BEAUFORTIA

SERIES OF MISCELLANEOUS PUBLICATIONS

ZOOLOGICAL MUSEUM - AMSTERDAM

No. 152 Volume 13 September 10, 1965

On the odonate fauna of Warmbad Villach in Southern Carinthia

BOSTJAN KIAUTA

Rivon-communication nr. 221

Carinthia, is with her rather warm and dry subalpine climate and more than two hundred lakes, rivulets, thermal springs, marshes, vallies, lowland and alpine forests, meadows and various other biotopes, one of the richest and most interesting parts of Austria. Zoogeographically this province is situated near the point of contact of the Central and West European, Mediterranean and Pontic faunistic areas; many meridional species have their northern border of distribution just there.

In July 1964 I had an opportunity to make some observations in Southern Carinthia. Particular attention was paid to the odonate fauna of the thermal system of Warmbad Villach. Nearly 14 days were spent there. New faunistic data and field observations seem worth being recorded in the present article.

Many thanks are due to my brother Tomas Kiauta, for his assistance in the field.

The thermal springs of Warmbad Villach are situated about 3 km south from the town of Villach (Beljak), at the foot of the easternmost slopes of the Dobratsch mountains (Villacher Alps) (46° 53′ N, 13° 50′ E). The southern part, composed of permanent thermal sources, is situated at an approximate altitude of 495 m; the northern section with periodical sources at an altitude between 497—514 m. The latter are active only in the periods of enduring rainfall. The hydrographical origin of the thermal sources is in the Triassic mountain region of Dobratsch with its well-developed subterranean karstic water system. The sources appear to be situated in conglomerate sediments at the base of which are older conglomerates (built up from Mesozoic rock-waste (de bris)), covered by Upper-Pleistocene fluvioglacial rubble and sand.

The thermal sources of Warmbad Villach have an hliarothermic and stenothermic character, their temperature being 20.9—29.2° C. The water is moderately hard approximately 18—19 German degrees, and a little

Received April 8, 1965

alkaline (pH 8—9). As to the origin of the water, the springs are fed by atmospheric and surface water only.

The quantity of free oxygen is nearly half as low as in the nearby cold springs, though for thermal water it is still rather high (3.900—4.900 ccm/1). Because of lower quantities of oxygen and due to the fact that a higher temperature requires more active respiration at the same time, thermal water is physiologically inferior to that of normal temperature biotopes. Therefore, in the sections of the thermal rivulets with higher temperature, true polyoxybiontic organisms do not occur, and are replaced by stagnicolous species. Rheophilous, so more or less polyoxybiontic species, are only found more abundantly in the lower sections, where the water is less hot and has obtained additional quantities of free oxygen during its course. The hydrology and hydrobiology of the Warmbad Villach's thermal system has been described by STROUHAL (1934).

The climate of Warmbad Villach is typically subalpine, rather dry and warm. The maximal temperature amplitude is approx. 55.5° C, the temperature being under 0° C for 93 days yearly and above it for 272 days, with 92 days warmer than 15° C. Average rainfall in the town of Villach is 1220 mm per year (CONRAD, 1928).

The dry and warm climate as well as the southern location are marked both in the flora and in the fauna. The following are some typical plant species as recorded by PEHR for the surroundings of Warmbad Villach and which show, according to Beck-Mannagetta, a ponto-illyro-mediterranean character; some of them reach the northern border of their distribution in Carinthia: *Tunica saxifraga, Saponaria ocymoides, Sempervivum glaucum, Saxifraga hostii, S. crustata, Aremonia agrimonioides, Cytisus purpureus, Medicago carstiensis, Angelica verticillaris, Fraxinus ornus, Lamium orvalae, Galium purpureum, Homogyne sylvestris, Centaurea carniolica, Aposeris foetida, Stipa pennata, Lasiagrostis calamagrostis, Lilium carniolicum, Ornithogalum pyrenaicum, Asparagus tenuifolius* and *Iris graminae.*

It is interesting to stress the occurrence of the following southern or xerophilous animal species: *Helicella obvia* Hartm. (xerophilous and eurythermic gastropod, abundant on railway-embankments etc.), the ponto-mediterranean bug *Graphosoma italicum* Müll., extremely abundant on umbelliferous plants growing in dry meadows, railway-embankments and in other sunny places, some southern and mediterranean Hymenoptera like *Camponotus vagus* (Scop.), *Xylopa violacea* (L.) etc. Among vertebrates *Vipera ammodytes* (L.) has its northern borders of distribution there, while *Bufo viridis* Laur. and *Natrix tessalata* Laur. are both abundant in the surroundings of Warmbad Villach, the former passing through its larval development in the thermal rivulets and outflows of the springs.

