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БОТАНИЧКОГ ЗАВОДА И БАШТЕ УНИВЕРЗИТЕТА У БЕОГРАДУ

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Milorad M. Janković

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САДРЖАЈ

Први послератни број „Гласника Ботаничког завода и баште Универзитета у Београду“ појављује се у 1959. години, у којој пада и 25-то годишњица смрти професора др Недељка Кошанина, оснивача и првог уредника овог часописа. На тај начин, својим поновним излажењем обележава „Гласник“ овај значајан датум, везан за име Недељка Кошанина, нашег истакнутог и заслужног научника, фитогеографа и фитоеколога и једног од првих професора ботанике на Београдском универзитету. Жеља је садашње редакције да „Гласник“, који је између два рата наилазио на знатан одзив у научним ботаничким круговима у свету, настави и данас сву ону позитивну традицију коју је некада подржавао. Зато „Гласник“ и треба да прикаже нашој и страној научној јавности део оне научне активности која се у оквиру Ботаничког завода и баште, једне од најстаријих научних установа у Србији, данас негује на пољу истраживачког рада у области ботанике. Исто тако, „Гласник“ ће на својим страницама пружити места и научним радовима насталим изван Ботаничког завода, уколико по својим особинама одговарају карактеру који „Гласник“ има. На крају, редакција је уверена да ће Ботанички завод преко свога „Гласника“ успоставити не само оне многобројне старе везе које је Завод пре рата имао са низом научних установа, већ исто тако и многе нове, и да ће се ове везе посебно повољно одразити у размени научних публикација.

Редакциони одбор

The first after-war issue of the „Bulletin of the Botanical Institute and Garden of the University in Beograd“ appears in 1959, coinciding so with the 25-th anniversary of Professor Dr. Nedeljko Košanin, its founder and first redactor. So re-appearance of the „Bulletin“ marks a date connected with the name of that distinguished scientist — phytogeografer and phytoecologist, and one of the first professors of Belgrade University.

It is the wish of the present Editorial Board to continue the positive tradition of the „Bulletin“, which was once familiar to botanists in our country and abroad. The „Bulletin“ will present to domestic and foreign scientific puclic a part of results emerging from the activitiec of the Botanical Institute and Garden, one of the oldest scientific institutions in Serbia. It will, as well, include papers concerning botanical problems from outside the Institute.

The editors trust that the „Bulletin“ shall not only help to re-establish those manyfold old connections of the Botanical Institute with numerous scientific institutions, but as well serve the honest purpose of establishing new ones, and that these connections shall accordingly be reflected in the exchange of scientific publications.

Editorial Board

GLASNIK BOTANIČKOG ZAVODA I BAŠTE UNIVERZITETA U BEOGRADU
BULLETIN DE L'INSTITUT ET DU JARDIN BOTANIQUES DE L'UNIVERSITÉ DE BEOGRAD
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VILOTIJE BLEČIĆ

DIE PANZERFÖHRENWÄLDER DER NÖRDLICHEN PROKLETIJA

(*Pinetum heldreichi bertiscum* B. -ić)

Die Panzerföhre (Pinus heldreichii), eine der bezeichnendsten endemischen Baumarten der Balkanhalbinsel, ist in den Alpen der Hercegovina, Bosniens, Dalmatiens, Montenegros, der Metochija, Albaniens, Makedoniens, Griechenlands, Bulgariens und Süditaliens verbreitet. In dieser Nadelholzart, die man aufführt, als Beispiel des disjunktischen Areals, haben wir fast alle Lokalitäten auf dem Terrain Jugoslaviens zusammengefasst (1950). Obzwar die Panzerföhre einen besonderen Vegetationsgürtel auf den hercegovinisch-montenegrinischen Alpen, sowie jenen der Kosovo-Metochia, Makedoniens und Albaniens bildet, von fitocenologischer Seite ist sie sehr schwach erforscht. Frühere Arbeiten Košanins (1939) und Markgrafs (1932) geben nur ein allgemeines Bild des florealen Bestandes dieses Waldes, doch ist es schwer, ihn vom Standpunkt der zeitgemässen Fitocenologie zu vergleichen. Einen sehr wertvollen Beitrag über die Panzerföhrenwälder des Olymp gab Grebenščikov (1949), aber leider befindet sich dieser als Manuskript für besondere Veröffentlichung des Naturwissenschaftlichen Museums in Beograd vorbereitet. Im Vorjahr, zusammen mit B. Tatić dem Assistenten des Botanischen Instituts, ging ich über einige Alpenkämme der Metochia und des montenegrinischen Teiles der Prokletija (Koprivnik, Maja Ljubenić, Čakor, Sjekirica, Visitor, Zeletin) und der Komovi. Bei dieser Gelegenheit entdeckten wir einen neuen Fundort der Panzerföhre auf der Südseite der Sjekiricagebirge.

Die Panzerföhre wird angeführt als Beispiel eines Waldbaumes, der auf Geröll sich ansiedelt, sowie auf sehr steilen Abhängen und sie reicht bis in unzugängliche alpine Abgründe und ist deswegen sehr zerrissen und schütter und dichte Wälder sehr selten. Und auch neben diesen oben angeführten Tatsachen im Bereich der Komovi—Alpe befinden sich grosse Komplexe dichter Panzerföhrenwälder, hie und da von Urwaldcharakter. An der Komovi Südostseite bedeckt die Panzerföhre einen Komplex von ungefähr 700 Hektar, so dass sie auch heute als unmittelbarer Nachbar von Almen die Viehhüter mit Feuer bedroht. Über dem Konjuche auf der nordöstlichen Seite der Komovi sind noch frische Spuren eines Brandes, der zehnfache Hektare der vitalsten Panzerföhrenwälder vernichtet hat, was sich aus den Resten halbvertrocknerter oder trockner Stämme und Klötze von über 15 Meter Höhe und Umfang vom mehr als Meterbreite schliessen lässt. Die Panzerföhre in jenem Teil Montenegros nimmt eine Höhenlage von 1700 bis 2000 (2100) Metern ein, wo man sie in Form von Krummholz antrifft. Soviel man aus der Zusammensetzung der Wälder und den Dimensionen der Bäume schliessen kann, erreicht die Panzerföhre unterhalb der Komovi eine optimale Entwicklung in einer Zone von 1800 b: 1920 Metern. In dieser Zone befinden sich grössere Komplexe von Panzerföhren wäldern, bestehend aus hochstämmigen Bäumen, deren Höhe 15 Meter übersteig und ihr Diameter misst über 65 sm. im Durchschnitt. Unterdessen sind Beständ der Panzerföhre sehr häufig, in denen sich ein Fünftel starker und durch diese Bedingung gerader Bäume befinden. Der andere Teil zeigt allerdings dicht zu- sammengedrängte junge Stämme von 8 Meter Höhe und von 15 bis 20 sm Umfang. Die jungen Stämme sind alle säbelförmig am Grund (Basis) gewunden und infolge dichten Zusammenstehens sind die Äste nur unterhalb des Wipfels entwickelt. Es ist glaubwürdig, dass auch jene alten geraden Stämme in jüngeren Stadien beim Grund (Basis) säbelförmig gewunden waren, aber dass sie sich später beim Wachsen der Massen ausbesserten, weil sie auf diese Weise leichter der schweren Schneeedecke widerstanden, sonst könnte man schwer die Möglichkeit begreifen, dass die alten Bäume mit geraden Stämmen unter leichteren Bedingungen aufwuchsen, als die heutigen. Bei der Überprüfung der Massive steht die Panzerföhre unmittelbar über dem Gürtel der Buchen und Tannen und nur auf der nordöstlichen Seite der Komovi auf dem Gürtel der subalpinen Buche, die hier ihre äusserste südöstliche Grenze ereicht. Auf den südlichen Abhängen der Komovi, über 1920 Metern, ist die Panzer- föhre bedeutend kleiner vom Wuchs; alle Stämme sind am Grund (Basis) säbelförmig gewunden und in der Höhe trocken. Neben der Form des Krumm- holzes zeigt sich die Panzerföhre auch im Aussehen einer Fahne. Auf nördlichen Expositionen, auf ausgesprochen steilem, steinigem Standorte, bekommt die Panzerföhre schon in einer Höhenlage von 1800 Metern das Aussehen typischen Krummholzes. Die Krummholzform ist, nach allem zu urteilen, ehestens die Folge der Wirkung der Nordwinde, doch kann auch die Wirkung der Schneedecke auf die Entwicklung dieser Form Bezug haben. Die Panzerföhre ist ausgesetzt den sehr schwierigen Lebensbedingungen des Kalkgrundes der Hochalpen, aber manche Forstfachleute (1941) erachten sie als günstig für die Aufforstung steiniger Voralpenhöhen. Unterdessen aber beweisen Forstpraktiker in Peć, dass die Samen der Panzerföhre einen sehr geringen Prozentsatz von Keim- fähigkeit besitzen. Nun, auf dem Koprivnik bestehen sehr dichte junge Panzer- föhrenwälder, deren Stämme nach Wuchs und Dicke annähernd so alt erscheinen und nur auf unzugänglichen Standorten befinden sich starke alte Stämme, die als Pflanzschule zur Erneuerung vernichteter Wälder gedient haben. Auch auf der südöstlichen Seite der Sjekirica befindet sich ein junger Panzerföhrenwald und nur zwischen den Wänden manchmal ein alter starker Baum. Am glaub- würdigsten ist es dass die schwache Keimfähigkeit des Samens der Panzer- föhre aus dem Bereich des Poprivnik daher stammt, weil dort Harzegewinung betrieben wird, und dass dadurch die Vitalität der Panzerföhre verringert wird und ausserdem ist sie sehr häufig mit Flechten aus den Gattungen der Usnea und der Ramalina bewachsen.

Der Aufbau der Assoziation. Der beigefügten Tabelle sind 20 Aufnahmen beigegeben, deren grösster Teil den Komovi entnommen ist. Die Aufnahmen wurden in verschiedenen Höhen von 1520 bis 2000 Metern gemacht. Bei allen fitocenologischen Aufnahmen sind in das Verzeichnis nicht die Angehörigen der Familie Graminae eingetragen, weil dieser Wald intensiv dem Weiden der Herden ausgesetzt ist, und es schwer ist, sie nach dem gefundenen vegetativen Stand einzubestimmen. Aus der fitocenologischen Tabelle ersieht man sofort,

Abb. 1. *Zeletin* (Goleš) Starker Panzerföhrenstamm und links Panzerföhre mit säbelförmigem Stamm

(Photo V. Blečić)

Abb. 2. Komovi: Der subalpiner Panzerföhrenwald

(Pnoto V Blečić)

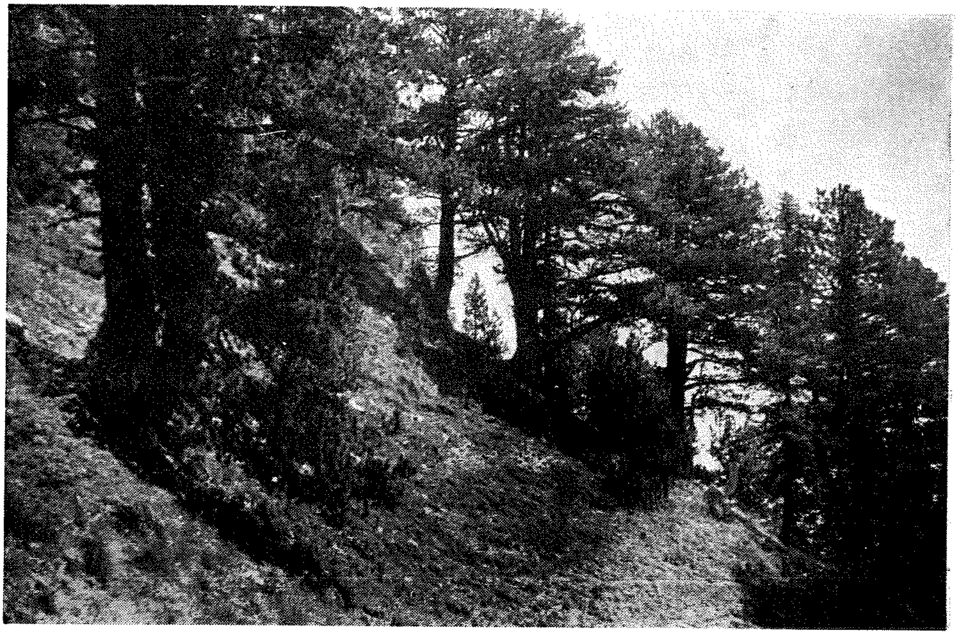

Abb. 3. Zeletin (Ċeransko) Schüttere Panzerföhrenbestände auf Geröll
(Photo V. Blečić)

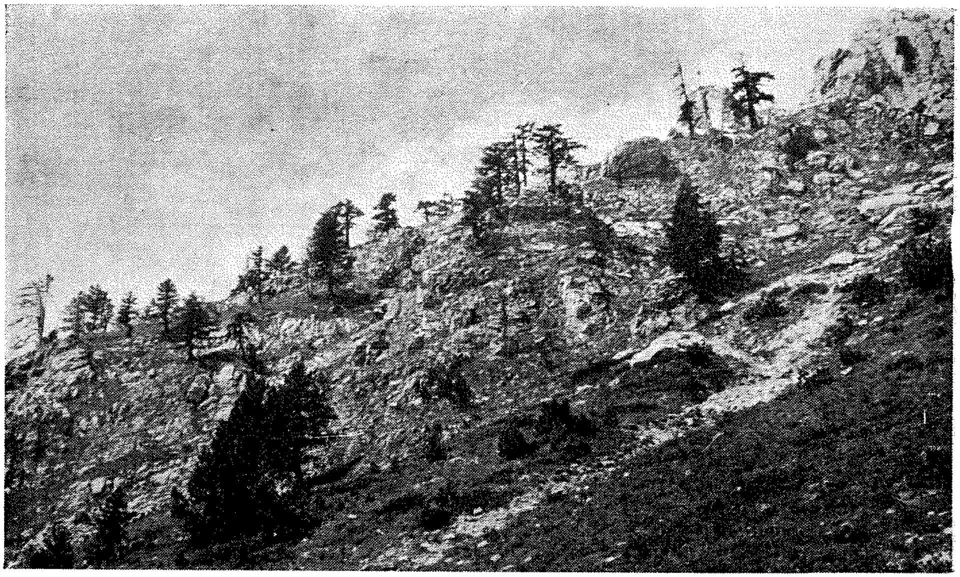

Abb. 4. Koprivnik (Vjetrno Brdo) Panzerföhrenreste nach einem Brand
(Photo V. Blečić)

dass sich der Panzerföhrenwald wesentlich in floristischem Bestand von anderen Nadelwäldern und von gemischten Laub-und Nadelwäldern unterscheidet. Dieser Unterschied betrifft alle Begleiterscheinung und besonders die Schichten der Krautschicht. Von 45 Kräuterarten, die in der Tabelle eingetragen sind, sind 51% in Wäldern wachsend, — 49% sind Wiesen, steinigem Terrain und Steinwänden zugehörig. Die charakteristische Zusammenfassung des Aufbaues der Assoziation umfasst zehn Arten von 61 Kräutern und holzigen Arten. Unter den Kräuterarten, die in den charakteristischen Zusammenschluss dieser Vereinigung treten, stellen nur drei Arten Waldflora dar, — die anderen fallen offenen Standorten zu. Auch ist der Unterschied zwischen den einzelnen Aufnahmen klar ersichtlich, was im Zusammenhang mit den Höhenlagen der einzelnen Bestände der Panzerföhre steht, wo die Aufnahmen gemacht wurden, ob auf der äussersten Grenze der Panzerföhre oder auf nördlichen Expositionen, wo die verwitterte Unterlage in höherem Grade vorherrscht, wo Elemente hochalpiner Kahlheit vertreten sind. In Gesellschaft von Strauchwerk ist in grösster Zahl Juniperus intermedia vertreten. Dieser Wacholder, im Verein mit der Panzerföhre, ist der typische *Juniperus intermedia,* aber auf offenen Standorten auf gleicher Höhe zeigt er sich als *Juniperus nana.* Diese Erscheinung kann man bis zu 1900 Meter Höhe verfolgen, jedoch unterhalb dieser Höhe ist der Wacholder gleichen Aussehens, wie im Bestand der Panzerföhre auf offenen Standorten.

Wenn wir unseren Panzerföhrenwald mit dem Panzerföhrenwald des Olymps und Albaniens vergleichen, werden wir sehen, dass jene Wälder auserordentlich mehr Arten auf offenen Standorten enthalten. Grebeščikov (1949) führt auf, den Panzerföhrenwald des Olymps betreffend, dass von der Gesammtzahl der Arten, die man dort findet: 33% der Pflanzenarten Wiesenblumen sind, 27% steinigen Wänden zufallen, 22% steinigem Grund, und dass nur 18% Waldpflanzen sind. Markgraf (1932) erwähnt, den Panzerföhrenwald betreffend, Lokalitäten von drei Höhenunterschieden mit 90 Pflanzenarten. Aus der Analyse der angführten Arten ersieht man, dass nur 1% der erwähnten Arten Wäldern zugehörig ist, aber 99% sind Angehörige offener Standorte, sowie Wiesen, Wänden und Steingrund. Damit zeigt sich klar die ökologische Unterschiedlichkeit zwischen den Panzerföhrenwäldern Griechenlands und Albaniens einerseitss und den Panzerföhrenwäldern in den erwähnten Massiven der Prokletija und der Komovi anderseits. Die Unterschiede der floristischen Bestände der erwähnten Wälder werden eingehender ausgeführt werden bei Gelengenheit der Aufstellung der systematischen Zugehörigkeit der Panzerföhrenwälder.

Obzwar sich die Panzerföhre als kräftiger Vegetationsgürtel über dem Gürtel der Buche und Tanne und hie und da über den Fichtenwäldern ausstellt, sehen wir, dass in die Panzerföhrenwalder nicht viele, für den Gürtel der Buche und Tanne charakteristische Pflanzenarten, eindringen. Solche sind:

Asperula odorata
Dentaria bulbifera
Dentaria ennaeaphyllos
Calamintha grandiflora
Oxalis acetosella
Lonicera nigra
Asarum europaeum
Elymus europaeus
Ranunculus lanuginosus
Prenanthes purpurea
Lonicera xylosteum

In dem bis dato erforschten Panzerföhrenwald sind keinesfalls folgende Arten gefunden werden: *Monotropa hypopitis, Corallorhiza trifida, Asyneuma* *trichocalycinum, Blechnum spicant, Aconitum* — Arten und Arten aus der Gattung des *Lycopodium,* die alle sehr oft in den benachbarten Fichtenwäldern des erforschten Bezirkes gezählt werden. Die Panzerföhre und die Molika-kiefer (Pinus peuce) stehen oft in unmittelbarer Nachbarschaft des erwähnten Teiles der Prokletija und mischen sich stellenweise, aber manche Pflanzen, die sich fast ständig in Molikakieferwäldern befinden kommen in Panzerföhrenwäldern überhaupt nicht vor, wie: *Geum montanum, Wulfenia carinthiaca, Potentilla ternata* u. and. Der floristische Unterschied zwischen den Panzerföhrenwäldern einerseits und den Buchen-und Fichtenwäldern anderseits ist dadurch begründet, dass Buchen-und Fichtenwälder sehr eng zusammenstehen und zum Typ der dunklen Wälder gehören, während die Panzerföhrenwälder offen und licht sind. Molikakieferwälder *(Pinetum peucis)* sehen in ihrer Gesammtheit ebenso licht aus wie Panzerföhrenwälder, aber die Kräuter, die sie bedecken, enthalten 95% Elemente des Waldes. Jedenfalls besteht zwischen diesen zwei Wäldern ein Unterschied in Regime des Lichtes, weil die Molikakieferwälder nördliche Standorte einnehmen, jene der Panzerföhre aber südlich. Ein wesentlicher Faktor für den floristischen Bestand ist der petrografische Aufbau des Grundes. Die Panzerföhre steht hier ausschliesslich auf Kalkgrund, Molikakiefer auf Silicatgrund. Im Panzerföhrenwald, der licht und trocken ist, und dessen Nadeln infolge der neutralen Wirksamkeit des Grundes schell zerfallen, erhält dadurch eine schwache Schichte von rohem Humus. Die Molikakiefer steht auf bedeutend feuchterem Silicatgrund, auf dem der Humus schwerer zerfällt, und viele Waldpflanzen, wie die Skiofiten, gedeihen hier infolge der grösseren Feuchtigkeit und des reicheren Inhalts des Humus.

Die Gliederung der Assoziation. Aus der beigefügten Tabelle ersieht man, dass die Aufnahmen vom Koprivnik, Maja Ljubenić und der Sjekirica sich von jenen Komovi unterscheiden. Diese Unterschiede sind auffallend in allen Schichten. In der Schicht von Bäumen, neben der Panzerföhre als Edifikator, befinden sich Molikakiefer, Tannen und Fichten und selbst die Buche ist häufiger als Komovi. Unter Gesträuch sind vertreten: Lonicera alpigena, Rhamnus fallax und Daphne mezereum. In der Krautschicht Flora befinden sich termofilen Charakters, ebenso wie aus Wäldern, auch auf offenen Standorten: *Veronica chamaedrys, Digitalis grandiflora, Euphorbia cyparissias, Gentiana asclepiadea, Veronica urticefolia* und *Ajuga reptans.* In den Panzerföhrenwäldern der Komovi sind in der Schicht von Bäumen nicht vertreten: Tanne, Fichte und Molikakiefer und die Buche zeigt sich nur in einer Aufnahme. In der Schicht von Gesträuch, wenn auch selten genug, befinden sich Sträucher der subalpinen Zone, wie: *Sorbus glabrata, S. chamaemespilus* und *Coteonaster integerima,* und höher als 1900 Meter *Juniperus nana.* Zwischen Kräuterpflanzen sind in den Panzerföhrenwäldern der Komovi hervorragend: *Helleborus purpurascens, Calamintha alpina, Erythronium dens canis, Homogyne alpina, Crocus sp.,* und noch einige Repräsentanten der hochalpinen Vegetation. Nach dem jetzt Ausgeführten können wir die Panzerföhrenwälder auf erforschtem Gebiet in zwei *Subassoziationen* teilen u.zw.: *Pinetum heldreichii-bertiscum mixtum* und *Pinetum heldreichii bertiscum typicum.*

Pinetum heldreichii bertiscum-mixtum. Der gemischte Panzerföhrenwald nimmt neben heterogenenfloristischen Beständen, in der Schicht von Bäumen, auch bedeutend niedrigere Lagen ein. Auf diese Weise ist er dem rauhen, hochalpinen klimatischen Regime weniger ausgesetzt, so dass sich in der Krautschicht, wie zuerst hervorgehoben, manche termofile Pflanzen wie aus Laubwäldern befinden, wie auch jene offener Standorte. Der heterogene Bestand der Panzerföhrenwälder ist nicht nur das Ergebnis der niedrigeren Lage, sondern mehr die petrografische Zusammensetzung des Grundes und der unmittelbaren Nachbarschaft von Fichten-und Molikakieferwäldern, wodurch sie in Panzerföhrenwälder übergehen.

Rudski (1949) führt für die Mokra Planina Panzerföhrenwälder an, in die: Fichten, Molikakiefern, Krummholz *(Pinus mughus)*, Buchen, *Acer visianii* und *A. intermedium* eingegangen sind.

Pinetum heldreichii bertiscum typicum: Dieser Panzerföhrenwald ist ausschlieslich aus Panzerföhren zusammengestellt. Molikakiefern, Tannen und Fichten weist er nicht auf, und die Buche zeigt sich selten. (bei 14 Aufnahmen nur einmal.). Die Abwesenheit der angeführten Arten ist vor allem durch den Kalkboden begründet, wie durch die bedeutend höhere Lage und hauptsächlich durch die südliche Exposition. Die Panzerföhre der Komovi, ähnlich wie jene in Griechenland (Olymp), erreicht nach bisherigen Beobachtungen ihre optimale Entwicklung in der Zone von 1800 bis 1900 Metern, soweit sie sich nicht auf steilen Wänden befindet, exponiert gegen den Norden. Auf der südöstlichen Seite der Komovi in der Höhe von 1820 Metern auf ebenem oder sanft geneigtem Terrain begegnet man Bestände von Panzerföhren, die dichter oder weniger zusammenstehen, deren Stämme eine Höhe von 10 Metern erreichen und einen Umfang von ungefähr eines Meter aufweisen. Die Äste sind sehr dick, lang und gedreht und meist mit Flechten bedeckt. In Höhen von über 1900 Metern ist die Panzerföhre etwas kleineren Wuchses und von anderem Habitus-gewöhnlich gleicht sie einer Fahne oder der Krummholz-Panzerföhre mit trockenem Wipfel. Daneben treten hier Pflanzen aus hochalpiner Rasenvegetation auf, als da sind: Dryas octopetala, Polygonum viviparum, Iberis sempervirens und Juniperus nana. Dem floristichen Bestand zufolge, könnte diesser Typ der Panzerföhre in eine besondere Subassoziation eingeteilt werden, was der Gegenstand der folgenden Prüfung sein wird.

Die systematische Stellung des Panzerföhrewaldes. Bei Gelegenheit der Aufstellung des floristischen Bestandes der Assoziation wurde die Verschiedenheit zwischen diesem Wald und anderen Nadelwäldern erwähnt. Die bisherigen Beiträge vom floristischen Bestand des Panzerföhrewaldes können uns sehr interessante Beilagen zur Panzerföhre aus Griechenland und aus den erforschten Teilen der Prokletija und der Komovi bieten. Hier wollen wir einige der interessanten Pflanzen anführen, die sich im Panzerföhrenwald auf dem Olymp und im nordöstlichen Teil der montenegrinischen wie auch in jenem der zur Metochia gehörenden Prokletija vorfinden.

Pinetum heldreichii Ht. (Olymp)		*Pinetum heldreichii bertiscum* B-ić (Komovi—Prokletije)
	Pinus heldreichii	
	Juniperus nana	
	Daphne mezereum	
	Fagus moesiaca	
Daphne oleoidea		*Rhamnus fallax*
Pinus pallasiana		*Pinus peuce*
Cotoneaster tomentosa		*Cotoneaster integerima*
Buxus sempervirens		*Lonicera alpigena*
		Rosa pendulina
		Abies alba

Krautschicht

Luzula silvatica
Geranium robertianum
Fragaria vesca
Senecio nebrodensis

Genista radiata
Stipa calamogrostis
Festuca cyllenica
Poa alpina
Sesleria nitida
Saxifraga scardica
Thymus leucotrichus
Minuartia setacea
Geranium macrorhizum
Bromus lacmonicus
Doronicum cordatum
Potentilla deorum
Jankaea heldreichii
Thymus boissieri
Cerastium banaticum
Sedum athoum
Carex laevis
Teucrium montanum
Campanula oreadum
Carum graecum
Linaria parnassica

Stachys officinalis
Thymus balcanus?
Cerastium lanigeri
Scabiosa portae
Polygala croatica
Euphorbia amygdaloides
Vaccinium myrtillus
Helleborus purpurascens
Aremonia agrimonioides
Hypericum alpigenum
Linum capitatum
Erythronium dens canis
Homogyne alpina
Anemone nemorosa
Veronica officinalis
Myosotis silvatica
Crocus sp.
Anemone hepatica
Gentiana asclepiadea
Iberis sempervirens
Dryas octopetala

Aus der vergleichenden Tabelle, auf der nur die bedeutendsten Arten gezeigt wurden kann man sofort den wesentlichen Unterschied zwischen dem Panzerföhrenwald des Olymp (Griechenland) und jenem des erwähnten Teiles der Prokletija und der Komovi ins Auge fassen. Die Zahl gemeinsamer Arten ist überaschend klein Von 95 Arten, die Grebenščikov erwähnt gibt es in zwei Aufnahmen aus dem Panzertföhrenwalde nur sieben gemeinsame Arten. Unter den erwähnten Arten der Panzerföhre des Olymps kommen 35 Arten nicht in den Bestand der Flora Montenegros und manche sind nur auf den Olymp beschränkt. Markgraf (1932) gibt ein Verzeichnis der Pflanzen in den Panzerföhrenwäldern des südöstlichen und östlichen Albaniens mit drei unterschiedlichen Lokalitäten, nach Höhenlage, Exposition, sowie nach der petrografischen Zusammensetzung des Grundes (Kalk und Serpentin). Für diese drei Fundstellen sind beiläufig 90 Pflanzen erwähnt, unter denen sich sieben gemeinsame Arten unserer Panzerföhrenwälder befinden. Aus der floristischen Analyse der Panzerföhrenwälder fallen die grossen Unterschiede zwischen den Panzerföhrenwäldern Griechenlands und Albaniens einerseits und den Panzerföhrenwäldern des nordöstliche Teiles jugoslavischer anderseits Prokletija und im Komovi ins Auge. Unser Panzerföhrenwald zeichnet sich als eine besondere geographische Variante aus und wird deswegen Pinetum heldreichii bertiscum genannt.

