89 - 16 V 1988, ♀ on *Salix*.

I S: 105 - 20 VII 1977, ♀ on *Leontodon*.

II N: 41 - 27 VII 1967, 6 ♀♀ on *Hieracium*. 47 - 16 V 1967, ♀ and ♂ on *Gagea lutea*. 50 - 17 VI 1969, 2 ♀♀ on *Taraxacum officinale*. 51 - 26 VI 1970, 3 ♀♀ on *Veronica chamaedris*. 53 - 19 VI 1970, 2 ♀♀ on *Potentilla aurea*. 54 - 15 V 1967, ♀. 55 - 27 and 29 VI 1969, 3 ♀♀ and ♂ and 11 VIII 1967, ♀ on *Potentilla aurea*. 56 - 25 VI 1967, ♀ on *Hieracium* and 19 and 26 VI 1970, 11 ♀♀ on *Taraxacum officinale*, *Potentilla aurea*, *Veronica chamaedris* and *Rannunculus*. 58 - 29 VI 1969, ♀ on *Hieracium*. 60 - 11 VIII 1973, ♀.

II S: 63 - 31 VI 1976, ♀ on *Leontodon*. 68 - 14 V 1985, ♀ on *Potentilla*. 69 - 14 V 1985, ♀ on *Tussilago farfara*. 71 - 29 VII 1977, 2 ♀♀ on *Potentilla erecta*. 72 - 30 VII 1977, ♀. 75 - 23 VII 1977, ♀ on *Potentilla erecta*. 77 - 25 VII 1977, ♀.

III N: 15 - 7 VIII 1971, 2 ♀♀ on *Potentilla erecta*. 16 - 19 VIII 1971, ♀ on *Potentilla*. 19 - 20 VIII 1971, 2 ♀♀ on *Hieracium*. 21 - 18 VI 1969, ♀ on *Potentilla erecta*. 23 - 8 VI

1967, 15 ♀♀ and 2 ♂♂ on *Potentilla aurea* and 24 VI 1967, ♀ and ♂ on *Hieracium*. 26 - 12 VIII 1973, ♀. 27 - 27 VII 1968, ♀ on *Hieracium*. 29 - 5 VIII 1968, ♀ on *Potentilla*.

IV N: 1 - 4 VII 1967, ♀ on *Potentilla*.

31. *Andrena coitana* (KIRBY, 1802)

I N: 84 - 31 VIII 1967, ♀ on *Hieracium*. 88 - 10 VII 1919, ♂ leg. ŁOZIŃSKI and 14 VII 1908, 3 ♀♀ leg. ŚNIEŻEK and 31 VII - 22 VIII, 4 ♀♀ leg. WIERZEJSKI. 89 - 20 VII 1987, ♀ and 3 ♂♂ on *Veronica*. 92 - 12-21 VII 1939, 12 ♂♂ and 12 VII - 8 VIII 1939, 7 ♀♀ leg. ZABŁOCKI. 94 - 21 VII 1965, ♀ and 31 VIII 1965, ♂.

I S: 105 - 20 VII 1977, ♀ on *Leontodon*.

II N: 41 - 27 VII 1967, 2 ♀♀ on *Chamaenerion angustifolium*. 46 - 18 VI 1967, 2 ♀♀ on *Potentilla erecta*. 50 - 20 VII and 4 VIII 1923, 2 ♀♀ leg. FUDAKOWSKI. 60 - 24 VIII 1956, ♀.

II S: 72 - 22 VII 1972, ♀ and ♂ on *Leontodon*.

III N: 15 - 24 VII 1974, 2 ♀♀ on *Hieracium* and 7 VIII 1976, 9 ♀♀ on *Potentilla erecta*. 17 - 7 VIII 1976, 2 ♀♀ on *Potentilla*. 18 - 10 VII 1976, 2 ♀♀ on *Hieracium*. 19 - 5 VII 1974, 2 ♀♀ on *Potentilla erecta*. 26 - 12 VIII 1973, 3 ♀♀. 27 - 27 VII 1967, ♀ on *Hieracium*.

III S: 37 - 27 VII 1977, ♀ on *Hieracium*.

32. *Andrena denticulata* (KIRBY, 1802)

I N: 88 - 31 VII 1968, 2 ♂♂ leg. WIERZEJSKI and 19 VIII 1968, ♀. 92 - 18 and 22 VII 1939, 2 ♂♂ leg. ZABŁOCKI.

33. *Andrena nigriceps* (KIRBY, 1802)

II N: 58 - 9 VIII 1919, ♀ (NOSKIEWICZ 1920).

34. *Andrena bicolor* FABRICIUS, 1775

I N: 84 - 31 VIII 1967, ♀ on *Leontodon*. 89 - 20 VII 1987, 2 ♀♀ on *Hieracium* and *Campanula*. 91 - 16 VII 1987, 6 ♀♀ on *Campanula patula*. 92 - 18-24 VII 1939, 3 ♀♀ leg. ZABŁOCKI. 94 - 21 VII 1965, ♂.

I S: 97 - 14 V 1975, ♀ on *Prunus*. 105 - 20 VII 1977, ♀ on *Campanula*. 109 - 23 V 1985, ♀ on *Salix fragilis*.

II N: 46 - 9 VIII 1968, ♀ and 3 ♂♂ on *Astrantia major*. 47 - 16 V 1967, ♀ on *Gagea lutea*. 49 - 13 V 1955, ♀. 50 - 17 VI 1971, 2 ♀♀ on *Taraxacum officinale*. 55 - 14 V 1955 and 14 V 1971, 5 ♀♀ on *Crocus scepusiensis*.

II S: 63 - 21 V 1973, 2 ♀♀ and 20 VIII 1971, ♂ on *Veronica chamaedris*. 65 - 29 V 1973, ♀ on *Lamnium rubrum*. 69 - 14 and 20 V 1985, 8 ♀♀ on *Tussilago farfara* and *Salix aurita*. 71 - 20 V 1985, 3 ♀♀ on *Taraxacum officinale* and *Salix aurita* and 29 VII 1977, ♀ on *Campanula*. 75 - 23 VII 1977, 2 ♀♀ and 2 ♂♂ on *Campanula*. 76 - 16 V 1985, 4 ♀♀ on *Taraxacum officinale*. 77 - 16 and 20 V 1985, 10 ♀♀ on *Salix auricula* and *Tussilago farfara* and 25 VII 1977, 2 ♀♀ on *Campanula* and 6 IX 1979, 2 ♀♀ on *Hieracium*.

III N: 14 - 12 and 16 V 1967, 2 ♀♀ on *Gagea lutea* and 23 VII 1971, ♂ on *Hieracium* and 8 VIII 1968, 2 ♂♂ on *Stellaria* and 19 VIII 1971, ♂ on *Hieracium*. 19 - 10 VIII 1968, ♂. 21 - 13 V 1955, ♀ and 18 VI 1968, ♀ on *Hieracium*. 29 - 5 and 19 VIII 1967, 2 ♀♀ and ♂ of *Potentilla* and *Hieracium*.

III S: 35 - 15 V 1975, 2 ♀♀ on *Tussilago farfara*. 37 - 11 V 1985, 6 ♀♀ on *Tussilago farfara*, *Salix aurita* and *Crocus scepusinsis*. 38 - 25 V 1985, ♀ on *Petasites glabratus*.

IV N: 4 - 9 VIII 1967, ♂ on *Hieracium*.

IV S: 9 - 15 V 1975, 2 ♀♀ on *Tussilago farfara*.

35. *Andrena ruficrus* NYLANDER, 1848

I S: 105 - 17 V 1985, ♀ on *Salix aurita*.

II S: 69 - 14 and 20 V 1985, 3 ♀♀ on *Salix aurita*. 71 - 20 V 1985, 2 ♀♀ on *Salix aurita*. 74 - 17 V 1985, 3 ♀♀ on *Salix aurita*.

III S: 35 - 22 V 1973, 3 ♀♀ on *Salix aurita* and *Tussilago farfara*.

36. *Andrena jakobi* PERKINS, 1914

I S: 109 - 23 V 1985, ♂ on *Salix fragilis*.

37. *Andrena rosae* PANZER, 1801

I S: 109 - 23 V 1985, 3 ♀♀ on *Salix fragilis*.

II S: 65 - MOCSÁRY (1918).

38. *Andrena praecox* (SCOPOLI, 1763)

I N: 83 - 14 V 1967, ♀ on *Salix*, 88 - 18 V 1988, 3 ♂♂ on *Salix*. 89 - 16 and 19 V 1988, 9 ♀♀ and 3 ♂♂ on *Salix*.

I S: 96 - 14 V 1975, 2 ♀♀. 97 - 13 V 1975, 5 ♀♀ on *Salix*. 105 - 11 and 17 V 1985, 36 ♀♀ on *Salix fragilis*. 107 - 20 V 1985, 35 ♀♀ on *Salix fragilis*. 109 - 23 and 29 V 1985, 42 ♀♀ on *Salix fragilis*.

II N: 44 - 12 V 1967, ♀ on *Salix*.

II S: 69 - 14 and 20 1985, 3 ♀♀ on *Salix aurita*. 71 - 20 V 1985, ♀ on *Salix aurita*.

39. *Andrena lapponica* ZETTERSTEDT, 1838

I N: 89 - 16 and 19 V 1988, ♀ and 2 ♂♂ on *Salix* and *Vaccinium myrtillus*.

II N: 47 - 16 V 1967, 4 ♀♀ and 6 ♂♂ on *Gagea lutea* and 27 VI 1967, ♀. 50 - 26 VI 1970, ♀ on *Veronica chamaedris*. 54 - 15 V 1967, 3 ♂♂ on *Vaccinium myrtillus*. 55 - 15 V 1967, ♀ and 4 ♂♂ on *Gagea lutea*. 56 - 19 VI 1970, ♀ on *Potentilla aurea*. 58 - 13 and 16 V 1971, 2 ♀♀ and 6 ♂♂ on *Salix* and *Vaccinium myrtillus*.

II S: 63 - 21 V 1973, 2 ♀♀ on *Gagea lutea*. 69 - 11 and 20 V 1985, 2 ♀♀ and ♂ on *Salix auricula*. 71 - 20 V 1985, 2 ♀♀ and ♂ on *Salix aurita* and *Taraxacum officinale*. 77 - 25 V 1985, 2 ♂♂ on *Tussilago farfara*.

III N: 12 - 13 IV 1967, 2 ♂♂ on *Anemone rannunculoides*. 14 - 10 and 12 V 1967, 8 ♀♀ on *Gagea lutea*. 16 - 16 V 1967, 2 ♂♂ on *Petasites albus* and *Tussilago farfara*. 23 - 8 VI 1967, 2 ♀♀. 24 - 23 V 1956, 2 ♀♀ on *Gagea lutea*.

III S: 31 - 19 and 23 V 1973, 4 ♂♂ on *Petasites albus*. 35 - 30 VI 1972, ♀ and ♂ on *Vaccinium murtillus* and 22 and 29 V 1973, 2 ♀♀ on *Salix*. 36 - 24 V 1973, 2 ♂♂ on *Salix*. 38 - 25 V 1985, 6 ♀♀ and 2 ♂♂ on *Petasites albus* and 25 VII 1977, ♀ on *Hypericum*.

IV N: 3 - 9 VIII 1955, ♀ on *Vaccicnium myrtillus* and 6 VII 1955, 3 ♀♀ on *Vaccinium myrtillus*. 5 - 19 and 22 VI 1970, 7 ♀♀ and 2 ♂♂ on *Vaccinium vitis idaea* and 23 V 1973, ♂ on *Petasites albus*. 6 - 6 VI 1969, ♂ on *Taraxacum officinale* and 22 VI 1970, ♀ on *Vaccinium myrtillus*.

IV S: 7 - 23 V 1973, 5 ♀♀ on *Salix*. 8 - 15 V 1975, ♀ and 8 ♂♂ on *Salix* and 25 VII 1977, ♀ on *Vaccinium vitis idaea*.

40. *Andrena fucata* SMITH, 1847

I N: 88 - 27 VI 1970, ♀ on *Sinapis arvensis*. 89 - 20 VII 1987, on *Rosa canina*. 91 - 16 VII 1987, 3 ♀♀ on *Campanula patula*.

I S: 105 - 20 VII 1977, ♀ on *Rubus idaeus*.

II N: 40 - 29 VII 1967, 2 ♀♀ on *Aruncus*. 54 - 8 V 1967, ♂ on *Taraxacum officinale*.

II S: 61 - 29 VI 1972, ♀. 63 - 21 VI 1972, 3 ♂♂. 69 - 19 VII 1977, 8 ♀♀ on *Rubus idaeus*. 77 - 23 and 25 VII 1977, 3 ♀♀ on *Rubus idaeus*.

III N: 15 - 7 VIII 1976, ♀.

41. *Andrena varians* (ROSSI, 1792)

II S: BELÁKOVÁ (1980).

42. *Andrena apicata* SMITH, 1847

I N: 88 - 18 V 1988, ♂ on *Salix*.

I S: 109 - 23 V 1985, ♀ on *Taraxacum officinale*.

II N: 44 - 12 V 1967, ♂ on *Salix*.

II S: 69 - 20 V 1985, ♂.

IV S: 9 - 15 V 1985, ♂.

43. *Andrena clarkella* (KIRBY, 1802)

I N: 89 - 14 and 16 V 1988, 4 ♀♀ on *Salix*.

I S: 97 - 13 and 14 V 1975, 2 ♀♀ on *Salix*. 109 - 23 V 1985, ♀ on *Salix fragilis*.

II N: 44 - 12 V 1969, 2 ♀♀ on *Salix*.

II S: 69 - 14 and 20 V 1985, 21 ♀♀ on *Salix aurita* and *Taraxacum officinale*. 74 - 17 V 1985, 3 ♀♀ on *Salix aurita*. 77 - 16 and 25 V 1985, 5 ♀♀ on *Salix aurita* and *Petasites albus*.

III S: 35 - 22 and 29 V 1973, 6 ♀♀ on *Salix aurita*. 37 - 11 V 1985, 2 ♀♀ on *Salix aurita*.

IV S: 9 - 29 V 1973, ♀ on *Salix* and 15 V 1975, ♀ on *Salix*. 10 - 26 V 1985, 4 ♀♀ on *Salix*.

44. *Andrena humilis* IMHOFF, 1832

I N: 84 - 31 VIII 1967, ♀ on *Hieracium*. 87 - 27 VI 1971, ♀ and 2 ♂♂ on *Hieracium*. 88 - 17 VI 1969, 6 ♀♀ on *Hieracium* and 20 VI 1988, 2 ♀♀ and 2 ♂♂ on *Taraxacum officinale* and 27 VI 1970, ♂ on *Hieracium* and 18 VII 1927, ♀ leg. FUDAKOWSKI. 89 - 21 VI 1988, ♀ and 6 ♂♂ on *Hieracium* and 20 VII 1987, ♀ on *Hieracium*. 90 - 25 VI 1977, ♀ and ♂ on *Hieracium*. 94 - 11 VII 1985, 8 ♀♀.

I S: 95 - 22 VI 1972, ♀ on *Leontodon* and 26 VI 1973, 3 ♀♀ on *Taraxacum officinale*. 97 - 13 V 1975, ♀ on *Taraxacum officinale*. 99 - 22 VI 1972, 4 ♀♀ and ♂ on *Hieracium*. 102 - 28 VI 1972, ♀ on *Hieracium*. 107 - 11 V 1985, 2 ♀♀ and 3 ♂♂ on *Taraxacum officinale*. 109 - 20 V 1985, 2 ♀♀ on *Taraxacum officinale*.

II N: 39 - 5 VII 1967, ♀ and 9 VIII 1967, ♀. 44 - 2 VII 1967, ♀ on *Hieracium*. 46 - 18 VI 1969, ♀ on *Hieracium*. 58 - 9 VI 1964, ♀ on *Hieracium* and 29 VI 1969, 2 ♀♀ and 3 ♂♂ on *Hieracium*.

II S: 63 - 21 VI 1973, 2 ♀♀ and ♂. 64 - 22 VI 1972, ♂ on *Leontodon*. 77 - 25 V 1985, ♂ on *Taraxacum officinale*.

45. *Andrena ventralis* IMHOFF, 1832

I S: 107 - 11 V 1985, ♀ on *Salix*.

46. *Andrena tarsata* NYLANDER, 1848

I N: 88 - 27 VII 1868, ♀ and ♂ leg. WIERZEJSKI. 92 - 12 VII - 4 VIII 1939, 3 ♀♀ and 6 ♂♂ leg. ZABŁOCKI.

47. *Andrena labiata* FABRICIUS, 1781

I S: 95 - 26 VI 1972, ♀ on *Taraxacum officinale*.

48. *Andrena marginata* FABRICIUS, 1776

I S: 95 - MOCSÁRY (1918)

49. *Panurgus banksianus* (KIRBY, 1802)

I N: 85 - 6 VIII 1933, 2 ♀♀ leg. ZABŁOCKI. 92 - 16-22 VII 1939, 24 ♀♀ and 16 ♂♂ leg. ZABŁOCKI. 94 - 21 VII 1960, 9 ♀♀ and 8 ♂♂ on *Hieracium*. 82 - 29 VII 1967, ♀ on *Hieracium*.

I S: 95 - 26 VI 1972, 8 ♀♀ on *Hieracium*. 105 - 20 VII 1977, ♀ and 3 ♂♂ on *Leontodon*.

II N: 39 - 5 VII 1967, ♀ and 2 ♂♂. 41 - 27 VII 1967, ♀ on *Potentilla*. 43 - 3 VII 1967, ♂ on *Hieracium*. 58 - 29 VI 1969, 2 ♂♂ on *Hieracium*.

II S: 63 - 21 VI 1972, ♂ on *Leontodon*. 69 - 19 VII 1967, ♀ and 2 ♂♂ on *Leontodon*. 75 - 23 VII 1977, ♂ on *Leontodon*.

III S: 33 - 30 VI 1972, ♀ and 2 ♂♂ on *Leontodon*.

IV N: 1 - 4 VII 1967, ♀ on *Hieracium*.

IV S: 7 - 12 IX 1974, ♂ on *Hieracium*.

50. *Panurgus calcaratus* (SCOPOLI, 1763)

II S: BELÁKOVÁ (1980).

Halictidae

51. *Halictus quadricinctus* (FABRICIUS, 1776)

I N: 86 - 5 VIII 1919, ♀ (NOSKIEWICZ 1920)

52. *Halictus rubicundus* (CHRIST, 1791)

I S: 95 - 29 V 1973, ♀ on *Taraxacum officinale* and 16 IX 1973, ♂ on *Hieracium*. 105 - 17 V 1985, 4 ♀♀ on *Taraxacum officinale* and 1 IX 1979, ♀ on *Thymus*. 107 - 13 IX 1979, 3 ♀♀ and 3 ♂♂ on *Scabiosa* and *Hieracium*. 108 - 12 IX 1979, ♂ on *Scabiosa*.

II S: 69 - 14 V 1985, ♀ on *Salix*. 71 - 20 V 1985, ♀ on *Taraxacum officinale*. 75 - 23 VII 1977, ♂ on *Leontodon*.

53. *Halictus tetrazonius* (KLUG, 1817)

I N: 87 - 5 VIII 1919, ♀ (NOSKIEWICZ 1920)

54. *Halictus simplex* BLUTHGEN, 1923

I S: 104 - 12 IX 1979, ♀ on *Cichorium inthybus*. 107 - 13 IX 1979, 6 ♀♀ and ♂ on *Scabiosa*. 108 - 15 IX 1979, ♀ on *Scabiosa*. 109 - 23 V 1985, ♀ on *Salix fragilis*.

55. *Halictus eurygratus* BLUTHGEN, 1930

II S: BELÁKOVÁ (1980).

56. *Halictus tumulorum* (LINNAEUS, 1758)

I N: 92 - 18 VII and 22 VIII 1939, 2 ♀♀ leg. ZABŁOCKI. 88 - 14 VII 1908, ♀ leg. ŚNIEŻEK.

I S: 95 - 29 V 1973, 5 ♀♀ on *Taraxacum officinale* and *Veronica chamaedris*. 105 - 17 V 1985, ♀ on *Salix fragilis*. 107 - 12 and 13 IX 1979, 3 ♀♀ and ♂ on *Hieracium*. 108 - 13 IX 1979, ♀ on *Hieracium*. 109 - 23 V 1985, 2 ♀♀ on *Salix fragilis*.