Our investigations on the Odonata were carried out mainly in the partly artificially regulated united outflow of the thermal springs (fig. 1) which runs — after the confluence with the cold water of Kalter Bach (Mrzli studenec) — to the river Gail (Zila). The larval and other material was intensively collected also in numerous other localities and spots along the thermal springs. While

FIG. 1. Artificially regulated united outflow of Warmbad Villach, now covered by vegetation. Photo B. Kiauta.

FIG. 2. Broad overflow of the outflow's bed with rather stagnant water. It is a habitat of Calopterygidae, Platycnemididae, *Ischnura elegans* and *Orthetrum coerulescens*: sometimes a hunting territority of *Aeshna grandis*; *Ae. cyanea* prefers to patrol along the sections where the bed is narrow. Photo B. Kiauta.

the main outflow bed is regulated (and now well covered again with vegetation), many side portions and waterpockets alongside the whole run of the outflow (fig. 2) are left in the natural state. Besides reeds, sagitaries and other bank plants, submerged vegetation of *Potamogeton, Myriophyllum, Ceratophyllum, Elodea,* etc. is very abundant. Among the native *Algae* some introduced tropical species, originating from the nursery of tropical water-lilies, also occur in the outflow of one of the thermal springs.

While the water in the main outflow bed runs slowly, the water in the pockets alongside the stream is nearly stagnant. It is absolutely stagnant in the side pools, which appear to communicate with the main outflow by narrow canals only. Some of them are partly covered by a rich *Lemna* vegetation.

The banks of the outflow are either covered with grass, or trees of nearby forests growing close to the water, their branches hanging over the surface. On the northern bank there is a little sandy path, running along the outflow rivulet to its delta in Gail river.

Probably all aquatic and semiaquatic animal species occurring in the waters of Warmbad Villach are eurythermal. Partly they are thermophilous, but to a great extent they have a thermoxenous character. Stenothermal species do not seem to occur in these waters. In the order of the dragonflies, true thermobiotic species do not exist, but BRUES (1928; 1932) reported larvae of *Libellula* sp. found in thermal water at a temperature of 41.8° C, and *Mesothemis simplicicollis* (Say) even at a temperature as high as 43° C. ISSEL (1906) gave evidence for larvae of *Orthetrum cancellatum* (L.) being found in a thermal spring at 38° C. BELYSHEV (1960a, 1960b) recently described an isolated, relic colony of *Orthetrum albistylum* (Sel.), breeding in a temperate (up to 30—35° C) section of an acrothermal spring in the northeastern Baikal region. A list of odonate species observed in Warmbad Villach is given in table I. The occurrence of larvae is indicated as well in the table, with the highest temperature at which they were observed. The species marked with an asterisk have not been recorded so far from the thermal springs of Warmbad Villach.

I was not able to determine the temperature at which the two *Calopteryx* species breed in the united outflow, owing to the seasonal changes in temperature.

It is worth mentioning that STROUHAL (1934) gave evidence for two not further identified larvae of *Aeshna* and *Sympetrum*, which were collected at 22.7° C. They might belong to one of the species of these genera mentioned in table I. All of them were frequently seen laying eggs at various spots along the united outflow.