Asocijacija	PINETUM HELDREICHII BERTISCUM B-ić																				Stepen stalnosti (Stetigkeitgrad)
Subasocijacija	Mixtum						Typicum														
Nalazište snimaka (Fundort Aufnahmen) i (und) Ekološka karakteristika (Ekologische charakteristik)	Koprivnik (Bjelopoljski stanovi)				Maja Ljubenić	Sjekirica	KOMOVI (K. Vasojevićki i K. Kučki)													Zeletin (Goleš)	
Veličina snimane pov. u. m.² (Grösse d. Aufnahmefläche in m²)	1000	1000	1000	1000	3000	800	2000	1500	2000	1200	1800	4000	3000	1500	2000	1000	1000	900	300	200	
Nadmorska visina (Höhe ü. M.)	1520	1590	1600	1680	1700	1800	1800	1900	1900	1920	1920	1900	1920	1970	2000	1960	1930	1980	1980	1830	
Ekspozicija (Expozition)	SO	SO	SO	N—NO	O—NO	S—SW	NW	S	S	S	S—SW	S	SW	SW	SO	SW	NO	S	N	N	
Nagib (Neigung)	10°	15°	20°	20°	15°	35°	30°	20°	20°	15°	25°	20°	25°	25°	30°	25°	5°	20°	35°	50°	
Geološka podloga (Geologische Untergrund)	Krečnjak																				
Redni broj snimka (Aufnahme №)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	
FLORISTIČKI SASTAV (Floristischezusammensetzung)																					
I. Sprat drveća (Baumschicht)																					
Pinus heldreichii	3.4	4 3	4.3	3.3	3.3	3.3	4.4	3.4	4.3	4.4	3.3	4.4	4 3	4.4	4 3	3 2	3.3	3.2	3.3	3.3	V
Pinus peuce				2.1	1.1	+														+	I
Fagus moesiaca	1.2	+				+				1.1											I
II. Sprat šiblja (Strauchschicht)																					
Pinus heldreichii	3.3	1.3		1 2	1.1	1.1	2.2	2.1	1.1	1.1	1.2	2.1	+	2 2	1.1	2.1	2 2	2 2	1.1	+2	V
Juniperus intermedia + nana	2.3	2.3	1.2		+2	1.2	+2	2.3	1.1	+	1.1				1.2	1.2	1.2	1.2	1.2	+2	V
Abies alba		1.1		+	+						+		+		+		+				II
Fagus moesiaca	1.1		1.1				+		+	1.1											II
Pinus peuce			+	+	1.1	+															I
Lonicera alpigena	+				+2															+	I
Pinus mughus				1.2																	I
Rosa alpina				1.1	3.2		+	+	1.1										1.2		II
Salix grandifolia				2.1																	I
III. Diferencijalne vrste (Diferentialarten)																					
Aspidium lonchitis		+	1.2		+2	+2				+2											II
Gentiana asclepiadea			1.1	1.1	1.2	+2														1.2	II
Veronica chamaedrys	1.1	1.1	1.1			+														1.1	II
Ajuga reptans	+	+	+			1.1															I
Picea excelsa (AB)	+	+	+			2.1															I
Abies alba (A)	+	+	+																		I
Daphne mezereum	1.1	1.1	1.1	+2																1.1	II
Rhamnus fallax	1.1	+1	+																	+	I
Euphorbia cyparissias	1.1	1.2	1.1																		I
Digitalis grandiflora	1.1	1.1	1.1																		I
Helleborus purpurascens							4.3	2.2	2.3	2.2		+3				+2	1.2				II
Crocus sp.								+		1.1	1.1	+	1.1	1.1			+				II
Erythronium dens canis								+		1.1	1.1	+	1.1				+				II
Veratrum album								+				+	+				1.1		+		II
Homogyne alpina										1.1	1.3						2.3	1.3			I
Iberis sempervirens															+		+	1.2	1.1		I
Polygonum viviparum																+	+1		1.1		I
Sorbus glabrata																			+	1.1	I
Sorbus chamaemespilus																			+2	1.1	I
Cotoneaster integerima																				1.1	I
IV. Zeljaste biljke (Krautschicht)																					
Stachys officinalis	+	1.1				1.2	1.1	1.1	1.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	1.1	1.1	1.2	V
Fragaria vesca	3.1	1.2	2.2		1.1	1.1	2.2	2.2	2.1	1.1	2.3	1.1	1.1	1.2		2.2	1.1	1.1			V
Vaccinium myrtillus				3.3	3.3	+3		+3		3.3	1.2	1.3	+2	1.2		+2	1.2	1.2	1.2		IV
Cerastium lanigeri f. silv.			1.2				1.3	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2			IV
Polygala croatica		+	1.1				+	1.1	+	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1			IV
Thymus balcanus f.	4.4	4.5	3.3				3.3	1.3	1 3	1.3	1.3	2.3	3.2	1.3		1.3	1 3	1.3			IV
Linum capitatum							1.2	+2	1.2	1.2	2.2	1.1	1.2	1.2	2.2	2.2	1.2	1.2	1.1		IV
Euphorbia amygdaloides	1.1	1.1	1.1	1.1		1.1		2.1		1.1		1.1				2.1		1.1		1·1	IV
Scabiosa portae	2.1	1.2	1.1				+			+	1.1		+	1.2	1.2	1.3	1.3				III
Aremonia agrimonioides	1.1	+	+	+	1.1		1.1	2.1	1.1	2.1		1.1									III
Hypericum alpigenum					3.3			1.1	+	1.1		1.1	1.1		1.1				1.1		III
Veronica officinalis							1.2	1.2	1.2	1.2			+2	1.2		1.2		1 2			II
Myosotis silvatica							1.1		1.1	1.1		1.1	1.1		1.1	1.1		1.1			II
Luzula silvatica				1.2	1.1					+2				+2			+2	+2	+2	1.2	II
Anemone nemorosa								+		1.1	1.1	1.1					1.1	1.1	1.3		II
Calamintha alpina									1.2		1.2	1.2		1.2	1.2	1.2	1.2				II
Senecio rupestris							2.2		1.1			1.1	1.2	1.1	1.2						II
Anemone hepatica						1.2	1.2	1.1		2.1									1.2	1.1	II
Viola silvestris	1.1						1.1	1.1				1.1									I
Potentilla crantzii									1.1	1.1	1.1	1.1									I
Pančićia serbica				1.1	2.1					1.1		+									I
Mycelis muralis							1.1		1.1					1.1							I
Geranium silvaticum					1.1										1.1				1.1		I
Ranunculus scutatus															1.1				2.1	1.1	I
Veronica urticifolia				1.1	1.1																I
Rubus saxatilis					2.2		2.1														I
Dryas octopetala																	1.3		+3		I
Galium rotundifolium							1.3						+3								I
Gentiana cruciata			+1		+1																I
Anthemis carpatica																			1.1	1.1	I
Valeriana montana						+2													1.2		I
Geranium robertianum		1.1					1.2														I

Osim toga dolaze u jednom ili dva snimka sledeće vrste (ausserdem kommen in zwei oder einer Aufnahme folgende Arten vor): Trifolium repens (3,5), Ceterach officinarum (4), Nephrodium filix mas (5), Galium silvaticum (7), Epilobium montanum (8), Polygonatum verticillatum (8), Adoxa moschatellina (9) Sedum glaucum (9), Aspidium lobatum (9), Moehringia trinervia (9), Sempervivum patens (9), Pirola secunda (20), Cirsium erisithales (7), Astrantia elatior (8), Convalaria majalis (7), Melampyrum silvaticum (8), Pirola uniflora (6). Geum bulgaricum (20), Origanum vulgare (2), Geum urbanum (3), Aquilegia vulgaris (2), Dentaria bulbifera (2), Ornithogalum sp. (3), Asplenium trichomanes (4), Veronica serpilifolia (5), Pimpinella magna (6), Saxifraga rotundifolia (7), Sanicula europaea (8), Antoxanthum odoratum (15), Globularia cordifolia (16), Galium anisophyllum (18), Gentiana lutea (20), Lilium bosniacum (20), Euphorbia capitulata (20), Gymnadenia conopaea (20), Vaccinium uliginosum (6), Arctostaphylos uva ursi (7) i A. alpina (20).

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V. BLEČIĆ

Rezime

MUNIKOVE ŠUME SEVERNIH PROKLETIJA

(*Pinetum heldreichii bertiscum* B-ić)

Munika *(Pinus heldreichii)* dolazi među najznačajnije endemične vrste Balkanskog Poluostrva i rasprostranjena je u planinama: Hercegovine, Bosne, Crne Gore, Srbije, Albanije, Makedonije, Bugarske, Grčke i Južne Italije. Munika na planinama Balkanskog Poluostrva izgrađuje poseban visinski vegetacijski pojas, koji se nastavlja na pojas bukve i jele ili mestimično na pojas subalpiske bukve. Iako je munika neposredni sused navedenih šuma ona se bitno razlikuje od njih u florističkom sastavu. Munikova šuma ne sadrži niz vrsta koje su redoviti pratioci bukovih šuma, kao što su: *Asperula odorata, Allium ursinum, Prenanthes purpurea, Asarum europaeum, Calamintha grandiflora, Elymus europaeus, Dentaria ennaeaphyllos, Ranunculus lanuginosus, Lonicera nigra* i dr. U dosad proučenoj munikovoj šumi *(Pinetum heldreichii bertiscum)* nisu zapažene: *Oxalis acetosella, Monotropa hypopitis, Corallorhiza trifida, Asyneuma trichocalycinum, Bleichnum spicant* i *Lycopodium* vrste, mada su sve one vrlo česte u smrčevim šumama proučavane oblasti. U ovom delu **Prokletija** na silikatnoj podlozi nalazi se šuma molike *(Pinetum peucis montene-*

grinum). Molikova šuma spada u tip svetlih šuma ali se bitno u florističkom sastavu razlikuje od munikove šume što dolazi od razlike u petrografskom sastavu podloge a pored toga i drukčijeg svetlosnog režima pošto molika zauzima severne ekspozicije. Munikova šuma ne samo da se u florističkom sastavu razlikuje od pomenutih šuma već se i ona sama diferencira u pojedinim masivima Prokletija. Munika na Koprivniku i Sjekirici znatno se razlikuje od onih sa Komova. Ove razlike su upadljive u svim spratovima. U spratu drveća pored munike nalaze se jela, smrča, molika, jela a i bukva je češće zastupljena nego u Komovima. U spratu šiblja nalaze se *Lonicera alpigena, Rhamnus fallax* i *Daphne mezereum*. U prizemnoj flori nalaze se pretstavnici otvorenih staništa ili iz nizinskih šuma, kao što su: *Veronica chamaedrys, Euphorbia cyparissias, Digitalis ambigua, Veronica urticefolia, Ajuga reptans* i *Gentiana asclepiadea*. U šumi munike na Komovima sprat drveća sastavljen je samo od munike. U spratu šiblja dolaze, mada dosta retko, žbunići iz subalpiske zone kao što su: *Sorbus glabrata, Juniperus nana, Sorbus chamaemespilus* i *Cotoneaster integerima*. U prizemnoj flori u munikovoj šumi Komova dolaze: *Helleborus purpurascens, Calamintha alpina, Erythronium dens canis, Homogyne alpina, Crocus* sp., *Veratrum album, Iberis sempervirens* i drugi pretstavnici visokoplaninske vegetacije. Pored ove razlike u florističkom sastavu munikove šume sa Komova i munikove šume Koprivnika i Maja Ljubenić razlikuju se i po visinskom položaju što se vidi iz priložene tabele. Na osnovu iznetih razlika izdvojene su dve subasocijacije i to: *Pinetum heldreichii bertiscum mixtum* i *Pinetum heldreichii bertiscum typicum*.

Naša munikova šuma i šuma munike iz Grčke (Olimp) i iz Albanije razlikuju se kako ekološki tako i u florističkom sastavu. *Pinetum heldreichii bertiscum* sadrži 51% šumskih elemenata dok na Olimpu ovaj procenat iznosi 18%. Iz spiska flore koju daje Markgraf za muniku Albanije broj šumskih pretstavnika iznosi 1%. Razlika u florističkom sastavu između *Pinetum heldreichii* sa Olimpa i *P. heldreichii bertiscum* izneta je u skraćenom obliku na str. 5 i 6. Istaknute razlike u florističkom sastavu ukazuju da su munikove šume u pojedinim oblastima Balkanskog poluostrva vrlo različitog florističkog sastava kao odraza različitog geografskog položaja i ekoloških uslova. Zato smo našu šumu izdvojili u posebnu varijantu geografsku *Pinetum heldreichii bertiscum* koja pripada istoj svezi *Pinion heldreichii* Horv.

GLASNIK BOTANIČKOG ZAVODA I BAŠTE UNIVERZITETA U BEOGRADU
BULLETIN DE L'INSTITUT ET DU JARDIN BOTANIQUES DE L'UNIVERSITÉ DE BEOGRAD
1, 1959, BEOGRAD

RADIVOJE Ž. MARINOVIĆ

ALGEN IN DEN QUELLEN DES FLUSSES GRADAC

(Vorläufige Mitteilung)

Die Algen in den Quellen Serbiens sind bis jetzt nicht studiert worden. Soweit eine Auslese von Arten bekannt ist, sind sie gesammelt und determiniert zusammen mit anderem Material. Unterdessen unter hydrographischen, sowie anderen Bedingungen, kann man in den Gewässern Serbiens überhaupt und nicht nur in Quellen, interessante Erscheinungen erwarten, die bei der Erforschung der Flora höherer Pflanzen festgestellt wurden (Košanin N., 1907).

Die Algen sind gesammelt und bestimmt aus einigen Quellen im Quellgebiet des Gradac (Donji Gradac), der ein Fluss im westlichen Serbien ist und den ersten grösseren Zufluss der Kolubara bildet. Von der Hauptquelle (Bogatićsko Vrelo, Glavno vrelo) bis Valjevo, wo er in die Kolubara mündet, fliesst der Fluss gewunden und bildet eine grössere Zahl Meander. Er fliesst mit einer grösseren Menge Wasser, besonders in trockenen Jahren, als die Jablanica und die Obnica zusammen, zwei Zuflüsse der Kolubara (Jovanović B., 1956). Im Quellgebiete des Flusses befindet sich eine grössere Anzahl von Quellen, von denen einige starke Quellen vorstellen mit einer relativ grossen Wassermenge.

Die Algen sind losgerissen von Moosen, Felswandteilen und anderen Gegenständen, die im Wasser liegen. Dem Planktonnetz sind Algen angesammelt, sofern sie sich unmittelbar im Wasser befanden. Bestimmte Algen sind nicht grupiert auf Krenobionten, Krenophilen und Krenoxenen (Naumann E., 1931). Gegeben ist nur eine systematische Übersicht festgestellter Algen in verschiedenen Quellarten und der qualitative Unterschied, der sich hier zeigt, als Folge der verschiedenen ökologischen Bedingungen in einzelnen Typen der Quelle. Beim Sammeln der Algen meldeten sich Schwierigkeiten im Erkennen, ob sie Quellformen oder Bachformen angehören. Das Ende der Quelle und der Beginn des Baches, die genaue Begrenzung dieser Biotopen, war oft nicht durchführbar.

Das Erdreich in der Nähe der Hauptquelle, ist infolge des ständigen Herumspritzens des Quellwassers, was durch das Anschlagen an die Felswände geschiet, die aus dem Wasser ragen, feucht. Wassertropfen, die gleichmässig und ununterbrochen fallen, rufen seine Befeuchtung und das Eindringen des Wassers in die Erde hervor. Bei hohem Wasserstand der Quelle, ergiesst sich das Wasser aus ihr und befeuchtet das sie umgebende Erdreich. Dieser Zustand dauert nicht lange, die ausgegossene Masse des Wassers ist nicht gross und erfasst keine grossen Flächen.

In dieser Arbeit sind Beiträge von Algenarten gegeben, festgestellt seit dem 23—25 April und seit dem 12—15 Mai 1958 in einigen Quellen des Gradac.

Das angesammelte Material ist im botanischen Institut der Universität Beograd studiert worden.

CHARAKTERISTIK DER ERFORSCHTEN QUELLEN

Die längste Zeit wurden die Algen aus der Hauptquelle (Bogatićsko Vrelo, Glavno Vrelo) gesammelt, die sich unterhalb des Hügelchen Tičjak befindet. Die Hauptquelle, im Sinne Steinmanns, stellt eine rheokrene Quelle vor, befindet sich über dem Flussbett, auf einer Seite ist eine Felswand auf ihr eine grössere Anzahl Löcher und Rinnen, aus denen das Wasser bricht. Es tritt unter starkem Druck aus und ist klar und geruchlos. In ihm sind minimale Mengen suspendierter Partikeln, im Grössen gehören sie zum Mikroseston (Naumann E., 1931) und sind hauptsächlich anorganischer Natur. Das Wasser ist nicht sehr kalt, die Temperatur beträgt ungefähr 10° C und zeigt im Verlaufe des Jahres keine grossen Oscillationen. In ihren thermischen Erscheinungen ist ihre Temperatur konstant und soweit Schwankungen derselben vorkommen, sind sie in engen Grenzen.

Die Felswände, über die das Quellwasser fällt, weisen an ihrer Oberfläche flache Vertiefungen, Furchen und andere Unebenheiten auf. Sie sind nicht so widerstandsfähig und können die Erosion der Wasserkraft nicht abwehren. Das Kahlwerden der steinigen Unterlage ist dort bedeutend stärker, wo keine Moosdecke besteht. Die Bedeckung mit Vegetation in Gestalt von Moosen, verhindert das Auswaschen und Wegschwemmen von Felswandteilen. Veränderungen an diesen entstehen auch durch die chemische Wirkung des Quellwassers.

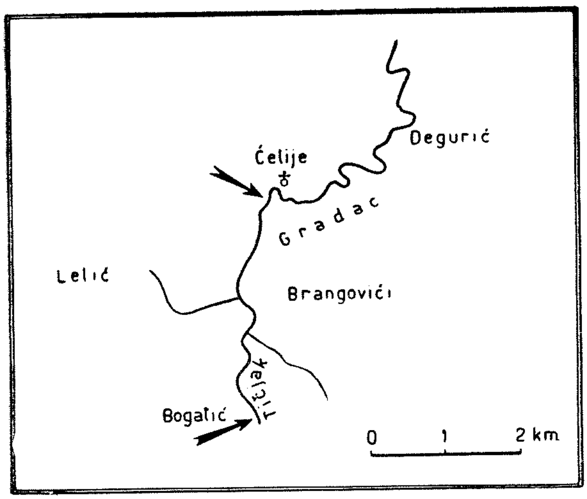

Abb. 3 Gradac. Die mit Pfeilen bezeichneten Orte sind jene, wo sich Quellen befinden, aus denen Algen entnommen wurden

(Orig.)

Unterhalb unweit der Hauptquelle, befindet sich eine Gruppe richtig verteilter Quellen die den Rissen, nahe dem Grunde des Flusstales entspringen. Sie befinden sich auf der linken Seite des Flussbettes und der Ausbruch des Wassers aus ihnen, sowie ihr Abfluss ist bedeutend gleichmässiger und ist nicht so rasch wie das Wasser der Hauptquelle. Ihr Boden ist mit Sand bedeckt und mit Kies und zeigt schon darin ersichtliche Abweichungen von der Hauptquelle.

Nach der Art des Ausbruchs des Wassers aus dem Erdreich und dem Aussehen, limnokrener Quellen (Steinmann 1923) ist die Popovoquelle (Popovo Vrelo) die Naheste. Von der Hauptquelle liegt sie tiefer und ist etwa vier Kilometer entfernt, auf der linken Seite des Gradac. Sie stellt eine

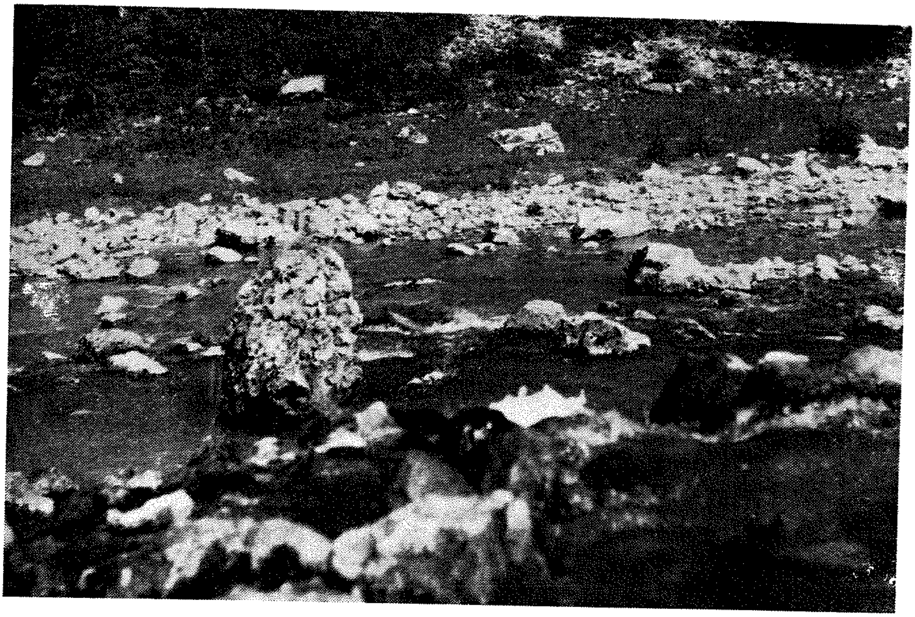

Abb. 1 Eine der Quellen, unweit der Hauptquelle
(Photo R. Marinović)

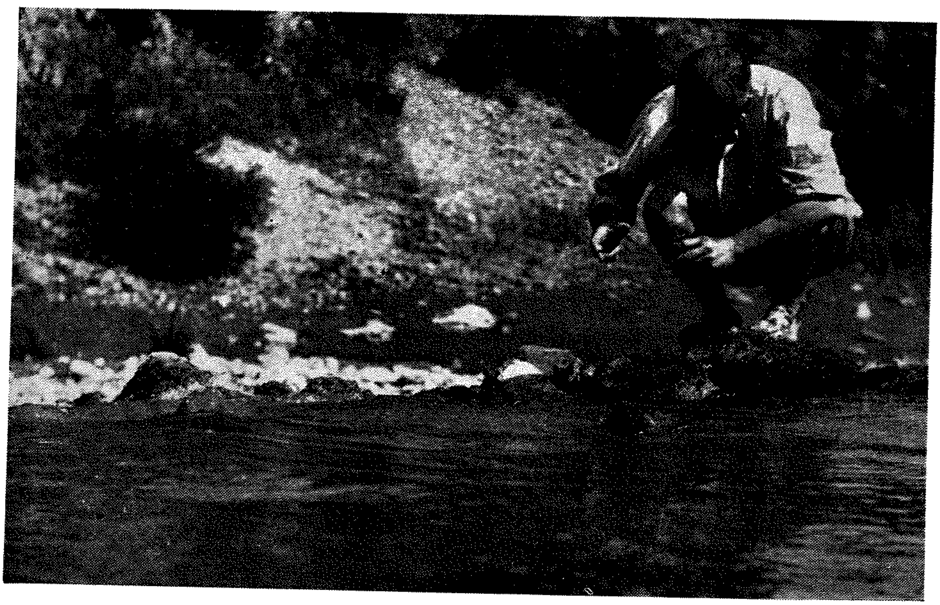

Abb. 2 Die Popovoquelle. Blick auf den westlichen Teil der Quelle
(Photo R. Marinović)

grosse Lache vor, mit einem Durchmesser von drei Metern, trichterförmig ist das Aussehen und der Boden ist mit Sand und Kies bedeckt. Aber auf dem Boden befindet sich auch Schlamm, reich an kleinen arganischen Partikeln und stellen weise schlagen aus der Quelle Teile der Felswand heraus. Die Tiefe der Quelle beträgt ungefähr 0,7 Meter. Zur Zeit gesammelter Algen hatte die Quelle eine niedrigere Temperatur als die anderen Quellen und im Hinblick auf sie, zeigte sich ein Unterschied 1,5—2° C.

Die Wassermenge, die während eines Jahres aus der Quelle bricht, ist veränderlich. Wenn Regen in dem Bezirk fallen, aus dem sie ihr Wasser erhalten, steigt das Wasser, trübt sich aber nicht. Zu trockener Zeit ist ihr Wasser bedeutend verringert. Beim Besuch der Hauptquelle im August des Jahres 1958 floss das Wasser nicht aus allen Löchern und Rissen und viele Vertiefungen in der Felswand zeigten sich leer. Die Moose, die jene Offnungen bedeckten, aus denen kein Wasser rann, boten den Anblick einer dunkelgefärbten Masse. Dieser Zustand ist die Folge der Trockenheit, die in jenem Jahr in den Sommermonaten geherrscht hatte.

ALGEN ERFORSCHTER QUELLEN

In der Hauptsache der Quellenerforschung wurde eine kleine Zahl von Algenarten festgestellt und in floristischer Hinsicht charakterisieren sie sich durch armseligen Formen. Die Quellen waren zur Zeit der Forschung reich an Wasser, aus ihnen trat es in grossen Mengen aus und aus einigen (Hauptquelle) bricht es unter starkem Druck aus und bewegt sich rasch. Infolge des raschen Ausbrechens des Wassers und Erosion seiner Kraft, können sich dorthin schwer höhere Pflanzen erhalten. Obwohl einzelne Moosarten auf den Wänden auf steiniger Unterlage grössere oder kleinere Büschel und stellenweise Decken bilden. Diese Art des Wasserausbruchs wirkt auch auf die Erhaltung der Algen in den Quellen und ihre floristischen Bestände grossenteils als Folge ein.

Die Hauptquelle unterscheidet sich durch den raschen Ausbruch des Wassers, hat eine starke Wassermasse, und ihre Wirkung ist von intensiver Art auf die Natur der Unterlage und ihre lebende Welt. Infolge ihrer starken und langdauernden dynamischen Kraft gelangen die Wasser zum Wechseln ihrer Lagen steinigen Grundes und Erosionen ihrer Oberfläche in bedeutendem Masse. Infolge der Einwirkung des Wassers zeigen sich Risse, Furchen und andere Unebenheiten. Je stärker der Ausbruch des Wassers einer Quelle ist, umso charakteristischer ist seine Pflanzenwelt. Die Wasser, die aus grossen Löchern der Hauptquelle ausbrechen, zerschlagen sich in vielen Wasserstrahlen, die das Niveau des Wassers um 50—60 sm erhöhen. In ihr erlauben solche Bedingungen die Erhaltung jener Formen, die eine besondere Anpassungfähigkeit zeigen und für den fikologischen Bestand eines solchen Biotops stellt die mechanische Kraft des Wassers einen vorbildlichen Faktor vor.

In Quellen, wie die Hauptquelle, finden sich jedoch Stellen, die mit Algen bewachsen sind. In der Hauptquelle finden sich Steinblöcke verschiedener Grösse, auf denen Algen festgestellt sind und zum Teil nehmen sie ihre Unterseiten ein, obzwar diese schwach belichtet sind. Das Licht ist hundertfach und noch mehrfach schwächer als in den höheren Schichten des Wassers und in Hinsicht auf die Stärke der Beleuchtung die Algen näherten sie sich den terrestrischen Formen höherer Erdschichten.

Solche Lokalitäten neben schwacher Beleuchtung charakterisieren sich im Wechsel der Lichtstärke in relativ kurzer Zeit. Das Wasser aus der Hauptquelle fliesst nicht gleichmässig, in kurzen Zeitabschnitten wechselt seine Menge und es zeigt Wellen. Beim Zufluss jeder neuen Wassermenge erhöht sich der Wasserstand und das schwächt den Stand der Lichtstärke am Quellengrund und bei verringerter Menge ist das Niveau niedriger und der Grund der Quelle ist mehr beleuchtet.

In der Hauptquelle die Stellen, wo sich Algen angesiedelt haben, sind mit unbedeutender Oberfläche und sie haben verschiedenes Aussehen: rund, eckig und andersartig, und sind nicht kontinuierlich. Teile der steinigen Unterlage haben durch den Zuwachs der Algen blaugrüne, gelbgrüne oder dunkelgelbe Farbe und unterscheiden sich dadurch von jenen, auf denen sich keine Algen angesiedelt haben. Und obwohl sie nach Grösse der Körper und nach dem Aussehen und der systematischen Zugehörigkeit der Algen sich stark unterscheiden, zeigen sie doch gemeinsame Eigenarten in der Verbindung mit dem Untergrund. Kräftig sind sie mit ihnen verbunden und beim abreissen der Algen löst sich immer ein Teil des Grundes los. Diese Algen sind an Wänden unter dem Wasser angesiedelt, finden sich in der Form des Aufwuchs und sind der unmittelbaren Einwirkung von Luft und Sonne nicht ausgesetzt. Oberhalb von ihnen, bei ausgiebiger Prüfung des Wassers der Quelle, befindet sich ein mehrere Dezimeter dicker Überzug des Wassers.

In unmittelbarer Nähe der Quelle befinden sich auch kleine Blöcke mit Algen. Jedoch werden diese Steingründe leicht feucht, weil kleine Tropfen des Quellwassers beim Aufschlagen an die Wand zerstieben und relativ weit fortspringen. In diesem Fall ist die mechanische Wirksamkeit des Wassers unmittelbar und sie ermöglicht die Befeuchtung jener Algen, die ausserhalb des Wassers angesiedelt sind. Ausserdem befestigen sich die Algen mit ihrer gallertartigen Hülle an ihrer Unterlage, trinken Wasser aus ihr und aus der Luft, sodass es ihnen möglich ist, auch Perioden der Trockenheit zu ertragen, die zur Zeit verringerten Ausströmens aus der Quelle entstehen. Pigmente in der gallertartigen Hülle stellen auch den Schutz vor dem zu starken chemischen Wirken der Sonnenstrahlen auf die Zellen der Algen vor (Ercegović A., 1932). Auf diese Weise erhalten und entfalten sich die Algen, wenn sie auch kurz dauernd der starken Insolation und den Winden, durch ihre Unterlage, ausserhalb des Wassers, ausgesetzt sind.

Aus dem Material, gesammelt an den Wänden unter dem Wasser der Hauptquelle wurden festgestellt: *Chroococcus turgidus, Gloeocapsa rupestris, Gloeothece rupestris, Scytonema rivulare, Sc. crispum, Oscillatoria limosa, Cymbella aspera, Gomphonema constrictum, Gyrosigma acuminatum, Navicula cryptocephala, N. radiosa.*

Aus der Hauptquelle ist im Planktonnetz eine kleine Anzahl von Algenarten angesammelt und das Quellwasser ist ärmer für sie als für jene an den Wänden unter dem Wasser auf steiniger Unterlage. Die Zahl der Arten ist ungefähr um 50% geringer als jener an den Wänden. Wie die Mehrheit dieser Algen im Material festgestellt wurde, das an jene der Algen unter Wasser auf steiniger Unterlage angesammelt wurde, lässt sich vorstellen, dass sie von dort ins Wasser gelangen. Es zeigt sich auch eine quantitative Verschiedenheit. Algen, dem Planktonnetz angesammelt, sind in relativ kleiner Anzahl von Individuen und man trifft sie nicht so oft, wie bei den, den Wänden entnommenen Proben.

Beim Sammeln der Algen des Planktonnetzes steht die Öffnung des Netzes unmittelbar auf dem Loch oder Riss, von wo das Wasser rann und das so gesammelte Material wurde in Flaschen mit Fixativ gefüllt. Der Geschwindigkeit des Wassers wegen, war es genügend, das Netz über der Öffnung des Loches oder des Risses zu halten u. zw. in der kurzen Zeit, in der 1000 Liter Wasser durchrinnen. Beim mikroskopieren wurde vollendet, was möglich war bei der Untersuchung des gesammelten Materials und bestimmt wurden auch Pflanzenformen, die sich darin nur sehr selten zeigten. Manche Algen wurden nicht konserviert bestimmt, es wurden aber dafür, soweit als möglich lebende Formen verwendet. Unter der Einwirkung des Formalins, wie es als Konservierungsmittel gebraucht wird, veränderten manche Algen die Farbe und in bedeutendem Masse ihr Aussehen.

In dem, unmittelbar aus dem Wasser der Hauptquelle gesammelten Material wurden festgestellt: *Chroococcus* sp., *Scytonema crispum, Merismopedia punctata, Oscillatoria tenuis, Cymbella microcephala, Gomphonema constrictum.*

Zwischen Algen und höheren Pflanzen bestehen verschiedene Beziehungen untereinander und höhere Pflanzenarten sind oft von bestimmendem Einfluss auf die Entwicklung und das Bestehen vieler Algenarten (Košanin N., 1907). In der Hauptquelle gibt es nicht viele Arten höherer Pflanzen, nur Moos ist vorhanden, aber ihm ist es unter besonderen Bedingungen gestattet, in einem solchen Biotop, wie es jene Quelle ist. In der Quelle wurde an den Stellen, wo sich Moose angesiedelt haben festgestellt, dass sich dort eine bedeutend grössere Anzahl von Algen befindet, als an den Wänden unterhalb des Wassers, auf steinigen Unterlagen und im Wasser selbst. Nach Zahl der Arten und besonders nach Zahl von Individuen hebt sich Cymbella hervor und diese, obzwar auch an anderen Stellen angesiedelt (im Wasser und an Wänden unter Wasser auf steiniger Unterlage), ist sie hier viel häufiger. Unter höheren Pflanzen und Algen als angesiedelte Mitglieder in einem Biotop, können auch solche Beziehungen bestehen, die für sie von besondrem ökologischen Wert sind (Golubić S., 1957). Golubić S. (1957) in der Arbeit: »Die Algenvegetation an Wasserfällen des Flusses Krka in Dalmatien«, stellte dies für die Algen und Moosen und diese Pflanzen, Moosen und Algen, fest, die sich zusammen auf allen ihren Standorten auf den Wasserfällen befinden, ausser dort, wo besondere ökologische Bedingungen bestehen, und wo nur die Cyanophyta festgestellt wurde. In der Hauptquelle, wo Moose sind, hielten sich immer Algen auf, und bei Prüfung solcher Lokalitäten wurden stets Algen festgestellt. Moose bedecken Teile der Wände, die sich im Wasser der Hauptquelle befinden in Form von Büscheln oder auf vielen Orten in Hinsicht gleichartiger Bedeckung. Die Zahl der Moosarten ist gering, sie erscheinen in kleiner Zahl, aber es zeigt eine grosse Anzahl von Individuen. Sie haben einen grösseren Teil dieser Quelle angesiedelt, auf Steinblöcken haben sie eine dicke Decke geschaffen und damit schufen sie besondere Daseinsbedingungen für die Ansiedlung anderer Pflanzen in einem solchen Biotop.

Algen festgestellt auf Standorten, die mit Moosen bewachsen sind, können dennoch nicht als Formen angesehen werden, deren Bestehen nur dann möglich ist, wenn sie ein epiphytisches Leben führen. Übrigens finden sich hier am häufigsten, siedeln sich, wenn auch weniger, auf steinigen Unterlagen im Wasser an und auch im Wasser selbst. Algen finden sich auch in akumuliertem Material, das sich zwischen der Moosdecke und der Wand befindet. Dieses Material stellt eine dünne Schichte vor, ist von dunkler Farbe und blieb hauptsächlich im Zerfall abgestorbener Moosteile. Auf Felswänden, die sich am

Rande der Quelle befinden, ist die Akumulisation dieser Masse grösser, als in der Mitte des Wassers.

Im gesammelten Material an Stellen, die von Moosen bewachsen sind, wurden folgende Algen festgestellt: *Chroococcus turgidus, Gloeocapsa aeruginosa, Gloeothece rupestris, G. palea, Lyngbya aerugineo-coerulea, Oscillatoria tenuis, O. limosa, Phormidium sp, Cymbella microcephala, C. prostata, C. aspera, Fragilaria sp, Gomphonema constrictum, Cocconeis pediculus, C. placentula, Synedra ulna, Navicula pupula, N. criptocephala, N. menisculus.*

Von den Algen der Hauptquelle, sind charakteristisch die Mikrophyten und hauptsächlich die Protophyten (S c h u s s i n g 1953) aber unter ihnen besteht keine grosse Zahl von Arten noch zeigt sich unter ihnen eine grosse Zahl von Individuen.