II S: 69 - 3 IX 1979, ♀ on *Hieracium*. 71 - 20 V 1985, 2 ♀♀ on *Taraxacum officinale*. 72 - 30 VII 1977, ♀ on *Potentilla*.

57. *Halictus confusus alpinus* ALFKEN, 1907

I N: 92 - 18 VII 1939, ♀ leg. ZABŁOCKI.

I S: 95 - 29 V 1973, ♀ on *Veronica chamaedris*. 105 - 1 IX 1979, 2 ♂♂ on *Thymus*. 107 - 19 IX 1979, ♂ on *Hieracium*. 109 - 20 V 1985, ♀ on *Taraxacum officinale* and 23 V 1985, ♀ on *Salix fragilis*.

II S: 69 - 3 IX 1979, ♂ on *Hieracium*.

58. *Lasioglossum quadrinotatum* (KIRBY, 1802)

II S: BELÁKOVÁ (1980).

59. *Lasioglossum zonulum* (SMITH, 1848)

I N: 92 - 20 VIII 1939, ♀ and 2 ♂♂ leg. ZABŁOCKI.

I S: 102 - 28 VI 1972, ♀ on *Hieracium*. 105 - 20 VII 1977, ♀ on *Leontodon*. 107 - 13 IX 1979, ♀ on *Hieracium*.

60. *Lasioglossum leucozonium* (SCHRANK, 1781)

I N: 88 - 6 VIII 1907, ♀ leg. ŚNIEŻEK. 92 - 5 and 22 VIII 1939, 5 ♂♂ leg. ZABŁOCKI. 94 - 21 VII 1965, ♀.

I S: 95 - 22 VI 1972, ♀ and 16 IX 1974, ♂ on *Hieracium*. 102 - 28 VI 1972, ♀ on *Hieracium*. 105 - 20 VII 1977, ♀ on *Leontodon*. 107 - 12 IX 1979, ♂ on *Hieracium*.

II N: 59 - 6 VIII 1967, ♀ on *Hieracium*.

II S: 63 - 21 VI 1972, ♀ on *Leontodon*. 71 - 2 IX 1979, ♂ on *Calluna vulgaris*. 75 - 29 VII 1977, ♀ on *Leontodon*.

61. *Lasioglossum calceatum* (SCOPOLI, 1763)

I N: 79 - 12 V 1971, ♀ and 27 VII 1967, ♀ and 9 ♂♂ on *Urtica*. 80 - 27 VII 1967, 2 ♀♀ on *Hieracium*. 84 - 14 V 1967, ♀ on *Tussilago farfara*. 87 - 27 VI 1970, ♀ on *Veronica chamaedris*. 92 - 17-19 VII 1939, 2 ♀♀ and 5, 8 and 20 VIII 1939, ♀ and 9 ♂♂ leg. ZABŁOCKI. 94 - 9 VIII 1970, ♀ on *Veronica chamaedris*.

I S: 97 - 13 V 1975, 2 ♀♀ on *Veronica chamedris*. 95 - 29 V 1973, 7 ♀♀ on *Potentilla aurea* and *Taraxacum officinale*. 101 - 28 VI 1973, ♀. 102 - 27 VI 1972, ♀ on *Hieracium*. 105 - 17 V 1985, 5 ♀♀ on *Taraxacum officinale* and 20 VII 1977, ♀ na *Leontodon*. 107 - 11 V 1985, 2 ♀♀ on *Salix* and 12 IX 1979, ♀ and 3 ♂♂ on *Hieracium*. 109 - 23 and 29 V 1985, 4 ♀♀ on *Salix fragilis*.

II N: 39 - 5 VII 1967, 9 ♀♀ and ♂ on *Hieracium*. 40 - 29 VII 1967, ♀ on *Hieracium*. 43 - 13 V 1967, 6 ♀♀ on *Tussilago farfara*. 46 - 18 VI 1967, ♀ on *Taraxacum officinale*. 47

- 16 V 1971, 2 ♀♀ on *Gagea lutea*. 51 - 26 VI 1970, ♀ on *Veronica chamaedris*. 54 - 8 VI 1967, ♀ on *Taraxacum officinale*. 56 - 19 VI 1970, 2 ♀♀ on *Taraxacum officinale* and *Potentilla aurea* and 25 VI 1969, ♀ on *Hieracium*. 58 - 16 V 1971, ♀ on *Vaccinium myrtillus*.

II S: 62 - 29 VI 1972, 2 ♀♀ on *Leontodon*. 63 - 21 V 1973, ♀ and 11 IX 1974, 4 ♂♂ on *Hieracium* and *Calluna vulgaris*. 64 - 29 V 1973, ♀. 65 - 21 VI 1972, ♀ on *Hieracium pilosella*. 68 - 20 VII 1969, 2 ♀♀ on *Hieracium*. 69 - 20 V 1985, ♀ on *Salix auricula*. 71 - 20 V 1085, ♀ on *Taraxacum officinale* and 29 VII 1977, ♀ on *Leontodon*. 72 - 20 VII 1977, 7 ♀♀ on *Leontodon*. 75 - 23 VII 1977, 2 ♀♀ on *Leontodon*. 75 - 23 VII 1977, 2 ♀♀ on *Leontodon*. 76 - 16 V 1985, 3 ♀♀ on *Taraxacum officinale*. 77 - 16 and 25 V 1985, 4 ♀♀ on *Tussilago farfara* and *Salix aurita* and 25 VII 1977, ♀ on *Leontodon* and 6 IX 1979, ♂ on *Hieracium*.

III N: 21 - 18 VI 1969, ♀ on *Hieracium*.

III S: 33 - 30 VI 1972, ♀ on *Leontodon*. 37 - 11 V 1985, 3 ♀♀ on *Tussilago farfara*.

62. *Lasioglossum albipes* (FABRICIUS, 1781)

I N: 79 - 27 VI 1967, ♀ and 2 ♂♂ on *Chamaenerion angustifolium*. 81 - 25 VII 1969, ♀ on *Potentilla*. 82 - 29 VII 1967, ♂ on *Potentilla*. 87 - 4 VIII 1968, ♀ and 2 ♂♂ on *Hieracium* and 26 VI 1971, ♀ on *Hieracium*. 88 - 17 VI 1969, 3 ♀♀ on *Hieracium*. 89 - 26 V 1988, ♀ on *Salix*. 90 - 25 VI 1976, ♀ on *Hieracium*. 91 - 16 VII 1987, ♀ on *Knautia arvensis*. 92 - 18-24 VII 1939, ♀ and 8 ♂♂ leg. ZABŁOCKI. 93 - 11 V 1967, 2 ♀♀ on *Tussilago farfara*. 94 - 21 VII 1967, 5 ♀♀.

I S: 95 - 29 V 1973, 9 ♀♀ on *Potentilla aurea*, *Taraxacum officinale* and *Veronica chamaedris*. 97 - 30 V 1973, ♀ on *Taraxacum officinale*. 105 - 17 V 1985, ♀ on *Salix fragilis* and 20 VII 1979, 3 ♀♀ on *Leontodon*. 107 - 12 and 13 IX 1979, 5 ♀♀ and 6 ♂♂ on *Scabiosa* and *Leontodon*. 108 - 13 IX 1979, 2 ♂♂ on *Leontodon* and *Scabiosa*.

II N: 39 - 5 VII 1967, 5 ♀♀. 40 - 29 V 1967, 2 ♀♀ on *Potentilla aurea* and *Hieracium*. 43 - 13 IV 1967, 16 ♀♀ on *Tussilago farfara* and *Potentilla*. 44 - 12 V 1967, ♀ on *Salix*. 45 - 13 V 1971, ♀. 46 - 9 VIII 1968, 2 ♂♂ on *Astrantia*. 47 - 16 V 1967, ♀ on *Gagea lutea* and 8 VIII 1968, ♂ on *Hieracium*. 49 - 26 VI 1971, ♀ on *Hieracium*. 51 - 17 V 1969, ♀ on *Lotus corniculatus* and 26 VI 1971, ♀ on *Veronica chamaedris*. 53 - 19 VI 1970, ♀ on *Potentilla aurea*. 54 - 8 VI 1967, 2 ♀♀ on *Taraxacum officinale* and 15 V 1967, ♀ on *Vaccinium myrtillus*. 56 - 19 VI 1970, ♀ on *Hieracium* and 25 VI 1968, 15 ♀♀ on *Potentilla aurea*, *Rannunculus* and *Taraxacum officinale*. 41 - 27 VII 1967, ♀ on *Chamaenerion angustifolium*.

II S: 61 - 29 VI 1972, 4 ♀♀ on *Hieracium* and *Leontodon*. 63 - 21 V 1973, 4 ♀♀ on *Leontodon* and 21 VI 1972, 6 ♀♀ on *Leontodon* and 11 IX 1974, 27 ♂♂ on *Hieracium*. 64 - 22 VI 1972, 8 ♀♀ on *Leontodon* and 29 V 1973, 6 ♀♀. 68 - 28 V 1985, 4 ♀♀ on *Taraxacum officinale*. 69 - 20 V 1985, ♀ on *Salix aurita* and 19 VII 1977, ♀ on *Leontodon* and 3 IX 1979, ♂ on *Chamaenerion angustifolium*. 71 - 20 V 1985, 12 ♀♀ on *Taraxacum officinale* and 2 IX 1979, ♀. 72 - 20-22 VII 1977, 13 ♀♀ on *Leontodon*. 74 - 17 V 1985, 2 ♀♀ on *Salix aurita*. 75 - 23 VII 1977, 7 ♀♀ on *Leontodon*. 76 - 16 V 1985, 2 ♀♀ on *Leontodon*. 77 - 22 VII 1977, 8 ♀♀ and ♂ on *Leontodon* and 6 IX 1969, ♀ and 7 ♂♂ of *Hieracium* and 7 IX 1979, ♂ on *Cichorium inthybus*.

III N: 17 - 19 VIII 1971, ♀. 21 - 18 VI 1969, 3 ♀♀ on *Hieracium* and 26 VI 1971, ♀. 25 - 21 VI 1970, ♀ on *Taraxacum officinale*. 26 - 12 VIII 1973, ♂. 28 - 19 VI 1969, 2 ♀♀ on *Potentilla aurea*. 29 - 6 VI 1967, ♀ on *Taraxacum officinale* and 19 VIII 1967, 3 ♂♂ on *Hieracium*.

III S: 32 - 26 VI 1972, 2 ♀♀ on *Veronica chamaedris* and *Hieracium pilosella*. 33 - 30 VI 1972, 3 ♀♀ on *Leontodon*. 34 - 30 VI 1972, 3 ♀♀ on *Hieracium*. 35 - 29 V 1974, 3 ♀♀ on *Taraxacum officinale* and 22 V 1975, 4 ♀♀ on *Salix aurita* and 30 VI 1977, ♀ on *Hieracium* and 13 IX 1974, 2 ♂♂ on *Hieracium*.

63. *Lasioglossum laticeps* (SCHENCK, 1868)

I N: 87 - 5 VIII 1920, ♀ (NOSKIEWICZ 1920).

II S: BELÁKOVÁ (1980).

64. *Lasioglossum fulvicorne* (KIRBY, 1802)

I N: 89 - 16 V 1988, ♀. 91 - 16 VII 1987, ♀. 92 - 20 and 21 VII 1939, 2 ♂♂ and 11 VIII 1939, 4 ♂♂ leg. ZABŁOCKI.

I S: 95 - 29 V 1973, 5 ♀♀ on *Veronica chamaedris*. 105 - 17 V 1985, ♀ on *Salix fragilis* and 20 VII 1977, ♀ on *Leontodon* and 1 IX 1979, ♂ on *Thymus*. 106 - 7 IX 1979, ♂ on *Primula*.

II N: 39 - 5 VII 1967, 3 ♀♀. 45 - 13 V 1971, ♀. 56 - 19 VI 1970, 3 ♀♀ on *Taraxacum officinale*.

II S: 65 - 15 IX 1974, ♂ on *Hieracium*. 69 - 11 and 20 V 1985, 9 ♀♀ on *Salix aurita* and 3 IX 1979, ♂ on *Hieracium*. 71 - 20 V 1985, 2 ♀♀ on *Taraxacum officinale* and 2 IX 1979, ♂ on *Calluna vulgaris*. 72 - 30 VII 1977, ♂. 74 - 17 V 1985, 2 ♀♀. 76 - 16 V 1985, ♀ on *Vaccinium myrtillus*.

III N: 25 - 17 IX 1955, ♀.

III S: 35 - 19 VII 1974, ♂ on *Hieracium*.

65. *Lasioglossum fratellus* (PÉREZ, 1903)

I N: 87 - 4 VIII 1968, ♀ and 2 ♂♂ on *Hieracium*. 89 - 16 V 1988, ♀ on *Salix* and 20 VII 1987, ♀ on *Veronica*. 91 - 11 VII 1987, ♂ on *Campanula patula*. 93 - 11 V 1971, 2 ♀♀ on *Tussilago farfara*.

I S: 95 - 23 V 1973, ♀ on *Taraxacum officinale* and 19 IX 1974, ♀ on *Hieracium*. 99 - 27 VI 1972, ♀ on *Hieracium*. 106 - 1 IX 1979, ♂ on *Prunella*. 107 - 12 IX 1979, ♂. 108 - 13 IX 1979, ♂ on *Scabiosa*.

II N: 40 - 29 VII 1967, ♂ on *Hieracium*. 41 - 27 VII 1967, ♀ on *Chamaenerion angustifolium*. 43 - 13 V 1967, ♀ on *Tussilago farfara*. 44 - 12 V 1967, 2 ♀♀ on *Salix*, 45 - 12 V 1967, ♀ on *Potentilla aurea* and 12 V 1971, ♀. 47 - 16 V 1967, 20 ♀♀ on *Gagea lutea*. 49 - 26 VI 1971, 2 ♀♀ on *Hieracium*. 53 - 19 VI 1970, 3 ♀♀ on *Potentilla aurea*. 55 - 14 V 1971, ♀ on *Crocus scepusiensis*. 56 - 19 VI 1970, 10 ♀♀ on *Rannunculus*, *Taraxacum officinale* and *Potentilla aurea*. 58 - 11 VII 1987, ♂ on *Campanula*.

II S: 63 - 11 VI 1972, ♀ on *Leontodon* and 11 IX 1974, ♂ on *Hieracium*. 65 - 21 V 1973, ♀ on *Taraxacum officinale*. 68 - 28 V 1985, 2 ♀♀ on *Taraxacum officinale*. 69 - 11 V 1985, 5 ♀♀ on *Salix aurea* and 3 IX 1979, ♂ on *Scabiosa*. 70 - 20 V 1985, 3 ♀♀. 71 - 29 VII 1977, ♀ and 2 IX 1979, 3 ♂♂ on *Calluna vulgaris*. 72 - 19 and 30 VII 1977, 2 ♀♀

on *Leontodon* and *Campanula*. 73 - 14 IX 1973, 11 ♂♂ on *Campanula*. 76 - 15 V 1975, 3 ♀♀ on *Potentilla* and *Taraxacum officinale*. 77 - 25 V 1985, ♀ on *Tussilago farfara*.

III N: 12 - 13 V 1967, 7 ♀♀ on *Gagea lutea* and *Potentilla*. 13 - 8 VIII 1968, 2 ♂♂. 14 - 12 and 16 V 1967, 2 ♀♀ *Gagea lutea* and 7 VII 1968, 4 ♂♂ and 7 and 8 VIII 1968, 14 ♂♂ on *Hieracium*. 15 - 7 VIII 1971, 2 ♀♀ and ♂ on *Potentilla erecta*. 16 - 15 V 1967, 2 ♀♀ on *Tussilago farfara* and 4 VIII 1968, 2 ♀♀ on *Hieracium*. 17 - 5 VIII 1968, 18 ♂♂ on *Campanula*. 19 - 24 VI 1969, 2 ♀♀ on *Hieracium* and 10 VII 1968, ♂ and 10 VIII 1967, 2 ♂♂ and 20 VIII 1971, ♂ on *Potentilla*. 21 - 26 VI 1967, ♀ and 18 VI 1969, 2 ♀♀ on *Potentilla*. 22 -20 VI 1970, 2 ♀♀ on *Taraxacum officinale*. 25 - 26 VII 1971, ♂ on *Hieracium*. 29 - 5 and 19 VIII 1967, 3 ♀♀ and 8 ♂♂ on *Potentilla* and *Hieracium*. 30 - 19 VI 1969, 3 ♀♀ on *Potentilla aurea* and *Vaccinium vitis idea* and 22 VI 1970, ♀ on *Vaccinium vitis idaea*.

III S: 32 - 21 VI 1972, ♀ on *Hieracium pilosella*. 35 - 22 V 1973, ♀ on *Salix*. 38 - 25 V 1985, ♀ on *Tussilago farfara*.

IV N: 1 - 2 VII 1971, ♂ on *Hieracium*. 2 - 5 VIII 1968, 4 ♀♀ and 8 ♂♂ on *Hieracium* and 18 VIII 1967, 14 ♂♂ on *Hieracium*. 3 - 21 VI 1970, ♀ on *Taraxacum officinale*. 4 - 19 VIII 1967, ♂ on *Hieracium*. 5 - 19 VI 1969, 2 ♀♀ on *Vaccinium vitis idaea* and 22 VI 1970, 9 ♀♀ on *Vaccinium vitis idaea*.

IV S: 7 - 23 V 1973, ♀ on *Salix*. 9 - 15 V 1975, 6 ♀♀ on *Salix* and 29 V 1973, ♀ on *Salix*. 11 - 7 IX 1979, 11 ♂♂ on *Campanula* and *Hieracium* and *Senecio*.

66. *Lasioglossum rufitarse* (ZETTERSTEDT, 1838)

I N: 84 - 31 VIII 1967, ♀ on *Hieracium*. 89 - 20 VII 1987, 2 ♀♀ on *Veronica*. 92 - 22 VII 1939 and 4 VIII 1939, 2 ♂♂ leg. ZABŁOCKI.

I S: 97 - 13 V 1975, 2 ♀♀ on *Salix* and 30 V 1973, ♀ on *Taraxacum officinale*.

II S: 63 - 21 VI 1972, 2 ♀♀ on *Leontodon* and 11 IX 1974, ♀ on *Hieracium*. 69 - 19 VII 1977, ♀.

III N: 19 VI 1968, ♀ on *Potentilla*.

67. *Lasioglossum morio* (FABRICIUS, 1793)

II S: BELÁKOVÁ (1980).

68. *Lasioglossum cupromicans* (PÉREZ, 1903).

II N: 49 - 19 VII 1919, ♀ (NOSKIEWICZ 1920). 58 - 1 VIII 1919, ♀ leg. NOSKIEWICZ, det. J.D. ALFKEN and A. W. EBMER.

69. *Lasioglossum bavaricum* (BLÜTHGEN, 1930)

II N: 53 - 19 VI 1970, ♀ on *Potentilla aurea*. 56 - 19 VI 1970, 5 ♀♀ on *Potentilla aurea* and *Taraxacum officinale*, det. A.W. EBMER.

II S: 69 - 19 VII 1977, ♀.

III N: 14 - 7 VIII 1968, ♀ det. A.W. EBMER. 21 - 18 VI 1968, ♀ on *Potentilla erecta* and 26 VI 1971, ♀ det. A.W. EBMER. 28 - 19 VI 1969, ♀ on *Potentilla aurea*.

III S: 35 - 13 IX 1974, ♂ det. A.W. EBMER.

70. *Lasioglossum villosulum* (KIRBY, 1802)

I N: 92 - 22 and 23 VII 1939, 2 ♀♀ and ♂ leg. ZABŁOCKI. 88 - 26 VII 1923, 4 ♀♀ leg. NOSKIEWICZ.

I S: 95 - 22 VI 1972, ♀ on *Leontodon*. 101 - 28 VI 1972, ♀ on *Hieracium*. 105 - 20 VII 1977, ♀ on *Leontodon*. 107 - 13 IX 1979, ♀ on *Scabiosa*.
II N: 58 - 1 VIII 1919, ♀ (NOSKIEWICZ 1920)
II S: 63 - 11 IX 1971, ♀ and ♂ on *Hieracium*. 64 - 22 VI 1972, ♀ on *Leontodon*. 72 - 22 VII 1977, 2 ♀♀ on *Leontodon*. 75 - 20 and 23 VII 1977, 4 ♀♀ on *Potentilla erecta*.
III S: 32 - 21 VI 1972, 2 ♀♀ on *Veronica* and *Hieracium pilosella*. 33 - 30 VI 1972, ♀ on *Leontodon*. 35 - 13 IX 1974, ♀ on *Hieracium*.