Although the larval stages of only four species were found so far in the thermal springs of Warmbad Villach, the total faunistic record is rather characteristic of this type of thermal water. It is interesting to stress that Warmbad Villach's fauna is very similar to that known from the thermal springs (18° C) at Medno (Slovenia, Yugoslavia), which are situated at a

TABLE I

Species	Taken stadia: L = larvae I = imagines	Locality	Maximum temperatures at which larvae were found
**Calopteryx splendens* (Harr., 1782)	L, I	united outflow	
Calopteryx virgo (L., 1758)	L, I	united outflow	
Sympecma fusca (v. d. Lind., 1823)	I	Warmer Tümpel Bahnquelle	
Lestes barbarus (Fabr., 1798)	I	Warmer Tümpel Bahnquelle	
Lestes sponsa (Hansem., 1823)	I	Warmer Tümpel Bahnquelle united outflow	
Lestes dryas Kirby, 1890	I	united outflow	
Lestes virens vestalis Rambur, 1842	I	Warmer Tümpel Bahnquelle	
Platycnemis pennipes (Pall., 1771)	L, I	Warmer Tümpel Bahnquelle Wäscherquelle united outflow, etc.	up to 26.4 ° C
**Coenagrion puella* (L., 1758)	I	united outflow	
Ischnura elegans (v. d. Lind., 1823)	L, I	Warmer Tümpel Bahnquelle Wäscherquelle united outflow	up to 26° C
**Onychogomphus forcipatus* (L., 1758)	I	united outflow	
**Aeshna cyanea* (Müll., 1764)	I	united outflow	
**Aeshna grandis* (L., 1758)	I	united outflow	
**Anax imperator* Leach, 1815	I	united outflow	
**Cordulia aenea* (L., 1758)	I	united outflow	
Libellula depressa L., 1758	L, I	Judenburger Teich united outflow	L. only at Jud. T. in normal water 12,5° C
**Libellula fulva* Müll., 1764	I	united outflow	
Orthetrum coerulescens (Fabr., 1798)	L, I	Warmer Tümpel Bahnquelle Wäscherquelle Schwimmschul- quelle united outflow, etc.	up to 27° C
Sympetrum sanguineum (Müll., 1764)	L, I	Warmer Tümpel Bahnquelle united outflow	up to 25.5° C
**Sympetrum vulgatum* (L., 1758)	I	united outflow	

distance of 65 km as the crow flies, on the southern side of the mountain chain of Karawanken. At Medno the following species prevail:

Sympecma fusca (v. d. Lind.), *Lestes barbarus* (Fabr.), *L. dryas* Kirby, *L. virens* Charp., *L. sponsa* Hansem., *Platycnemis pennipes* (Pall.), *Coenagrion puella* (L.), *Ischnura elegans* (v. d. Lind.), *Aeshna cyanea* (Müll.), *Ae. juncea* (L.)(!), *Libellula depressa* L., *Orthetrum brunneum* (Fonsc.), *O. coerulescens*

(Fabr.), *Sympetrum flaveolum* (L.), *S. sanguineum* (Müll.), *S. striolatum* (Charp.) and *S. vulgatum* (L.).

All species occurring in Warmbad Villach are also known from other localities in Carinthia. They are locally abundant also on the southern side of the Karawanken (KIAUTA, 1961). In spite of this, it seems worth mentioning that *Anax imperator* has been recorded so far for Carinthia from Waidischsee only (PUSCHNIG, 1930; PASCHINGER & PUSCHNIG, 1935); *Cordulia aenea* from Wörthersee only (Vrbsko jezero) (PUSCHNIG, 1908), and from Weidischsee (PUSCHNIG, 1930; PASCHINGER & PUSCHNIG, 1935), while evidence has been given of *Orthetrum coerulescens* from Warmbad Villach only (STROUHAL, 1934), and from Ossiachersee (Osojsko jezero) (PUSCHNIG, 1905; WERNER, 1913, 1915).