Die Gruppe jener Quellen, die tiefer und unweit der Hauptquelle sich befinden, ist von anderem fikologischem Bestand. In ihnen sind makroskopische fadenartige Algen und diese bilden sowohl im Wasser, wie auf dessen Oberfläche ein Geflecht von Fäden in der Dicke von 6—8 sm. Es gibt sterile Fäden, ihre Arten sind nicht bestimmt, aber auch in diesem Stadium konnte man auf mehrere Arten schliessen. Die dicke Fädenmasse, sichtbar auf der Oberfläche des Wassers hindert in bedeutendem Masse das Eindringen des Lichtes und die Schichten des Wassers sind darunter schwach beleuchtet. Für diese Quellen ist charakteristisch, zeigt sich in grossen Massen und üppig entwickelt ist Oedogonium das sonst eine Alge klarer Gewässer ist. Es stellt eine der häufigsten makroskopischen Fadenalgen dar und in Bezug auf andere Algen der Quellen zeichnet sie sich durch dichtes Geflecht von Fäden aus und durch die hellgrüne Farbe ihres Körpers. Dieser Zustand wurde beide Male beim Sammeln von Algen festgestellt, im April und Mai 1958 und mehr als 15 Tage bot sich das Aussehen der Vegetation der Quelle dar.

Mikrophyten in diesen Quellen zeigen sich in kleiner Anzahl der Formen, ihr qualitativer Bestand ist ärmlich und vorhanden sind nur einige Arten von Cyanophyta, Bacillariophyceae und Chlorophyta. Algen Mikrophyten sind hier selten und beinahe unterdrückt. Selbst in Bezug auf die Hauptquelle, in der sich sonst wenige Algen befinden, sind diese Quellen bedeutend ärmer. Es ist nicht ausgeschlossen, dass der Folge die schwache Beleuchtung ist, die durch das üppige Wachstum der makroskopischen Fadenalgen auf der Oberfläche des Wassers entstand. P e v a l e k I. (1924) der das Moorgebiet Topuska studierte, fand in den Wässern dieses Gebiet stellenweise keine Algen und er schreibt dies dem Mangel an Licht zu. Jedoch zeigt sich ein Unterschied in der Zahl der Individuen, die hier in grösserer Anzahl vertreten sind und bedeutend häufiger, als in der Hauptquelle. Festgestellt sind *Merismopedia punctata, M. glauca, Oscillatoria tenuis, Synedra ulna, Scenedesmus quadricauda, S. bijugatus.*

Popovo Vrelo in Bezug auf die übrigen Qeullen des Gradac ist bedeutend reicher an Algen und steht an Zahl der Arten an erster Stelle. Das Wasser der Quelle siedelt Algen an, die nicht in der Hauptquelle befindlich sind. Das rasch ausströmende Wasser und seine schnelle Bewegung in der Hauptquelle, wie früher erwähnt wurde, entsprach nicht der Ansiedlung von Algen, die in der Popovoquelle vertreten sind. Andererseits viele Algen, die in der Hauptquelle in einer kleinen Zahl von Individuen vertreten sind, weisen hier eine grosse Zahl von Individuen auf.

Der floristische Bestand des Wassers der Popovoquelle war nicht immer so wie jetzt. Die Ansiedlung von Algen in ihrem Wasser durch mehrere Etappen reichte. Vor einigen Dezenien war sie bedeutend tiefer und das Wasser brach erheblich rascher aus ihr als heute. Veränderungen in ihr ereigneten sich vor nicht langer Zeit, vermutlich vor wenigen Jahrzehnten und sie stellt jetzt eine flache Quelle vor mit schwachem Aufschlag des Wassers. Ihr floristischer Bestand in Bezug auf Algen unterscheidet wenig von jenem der in fliessenden und in stehenden Gewässern besteht.

Die Wasser der Popovoquelle bereichern sich durch grössere Mengen organischer Materie. Von den Bäumen der Umgebung, sowie von andern Pflanzen fallen leicht Zweige und trockene Blätter hinein und im Wasser befinden sich grosse Mengen schwimmender Laubmasse. Die zugesellte Materie hatte einen grossen Einfluss auf das Wasser, unter dessen Einwirkung ihre physische und chemische Natur ausgewechselt wurde und ein solchen Biotop charaktesiert durch bestimmte Arten der Algen. Obzwar der grösste Teil von Pflanzen am Ende der Vegetation in die Quelle gelangte, und eine Veränderung des Wassers verursachte, so konnte dies doch früher geschehen mit einer unbedeutenden Pflanzenmasse. Ist der Wasserstand niedrig und die Wassermenge gering, dann verändern unbedeutende Mengen von Pflanzenmaterial die Natur des Wassers.

Die organische Materie wird auch hinzugefügt, wenn Ausflügler und Einheimische das Wasser der Quelle trinken, mit ihren Gefässen berühren, am Rande der Quelle essen und sie dient auch zur Viehtränke. In allen diesen Fällen gelangt die Materie unter Einwirkung der Mikroorganismen des Wassers, vor allem von Bakterien und abgebaut wurde. Die Bereicherung des Quellwassers mit organischen Supstanzen hat zwar keine bedeutenden Ausmasse angenommen, hat aber sichtlich begonnen.

Die Popovoquelle bewohnen makroskopische Fadenalgen und diese bauen auf dem Überzug und der Oberfläche des Wassers kleine schwimmende Inselchen. Die Wasserkraft verschiebt sie, unter ihrer Einwirkung wechseln sie ihre Plätze, entfernen sich aber selten von der Quelle. Beim seitlichen Zusammenstoss kleiner Inselchen entstehen Fadenmassen von grösserer Oberfläche. Inselchen bilden Cladophora sp, Vaucheria sp, Spirogyra sp, ihre qualitative Zusammenstellung ist nicht verschiedenartig und die Zusammensetzung der bedeckenden Fadenmasse bilden nur eine kleine Anzahl Algenarten. Zur Zeit des Sammelns von Material, Anfang April und Mitte Mai 1958 bildeten die Fadenalgen 3—8 sm dicke Überzüge und diese erhielten relativ lange. Die Oberfläche und die Dicke dieser schwimmenden Masse veränderte sich fast nicht vom 25 April bis zum 15 Mai 1958. Dunkelgrüne und gut verzweigte Fäden der Cladophora stellen die Hauptmasse der schwimmenden Inselchen dar.

Die Mikrophyten in der Popovoquelle befinden sich auf submersischen steinigen Unterlagen, unmittelbar im Wasser und auf makroskopischen Fadenalgen. In der Quelle sind folgende Mikrophyten festgestellt worden *Chroococcus helveticus, Ch. turgidus, Gloeothece rupestris, G. palea, Scytonema crispum, Rivularia sp, Merismopedia punctata, M. glauca, M. elegans, Oscillatoria tenuis, O. limosa, O. chalybea, Diatoma vulgare, Cymbella lanceolata, Cocconeis pediculus, C. placentula, Synedra ulna, S. capitata, Gyrosigma acumintum, Navicula pupula, Cosmarium sp, Closterium sp, Scenedesmus quadricauda, S. obliquus, S. costatus, S. bijugatus, Pediastrum simplex, P. duplex, P. boryanum, P. tetras.*

ZUSAMMENFASSUNG

In den Quellen des Flusses Gradac wurde eine kleine Anzahl von Algenarten festgestellt. Anderseits wurde bei dem Vergleichen der Funde in verschiedenen Quellen erkannt, das zwischen ihnen bedeutende Unterschiede bestehen. Die qualitative Erforschung der Algen bei der Prüfung der Quellen zeigte, dass sie sich sowohl im Hinsicht der erhaltenen Algenarten wie in ihrer Gesammtzahl unterscheiden. In der Hauptquelle befinden sich Mikrophyten und zwar hauptsächlich Protophyten und sie besiedeln submersische steinere Unterlagen, das Wasser selbst und Stellen, die mit Moos bewachsen sind. Die grösste Zahl ist festgestellt in der Gemeinschaft der Moose, besonders dort, wo Moose steinere Unterlagen bedecken in Gestalt dichter Büschel oder gleichartiger Decken. Der Aufenthalt der Algen in solchen Ansiedlungen kann jedoch, indem er erfolgte, nicht nur als Folge ihrer epiphytischen Lebensweise erachtet werden und wahrscheinlich ist die Zahl jener Algen, die sich in solchen Biotopen, gemeinsam mit Moosen, aufhalten nicht klein. Nach Zahl der Arten die Mikrophyten, angesiedelt auf submersischen steinigen Unterlagen und unmittelbar im Wasser, bleiben sie aus bei jenen, die gemeinsam mit Mossen sind.

Die Gruppe der Quellen, die niedriger und unweit der Hauptquelle sich befinden, ist anders in ihrer floristischen Zusammenstellung. In den oberen Schichten des Wassers und auf ihrer Oberfläche bilden makroskopische Algen dichtgeflochtene Massen von Fäden, von 6—8 sm Dicke. Die Mikrophyten sind in diesen Quellen von kleiner Anzahl, ihre qualitative Zusammensetzung ist dürftig und vorgestellt ist sie in einigen Arten blaugrüner, grüner und Kieselalgen. Algen Mikrophyten sind hier selten und beinahe unterdrückt.

Die reichste Quelle an Algen ist die Popovoquelle. In oberen Schichten des Wassers und auf ihrer Oberfläche bilden makroskopische Fadenalgen kleine schwimmende Inselchen. Die Wasserkraft verschiebt sie langsam, unter ihrer Einwirkung wechseln sie ihre Plätze, entfernen sich aber selten vom der Quelle. Die Mikrophyten in dieser Quelle sind auf submersischen steinigen Unterlagen angesiedelt, unmittelbar im Wasser und makroskopischen Fadenalgen.

Für den floristischen Bestand der Popovoquelle ist die vergrösserte Menge organischer Materie von grosser Bedeutung. Von den Bäumen der Umgebung und anderen Pflanzen gelangen leicht Zweige und fallendes Laub ins Wasser und in der Quelle befindet sich eine grosse schwimmende Laubmasse. Diese Materien hatten einen grossen Einfluss auf das Wasser, ausgewechselt ihre physische und chemische Natur, und ein solcher Biotop charakterisiert eine bestimmte Anzahl von Algenarten. Obzwar der grösste Teil von Pflanzenteilen in die Quelle am Ende der Vegetationsperiode gelangt, kann dies aber auch viel früher geschehen und durch unbedeutende Mengen derselben. Wenn der Wasserstand der Quelle niedrig, und ihre Wassermenge verringert ist, verändern selbst unbedeutende Mengen von Pflanzenteilen die Natur des Wassers.

Organische Materien erreichen auch auf diese Weise ins Wasser, wenn es von Ausflüglern und Einheimischen getrunken und mit ihrer Gefässen berührt wird, wenn sie an seinem Rand essen und wenn es als Viehtränke dient. Die in allen diesen Fällen gelangte Materien faulen sich unter Einwirkung von Mikroorganismen, vor allem von Bakterien. Die Bereicherung des Quellwassers durch organische Substanzen, wenn sie auch keinen grossen Umfang erreicht, hat dennoch begonnen.

Der Unterschied in Hinsicht auf die erhaltenen Algen in erforschten Quellen, zeigt sich als Folge ökologischer Bedingungen in einigen typischen Einzelarten der Quellen. Jedenfalls wäre es von grossem Interesse, die ökologischen Faktoren zu erforschen, unter denen sich Algen in Quellen entwickeln. Unterdessen verlangt eine solche Forschung nicht nur Kenntnis vieler ökologischer Faktoren des Standortes neben vielen Experimenten an dem selben und eventuelle Übertragung dieser Arbeit vom Terrain ins Laboratorium, sondern auch den Überblick und das Vergleichen des fikologischen Materials, gesammelt im Verlauf der ganzen Vegetationsperiode, beginnend bei der Schneeschmelze im Vorfrühling bis zum neuen Schneefall im Winter, wie auch die Übersicht und das Vergleichen der Algen aus viel mehr Quellen, als sich im Quellgebiet des Gradac befinden.

Tabulare Übersicht der in erforschten Quellen festgestellten Algen

Das Zeichen (+) plus zeigt an, dass die Alge festgestellt und das Zeichen (—) minus dass sie nicht in der erforschten Quelle festgestellt wurde

Art der Algen	Hauptquelle	Quellengruppe der Nähe der Hauptquelle	Popovoquelle
Cyanophyta			
Chroococcus			
helveticus Näg.	—	—	+
„ *turgidus* (Kütz) Näg.	+	—	+
„ *sp*	+	—	+
Gloeocapsa			
rupestris Kütz.	+	—	—
„ *aeruginosa* (Carm.) Kütz.	+	—	—
Gloeothece			
rupestris (Lyngb.) Born.	+	—	+
„ *palea* (Kütz.) Rabh.	+	—	+
Merismopedia			
punctata Meyen	+	+	+
„ *glauca* (Ehr.) Näg.	—	+	+
„ *elegans* A. Br.	—	—	+
Rivularia			
sp	—	—	+
Scytonema			
crispum (Ag.) Born.	+	—	+
„ *rivulare* Borzi	+	—	—
Oscillatoria			
limosa Ag.	+	—	+
„ *tenuis* Ag.	+	+	+
„ *chalybea* Mertens	—	—	+

Art der Algen	Hauptquelle	Quellengruppe der Nähe der Hauptquelle	Popovoquelle
Phormidium			
sp	+	—	—
Lyngbya			
aerugineo-coerulea (Kütz.) Gom.	+	—	—
Chrysophyta			
Heterocontae			
Tribonema			
sp	—	+	+
Vaucheria			
sp	—	+	+
Bacillariophyceae			
Diatoma			
vulgare Bory	—	—	+
Fragilaria			
sp	+	—	—
Synedra			
ulna (Nit'zsch) Ehr.	+	+	+
„ *capitata* Ehr.	—	—	+
Cocconeis			
pediculus Ehr.	+	—	+
„ *placentula* Ehr.	+	—	+
Gyrosigma			
acuminatum (Kütz.) Rabh.	+	—	+
Navicula			
pupula Kütz.	+	—	+
„ *cryptocephala* Kütz.	+	—	—
„ *radiosa* Kütz.	+	—	—
„ *menisculus* Schumann	+	—	—
„ *sp*	+	—	—
Cymbella			
microcephala Grun	+	—	—
„ *prostata* (Berk.) Cleve	+	—	—
„ *lanceolata* (Ehr.) v. Heurck	—	—	+
„ *aspera* (Ehr.) Cleve	+	—	—
Gomphonema			
constrictum Ehr.	+	—	—
Chlorophyta			
Pediastrum			
simplex (Meyen) Lemm.	—	—	+
„ *duplex* Meyen	—	—	+
„ *boryanum* (Turpin) Meneghini	—	—	+
„ *tetras* (Ehr.) Ralfs	—	—	+

Art der Algen	Hauptquelle	Quellengruppe der Nähe der Hauptquele	Popovoquelle
Scenedesmus			
obliquus (Turpin) Kütz.	—	—	+
„ *costatus* Schmidle	—	—	+
„ *quadricauda* (Turpin) Bréb.	—	+	+
„ *bijugatus* (Turpin) Kütz.	—	+	+
Oedogonium sp	—	+	—
Cladophora sp	—	+	+
Closterium sp	—	—	+
Cosmarium sp	—	—	+
Spirogyra sp	—	—	+

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RADIVOJE Ž. MARINOVIĆ

Rezime

ALGE U IZVORIMA REKE GRADCA

Alge su prikupljane i određivane iz nekoliko izvora u izvorišnom delu Gradca koji je reka zapadne Srbije i prva veća pritoka Kolubare. U izvorišnom delu ove reke nalazi se veći broj izvora od kojih izvesni pretstavljaju jaka vrela sa relativno velikom količinom vode.

Glavni izvor reke Gradca koji u smislu Steinmann-a pretstavlja neokreni izvor, nad rečnim je koritom, sa strane je stena i na njima nalazi se veći broj grotla i pukotina odakle izbija voda. Voda izlazi pod pritiskom uz jak žubor, bistra je, bez mirisa, temperatura iznosi oko 10° C i preko godine ukoliko postoji kolebljivost iste u uzanim je granicama.

Glavni izvor odlikuje se naglim izbijanjem vode, iz njega ističe velika količina vodene mase i njeno dejstvo veoma je intenzivno na prirodu podloge i njegov živi svet. Usled jake i dugotrajne mehaničke snage vode dolazi do menjanja položaja stenovitih podloga kao i erozije njihovih površina u znatnoj meri. Voda što izbija iz širokih grotla pri udaru o stene razbija se u niz mlazeva koji nadvisuju nivo izvora za 50—60 santimetara. Takvi uslovi dopuštaju opstanak oblicima koji pokazuju osobitu prilagođenost i za fikološki sastav jednog takvog biotopa mehanička snaga vode pretstavlja jedan od primarnih faktora.

Vode glavnog izvora karakterišu mikrofite i one naseljavaju submerzne stenovite podloge, samu vodu i mesta obrasla mahovinama. Najveći broj konstatovan je u zajednicama sa mahovinama, naročito tamo gde mahovine pokrivaju stenovite podloge u obliku gustih busenova ili jednostavnih pokrivača. Održavanje alga na takvim staništima ipak ne bi se moglo smatrati da je usledilo samo zbog njihovog epifitskog načina života i verovatno nije mali broj onih koje se u takvim biotopima održavaju što su zajedno sa mahovinama. Po broju vrsta mikrofite nastanjene na submerznim stenovitim podlogama i neposredno u vodi izostaju od onih što su zajedno sa mahovinama.

Nizvodno, nedaleko od glavnog izvora, nalazi se grupa pravilno raspoređenih izvora koji izbijaju iz pukotina bliže dnu rečne doline. Nalaze se sa leve strane rečnog korita i izbijanje vode iz njih kao i njeno oticanje znatno je ravnomernije i ne izbija tako naglo kao iz glavnog izvora. U odnosu na glavni izvor slabiji su i iz njih ističe manja količina vode. Temperatura njihovih voda iznosi koliko i glavnog izvora.

U ovim izvorima nalaze se makroskopske končaste alge i one u gornjim slojevima vode kao i na njenoj površini grade končaste spletove debele 6—8 santimetara. Debela končasta masa obrazovana na površini vode sprečava u znatnoj meri prodiranje svetlosti i slojevi vode ispod nje slabo su osvetljeni. Mikrofite u ovim izvorima javljaju se u malom broju oblika, njihov kvalitativni sastav oskudan je i pretstavljene su sa po nekoliko vrsta modrozelenih, silikatnih i zelenih alga.

Nizvodno od glavnog izvora, na udaljenju oko četiri kilometara od njega i sa leve strane Gradca nalazi se izvor Popovo vrelo. Ono pretstavlja veliku lokvu levkastog oblika, sa prečnikom oko tri metra i duboku do 0,7 metra. Dno je pokriveno peskom i šljunkom, ali se nalazi i mulj bogat sitnim organskim partikulama. Iz izvora mestimično izbijaju delovi stena koji nadvisuju vodeni

nivo za nekoliko desimetara i u doba visokog vodostaja. U vreme prikupljanja alga temperatura vode bila je niža nego u ostalim izvorima i javljala se razlika za 1,5—2° C.

Od ispitivanih izvora Popovo vrelo algama je najbogatije i po broju vrsta dolazi na prvo mesto. U gornjim slojevima vode i na njenoj površini makroskopske končaste alge grade mala ploveća ostrvca. Vodena struja lagano ih pomera, pod njenim dejstvom menjaju se njihova mesta, ali se iz izvora retko udaljavaju. Mikrofite u ovom izvoru nastanjene su na submerznim stenovitim podlogama, neposredno u vodi i makroskopskim končastim algama.

Za floristički sastav Popovog vrela od velikog je značaja uvećana količina organskih materija. Sa okolnog drveća i drugih biljaka lako dospevaju grančice i opalo lišće i u izvoru nalazi se velika količina flotirajuće lisne mase. Ove materije imale su veliki uticaj na vodu, pod njihovim dejstvom izmenjena je njena fizička i hemijska priroda i jedan takav biotop karakteriše se određenim vrstama alga. Iako najveća količina biljnih delova dospeva u vrelo krajem vegetacione periode što izaziva promenu njegove vode, ipak se to može desiti znatno ranije i sa neznatnom količinom prispelih biljnih delova. Kad je nizak vodostaj izvora, u njemu je umanjena količina vode pa tada neznatne količine prispelih biljnih delova brzo menjaju prirodu njegove vode.

Organske materije dospevaju i na taj način što izletnici i meštani piju vode sa izvora, iz njega je zahvataju sudovima, kraj izvora jedu, a služi i kao pojilo za stoku. U svima ovim slučajevima dospele materije pod dejstvom raznih vodenih mikroorganizama, u prvom redu bakterija, razlažu se. Obogaćivanje izvorske vode organskim supstancama, iako nije uzelo velike razmere, ipak u izvesnoj meri počelo je.

Floristički sastav voda Popovog vrela nije bio uvek ovakav kakav je sad. Naseljavanje njegovih voda algama prolazilo je kroz više etapa. Pre nekoliko decenija bilo je znatno dublje i iz njega isticala je voda znatno brže nego danas. Promene na njemu desile se ne tako davno, verovatno pre nekoliko desetina godina, i ono sad pretstavlja plitak izvor sa relativno sporim oticanjem vode. Njegov floristički sastav u pogledu alga malo se razlikuje od onoga što postoji u sporo tekućim i stajaćim vodama.

Razlika u pogledu sadržanih vrsta alga u ispitivanim izvorima javlja se kao posledica ekoloških uslova u pojedinim tipovima izvora. Svakako bilo bi od velikog interesa izučavanje ekoloških faktora pod kojima se alge razvijaju u izvorima. Međutim takva istraživanja zahtevaju ne samo upoznavanje niza ekoloških faktora staništa, postavljenje niza eksperimenata na samom staništu i eventualno prenošenje ovog rada sa terena u laboratoriju, već isto tako pregled i upoređivanje fikološkog materijala prikupljenog u toku cele vegetacione periode počev od topljenja snega u rano proleće pa do ponovog padanja snega u zimu kao i pregled i upoređivanje alga iz mnogo većeg broja izvora no što se nalaze u izvorišnom delu reke Gradca.

GLASNIK BOTANIČKOG ZAVODA I BAŠTE UNIVERZITETA U BEOGRADU
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I, 1959, BEOGRAD

BUDISLAV TATIĆ

SEVERAL NEW SPECIES OF FLORA OF WEST SERBIA

For the last few years I have had a conveniant opportunity to devote myself to the study of Flora and vegetation of the Studena Planina (Mountain) in the neighbourhood of Kraljevo. Studena Planina being only a link in the chain of serpentines in the direction: Bosnia and Hercegovina. Zlatibor — the gorge of Ibar (in the district of which the mentioned mountain is) — Albania, it is clear by itself that both Flora and vegetation of that basic rock are very specific and this has been already pointed out by many authors as: Lämmermayer 1936), Nevole, Maly (1928), Novak (1927), Pavlovic (1951), Pancic (1827) and others.

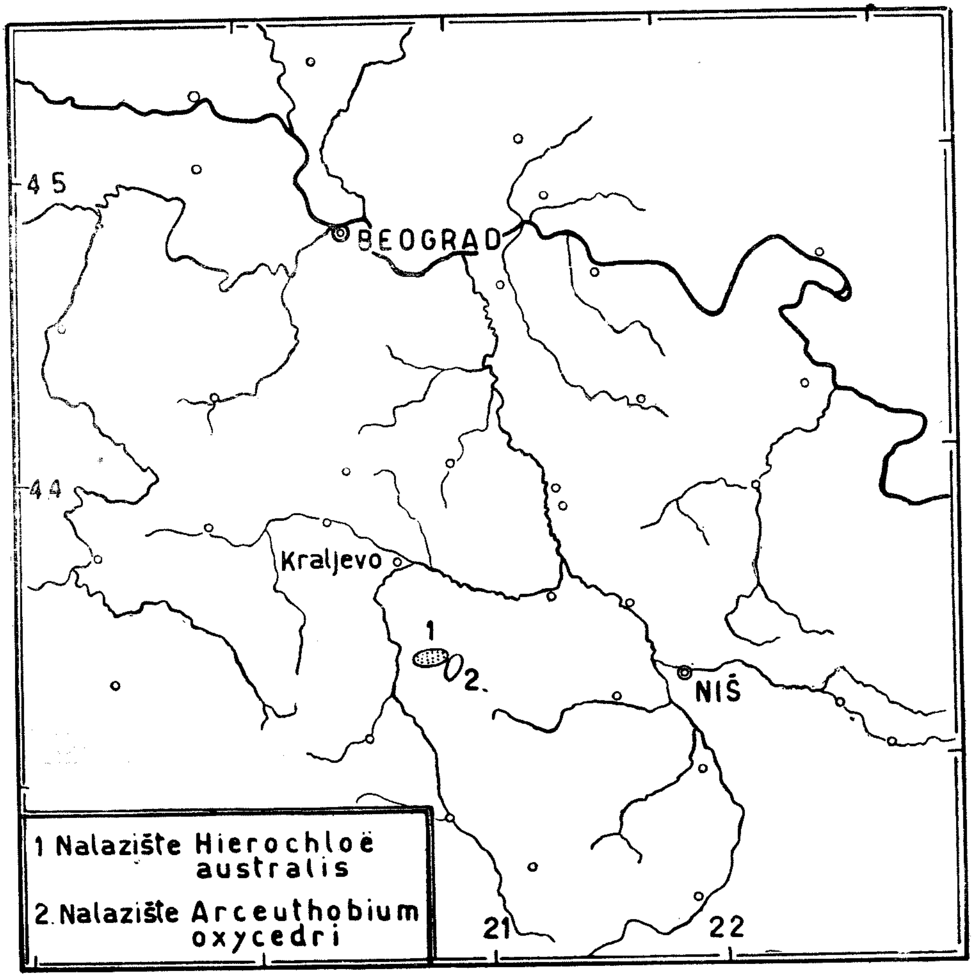
The specificity of Flora of the serpentine substrata could not be overlooked by our experienced botanist Josif Pancic, and so in 1859 in Vienna his paper »Die Flora der Serpentinberge in Mittel Serbien« was published and in that paper were quoted some plants the author considered to be those of the serpentine species. In that paper of his as well as in many others J. P. stated that Flora in the gorge of Ibar was very characteristic and because of its containing a lot of Mediterranean Flora elements, like the Pass of Sicevo, it could be considered enclaves of Mediterranean species. Among a great number of Mediterranean species which can be found on the serpentines of the Pass of Ibar, let us mention but a few: *Juniperus oxycedrus, Colutea arborescens, Quercus pubescens, Quercus conferta, Acer tataricum, Tamus communis, Notholaena marantae* and many others. The same remarks can be seen in others authors as: Adamovic (1909), Pavlovic (1951) and others.

Staying for a while in the mentioned area, I had an opportunity to come across specimens of the species *Juniperus oxycedrus* with the radius of its stem being 20 cm. On stems belonging to this species especially in Popova Reka, a semi-parasite species called Arceuthobium oxycedri, called by the local people »klekova imela« or »klekina imela« is found frequently. Among the great number of works which are referring to Serbia, it is only J. Pancic who quotes the mentioned species *Arceuthobium oxycedri,* and on page 368 of his book »The Flora of Serbia«, he says:»*Arceuthobium oxycedri* is grown upon the red 'fenja' *Juniferus oxycedrus,* over Maglic, about Demeronja, Zimovnik and Borje in Cacak region«. So J. Pancic, to be sure, was of the same opinion as some of his contemporaries when he believed that particular kind of mistletoe as a semi-parasite to grow upon *Juniperus oxycedrus.*

I had also a chance to get familiar with the work of C. von Tubeuf (1919) and to grasp out of it that the species *Arceuthobium oxycedri* is found on a great number of species of gen. *Juniperus,* such as: *oxycedrus, communis.*

rufescens, drupacea, and as the author supposed it to be in his own time: »angeblich auch auf *Sabina*«.

Very much interested in this phenomenon, I made inquires with some of the older but very clever people, about where to find some more dense population of the red »fenja« in order to cheque up whether it was possible to spot mistletoe on the blue »fenja«, too, because it was not an isolated case for them to be found side by side in that region.



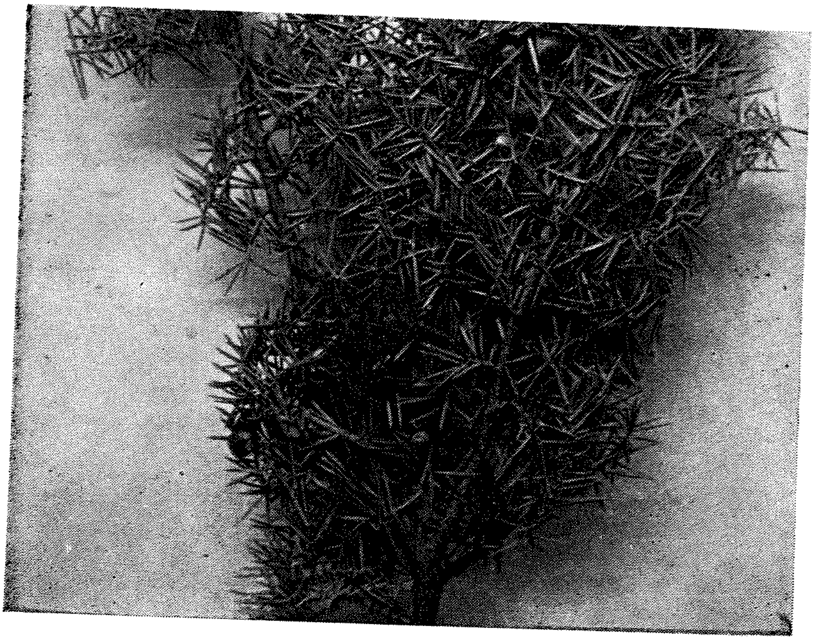
Picture 3. 1. Finding-place of *Hierochloe australis*
2. Finding-place of *Arceuthobium oxycedri*
(Orig.)

And really, in the very neighbourhood of the hamlet Rudnjak I came across a very dense population of the both species of gen. Juniperus. In that region the species of *Juniperus* semi-parasite *Arceuthobium oxycedri* is very frequent on blue *Juniperus communis,* too.

Accordingly, what was found in the Ibar Pass can contribute to what C. von T u b e u f had stated in the mentioned paper of his. It is to be pointed

Picture 1. A twig of red „kleka" *Juniperus oxycedrus* with mistletoe *Arceuthobium oxycedri*

(Photo M. M. Janković)



Picture 2. Mistletoe *Arceuthobium oxycedri* on a twig of blue „kleka" *Juniperus communis*

(Photo M. M. Janković)

out that J. Pancic was the only author who quoted the species *Arceuthobium oxycedri* as found in Serbia and also the fact that he had never stepped on to that area.

Locality of population of the species *Juniperus oxycedri* and *Juniperus communis,* on both of which *Arceuthobium oxycedri* can be found is marked on the map of Serbia as № 2.

Another interesting plant is *Hierochloe australis.* According to Hayek this species is spread in Croatia, Bosnia and Hercegovina and in Bulgaria.

In May 1957, and in the same month of 1958, I found this species in the region of Leskovacka Reka, on the left side, on the slopes of some not very dense oak-woods. The species *Hierochloe australis* in Bosnia and Hercegovina was found by Carl Malý as well as by Germans — W. Krause and W. Ludwig (1956) on the serpentine ground and some of the same vegetation which appeared at Studena Planina.

As this discovery is a novelty for Serbia, we are going to examine in details the habitat and vegetation of that region. The slope is facing the north and northwest. The bending of the terrain is amounting up to 40°. The forest has been cleared, and on an area of 100 x 100 m. there are three older trees *Fagus silvatica* and a few trees *Quercus sessilis.* Bush forms are of considerable frequency conatining: *Fraxinus ornus, Cytisus nigricans, Rubus idaeus, Ostrya carpinifolia, Spiraea ulmifolia, Erica Carnea* and others. Among of which the following species are seen at places: *Festuca heterophylla, Galium aristatum, Vicia cracca, Alyssum Markgrafii, Asplenium trichomanes, Asplenium adulterinum, Asplenium adianhum nigrum, Melica nutans, Galium pedemontanum, Selaginella helvetica, Verbasum nigrum, Luzula silvatica, Campanula persicifolia, Stellaria graminea, Aruncus silvester, Doronicum* sp., *Melica ciliata* and others.

The place where *Hierochloe australis* is to be found is marked as № 1 on our map.

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BUDISLAV TATIČ

Rezime

NEKOLIKO NOVIH VRSTA ZA FLORU ZAPADNE SRBIJE

Zainteresovan problematikom serpentinske flore i vegetacije, bavio sam se nekoliko poslednjih godina ispitivanjima Studene Planine. Ovaj serpentinski masiv u Ibarskoj Kotlini čini kariku u lancu prostiranja serpentina pravcem Bosna — Zlatibor — Ibarska Klisura — Albanija.