71. *Lasioglossum leucopum* (KIRBY, 1802)
I N: 87 - 4 VIII 1968, ♂ on *Hieracium*. 92 - 17 and 23 VII 1939, 2 ♀♀ leg. ZABŁOCKI. 94 - 21 VII 1965, 3 ♀♀.
I S: 95 - 29 V 1973, ♀ on *Potentilla*. 105 - 3 IX 1979, ♀ on *Hieracium*. 107 - 12 and 13 IX 1979, 3 ♀♀ on *Potentilla aurea* and *Hieracium*.
II S: 64 - 22 VI 1972, ♀ on *Leontodon*. 69 - 3 IX 1979, ♀ on *Hieracium*. 75 - 23 VII 1977, ♀ on *Leontodon*.

72. *Lasioglossum politum* (SCHENCK, 1853)
I N: stonepit (Zakopane) 28 VII 1919, ♀ (NOSKIEWICZ 1920).

73. *Sphaecodes puncticeps* THOMSON, 1870
I N: 92 - 18-22 VII 1939, 4 ♀♀ leg. ZABŁOCKI.
II S: BELÁKOVÁ (1980).

74. *Sphaecodes crassus* THOMSON, 1870
I N: 92 - 12 VII 1939, ♀ leg. ZABŁOCKI.

75. *Sphaecodes hyalinatus* v. HAGENS, 1874
I N: 92 - 12 VII 1939, ♂ leg. ZABŁOCKI.

76. *Sphaecodes divisus* (KIRBY, 1802)
I N: 92 - 12 VII 1939, ♀ leg. ZABŁOCKI.
I S: 105 - 20 VII 1977, ♀ on *Leontodon* and 1 IX 1979, ♀ on *Thymus*.

77. *Sphaecodes ferruginatus* v. HAGENS, 1882
I N: 92 - 4 VIII 1939 and 18 IX 1939, 2 ♀♀ leg. ZABŁOCKI.

78. *Sphaecodes miniatus* v. HAGENS, 1882
I N: 92 - 12-23 VII 1939 and 5 VIII 1939, 2 ♀♀ leg. ZABŁOCKI.
II S: 63 - 21 VI 1972, ♀. 72 - 30 VII 1971, ♀ on *Leontodon*.

79. *Sphaecodes fasciatus* v. HAGENS, 1882
I N: 92 - 12 VII 1939 and 5 VIII 1939, 6 ♀♀ leg. ZABŁOCKI.

80. *Dufourea halictula* (NYLANDER, 1848)
II S: BELÁKOVÁ (1980).

81. *Dufourea dentiventris* (NYLANDER, 1848)
I N: 91 - 16 VII 1987, 2 ♂♂ on *Campanula patula*. 94 - 21 VII 1965, ♀.
II S: 71 - 29 VII 1977, ♀ on *Leontodon*. 75 - 23 VII 1977, ♂ on *Leontodon*.

82. *Dufourea vulgaris* SCHENCK, 1879

I N: 92 - 12-18 and 8 VIII 1939, 27 ♀♀ and 11 ♂♂ leg. ZABŁOCKI.

I S: 107 - 13 IX 1979, ♂.

III N: 16 - 27 IX 1974, 2 ♀♀ on *Hieracium*. 19 - 29 VIII 1974, ♀ on *Hieracium*.

III S: 35 - 13 IX 1974, 3 ♀♀ on *Hieracium*.

83. *Rhophitoides canus* EVERSMANN, 1852

I S: 98 - MOCSÁRY (1918).

Melittidae

84. *Melitta haemorrhoidalis* (FABRICIUS, 1775)

I N: 86 - 5 VIII 1920, ♀ (NOSKIEWICZ 1920).

I S: 105 - 20 VII 1977, 2 ♀♀ on *Campanula*.

85. *Macropis labiata* (FABRICIUS, 1804)

I S: 65 - MOCSÁRY (1918).

86. *Macropis fulvipes* (FABRICIUS, 1804)

II S: 65 - MOCSÁRY (1918).

Megachilidae

87. *Trachusa serratulae* (PANZER, 1805)

I N: 85 - 13 VII 1933, ♂ leg. ZABŁOCKI. 88 - 30 VII 1905, ♂ leg. ŚNIEŻEK. 92 - 17-20 VII 1939, 3 ♀♀ and 3 ♂♂ leg. ZABŁOCKI.

I S: 105 - 20 VII 1977, 2 ♀♀ and 11 ♂♂ on *Chamaenerion angustifolium*.

II S: 69 - 19 VII 1977, ♀ and 2 ♂♂ on *Lotus corniculatus* and *Lathyrus*. 72 - 22 and 30 VII 1977, 2 ♀♀ and 4 ♂♂ on *Lathyrus* and *Thymus*. 75 - 25 VII 1977, 2 ♀♀ and 5 ♂♂ on *Lotus corniculatus*. 77 - 23 and 25 VII 1977, 2 ♀♀ and 6 ♂♂ on *Lotus corniculatus*.

88. *Anthidium manicatum* (LINNAEUS, 1758)

I N: 89 - 20 VII 1987, 4 ♀♀ and ♂ on *Stachys*. 91 - 16 VII 1987, ♂ on *Stachys pratensis*.

II S: 69 - 19 VII 1977, ♂.

89. *Anthidium montanum* MORAWITZ, 1864

I N: 88 - 17 VI 1967, ♀ on *Lotus corniculatus*. 92 - 17 VII 1939, ♂ leg. ZABŁOCKI.

I S: 95 and 103 - MOCSÁRY (1918).

III S: 35 - 30 VI 1972, 4 ♀♀ on *Lotus corniculatus*.

90. *Anthidium puctatum* LATREILLE, 1809

I S: 105 - 20 VII 1977, 2 ♀♀ on *Trifolium pratense* and *Campanula* and 3 ♂♂ on *Lamnium rubrum*.

91. *Anthidiellum strigatum* (PANZER, 1805)

I N: 92 - 15 and 17 VII 1939, ♀ and 2 ♂♂ leg. ZABŁOCKI.

II S: 75 - 23 VII 1977, ♂.

92. *Stelis ornatula* (KLUG, 1807)

I N: 92 - 20 VII 1939, ♂ leg. ZABŁOCKI.

II N: 58 - 29 VI 1969, ♀ on *Hieracium*.

93. *Chelostoma maxillosum* (LINNAEUS, 1769)

II N: 58 - 29 VI 1969, 4 ♂♂. 55 - 27 VI 1969, 7 ♂♂. 40 - 29 VII 1967, ♀ on *Hieracium*.

II S: 62 - 29 VI 1972, ♀ on *Leontodon*. 72 - 30 VII 1977, ♂.

III N: 21 - 26 VI 1974, ♀ and ♂.

94. *Chelostoma nigricorne* NYLANDER, 1848

I N: 39 - 25 VI 1969, 2 ♀♀ and ♂ on *Campanula* and 20 VII 1987, ♀ on *Campanula*. 91 - 16 VII 1987, 13 ♀♀ and 5 ♂♂ on *Campanula patula*. 81 - 25 VII 1969, 2 ♂♂ on *Potentilla*.

II N: 58 - 29 VI 1969, ♀ and ♂.

II S: 63 - 21 VI 1972, ♂ on *Campanula*. 69 - 19 VII 1977, ♂.

95. *Chelostoma florisomne* (LINNAEUS, 1758)

I N: 89 - 25 VII 1969, ♂ on *Campanula* and 20 VII 1987, ♂ on *Campanula*. 91 - 19 VII 1987, 2 ♀♀ and 3 ♂♂ on *Campanula patula*. 92 - 17 VII 1939, ♀ leg. ZABŁOCKI. 80 - 27 VII 1967, ♂ on *Campanula*.

II N: 40 - 29 VII 1967, ♀ and 2 ♂♂ on *Hieracium*. 58 - 29 VI 1969, ♂ on *Hieracium*.

II S: 69 - 19 VII 1977, ♀ and ♂ on *Campanula*.

96. *Osmia rufa* (LINNAEUS, 1758)

I N: 88 - 18 V 1988, 2 ♀♀ on *Primula*. 89 - 16 V 1988, ♀ and 6 ♂♂ on *Vaccinium myrtillus*. 93 - 11 V 1967, 2 ♀♀ on *Tussilago farfara*.

97. *Osmia parietina* CURTIS, 1828

I N: 89 - 21 VII 1967, ♂ on *Leontodon*.

II N: 58 - 19 VI 1969, ♂ and 16 V 1971, ♀.

98. *Osmia leaiana* (KIRBY, 1802)

I N: 88 - VII 1914, ♀ leg. ŚNIEŻEK and 19 VII 1969, ♀ on *Lathyrus pratensis*. 89 - 20 and 21 VII 1987, ♀ and ♂ on *Cirsium* and *Hieracium*.

I S: 98 - MOCSÁRY (1918).

II N: 58 - 9 VI 1969, ♂.

99. *Osmia leucomelaena* (KIRBY, 1802)

II S: 75 - 23 VII 1977, 2 ♀♀ on *Lotus corniculatus*.

100. *Osmia inermis* (ZETTERSTEDT, 1838)

II N: 48 - 9 VIII 1920, ♀ on *Vaccinium myrtillus* (NOSKIEWICZ 1920). 58 - 1 VIII 1919, ♀ (NOSKIEWICZ 1920).

101. *Osmia uncinata* GERSTACKER, 1869

II S: BELÁKOVÁ (1980).

102. *Osmia fulviventris* PANZER, 1798)

I N : 86 - 5 VIII 1920, ♀ (NOSKIEWICZ 1920).

103. *Osmia adunca* (PANZER, 1798)

I N: 89 - 5 VIII 1920, ♀ (NOSKIEWICZ 1920).

104. *Osmia anthocopoides* SCHENCK, 1853

I N: 86 - 5 VIII 1920, ♀ (NOSKIEWICZ 1920).

I S: 95 - 22 and 26 VI 1972, ♀ and ♂ on *Echium vulgare*. 105 - 20 VII 1977, 3 ♀♀ and 4 ♂♂ on *Leontodon*.

105. *Osmia villosa* (SCHENCK, 1853)

I N: 89 - 20 VII 1987, ♀ on *Cirsium* and 17 VI 1969, 2 ♀♀ on *Lathyrus pratensis*.

II N: 41 - 27 VII 1967, ♀ on *Potentilla*. 49 - 19 VII 1920, ♂ (NOSKIEWICZ 1920).

II S: 69 - 17 VII 1977, ♀ on *Lotus corniculatus*. 72 - 22 VII 1977, ♂ on *Leontodon*.

III S: 35 - 13 IX 1974, ♀.

106. *Megachile alpicola* ALFKEN, 1924

I N: 88 - 18 VII 1923, ♂ leg. FUDAKOWSKI. 89 - 20 VII 1987, ♀ on *Leontodon*. 92 - 19 VII 1939, ♀ leg. ZABŁOCKI.

I S: 107 - 29 VII 1979, ♀ on *Medicago* and 13 VIII 1979, ♀ on *Hieracium*.

II S: 77 - 25 VII 1977, ♀ on *Lotus corniculatus*.

107. *Megachile versicolor* SMITH, 1844.

I N: 87 - 19 VIII, ♀ leg. WIERZEJSKI (WIERZEJSKI 1874: as *Megachile octosignata* NYL.).

108. *Megachile ligniseca* (KIRBY, 1802)

I N: 91 - 16 VII 1987, ♀ on *Vicia silvestris*. 88 - 28 VII 1919, ♀ (NOSKIEWICZ 1920).

II S: 63 - 11 IX 1974, ♀ on *Centaurea*.

109. *Megachile lapponica* THOMSON, 1872

II S: 65 - MOCSÁRY (1918)

110. *Megachile analis* NYLANDER, 1852

I S: 103 - MOCSÁRY (1918).

II S: 65 - MOCSÁRY (1918).

111. *Megachile willoughbiella* (KIRBY, 1802)

I N: 88 - 17 VI 1969, ♂ on *Lathyrus pratensis* and 12 VII 1908, ♂ leg. ŚNIEŻEK. 89 - 21 VII 1987, ♀ on *Cirsium*. 91 - 16 VII 1987, ♀ on *Vicia silvestris*. 92 - 19 and 24 VII 1939, 2 ♀♀ leg. ZABŁOCKI.

I S: 105 - 20 VII 1977, ♀ on *Anthylis vulneraria*. 107 - 12 IX 1979, ♀ and 2 ♂♂ on *Lotus corniculatus*.

II N: 50 - 20 VII 1923, ♀ leg. FUDAKOWSKI.

II S: 77 - 23 and 25 VII 1977, ♀ and 2 ♂♂ on *Lotus corniculatus*.

112. *Megachile maritima* (KIRBY, 1802)

I N: 86 - 5 VIII 1919, ♀ (NOSKIEWICZ 1920)

113. *Megachile circumcincta* (KIRBY, 1802)

I N: 92 - 16 and 24 VII 1939, 2 ♀♀ leg. ZABŁOCKI.

I S: 98 and 103 (MOCSÁRY 1918).

114. *Megachile nigriventris* SCHENCK, 1868[(1)]

I N: 2 ♀♀ ex coll. RADOSZKOWSKI. 85 - 13 VII 1933, ♂ leg. ZABŁOCKI. 88 - 18 VII 1933, ♂ leg. ZABŁOCKI and 17 VI 1969, ♀ and ♂ on *Lathyrus*. 91 - 16 VII 1987, ♂ on *Salvia pratensis*. 92 - 24 VII 1939, ♀ leg. ZABŁOCKI.

I S: 97 - 30 V 1973, ♂.

II N: 56 - 25 VI 1969, ♀.

II S: 77 - 25 VII 1977, ♀.

115. *Coelioxys rufescens* LEPELETIER, 1825

I N: 88 - 30 VII 1909, ♀ leg. ŚNIEŻEK. 89 - 20 VII 1987, ♀ on *Stachys*. 91 - 16 VII 1987, ♂ on *Knautia arvensis*.

II N: 48 - 9 VIII 1920, ♀ (NOSKIEWICZ 1920)

116. *Coelioxys quadridentata* (LINNAEUS, 1758)

I N: 92 - 17, 20 and 22 VII 1939, 4 ♀♀ and 2 ♂♂ leg. ZABŁOCKI.

Anthophoridae

117. *Nomada rufipes* FABRICIUS, 1739

I N: 92 - 12 VII 1939, ♀ leg. ZABŁOCKI.

118. *Nomada bifasciata fucata* PANZER, 1798

IV N: 2 - 5 VIII 1968, ♂ on *Hieracium*.

119. *Nomada emarginata* MORAWITZ, 1877

I N: 92 - 17-21 VII 1939, ♀ and 2 ♂♂ and 3-4 VIII 1939, 2 ♂♂ leg. ZABŁOCKI.

120. *Nomada roberjeotiana* PANZER, 1799

I N: 92 - 12-23 VII and 4 VIII 1939, 2 ♀♀ and 2 ♂♂ leg. ZABŁOCKI.

II S: MOCSÁRY (1918).

121. *Nomada obtusifrons* NYLANDER, 1848

I N: 89 - 20 VII 1987, 2 ♀♀. 92 - 12 VII - 5 VIII 1939, 2 ♀♀ and 2 ♂♂ leg. ZABŁOCKI. 94 - 21 VII 1985, 3 ♀♀.

II N: 41 - 27 VII 1967, ♀ on *Chamaenerion angustifolium*.

III N: 16 - 24 VII 1974, ♀ on *Hieracium*. 26 - 12 VIII 1973, 2 ♀♀.

122. *Nomada striata* FABRICIUS, 1973

I N: 87 - 27 Vi 1971, ♂ on *Hieracium*. 92 - 12-16 VII 1939, 5 ♀♀ leg. ZABŁOCKI.

I S: 98 - MOCSÁRY (1918).

123. *Nomada obscura* ZETTERSTEDT, 1838

II S: 74 - 17 V 1985, ♀ on *Salix aurita*.

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[1] ALFKEN (1936) reported from the Tatras *Megachile maaki* RADOSZKOWSKI, 1874, on the basis of the material collected by RADOSZKOWSKI and kept in the Museum of the Humboldt University in Berlin. As systematical status of this species has not yet been precisely determined I mention from the Tatras and Pieniny Mts. *Megachile nigriventris*.

124. *Nomada flava* PANZER, 1798

II S: 69 - 20 V 1985, ♂ on *Salix aurita*.

125. *Nomada panzeri* LEPELETIER, 1841

I N: 84 - 14 V 1967, ♀. 92 - 12 VII 1939, ♀ leg. ZABŁOCKI.

II N: 47 - 12 and 16 V 1967, 2 ♀♀ and 2 ♂♂ on *Gagea lutea* and 25 V 1970, ♀. 54 - 15 V 1967, ♀ on *Vaccinium myrtillus*. 53 - 19 VI 1970, ♀.

II S: 63 - 21 VI 1972, ♀. 77 - 25 V 1985, ♀ on *Petasites*.

III N: 12 - 13 V 1967, 7 ♂♂. 23 - 8 VI 1972, ♀ on *Potentilla aurea*. 29 - 6 VI 1969, ♂ on *Taraxacum officinale*.

III S: 35 - 30 VI 1972, ♂ on *Vaccinium vitis idaea*.

IV N: 3 - 21 VI 1970, 2 ♀♀. 5 - 19 VI 1969, ♀ on *Vaccinium vitis idaea* and 22 VI 1970, ♀ and 3 ♂♂ on *Vaccinium vitis idaea*. 6 - 19 VI 1970, ♀.

126. *Nomada leucophtalma* (KIRBY, 1802)

II N: 12 - 13 V 1967, ♀ and 3 ♂♂ on *Gagea lutea*.

II S: 69 - 20 V 1985, 2 ♂♂.

IV S: 9 - 15 V 1975, ♀ on *Salix*.

127 *Nomada bifida* THOMSON, 1872

I S: 95 - 29 V 1973, ♀ det. CELARY.

128. *Nomada ferruginata* (LINNAEUS, 1767)

I N: 87 - 27 VI 1971, ♀ on *Hieracium*.

I S: 107 - 11 V 1985, ♀ on *Taraxacum officinale*. 109 - 23 V 1985, ♀ on *Salix fragilis*.

II S: 63 - 21 VI 1972, ♀. 71 - 20 V 1985, ♀ on *Taraxacum officinale*.

129. *Nomada flavoguttata* (KIRBY, 1802)

I N: 92 - 12-16 VII 1939, 7 ♀♀ and ♂ leg. ZABŁOCKI.

I S: 95 - 29 V 1973, ♀ on *Potentilla aurea*.

II N: 46 - 18 VI 1969, ♂ on *Potentilla erecta*. 58 - 19 VI 1969, 2 ♀♀ on *Hieracium*.

III N: 21 - 18 VI 1969, ♂ on *Potentilla erecta*.

130. *Nomada similis* MORAWITZ, 1872

I N: 92 - 12-16 VII 1939, 2 ♀♀ leg. ZABŁOCKI.

II S: 63 - 21 VI 1972, 2 ♀♀.

131. *Nomada mutabilis*, MORAWITZ, 1871

I N: 88 - July (ŚNIEŻEK 1910).

II S: BELÁKOVÁ (1980).

132. *Nomada fabriciana* (LINNAEUS, 1767)

II N: 45 - 13 V 1971, ♂.

133. *Nomada sexfasciata* PANZER, 1799

I S: 95 - 22 VI 1972, 2 ♀♀ on *Knautia arvensis*.

134. *Biastes truncatus* (NYLANDER, 1848)

I N: 92 - 12 VII-4 VIII 1939, 25 ♀♀ and ♂ leg. ZABŁOCKI.

135. *Eucera longicornis* (LINNAEUS, 1758)

I S: 101 - 26 VI 1972, ♀ on *Lotus corniculatus*. 95 - 22 VI 1972, ♂.

136. *Anthophora quadrimaculata* (PANZER)

I N: 87 - 18 VIII 1988, 3 ♀♀. 89 - 27 VIII 1987, 9 ♀♀ and ♂ on *Stachys*. 91 - 16 VII 1987, 2 ♂♂ on *Salvia pratensis*

137. *Anthophora acervorum* (LINNAEUS, 1758)

I S: 107 - 9 and 22 V 1985, 2 ♀♀ and ♂.

II S: 64 - 29 V 1973, 3 ♂♂.