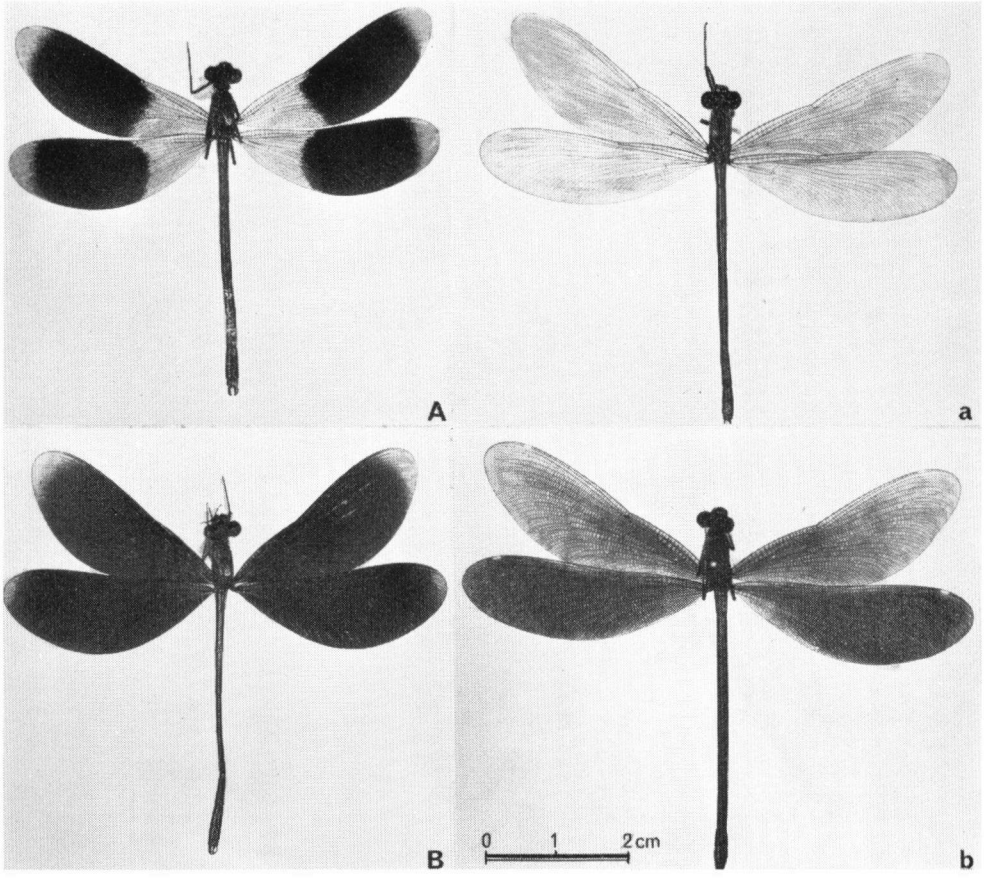

FIG. 3. Specimens of Calopterygidae from Warmbad Villach. Top: male (A) and female (a) of *Calopteryx splendens*. Bottom: male (B) and female (b) of *C. virgo*. Dimensions of first wing pair from top-to-top of mounted specimens are as follows: *C. splendens* ♂ — 5.9 cm, ♀ — 6.3 cm; *C. virgo* ♂ — 5.5 cm, ♀ — 6.8 cm.

It is difficult to point out the quantitative abundance of the species occurring at a certain locality, their territories being in accordance with the size of the insects involved, but in Warmbad Villach *Platycnemis*, *Calopteryx*, and particularly *C. virgo* are the most abundant damselflies. Among the anisopterous species *Orthetrum* and *Onychogomphus* are the most abundant.

PUSCHNIG (1908b) has already observed that in longer series of *C. virgo* some specimens usually turn up which show the "southern colour pattern", as Puschnig interpreted the heavily pigmented apex.

One would, in consequence, expect the same phenomenon in insects breeding at considerably higher temperatures than normal Central European waters usually have. But as shown in fig. 3, all animals are normally coloured, as are those from other Carinthian springs and rivulets. It appears that the temperature of the breeding sites and the climate of the surroundings do not exercise sufficient abiotic influence to induce melanism. Until more of the physiology and genetics of this phenomenon becomes known, one can only guess whether length of the day, solar intensity etc. produce it. The problem of *Calopteryx* modifications and infraspecific differentiation is far more complicated than is usually supposed. At any rate the temperature of the breeding site is not the sole active factor.

ST. QUENTIN (1960) showed that the European odonate fauna is composed — due to the Pleistocene glaciations — of two zoogeographical components. The first group is made up of Mediterranean and Pontic species, which found their climatic refuges in the Mediterranean area and in the Pontic steppes during the glaciations. After the climatic reimprovement some species reoccupied Central Europe and Northern Europe as well. To the second group belong species which at the same time occupied Europe from their eastern areas, which during glacial periods were not covered by the ice.