I pored toga što je vrlo veliki broj ispitivača radio u oblasti Zapadne Srbije, ipak neke florističke interesantnosti do današnjeg dana nisu bile iznošene.

Pre nekoliko godina čitao sam rad C. von Tubeuf-a (1919) i iz istoga saznao da se poluparazitska vrsta imele *Arceuthobium oxycedri* ne nalazi samo na crvenoj fenji (kleki) kako je svojevremeno tvrdio naš prvi botaničar J. Pančić u svojoj knjizi »Flora Kneževine Srbije«. Ova me je pojava zainteresovala naročito zbog toga što sam znao da se u Ibarskoj Klisuri nalaze obe vrste kleke u zajedničkoj populaciji. U zaseoku Rudnjak naišao sam na populaciju ovih vrsta a na njima je bilo vrlo mnogo imele *Arceuthobium oxycedri*. Istina, ova vrsta imele zastupljena je mahom na crvenoj kleki, ali je znatno česta i na egzemplarima plave kleke *Juniperus communis*.

Foto snimci prikazuju grančice crvene (1) i plave (2) kleke na kojima se vide gomilice imele.

Druga interesantna biljka za oblast Zapadne Srbije koja do sada nije nalažena je *Hierochloe australis*. Po Hayek-u ova je vrsta nalažena u Hrvatskoj, Bosni i Hercegovini i Bugarskoj. Nađena je na padinama proređene hrastove šume na levoj strani Leskovačke Reke, što se vidi iz priložene karte Srbije.

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1, 1959, BEOGRAD

MILORAD M. JANKOVIĆ

A STUDY IN THERMAL CONDITIONS IN SOME PLANT COMMUNITIES OF MOUNTAIN OF PROKLETIJE OF METOHIJA

In 1958 I started intensive phyto-climatic research in some of the Phytocenoses in Prokletije of Metohija, giving a special stress to the analysis of conditions in the forests of »Munica«* (*Pinus heldreichii* Christ.). It is a fact that our forests of »Munica« have been very poorly researched so far, so it is undoubtedly very important that they should be given the utmost attention and in ecological respect, too. The mentioned research was continued in 1959 as well. In this paper only the results of observation carried out within 1958 will be exposed, and only those referring to thermal conditions for the limited space here does not allow the results related to other factors to be exposed as a whole. For this reason moist and light conditions will be dealt with on some other occasion.

In 1958 phyto-climatic observations were carried out in the region called Stavnice (on the map marked as »Bjelopoljski stanovi«), which is situated at the approximate height of 1400 m., upon the Metohija side of Prokletije, overlooking the town of Pec. It is, so to say, a valley running along the brook Susice, between the massive of Koprivnik on one side and the mountain of Ljubenica on the other. The whole of the valley through which the Susica is streaming northward and eastward and in which the ditch of Stavnica (with »Bjelopoljski stanovi«) opens itself to the east, that is, to the plain of Metohija, and high peaks and ridges shut it up at the north, south and west. On the south side the peak Maja Ljubenic is raising itself (2097 m;), on the north the peaks of Koprivnik (2377 and 2460 m), and on the south-west side the valley is closed in a semicircle by a very high ridge (tops 2245 m, 2170 m, etc.), inserting itself between the peaks Maja Ljubenic and Krs Cvrlje (2460). The whole of this region is built mainly in carst, whereas the terrain concerning the mentioned observations is situated exclusively on carst.

With regards to vegetation this region is characterised mainly pineries. On the south-east and south slopes of Koprivnik, which means on the left side of the valley of Susice, there are vast pure »Munica« forests (*Pinetum heldreichii*) to be found, on the northern slopes fir and beech forests, and at places there are »Molika« (*Pinetum peucis*) forests. Close to »Bjelopoljski stanovi«, on the right side of the Susica, the valley gets larger and the terrain has a quite mild slope. On that spot the forest is cleared, round »Bacije«**, so that the valley is turend into a feeding-ground. On the right side of the Susica,

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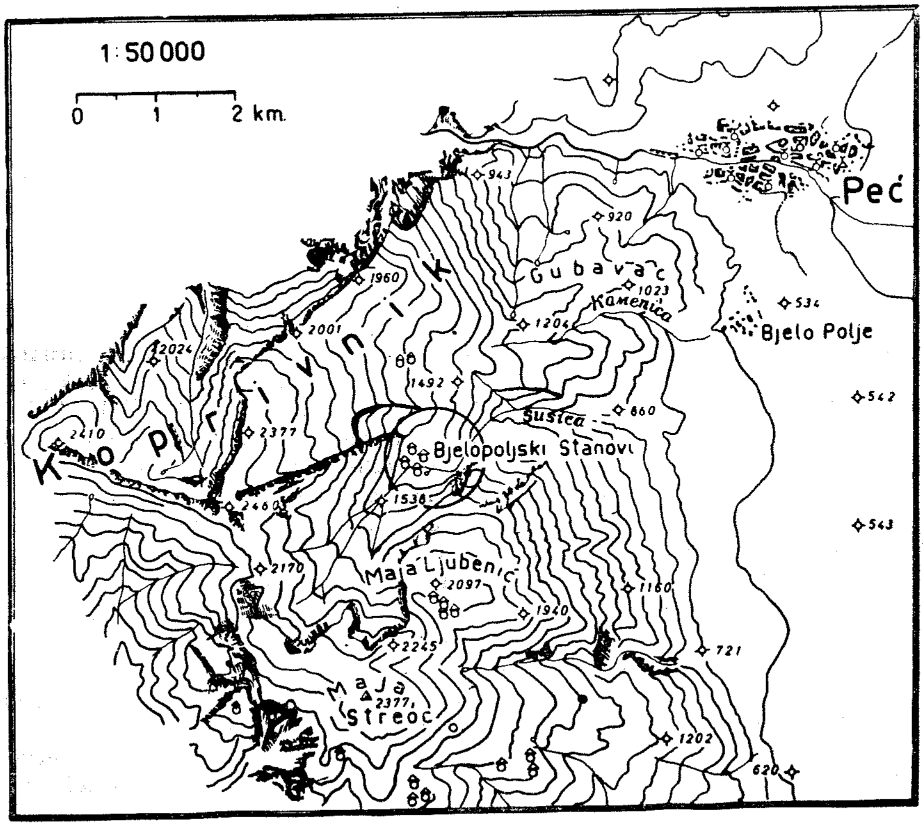
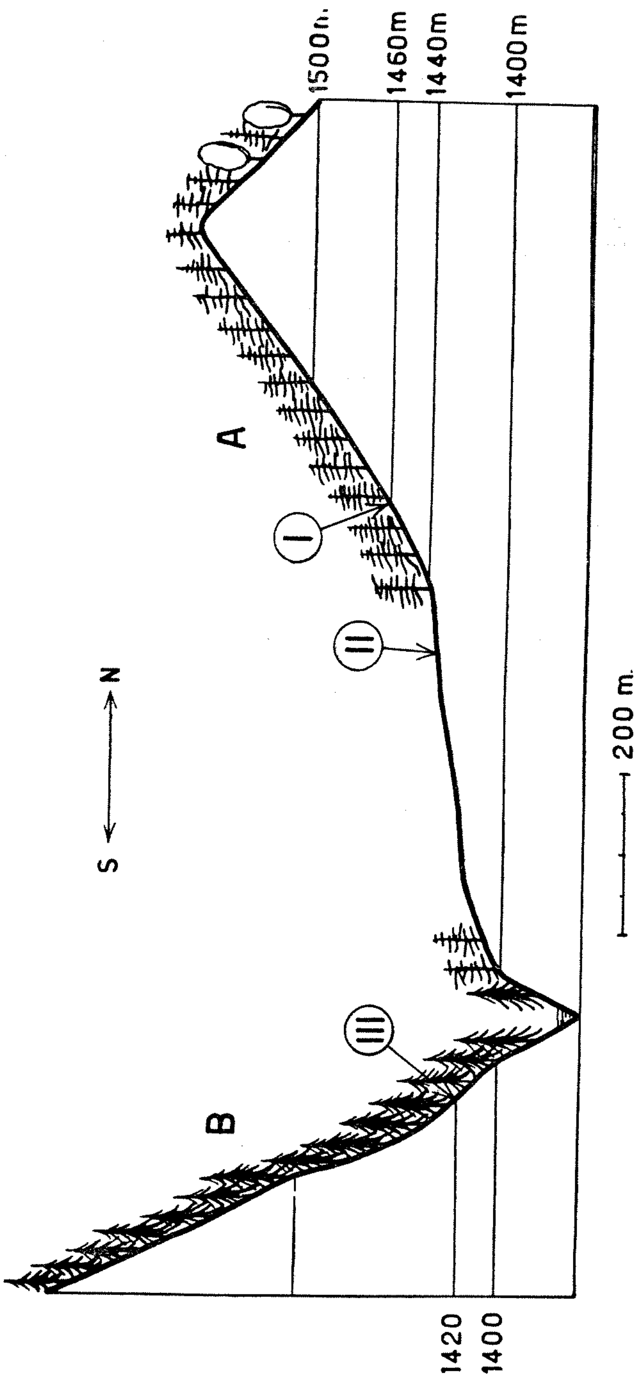
* it is how local people call it and the author of this paper will stick to it.
** Primitive lodgings made of wood, situated on high mountains in which she pherds live during summer season and make their flocks feed about the region.

the sides opening to the mountain of Ljubenica get very steep, at some places they are rocky and nearly quite precipitous. They are overgrown with fir-trees, close to the Susica, and they turn into Picea trees as one goes higher up the mountain. On greater heights as well as on very rocky terrains »Munika« forests are to be found. Thus, those fir and beech woods and *Picea* woods not far from »Bjelopoljski stanovi« are frequent on the north slopes of the mountain of Ljubenica which, as was already stated, closes the valley of Stavnica from southeast side. On the left side of the Susica the valley, at first gradually then suddenly, turns into southeast slopes of Koprivnik, and those slopes close up the valley of Stavnik on the north-west side. On these southeast and south slopes of Koprivnik the pure »Munika« forests are to be seen. It is just here, in the region of »Bjelopoljski stanovi« that microclimatic stations are



Picture 1. — The map of the part of Prokletije above Pec, between Koprivnik and Ljubenicke Planine; close to Bjelopoljski Stanovi (marked with a ring) microclimatic stations I, II and III were set up

set up from which the observations were carried out, three times, in spring (May), in summer (July), in autumn (September). These three microclimatic stations will be in further text, that is in tables, diagrams and other articles marked in Roman numbers, e.g. station I, station II and station III.



Picture 2. — The profile of the terrain at Bjelopoljski Stanovi on which micro-climatic research was carried out; A. Pinetum heldreichii, B. Abieto-Fagetum; I, II and III micro-climatic stations

Station I was set up in »Munika« forest, Station II in the open field (not far from St. I), and Station III in the fir forest on the opposite side of the valley. The position of the stations as well as the general view of the terrain and the range of vegetation are shown on the added profile (pict. 2) and on the added map (pict. 1).

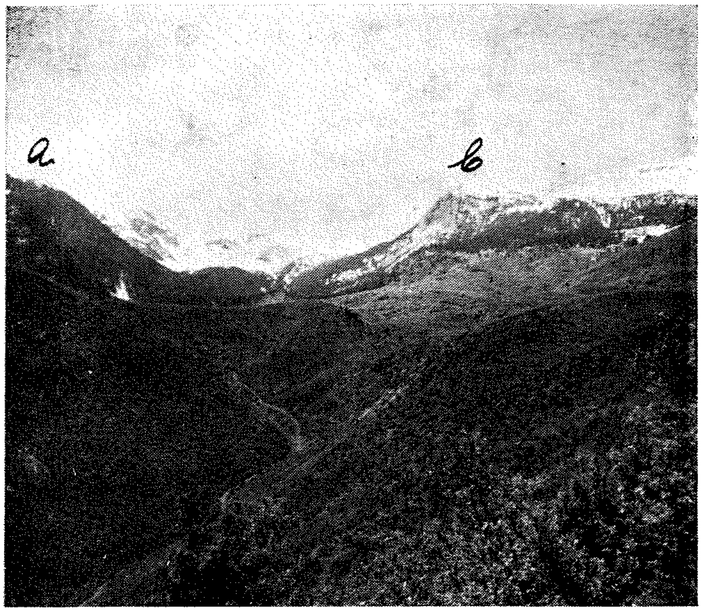
DESCRIPTION OF HABITAT AND VEGETATION ON PLACES AT WHICH MICRO-KLIMATIC STATIONS HAVE BEEN SET UP

Micro-climatic station № I. — Pure »Munika« forest upon carst (*Pinetum heldreichii typicum* M. J a n k.).

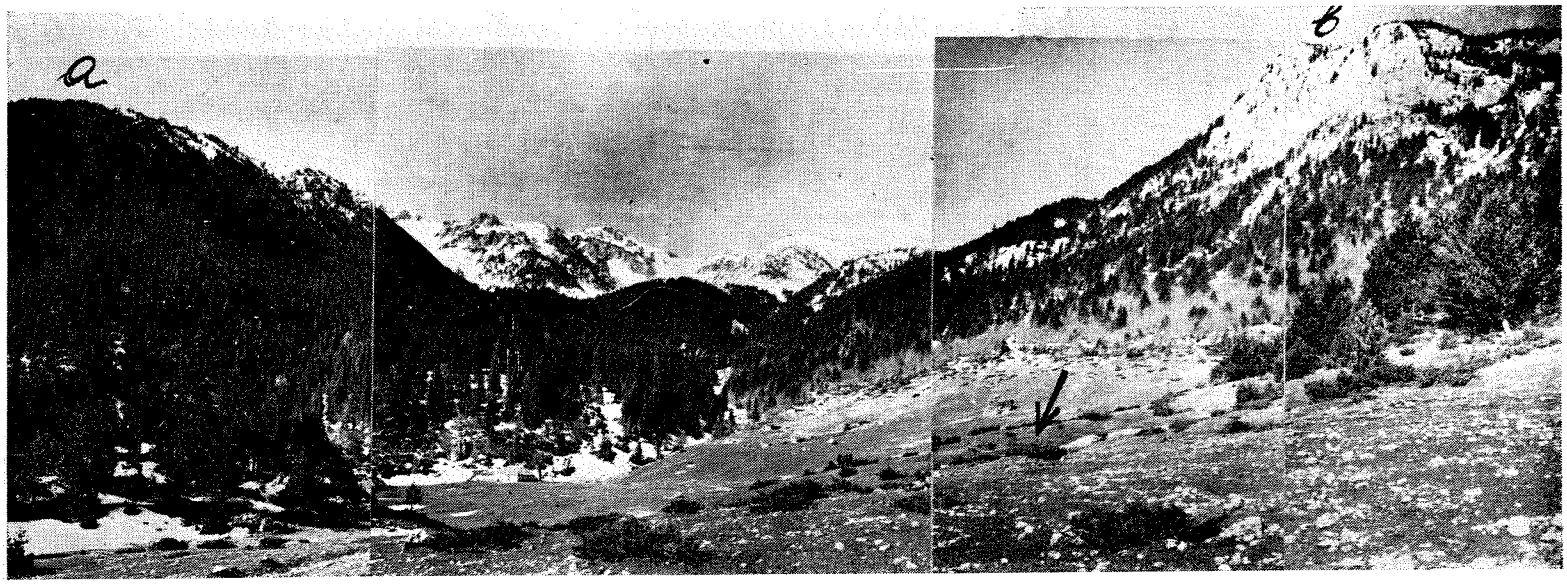
As it has been already said, on southeast and south slopes of Koprivnik, over »Bjelopoljski stanovi«, upon carst pure »Munika« forest is developed, and this being of the kind belonging to the typical association of »Munika« forests of Procletije of Metohija. This range over »Bjelopoljski stanovi« is to be found on south and southeast sides, with a slope of 25—50°, in the area of approximately 1400 up to 1900 m. The edificator of the community is *Pinus heldreichii* which has a dominating role both in the floors of trees and in the floors of bushes. As a rule this range is differentiated into two floors of trees, the higher and the lower one, then into the floor of bushes and finally into the kinf of ground-floor plants. Besides »Munika«, here and there and in a smaller number one can see *Fagus moesiaca, Picea excelsa* and *Abies alba,* and on greater heights even a *Pinus peuce,* too. For the floor of bushes as very characteristic representatives besides »Munika« are *Juniperus intermedia* (on greater heights *y; nana*) and *Rhamnus falax.* In ground-floor plants the most predominant ones and those with a leading role are species from the family *Graminiae* (gen. *Poa, Bromus, Festica, Brachypodium* and others.), and also species of gen. Thymus from the group Serpyllum. Very characteristic are also species *Verbascum nikolai, Primula columnae, Scabiosa columbaria* ssp. *portae, Daphne mezereum, Calamintha alpina* and others. It is very characteristic that upon the branches of »Munika« very frequently *Usnea barbata* is developed in a great mass, whereas upon the stams and branches Lichens are very abundant. The average height of »Munika« in the first floor is 20—25 m., whereas the average thickness of the radius 40—60 cm (some of the stems are up to 1 m. thick, and even more thaan that). The constitution of the first floor is due to very frequent clearings resulting from cutting some of the trees and it varies approximately from 50—70%.

The following phytocoenologic snapshot, taken on the 10 of July, 1958 on the surface of about 5000 m^2 in the »Munika« forest over »Bjelopoljski stanovi« presents very well the general character of this kind of community *Pinetum heldreichii typicum.*
Locality: Procletije, upon the southeast sides of Koprivnik which over »Bjelopoljski stanovi« get down to the Susica.
Exposition: S; height above sea-level 1600 m.; the terrain is bending 40—50°; Dead cover 70%; thickness about 2 cm.
The soil is shallow, stony, with bigger and smaller pieces of rocks which emerge on to the surface of the ground.

Picture 3. — The view from Pec toward Koprivnik (b) and Ljubenicke Planine (a), between them is the valley with Bjelopoljski Stanovi



Picture 4. — The valley with Bjelopoljski Stanovi, between steep ridges of Ljubenicke Planine (a) and Koprivnik (b); close up the hill of Gubavac



Picture 5. — The valley of Susica with Bjelopoljski Stanovi, between the ridges of Ljubenicke Planine (a) and Koprivnik (b); the arrow points out to the place on which the micro-climatic station I was set up

(Photo M. M. Jankovic)

Picture 6. — „Munika" forest (*Pinetum heldreichii*) on the sides of Koprivnik, above Bjelopoljski Stanovi, in which the micro-climatic station II was set up

(Photo M. M. Jankovic)

Picture 7. — Micro-climatic station II, on the open field close to *Pinetum heldreichii* forest near-by Bjelopoljski Stanovi

(Photo M. M. Jankovic)

This is a rather scarce »munika« forest in which the majority of stems are bent and curved dagger-like, probably the influence of snow. Upon the branches *Usnea barbata* is found in a considerable quantity. In the ground-floor the soil is almost quite covered with species of fam. *Gramineae,* as well as with species of gen. *Thymus.*

I Floor (of trees)
Coverage 50%, height 20—22 m.

Pinus heldreichii	4.3
Abies alba	R

II Floor (of trees)
Coverage 40%, height 10—15 m.

Pinus heldreichii	4.4
Fagus moesiaca	+
Abies alba	+

III Floor (of bushes)
Coverage 30%, height up to 3 m.

Pinus heldreichii	3.2
Juniperus nana	3.2
Fagus moesiaca	+
Picea excelsa	+
Rhamnus falax	+

IV Floor (of ground — floor plants)
Coverage 80—90%

Thymus balcanus	4.4
Poa ursina	3.3
Poa pratensis	3.3
Brachypodium pinnatum	3.2
Bromus erectus	2.3
Brachypodium silvyticum?	2.2
Festuca duriuscula	2.2
Thymus pulegioides	2 2
Verbascum nikolai	2.2
Trifolium repens	2.2
Anthoxantum odoratum	2.2
Fragaria vesca	2.1
Calamintha alpina ssp. *eualpina*	2.1
Juniperus nana	2.1
Pinus heldreichii	2.1
Euphorbia cyparissias	2.1
Trifolium ochroleucum	2.1
Rhamnus falax	1.1
Calamintha vulgaris	1.1
Stachys alpina	1.1
Luzula campestris	1.1
Potentila crantzii	1.1
Primula columnae	1.1
Scabiosa columbaria ssp. *portae*	1.1
Polygala comosa	1.1
Daphne mezereum	1.1
Colchicum autumnale	1.1
Vaccinium myrtillus	+.1
Euphorbia amygdaloides	+
Teucrium montanum	+
Carduus cardeulis?	+
Cererach officinarum	+
Asplenium trichomanes	+
Arctostaphylos uva ursi	+
Abies alba	+
Sedum glaucum	+
Orobanche alba	+
Viola sp.	+
Polystichum lobatum	+
Cerastium lanigerum	+
Cerastium moesiascum	+
Digitalis ambigua	+
Campanula persicifolia	+
Rubus idaeus	+
Veronika chamaedrys	+
Galium lucidum	+
Verbascum nigrum	+
Lonicera alpigena	+
Epilobium sp.	+
Daphne oleoides	+
Gentiana cruciata	+
Arabis turrita	+
Helianthemum nummularium ssp. *vulgare*	+

Micro-climatic station № I is situated in this »munika« forest at about 150 m from the edge of the forest (facing the clearing where »Bjelopoljski stanovi« are), at the height of about 1460 m. and at a slope with the exposition S. SO (south, southwest). The slope of the area is about 30°. Quite near the station I only »munika« trees are found in the first dloor, whereas in the floor of bushes one can find some of *Picea excelsa* i.e. *Fagus moesiaca*. In ground-floor plants close to the station following plants are to be found: *Poa ursina, Poa pretensis, Brachypodium pinnatum, Thymus balcanus,* (the quoted species are the most numerous and with the greatest coverage), *Primula columnae, Fragaria vesca, Calamintha vulgaris, Ajuga reptans, Calamintha alpina, Verbascum nikolai, Euphorbia cyparissias, Hypericum* sp., *Viola* sp., *Anemone nemorosa, Polygala comosa, Daphne mezereum, Scabiosa columbaria* ssp. *portae, Mycelis muralis, Rhamnus falax, Trifolium ochroleucum, Lathyrus pratensis. Aremonia agrimonioides, Rumex acetosa, Lonicera alpigena, Veronica chamaedrys* and others.

Micro-climatis station II is situated upon a clearing with low meadow vegetation, outside »munica« forest, at a distance of about 80 m from it. This clearing is on a side with the slope of about 20°, facing the South. As it has been previously told, this clearing was made after »munica« forest had been cut and cleared. Round the very station II, upon a very shallow and stony ground, mainly following plants were growing and they were making a low vegetation cover (approximate height about 10 cm.), which is under a constant influence of cattle feeding there. The plants are as following: *Juniperus nana, Euphorbia cyparissias,* (the most numerous), *Primula veris, Calamintha alpina, Sedum* sp., *Thymus balcanus, Plantago* sp., *Hieracium pilosella,* and others. The height above sea-level is about 1430 m.

Micro-climatic station III is situated on the opposite side of the valley, in a mixed fir-beech forest which, close above the Susica, is spreading up upon the steep north-east slopes which from the peak Maja Ljubenic are running down the sides to »Bjelopoljski stanovi«. The height above sea-level is about 1420 m., exposition is N. NO. and the slope of the terrain is 35—40°. This fir-beech forest belongs to a high upright zone of the community *Fagetum abietetosum* (Horvat).

It is a very important fact to state that beech trees are almost all cut in the first floor, so that the only edificator of the first floor is *Abies alba*. The ground is stony, crisp and smashed, and upon its surface the geological layer is emerging in forms of bigger or smaller stones, even in forms of bigger rocks at places. The general percentage of the surface of the terrain covering the geological layer is about 10%. The dead coverage, 1—2 cm. thick covers the surface for about 60%. The community is made rather thin by cutting at certain places, so that bigger or smaller gapes are to be seen here and there. This phenomenon is certainly of some importance for the micro-climatic conditions in the forest itself. The following phytocenological snapshot taken in the vicinity of the station III on the surface of about 5000 m², will give one a rather clear idea of the character of the fir-beech forest in which the given phyto-climatic research were done (Note: this phytocenological snapshot was taken on the 14-th of May 1958, but it was added the data taken at the same place on the 10-th of July 1958, in connection with changes of vegetation in the course of the year; in this way the snapshot offers a more or less complete picture of the character of the vegetation at that spot upon which tha station III has had its function.

I Floor (of trees)
Coverage 70%, height 20—25 m., thickness of stems 30—60 cm.

Abies alba	4.4
Picea excelsa	+
Fagus moesiaca	R

II Floor (of trees)
Coverage 10%, height up to 6 m.

Fagus moesiaca	2.1

III Floor (of bushes)
Coverage 10%.

Fagus moesiaca	2.1
Abies alba	2.1
Picea excelsa	+

IV Floor (of ground-floor plants)
Coverage 10% (if the total coverage, both in spring and summer, is taken into account, then it is about 20%).

Cardamine bulbifera	3.1
Saxifraga rotundifolia	3.1
Oxalis acetosella	2.2
Euphorbia amygdaloides	2.1
Cardamine eneaphyllos	2.1
Hieracium murorum	2.1
Geranium robertianum	2.1
Mycelis muralis	2.1
Chrysosplenium alternifolium	2.1
Vaccinium myrtillus	1.2
Abies alba	1.1
Veronica officinalis	1.1
Nephrodium filix mas	1.1
Actea spicata	1.1
Mulgedium sonchifolium	+
Lamium luteum	+
Polystichum lobatum	+
Anemone nemorosa	+
Picea excelsa	+
Epilobium montanum	+
Polystichum lonchitis	+
Arabis turrita	+
Asplenium trichomanes	+
Lathyrus pratensis	+
Malampyrum silvaticum	+
Phegopteris robertianum	+
Sambucus racemosa	+
Galium silvatica	+
Luzula forsteri	+
Gentiana asclepiadea	+
Hieracium sp.	+
Campanula persicifolia	+
Urtica dioica	R
Pinus peuce	R

METHODS OF WORK AND TIME OF OBSERVATION

As it has been said already, in the area of »Bjelopoljski stanovi« three micro-climatic stations were operating, one in the pure »munika« forest (I), one in the open field, on a feeding ground close to »munika« forest (II), and filally one in a fir-beech forest on the opposite slope (III). At all the three stations the reading of the given elements was done in the same time, or with a very slight difference in time. In the course of 1958 the stations were set up three times and the observations were done also in installments, in spring (from 12—15 of May), in summer (from the 8—18 of July), and in autumn (from the 6—12 of September). Out of different reasons, the results of all measuring on all of those days cannot be presented here, so some of them had to be left out.

At all micro-climatic stations the following elements were observed: the temperature of the ground, the temperature of air, the moisture of air, the light and the intensity of sun radiation. Owing to the limited space we are able to present only the data and the results referring to the temperature of the ground and air, whereas the other factors will be presented some other time.

The temperature of the ground was taken on each station at a different depth, as on —50 cm, —30 cm, —20 cm, —10 cm, —5 cm, and —2 cm (the

— means that the level of measuring is in the gound, and the mark + means that the level is above the ground, in the air). In that way at each of the stations the temperature was taken at six different underground horizons. The exception is only the measuring in May, when the temperature was not taken at —50 cm. The temperature was taken by the way of special geothermometers. Due to technical inconveniances, the temperature of the surface of the ground was not taken into consideration. To be exact, a mercury thermometer was put on the surface at each station, but I thought that what it said was referring to the layer of the ground air up to +1 cm, because it was under cover, and, on the other hand, the appliance of mercury thermometers for ground surface has a lot of disadvantages.

The temperature of air was taken on different heights above the ground surface, so that it could be recorded its thermal stratification, the way we do it with ground. The air temperature was observed at +1 cm, +10 cm, +50 cm and +100 cm, which means in four different air layers. Standard psihrometrical mercury thermometers were used. Here it is to be particularly pointed out that in all of those observations separate protectors of unique construction were applied the characteristics and basis of which being shown in details in one of my former papers (Janković, M. M. 1959). It is sufficient to say now that each of those protectors consisted of two little planks, both of them having definite dimensions and forms, which were joined by borders to each other in a right angle. Psyhrometrical thermometer was hanging in the protector fixed on the upper plank. The protectors were fixed on a board, on protector on each of the examined levels, and the lowest protector served in the same time as protection both to the thermometer upon +10 cm, and to the thermometer on +1 cm, which was laid on the ground surface. The board with protectors was inserted into the earth and laid in such a way so that the openings of protectors were facing the South. These protectors acted as full protection to the thermometers from direct sun radiation. Accordingly, the values quoted as air temperature in this paper can be considered as real values of air temperature, because the thermometers were not affected by direct sun radiation, the very air temperature being the only factor which could affect the thermometers. At each micro-climatic station one board was placed with the corresponding set of protectors and thermometers.

Besides, on each of the stations one thermohygrograph (product of the firm »Lambrecht« — Göttingen) was placed on the ground surface so that the temperature got in that way — and the temperature was taken by bimetalic semi-ring — refers to ground air strata from +10 to +15 cm. It is self understood that the thermohygrograph itself was protected from direct sun radiation in an appropriate way.

On all of the stations the reading of ground and air temperature were performed several times in the course of a day. The time of reading was aimed to be the same, but due to a number of obstacles, the latter being out of technical reasons, it could not be attained. Thus, only during the July excursion one managed to carry out readings every two hours (at 6, 8, 10, 12, 14; 16, 18 and 20), whereas the readings both in May and September excursions were performed every three hours, (at 7, 10, 13, 16 and 19, e.i. at 6, 9, 12, 15, 18 and 20). This is undoubtedly one of disadvantages of these observations, but surely not of the kind which could prevent us from comparing temperature conditions in different seasons with success. At night the reading could not be performed at all. This is where the work of thermohygrograph was very welcome because owing to the results got by means of that apparatuswe could at least judge of the air temperature at night, though having mainly the air strata of +10 cm to +15 cm as a basis.

THE RESULTS OF OBSERVATIONS PERFORMED IN MAY 1958

As it has already been said, in the spring of 1958 micro-climatic observations were carried out from the 12-th to the 15-th of May. Owing to the high water level in the Susica, which prevented us from carrying across the instruments, the station № III could not be set up in firbeech forest. Due to that fact only stations I and II were in function in May. Besides, here it is possible to present only the diagram of the temperature taken by thermohygrograph at the station I, e.i. from »munika« forest. Also, for presentation in tables and diagrams only the dates the 13-th and the 14-th of May were chosen as the data covering the two days were most complete.

Generally speaking, conditions in the area of »Bjelopoljski stanovi« from the 12-th to the 15-th of May were characterised by melting snow upon the south slopes, which meeans first of all in »munika« forest, and a lingering snow upon the north slopes, the snow being of both considerable quantity and thickness. In the »munika« forest, where station I was placed, in that time of year there was no snow, or very little snow in small heaps, not bigger than a few square metres. But at places, in »munika« forest, the snow covered about 20% of the surface and the heaps were from 12 to 60 cm. thick. On the meadow on which the station II was placed (the clearing outside »munika« forest), there was no snow at all. There were in full bloom *Crocus veluchensis, Scila bifolia, Corydalis solida, Gagea* sp., and then *Ficaria ranunculoides,* and *Anemone ranunculoides.* On the 11-th of May on the meadow *Crocus veluchensis* and *Scila bifolia* were coming into flower and only on the 14-th of May *Crocus veluchensis* was almost blown up, and so was *Scila,* so that *Corydalis, Gagea* and *Ficaria* beginning to blossom in masses take up the leading role on the meadow. By the brook of Susica, at damp places, *Caltha palustris, Chrysosplenium alternifolium* and *Taraxacum officinalis.* In »munika« forest the following plants were in bloom: *Crocus veluchensis, Primula veris* ssp. *officinalis, Scila bifolia, Muscari botryoides, Daphne mezereum, Potentilla micrantha* and *Corydalis solida.* The majority of these plants are growing either at the edge of »munika« forest, or on lighter and clearer places in it. As it was already seen, the spring days in middle May are characterised by a full growth and blooming of a number of ephemere plants upon meadows in »munika« forest. As for the beech and its bursting into leaf, the beech being found in fir-beech forest in the vicinity of Stavnica, some separate trees are to be found in »munika« forest, and on north-west slope, above the meadow forms a rather large shrubbery of logs, it is interesting to say that it was not yet covered with leaves at the beginning of our excursion, only some of the trees had produced a few leaves. Anyway, the leaf-buds were in the state which precedes the opening of leaves. On the 14-th of May, which means three days after, the beech was all covered with leaves. Obviously, the days (middle

May) can be considered as the moment of full burst into leaf for the beech at that height. It should be pointed out that in the course of observation (12-th to 15-th of May) the weather was nice and sunny.