138. *Anthophora plagiata* (ILLIGER, 1806)

I S: 103 - MOCSÁRY (1918)

II S: 65 - MOCSÁRY (1918).

139. *Anthophora furcata* (PANZER, 1798)

I N: 79 - 29 VII 1967, ♀ on *Ballota nigra*. 80 - 27 VII 1967, ♂. 89 - 20 VII 1987, ♂ on *Cirsium*. 91 - 16 VII 1987, 4 ♂♂ on *Salvia pratensis*. 92 - 12 and 20 VII 1939, ♀ and ♂ leg. ZABŁOCKI.

I S: 100 - 21 IX 1979, ♀ on *Trifolium*. 101 - 28 VI 1972, ♂. 105 - 20 VII 1977, 2 ♀♀ and 2 ♂♂ on *Digitalis lutea*.

II N: 58 - 29 VI 1969, ♀ and 2 ♂♂ on *Ballota nigra*.

II S: 69 - 19 VII 1977, ♀ and ♂ on *Stachys*. 72 - 30 VII 1977, ♀. 75 - 23 VII 1977, ♀ and ♂ on *Stachys*.

III S: 37 - 27 VII 1977, 2 ♂♂ on *Stachys*.

V. FAUNISTIC ANALYSIS

1. Number of recorded localities and species

The author found 109 localities in zones I - IV (Fig. 1) in which the families of *Apoidea* under study occurred. In zones V - VI, however, only representatives of the family *Apidae* were found. The numbers of localities on the northern (64) and southern slopes (45) are not distributed evenly (Table II), the differences being particularly marked in zones II and III. In zone II the numbers were 22 and 17 respectively, while in zone III the number of localities on the northern slopes (19) was more than twice that on the southern ones (8). Differences in the number of localities in zones I and IV were far smaller. The differences in the number of localities between the northern and southern slopes, particularly in zones II and III, were not the consequence of less searching of the latter slopes.

The list of species collected in the Tatras comprises 139 representatives of *Apoidea* (excluding the family *Apidae*). Of these 139 species, 54 are new to the Tatras and to the sub-Tatra zone, including *Hylaeus cardioscapus* which is also new to the fauna of Poland. 29 species reported from the Tatras by the authors quoted in Chapter I were not found by the present author. These are the following species recorded from the northern slopes: *Colletes daviesanus* (ŚNIEŻEK 1910), *Andrena nigriceps*, *Halictus quadricinctus*, *H. tetrazonius*, *Lasioglossum laticeps*, *L.cupromicans*, *L. politum*, *Osmia adunca*, *O. iner-*

mis, *O. fulviventris*, and *Megachile maritima* (NOSKIEWICZ 1920) and from the southern slopes: *Andrena limata*, *A. marginata*, *Rhophitoides canus*, *Megachile lapponica*, *Macropis labiata*, *M. vulvipes*, *Nomada armata* (MOCSÁRY 1918), *Hylaeus cornutus* (BALTHASAR 1952), *Andrena varians*, *Panurgus calcaratus*, *Halictus eurygnatus*, *Lasioglossum pauxillum*, *L. quadrinotatum*, *L. morio*, and *Dufourea halictula* (BELÁKOVÁ 1980).

Out of the total number of species (139) recorded from the Tatras and from the sub-Tatra zone, more than half (87) are those collected exclusively either on the northern (39) or the southern slopes (48). Most of these species were caught in 1-2 localities and generally in small numbers (1 - 5 individuals), with the exception of four species found on N slopes (*Biastes truncatus* - 1 locality, 26 specimens; *Osmia rufa* - 3, 11; *Andrena tarsata* - 2, 11 and *Anthophora quadrimaculata* - 3, 15 and three on S slopes (*Andrena combinata* - 2, 13; *Halictus rubicundus* - 7, 17; *H. simplex* - 4, 10).

2. Number of species and individuals collected in the distinguished altitudinal zones and their abundance

Table II shows the number of species and individuals of the particular families of *Apoidea* (except the family *Apidae*) collected on the northern (N) and southern (S) slopes of the distinguished altitudinal zones. As can be seen from Table II, the family *Melittidae* is represented by 3 species and by the smallest number of specimens (7), recorded only in zones I N, I S, and II S. The other poorly represented family is *Colettidae*; altogether 46 specimens were caught belonging to 11 species in zones I, II and III N. Also the family *Megachilidae* occurred in the Tatras only up to and including zone III, i.e. in the lower part of the upper montane forest zone; 205 specimens from 28 species were collected. The remaining families of *Apoidea*, listed in Table II, *Andrenidae*, *Halictidae*, and *Anthophoridae*, live in the Tatras up to timber line or in the lower line of dwarf mountain pine. The greatest numbers of species and specimens collected were from the family *Andreanidae* (39 species, 956 specimens), followed by *Halictidae* (33, 880), and *Anthophoridae* (23, 193).

With the increase in altitude the number of species and individuals caught in the particular altitudinal zone decreases. Altogether in zone I 1065 individuals were caught; this accounting for about 46,5% of the collected material (2291). In zone II - 820 individuals (about 36%); in zone III - 295 (12,5%); and in zone IV - 111 (about 5%). The numbers of species collected from zones I-IV were 115, 85, 26, and 9 respectively. In the particular zones I-IV on the northern slopes the author found 93, 43, 21, and 7 species, but on the southern ones 54, 74, 20, and 8 respectively. On the northern side the number of species gradually falls as the altitude rises but this is not the case on the southern side (Fig. 3). In zone I S the author caught fewer species than in zones I N and II S. The same feature was observed on Mt Babia Góra (DYLEWSKA 1966). This does not result from the number of localities, since in zone II it is smaller on southern slopes and yet the number of collected individuals and of species was distinctly greater. On the other hand, in zone I in spite of a similar number of localities, the situation was reversed. In zone III the numbers of species captured on the two slopes are almost equal, though the number of

Number of species (sp) and specimens (spm) of the *Apoidea* families (exept
and number of the localities in the granite (g)

High zone	*Colletidae*				*Andrenidae*				*Halictidae*				*Melittidae*			
	N		S		N		S		N		S		N		S	
	sp	spm	sp	spm	sp	spm	sp	spm	sp	spm	sp	spm	sp	spm	sp	spm
I	8	21	2	7	23	251	26	240	24	173	15	137	1	1	2	3
II	3	3	4	14	14	123	23	166	8	151	20	235			3	3
III	1	1			9	90	7	44	7	97	7	45				
IV					5	20	5	25	1	40	1	8				
V																
VI																
Total of sp	10		5		27		31		27		24		1		3	
Total of spm		25		21		483		473		461		419		1		6
Total of sp																
Total of spm																
Total of localities																

localities in zone III N is more than twice that in zone III S. In zone IV the number of localities and species on the northern slopes is 6 and 7 respectively, while on the southern ones it is 5 and 8. In this zone the number of individuals was higher on northern (69) than on southern slopes (42).

3. Common species

Out of 139 species recorded from the Tatras and from the sub-Tatra zone, 12 may be considered as common because they were represented by 52 - 260 specimens each and were collected in 11 - 54 localities (Table III). These species are as follows: *Lasioglossum fratellum* (54 localities - 236 specimens), *L. albipes* (41 - 260), *L. calceatum* (36 - 115), *Andrena lapponica* (26 - 109), *A. praecox* (11 - 141), *A. subopaca* (35 - 68), *A. bicolor* (30 - 88), *A. humilis* (21 - 70), *A. haemorrhoa* (18 - 64), *A. clarkella* (11 - 52), *A. coitana* (20 - 71), and *Panurgus banksianus* (18 - 89). The above- mentioned species differed in the frequency of their occurrence, e.g. *Andrena coitana* and *Panurgus banksianus* were common only on the northern side of the Tatras, and *Andrena clarkella* and *A. praecox* only on the southern side. 27 species were recorded only once and as single specimens. The majority of species (104) were represented by 1 - 12 specimens collected in 1 - 8 localities, and 21 species by 13 - 44 specimens found in 5 - 17 localities. *Biastes truncatus*, which is one of the rarest species in the Polish fauna of *Apoidea*, was caught by ZABŁOCKI

Table II

the family *Apidae*) in the Tatra high zones on the north (N) and south (S) slopes and calcareous (c) Tatra ranges

Megachilidae				*Anthophoridae*				Total				Localities in the Tatras					
N		S		N		S		N		S		g		c		total	
sp	spm	sp	spm	sp	spm	sp	spm	sp	spm	sp	spm	N	S	N	S	N	S
23	87	10	36	14	92	9	17	93	625	54	440					17	15
11	29	15	48	7	28	9	21	43	334	74	486	2	7	21	10	22	17
2	4	2	5	2	3	3	6	21	195	20	100	5	7	14	1	19	8
				2	9	2	9	7	69	8	42	3	3	3	2	6	5
25		20		17		16		110		100							
	113		92		131		65		1223		1068						
									139								
										2291							
												10	17	38	13	64	45

(22 specimens) in one locality (I N), while *Anthophora quadrimaculata* was found by the present author to the number of 15 specimens in three localities (I S).

4. *Apoidea* in the particular altitudinal zones

Table III shows the species of *Apoidea* (except the family *Apidae*) from the Tatras and from the sub-Tatra zone grouped according to the time of their appearance, i.e. early spring, late spring, and summer. The period of appearance of the particular bee species covers about two months but some early and late spring species produce two (*Hylaeus communis, Andrena flavipes, A. gravida, A. minutula, A. minutuloidea, A. falsifica, A. semilaevis, A. subopaca, A. bicolor*, and *A. praecox*) or three generations (species of the genera *Halictus* and *Lasioglossum*) and are observed also in summer and autumn. As can be seen from Table III the early spring bees were the most numerous, the greatest number of specimens being caught (1382), although as to number of species (45), they came second to the late spring ones. Among the early spring bees 9 species (*Andrena lapponica, A. praecox, A. subopaca, A. bicolor, A. haemorrhoa, A. clarkella, Lasioglossum fratellum, L. calceatum*, and *L. albipes*) were common ones. A further five species (*Andrena falsifica, A. semilaevis, Lasioglossum fulvicorne, L. rufitarse*, and *Nomada panzeri*) were captured in 8 - 18 localities to the number of 12 - 44 specimens each. The above-mentioned common species belonging the early spring group were found in zones I - IV (5 species), I - III

Number of localities (l) and specimens (spm) of spring, late spring
zones (I–IV) on northern (N) and southern (S) slopes and

No	Species	N							
		I		II		III		IV	
		l	spm	l	spm	l	spm	l	spm
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	Early spring species								
1	*Colletes cunicularius*			1	1				
2	*Andrena haemorrhoa*	5	26	3	9	1	1		
3	*A. nigroaenea*	1	1						
4	*A. flavipes*	1	1						
5	*A. gravida*							1	1
6	*A. nitida*								
7	*A. cineraria*	1	1						
8	*A. bicolor*	5	13	4	6	5	15	1	1
9	*A. limata*								
10	*A. minutula*					1	2		
11	*A. minutuloides*								
12	*A. falsifica*			1	1	1	1		
13	*A. semilaevis*			1	1	1	5		
14	*A.subopaca*	7	13	11	37	9	28	1	1
15	*A. jakobi*								
16	*A. rosae*								
17	*A. praecox*	3	16	1	1				
18	*A. lapponica*	1	3	6	30	5	16	4	16
19	*A. varians*								
20	*A. apicata*	1	1	1	1				
21	*A. clarkella*	1	4	1	2				
22	*A. ruficrus*								
23	*A. ventralis*								
24	*Halictus rubicundus*								

Table III

and summer *Apoidea* (except family *Apidae*) in the particular altitudinal
in the granite (g) andcalcareous (c) parts of the Tatras

S								Total				Tatras			
I		II		III		IV		N		S		g		c	
l	spm	l	spm	l	spm	l	spm	l	spm	l	spm	l	spm	l	spm
(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(23)	(24)	(25)	(26)
								1	1	–	–	–	–	1	1
6	13	2	13					9	36	8	26	1	1	5	22
1	5							1	1	1	5	–	–	–	–
		1	1					1	1	1	1	?	?	?	?
								1	1	–	–	–	–	1	1
		1	1					–	–	1	1	?	?	?	?
								1	1	–	–	–	–	–	–
3	3	8	39	3	9	1	2	15	35	15	53	6	18	16	54
1	1							–	–	1	1	–	–	–	–
1	1	2	3					1	2	3	4	1	1	2	4
2	2							–	–	2	2	–	–	–	–
3	12	3	7					2	2	6	19	2	4	3	5
2	4	2	2	1	1			2	6	5	7	1	1	4	8
1	1	6	7					28	72	7	8	5	5	22	68
1	1							–	–	1	1	–	–	–	–
1	3	1	1					–	–	2	4	1	1	–	–
5	120	2	4					4	17	7	124	–	–	3	5
		4	10	4	19	2	15	16	65	10	44	8	39	17	67
		1	1					–	–	1	1	?	?	?	?
1	1	1	1			1	1	2	2	3	3	1	1	2	2
2	3	3	29	2	8	2	6	2	6	9	46	4	14	4	31
1	1	4	9	1	3			–	–	6	13	1	3	4	9
1	1							–	–	1	1	–	–	–	–
3	10	3	3					–	–	6	13	–		3	3

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
25	*Halictus confusus alpinus*	1	1						
26	*Lasioglossum calceatum*	7	30	9	26	1	1		
27	*L. albipes*	11	29	13	58	6	13		
28	*L. fulvicorne*	3	8	3	7	1	1		
29	*L. fratellum*	4	8	11	50	11	74	5	40
30	*L. rufitarse*	3	5			1	1		
31	*L. morio*								
32	*Sphecodes hyalinatus*	1	1						
33	*S. divisus*	1	1						
34	*S. fasciatus*	1	6						
35	*S. miniatus*	1	6						
36	*Osmia rufa*	3	11						
37	*O. uncinata*								
38	*Nomada bifasciata fuscata*							1	1
39	*N. roberjeotiana*	1	4						
40	*N. obscura*								
41	*N. panzeri*	2	2	4	14	2	2	3	8
42	*N. bifida*								
43	*N. flava*								
44	*N. leucophtalma*			1	4				
45	*N. flavoguttana*	1	8	2	3	1	1		
46	*N. fabriciana*			1	1				
47	*Anthophora acervorum*	1	3						
	Late spring species								
48	*Hylaeus confusus*	3	3	1	1				
49	*H. cardioscapus*	4	5						
50	*H. communis*	2	8						
51	*H. cornutus*								
52	*H. hyalinatus*	1	1						
53	*Andrena labialis*	1	1						

Table III ctd.

(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(23)	(24)	(25)	(26)
4	6	1	1					1	1	5	7	–	–	1	1
7	27	10	28	2	4			17	57	19	59	5	12	17	47
8	29	10	116	4	18			30	100	22	163	10	77	23	128
3	9	6	18	1	1			7	16	10	28	2	2	9	25
5	6	11	35	4	14	2	8	31	172	22	63	10	42	34	179
1	3	2	4					4	6	3	7	3	7	1	1
		1	1					–	–	1	1	?	?	?	?
								1	1	–	–	–	–	–	–
1	2							1	1	1	2	–	–	–	–
								1	6	–	–	–	–	–	–
		2	2					1	6	2	2	1	1	1	1
								3	11	–	–	–	–	–	–
		1	1					–	–	1	1	?	?	?	?
								1	1	–	–	–	–	1	1
		1	1					1	1	1	1	1	1	–	–
1	1							–	–	1	1	–	–	–	–
		2	2	1	1	2	8	11	26	5	11	7	17	7	18
1	1							–	–	1	1	–	–	–	–
		1	1					–	–	1	1	–	–	1	1
		1	2			1	1	1	4	2	3	1	1	2	6
1	1							4	12	1	1	–	–	3	4
								1	1	–	–	–	–	1	1
		1	3					1	3	1	3	1	3	–	–
		4	8					4	4	4	8	–	–	5	9
								4	5	–	–	–	–	–	–
								2	8	–	–	–	–	–	–
		1	1					–	–	1	1	1	1	–	–
3	5	3	3					1	1	6	8	–	–	3	3
								1	1	–	–	–	–	–	–

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
54	*Andrena schencki*	1	1						
55	*A. combinata*								
56	*A. wilkella*	1	6						
57	*A. ovatula*	3	3						
58	*A. fucata*	3	5	2	3	1	1		
59	*A. humilis*	7	35	4	10				
60	*A. labiata*								
61	*Halictus quadricinctus*	1	1						
62	*H. tetrazonius*	1	1						
63	*H. simplex*								
64	*H. eurygnatus*								
65	*H. tumulorum*	2	3						
66	*Lasioglossum quadrinostatum*								
67	*L. zonulum*	1	3						
68	*L. leucozonium*	3	7	1	1				
69	*L. laticeps*	1	1						
70	*L. cupromicans*			2	2				
71	*L. bavaricum*			2	6	3	4		
72	*L. villosulum*	2	7	1	1				
73	*L. leucopum*	3	6						
74	*L.politum*	1	1						
75	*Sphecodes puncticeps*	1	4						
76	*S. crassus*	1	1						
77	*S. ferruginatus*	1	2						
78	*Chelostoma maxillosum*			2	12	1	2		
79	*C. nigricorne*	2	2	1	2				
80	*Osmia parietina*	1	1	1	2				
81	*O. leaiana*	2	4	1	1				
82	*O. leucomelanea*								
83	*O. intermis*			2	2				

Table III ctd.

(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(23)	(24)	(25)	(26)
								1	1	–	–	–	–	–	–
2	12	1	1					–	–	3	13		–	1	1
1	4							1	6	1	4	–	–	–	–
3	14	2	2					3	3	5	16	2	2	–	–
1	1	4	15					6	9	5	16	2	4	5	15
7	20	5	6					11	45	12	26	2	4	5	12
1	1							–	–	1	1	–	–	–	–
								1	1	–	–	–	–	–	–
								1	1	–	–	–	–	–	–
4	10							–	–	4	10	–	–	–	–
		1	1					–	–	1	1	?	?	?	?
5	16	3	4					2	3	8	20	–	–	3	4
		1	1					–	–	1	1	?	?	?	?
3	3							1	3	3	3	–	–	–	–
4	5	3	3					4	8	7	8	2	2	2	2
		1	1					1	1	1	1	?	?	?	?
								2	2	–	–	–	–	2	2
		1	1	1	1			5	10	2	2	2	2	5	10
4	5	4	9	3	4			3	8	11	18	4	7	4	7
3	5	3	3					3	6	6	8	1	1	2	2
								1	1	–	–	–	–	–	–
		1	1					1	4	1	1	?	?	?	?
								1	1	–	–	–	–	–	–
								1	2	–	–	–	–	–	–
		2	2					3	14	2	2	1	1	4	15
1	2	2	2					3	4	3	4	1	1	2	3
								2	3	–	–	–	–	1	2
1	1							3	5	1	1	–	–	1	1
		1	2					–	–	1	2	–	–	1	2
								2	2	–	–	–	–	2	2

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
84	*Osmia fulviventris*	1	1						
85	*O. anthocopoides*	1	1						
86	*O. villosa*	1	3	2	2				
87	*Anthidium montanum*	2	2						
88	*Megachile nigriventris*	5	8	1	1				
89	*Coelioxys quadrimaculata*	1	6						
90	*Nomada striata*	2	6						
91	*N. ferruginata*	1	1						
92	*N. mutabilis*	1	1						
93	*N. sexfasciata*								
94	*Eucera longicornis*								
95	*Anthophora plagiata*								
	Summer species								
96	*Colletes daviesanus*	1	1						
97	*Hylaeus signatus*	1	1						
98	*H. gibbus*	1	1						
99	*H. annulatus*	1	1			1	1		
100	*H. nigritus*			1	1				
101	*Andrena hattorfiana*	4	8						
102	*A. rufizona*	1	1	1	1				
103	*A. coitana*	5	35	6	11	6	21		
104	*A. denticulata*	2	5						
105	*A. nigriceps*	1	1						
106	*A. tarsata*	2	11						
107	*A. marginata*								
108	*Panurgus banksianus*	4	60	4	10			1	1
109	*P. calcaratus*								
110	*Rhophites canus*								
111	*Dufourea dentiventris*	2	3						
112	*D. halictula*								

Table III ctd.