This interpretation of the zoogeographical origin of European odonate fauna corresponds to the opinion given by HOLDHAUS (1929), who divided European entomofauna into Mediterranean and Euro-Siberian species.

Table II shows the detailed zoogeographical composition of the fauna of Warmbad Villach.

In table II the account of the zoogeographical origin of our dragonflies shows that the fauna of Warmbad Villach is composed of both European faunistic elements, in the proportion of 1 : 1. Adding to the Mediterranean species the five species which are originally Euro-Siberian, but are now widely distributed in the Mediterranean area, there remains 25% of pure, de facto Euro-Siberian elements among Warmbad Villach's dragonflies.

Before commenting in detail on the biogeography of the five, at present real holarctic species and species belonging to holarctic genera one has to bear in mind the following general zoogeographical characteristics of distribution of these two groups.

The European holarctic species are widely distributed and reach, particularly in the East, the eastern Siberian areas. Towards the West they occur as far as England and towards the North they reach the Polar circle. In the South some, though only a few, of them extend the southern limit of their

TABLE II

Species	Mediterranean species			Euro-Siberian species			
	distributed in the whole Mediter. area	chiefly in the East Med. area	Transit. betw. Mediter. and Euro-Sib. faunas	widely distrib. also in Mediter. area	Holarctic	belong to genera with main distrib. in N. Amer.
Calopteryx splendens	+					
Calopteryx virgo				+		
Sympecma fusca		+				
Lestes barbarus	+				+	
Lestes dryas					+	
Lestes sponsa						
Lestes virens	+					
Platycnemis pennipes				+		
Coenagrion puella			+			
Ischnura elegans			+			
Onychogomphus forcipatus	+					
Aeshna cyanea				+		
Aeshna grandis						+
Anax imperator		+				
Cordulia aenea					+	
Libellula depressa				+		
Libellula fulva				+		
Orthetrum coerulescens	+					
Sympetrum sanguineum	+					
Sympetrum vulgatum						+

area as far as southern Italy. The other species — those belonging to the group of not genuinely holarctic fauna elements, but to genera with the main distribution in northern America — occur in the East as far as Siberia, in the West as far as England and in the North frequently up to and within the Arctic region. Their southern border differs from species to species quite considerably, but as a rule they never go so far to the South as the species of the holarctic group.

Warmbad Villach's holarctic species have the following southern distribution limits: *Lestes dryas* (conspecific with the North American *L. uncatus* Kirby) to Campania, *L. sponsa* (conspecific with the North American *L. disjunctus* Selys) to Pavia, but *Cordulia aenea* (infraspecifically different from North American *C. shourleffi* Förster) is recorded only down to the Prealpine areas of northern Italy*. From the remaining two species, *Aeshna grandis* reaches the southern border of its area at Piemont, while *Sympetrum vulgatum* has been reported to occur in Spain and central Italy.

* Between the completion of the manuscript and the proof-reading, we were able to collect in June 1965 a large series of *C. aenea* near the confluence of the rivers Lot and Vers in southern France. This record extends the distribution area of the species considerably to the South.

Since the Mediterranean species given in table II do not need any particular zoogeographical comment, one can see from the above analysis that holarctic species and holarctic genera of the fauna of Warmbad Villach also have a fairly wide southern distribution. We may therefore consider the odonate fauna of Warmbad Villach as typically southern.

Ecological composition of the fauna with regard to the movement of water is shown in table III.

TABLE III

Species	Rheophilic	Rheoxenic	Stagnicolous
Calopteryx splendens	+		
Calopteryx virgo	+		
Sympecma fusca			+
Lestes barbarus			+
Lestes dryas			+
Lestes sponsa			+
Lestes virens			+
Platycnemis pennipes		+	+
Coenagrion puella			+
Ischnura elegans			+
Onychogomphus forcipatus	+		
Aeshna cyanea			+
Aeshna grandis			+
Anax imperator			+
Cordulia aenea			+
Libellula depressa			+
Libellula fulva			+
Orthetrum coerulescens			+
Sympetrum sanguineum			+
Sympetrum vulgatum			+

It is evident — and interesting — that the fauna of Warmbad Villach appears to be composed of stagnicolous species (85%) although it inhabits chiefly a running water habitat. This phenomenon is easily explained by the smaller amount of free oxygen required by stagnicolous animals, as polyoxybiontic rheophilous species would not tolerate lack of free oxygen.