In diagrams № 1—9 daily courses of temperature on stations I and II (from 6—19, e.i. 7—19) are shown for the 13-th and the 14-th of May, in different layers of ground and air. For the station I also minimum night temperatures are given. On table I the values for the ground and air temperature at stations I and II were shown, and displayed in the way so that from one side the variations of temperature in the course of one day can be seen, whereas from the other the difference in temperature in different air strata and ground layers in the same moment (of course at one station only), with the possibility of comparison between the stations.

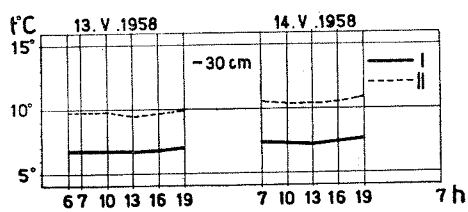


Diagram 1 — The course of ground temperature at 30 cm under ground level at stations I „munika" forest) and II (open field) on the 13th and 14th of May 1958; ont he ordinate temperature values were given and on the apsis the time of reading in the course of day

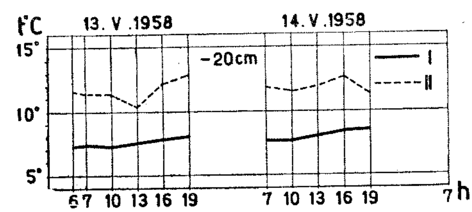


Diagram 2. — The course of ground temperature at 20 cm under the surface at stations I and II on the 13th and 14th of May 1958

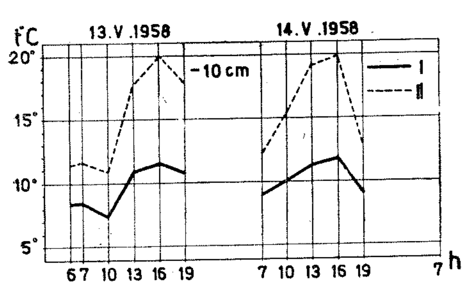


Diagram 3. — The course of ground temperature at 10 cm under the ground surface at stations I and II on the 13th and 14th of May 1958.

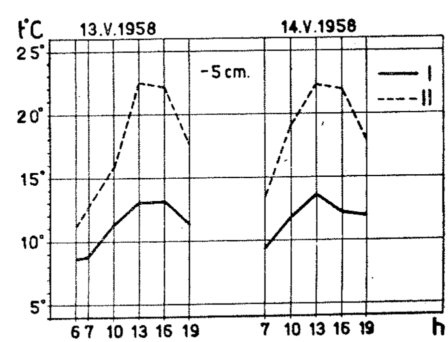


Diagram 4. — The course of ground temperature at 5 cm under the ground surface at stations I and II on the 13th and 14th of May 1958.

In referrence to the ground temperature in diagrams and tables, the thing that first strikes us is that in the course of a day the least variation occurs at the depth of —30 cm and —20 cm. It specially refers to the depth of —30 cm. where the temperature on the 13-th and the 14-th of May changes very little: from 6,8° to 7,6° C at the station I, and from 9,5° to 10,9° C at the station II. At the depth of —20 cm. the variation is not very great, either, at least not for the station I ; from 7,2° to 8,5° C. At the station II (open

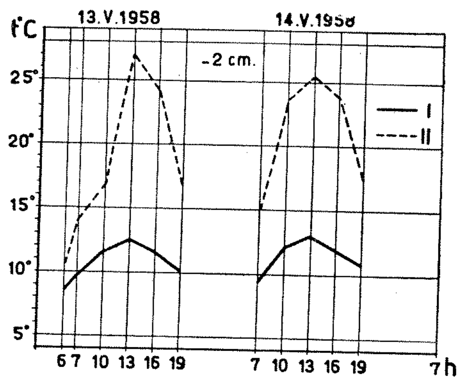


Diagram 5. — The course of ground temperature at 2 cm under the ground surface at stations I and II on the 13th and 14th of May 1958.

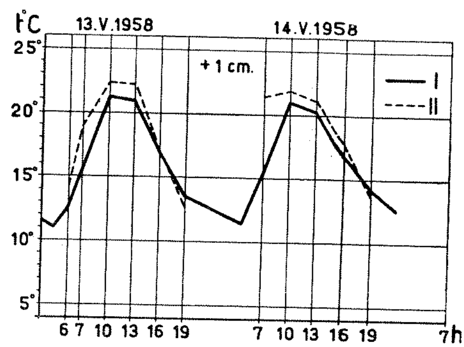


Diagram 6. — The course of air temperature at 1 cm above the ground surface at stations I and II on the 13th and 14th of May 1958.

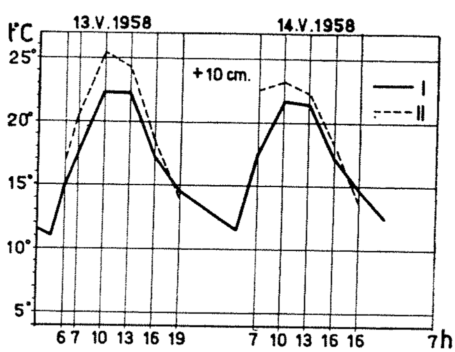


Diagram 7. — The course of air temperature at 10 cm above the ground surface at stations I and II on the 13th and 14th of May 1958.

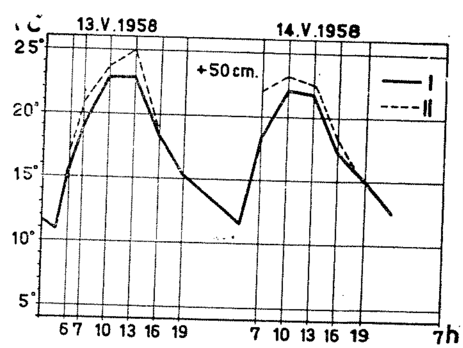


Diagram 8.— The course of air temperature at 50 cm above the ground surface at stations I and II on the 13th and 14th of May 1958.

field outside the forest!) the variation is somewhat geater : 10,3° to 12,8° C. At the depths of —10 cm, —5 cm and —2 cm the variation of temperature in the course of a day is not only far greater, but even the maximum temperatures are very high. It is obviously due to very strong influence of sun radiation upon the surface layers of the ground. In »munika« forest (station I) the temperature at —10 cm varies from 7,5° to 11,7° C, and at —5 cm from 8,6° to 13,6° C. At the open field the variation of temperature at —10 cm is from 11° to 19,9° C, and at —5 cm from 11° to 23,6° C. At the level of —2 cm.

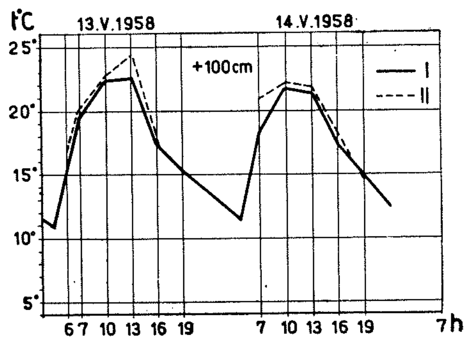


Diagram 9. — The course of air temperature at 100 cm above the ground surface at stations I and II on the 13th and 14th of May 1958.

this picture is even more emphasised because the temperature at the clearing attains the maximum value of 27° C. What should be especially pointed out concerning the ground temperature at stations I and II is the fact that the temperature in deeper layers (—30 cm i —20 cm) increases gradually towards the end of the second half of day, so that maximal temperatures between o'clock and 7 o'clock p.m., whereas in more shallow layers (—10 cm, —5 cm) the ground temperature attains its higher value between 1 o'clock and 4 o'clock p.m., and for the layer of —2 cm a more considerable rise in noticed at 10 o'clock a.m. already. For this reason one can say that the maximum temperature for the ground depth of —10 cm occurs approximately at 4 p.m., and for the ground depth of —5 cm and —2 cm at about 1 p.m. After 4 o'clock p.m. the temperature decreases in all the three layers. From the diagram one can also see that the differences in ground temperature between »munika« forest and feeding-grounds become greater and greater towards the ground surface (this is specially pointed out in tables 2—4). This is certainly the influence of the forest upon the heating of the ground, because the ground in a forest, owing to the protecting forest cover, can neverbe under such influence of direct sun radiation, as it is the case with the grouad out of a forest for it is generally covered by low grass or feeding-ground vegetation. Then, one should point out the very important fact that in time of observation, which is the middle of May, the ground temperature in »munika« forest and out of it as well, at some clearing, attains very high values (in the open field up to 27° C, and in »munika« forest up to 13,6° C), and also the fact that minimum ground temperatures still are very high, in any case not under 5° C. Finally, we should consider it an interesting fact that the diagram of ground temperature at stations I and II show, for all the depths, too, a common course of daily chenges what is, first of all, to be seen in their similar form.

In diagrams 6, 7, 8 and 9 the daily movement of temperature in different air strata was shown, beginning from the stratus close to th ground surface (+1 cm), and through the strata +10 cm and +50 cm to th stratus +100 cm. The striking fact is that the temperature diagram of stations I and II have a very similar form. Generally speaking, the heights of their air temperatures in the course of a day are very alike, which is to be seen in rather slight differences between their maximal day temperatures. In that respect, the greatest difference is shown in air stratus +10 cm, at 10 o'clock a.m. on the 13-th of May, when the temperature difference between station I and station II at that height was only 3,1° C. It is certainly incomparatively less than the differences stated referring to temperatures of certain ground layers between station I and station II, and this is specially concerning ground layers (for example: at —2 cm on the 13-th of May the temperature difference between stations I and II at 1 o'clock p.m. was 14,4° C!). It is, undoubtedly, the possibility of mixing forest air with that of the outside by aid of air streams that makes the air temperature in »munika« forest and above the open space become more alike or at least less different in value. This possibility, of course, does not come in question when ground temperature is concerned and so the differences, arising due to the probability for the low feeding-ground vegetation to receive full intensity of sun radiation on one side, and for the forest ground to be protected by forest vegetation from that radiation on the other side, vill manifest themselves to a great extent. Normally, air temperature in the open field attains maximum values of 21,8° to 25,5° C, and in »munika« forest from 21° to 22,8° C. Air temperature reaches its climax already at 10 o'clock a.m., and in some cases about 1 o'clock p.m., so that day maximum is approximately between 10 o'clock a.m. and 1 o'clock p.m. According to the data recorded by thermohygrograph the maximum temperature is about 12 (noon).

According to everything already recorded, air temperature in the course of night did not fall under 10° C. There is no doubt that the difference between air and ground temperature regarding time in which in the course of day the temperature maximum fits (when air is concerned it is earlier, between 10 a.m. and 1 p.m., and if ground is concerned it is later, between 1 and 4 p.m.), indicates the possibility for air to be heated by the ground surface in a quicker way than the ground layers under its surface. However, we have seen that the temperature maximum in deeper layers (—30 cm and —20 cm) moves up to 7 p.m., which shows us that the heat is transferred from the ground surface to soma deeper layers with some delay, and the bigger the depth the greater the delay. Different air strata (up to +100 cm) show different pictures, differences between them are very slight this being the result of a quicker difusion of air from the place where it was heated by the ground surface (open habitat with low vegetation) towards places where such heating is not so intensive (forest interior).

We must, undoubtedly, realise that relatively high maximum and minimum temperature of air and ground in »munika« forest and outside it as well, and also on very damp soil due to melting snow, is on of the most important causes of so prosperous vegetation of ephemere-mezophytae in the middle of May.

From the table 1 is seen that there is an essential difference regarding thermical layers of air and ground between »munika« forest and open habitat. It is seen very clearly that air temperature in morning hours on both stations is higher than the ground temperature which decreases with the depth. But whereas this relationship, e.i. the air warmer and warmer and the ground colder and colder, in »munika« forest remains for long, in noontime and in afternoon hours, it is changing in the open field : here already at 1 p.m. ground temperature at the depth of —2 cm is higher than air temperature, and the ground temperature in the layer of —5 cm is very close to the temperature value of air. This relationship is maintained and towards evening made even stronger due to the fact that air is cooled faster than soil (because of mixing with air masses from colder expositions). This is certainly one of the most essential differences in the dynamic of ground thermal stratification regime between the forest community (»munika« community, in this case), and open field (low

Table 1. — Temperature values for air and ground at stations I and II on the 14th of May 1958.

14. V. 1958										
Cm	7 h		10 h		13 h		16 h		19 h	
	t° C		t° C		t° C		t° C		t° C	
	I	II	I	II	I	II	I	II	I	II
+100	18,4	21,0	21,8	22,1	21,4	21,8	17,4	18,1	15,0	14,6
+ 50	18,4	22,0	22,0	23,2	21,8	22,6	17,4	18,3	15,0	14,5
+ 10	17,4	22,6	21,7	23,2	21,4	22,3	17,2	18,2	14,7	13,8
+ 1	15,2	21,4	21,0	21,8	20,3	21,2	17,0	17,8	14,2	13,6
— 2	9,4	14,8	12,1	23,4	13,0	25,4	12,0	23,7	10,8	17,2
— 5	9,4	13,3	11,8	19,0	13,6	22,4	12,4	22,0	12,0	17,9
— 10	9,0	12,1	10,0	15,3	11,3	19,0	11,7	19,8	9,2	12,9
— 20	7,7	11,8	7,7	11,5	8,0	11,9	8,3	12,6	8,5	11,4
— 30	7,7	10,6	7,3	10,4	7,2	10,4	7,4	10,5	7,6	10,9

feeding-ground vegetation, in this case), and it will be more precisely expressed in later observations, especially in July.

These differences in thermal stratification regime in the course of a day are also depending on the enfluence made on temperature, on ground, too, by forest vegetation. One can say that the forest, and this is particularly referring to lighter and more open types, allows warm air streams to penetrate to a small or to a greater extent from the open spaces where the air could be heated to the maximum by the ground surface, or by vegetation surface (of course, this possibility of air masses to penetrate can also refer to cold streams), but, on the other hand, it does not allow the ground to be heated to maximum, because it presents, in respect to sun radiation, one more or less efficient heat protector. In dark forests the efficiency of such forest protector is highly increased, in any casemuch more than the possibility ofhot (or cold) air masses to penetrate from the open area. It is taken for granted that in forests during warm and sunny days in noontime and afternoon hours the air temperature will be higher or at least not lower, than the surface ground temperature, which is opposite to the habitat with low vegetation of meadows and feeding-grounds. On the other hand, generally taken, there are conditions for this difference between air temperature and ground temperature to be lower in more open and lighter forests (in which the possibility for air masses to penetrate is greater, but the efficiency of temperature protection of forest floor trees with regard to the ground is smaller), and bigger in more closed and darker forests, just because in the latter the temperature protection of trees floor for sun radiation is complete, whereas the possibility air sream penetration from the area outside the forest is still existing to a considerabla extent, though less than when open and light forests are concerned. Although phytoclimatic observations in forest and feeding-ground vegetation of Prokletije of Metohija in 1958 and in 1959 give colour to these assumption and almost direct us to make similar conclusions, a very clear picture of all these processes and relationship will be formed only after further and more specified research.

In the table 2 were given the differences between stations I and II stated on the 14-th of May, that being done for every hour of observation and for every stratus of air and layer of ground upon which measuring took place The most underlined fact here is the difference in ground temperature between »munika« forest and the open field, especially of layers of —2 cm and —5 cm. In afternoon hours that difference for the layer of —2 cm is even more that 12^0 C. On the contrary, the differences in air temperature are very small and they are ranging from $1{,}5^0$ to $0{,}4^0$ C, which is from ecological point of view can be neglected. The only exception are morning hours when temperature differences between stations I and II are not only greater compared to later hours (at 7 A.m. these differences arefrom $3{,}6^0$ to $6{,}2^0$ C), but also compared to differences in ground temperature in the same time.

In table 3 were given maximum temperatures for different layers of ground and air at stations I and II on the 14-th of May. It is shown very clearly that in »munika« forest maximum temperature values related to air surrounding, for the layer of +50 cm (22^0 C), and in meadow vegetation for the layer of ground at the depth of —2 cm ($25{,}4^0$ C). It is also seen that maximum temperature for all the layers of air and ground is higher in the open than in »munika« forest. In Table 6 differences in maximum temperature between stations I and II were given, for all the layers on the 14-th of May. It is the most essential thing to state that between the two stations, e.i. between

Table 2. — Temperature differences given in t° C, between the stations I and II on the 14th of May 1958, calculated for every hour of reading and every level of observation

14.V 1958	7 h t° C								
	cm −30	cm −20	cm −10	cm −5	cm −2	cm +1	cm +10	cm +50	cm +100
I / II	3,2	4,1	3,1	3,9	5,4	6,2	5,2	3,6	2,6

14.V 1958	10 h t° C								
	cm −30	cm −20	cm −10	cm −5	cm −2	cm +1	cm +10	cm +50	cm +100
I / II	3,1	3,8	5,3	7,2	11,3	0,8	1,5	1,2	0,3

14.V 1958	13 h t° C								
	cm −30	cm −20	cm −10	cm −5	cm −2	cm +1	cm +10	cm +50	cm +100
I / II	3,2	3,9	7,7	8,8	12,4	0,9	0,9	0,8	0,4

14.V 1958	16 h t° C								
	cm −30	cm −20	cm −10	cm −5	cm −2	cm +1	cm +10	cm +50	cm +100
I / II	3,1	4,3	8,1	9,6	11,7	0,8	1,0	0,9	0,7

14.V 1958	19 h t° C								
	cm −30	cm −20	cm −10	cm −5	cm −2	cm +1	cm +10	cm +50	cm +100
I / II	3,3	2,9	3,7	5,9	6,4	0,6	0,9	0,5	0,4

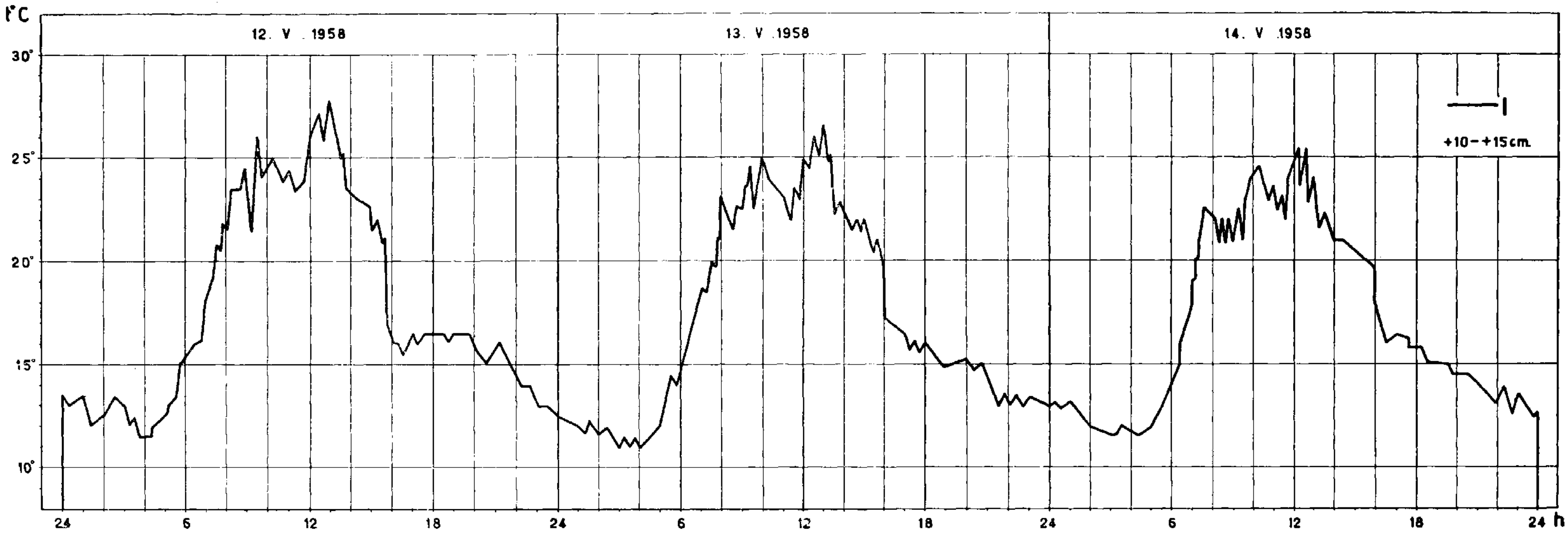


Diagram 10. — The course of air temperature in the layer between 10 and 15 cm above the ground surface at station I from 12[th] to 14[th] of May 1958.

Table 3. — Maximum temperature of separate levels of air and ground at stations I and II, on the 14th of May 1958.

t° C max.	14. V. 1958								
	cm −30	cm −20	cm −10	cm −5	cm −2	cm +1	cm +10	cm +50	cm +100
I	7,6	8,5	11,7	13,6	13,0	21,0	21,7	22,0	21,8
II	10,9	12,6	19,8	22,4	25,4	21,8	23,2	23,2	22.1

Table 4. — Differences between stations I and II regarding their maximum temperatures on the 14th of May 1958.

t° C max. I— max. II	14. V. 1958								
	cm −30	cm −20	cm −10	cm −5	cm −2	cm +1	cm +10	cm +50	cm +100
I / II	3,3	4,1	8,1	8,8	12,4	0,8	1,5	1,2	0,3

Table 5. — Maximum and minimum temperatures of air (stratus +10 to +15 cm) at station I from the 12th to the 14th of May 1958.

+ 10 cm — + 15 cm			
I	12. V	13. V	14. V
t° C max.	27,7	26,7	25,4
t° C min.	11,5	10,9	11,5

»munika« forest and the meadow are to be found the greatest differences in maximum temperature. These differences are ranging from 3,3° to 12,4° C. The highest are in layers of —2 cm (12,4° C) and —5 (8,8° C). The differences of maximum air temperature are minimum. (0,3° to 1,5° C).

In diagram 10, the course of temperature in »munika« forest (station I) within three days (12—14 of May 1958) was shown and the results were obtained by the thermohygrograph.

This temperature course refers to air stratus from 10 to 15 cm. above the surface ground. The temperature line presented in that diagram is very interesting and important because it gives us the detailed course of air temperature in »munika« forest and in the layer in which there is the majority of ground-floor plants and, on the other hand, it gives us precious data of

Table 6. — Diapason of air temperature variations (stratus from +10 cm to +1 cm), at station I.

I	12. V	13. V	14. V
t° C	16,2	15,8	13,9

temperature in the course of night. One thing which can be seen first of all is that the temperature maximum falls about noon, between 12 and 1 p.m. to be more precise, and that it moves from 25,5° to 27,8° C (see diagram 11). More over, the temperature minimum falls between 3 and 4 p.m., and it moves between 11° and 11,5° C. From 6 a.m. the temperature begins to increase attain-

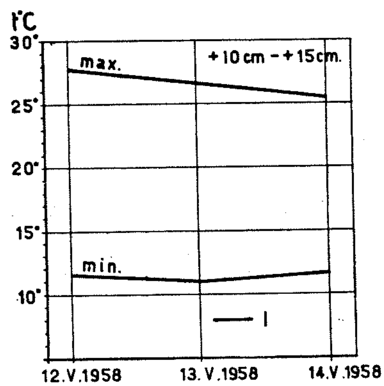


Diagram 11. — Maximum and minimum temperatures in the air layer between 10 and 15 cm above the ground surface, at station I from 12th to 14th of May 1958

ing quickly, already at 8 p.m. a very high value of about 23° C. It is interesting that about 9 a.m. or so, the temperature course has a noticeablefall, even for 3,5° C sometimes. Then, about 10 a.m. the rise of temperature is very high, up to 24,5° to 26° C, and then, just about the day maximum another fall at about 11 a.m. which could be recorded as 2,5—26° C. After the day maximum, which as it has been stated is about 1 p.m. the temperature falls rather quickly, so that about 4 p.m. it comes down to the value of 15,5° — 17° C, which means that for a relatively short time of only tree days the temperature decreasesfor 8 — 12,2° C. From 4 p.m. the temperature decreases gradually towards the temperature minimum which begins at about 3—4 a.m. According to the above facts, it is seen that the greatest oscilation of temperature and its greater changes connected with morning hours, that the period from 8—13 is the period of greatest oscilation. On table 5 maximum and minimum temperatures from 12—14 of May 1958 were given, according to diagram 10 and 11. On Table 6 diapazon, of temperature variation was shown having the former table as a basis, in the same period of time and for the air layer +10 to 15 cm. As it is seen from this table, the day air amplitude temperature is from 13,9° to 16,2° C.

RESULTS OF OSERVATION IN JULY 1958

In July 1958 there were some better possibilities to carry out longer and more complete observation than it had been the case in May. First of all, It was now possible to place a micro-climatic station in fir-beech forest as well (station III). Then measuring was carried out in a considerably longer period of time, from the 8-th — 18-th of July. In that time in »munika« forest, at the station I the following plants were coming into flowers: *Thymus balcanus,*

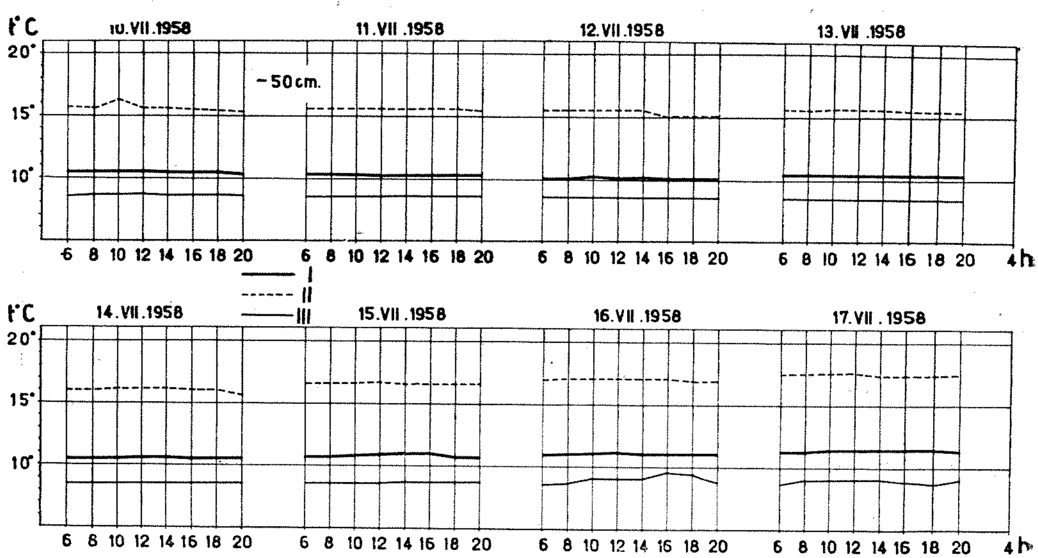


Diagram 12. — The course of ground temperature at 50 cm under the surface at stations I („munika" forest), II (open field) and III (fir-beech forest), from 10th to 17th of July 1958; on the ordinate the temperature values were given (in t° C), and on the apsis the time of reading in the course of day.

Fragaria vesca, Calamintha alpina, Euphorbia ciparissias, Poa ursina, Poa pratensis, Calamintha vulgaris, Ajuga reptans, Polygala comosa, Mycelis muralis (beginning of blooming), *Brachypodium pinnatum. Daphne mezereum* was just having fruit. On the meadow outside the forest (station II) *Thymus balcanus*

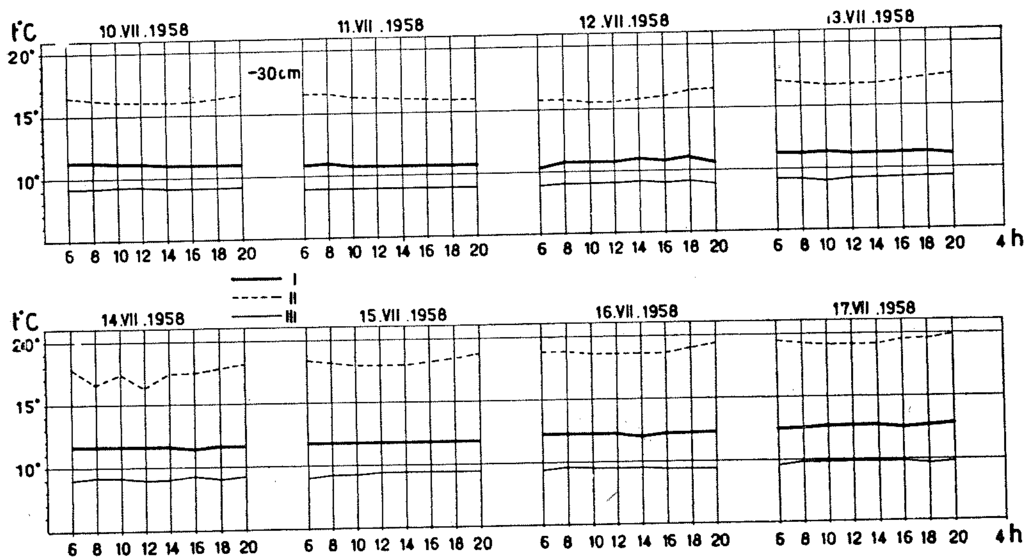


Diagram 13. — The course of ground temperature at 30 cm under the ground surface at stations I, II and III, from 10[th] to 17[th] of July 1958

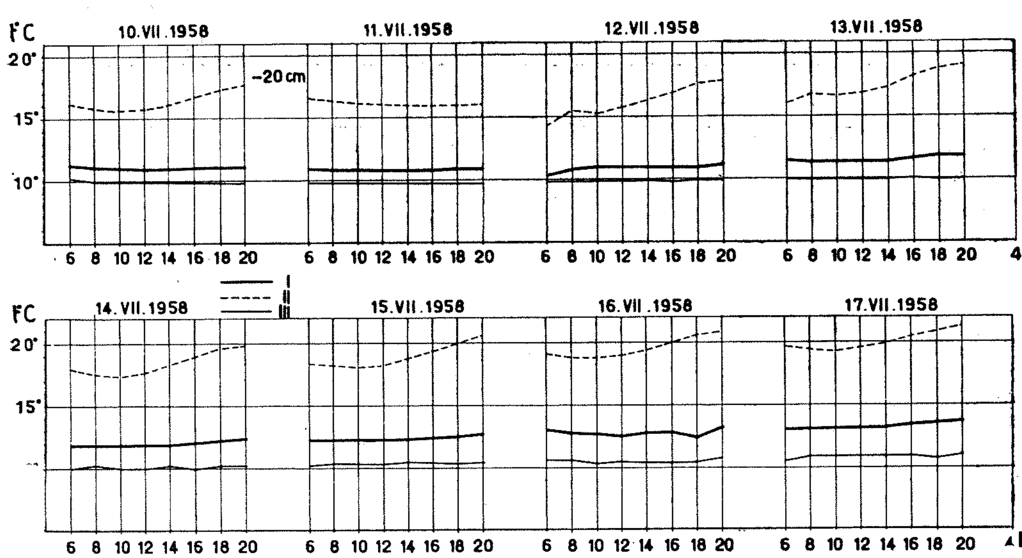


Diagram 14. — The course of ground temperature at 20 cm under the surface at stations I, II and III, from 10[td] to 17[th] of July 1958,

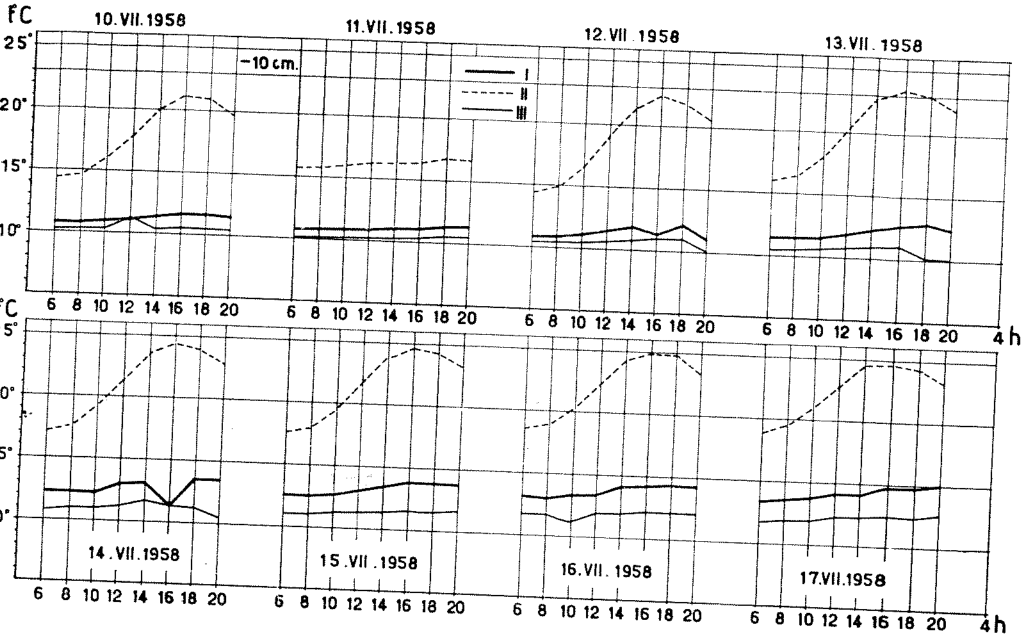


Diagram 15. — The course of ground temperature at 10 cm under the surface at stations I, II and III, from 10th to 17th of July 1958.