(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(23)	(24)	(25)	(26)
								1	1	–	–	–	–	–	–
2	9							1	1	2	9	–	–	–	–
		2	2	1	1			3	5	3	3	1	1	4	4
2	2			1	4			2	2	3	6	1	4	–	–
1	1	1	1					6	9	2	2	1	1	1	1
								1	6	–	–	–	–	–	–
1	1							2	6	1	1	–	–	–	–
2	2	2	2					1	1	4	4	1	1	1	1
		1	1					1	1	1	1	?	?	?	?
1	2							–	–	1	2	–	–	–	–
2	2							–	–	2	2	–	–	–	–
1	1	1	1					–	–	2	2	1	1	–	–
2	2							1	1	2	2	–	–	–	–
								1	1	–	–	–	–	–	–
								1	1	–	–	–	–	–	–
		2	2					2	2	2	2	–	–	3	3
								1	1	–	–	–	–	1	1
1	2	2	4					4	8	3	6	1	1	1	3
								2	2	–	–	–	–	1	1
1	1	1	2	1	1			17	67	3	4	4	6	10	29
								2	5	–	–	–	–	–	–
								1	1	–	–	–	–	–	–
								2	11	–	–	–	–	–	–
1	1							–	–	1	1	–	–	–	–
2	12	3	5	1	3	1	1	9	71	7	21	3	5	7	15
		1	1					–	–	1	1	?	?	?	?
1	1							–	–	1	1	–	–	–	–
		2	2					2	3	2	2	–	–	2	2
		1	1					–	–	1	1	?	?	?	?

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
113	*Duforea vulgaris*	1	38			2	3		
114	*Melitta haemorrhoidalis*	1	1						
115	*Macropis labiata*								
116	*M. fulvipes*								
117	*Trachusa byssina*	3	11						
118	*Anthidium manicatum*	2	6						
119	*A. punctatum*								
120	*Anthidiellum strigatum*	1	3						
121	*Chelostoma florisomne*	4	9	2	4	1	2		
122	*Osmia adunca*	1	1						
123	*Megachile alpicola*	3	3						
124	*M. versicolor*	1	1						
125	*M. ligniseca*	1	1						
126	*M. willoughbiella*	4	6	1	1				
127	*M. maritima*	1	1						
128	*M. circumcineta*	1	2						
129	*M. analis*								
130	*M. lapponica*								
131	*Stelis ornatula*	1	1	1	1				
132	*Celioxys rufescens*	3	3	1	1				
133	*Nomada rufipes*	1	1						
134	*N. emarginata*	1	5						
135	*N. obtusifrons*	3	9	1	1				
136	*N. similis*	1	2	1	2				
137	*Anthophora quadrimaculata*	3	15						
138	*A. furcata*	5	9	1	3				
139	*Biastes truncatus*	1	26						
Total number of species and specimens		93	625	44	334	21	195	8	69
Total of early spring species and specimens		26	202	16	252	14	161	7	68
Total of late spring species and specimens		33	141	16	46	3	7		
Total of summer species and specimens		34	282	12	36	4	27	1	1

Table III ctd.

(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(23)	(24)	(25)	(26)
1	1			1	3			3	41	2	4	1	3	2	3
1	2	1	1					1	1	2	3	1	1	–	–
1	1	1	1					–	–	2	2	1	1	–	–
		1	1					–	–	1	1	1	1	–	–
2	14	4	24					3	11	6	38	–		4	24
		1	1					2	6	1	1	–	–	1	1
		1	5					–	–	1	5	–		1	5
		1	1					1	3	1	1	–	–	1	1
								7	15		–	–	–	3	6
								1	1	–	–	–	–	–	–
1	2	1	1					3	3	2	3	–	–	1	1
								1	1	–	–	–	–	–	–
		1	1					1	1	1	1	1	1	–	–
2	2	1	3					5	7	3	5	–	–	2	4
								1	1	–	–	–	–	–	–
2	2							1	2	2	2	–	–	–	–
1	1	1	1					–	–	2	2	1	1	–	–
		1	1					–	–	1	1	1	1	–	–
								2	2	–	–	–	–	1	1
								4	4	–	–	–	–	1	1
								1	1	–	–	–	–	–	–
								1	5	–	–	–	–	–	–
				2	3			4	10	2	3	1	1	2	3
								2	4	–	–	1	2	–	–
								3	15	–	–	–	–	–	–
3	6	3	8	1	2			6	12	7	16	1	3	4	10
								1	26	–	–	–	–	–	–
64	440	74	485	19	100	8	42	110	1223	100	1067	49	311	66	905
27	266	30	344	10	78	7	41								
23	144	24	75	4	10										
14	40	20	66	5	12	1	1								

Table IV

Numbers of specimens of early spring *Andrena lapponica* (*A.l.*), late spring *A. humilis* (*A.h.*), summer *A. coitana* (*A.c.*) and *Panurgus banksianus* (*P.b.*) collected during the vegetation season in particular high zones of the Tatras

Month	Date	Species	North slopes				South slopes			
			I	II	III	IV	I	II	III	IV
April	13	*A.l.*			2♂♂					
May	11-14	*A.l.*		3♂♂	8♀♀			♂		
		A.h.						♀		
	15-20	*A.l.*	♀ 2♂♂	7♀♀ 16♂♂	10♀♀ 2♂♂	♂		6♀♀ 3♂♂	8♀♀ 8♂♂	8♀♀ 8♂♂
		A.h.						♂		
June	9-11	*A.l.*				2♂♂				
		A.h.		♀			2♀♀ 3♂♂			
	15-21	*A.l.*		3♀♀		8♀♀ ♂			♀ ♂	♀
		A.h.	9♀♀ 10♂♂	3♀♀			3♀♀	2♀♀ ♂		
		A.c.	♀							
		P.b.		4♂♂			8♀♀	♂		
July	2-11	*A.l.*				3♀♀				
		A.h.	8♀♀	♀ 2♂♂					♀	
		A.c.	3♀♀ 4♂♂							
		P.b.			4♀♀				2♂♂	
	15-21	*A.l.*				♀				
		A.h.	3♀♀ 4♂♂				6♀♀ ♂			
		A.c.	4♀♀	4♀♀ ♂	3♀♀		♀	3♀♀ ♂	♀	
		P.b.		♂		♀	♀ 3♂♂	3♀♀ 3♂♂	♀	
August	1-14	*A.h.*						♀		
		A.c.		3♀♀	14♀♀					
		P.b.						♀ 2♂♂		
	15-30	*A.h.*	♀					♀		
		A.c.	3♀♀ ♂	♀						
Sept.	12	*P.b.*								♂

(3 species), and in I - II (1 species). A total of 12 early spring species were recorded from zone I only, 14 from zones I and II, 9 from zones I - III, and 10 from zones I - IV.

Altogether 50 late spring species were found in the investigated area, of which only one (*Andrena humilis*) was common and occurred in zones I and II. 11 species of this group were represented by 11 - 26 specimens from 5 - 14 localities. The remaining species were rarer. 20 late spring species were recorded from zone I only, 22 from zones I and II, and 7 from zones I - III. A total of 427 specimens of late spring bees were caught. In the investigated area 44 species of summer bees were recorded, in number 474 specimens being collected. Two of these species (*Andrena coitana* and *Panurgus banksianus*) were regarded as common, the former occurring in zones I - III, the latter in zones I - IV. 8 summer species were represented by 13 -48 specimens from 1 - 11 localities. They are the following: *Andrena hattorfiana*, *Chelostoma florisomne*, *Trachusa byssina*, *Megachile willoughbiella*, *Nomada obtusifrons*, *Anthophora furcata*, *A. quadrimaculata*, and *Biastes truncatus*. The remaining summer species were recorded in 1 - 5 localities to the number of 1 - 7 specimens. Altogether 16 summer were found in zone I only, 20 in zones I - II, 5 in zones I - III, and 1 in zone I - IV.

The species composition of *Apoidea* changes distinctly during the vegetative season. Tables IV - VII show the numbers of females and males caught in successive months, in the determined periods (days) in the distinguished zones. The data in these tables come from the entire study period from different years.

Table IV gives the time of appearance of 4 common species: the early spring *Andrena lapponica*, late spring *A. humilis*, and summer *A. coitana* and *Panurgus banksianus*. As can be seen the earliest record of *A. lapponica* was 13 April in zone III while it was still observed in zone II in the second half of June. Thus, the species most likely appears in zones I - III in the first half of April and flies till the second half of June. On the other hand, in zone IV this species appeared in the second decade of May and on the northern slopes it was caught until the ent of July. The absence of *A. lapponica* on the southern slopes of zone I was probably due to the lack of forest and of its food plant *Vaccinium* in the recorded localities. Data from the southern slopes of zones II - IV were too few to allow a more detailed determination of the time of appearance, though the presence of *A. lapponica* females in zone IV S in the second half of May indicates that this species appears there earlier (at the beginning of May) than on the northern slopes of this zone. This conclusion results from the bionomics of the genus *Andrena* in which the males always appear earlier than the females. It is probably also for this reason that the late spring species *Andrena humilis* appears on the southern slopes as early as the second half of May and on the northern ones in the second half of June, being found on both slopes up to the second half of July, single specimens even being caught in August. From mid-June to the first half of August on the southern slopes and to the second half of that month on the northern slopes of the two montane forest zones summer species were observed which zones I - III flew simultaneously with late spring ones. Only in the first half of June was *A. humilis* observed unaccompanied by summer bees. In zone IV, with the early spring species a single summer species, *Panurgus banksianus* was found.

Table V shows the number of specimens caught of *Andrena bicolor* a species which produces two generations. On both northern and southern slopes the first generation was

Table V

Number of specimens of early spring *Andrena bicolor* (♀ ♂) appearing in two generations, collected during the vegetation season in particular high zones of the Tatras

Month	Date	North slopes				South slopes			
		I	II	III	IV	I	II	III	IV
April									
May	11-14		3♀	♀			4♀♀	7♀♀	
	15-30			2♀♀			24♀♀	3♀♀	2♀♀
June	18			♀					
July	10-14	6♀♀ 6♂♂							
	15-31	9♀♀ 9♂♂	4♀♀ ♂	♂		♀	5♀♀ 2♂♂		
August	5-10			♀ 4♂♂	♂				
	15-31	3♀♀	3♀♀	♀ 2♂♂			♂		
September	6						2♀♀		

Table VI

Number of specimens of early spring *Lasioglossum fratellum* appearing in three generations, collected during the vegetation season in particular high zones of the Tatras

Month	Date	North slopes				South slopes			
		I	II	III	IV	I	II	III	IV
April									
May	11-15	2♀♀	13♀♀	♀		5♀♀	5♀♀		
	16-31	♀	23♀♀	3♀♀		10♀♀	10♀♀	2♀♀	8♀♀
June	19-26		12♀♀	11♀♀	12♀♀	♀		♀	
July	7-11	2♂♂	♂	5♂♂	♂				
	19-30	♀		♂		4♀♀ ♂	4♀♀ ♂		
August	4-10	♀ 2♂♂		6♀♀ 41♂♂	4♀♀ 8♂♂				
	18-20			6♂♂	15♂♂				
September	1-13					6♂♂	16♂♂	11♂♂	

Table VII

Number of specimens of early spring *Lassioglossum calceatum* (*L.c.*) and *L. albipes* (*L.a.*) appearing in three generations collected during the vegetation season in particular high zones of the Tatras

Month	Date	Species	North slopes				South slopes			
			I	II	III	IV	I	II	III	IV
April	13	*L.a.*		16♀♀						
May	1-14	*L.c.*	♀	6♀♀			2♀♀	3♀♀	3♀♀	
		L.a.	2♀♀	2♀♀						
	15-30	*L.c.*		2♀♀			16♀♀	7♀♀		
		L.a.	♀	2♀♀			12♀♀	32♀♀	7♀♀	
June	1-14	*L.c.*		♀	♀					
		L.a.		♀						
	15-31	*L.c.*	♀	6♀♀	♀		2♀♀	3♀♀	♀	
		L.a.	5♀♀	22♀♀	6♀♀			18♀♀	9♀♀	
July	1-14	*L.c.*						9♀♀ ♂		
		L.a.						5♀♀		
	15-31	*L.c.*	2♀♀				♀	15♀♀ 9♂♂		
		L.a.	7♀♀ 8♂♂				4♀♀	21♀♀ 2♂♂	♀	
August	1-14	*L.c.*	3♀♀							
		L.a.	♀ 2♂♂	3♂♂	♂					
	15-30	*L.c.*	9♂♂							
		L.a.			♀ 3bb					
Sept.	1-12	*L.c.*					♀ 3♂♂	5♂♂		
		L.a.					13♀♀	2♀♀ 37♂♂	2♂♂	

caught in the first and second half of May, and in zone III still on 18 June. However, the males of *A. bicolor* probably appear in zones I - II in April on *Crocus scepusiensis*.

The second generation was observed on the northern slopes throughout July and in the second half of August. Because of the earlier appearance of the males, the whole period of appearance of the second generation lasts in zones I - II probably from the beginning of June, but in zone III from the second half of July until September. Records from the southern slopes were fewer, but nevertheless the author was able to establish there the occurrence of two generations of *A. bicolor*. Records from zone IV, for both slopes, were too few to permit discussion on the number of generations occurring there. It would seem that on the southern slopes of this zone the presence of the first generation has been established but the single male specimen caught on the northern slopes in the first decade of August moght equally well have belonged to the first and only generation on these slopes as to the second one.

Data concerning the number of individuals and the time of appearance of the three species of the genus *Lasioglossum* are given in Tables VI and VII. On the southern slopes of zones I - II *L. fratellum* has distinctly three generations, this concerning also the other two species. Interpretation of data compiled in Tables VI and VII is difficult; nevertheless it can be seen that as the altitude rises the appearance of successive generations is delayed, while on the northern slopes only two generations occur.

The discussed species of the genus *Lasioglossum* (Tables VI and VII) belong to the early spring group. The late spring species of this genus occur in zones I S and II S in the Tatras only in two generations,of which the first was observed in the second half of June and in July and the second one in September. On the northern slopes, however, there probably occurs only one generation in the second half of July and in August.

VI. ZOOGEOGRAPHICAL ANALYSIS

1. Division into zoogeographical elements

15 groups of zoogeographical elements were found in the Tatra Mountains and in the sub-Tatra zone:

1) 6 Holarctic species (4,3%): *Andrena wilkella, A. clarkella, Halictus rubicundus, Lasioglossum leucozonium, L. zonulum, L. rufitarse*

2) 28 Palearctic species (20,2%): *Colletes daviesanus, Hylaeus confusus, H. nigritus, Andrena haemorrhoa, A. cineraria, A. ovatula, A. rosae, A. humilis, A. ventralis, A. labiata, Halictus quadricinctus, H. tetrazonius, H. tumulorum, Lasioglossum calceatum, L. albipes, L. fulvicorne, Sphaecodes crassus, S. divisus, S. hyalinatus, S. fasciatus, Stelis ornatula, Osmia rufa, O. fulviventris, Megachile maritima, Coelioxys quadridentata, C. rufescens, Nomada ferruginata, N. flavoguttata.*

3) 27 Western Palearctic species (19,4%): *Colletes cunicularius, Hylaeus signatus, H. gibbus, H. communis, Andrena labialis, A. hattorfiana, A. schencki, A. nitida, A. nigroaenea, A. minutula, A. minutuloides, A. bicolor, Lasioglossum quadrinotatum, L. laticeps, L. villosulum, L. leucopum, L. morio, Sphaecodes puncticeps, Anthidium manicatum, A. punctatum, Anthidiellum strigatum, Chelostoma florisomne, Osmia anthocopoides, Nomada bifasciata, Anthophora acervorum, A. quadrimaculata, A. plagiata.*

4) 34 European species (24,5%): *Hylaeus cardioscapus, H. hyalinatus, Andrena varians, A. apicata, Panurgus calcaratus, Dufourea vulgaris, Sphaecodes ferruginatus, S. miniatus, Trachusa byssina, Chelostoma maxillosum, Ch. nigricorne, Osmia leaiana, O. uncinata, Megachile versicolor, M. willoughbiella, M. ligniseca, M. analis, M. circumcincta, Nomada sexfascaiata, N. rufipes, N. emarginata, N. roberjeotiana, N. striata,*

N. fabriciana, N. flava, N. leucophtalma, N. bifida, N. similis, N. mutabilis, N. panzeri, Eucera longicornis, Anthophora furcata, Macropis labiata, M. fulvipes

5) 6 European Caucasian species (4,3%): *Andrena combinata, A. falsifica, A. nigriceps, A. jakobi, A. praecox, A. fucata*

6) 5 North Central Europe species (3,6%): *Andrena semilaevis, A. tarsata, Panurgus banksianus, Melitta haemorrhoidalis, Osmia leucomelaena*

7) 4 European Siberian species (3%): *Andrena subopaca, A. coitana, A. denticulata, Nomada obtusifrons*

8) 1 West European species (0,7%): *Halictus eurygnatus*

9) 6 Montane species (4,3%): *Andrena rufizona, Halictus confusus alpinus, Lasioglossum cupromicans, L. bavaricum, Anthidium montanum, Osmia villosa*

10) 12 North Montane species (8,6%): *Hylaeus annulatus, Andrena ruficrus, A. lapponica, Lasioglossum fratellum, Duphourea halictula, D. dentiventris, Osmia inermis, O. parietina, Megachile nigriventris, M. lapponica, M. alpicola, Nomada obscura*

11) 1 South Central Europe species (0,7%): *Andrena gravida*

12) 5 Submediterranean species (3,6%): *Hylaeus cornutus, Lasioglossum politum, Halictus simplex, Osmia adunca, Biastes truncatus*

13) 1 Submediterranean Siberian species (0,7%): *Andrena flavipes*

14) 2 Subponto Mediterranean species (1,4%): *Andrena limata, A. marginata*

15) 1 Subpontic species (0,7%): *Rhophitoides canus.*

2. Vertical distribution of various zoogeographical elements

Those species which are southern or south-eastern zoogeographical elements in the Tatra Mts (Submediterranean, Subpontic, Subponto-Mediterranean, Submediterranean-Siberian) were found as single specimens in zone I N and in zones I S and II S. The only South Central European species, *Andrena gravida*[(1)], was recorded from one specimen collected in zone IV N. All the above-mentioned elements are represented by 10 species (6,8% of the whole material) and by 44 specimens (constituting only 2%).

Montane species (6 - 4,2%), collected to at number of 1 - 12 specimens, were recorded only from zones I - II (*Andrena rufizona, Halictus confusus alpinus, Lasioglossum cupromicans*), or from zones I - III (*Anthidium montanum, Osmia villosa, Lasioglossum bavaricum*). Altogether 40 individuals of the montane species were caught, accounting for 1,7% of the material collected.

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[1]The specimen determined as *Andrena gravida* is very interesting. It was a female, probably of the second generation, caught on Siwe Sady on 5 August 1968. The insect was not damaged, thus it could not have been carried to this place by a strong wind. However, this specimen differs from other representatives of the species known to the author from Central Europe (DYLEWSKA 1987), in having reddish hairs at the end of the abdomen. there is a very similiar female of this species, cought in Germany by STOECKHERT, there is stored in Zoological Museum of the Humboldt University in Berlin. Both these specimens resemble in size the typically coloured ones, but their body lenght is distinctly smaller. STOECKHERT found his specimen in a nesting colony of *Andrena gravida*, which seems to confirm its belonging to the species in question.

Among the North Montane species *Andrena lapponica* and *Lasioglossum fratellum* may be considered as common. They occur in zones I - IV. The remaining species of this group were captured in numbers of 1 - 13 individuals in zones I - III (*Hylaeus annulatus*, *Andrana ruficrus*), in zones I - II (*Dufourea halictula*, *D. dentiventris*, *Osmia inermis*, *O. parietina*, *Megachile nigriventris*, *M. lapponica*, *M. alpicola*), or only in zone I (*Nomada obscura*). Altogether 390 specimens of north-montane species were collected, constituting about 17% of the whole material.

European Siberian species (4) were observed in zones I - IV (*Andrena subopaca*), I - III (*Andrena coitana*), I - II (*Nomada obtusifrons*), or only in zone I (*A. denticulata*). *A. subopaca* and *A. coitana* were considered by the author as common, the remaining two species were collected in numbers of 10 and 5 specimens respectively. Altogether 186 specimens of Euro-Siberian elements were studied, constituting 8,1% of the collected material.

Besides, the author noted 5 North Central European species, of which only *Panurgus banksianus* was common, occurring in zones I - IV. The remaining species were recorded in zones I - III (*Andrena semilaevis*), I - II (*Melitta haemorrhoidalis*), *O. leucomelaena*), or only in zone I (*Andrena tarsata*) to the number of 1 - 13 specimens. A total of 125 specimens belonging to this group was studied (5,3% of the collected material).