Among the 17 stagnicolous species only *Platycnemis pennipes* is to some extent ubiquitous, occasionally exhibiting a rheoxenic character. With regard to the three rheophilic species, only for both species of *Calopteryx* do we have positive evidence that they breed in a united outflow. Although both are rheophilic and rather polyoxybiontic, they sometimes occur abundantly in nearly stagnant but seasonally running waters as well (KIAUTA, 1961); *Calopteryx virgo* was even described in a temporarily built up colony in a small isolated high-alpine lake (KIAUTA, 1963).

There is no evidence of the breeding of *Onychogomphus forcipatus* in the united outflow. Its abundance, however, suggests that it must undergo its larval development in these waters.

It is probably the temperature of breeding sites which influences the growth

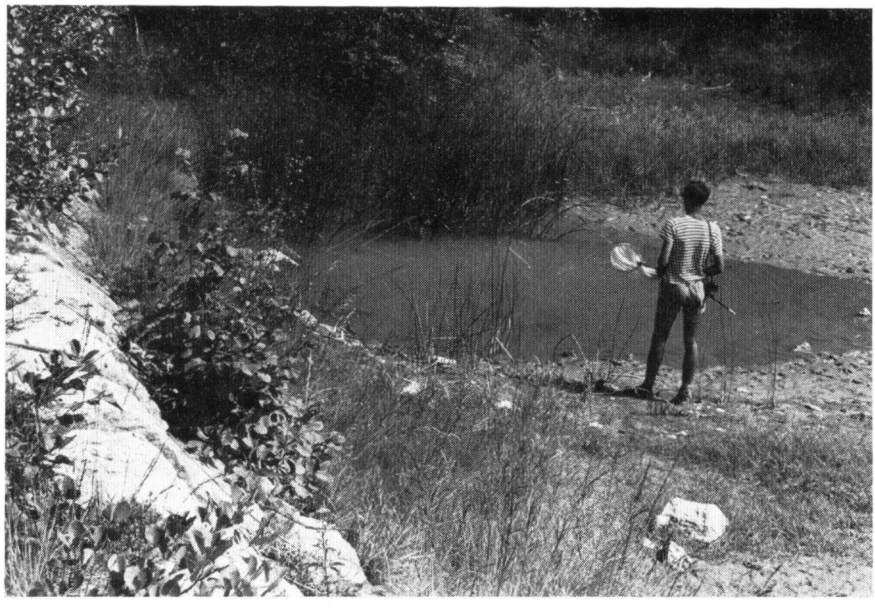

FIG. 4. Small pool near the regulated bed of the river Gail, fed with rainwater and with water from the river when at high level. The pool is permanent but its size varies much according to rainfall. It is in particular the habitat of *Libellula depressa*. Photo B. Kiauta.

of larval stadia and possibly also the phenology. Owing to the short duration of the observations, I was not able to collect any evidence regarding this aspect. PACAUD, 1948, however, made an interesting experiment, feeding larvae of *Calopteryx splendens* at different temperatures. A single animal took within 10 days, according to the temperature at which it was kept, the following amount of chironomid larvae: at 5° — 1, at 10° — 8, at 15° — 15, at 20° — 18 and at 28° — 23. Since that author has made observations on other insects, among them the damselfly *Erythromma*, which reaches its optimum at 15° C, one may infer a high influence of environmental temperature on metabolism and the thermoxenic character of *Calopteryx* when compared to *Erythromma*.

As regards to the total fauna of Warmbad Villach, it should be stressed that some of the species occur only rarely along and above the thermal water bodies. They were never seen to have established their hunting or sexual territories there. Typical in this respect seems to be *Libellula depressa*, which — according to known evidence — does not breed in the thermal water and is rather scarce in thermal localities, although it occurs very commonly in the surroundings of Warmbad Villach, in pools and ponds with stagnant water at normal temperature (fig. 4).