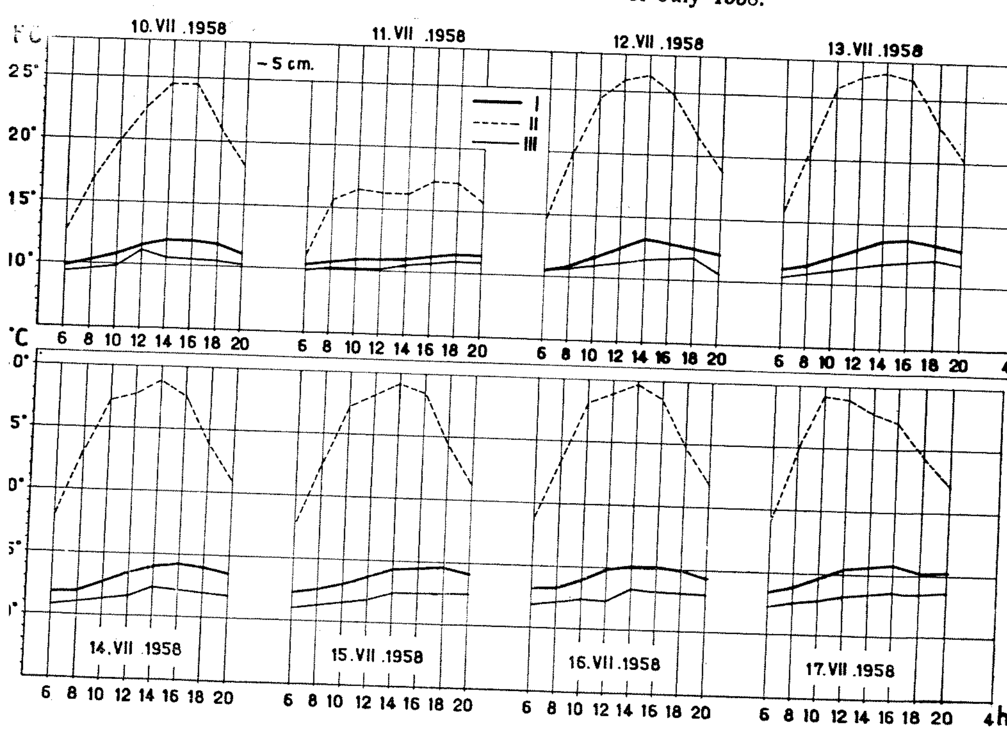


Diagram 16. — The course of ground temperature at 5 cm under the surface at stations I, II and III, from 10th to 17th of July 1958.

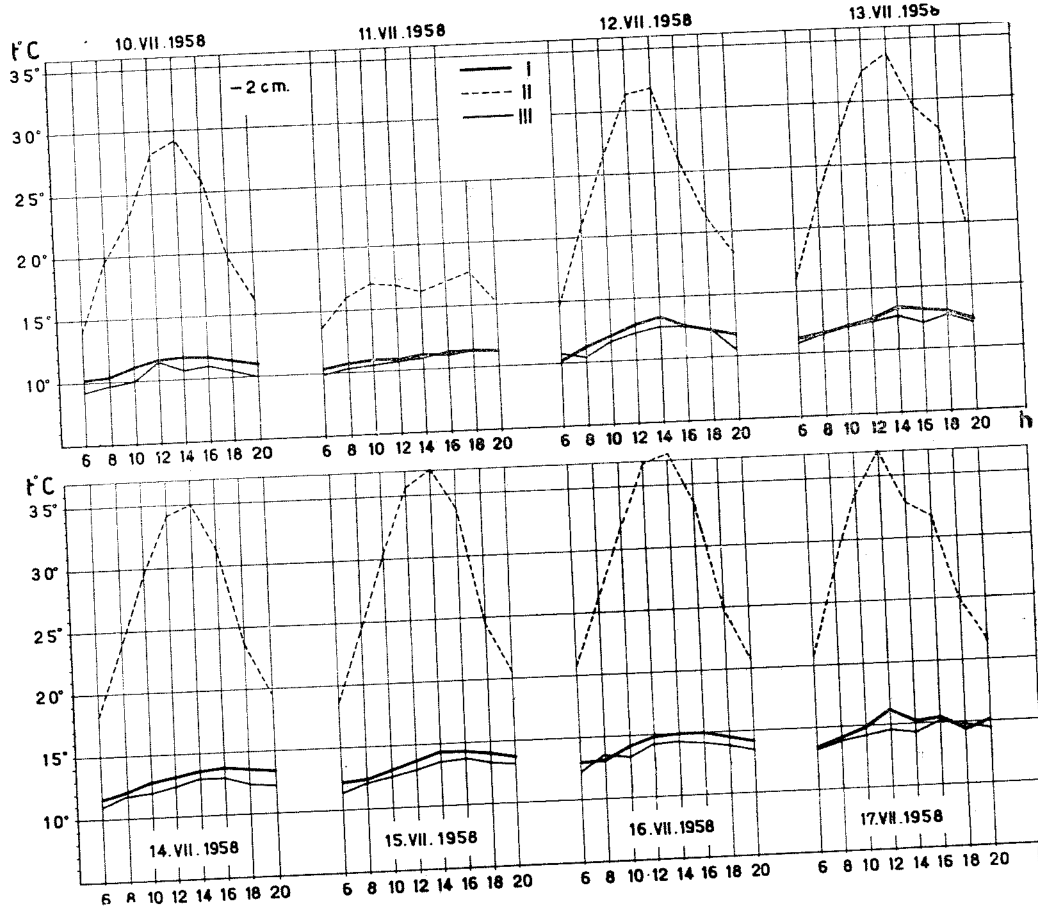


Diagram 17. — The course of ground temperature at 2 cm under the surface at stations I, II and III, from 10[th] to 17[th] of July 1958.

and *Calamintha alpina* were in bloom; finally, in fir-beech forest, at the station III were blooming *Hieracium murrorum*, *Hieracium* sp., *Saxifraga rotundifolia*, *Geranium sanguineum*, *Euphorbia amygdaloides*, *Veronica officinalis* and *Lathyrus pratensis*, whereas *Cardamine eneaphyllos*, *Arabis turrita* and *Actea spicata* were having fruit. *Mulgedium sonchifolium* was both in bloom and fruit. Besides, some other plants in vegetative status were present: *Melampyrim silvaticum*, *Galium silvaticum*, *Oxalis acetosella*, *Gentiana asclepiadea*, *Campanula persicifolia*, *Mycelis muralis*, as well as *Polystichum lonchitis*, *Phegopteris robertianum* and *Nephrodium filix mas*.

The weather from 8-th to 18-th of July was very changeable, dull foggy, with rains from time to time. The 11-th of July was very dull. The weather after the 11-th of July was very nice, sunny and bright. The readings of thermometers was performed eight times in the course of a day, e.i. from 6

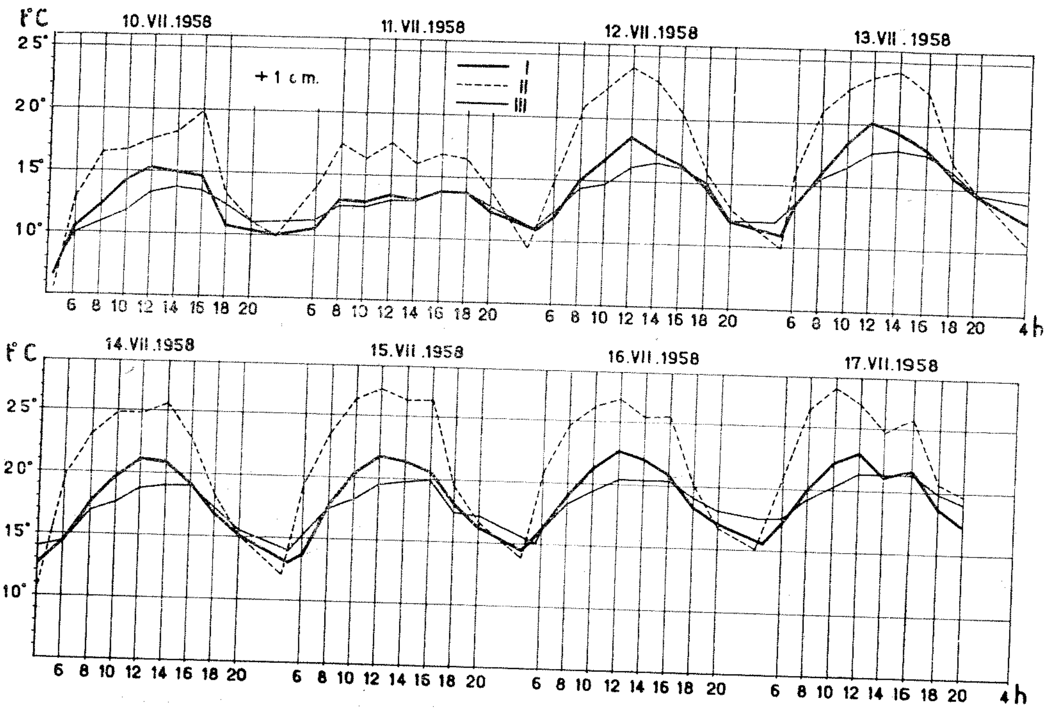


Diagram 18. — The course of air temperature at 1 cm above the ground surface at stations I, II and III. from 10^{th} to 17^{th} of July 1958

a.m. to 8 p.m. (6, 8, 10, 12, 2, 4, 6; 8). In diagrams 12 — 21 the lines of day temperature are shown parallelly for all the three stations, on each diagram one examined layer in the course of eight days, from 10-th to 17-th of July 1958.

The ground temperature at the depth of —50 cm. and —30 cm shows a very steady value in the course of day, especially concerning »munika« forest (I) and fir-beech forest (III). The temperature at —50 cm, and at —30 cm in this forest community varies from 0,2 to 0,4° C. It is a frequent case for the temperature not to change in this layer at all. Thus, for example, on the 14-th of July the temperature at —50 cm in the fir-beech forest remained the whole day steady at 8,5° C, and in »munika« forest at 10,5° — + 10,6° C. As for the temperature of the same layers on the meadow (station III), the picture is almost the same. Only somewhat bigger variations can be noticed, as for etample on the 14-th of July at the depth of —30 cm when the temperature was changed for 1,8° C. With regard to the course of temperature covering several days one could notice a rather great stability. At the depth of —50 cm the temperature at station I varied for the eight days from 10° to 11,4° C, at station III from 8,4 to 9,4° C. As it has been seen, the greatest variation of temperature is in the open field. On the other hand, the differences between »munika« forest and fir-beech forest are not very great (up to 2,5° C., whereas the ground layer temperature on the clearing is far more different:

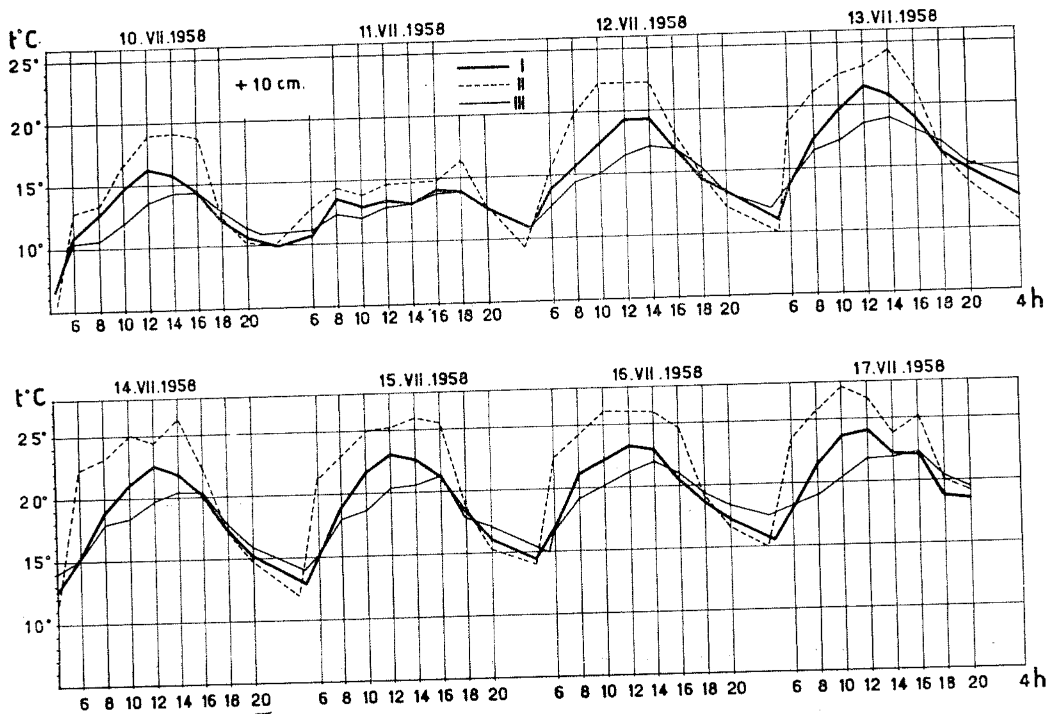


Diagram 19. — The course of air temperature at 10 cm above the ground surface at stations I, II and III, from 10^{th} to 17^{th} of July 1958

compared to station I for more than 6^0 C, and compared to station III even for more than $8{,}5^0$ C. At the depth of —30 cm, the situation is more or less like the one referring to character of variation of temperature and differences between the stations. In the course of this period of time the temperature at station III varied between 9^0 and 10^0 C, at station I between 10^0, (and $12{,}6^0$ C, and at station II between $16{,}5^0$ and $19{,}5^0$ C. The differences between stations I and III amount up to 3^0 C and the differences between stations II and I up to 7^0 C, and between stations II and III up to $9{,}5^0$ C.

In the more shallow ground layers, going from —20 up to —2 cm the amplitude of temperature becomes greater, general temperature values increase (sometimes attaining very high values), the differences between the stations become greater (and finallyattain very high values in surface layers). At —20 cm (diagram 14) the temperature at station I and III still has a rather slow course by day, which occurs in fir-beech forest. But at station II the temperature shows considerable flexibility, between $14{,}4^0$ and $21{,}2^0$ C. (The difference $6{,}8^0$ C.) It is of essential interest that at station II the temperature maximum at —20 cm is reached only at 8 p.m., and the minimum at about 10 a.m.! This is very pronounced in form of temperature diagram. This course of temperature is undoubtedly the consequence of a slow transfer of heat from the ground surface towards deeper layers which bring about delay in delivering sun radiation energy and of some inversion in distribution of temperature in the course of day. At —10 cm (diagram 15) the temperature maximum at station II is attained at about 4 p.m. (the exception was the 11-th of July

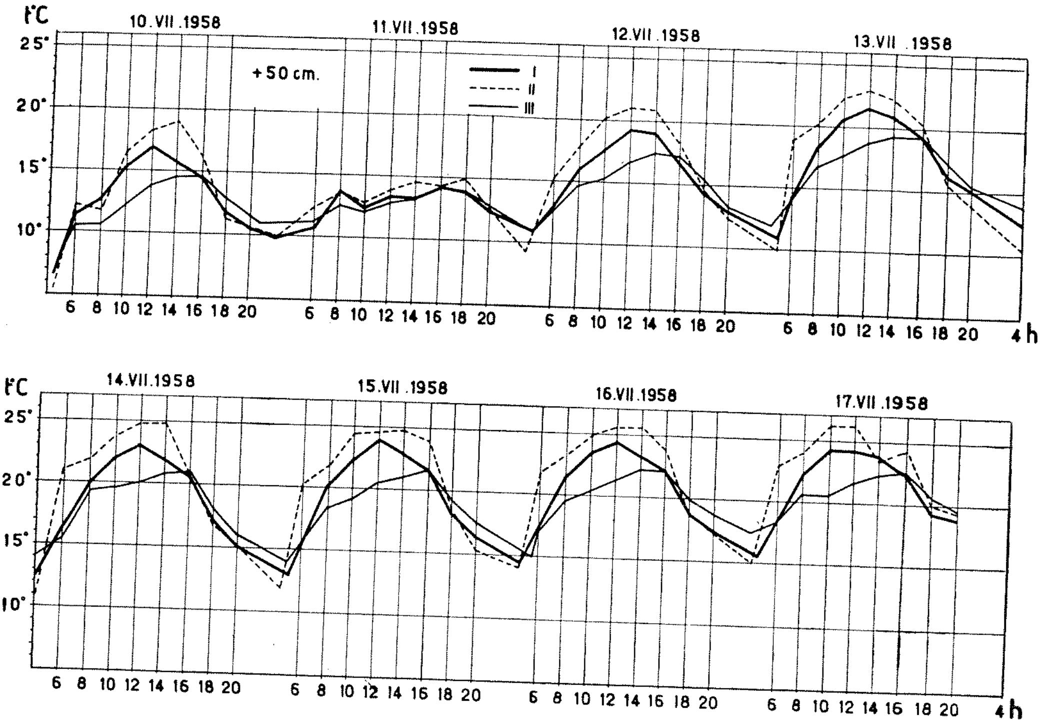


Diagram 20. — The course of air temperature at 50 cm above the ground surface at stations I, II and III, on the 10^{th} to 17^{th} of July 1958.

when due to very clouded sky, the temperature course was normal) and then decreases. It is characteristic for the temperature line at station II that from 6 a.m. towards noón or rather 2 p.m., it has a sudden rise, and then assumes the form of an arch between 2 and 8 p.m.. The maximum values attained by the temperature at station II in the layer of —10 cm, are ranging in that eight-day-period from $21,2^0$ to $24,9^0$ C. The courses of temperature line at station I and III are far more normal and show a general tendency of a slight rise from 6 to 8 p.m. The temperature maximum in »munika« forest is ranging between $11,4^0$ and 15^0 C, and in fir-beech forest between $10,6^0$ and $12,8^0$ C. In every case, at all three stations, the highest ground layer temperature of —10 cm is on the secon part of day between 2 and 8 p.m. Accordingly, the phenomenon of delay in heat transfer from the ground surface is present here, too. The greatest difference in maximum temperature between stations I and III is for that eight-day-period a little more than 2^0 C. The difference between stations II and I is about $10,8^0$ C, and between stations II and III about 13^0 C.

At the depth of —5 cm and —2 cm differences in character of temperature curve, in relationship to maximum values of temperature as well as to

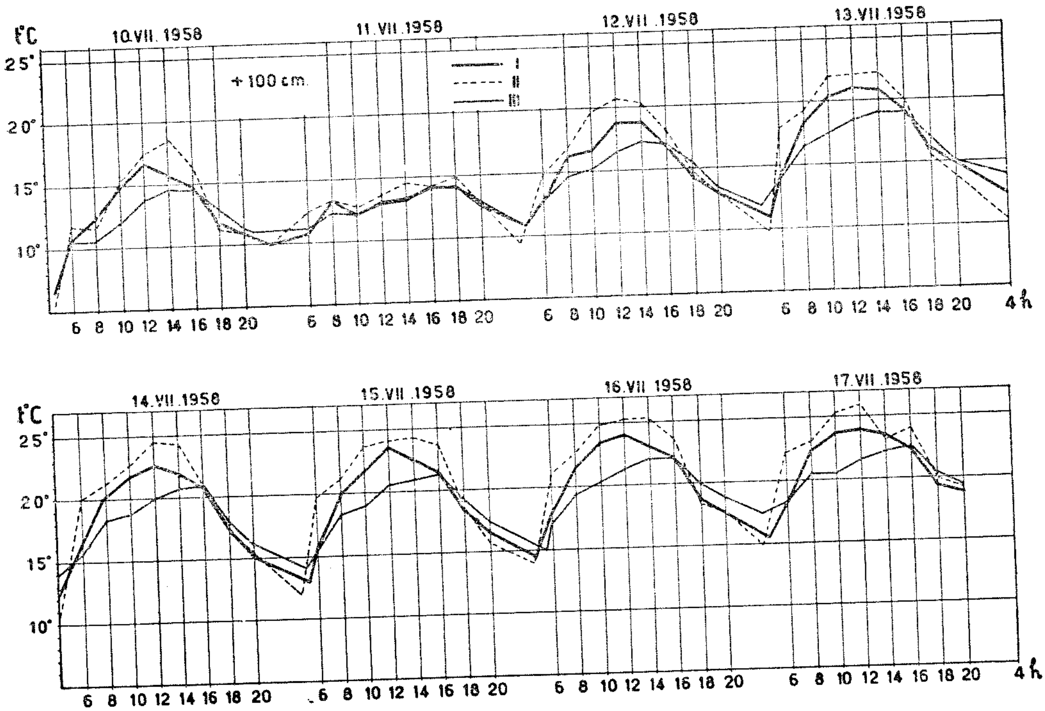


Diagram 21.— The course of air temperature at 100 cm above the ground surface at stations I, II and III, from 10th to 17th of July 1958.

the length of temperature amplitude, between the open field (station II) from one side, and forest community (station I and III) from the other, are very underlined. While at station I and III the highest temperature occurs in the second half of day, from 12 up to 8 o'clock p.m., at station II the highest temperature are generally between 10 a.m. and 4 p.m. with the maximum at 2 p.m., which correspond to the character of daily course of sun radiation intensity. Besides, while these differences in maximum temperatures between »munika« forest and fir-beech forest relatively rather small (up to 2,2° C at the most), these differences between the open field from one side and forest community from the other very high (between the stations I and II up to 14,6° C, and between the stations II and III up to 16,6° C!). The picture is very similar on the level of —2 cm, too, but here the essential specificity of the surface layer temperature regime are emphasised to the extreme. While the differences of maximum temperature between the stations I and III are minimum indeed, (up to 1° C at the most!), the differences in temperature between the stations II on one side and stations I and III on the other are more than great. Thus, in the course of these July days the greatest difference was stated in temperature of layer of —2 cm, between the meadow (station II) i »munika« forest (station I) and it amounted up to 22,6° C (!), and between the meadow and fir forest 23,2° C (!). On the other hand, the daily variations of temperature of this layer between 8 a.m. to 8 p.m. in fir-beech forest and »munika« forest are not very great (up to 3,2^0 C for »munika« forest and up to 2,4^0 C for the fir forest), whereas dailychanges in, temperature are very considerable (up to 18^0 C !).

According to what has been said so far, it is quite clear that referring to the character of surface layer temperature regime, first of all to the depth of —10 cm, the temperature relationship of forest communities (in this case that of »munika« forest and fir-beech forest) and plant communities (in this case the meadow and feeding-ground low vegetation differ to a great extent, these differences being the result of some specific quality of these two types of vegetation. A poised course of temperature in all od the underground layers, even in those surface ones, is the essential quality characterising a forest community as a contrast to plants in which the temperature in the course of day varies to a great extent. Besides, maximum temperatures in forests are generally very moderate(in our case we have seen that in »munika« and fir forest they do not excede the value of 16,2^0 C, that is 15,2^0 C on the level —2 cm), whereas in the open field they are very high (in our case at station II they reach the valueof 37,5^0 C, on the level of —2 cm!). It has already been said that these specificities of temperature regime of forest and vegetation are due to the protecting role of forest vegetation which does not allow the ground to take in full intensity of sun radiation.

As for the air temperature regime at stations I, II and III from the 9-th to 17-th of July 1958, it can be seen (diagrams 18 up to 21) that between the three stations there are not essential differences. The movement of temperature curves for the three stations and for all examined air strata, are essentially the same. It is best seen in the fact that the air curves in »munika« and fir-beech forest follow the course of temperature at station II: temperature maximums and minimums, as well as the general heat distribution in the course of day are the same. However: it should be pointed out that there are some definite differences between »munika« and fir-beech forest. In »munika« forest the highest temperatures are between 10 a.m. and 14 p.m. (the maximum being at 12), whereas in fir-beech forest the highest temperatures from 12 to 4 p.m. (with the maximum at 2 or 4 p.m.). As for the existing differences they are seen first of all in the fact that day temperature amplitude in the open field (station II) greater than in forests, and in fir-beech forest it is the least shown. In the open field maximum temperatures are the highest, and minimum ones the lowest, and in fir forest maximum temperatures are the lowest and minimum ones the highest. On the level +1 cm are the greatest differences between forest vegetation (stations I and III) and the open field (station II), and they referring to maximum day temperatures. Thus, between stations I and II the greatest difference is 5,6^0 C, and between stations II and III 7,6^0 C. The greatest differences of maximum temperatures between »munika« forest and fir-beech forest is only 2,2^0 C. The highest attained temperature of air at station II is 28,2^0 C (17-th of July 1958), at station I 23^0 C, and at station III 21,4^0 C. At levels of —10, +50 and —100 cm the picture is very similar to the one on level +1 cm, only with the difference that in these higher air strata temperature curves between the three stations are more like to each other. In that respect the level of +100 in which the temperature curve of »munika« forest approaches the open field curve. On the other hand, the differences between »munika« forest and fir-beech forest become somewhat greater, with referrence to level +1 cm. There is no doubt that the ground floor air strata are much more influenced by ground surface temperature, not only because they are very close to it, but because air streamining is weaker close to the ground surface, whereas on higher levels (in our case especially on +100 cm) the mixing of air is far greater, and that is why the higher levels have the tendency to make the temperature equal.

In connection with air temperature there is one thing more to be pointed out because of its great importance. Compared to the temperature of surface ground layers, the air temperature on the meadow (station II) is considerably lower (even for 10^0 C in maximum temperatures). On the contrary, air temperature in »munika« forest and in fir beech forest is higher than the temperature of surface ground layers, without counting, of course, the ground surface itself (in »munika« forest the maximum day temperature of air is for about 8^0 C higher than maximum day temperatures of the ground on level —2 cm, in fir forest for about 7^0 C.). These important particularities of temperature regime of forest and plant vegetation, connected with different values, relationships and courses of both ground and air temperature, have been pointed out so far, and it was already stated that they were due to the protecting role of the forest referring to heating of the ground by sun radiation, e.i. the impossibility for the ground to take in sun radiation to full extent, and, on the other hand, the possibility for warm air to penetrate into the forest from the open spaces, by aid of air masses sreaming about, and to bring along to the forest air a part of that sun energy which was received in great quantities by the ground outside the forest, that is by the outer surface of the vegetation itself.

In order to point out, as clearly as possible, the specifities of temperature regime of air and ground of the studied communities, in diagrams 22 and 23, temperature curves for several layers both of air and ground were given, and they refer to days 11-th and 16-th of July 1958 (the 11-th being a very dull day, and the 16-th extremely sunny). In that way it is possible to follow in these diagramsthe distribution of temperature in the course of a day both of air and ground, on all stations, on one side, and to see what the basic differences referring to temperature between a dull and a sunny day are like, on the other side. First of all, the fact that can be stated by mutual comparing the two diagrams is that during a dull and foggy day (11-th of July) the temperatures are considerably lower than on a sunny day (the 16-th of July), and this is so on every given layer of ground and air. Then, on a dull day the temperature of all layers varies far less and the differences in temperature between particular layers of ground and air are on the same place far slighter than it is the case on a sunny day: dull and foogy weather has the tendency of making the temperature of all layers both of ground and air equal to each other. And finally, it is very easy to notice that the differences between the given stations during a dull day considerably smaller that during a sunny one, which means that dull weather has the tendency to make the temperature between different plant communities equal.

The diagram 23 which is referring to one extremely sunny day of July, marks a very clear difference in temperature regime of ground and air between »munika« (I) and fir-beech (III) communities on one side and the meadow (II) on the other. First of all, it is very clear that between them referring to temperature the basic difference is in ground temperature, espacially in

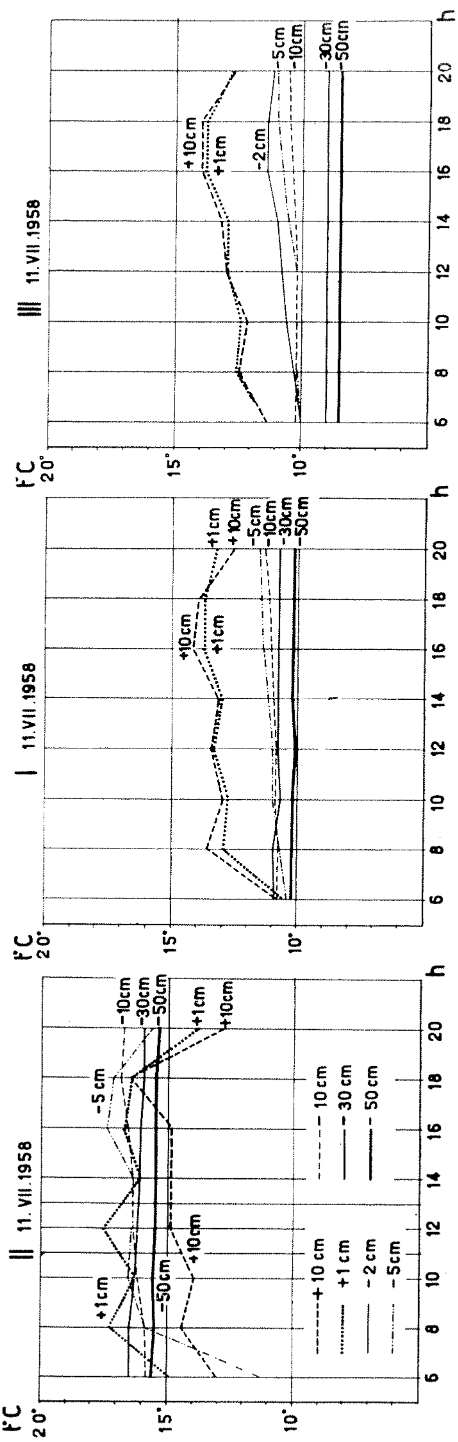


Diagram 22. — Comparative diagram of temperature curves for different layers of air and ground at stations I, II and III, on the 11th of July 1958 (dull day).