The number of Montane, North Montane, European Siberian, and North Central European species recorded was 27 (19,5%) while the total number of collected specimens from the above groups was 739, this constituting 32,1% of the studied specimens.

Widely distributed species (Holarctic, Palearctic, Western Palearctic, European, and European Caucasian) constituted the most numerous groups (102 - 73,7%). Among them were 5 common species occurring in zones I - IV (*Andrena clarkella*), I - III (*Andrena haemorrhoa*, *Lasioglossum calceatum*, *L. albipens*, and I - II (*A. humilis*). The remaining widely distributed species were found in numbers of 1 - 45 individuals in zones I - IV. Altogether 1508 specimens (about 66%) belonging to this group were collected.

VI. ECOLOGICAL ANALYSIS

1. The effect of climate on the distribution of *Apoidea* (excluding the family *Apidae*) in the Tatras and in the sub-Tatra zone

In her prevoius works (DYLEWSKA 1966, 1970) the author expressed the view that microclimatic conditions are decisive in the selection of nesting places and flight areas, and that the limits of microclimatic zones are at the same time those of distribution of early spring, late spring, and summer bees. Thus, in general, summer species do not live where there is no climatic summer and the limits of climatic spring and late spring are also the limits of occurrence of early and late spring species. The only exceptions to this rule, based on microclimatic data, may be localities with a very specific microclimate. Early spring species appear when the average daily temperature reaches at least 5°C and the temperature in the sun is at least 21°C. At a temperature of 26°C in the sun all species of this group may be observed. Late spring species appear only when the average daily temperature is at least 10°C and that in the sun exceeds 26°C. Summer species appear at an average daily temprature exceeding 15°C and 30°C in the sun.

Table III shows the numbers of captured specimens and localities in the particular altitudinal zones on the northern and southern slopes of early spring, late spring, and summer species. Early spring species were found in zones I - IV, i.e. up to and including the dwarf mountain pine zone and, at the same time, up to the limit of climatic late spring. However, the distribution of those species in the particular zones in uneven - with the increase in altitude the number of species clearly diminishes (see Table III). The late spring species occur in the Tatras only in zones I to III, i.e. below the limit of late spring.

The localities of late spring species found in zone III were situated in very warm places, sheltered from the wind and well insolated in this zone only 19 specimens were collected of which 11 were montane species.

Summer species may be divided into two groups: the first includes 31 species which were found on the northern slopes only in zone I but on the southern ones also in zone II (lower montane forest zone). The second group of summer bees was also found in the higher zones and comprised (13) species, of which 5 belong to Montane, North Montane, European Siberian, and North Central European elements. The remaining species are widely distributed. The number of specimens representing summer species (Table III) totalling 346 (282 in zone I N, 36 in zone II N, 27 in zone III N, and 1 in zone IV N), may be considered as large in an area with no climatic summer. From the first group of summer species 105 specimens were collected exclusively in zone I N and 82 in zones I S and II S. Climatic summer occurs in zone I S and at the lower limit of zone II S. The number of specimens representing the second group of summer species was very great, amounting to 241 on northern slopes and to 46 on southern slopes. To this number mainly common species contributed, i.e. *Andrena coitana* (64 specimens on N slopes and 4 on S slopes), *Panurgus banksianus* (71 and 21 respectively), *Anthophora furcata* (12 and 16), *Chelostoma florisomne* (15 on N slopes), and *Dufourea vulgaris* (41 and 4). The remaining species of this group were found in numbers from 1 - 4 specimens on both slopes of the Tatras.

2. *Apoidea* (excluding the family *Apidae*) of the limestone and granite Tatras

Table II shows the numbers of localities of *Apoidea* recorded from the limestone and granite Tatras. They total 50 and 27 respectively, while the totals for the particular zones II, III, and IV are 30, 15, and 5 in the limestone and 9, 12 and 6 in the granite Tatras. Still greater differences in the number of localities occur between the northern and southern slopes. Thus, on the northern slopes of the limestone Tatras, in zones II, III, and IV, were found 20, 13, and 3 localities, but on the southern ones 10, 1, and 2 respectively. On the northern slopes of the granite Tatras the numbers of localities were 2, 5, and 3, and on southern ones 7, 7, and 3.

The numbers of localities and specimens of the particular bee species recorded from the limestone and granite Tatras are given in Table III. Altogether 43 species were found in the granite and 66 in the limestone Tatras. The number of individuals captured in the latter (905) was much greater than that in the former (311). As the total number of localities was smaller (27) in the granite than in the limestone Tatras (51) it is not possible to make a direct comparison of the numbers of species and specimens caught in the two parts. The average number of specimens caught per one locality in the limestone Tatras was 14 and in the granite part 11,4.

No detailed information on the localities of 12 species reported from the Tatras by BELÁKOVÁ (1980) is given. All the remaining species, however, may be grouped according to the substratum or other parameters.

Out of 14 species recorded exclusively from the granite Tatras, 3 (21%) appeared in early spring, 4 (29%) in late spring, and 7 (50%) in summer. On the other hand,out of the species known only from the limestone Tatras, 7 (22,5%) were observed in early spring, 11 (35,5%) in late spring, and 13 (42%) in summer.

The remaining 35 Tatra species were collected in both granite and limestone parts of the range. Among species from this last group 18 (51,5%) appear in early spring, 11 (31,5%) in late spring, and 6 (17%) in summer. Species recorded only from the granite Tatras were found in numbers of 1 - 4 specimens in 1 -2 localities. In view of their rarity it is impossible to state that they are confined to a granite substratum. However, in the limestone Tatras the author collected individuals of the discussed species in numbers from 1 - 24 from 1 - 5 localities. Only about the species nesting in the crevices of limestone rocks (*Trachusa serratulae* and other of the family *Megachilidae*) can it be stated with certainly that in the Tatras they are associated with these rocks. Although detailed bionomical data on these species are lacking, it is not impossible that they nest also in other porous rocks. Moreover, some species of the genera *Chelostoma* and *Megachile* nest in dead wood in numerous shepherd's huts and hay sheds, the great majority of which are in the limestone Tatras. Most of the species occurring all over the Tatras are early spring ones. They chiefly nest in the ground and have very small thermal demands. The greater part of the common Tatra species occur throughout the range, and are early spring ones. Besides, the much larger numbers of localities, species, and specimens recorded from the limestone Tatras, mainly results from their considerably differentiated morphology and the possibility of occurrence of warm places. This chiefly concerns the northern slopes of the sub-Tatra zone and the lower montane forest zone, since the southern slopes are smooth, without forest cover and, in higher parts, very steep and exposed to strong winds which impede or prevent the flight of bees.

3. Food plants

The food plants and species of *Apoidea* (excluding the family *Apidae*) visiting them are listed in Table VIII. Some plants were identified to the species, other to the genus, while the genera *Leontodon* and *Hieracium* were treated together. To elaborate a detailed list of all the plant species and the bees visiting them would require special studies; the investigations hitherto carried out indicate that bees do not necessarily choose a particular plant species, their choice depending rather on the size, colour and shape of a flower, though in a given area they visit specific plants. The majority of *Apoidea* are polyphagous and visit numerous plant species or even whole families of plants.

Table VIII

Food plants visited by *Apoidea* species in the Tatra Mountains

No.	Food plants	Visiting *Apoidea* species	Number of collected *Apoidea*: species	Number of collected *Apoidea*: specimens
(1)	(2)	(3)	(4)	(5)
1	*Crocus scepusiensis*	*Andrena bicolor* (5♀♀), *Lasioglossum fratellum* (1♀)	2	6
2	*Salix* sp.	*Andrena lapponica* (11♀♀, 14♂♂), *A. apicata* (2♂♂), *A. clarkella* (39♀♀), *A. ventralis* (♀), *A. semilaevis* (♀, 2♂♂), *A. subopaca* (♀), *A. bicolor* (14♀♀), *A. ruficrus* (12♀♀), *A. jakobi* (♂), *A. rosae* (3♀♀), *A. praecox* (133♀♀, 6♂♂), *A. haemorrhoa* (20♀♀, 40♂♂), *A. combinata* (♂), *A. minutula* (2♀♀), *A. minutuloides* (♀), *A. falsifica* (♀), *Colletes cunicularis* (♀), *Halictus confusus alpinus* (♀), *H. rubicundus* (2♀♀), *H. tumulorum* (3♀♀), *Lasioglossum albipes* (5♀♀), *H. calceatum* (7♀♀), *L. rufitarse* (2♀♀), *L. fulvicorne* (10♀♀), *L. fratellum* (14♀♀), *Nomada panzeri* (7♂♂), *N. leucophtalma* (♀), *N. ferruginata* (♀), *N. obscura* (♀), *N. flava* (♂),	31	363
3	*Petasites* sp.	*Andrena lapponica* (6♀♀, 7♂♂), *A. clarkella* (3♀♀), *A. bicolor* (♀, ♂), *Nomada panzeri* (♀, ♂)	4	20
4	*Padus avium*	*Andrena bicolor* (♀), *A. ruficrus* (♀)	2	2
5	*Gagea lutea*	*Andrena subopaca* (♀, ♂), *A. falsifica* (♀), *A. lapponica* (15♀♀, 10♂♂), *Lasioglossum calceatum* (2♀♀), *L. fratellum* (25♀♀), *Nomada leucophtalma* (♀)	7	56
6	*Taraxacum officinale*	*Andrena haemorrhoa* (♀, 2♂♂), *A. falsifica* (6♀♀, 3♂♂), *A. subopaca* (6♀♀), *A. bicolor* (7♀♀), *A. apicata* (♀), *A. clarkella* (10♀♀), *A. lapponica* (2♀♀, ♂), *A. fucata* (♂), *A. humilis* (11♀♀, 6♂♂), *A. labiata* (♀), *Halictus rubicundus* (6♀♀), *H. confusus alpinus* (♀), *H. tumulorum* (4♀♀), *Lasioglossum fratellum* (8♀♀), *L. rufitarse* (3♀♀), *L. albipes* (22♀♀), *L. calceatum* (13♀♀), *L. fulvicorne* (5♀♀), *L. bavaricum* (2♀♀), *Nomada ferruginata* (2♀♀), *N. panzeri* (♂)	21	125
7	*Primula elatior*	*Lasioglossum fulvicorne* (♂), *Osmia rufa* (2♀♀)	2	3
8	*Vaccinium myrtillus*	*Andrena haemorrhoa* (♀), *A. combinata* (♂), *A. lapponica* (16♀♀, 12♂♂), *Lasioglossum calceatum* (♀), *L. albipes* (♀), *L. fulvicorne* (♀), *Osmia inermis* (2♀♀), *Nomada panzeri* (♀)	8	36
9	*V. vitis-idaea*	*Lasioglossum fratellum* (14♀♀), *Nomada panzeri* (2♀♀, 4♂♂)	2	20
10	*Rubus idaeus*	*Andrena fucata* (12♀♀)	1	12

Table VIII ctd.

(1)	(2)	(3)	(4)	(5)
11	*Potentilla* sp.	*Andrena haemorrhoa* (♂), *A. nigroaenea* (2♂♂), *A. combinata* (10♂♂), *A. minutula* (2♀♀), *A. falsifica* (9♀♀, 2♂♂), *A. semilaevis* (6♀♀, ♂), *A. subopaca* (35♀♀, 3♂♂), *A. bicolor* (2♀♀), *A. coitana* (15♀♀), *A. lapponica* (♀), *Hylaeus confusus* (♀), *H. hyalinatus* (♀), *Lasioglossum albipes* (14♀♀, ♂), *L. calceatum* (8♀♀), *L. rufitarse* (♀), *L. fratellum* (17♀♀, 8♂♂), *L. leucopum* (4♀♀), *L. bavaricum* (4♀♀), *Osmia villosa* (♀), *Chelostoma nigricorne* (2 ♂♂), *Nomada flavoguttata* (♀, 2♂♂), *N. panzeri* (♀)	22	155
12	*Rosa canina*	*Andrena fucata* (♀), *A. rufizona* (♂)	2	2
13	*Reseda lutea*	*Hylaeus signatus* (♀), *Andrena nigroaenea* (3♂♂), *A. ovatula* (♀)	3	5
14	*Leontodon* sp. and *Hieracium* sp.	*Hylaeus confusus* (5♀♀, ♂), *H. annulatus* (♀), *H. cardioscapus* (♀), *H. hyalinatus* (♀), *Andrena gravida* (♀), *A. ovatula* (♀), *A. minutula* (2♀♀), *A. minutuloides* (♀), *A. falsifica* (3♀♀, ♂), *A. subopaca* (15♀♀, ♂), *A. coitana* (8♀♀, 2♂♂), *A. bicolor* (5♀♀, 4♂♂), *A. humilis* (22♀♀, 14♂♂), *Panurgus banksianus* (23♀♀, 21♂♂), *Halictus rubicundus* (♀, 4♂♂), *H. tumulorum* (6♀♀, ♂), *H. confusus alpinus* (2♂♂), *Lasioglossum zonulum* (3♀♀), *L. leucozonium* (5♀♀, 2♂♂), *L. leucopum* (3♀♀), *L. rufitarse* (4♀♀), *L.fratellum* (19♀♀, 49♂♂), *L.calceatum* (32♀♀, 9♂♂), *L. albipes* (95♀♀, 32♂♂), *L. villosulum* (10♀♀, ♂), *L. fulvicorne* (♀, 3♂♂), *Sphaecodes divisus* (♀), *Sph. miniatus* (♀), *Duforea dentriventris* (♀, ♂), *D. vulgaris* (6♀♀), *Stelis ornatula* (♀), *Chelostoma florisomne* (♀, 3♂♂), *Ch. maxillosum* (2♀♀), *Osmia athocopoides* (3♀♀, 4♂♂), *O. villosa* (♀), *O. leaiana* (♀), *Megachile alpicola* (2♀♀), *Nomada striata* (♂), *N. bifasciata* (♂), *N. obtusifrons* (♀), *N. flavoguttata* (2♀♀)	43	448
15	*Senetio* sp.	*Lasioglossum fratellum* (5♂♂)	1	5
16	*Cirsium* sp.	*Osmia villosa* (♀), *Megachile willoughbiella* (♀), *Anthophora furcata* (♂)	3	3
17	*Centaurea* sp.	*Megachile ligniseca* (♀)	1	1
18	*Cichorium inthybus*	*Lasioglossum albipes* (♂), *L. calceatum* (♀, ♂)	2	3
19	*Campanula* sp.	*Andrena bicolor* (11♀♀), *A. fucata* (3♀♀), *Lasioglossum fratellum* (31♂♂), *Duphourea dentiventris* (2♂♂), *Melitta haemorrhoidalis* (2♀♀), *Chelostoma florisomne* (3♀♀, 7♂♂), *Ch. nigricorne* (15♀♀, 10♂♂)	7	84
20	*Lotus corniculatus*	*Trachusa byssina* (6♀♀, 22♂♂), *Anthidium montanum* (5♀♀), *Osmia leucomelaenea* (2♀♀), *O. villosa* (♀), *Megachile willoughbiella* (♀, 2♂♂), *Eucera longicornis* (♀), *Megachile alpicola* (♀)	7	41
21	*Vicia silvatica*	*Megachile willoughbiella* (♀), *M. ligniseca* (♀)	2	2
22	*Lathyrus pratensis*	*Trachusa byssina* (3♀♀, 4♂♂), *Osmia leaiana* (♀), *O. villosa* (2♀♀), *Megachile nigriventris* (♀, ♂)	4	12

Table VIII ctd.

(1)	(2)	(3)	(4)	(5)
23	*Trifolium* sp.	*Andrena ovatula* (2♀♀), *Anthidium punctatum* (2♀♀), *Anthophora furcata* (♀)	3	5
24	*Medicago* sp.	*Andrena schencki* (♀), *Megachile alpicola* (♀), *M. willoughbiella* (♀)	3	3
25	*Anthylis* sp.	*Megachille willoughbiella* (♀)	1	1
26	*Knautia arvensis*	*Andrena hattorfiana* (13♀♀), *Celioxys rufescens* (♂), *Nomada sexfasciata* (2♀♀)	3	16
27	*Scabiosa* sp.	*Hylaeus hyalinatus* (2♀♀), *Halictus rubicundus* (♀, 2♂♂), *H. simplex* (7♀♀, ♂), *Lasioglossum albipes* (♀), *L. villosulum* (♀), *L. fratellum* (♂)	6	16
28	*Sinapis arvensis*	*Andrena fucata* (♀)	1	1
29	*Thymus* sp.	*Halictus tumulorum* (♂), *H. confusus alpinus* (2♂♂), *Sphaecodes divisus* (♀)	3	4
30	*Prunella* sp.	*Lasioglossum fratellum* (♂)	1	1
31	*Ballota nigra*	*Anthophora furcata* (2♀♀, 2♂♂)	1	4
32	*Lamium purpureum*	*Anthidium punctatum* (3♂♂)	1	3
33	*Stachys* sp.	*Anthidium manicatum* (4♀♀, ♂), *Celioxys rufescens* (♀), *Anthophora quadrimaculata* (9♀♀, ♂), *A. furcata* (♀, 3♂♂)	4	20
34	*Salvia pratensis*	*Anthidium manicatum* (♂), *Megachile nigriventris* (♂), *Anthophora quadrimaculata* (2♂♂), *A. furcata* (4♂♂)	4	8
35	*Veronica* sp.	*Hylaeus communis* (3♀♀), *H. cardioscapus* (♀), *Andrena subopaca* (6♀♀), *A. coitana* (3♀♀, ♂), *A. bicolor* (♂), *A. lapponica* (♀), *Halictus tumulorum* (3♀♀), *H. confusus alpinus* (♀), *Lasioglossum calceatum* (6♀♀), *L. albipes* (8♀♀), *L. fulvicorne* (5♀♀), *L. villosulum* (2♀♀), *L. rufitarse* (2♀♀), *L. fratellum* (♀)	14	44
36	*Anemone rannunculoides*	*Andrena lapponica* (2♂♂)	1	2
37	*Rannunculus* sp.	*Andrena subopaca* (♀), *Lasioglossum fratellum* (3♀♀)	2	4
38	*Urtica* sp.	*Lasioglossum albipes* (♀, 9♂♂)	1	10
39	*Chamaenerion angustifolium*	*Trachusa byssina* (♀, 2♂♂), *Lasioglossum albipes* (2♀♀, 3♂♂), *L. fratellum* (♀), *Nomada obtusifrons* (♀)	4	10
40	*Astrantia major*	*Andrena bicolor* (♀, 3♂♂)	1	4
41	*Hypericum* sp.	*Andrena lapponica* (♀)	1	1
42	*Calluna vulgaris*	*Lasioglossum leucozonium* (♂), *L. calceatum* (2♂♂), *L. fulvicorne* (♂), *L. fratellum* (3♂♂)	4	7
		Total of specimens		1568

As can be seen from Table VIII, the author caught 448 specimens of the *Apoidea* (41 species) on plants of the genera *Leontodon* and *Hieracium*. This constitutes 28% of all beees collected on flowers. 336 specimens (28%), representing 34 early spring species, were captured on willow catkins. 155 specimens (10%) belonging to 21 late spring species were found on *Potentilla*. The flowers of *Taraxacum officinale* were visited by 20 species (125 individuals - 8%). The remaining plant species were visited far less frequently.

Early spring species were captured mainly on *Salix* but also on *Petasites*, *Padus avium*, *Gagea lutea*, *Taraxacum officinale*, *Primula elatior*, and *Vaccinium*. Late spring and summer species mainly visited the flowers of *Potentilla*, *Leontodon* and *Hieracium*. The flowers of *Potentilla* were chiefly visited by the small species of the genus *Andrena* (above all from the group of *A. minutula* and *A. coitana*, but those of *Leontodon* and *Hieracium* by species of the genera *Halictus* and *Lasioglossum*.

In the Tatras among monophagous bee species the author found *Andrena hattorfiana* which is confined to the flowers of *Knautia arvensis*. Of the oligophagous species visiting flowers of the genus *Campanula* were observed: *Melitta haemorrhoidalis*, *Andrena bicolor* (II. generation), *Chelostoma florisomne*, and *Ch. nigricorne*. *Trachusa byssina* was captured exclusively on the flowers of *Lotus corniculatus* and *Lathyrus silvestris*. At the beginning of its appearance *Andrena lapponica* (chiefly males) visited species of the genus *Salix* and then *Vaccinium*, *while A. furcata* mainly visited *Rubus*. Many bees of the family *Megachilidae* visited plant species belonging to the families *Papilionaceae* and *Compositae*.