The ethology of the dragonflies of Warmbad Villach will be dealt with in a further article.

REFERENCES

BELYSHEV, F. B.
1960a Hot spring as a breeding site of dragonflies. — Acta barguz. gosud. zap., **2**: 131—133 (in Russian).
1960b Conditions of existence of the larvae of a relic dragonfly Orthetrum albistylum Selys in a hot spring of North-East Baikal Territory. — Zool. Jour., **39**, 9: 1432—1433.

BRUES, C. T.
1928 Studies of the fauna of hot springs in the Western United States and the biology of thermophilous animals. — Proc. Amer. Acad. Arts Sci., **63**: 139—228.
1932 Further studies on the fauna of North American hot springs. — Proc. Am. Acad. Arts Sci., **67**: 185—303.

CONRAD, V.
1928 Das Klima der österreichischen Kurorte. — Österr. Bäderbuch: 1—22 (Wien).

ISSEL, R.
1906 Sulla termobiosi negli animali acquatici. Richerche faunistiche e biologiche. — Atti Soc. Ligust. Sci. natur. geogr., **17**: 1—72.

HOLDHAUS, K.
1929 Die geographische Verbreitung der Insekten. — In: SCHRÖDER, Handb. Ent., **2**: 592—1057.

KIAUTA, B.
1961 Beitrag zur Kenntnis der Odonaten-Fauna Sloweniens. — Biol. Vestn., **8**: 31—40.
1963 A note on an unusual habitat of Calopteryx virgo (L.). (Calopterygidae). — Tombo, Acta odonatol., **6**, 3—4: 25—26.

PACAUD, A.
1948 Température et relations de nutrition dans les biocoenoses limniques. — Bull. Soc. cent. Aquic. Pêche, **4**: 1—5.

PASCHINGER, H. & R. PUSCHNIG
1935 Vom Waidischsee. — Carinthia II, **125** (45): 87—94.

PEHR, F.
—— Die Napoleonwiese bei Warmbad Villach. — Separatum ex Villacher Zeitung, Villach (cit.: STROUHAL, 1934).

PUSCHNIG, R.
1905 Kärntnerische Libellenstudien. — Carinthia II, **95**: 18—31, 61—72.
1906 Weitere Kärntnerische Libellenstudien. — Carinthia II, **96**: 109—120.
1908a Kärntnerische Libellenstudien. Dritte Folge. — Carinthia II, **98**: 87—101.
1908b Einige Beobachtungen an Odonaten und Orthopteren im steirisch-kroatischen Grenzgebiete. — Mitt. nat.wiss. Ver. Steiermark, **44**: 102—111.
1930 Von der Tierwelt des Rosentales. Eine faunistische Skizze. Beitr. nat.wiss. Heimatkunde Kärntens: Naturgeschichtliches aus dem Abstammungsgebiet. — Carinthia II, Sonderheft: 83—133.

ST. QUENTIN, D.
1959 Odonata. Catalogus faunae Austriae, **12** (c): 1—11 (Wien).
1960 Die Odonatenfauna Europas, ihre Zusammensetzung und Herkunft. — Zool. Jb. Syst., **87**, 4—5: 301—316.

STROUHAL, H.
1934 Biologische Untersuchungen an den Thermen von Warmbad Villach in Kärnten. (Mit Berücksichtigung der Thermen von Badgastein). — Arch. Hydrobiol., **25**: 323—385, 495—583.

WERNER, F.
1913 Zur Kenntnis der Fauna der Umgebung des Ossiachersees. — Carinthia II, **103**: 165—172.
1915 Zoologische Beobachtungen am Ossiachersee. — Carinthia II, **105** (25): 4—10.

Drs. B. KIAUTA
State Institute for Nature Conservation Research (RIVON)
Laan van Beek en Royen 40—41
Zeist — The Netherlands

For sale at the Administration of the Zoological Museum, Amsterdam.
Price *f* 3.00 (Dutch Guilders)