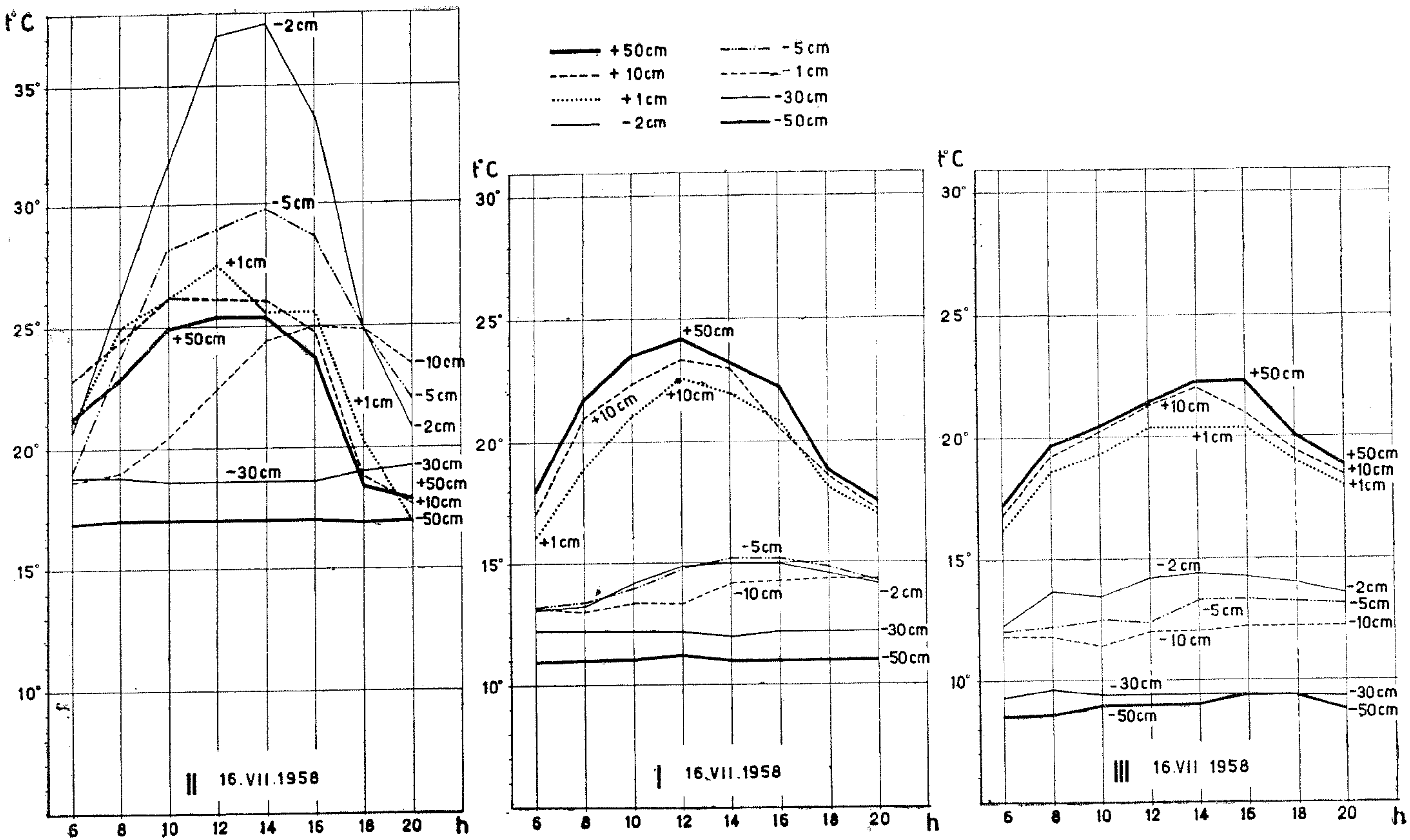


Diagram 23. — Comparative diagram of temperature curves for different layers of air and ground at stations I, II and III, on the 15th of July 1958 (sunny day)

Table 7. — Temperatures values for air and ground at stations I, II and III on the 16th of July 1958

Cm	16.VII.1958																							
	6 h			8 h			10 h			12 h			14 h			16 h			18 h			20 h		
	t° C			t° C			t° C			t° C			t° C			t° C			t° C			t° C		
	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III
+100	18,0	21,2	17,1	21,7	22,8	19,6	23,6	25,0	20,4	24,2	25,4	21,4	23,2	25,4	22,2	22,1	23,7	22,2	18,8	18,4	20,0	17,5	17,7	18,8
+ 50	17,6	21,8	17,1	21,4	23,2	19,6	23,6	25,0	20,4	24,4	25,5	21,4	23,4	25,6	22,2	22,2	23,9	22,2	18,7	18,6	20,0	17,4	17,3	18,8
+ 10	16,9	22,8	16,8	21,2	24,4	19,2	22,4	26,2	20,2	23,4	26,2	21,3	23,0	26,0	22,0	20,6	24,8	21,0	18,6	18,9	19,4	17,2	16,6	18,4
+ 1	16,0	20,9	16,2	19,0	24,9	18,6	21,2	26,2	19,3	22,6	26,8	20,4	22,0	25,6	20,4	20,8	25,6	20,4	18,2	20,2	19,0	17,0	16,8	18,0
− 2	13,0	20,7	12,3	13,2	26,3	13,6	14,2	31,8	13,3	14,8	36,9	14,2	15,0	37,5	14,4	15,0	33,6	14,3	14,6	24,9	14,0	14,2	20,8	13,6
− 5	13,2	18,9	12,0	13,4	23,8	12,2	14,0	28,2	12,3	14,8	29,0	12,4	15,2	29,8	13,3	15,2	28,7	13,3	15,0	24,8	13,2	14,4	22,0	13,1
− 10	13,2	18,6	11,8	13,0	19,0	11,8	13,4	20,4	11,4	13,4	22,4	12,0	14,2	24,4	12,0	14,3	25,0	12,2	14,4	24,9	12,2	14,4	23,4	12,2
− 20	13,7	19,1	10,6	12,7	18,8	10,5	12,7	18,8	10,3	12,5	19,0	10,4	12,8	19,4	10,3	12,8	20,0	10,3	12,5	20,6	10,3	13,2	20,8	10,7
− 30	12,2	18,8	9,3	12,2	18,8	9,6	12,2	18,6	9,4	12,2	18,6	9,4	12,0	18,6	9,4	12,2	18,6	9,3	12,2	19,0	9,3	12,2	19,2	9,3
− 50	10,9	16,9	8,5	11,0	17,0	8,6	11,0	17,0	9,0	11,1	17,0	9,0	11,0	17,0	9,0	11,0	17,0	9,0	11,0	16,9	9,0	11,0	17,0	8,9

Table 8. — Temperature differences between sattions I, II and III on the 16th of July 1958, calculated for every hour of reading every level of observation

16 VII 1958	6 h t° C									
	cm −50	cm −30	cm −20	cm −10	cm −5	cm −2	cm +1	cm +10	cm +50	cm +100
I / II	6,0	6,6	5,4	5,4	5,7	7,7	4,9	5,9	4,2	3,2
I / III	2,4	2,9	3,1	1,4	1,2	0,7	0,2	0,1	0,5	0,9
II / III	8,4	9,5	8,5	7,0	6,9	8,4	4,7	6,0	4,7	4,1

16. VII 1958	8 h t° C									
	cm −50	cm −30	cm −20	cm −10	cm −5	cm −2	cm +1	cm +10	cm +50	cm +100
I / II	6,0	6,6	6,1	6,0	10,4	13,1	5,9	3,2	1,8	1,1
I / III	2,4	2,6	2,1	1,2	1,2	0,4	0,4	2,0	1,8	2,1
II / III	8,4	9,2	8,2	7,2	11,6	12,7	6,3	5,2	3,6	3,2

16. VII 1958	10 h t° C									
	cm −50	cm −30	cm −20	cm −10	cm −5	cm −2	cm +1	cm +10	cm +50	cm +100
I / II	6,0	6,4	6,1	7,0	14,2	17,6	5,0	3,8	1,4	1,4
I / III	2,0	2,8	2,4	2,0	1,7	0,9	1,9	2,2	3,2	3,2
II / III	8,0	9,2	8,5	9,0	15,9	18,5	6,9	6,2	4,6	4,6

16. VII 1958	12 h t° C									
	cm −50	cm −30	cm −20	cm −10	cm −5	cm −2	cm +1	cm +10	cm +50	cm +100
I / II	5,9	6,4	6,5	9,0	14,2	22,1	4,2	2,8	1,1	1,2
I / III	2,1	2,8	2,1	1,4	2,4	0,6	2,2	2,1	3,0	2,8
II / III	8,0	9,2	8,6	10,4	16,6	22,7	6,4	4,9	4,1	4,0

16. VII 1958	14 h t° C									
	cm −50	cm −30	cm −20	cm −10	cm −5	cm −2	cm +1	cm +10	cm +50	cm +100
I / II	6,0	6,6	6,6	10,2	14,6	22,5	3,6	3,0	2,2	2,2
I / III	2,0	2,6	2,5	2,2	1,9	0,6	1,6	1,0	1,2	1,0
II / III	8,0	9,2	9,1	12,4	16,5	23,1	5,2	4,0	3,4	3,2

16. VII 1958	16 h t° C									
	cm −50	cm −30	cm −20	cm −10	cm −5	cm −2	cm +1	cm +10	cm +50	cm +100
I / II	6,0	6 4	7,2	10,7	13,5	18,6	4,8	4,2	1,7	1,6
I / III	2,0	2,9	2,5	2,1	1,9	0,7	0,4	0,4	0,0	0,1
II / III	8,0	9,3	9,7	12,8	15,4	19,3	5,2	3,8	1,7	1,5

16. VII 1958	18 h t° C									
	cm −50	cm −30	cm −20	cm −10	cm −5	cm −2	cm +1	cm +10	cm +50	cm +100
I / II	5,9	6,8	8,1	10,5	9,8	10,3	2,0	0,3	0,1	0,4
I / III	2,0	2,9	2,2	2,2	1,8	0,6	0,8	0,8	1,3	1,2
II / III	7,9	0,3	10,3	12,7	11,6	10,7	1,2	0,5	1,4	1,6

16. VII 1958	20 h t° C									
	cm −50	cm −30	cm −20	cm −10	cm −5	cm −2	cm +1	cm +10	cm +50	cm +100
I / II	6,0	7,0	7,6	9,0	7,6	6,6	0,2	0,6	0,1	0,2
I / III	2,1	2,9	2,5	2,2	1,3	0,6	1,0	1,2	1,4	1,3
II / III	8,1	10,9	10,1	11,2	8,9	7,2	1,2	1,8	1,5	1,1

surface layers; whereas air temperature in all three communities sticks to about the same scope (at station II between 17° and 26,5° C, at station I between 16° and 24,2° C, at station III between 16° and 22,2° C). In the open field (I) the ground temperature of difference layers is ranging in the cours of day in the diapason of 16,9° up to 37,5° C(!), in »munika« forest of 10,9° to 15,2° C, and in fir forest from 8,5° up to 15,4° C. The difference is more than evident. But, what represents an essential difference in temperature regime of these communities is the phenomenon that in the open field surface ground layers are by far the hottest ones (—2 cm and —5 cm), but, on the contrary, in forest communities the air environment is the hottest one. Accordingly, the temperature regime of the forest atmosphere and that of the pedosphere shows a quite definite inversion referring to the temperature regime of a low meadow community. The basic cause of this phenomenon has been pointed out at the n'eginning of this paper several times.

On table 7 temperature data for all the three stations were given for the 16-th of July 1958 in the way so that one could follow the difference in temperature of different layers of ground and air at one moment for one place on one side, and the chenge of values of temperature for one same layer in the course of a day, as well as the differences between the stations themselves to that respect, on the other side (these two last moments can be separately followed on given diagrams). Even on these tables, too, one can see that same essential; moment and this is that on station II the highest temperatures are connected to surface ground layers, and in forest communities air environment.

On tables № 8 temperature differences expressed in t° C were given, between micro-climatic stations, separately for each moment of reading, separated in different layers of atmosphere and pedosphere. It is very clear from the tables that the greatest differences are to be found between the stations II and III (fir-beech forests and open field), then between stations I and II (»munika« forest and open field) and finally the stations I and III (»munika« forest and fir forest).

On table № 9 the maximum temperatures for all the layers were given, and on table № 10 the differences in these maximum temperatures between the given stations (for the 11-th and 16-th of July).

Table 9. — Maximum temperatures of separate layers of air and ground at stations I, II and III, on the 16th of July 1958.

t° C max.	16. VII. 1958									
	cm −50	cm −30	cm −20	cm −10	cm -5	cm −2	cm +1	cm +10	cm +50	cm +100
I	11,1	12,2	13,7	14,4	15,2	15,0	22,6	23,4	24,4	24,2
II	17,0	19,2	20,8	25,0	29,8	37,5	26,8	26,2	25,6	25,4
III	9,0	9,6	10,7	12,2	13,3	14,4	20,4	22,0	22,2	22,2

On diagram 24 one can see the course of temperature curves for all the three stations from the 9-th to 17-th of July 1958, for the ground floor layer of air of +10 cm to +15 cm. The curves were got, the same way as in May, by the way of Lambrecht's thermohygrograph. The thing most outstanding

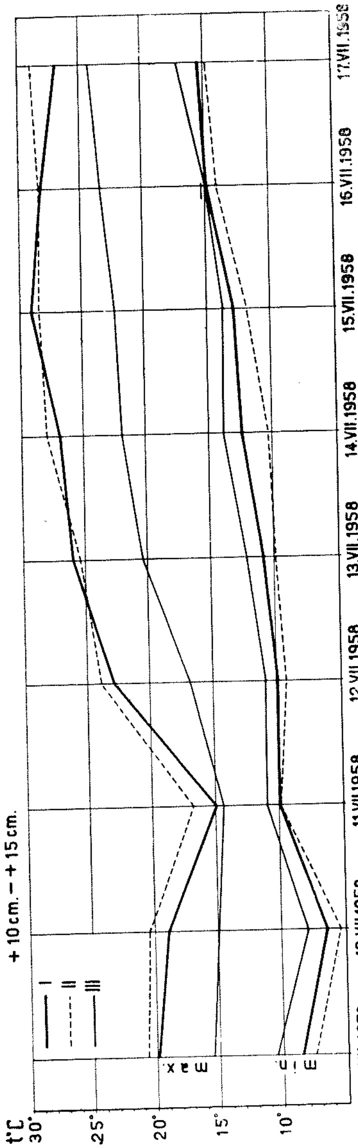


Diagram 25. — Maximum and minimum temperatures in air stratus between 10 and 15 cm above the ground surface at stations I, II and III, from the 9th to the 17th of July 1958.

of all is the phenomenon that at all the three stations day temperature maximum occurs approximately between 12 and 2 p.m., whereas temperature maximum falls between 3 and 4 a.m. (with the exception of 11-th of July, of course). Then, the curves show that the most balanced day course has the temperature in fir-beech forest, whereas the temperature in »munika« forest and

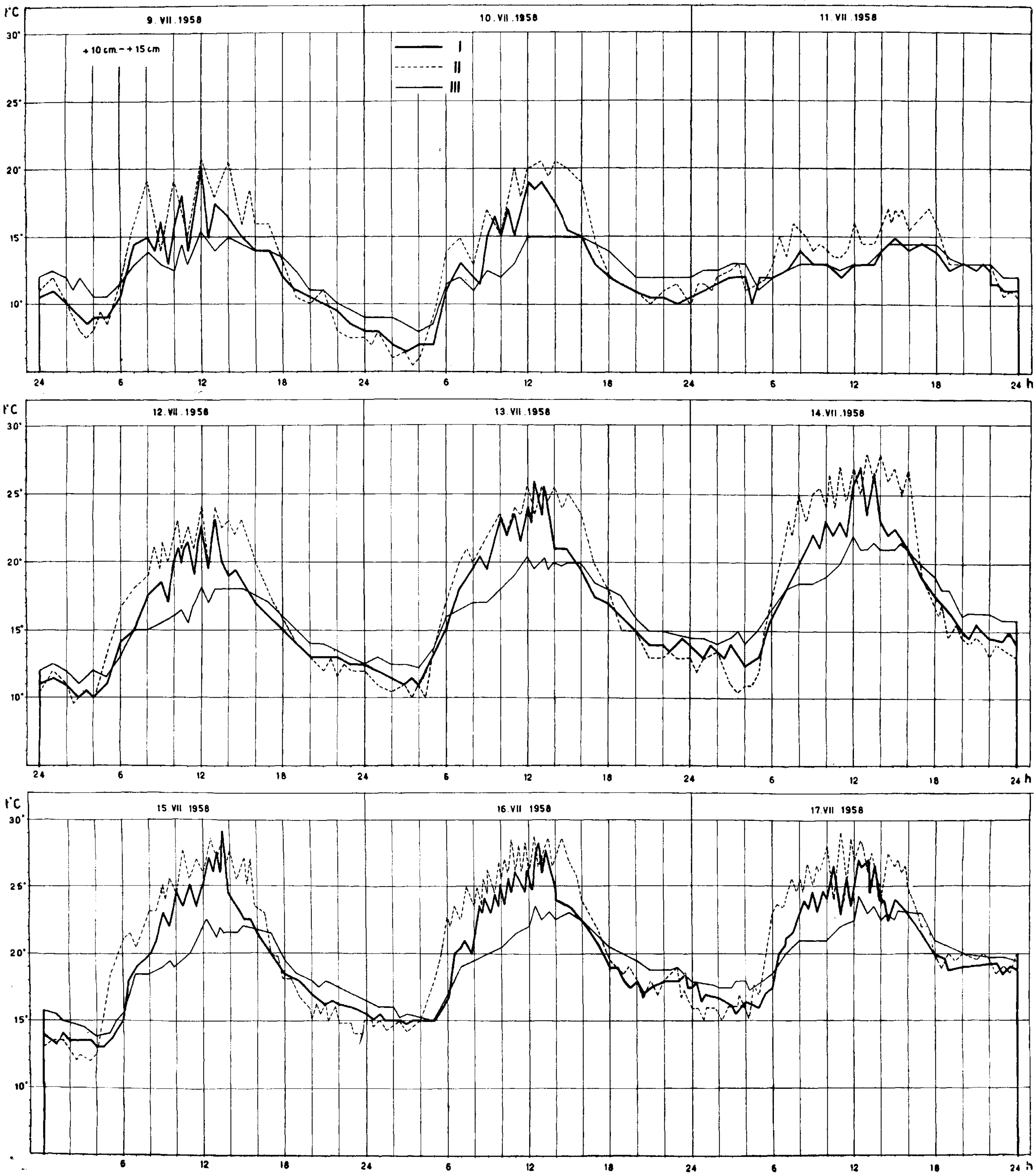


Diagram 24. — The course of air temperature in stratus between 10 and 15 cm above the ground surface at stations I, II and III, from the 9th to 17th of July 1958

in the open space has relatively great oscilations, which is specially referring to the station II. The greatest temperature oscilation is between 8 a.m. and 2 p.m. (for the stations I and II), and the temperature at station II has oscilations at night as well. In this period maximum air temperature at —10 cm to 15 cm vary for the station II from 17° to 29° C, for the station I from 15° to 29° C, and for the station III from 14,5° to 24,3° C (diagram 25). The minimum temperatures for the station II are from 5,5° to 15°C, for the station

Table 10. — Differences between stations I, II and III regarding their maximum temperatures on the 16th of July 1958.

t° C max.—max.	16. VII. 1958									
	cm −50	cm −30	cm −20	cm −10	cm −5	cm −2	cm +1	cm +10	cm +50	cm +100
I / II	5,9	7,0	7,1	10,6	14,6	22,5	4,2	2,8	1,2	1,2
I / III	2,1	2,6	3,0	2,2	1,9	0,6	2,2	1,4	2,2	2,2
II / III	8,0	9,6	10,1	12,8	16,5	23,1	6,4	4,2	3,4	3,2

Table 11. — Maximum and minimum air temperatures (stratus +10 cm to +15 cm) at stations I, II and III, from the 9th to the 17th of July 1958.

t° C		9.VII	10.VII	11.VII	12.VII	13.VII	14.VII	15.VII	16.VII	17.VII
I	max.	20	19	15	23	26,1	27	29	28,2	27
	min.	8,5	6,5	10	10	11	12,5	13	15	15,4
II	max.	20,7	20,5	17	24	25,5	28	28,5	28,5	29
	min.	7,5	5,5	10	9,5	10	10,5	12	14,2	15
III	max.	15,5	15	14,5	17	20,5	22	22,5	23,5	24,3
	min.	10,5	8	11	10,8	13,3	14	13,8	15	17,3

I from 6,5° to 15,4° C, and for the station III from 8° to 17,3° C. The values of minimum and maximum temperatures were given on the table № 11, too. On the tables 12 and 13 the differences between the stations concerning maximum, that is, minimum temperatures were given for the same ground floor layer of air. Out of them one can see very clearly that the greatest differences between the open space (II) and the fir forest (III), then »munika« forest and fir forest (I and III), and finally between an open space and »munika«

Table 12. — Differences between stations I, II and III regarding their maximum air temperatures (stratus + 10 cm to +15 cm), from the 9th to the 17th of July 1958.

t° C max.	9.VII	10.VII	11.VII	12.VII	13.VII	14.VII	15.VII	16.VII	17.VII
I/II	0,7	1,5	2	1	0,6	1	0,5	0,3	2
I/III	4,5	4	0,5	6	5,6	5	6,5	4,7	2,7
II/III	5,2	5,5	2,5	7	5	6	6	5	4,7

Table 13. — Differences between stations I, II and III regarding their minimum tempera tures of air (stratus +10 cm to +15 cm), from the 9th of July to the 17th of July 1958.

t° C min.	9.VII	10.VII	11.VII	12.VII	13.VII	14.VII	15.VII	16.VII	17.VII
I/II	1	1	0	0,5	1	2	1	0,8	0,4
I/III	2	1,5	1	0,8	2,3	1,5	0,8	0	1,9
II/III	3	2,5	1	1,3	3,3	3,5	1,8	0,8	2,3

Table 14. — Diapason of air temperatures variations (stratus +10 cm to +15 cm), at stations I, II and III from the 9th to the 17th of July 1958.

t° C	9.VII	10.VII	11.VII	12.VII	13.VII	14.VII	15.VII	16.VII	17.VII
I	11,5	12,5	5	13	15,1	14,5	16	13,2	11,6
II	13,2	15	7	14,5	15,5	17,5	16,5	16,3	14
III	5	7	3,5	6,2	7,2	8	8,7	8,5	7

forest (I and II). It could be concluded out of it that the temperature of the groundfloor layer of air in munika forest more similar to the air temperature in the open field, than to the temperature of fir-beech forest. On table № 14, on the basis of the data got by the way of thermohygrograph, the temperature amplitude was given for separate stations (which means the diapason between maximum and minimum temperatures). The table № 15 show the differences between the micro-climatic stations concerning the temperature amplitude. First of all, it strikes one that the air temperature amplitude is the lowest in fir forest, (from 5⁰ to 8,7⁰ C), whereas at two other stations it is considerably

Table 15. — Differences in diapason of air temperature variations (stratus +10 cm to +15 cm), between stations I, II and III, from the 9th to the 17th of July 1958.

	9.VII	10.VII	11.VII	12.VII	13.VII	14.VII	15.VII	16.VII	17.VII
I/II	1,7	2,5	2	1,5	0,4	3	0,5	3,1	2,4
I/III	6,5	5,5	1,5	6,8	7,9	6,5	7,3	4,7	4,6
II/III	8,2	8	3,5	8,3	8,3	9,5	7,8	7,8	7

higher: in »munika« forest from 5⁰ to 16⁰ C, and in the open field from 7⁰ to 17,5⁰ C. In that respect the greatest differences are between the stations II and III, and then between the stations I and III, whereas the differences between the stations I and II are far less considerable and often irrelevant. This, too, leads us to the conclusion that the temperatures regimes of air environment of »munika« forest at station I and in the open field at station II are vely like each other, in any case more similar than the temperature regimes of the same layer of air in »munika« forest and in fir-beech forest.

THE RESULTS OF OBSERVATIONS IN SEPTEMBER 1958

In September micro-climatic observations refers to the period from th 6-th to th 12-th July. The readings were done six times a day, every three hours (except for the last measuring which was done two hours after the last but one), as follows: 6, 9, 12, 3 p.m., 6 p.m. and 8 p.m.. The results of these observations were given on diagrams 26—35, and on tables 16—18. Essentially, the picture is similar to the one from July 1958, with the difference that minimum and maximum temperatures, of course, are lower than the ones in July. The diagram 36 represents the course of temperature curves from the 6-th to the 8-th of September 1958, for all the three stations, in the air stratum +10 cm up to +15 cm (it was got by the thermohygrograph, too,). The diagram 37 gives us minimum and maximum temperature for this layer in the same period. Both the diagrams are referred to as above. Table 2 gives the values in figures for minimum and maximum temperatures, and the table 21 and 22 the differences between them? Finally, in tables 23 and 24 air temperature amplitude was given at +10 cm up to +15 cm at stations I, II, and III, that is the differences between these stations with regard to diapason of variation. In fact, temperature data too, got by means of the thermohygrograph represented in diagrams 36 and 37 and in tables 20—24, offer the same picture of changes of the course of temperature, of the temperature regime and the difference between the studied plant communities, which we had in July, too, and in May as well 1958.

Only, it is to be pointed out, as a very important fact, that in the first half of September, the differences in thermal conditions of ground and air between »munika« forest and fir-beech forest become considerably greater, particularly in July. Thus, for example, in the surface air layer the differences between maximum temperatures between station I and station III amount even up to 8° C. For the ground at —2 cm differences of maximum temperatures between station I and station III are up to 5°C. It is probably possible to believe that the most essential differences between »munika« forest and fir-beech forest referring to their thermal regimes are connected to colder parts of vegetational period, for the beginning of spring and autumn.

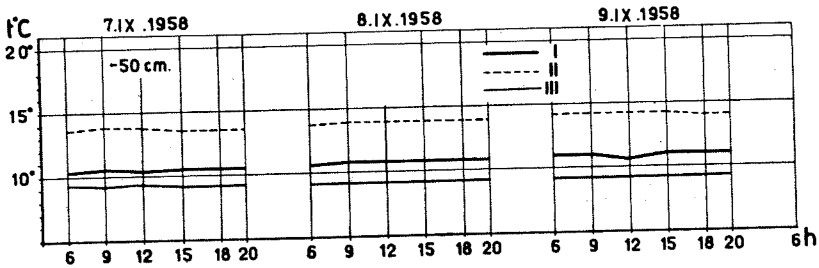


Diagram 26. — The course of ground temperature at 50 cm under the ground surface, at stations I („munika" forest), II (open field), and III (fir — beech forest), from the 7th to the 9th of September 1958.

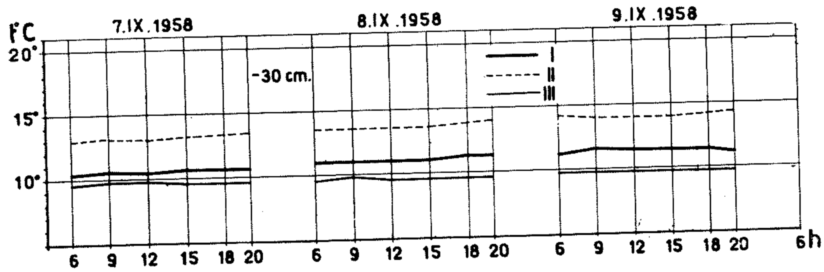


Diagram 27. — The course of ground temperature at 30 cm under the ground surface, at stations I, II and III, from the 7th to the 9th of September 1958

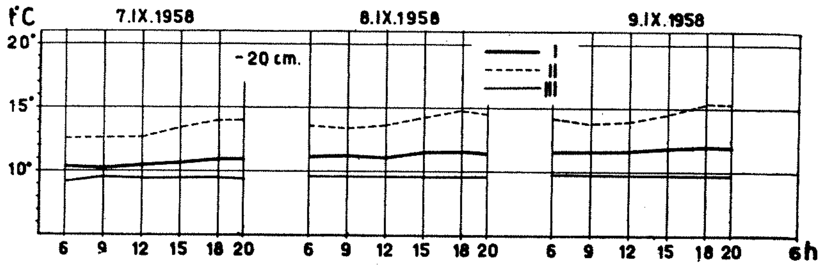


Diagram 28. — The course of ground temperature at 20 cm under the ground surface at stations I, II and III, from the 7th to the 9th of September 1958.

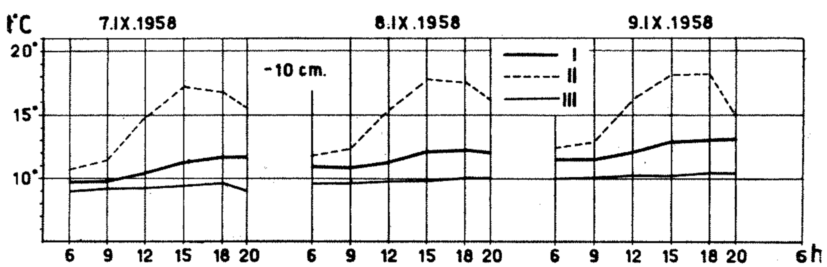


Diagram 29. — The course of ground temperature at 10 cm under the ground ons I, II and III, from the 7th to the 9th of September 1958.

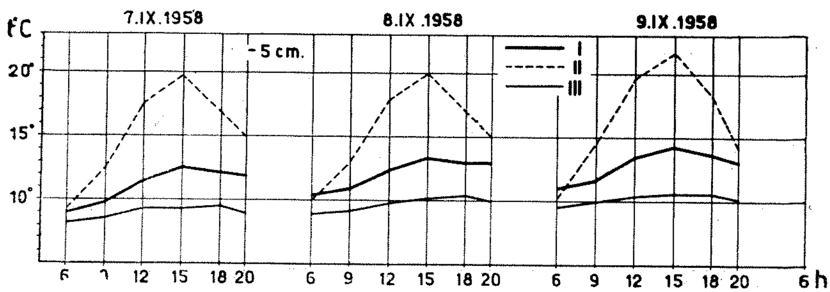


Diagram 30. — The course of ground temperature at 5 cm under the ground surface at stations I, II and III, from the 7th to the 9th of September 1958.

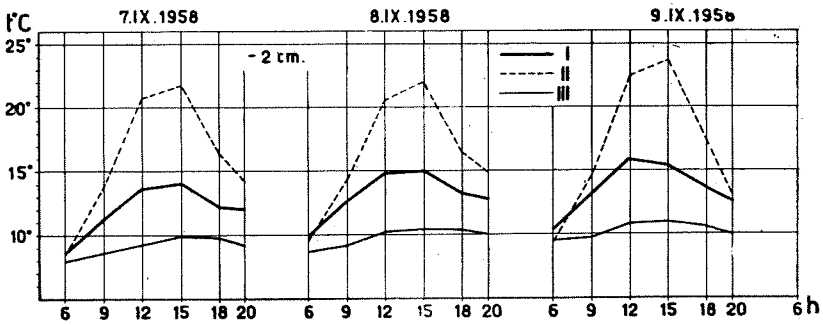


Diagram 31. — The course of ground temperature at 2 cm under the ground surface at stations I, II and III, from the 7th to the 9th of September 1958

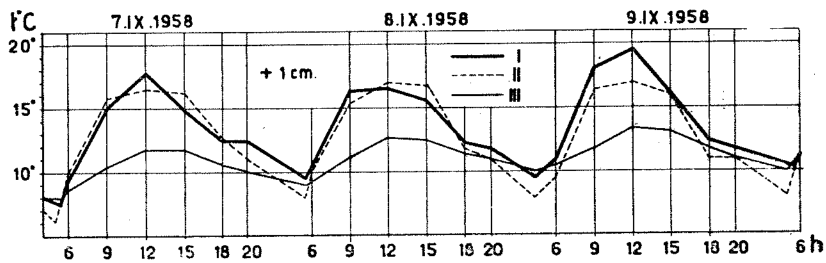


Diagram 32. — The course of air temperature at 1 cm above the ground surface at stations I, II and III, from the 7th to the 9th of September 1958.

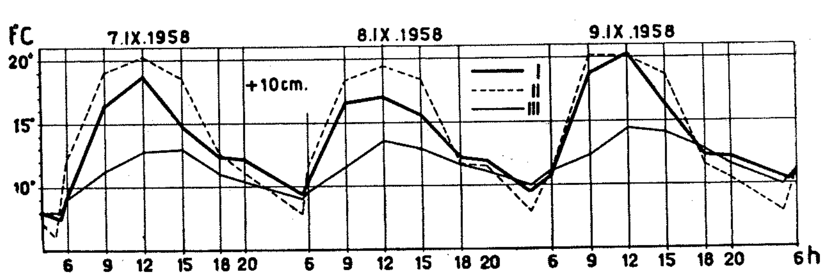


Diagram 33. — The course of air temperature at 10 cm above the ground surface at stations I, II and III, from the 7th to the 9th of September 1958.