In general, common species visited the largest number of plant species, with the exception of *Andrena humilis* and *A. lapponica* which are oligophageous. The findings of *Lasioglossum albipes* on *Urtica* was astonishing and could only have been dictated by hunger. To sum up, it seems that the flower supply in the Tatras is sufficient for the poor fauna of *Apoidea*. The absence of *Apoidea* on the large areas overgrown by apidophilous vegetation is explained by the thermal conditions, which are unsuitable for bees.

4. Xerothermic species

The bee species belonging to southern or south-eastern zoogeographical elements (Submediterranean, Subponto Mediterranean, Subpontic, Submediterranean Siberian) and *Andrena gravida*, known from South Europe and from warm localities in Central Europe, are xerothermic. Also, as species that have greater temperature demands may be regarded numerous widely distributed summer species as well as some late spring ones. Xerothermic species (apart from *Andrena gravida*) were recorded only from the sub-Tatra zone (from both N and S slopes) and from zone II S. These are chiefly connected with xerothermic plants, above all with *Papilionaceae* (MICHALIK 1979). Altogether, in the Tatras and in the sub-Tatra zone there live 70 xerothermic species, constituting about 50% of the species reported from that area.

All remaining species, apart from the widely distributed ones, nest and fly only in the warmest places in the investigated area. At the upper limits of their vertical range even the common species behave similarly as xerothermic ones.

VIII. *APOIDEA* (excluding the family *Apidae*) OF THE TATRA MTS AS COMPARED WITH THAT FAUNA OF OTHER PARTS OF THE POLISH WEST CARPATHIANS

In Table IX the author has compiled the data on the occurrence of the investigated families of *Apoidea* in the Tatras and in the Polish part of the West Carpathians, except for the Carpathian foothills (Pogórze). Data from Mt Babia Góra and from the Pieniny Mts are based on monographs (DYLEWSKA 1962, 1966, DYLEWSKA, NOSKIEWICZ 1963) while those from the other parts of the West Carpathians single records are taken from papers by WIERZEJSKI (1868, 1874), ŚNIEŻEK (1910), NOSKIEWICZ (1949), DYLEWSKA, ZABŁOCKI (1972), SZADZIEWSKI et al. (1973), and DYLEWSKA (1987).

1. Comparison of the *Apoidea* fauna of the Tatras, of Mt Babia Góra and of the Pieniny Mts

As can be seen from Table IX, in the Tatras during 16 vegetative seasons 2294 specimens were collected, on but Babia Góra during three-year study 2124, and in the Pieniny from 1954-1961 2542. In one vegetative season the investigations were carried out over about six weeks in which period the average number of specimens collected was 143 in the Tatras, 798 on Mt Babia Góra, and 318 in the Pieniny Mts. This particularly small number of specimens collected during one season in the Tatras may be explained by the prevailing very unfavorable climatic conditions for the bees.

All the common species recorded from the Tatras were also found on Mt Babia Góra. Most of these species, namely: *Andrena haemorrhoa, A. humilis, Lasioglossum calceatum, L. albipes,*and *L. fratellum* were also common on Mt Babia Góra. For some of the montioned species even the number of specimens caught are similar, though three common species (*A. praecox, A. lapponica,* and *A. humilis*) were recorded on the basis of twice as many specimens as in the Tatras and in the case of *A. haemorrhoa* on that of five times as many (Table IX). Conversely, the number of *L. fratellum* specimens captured on Mt Babia Góra was five times smaller than that in the Tatras. *Andrena coitana* and *Panurgus banksianus* were common in the Tatras but not on Mt Babia Góra. Only four species common in the tatras and on Mt Babia Góra were also common in the Pieniny Mts where they were captured in numbers of 77 - 168 specimens each. They were: *Andrena haemorrhoa, A. bicolor, Lasioglossum calceatum,* and *L. albipes*. *A. lapponica,* common in the Tatras and on Mt Babia Góra does not inhabit the Pieniny Mts because its food plants of the genus *Vaccinium* are lacking there. *Andrena subopaca, A. humilis,* and *A. coitana,* common in the Tatras and on Mt Babia Góra, were caught in the Pieniny Mts in numbers of 8, 19, and 2 specimens respectively.

On Babia Góra 6 North Montane species were found, all of which are known also in the Tatras. Of these six species only one, *Osmia parietina*, was caught in the Pieniny Mts. Of these species *Andrena lapponica* and *Lasioglossum fratellum* are common both on Mt Babia Góra and in the Tatras. The remaining Montane species were recorded from the Tatras and Mt Babia Góra on the basis of 1-13 specimens. One Montane species, *Osmia villosa*, is knon not only from the Tatras and Mt Babia Góra but also from the Pieniny Mts and from other part of the West Beskid Mts. In the Tatras 13 North Montane and 5 Montane

The list of Apoidea species (excl. Apidae) and numbers of their specimens collected on the Babia Mt and in the Pieniny Mts The other Polish West Carpathian

No	Species	Particular high zones									
		Tatras					Babia Góra Mt				
		I	II	III	IV	V	I	II	III	IV	V
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	Colletidae										
1	*Colletes cunicularius*		1								
2	*C. daviesanus*	3					2				
3	*Hylaeus signatus*	1									
4	*H. gibbus*	1									
5	*H. confusus*	3	9				1	4			
6	*H. brevicornis*										
7	*H. sinuatus*						18				
8	*H. annulatus*	1	2	1							
9	*H. cardioscapus*	5									
10	*H. angustatus*										
11	*H. communis*	8					1	2			
12	*H. nigritus*		1								
13	*H. difformis*						9				
14	*H. cornutus*		1								
15	*H. hyalinatus*	6	3				1	6			
16	*H. annularis*										
	Andrenidae										
17	*Andrena labialis*	1									
18	*A. agilissima*										
19	*A. tibialis*						1			1	
20	*A. bimaculata*										
21	*A. pilipes*										
22	*A. carbonaria*										
23	*A. haemorrhoa*	39	22	1			235	73	2	7	

Table IX

in particular high zones in the Tatra Mts compared with those collected localities (or regions) where the species have been notet are added.

Total: Tatras	Total: Babia Góra Mt	Total: Pieniny Mts	Localities in other Carpathian regions	Zoogeographic element
(13)	(14)	(15)	(16)	(17)
1	–	–		Western Palearctic
3	2	1		Palearctic
1	–	–		Western Palearctic
1	–	–		Western Palearctic
12	5	30	Poprad valley	Palearctic
–	–	6		Western Palearctic
–	18	2	Poprad valley	Western Palearctic
4	–	–	Poprad valley	North Mountain
5	–	–		European
–	–	–	Poprad valley	Western Palearctic
8	3	13	Poprad valley	Western Palearctic
1	–	11	Mszana Dolna	Palearctic
–	9	10	Mszana Dolna, Poręba Wielka	Western Palearctic
1	–	–		Submediterranean
9	7	54		European
–	–	–	Poprad valley	Western Palearctic
1	–	1	Dunajec valley	Western Palearctic
–	–	26	Poprad a. Dunajec valleys, Beskid Niski	West Submediterranean
–	2	7		European Siberian
–	–	–	Dunajec valley	Palearctic
–	–	–	Chabówka, Mszana Dolna, Poprad a. Dunajec valley	Palearctic
–	–	–	Poprad a. Dunajec valleys	European
62	317	147		Palearctic

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
24	*Andrena hattorfiana*	10	4				4				
25	*A. schencki*	1									
26	*A. proxima*										
27	*A. suerinensis*										
28	*A. curvungula*										
29	*A. rufizona*	1	1								
30	*A. pandellei*										
31	*A. paucisquama*										
32	*A. thoracica*										
33	*A. limata*		1								
34	*A. nitida*		1				4			2	
35	*A. cineraria*	1									
36	*A. nigroaenea*	6									
37	*A. flavipes*	1	1								
38	*A. gravida*				1						
39	*A. polita*										
40	*A. fulvago*							4			
41	*A. pontica*										
42	*A. chrysosceles*						1				
43	*A. floricola*										
44	*A. combinata*	12	1								
45	*A. fulvida*										
46	*A. ovatula*	17	2				4	2			
47	*A. wilkella*	10					5	2			
48	*A. gelriae*										
49	*A. similis*										
50	*A. intermedia*										
51	*A. dorsata*						4	1	1		
52	*A. congruens*										
53	*A. minutula*	1	3	2			3	2	1		
54	*A. minutuloides*	2						2			

Table IX ctd.

(13)	(14)	(15)	(16)	(17)
14	4	16	Mszana Dolna, Nowy Targ	Western Palearctic
1	–	–	Poprad valley	Western Palearctic
–	–	39		Western Palearctic
–	–	–	Poprad valley	Western Submediterranean
–	–	1		Subponto Mediterranean
2	–	–		Mountain
–	–	1	Poprad valley	Subponto Mediterranean
–	–	1	Dunajec valley	Subpontic
–	–	8	Nowy Targ	Palearctic
1	–	2	Dunajec a. Poprad valleys	Subponto Mediterranean
1	6	21		Western Palearctic
1	–	–	Nowy Targ	Palearctic
6	–	6	Mszana Dolna, Poręba Wielka	Western Palearctic
2	–	–		Submediterranean Siberian
1	–	–		South Central European
–	–	–	Poprad valley	Subponto Mediterranean
–	4	9		European Caucasian
–	–	1	Dunajec valley	Subpontic
–	1	–		European Caucasian
–	–	4		European Caucasian
13	–	9	Poręba Wielka	European Caucasian
–	–	–	Dunajec a. Poprad valleys	European
19	6	–	Mszana Dolna	Palearctic
10	7	6		Holarctic
–	–	1		European Caucasian
–	–	1	Dunajec a. Poprad valleys	Western Palearctic
–	–	–	Poprad valley	European
–	6	6		Western Palearctic
–	–	5	Dunajec valley	Subponto Mediterranean
6	6	21		Western Palearctic
2	2	30		Western Palearctic

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
55	*Andrena falsifica*	12	8	1			5	14	1		
56	*A. pusilla*										
57	*A. subopaca*	14	44	28	1		15	44	7		
58	*A. semilaevis*	4	3	6			4	4			
59	*A. niveata*										
60	*A. barbilabris*										
61	*A. coitana*	36	13	22	?		6	4			
62	*A. lathyri*						2				
63	*A. nigriceps*	1									
64	*A. denticulata*	5									
65	*A. bicolor*	16	45	24	3		68	40	8		
66	*A. ruficrus*	1	9	3			3				
67	*A. jakobi*	1					14				
68	*A. rosae*	3	1								
69	*A. varians*		1								
70	*A. praecox*	136	5				155	23	4		
71	*A. lapponica*	3	40	35	31	?	11	78	36	89	3
72	*A. fucata*	6	18	1			13	36			
73	*A. apicata*	2	2		1		42	3	15	9	
74	*A. nycthemera*										
75	*A. clarkella*	7	31	8	6		5	2			
76	*A. fulva*										
77	*A. vaga*										
78	*A. humilis*	55	16				63	45	1		
79	*A. taraxaci*										
80	*A. ventralis*	1									
81	*A. tarsata*	11									
82	*A. labiata*	1									
83	*A. marginata*		1								
84	*A. potentillae*										
85	*Panurgus baksianus*	72	15	3	2		10	8	1	3	

Table IX ctd.

(13)	(14)	(15)	(16)	(17)
21	20	31		European Caucasian
–	–	–	Dunajec a. Poprad valleys	Submediterranean
86	66	8		European Siberian
13	8	1		North Central European
–	–	–	Dunajec valley	Subponto mediterranean
–	–	11		European Siberian
71	10	2	Krynica	European Siberian
–	2	–	Raba Wyżnia, Dunajec valley	European
1	–	–	Nowy Targ, Poprad valley	European Caucasian
5	–	3	Mszana Dolna	European Siberian
88	116	75		Western Palearctic
13	3	–		North Montane
1	14	6		European Caucasian
4	–	–	Chabówka, Nowy Targ	Palearctic
1	–	–		European
141	182	119		European Caucasian
109	217	–		North Montane
25	49	10		European Caucasian
5	69	15		European
–	–	7		South Central European
52	7	13		Holarctic
–	–	–	Andrychów	European
–	–	5		European Siberian
71	109	19		Palearctic
–	–	27	Dunajec a. Poprad valleys	Subponto Mediterranean
1	–	66		Palearctic
11	–	–	Krynica	North Central European
1	–	2		Palearctic
1	–	6		Subpontic
–	–	1		Submediterranean
92	22	–	Poręba Wielka	North Central European

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
86	*Panurgus calcaratus*		1								
	Halictidae										
87	*Halictus quadricinctus*	1					4				
88	*H. rubicundus*	10	3				1				
89	*H. maculatus*										
90	*H. tetrazonius*	1									
91	*H. simplex*	10									
92	*H. eurygnatus*		1								
93	*H. tumulorum*	19	4				17	1	1		
94	*H. confusus alpinus*	7	1								
95	*Lasioglossum xanthopum*							1			
96	*L. quadrinotatum*		1								
97	*L. lativentre*										
98	*L. sexnotatum*										
99	*L. zonulum*	6									
100	*L. calceatum*	57	54	5			82	27	5		
101	*L. albipes*	58	174	31	?		99	856	1		
102	*L. leucozonium*	12	4				1				
103	*L. laeve*										
104	*L. pauxillum*										
105	*L. laticeps*	1	1								
106	*L. fulvicorne*	17	25	2			34	3	4		
107	*L. fratellum*	14	85	87	48	?	30	21	3		
108	*L. rufitarse*	8	4	1			24				
109	*L. morio*		1								
110	*L. parvulum*						4	1			
111	*L. nitidum aeneidorsum*										
	L. nitidium nitidium										
112	*L. cupromicans*		2								
113	*L. bavaricum*		7	5							
114	*L. villosulum*	12	10	4			32	33	1		

Table IX ctd.

(13)	(14)	(15)	(16)	(17)
1	–	47	Poręba Wielka	European
1	4	–		Palearctic
13	1	–	Mszana Dolna	Holarctic
–	–	–	Poręba Wielka	Western Palearctic
1	–	–		Palearctic
10	–	170		Submediterranean
1	–	–		West European
23	19	37		Palearctic
8	–	–		Mountain
–	1	1		Western Palearctic
1	–	1		Western Palearctic
–	–	7		Western Palearctic
–	–	9	Mszana Dolna	European Siberian
6	–	–		Holarctic
116	114	168		Palearctic
263	186	130		Palearctic
16	1	19		Holarctic
–	–	2		Western Palearctic
–	–	35		Western Palearctic
2	–	34		Western Palearctic
44	41	93		Palearctic
235	54	–		Holarctic (North Montane)
13	24	1		Holarctic
1	–	–		Western Palearctic
–	5		Mszana Dolna	Western Palearctic
–	–	24		European
–	1	–		European
2	–	–		Mountains
12	–	–		Mountains
26	66	17		Western Palearctic

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
115	*Lasioglossum leucopum*	11	3				12	24			
116	*L. lucidulum*										
117	*L. intermedium*										
118	*L. politum*	1									
119	*Sphecodes monilicornis*										
120	*S. gibbus*										
121	*S. pellucidus*										
122	*S. divisus*	3									
123	*S. puncticeps*	4	1				2				
124	*S. ferruginatus*	2									
125	*S. hyalinatus*	1					3	3			
126	*S. crassus*	1									
127	*S. miniatus*	6	2								
128	*S. fasciatus*	6									
129	*Dufourea halictula*		1								
130	*D. dentiventris*	3	2				7				
131	*D. vulgaris*	39		6			3	2			
132	*Rhophitoides canus*	1									
133	*Rh. quinquespinosus*						1				
	Melittidae										
134	*Melitta leporina*										
135	*M. haemorrhoidalis*	3	1				2				
136	*Macropis fulvipes*		1								
137	*M. labiata*	1	1								
	Megachilidae										
138	*Trachusa byssina*	25	24								
139	*Anthidium manicatum*	6	1								
140	*A. montanum*	4		4							
141	*A. punctatum*		5								
142	*A. strigatum*	3	1								
143	*Stelis phaeoptera*						2				

Table IX ctd.

(13)	(14)	(15)	(16)	(17)
14	36	91		Western Palearctic
–	–	1		European Siberian
–	–	6		Western Palearctic
1	–	–		Submediterranean
–	–	3		Western Palearctic
–	–	–	Nowy Targ	Western Palearctic
–	–	3		Western Palearctic
3	–	4		Palearctic
5	2	3		Western Palearctic
2	–	9		European
1	6	10		Palearctic
1	–	–		Palearctic
8	–	2		European
6	–	1		Palearctic
1	–	–		North Montane
5	7	–	Poprad valley	North Montane
45	5	64	Poręba Wielka, Nowy Targ	European
1	–	4		Subpontic
–	1	7	Poprad valley, Poręba Wielka	Western Palearctic
–	–	1	Poprad valley	European
4	2	29	Poprad valley, Chabówka	North Central European
1	–	3	Poręba Wielka	European
2	–	–		European
49	–	20	Mszana Dolna, Nowy Targ	European
7	–	33		Western Palearctic
8	–	1		Mountain
5	–	38		Western Palearctic
4	–	14		Western Palearctic
–	2	1		Western Palearctic

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
144	*Stelis ornatula*	1	1								
145	*S. minuta*						2				
146	*S. signata*										
147	*Dioxys tridentata*										
148	*Heriades truncorum*										
149	*Chelostoma maxillosum*		14	2			3				
150	*Ch. florisomne*	9	4	2			12	10			
151	*Ch. nigricorne*	4	4				44	1			
152	*Ch. distinctum*										
153	*Osmia rufa*	11					24	1			
154	*O. cerinthidis*										
155	*O. inermis*		2								
156	*O. uncinata*		1								
157	*O. parietina*	1	2				1				
158	*O. atroaerulea*										
159	*O. fulviventris*	1					6				
160	*O. adunca*	1					25				
161	*O. anthocopoides*	10									
162	*O. leucomelanea*		2				1				
163	*O. leaiana*	5	1				1				
164	*O. coerulescens*						3	1			
165	*O. andrenoides*										
166	*O. aurilenta*										
167	*O. bicolor*						1				
168	*O. villosa*	3	4	1			9				
169	*O. spinulosa*										
170	*O. ononidis*										
171	*Megachile centuncularis*										
172	*M. versicolor*	1									
173	*M. lapponica*		1				2				
174	*M. alpicola*	5	1								

Table IX ctd.

(13)	(14)	(15)	(16)	(17)
2	–	3		Palearctic
–	2	–		European
–	–	2		European
–	–	7		South Central European
–	–	7	Wadowice	Western Palearctic
16	3	77		European
15	22	6		Western Palearctic
8	45	13	Poręba Wielka	European
–	–	3		South Central European
11	25	13		Palearctic
–	–	48		Subpontic
2	–	–		North Montane
1	–	–		European
3	1	1		North Montane
–	–	1		Western Palearctic
1	6	2	Poręba Wielka	Palearctic
1	25	23	Poręba Wielka, Poprad valley	Submediterranean
10	–	13		Western Palearctic
2	1	1	Poręba Wielka	North Central European
6	1	3		European
–	4	1		Western Palearctic
–	–	30		Submiterranean
–	–	1		Western Palearctic
–	1	–		Western Palearctic
8	9	4		Mountain
–	–	7		South Central European
–	–	1		Subpontic
–	–	3		Western Palearctic
1	–	7		European
1	2	–		North Montane
6	–	–		North Montane

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
175	*Megachile analis*	1	1								
176	*M. ligniseca*	1	1								
177	*M. willoughbiella*	8	4				4				
178	*M. maritima*	1									
179	*M. lagopoda*										
180	*M. circumcineta*	4									
181	*M. nigriventris*	9	2								
182	*M. ericetorum*						1				
183	*Coelioxys quadridentata*	6									
184	*C. rufescens*	3	1				1				
185	*C. lanceolata*										
186	*C. alata*										
187	*C. elongata*										
	Anthophoridae										
188	*Nomada goodeniana*										
189	*N. bifasciata ssp. fucata*				1						
190	*N. lineola*										
191	*N. marshamella*										
192	*N. sexfasciata*	2					2				
193	*N. rufipes*	1									
194	*N. emarginata*	5									
195	*N. roberjeotiana*	4	1								
196	*N. obtusifrons*	9	1	3							
197	*N. striata*	7					2	2			
198	*N. guttatula*										
199	*N. zonata*										
200	*N. panzeri*	2	16	3	16	?		12	2	3	
201	*N. flava*		1				3	2			
202	*N. leucophtalma*		6		1		9	8			
203	*N. ferruginata*	3	2				1				
204	*N. bifida*	1					7	4	1		

Table IX ctd.

(13)	(14)	(15)	(16)	(17)
2	–	–		European
2	–	49	Poprad valley	European
12	4	11		European
1	–	–	Nowy Targ	Palearctic
–	–	–	Poprad valley, Poręba Wielka	Western Palearctic
4	–	14		European
11	–	3		North Montane
–	1	4		Western Palearctic
6	–	7		Palearctic
4	1	3		Palearctic
–	–	1		North Montane
–	–	1		Submediterranean
–	–	1		Western Palearctic
–	–	4		European
1	–	–		Western Palearctic
–	–	2		European
–	–	10		European
2	2	1	Poprad valley	European
1	–	–		European
5	–	5		European
5	–	–		European
13	–	–		European Siberian
7	4	–		European
–	–	5		European
–	–	3		South Central European
37	17	2		European
1	5	4		European
7	17	2		European
5	1	16		Palearctic
1	12	12		European

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
205	*Nomada alboguttata*										
206	*N. flavoguttata*	9	3	1			2	15	2		
207	*N. castellana*										
208	*N. conjungens*										
209	*N. fuscicornis*										
210	*N. similis*	2	2								
211	*N. armata*										
212	*N. mutabilis*	1	1								
213	*N. fabriciana*		1				2	2			
214	*N. obscura*	1									
215	*N. argentata*										
216	*N. fulvicornis*										
217	*Biastes truncatus*	26									
218	*Eucera longicornis*	2					3				
219	*Anthophora acervorum*	3	3				6				
220	*A. aestivalis*										
221	*A. quadrimaculata*	15									
222	*A. plagiata*		1	1			1				
223	*A. furcata*	15	11	2			2				
224	*Thyreus orbatus*						1				
225	*Ceratina cyanea*						1				
	total species	106	79	27	11		72	43	9	7	1
	total specimens	1065	820	295	111		1251	659	97	114	3

species were found. From the Pieniny Mts the author reported 3 North Montane species, two of them (*Megachile nigriventris* and *Osmia parietina*) being knwon from the Tatras, and 2 Montane species (*Osmia villosa* and *Anthidium montanum*) both known also from the Tatras. Some Montane species recorded from the Tatras and associated with limestone rocks, namely: *Anthidium montanum*, *Lasioglossum cupromicans*, *L. bavaricum*, and *Halictus confusus alpinus*, were not found on Mt Babia Góra. In the limestone Pieniny Mts, however, only *A. montanum* was found.

Table IX ctd.

(13)	(14)	(15)	(16)	(17)
–	–	4		South Central European
13	19	12		Palearctic
–	–	1		Western Palearctic
–	–	1		South Central European
–	–	3		European
4	–	–	Poprad valley	European
–	–	2	Poprad valley	North Central European
2	–	–		European
1	4	1		European
1	–	–		North Montane
–	–	4		Central South European
–	–	2		Central South European
26	–	–		Submediterranean
2	3	45		European
6	6	9		Western Palearctic
–	–	1		South Central European
15	–	–		Western Palearctic
2	1	1		Western Palearctic
28	2	7	Chabówka, Nowy Targ	European
–	1	1		Submediterranean
–	1	–		Submediterranean
139	85	154	67	
2291	2124	2542		

On Mt Babia Góra the author found only 3 Submediterranean species among which *Osmia adunca* is known from the Tatras, Pieniny Mts, and West Beskid Mts, and *Thyreus orbatus* from the Pieniny Mts. Out of 19 Submediterranean, Subpontic, and Subponto Mediterranean species which the author found in the Pieniny Mts, only 5 are also known from the Tatras. In the Tatras there live altogether 9 species belonging to the above mentioned zoogeographical elements.

The proportions of species caught in the particular altitudinal zones of the Tatras and of Mt Babia Góra are similar (Fig.3). It is particularly noticeable that in the Tatras as well as on Mt Babia Góra the number of species in zone I S is distinctly smaller than in zones II S and I N. This is connected with the sensitivity of bees to the thermal conditions. In zone V in the Tatras no species was found, but on Mt Babia Góra *Andrena lapponica* was caught in that zone (alpine meadows).

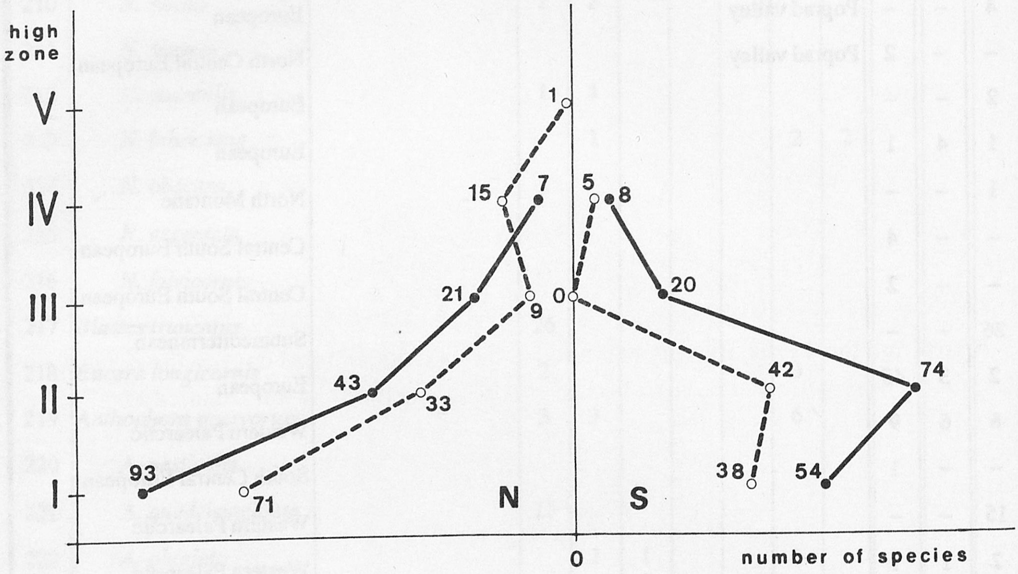

Fig. 3. Numbers of Apoidea species (except Apidae) caught in particular high zones of the northern (N) and southern (S) slopes of the Tatra Mts (solid line) and of Mt Babia Góra (broken line).

In Table X are assembled the numbers of species collected in the Tatras, Pieniny Mts, and on Mt Babia Góra as well as the numbers of species that the Tatras have in common with the Pieniny Mts and Mt Babia Góra. These numbers are given for all the recorded species and for the following distinguished groups of zoogeographical elements: 1) Montane and North Montane, 2) Submediterranean, Subpontic, Subponto Mediterranean, West Submediterranean, and Submediterranean Siberian, 3) widely distributed species and phenological groups, i.e. (early spring, late spring, and summer species). These data made possible the determination of similarities between the investigated faunas. Those were calculated using SØRENSEN's formula:

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

where c is the number of species the two areas have in common, and a and b are the numbers of species in the particular areas. Table X shows that the index of similarity between the Tatra and Pieniny fauna as well as that betwen the Tatra and Mt Babia Góra fauna is 60. However, the similarity indices calculated for the groups of faunistic elements distinguished above are different. Thus, the groups of North Montane and Montane species from Mt Babia Góra and from the Tatras as well as the groups of widely distributed species from these areas have similar indices (56 and 63 respectively), while the groups of species connected with a warm climate have very low ones (19). In the case of the Pieniny and Tatra Mts only the groups of widely distributed species have a high index of similarity (65). The Montane and North Montane fauna of the Pieniny Mts is less similar to that fauna in the Tatras (35) than to the corresponding group of species from Mt Babia Góra. On the other hand, the index of similarity between the Pieniny and Tatra faunas of warm climate (46) is more than twice that calculated with reference to the corresponding fauna of Mt Babia Góra. Thus, the *Apoidea* fauna of the Tatras is more similar to that of Mt Babia Góra with regard to the elements of cool climate and to that of the Pieniny Mts with regard to the elements of warm climate. This is confirmed by an analysis of the indices of similarity concerning the particular phenological groups. The similarity of the early spring, late spring, and summer faunas between the Tatras and Pieniny Mts is almost equal (58 - 63), while in the case of the Tatras and Mt Babia Góra it is distinctly reduced (from 72 to 42).

2. *Apoidea* of the Tatras and the remaining parts of the West Carpathians

Apart from the Tatras, Pieniny Mts and Mt Babia Góra, most of data on the occurrence of *Apoidea* were collected in the Beskid Sądecki Mts, namely in the Dunajec and Poprad river valleys and in Krynica. Besides, there were a few records from the Gorce (Chabówka, Poręba Wielka), Beskid Wyspowy (Mszana Dolna), Beskid Mały (Andrychów), and Beskid Niski (Gorlice) Mountains.

When comparing the *Apoidea* fauna of the Tatras with that of the Pieniny Mts the latter area should be discussed together with the Dunajec and Poprad valleys, not only because this mountain range is intersected by the Dunajec valley and because the areas situated along the Rivers Dunajec and Poprad have for the Carpathians an exceptionally warm climate but also because these areas have many species in common. Hitherto from the Dunajec and Poprad valleys 37 species of *Apoidea* (excluding the family *Apidae*) have been reported out of 66 known from the whole area of the Polish West Carpathians (Tatras, Mt Babia Góra and Pieniny Mts excluded).

From the Dunajec and Poprad valleys are known two Subpontic (*Andrena paucisquama* and *A. pontica*), four Submediterranean (*Andrena suerinensis*, *A. agilissima*, *A. pusilla*, and *Osmia adunca*), and five Subponto Mediterranean species (*Andrena pandellei*, *A. limata*, *A. polita*, *A. niveata*, *and A. taraxaci*).

North Montane elements are represented in the Dunajec and Poprad valleys by two species - *Hylaeus annulatus* and *Dufourea dentiventris*. Among the North Central European species collected in the Dunajec and Poprad valleys is *Melitta haemorrhoidalis*, known from all the discussed areas. The remaining species from these two valleys are widely distributed.

Similiarity (QS %) between *Apoidea* (excl. *Apidae*) of the Tatras,

Mountain ridge	Number of species collected			Number of cold-climate[1] species			Number of xerot-hermic[2] species		
	total	common[4]	QS	total	common[4]	QS	total	common[4]	QS
Tatras	139			18			9		
Pieniny Mts	153	88	60	5	4	35	19	5	46
Babia Góra Mt	85	67	60	7	7	56	3	1	19

1Montane and North Montane species
2Submediterranean, Subpontic, Subponto Mediterranean, West Submediterranean, Submediterranean Siberian species

35 species have been reported from the Beskid Niski, Beskid Sądecki, Beskid Wysoki, Beskid Wyspowy, and Beskid Mały Mountains. Out of these 35 species: 1) 24 are widely distributed (19 were found in the Tatras or at least on Mt Babia Góra, but 5 in the lower parts of the Polish West Carpathians only; while of the remaining species 2) 5 occur in North and Central Europe (*Panurgus banksianus, Andrena tarsata, Melitta haemorrhoidalis, Osmia leucomelaena*, and *Macropis fulvipes*); 3) 2 are European Siberian elements (*Andrena coitana* and *A. denticulata*); 4) *Lasioglossum parvulum*, a Subatlantic element, (is known only from Mt Babia Góra and from Mszana Dolna); 5) *Andrena fulva*, reaching in Poland the eastern limit of its distribution (has been recorded from the Polish Carpathians only from Andrychów - Beskid Maly Mts); 6) *A. pilipes*, a South Central European element (inhabits in the Carpathians only lower situated areas - Chabowka, Mszana Dolna, Dunajec and Poprad valleys); 7) *Osmia adunca*, a Submediterranean element (has been reported from many localities in the Polish Carpathians up to zone I N at the foot of the Tatras).

IX. RESULTS

1. 83 species of *Apoidea* (excluding the family *Apidae*) were found in the Tatras, in both their Polish and Slovakian parts, from the lowest parts of the lower mountain forest zone up to the lower part of dwarf montaine pine zone (subalpine zone) (zones II - IV).

2. In the sub-Tatra zone live 56 *Apoidea* species which do not penetrate the Tatras; the altitudinal range of 61 species ends in the lower montane forest zone, that of 23 species in the upper montane forest zone, and of 8 species in the dwarf mountain pine zone, the numbers of species recorded from N and S slopes being similar (Fig. 3).

Table X

Pieniny Mts and Babia Góra Mt.

Number of widely distributed[3] species			Number of early-spring species			Number of late-spring species			Number of summer species		
total	common[4]	QS	total	common[4]	QS	total	common4	QS	total	common[4]	QS
112			45			50			44		
130	79	65	56	30	60	57	34	63	40	24	58
75	59	63	30	27	72	37	27	62	18	13	42

3Holarctic, Palearctic, West Palearctic, European Caucasian, European Siberian, European species

[4]common for the Tatras and Pieniny Mts., or for the Tatras and Babia Góra Mt.

3. The species composition of the *Apoidea* in the distinguished altitudinal zones changes in the particular months of the vegetation period because it depends upon the time of appearance of species and upon the number of their generations (Tables IV-VII).

4. Early spring species (45) inhabit the Tatras up to the lower part of subalpine zone (±1600 - 1700 m), hence they do not reach the upper limit of climatic spring. This is the most abundant group of bees (1382 specimens caught). Late spring bees (50 species, 427 specimens caught) were recorded only from the lower and upper montane forest zones but in the latter, i.e. to the upper limit of climatic late spring, only 7 species were found. Summer bees (44 species, 474 specimens) were observed up to the dwarf mountain pine zone. However, in this zone they were represented only by *Panurgus banksianus*. 6 summer species were recorded from the upper montane forest zone, 22 from the lower montane forest zone, and 34 (on S slopes 14) from the foothills (sub-Tatra zone) where there is no climatic summer.

5. There are fewer generations in the dwarf mountain pine zone (subalpine zone) as well as on the northern slopes of the two forest zones than in lower situated areas. In zones II and III early spring species usually appear in three generations, and late spring species in three or only two. In the Tatras on the northern side there is probably one generation less than on the southern one.

6. Spring species occur in the sub-Tatra zone and in the two forest zones from April to the first half of June and in the dwarf mountain pine zone from the end of May till the end of July. On S slopes these species appear about two weeks earlier than on N ones. Late spring species were observed in lower and upper montane forest zone from the end of May on S slopes and in the 2nd half of June on N ones. In July and August there late spring and summer species occurred simulteneously as well as the second generations of early

and late spring species. In Sptember and October the third generations of species of the family *Halictidae* were observed on S slopes. On N slopes the flights of species belonging to this family ended in August (there were only two generations).

7. In the Tatras and sub-Tatra zone were found 6 Montane, 12 North Montane (in the Tatras only 10), 4 European Siberian (in the Tatras 2), and 5 North Central European species (in the Tatras 4). These species constitute 19,5% of all the species recorded from the investigated area.

8. In the Tatras (the lowest parts of the lower montane forest zone on S slopes) one Submediterranean species (*Hylaeus cornutus*) and one Submediterranean Siberian (*Andrena flavipes*) are likely to occur. Besides, one South Central European element (*Andrena gravida*) was reported by the author from the dwarf mountain pine zone (on N slopes). Altogether, in the investigated area in zones I N, I S, and II S, the author found 10 species representing Subpontic, Subponto Mediterranean, Submediterranean Siberian, Submediterranean, and South Central European zoogeographical elements (see page 233).

9. Widely distributed species form the most numerous group in the investigated area, 102 being collected, this constituting 73,3% of the total number of recorded species.

10. In the Tatras (zone II S) and the sub-Tatra zone live 70 xerothermic species (about 50% of the total number recorded).

11. The limestone Tatras have a richer *Apoidea* fauna (excluding the family *Apidae*) than the granite Tatras (66 and 49 species respectively). The average catch from one locality in the limestone Tatras was 14 specimens, while in the granite Tatras it was 11,4.

12. A markedly smaller number of species in the sub-Tatra zone on S slopes than on N slopes of that zone and in two lower montane forest zone on S slopes indicates that zone I S is the coolest one. A similar situation was found in the corresponding zones on Mt Babia Góra (Fig. 3). Apart from the inversion of temperature, the phenomenon may be explained by the morphological structure of the N and S slopes of the Tatras and Mt Babia Góra. Namely, S slopes are smooth and steep, while N slopes are strongly broken up and rise gradually.

13. The most frequently visited plants in the Tatras and in the sub-Tatra zone were *Hieracium* and *Leontodon* (20,3% of the collected material, 41 species of *Apoidea*), *Salix* (16%, 34), *Potentilla* (6,8%, 22), and *Taraxacum officinale* (5,6%,20). On the remaining plant species or groups of species (Table VIII) the author collected 1-8 bee species in numbers of 1-56 individuals.

14. Most of the bee species were collected as single specimens in warm places sheltered from the north and west and well insolated. Only common species (11) were observed also in coller places. Interestingly localities situated in the highest range of the particular species were found in very warm places, this also concerning the common species.

15. The similarity, expressed by the SØRENSEN index, between the *Apoidea* fauna of the Tatras (excluding the family *Apidae*) and that of Mt Babia Góra is the same as that calculated for the faunas of the Tatra and Pieniny Mts (60% in both cases). However, when the particular zoogeographical groups are taken into account, considerable differences may be observed. With regard to Montane and North Montane species the *Apoidea* fauna

of the Tatras is more similar to that of Mt Babia Góra (56%) than to that of the Pieniny Mts (35%), but with regard to the species of southern or south-eastern origin the similarity between the Tatra and Pieniny faunas of *Apoidea* (46%) is much greater than that between the faunas of the Tatras and of Mt Babia Góra (19%).

X. CONCLUSIONS

1. Submediterranean, Subpontic, Subponto Mediterranean, Submediterranean Siberian, South Central European species as well as summer and xerothermic ones live on the northern slopes of the sub-Tatra zone in relict localities situated in very warm places and they are connected with the microclimate. Hence, in the investigated area these species may be considered as relicts.

2. Common species, found also in cooler places, are connected with the mesoclimate and they have a chance to expand.

3. Species considered as relicts may have reached the sub-Tatra zone and the Tatras when mesoclimatic conditions more favourable for them prevailed in these regions[1].

4. The highest localities of all the Tatra species, situated only in the warmest places, are also relicts. Relict localities were most frequenter situated higher by one climatic zone, e.g. summer species were observed above the limit of climatic summer. For this reason also the relict localities are demonstrate a lowering of climatic zones by 200 - 300 m, similarly as the lowering of the timber line in the Tatras by about 300 m revealed by botanists (MIREK, PIĘKOŚ-MIREK in press).

5. *Andrena lapponica*, *Lasioglossum fratellum*, and *L. albipes* might found in the alpine meadow zone of the Tatras since in the dwarf mountain pine zone they were still abundant (in 5-6 localities 31, 31, and 48 specimens respectively were found) and because on Mt Babia Góra *A. lapponica* was observed (one specimens) up to and including the alpine zone.

6. Many xerothermic species enter the northern slopes of the sub-Tatra zone along the western and eastern boundaries of the Tatras. This is indicated by the record of *Andrena flavipes*. The species is known in the Polish Carpathians from the northern side of the sub-Tatra zone only.

7. Xerothermic species reach the northern slopes of the sub-Tatra zone also from the Pieniny Mts through the limestone hills running from that mountain range to Mt. Galicowa Grapa near the village of Poronin (Fig. 1).

8. The upper limit of the altitudinal distribution of bees in the lower montane forest zone distinctly correlates with the upper limit of oat cultivation in the Carpathians alt. (1150-1200 m) and that in the upper montane forest zone with the upper limit of hay

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[1] According to PAWŁOWSKI (in press), the process of settling of xerothermic species in southern Poland is a dynamics one, and permanent invasion could take place. Its beginning is not clearly defined becouse of a lack of fossil arthropods. The Atlanticum, although it was the warmest period in posglacial times, was not suitable for bees as it was too humid.

meadows (alt. about 1500 m), since almost all the localities recorded from these zones lie in their lower parts. Also in the dwarf mountain pine zone (subalpine zone) the localities of *Apoidea* are situated in its lower part of that zone (±1600-1700 m). Thus, the upper limit of distribution of *Apoidea* (excluding *Apidae*) is to be found on the upper limit of late spring in the climatic sense.

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