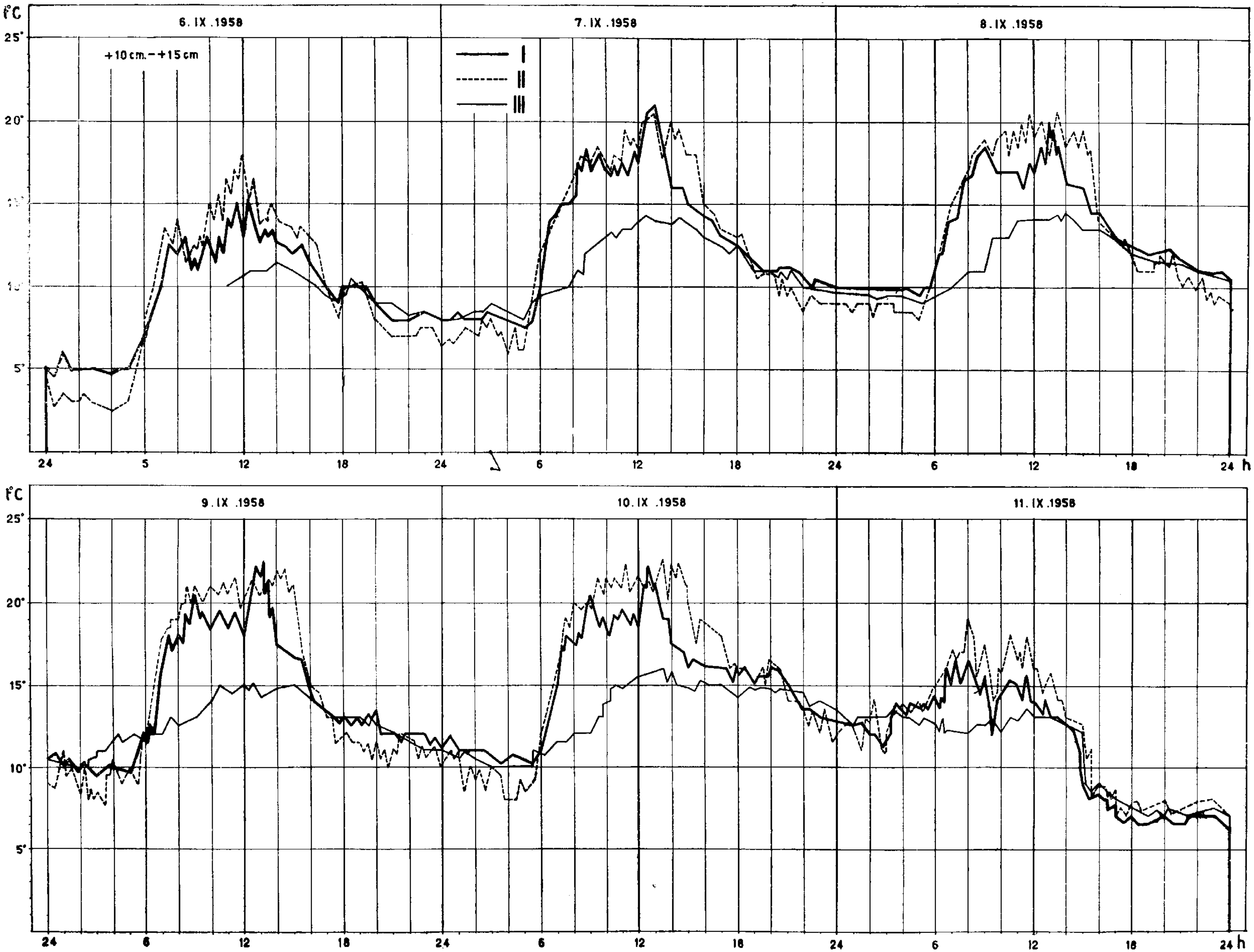


Diagram 36. — The course of air temperature in the stratus between 10 and 15 cm above the ground surface, at stations I, II and III, from the 6th to the 11th of September 1958

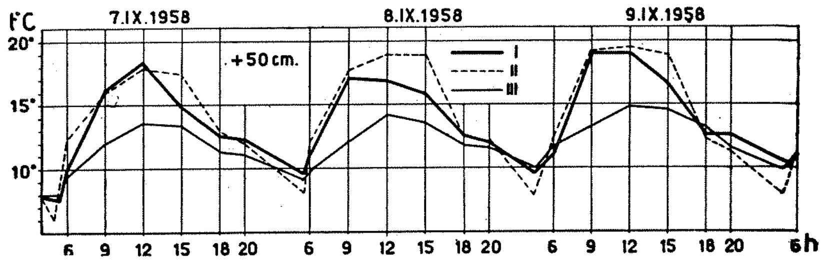


Diagram 34. — The course of air temperature at 50 cm above the ground surface at stations I, II and III, from the 7th to the 9th of September 1958.

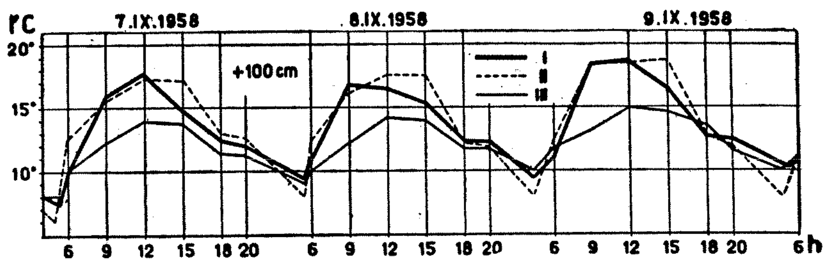


Diagram 35. — The course of air temperature at 100 cm above the ground surface, at stations I, II and III, from the 7th to the 9th of September 1958.

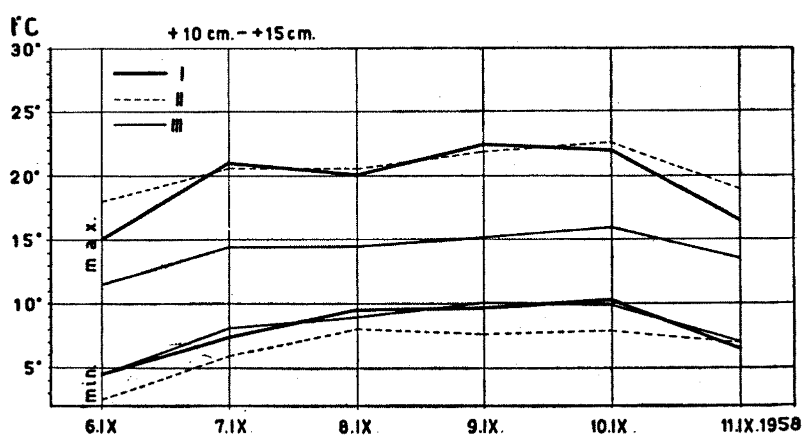


Diagram 37. — Maximum and minimum temperature in the air stratus between 10 and 15 cm above the ground surface, at stations I, II and III, from the 6th to the 11th of September 1958.

Table 16. — Temperature values for air and ground at stations I, II and III, on the 9th of September 1858.

Cm	9.IX.1958																	
	6 h			9 h			12 h			15 h			18 h			20 h		
	t° C			t° C			t° C			t° C			t° C			t° C		
	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III
+100	11,2	12,4	12,0	18,4	18,6	13,2	18,8	18,6	15,0	16,6	18,8	14,8	12,8	12,8	13,6	12,6	12,0	11,6
+ 50	11,0	12,4	11,8	19,0	19,2	13,2	19,0	19,4	14,8	16,6	18,8	14,6	12,6	12,2	13,2	12,6	11,4	11,6
+ 10	10,6	11,2	11,2	18,8	20,2	12,4	20,3	20,0	14,4	16,2	18,6	14,2	12,4	11,6	12,8	12,2	10,6	11,6
+ 1	10,8	9,6	10,6	18,2	16,6	11,8	19,6	17,0	13,4	16,2	16,0	13,2	12,4	11,0	11,8	11,8	10,6	11,0
− 2	10,4	9,4	9,6	13,2	14,6	9,8	15,8	22,4	10,8	15,4	23,6	11,0	13,6	17,2	10,6	12,6	13,0	10,0
− 5	11,0	10,2	9,6	11,6	14,4	10,0	13,4	19,6	10,4	14,2	21,6	10,6	13,6	18,0	10,6	13,0	14,0	10,2
− 10	11,4	12,4	10,0	11,4	12,8	10,0	12,0	16,2	10,2	12,8	18,1	10,2	13,0	18,2	10,4	13,0	14,8	10,4
− 20	11,6	14,2	9,8	11,6	13,8	9,8	11,6	14,0	9,8	11,8	14,6	9,8	12,0	15,4	9,8	12,0	15,4	9,8
− 30	11,2	14,2	9,8	11,6	14,0	9,8	11,4	14,0	9,8	11,4	14,0	9,8	11,4	14,2	9,8	11,2	14,4	9,8
− 50	11,0	14,2	9,2	11,0	14,2	9,2	10,5	14,2	9,2	11,0	14,2	9,2	11,0	14,0	9,2	11,0	14,0	9,2

Table 17. — Temperature differences (given in t° C) between stations I, II and III on the 9th of September 1958, calculated for every hour of reading and for every layer on which the observation was done

9. IX 1958	6 h t° C									
	cm −50	cm −30	cm −20	cm −10	cm −5	cm −2	cm +1	cm +10	cm +50	cm +100
I / II	3,2	3,0	2,6	1,0	0,8	1,0	1,2	0,6	1,4	1,2
I / III	1,8	1,4	1,8	1,4	1,4	0,8	0,2	0,6	0,8	0,8
II / III	5,0	4,4	4,4	2,4	0,6	0,2	1,0	0,0	0,6	0,4

9. IX 1958	9 h t° C									
	cm −50	cm −30	cm −20	cm −10	cm −5	cm −2	cm +1	cm +10	cm +50	cm +100
I / II	3,2	2,4	2,2	1,4	2,8	1,4	1,6	1,4	0,2	0,2
I / III	1,8	1,8	1,8	1,4	1,6	3,4	6,4	6,4	5,8	5,2
II / III	5,0	4,2	4,0	2,8	4,4	4,8	4,8	7,8	6,0	5,4

9. IX 1958	18 h t° C									
	cm −50	cm −30	cm −20	cm −10	cm −5	cm −2	cm +1	cm +10	cm +50	cm +100
I / II	3,0	2,8	3,4	5,2	4,4	3,6	1,4	0,8	0,4	0,0
I / III	1,8	1,6	2,2	2,6	3,0	3,0	0,6	0,4	0,6	0,8
II / III	4,8	4,4	5,6	7,8	7,4	6,6	0,8	1,2	1,0	0,8

9. IX 1958	20 h t° C									
	cm −50	cm −30	cm −20	cm −10	cm −5	cm −2	cm +1	cm +10	cm +50	cm +100
I / II	3,0	3,2	3,4	1,8	1,0	0,4	1,2	1,6	1,2	0,6
I / III	1,8	1,4	2,2	2,6	2,8	2,6	0,8	0,6	1,0	1,0
II / III	4,8	4,6	5,6	4,4	3,8	3,0	0,4	1,0	0,2	0,4

9. IX 1958	12 h t° C									
	cm −50	cm −30	cm −20	cm −10	cm −5	cm −2	cm +1	cm +10	cm +50	cm +100
I / II	3,7	2,6	2,4	4,2	6,2	6,6	2,6	0,3	0,4	0,2
I / III	1,3	1,6	1,8	1,8	3,0	5,0	6,2	5,9	4,2	3,8
II / III	5,0	4,2	4,2	4,0	9,2	11,6	3,6	5,6	4,6	3,6

9. IX 1958	15 h t° C									
	cm −50	cm −30	cm −20	cm −10	cm −5	cm −2	cm +1	cm +10	cm +50	cm +100
I / II	3,2	2,6	2,8	5,3	7,4	8,2	0,2	2,4	2,2	2,2
I / III	1,8	1,6	2,0	2,6	3,6	4,4	3,0	2,0	2,0	1,8
II / III	5	4,2	4,8	7,9	11	12,6	2,8	4,4	4,2	4

Table 18. — Maximum temperatures of separate layers of ground and air at stations I, II and III on the 9th of September 1958.

t° C max.	9.IX.1958									
	cm −50	cm −30	cm −20	cm −10	cm −5	cm −2	cm +1	cm +10	cm +50	cm +100
I	11,0	11,6	12,0	13,0	14,2	15,8	19,6	20,3	19,0	18,8
II	14,2	14,4	15,4	18,2	21,6	23,6	17,0	20,2	19,4	18,8
III	9,2	9,8	9,8	10,4	10,6	11,0	13,4	14,4	14,8	15,0

Table 19. — Differences between stations I, II and III regarding their maximum temperatures on the 9th of September 1958.

t° C max.— min.	9.IX.1958									
	cm −50	cm −30	cm −20	cm −10	cm −5	cm −2	cm +1	cm +10	cm +50	cm +100
I / II	3,2	2,8	3,4	5,2	7,4	7,8	2,6	0,1	0,4	0,0
I / III	1,8	1,8	2,2	2,6	3,6	4,8	6,2	5,9	4,2	3,8
II / III	5,0	4,6	5,6	7,8	11,0	12,6	3,6	5,8	4,6	3,8

Table 20. — Maximum and minimum air temperatures (stratus +10 cm to +15 cm), at stations I, II and III, from the 6th to the 11th of September 1958.

t° C		6.IX	7.IX	8.IX	9 IX	10.IX	11.IX
I	max. min.	15 4,5	21 7,5	20 9,5	22,4 9,7	22 10,2	16,5 6,5
II	max. min.	18 2,5	20,5 6	20,5 8	22 7,7	22,5 8	19 7
III	max. min.	11,5 4,5	14,4 8	14,5 9	15,2 10	16 10	14,3 7

Table 21. — Differences between stations I, II and III, regarding their maximum air temperatures (from +10 cm to +15 cm), from the 6th to the 11th of September 1958.

t° C max.	6 IX	7 IX	8 IX	9 IX	10 IX	11 IX
I / II	3	0,5	0,5	0,4	0,5	2,5
I / III	3,5	6,6	5,5	7,2	6	2,2
II / III	6,5	6,1	6	6,8	6,5	4,7

Table 22. — Differences between stations I, II and III regarding their minimum air temperatures (from +10 cm to +15 cm), from the 6th to the 11th of September 1958.

t° C min.	6 IX	7 IX	8 IX	9 IX	10 IX	11 IX
I / II	2	1,5	1,5	2	2,2	0,5
I / III	0	0,5	0,5	0,3	0,2	0,5
II / III	2	2	1	2,3	2	0

Table 23. — Diapason of air temperature variation (stratus +10 cm to +15 cm), at stations I, II and III from the 6th to the 11th of September 1958.

t° C	6.IX	7.IX	8.IX	9.IX	10.IX	11.IX
I	10,5	13,5	10,5	12,7	11,8	10
II	15,5	14,5	12,5	14,3	14,5	12
III	7	6,4	5,5	5,2	6	7,3

able 24. — Differences in diapason of air temperature variation (from +10 cm to +15 cm) between stations I, II and III from the 6th to the 11th of September 1958.

t⁰ C	6.IX	7.IX	8.IX	9.IX	10.IX	11.IX
I/II	5	1	2	1,6	2,7	2
I/III	3,5	7,1	5	7,5	5,8	2,7
II/III	8,5	8,1	7	9,1	8,5	4,7

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Rezime

M. M. JANKOVIĆ

PRILOG POZNAVANJU TERMIČKIH USLOVA U NEKIM FITOCENOZAMA METOHIJSKIH PROKLETIJA

U toku 1958 godine vršio sam fitomikroklimatska ispitivanja na metohijskim Prokletijama, na području Belopoljskih stanova, koje se nalazi između masiva Koprivnika i Ljubeničke planine. To je ustvari jedna prostrana uvala, na visini od oko 1400 m, otvorena prema Metohijskoj ravnici, odnosno prema istoku, dok je s juga, zapada i severa zatvorena visokim planinskim vrhovima i grebenima. U vegetaciskom pogledu ovo područje karakterišu uglavnom četinarske šume (munika, smrča, jela i molika). Čitavo područje izgrađeno je uglavnom od krečnjaka, dok se teren na koji se data posmatranja neposredno odnose nalazi isključivo na krečnjaku.

Fitoklimatska posmatranja vršena su tokom 1958 godine u tri maha, i to u proleće (od 12 do 15 maja), leto (od 8 do 18 jula) i jesen (od 6 do 12 septembra). Postavljene su tri mikroklimatske stanice: u munikovoj šumi (stanica I), na otvorenom polju (st. II), i u jelovo-bukovoj šumi (st. III). Na svakoj od ovih stanica registrovani su temperatura vazduha (na 1, 10, 50 i 100 cm iznad površine zemljišta), temperatura zemljišta (na dubinama od 2, 5, 10, 20, 30 i 50 cm ispod površine zemljišta), vlažnost vazduha, svetlosni intenzitet i intenzitet sunčevog zračenja. Očitavanje instrumenata vršeno je tokom dana svakih 2 časa. Na svakoj stanici bio je postavljen i po jedan Lambrecht-ov termohigrograf, i to na samu površinu zemljišta, tako da se njegovo pokazivanje temperature i vlažnosti odnosi na sloj vazduha od 10 do 15 cm iznad površine. Za merenje temperature vazduha živinim termometrima korišćeni su specijalni zaštitnici originalne konstrukcije (vidi M. M. Jankovnć, 1959). U ovom radu bilo je moguće da se prikažu samo osnovne karakteristike termičkih uslova vazduha i zemljišta, dok će ostali faktori biti prikazani drugom prilikom.

Stanica br. I postavljena je u čistoj munikovoj šumi (*Pinetum heldreichii typicum* M. Jank. prov.), koja je na strmim južnim padinama Koprivnika, iznad Belopoljskih stanova, razvijena na trijaskom krečnjaku, u pojasu od približno 1400 do 1900 m n.v. Pored munike (*Pinus heldreichii*), koja je edifikator ove zajednice, sreću se u njoj ponegde još i *Fagus moesiaca, Picea excelsa* i *Abies alba,* a na većim visinama i *Pinus peuce.* Od žbunastih i zeljastih biljaka kao karakteristične treba spomenuti *Juniperus intermedia, Rhamnus falax,* vrste rodova *Poa, Bromus, Festuca, Brachypodum* i *Thymus,* zatim *Verbascum nikolai, Primula columnae, Scabiosa columbaria* ssp. *portae, Daphne mezereum, Calamintha alpina* i dr. Oko same mikroklimatske stanice I, (koja je u munikovoj šumi postavljena na oko 150 m od ivice šume, na visini od oko 1460 m, na padini sa ekspozicijom S.SO i sa nagibom od oko 30°), nalazile su se pored dominantne munike, u spratu žbunova i po neka *Picea excelsa* odnosno *Fagus moesiaca,* a u prizemnom spratu *Poa ursina, P. pratensis, Brachypodium pinnatum, Thymus balcanus, Primula columnae, Fragaria vesca, Calamintha alpina, Verbascum nikolai, Euphorbia cyparissias, Calamintha vulgaris, Ajuga reptans, Anemone nemorosa, Polygala comosa, Daphne mezereum, Scabiosa columbaria* ssp. *portae, Mycelis muralis, Rhamnus falax, Trifolium ochroleucum, Lathyrus pratensis, Aremonia agrimonioides, Rumex acetosa, Lonicera alpigena, Veronica chamaedrys,* i druge.

Mikroklimatska st. II postavljena je na čistini sa niskom livadskom vegetacijom, na oko 80 m od ivice munikove šume, na južnoj padini sa nagibom od oko 20°. Oko same stanice, na dosta plitkom i skeletnom zemljištu na krečnjaku, rasle su uglavnom sledeće biljke, izgrađujući nizak vegetaciski pokrivač (prosečna visina 10 cm): *Juniperus nana, Euphorbia cyparissias* (najbrojnija!), *Primula veris, Calamintha alpina, Sedum* sp., *Thymus balcanus, Plantago* sp., *Hieracium pilosella,* i druge.

Stanica III postavljena je na suprotnoj strani doline, u mešovitoj jelovobukovoj šumi, razvijenoj na strmim krečnjačkim padinama okrenutim prema severoistoku, na oko 1420 m n.v. Bukva je u prvome spratu gotovo u potpunosti posečena, tako da je skoro jedini edifikator prvoga sprata *Abies alba* (sa ponekom smrčom). U spratu prizemnih biljaka ova zajednica karakteriše se sledećim biljkama, koje se nalaze i oko same stanice: *Cardamine bulbifera,* *Saxifraga rotundifolia, Oxalis acetosella, Euphorbia amygdaloides, Cardamine eneaphyllos, Hieracium murorum, Geranium robertianum, Mycelys muralis Chrysosplenium alternifolium, Vaccinium myrtyllus, Veronica officinalis, Nephrodium filix mas, Actea spicata, Mulgedium sonchifolium, Lamium luteum, Polystichum lobatum, Melampyrum silvaticum,* i druge.

U vremenu od 12 do 15 maja 1958 godine prilike na području Belopoljskih stanova karakterisale su se uopšte uzev gotovo potpunim otopljenjem snega na južnim padinama, što znači i u munikovoj šumi kod stanice I, i na otvorenom polju kod st. II, kao i njegovim zadržavanjem na severnim padinama, često u znatnim količinama (u ovo vreme nije se mogla da postavi st. III, usled nabujalosti Sušice koja je sprečavala pristup). Na livadi gde je postavljena st. II snega već uopšte nije bilo. Na njoj u to vreme masovno cvetaju *Crocus veluchensis, Scila bifolia, Corydalis solida, Gagea* sp., *Ficaria ranunculoides, Anemone ranunculoides.* Na vlažnijim mestima, kraj potoka Sušice, cvetaju *Caltha palustris, Chrysosplenium alternifolium, Taraxacum officinalis.* U munikovoj šumi gde je postavljena st. I snega u ovo vreme već nije bilo, tek su se ponegde zadržale manje gomilice snega. Ali ponegde sneg pokriva u munikovoj šumi i do 20% površine, naslagama debelim od 12 do 60 cm. U munikovoj šumi cvetaju *Crocus veluchensis, Primula veris* ssp. *officinalis, Scila bifolia, Muscari botryoides, Daphne mezereum, Potentila micrantha* i *Corydalis solida.* Kao što se vidi ovi prolećni dani polovinom maja karakterišu se ovde punim razvojem i masovnim cvetanjem niza efemernih biljaka na livadama i u munikovim šumama. Isto tako pada u ovo vreme na ovim visinama i početak listanja bukve.

Na dijagramima 1—9 prikazani su dnevni tokovi temperature na stanicama I i II, za 13 i 14 maj, u različitim slojevima zemljišta i vazduha.

U odnosu na temperaturu zemljišta pada pre svega u oči da je u toku dana najmanje variranje na dubini od —30 cm i —20 cm. Tako se u toku 13 i 14 maja temperatura na —30 cm vrlo malo menjala: od 6,8° do 7,6° C na stanici I, i od 9,5° do 10,9° C na st. II. Na dubinama —10 cm, —5 cm i —2 cm variranje temperature ne samo da je daleko veće, već su veće i same maksimalne temperature. To se naročito odnosi na sloj zemljišta od —2 cm. Ono što za temperaturu zemljišta na st. I i II treba naročito podvući jeste činjenica da u dubljim slojevima temperatura postepeno raste (mada u skromnim granicama) ka završetku druge polovine dana, tako da su maksimalne temperature između 16 i 19 h, dok u plićim horizontima (—10 cm, —5 cm) temperatura zemljišta dostiže najveće vrednosti između 13 i 16 h, a za sloj od —2 cm znatnije povećanje temperature zapaža se već u 10 h. Iz dijagrama (a naročito tablica 2—4), takođe se vidi i to da razlike u temperaturi zemljišta između munikove šume i pašnjaka postaju sve veće idući ka površini zemljišta. To je svakako odraz uticaja šume na zagrevanje samog zemljišta. Dalje, treba podvući vrlo važnu činjenicu da u vreme posmatranja, tojest polovinom maja, temperatura zemljišta kako u munikovoj šumi tako i izvan nje, dostiže relativno visoke vrednosti (na otvorenom polju do 27°, a u munikovoj šumi do 13,6° C).

Što se tiče temperature vazduha (dijagrami 6—9), pre svega pada u oči činjenica da temperaturne krivulje sa stanica I i II imaju vrlo sličan oblik, kao i to da su i visine njihovih vazdušnih temperatura tokom dana vrlo slične. To se ogleda prvenstveno u dosta malim razlikama između njihovih maksimalnih dnevnih temperatura (najviše 3,1° C). Ove razlike su neuporedivo manje od razlika koje su konstatovane između stanica I i II u pogledu temperature pojedinih slojeva zemljišta, naročito površinskih. Tako na pr. na —2 cm razlika je 13 maja iznosila čitavih 14,4° C! Van svake je sumnje da na izjednačavanje ili bar približavanje vrednosti temperatura vazduha u munikovoj šumi i iznad otvorenog polja utiče mogućnost mešanja šumskog i spoljašnjeg vazduha putem vazdušnih strujanja. Ova mogućnost, naravno, otpada, kada je u pitanju temperatura zemljišta. Inače, temperatura vazduha dostiže na otvorenom polju maksimalne vrednosti od 21,8° do 25,5° C, a u munikovoj šumi od 21° do 22,8° C. Temperatura vazduha dostiže svoj maksimum već oko 10 h, u nekim slučajevima oko 13 h, tako da dnevni temperaturni maksimum pada na vreme između 10 i 13 h. Po podacima dobijenim termohigrografom maksimum temperature vazduha pada oko 12 h.

Nema sumnje da upravo u relativno vrlo visokim prolećnim maksimalnim i minimalnim temperaturama zemljišta i vazduha u munikovoj šumi i na livadi izvan nje, kao i u vrlo vlažnom zemljištu uslovljenom topljenjem snega, treba videti jedan od najvažnijih uzroka bujnog razvoja i masovnog cvetanja vegetacije efemera-mezofita, polovinom maja.

Iz tablice 1 vidi se da u pogledu termičke slojevitosti vazduha i zemljišta postoji između munikove šume i otvorenog staništa jedna vrlo bitna razlika. Jasno se zapaža da je u jutarnjim časovima temperatura vazduha i na jednoj i na drugoj stanici veća od temperature zemljišta, koja sa dubinom sve više opada. Ali, dok se ovaj odnos, vazduh topliji a zemljište hladnije, u munikovoj šumi zadržava i docnije, u podnevnim i popodnevnim časovima, on se na otvorenom polju u suštini menja: ovde već oko 13 h temperatura zemljišta na dubini od —2 cm premašuje temperaturu vazduha. Ove razlike i specifičnosti u režimu termičke stratifikacije tokom dana uslovljene su pre svega uticajem koji na temperaturu, posebno zemljišta, vrši šumska vegetacija. Može se reći da šuma, a to se naročito odnosi na svetlije i otvorenije tipove, dopušta da tople vazdušne struje dopru u većoj ili manjoj meri sa otvorenih prostora, gde je vazduh mogao da bude maksimalno zagrejan površinom zemljišta ili uopšte površinom vegetacije, ali da s druge strane ne dopušta da zemljište bude maksimalno zagrejano jer ona za površinu zemljišta pretstavlja jedan više ili manje efikasan toplotni paravan. U tamnim i gustim šumama efikasnost ovog šumskog paravana ogromno se povećava, u svakom slučaju neuporedivo više nego što u njima opada mogućnost prodiranja toplih (ili hladnih) vazdušnih masa sa otvorenog prostora. Uopšte uzev može se reći da će u šumama za vreme toplih i sunčanih dana biti u podnevnim i popodnevnim časovima temperatura vazduha veća, ili bar ne manja, od temperature površinskih slojeva zemljišta, što je slika upravo obrnuta onoj koju imamo na otvorenim staništima sa niskom vegetacijom livada i pašnjaka. S druge strane, uopšte uzev, ima uslova da ova razlika između temperature vazduha i temperature zemljišta bude manja u otvorenijim i svetlijim šumama (u kojima je mogućnost prodiranja vazdušnih masa iz okoline veća ali i efikasnost temperaturne paravantnosti šumskog sprata drveća u odnosu na zemljište manja), a veća u zatvorenijim i tamnijim šumama, upravo zato što je u ovim poslednjim temperaturna paravantnost sprata drveća za sunčevo zračenje manje-više potpuna, dok mogućnost prodiranja (toplih) vazdušnih struja iz prostora izvan šume i dalje postoji, mada manje nego u slučaju otvorenih i svetlih šuma.

U toku jula 1958, za vreme posmatranja od 8 do 18, cvetaju u munikovoj šumi, kod st. I, sledeće biljke: *Thymus balcanus, Fragaria vesca, Calamintha alpina, Euphorbia cyparissias* (precvetava!), *Poa ursina, P. pratensis, Calamintha vulgaris, Ajuga reptans, Polygala comosa, Mycelis muralis* (početak cvetanja), *Brachypodium pinnatum.* U plodu se nalazila *Daphne mezereum.* Na livadi izvan šume (st. II), cvetaju uglavnom *Thymus balcanus* i *Calamintha alpina.* Najzad, u jelovo-bukovoj šumi, kod st. III, cvetaju *Hieracium murrorum, Saxifraga rotundifolia, Geranium sanguineum, Euphorbia amygdaloides, Veronica officinalis* i *Lathyrus pratensis,* dok su u plodu *Cardamine eneaphyllos, Arabis turrita* i *Actea spicata. Mulgedium sonchifolium* nalazio se i u cvetu i u plodu. Osim toga bile su prisutne, u vegetativnom stanju, i sledeće biljke: *Melampyrum silvaticum, Galium silvaticum, Oxalis acetosella, Gentiana asclepiadea, Campanula persicifolia, Mycelis muralis,* kao i paprati *Polystichum lonchitis, Phegopteris robertianum* i *Nephrodium filix mas.*

Temperatura zemljišta na dubini od —50 cm i —30 cm pokazuje u to vreme uopšte vrlo postojane vrednosti u toku dana, a takođe i u višednevnom posmatranom periodu. To se naročito odnosi na munikovu (I) i jelovo-bukovu šumu (II). Slična je slika i na livadi (III). Inače, razlike u temperaturi ovih slojeva između munikove i jelovo-bukove šume dosta su male, ali u poređenju sa otvorenim poljem pokazuju ove šumske zajednice znatne razlike u pogledu temperature ovih dubljih slojeva zemljišta: razlika je od 6 do 9,5°C.

U plićim slojevima zemljišta, idući od —20 cm pa do —2 cm, amplituda temperature postaje sve veća, opšte temperaturne vrednosti se povišavaju (često ka vrlo visokim vrednostima), razlike između pojedinih stanica postaju sve veće (da dostignu najzad u površinskim slojevima zaista izvanredno visoke vrednosti). Od bitnog je interesa da se na stanici II temperaturni maksimum na —20 cm postiže tek u 20 h, a minimum uopšte uzev oko 10 h! Nema sumnje da je ovakav tok temperature posledica sporog prenošenja toplote od površine zemljišta ka dubljim slojevima, što dovodi do zakašnjavanja u predaji energije sunčevog zračenja i određene inverzije u distribuciji temperature tokom dana u odnosu na tok temperature na površini zemljišta i u njegovim površinskim slojevima.

Na dubini od —5 cm i —2 cm razlike u karakteru temperaturne krivulje, kako u odnosu na maksimalne vrednosti temperature tako i u odnosu na veličinu temperaturne amplitude, između otvorenog polja (st. I) s jedne strane i šumskih zajednica (st. I i III) s druge, veoma se potenciraju. Dok se na stanicama I i III najviše temperature postižu u drugoj polovini dana, od 12 do 20 h, na stanici II najveće temperature su uglavnom između 10 i 16 h, sa maksimum u 14 h, što odgovara uglavnom i karakteru dnevnog toka intenzivnosti sunčevog zračenja. Na nivou od —2 cm bitne specifičnosti karaktera temperaturnog režima površinskog sloja zemljišta do krajnosti se potenciraju. Dok su razlike maksimalnih temperatura između I i III zaista minimalne (najviše do 1° C!), dotle su razlike između stanice II s jedne strane i stanica I i III s druge više nego ogromne. Tako je u toku ovih osam julskih dana najveća razlika konstatovana u temperaturi sloja od —2 cm između livade i munikove šume iznosila 22,6° C(!), a između livade i jelovo-bukove šume 23,2° C(!). S druge strane dok dnevno variranje temperature ovoga sloja u vremenu od 8 do 20 h nije naročito veliko u jelovo-bukovoj i munikovoj šumi (do 2,4° C, odnosno do 3,2° C), dotle je na otvorenom polju ono veoma znatno (do 18° C!).

Prema svemu što je rečeno jasno je da se upravo u pogledu karaktera temperaturnog režima površinskog sloja zemljišta, pre svega do dubine od 10 cm, temperaturni odnosi šumskih i zeljastih zajednica bitno razlikuju, i da su baš te razlike one koje proističu iz specifičnih osobina ova dva tipa vegetacije. Ravnomerniji dnevni tok temperature u svim slojevima zemljišta pod šumom, naročito površinskih, bitna je osobenost koja karakteriše šumsku zajednicu nasuprot zeljastoj, u kojoj ova temperatura varira u toku dana u vrlo širokim granicama. Osim toga maksimalne temperature zemljišta u šumi uopšte su dosta umerene (u našem slučaju videli smo da u munikovoj i jelovoj šumi ne prelaze vrednosti od 16,2° C, odnosno 15,2° C na nivou od —2 cm), dok su na otvorenom polju nasuprot tome vrlo visoke (na st. II dostižu vrednost od 37,5° C na nivou od —2 cm!).

Što se tiče temperaturnog režima vazdušne sredine na stanicama I, II i III u periodu od 9—17.VII.1958, može se videti (dijagrami 18 do 21) da između ove tri stanice u pogledu njegovog karaktera nema bitnih razlika. Uglavnom kretanja temperaturnih krivulja za sve tri stanice i za sve ispitivane slojeve, u suštini su istovetni. To se pre svega ogleda u tome da krivulje temperature vazduha tokom dana u munikovoj i jelovoj šumi uglavnom prate tok temperature vazduha na stanici II. Razlike ipak postoje, i one se mogu jasno uočiti na priloženim dijagramima. Treba istaći da, uopšte uzev, temperatura vazduha u munikovoj šumi, po svome toku i vrednostima, više odgovara temperaturi otvorenog polja, nego temperaturi vazduha u jelovoj šumi. Između ove dve šumske zajednice postoje u pogledu temperaturnog režima vazdušnih slojeva znatne razlike, i to i u drugim periodima godine. Amplituda dnevnog variranja temperature vazduha daleko je manja u jelovoj šumi nego u munikovoj. To se ogleda u njenom dosta ravnomernom toku. Osim toga, važna je činjenica da su maksimalne temperature vazduha u jelovoj šumi dosta niže od istih u munikovoj, a da su minimalne nasuprot tome više.

U vezi sa temperaturom vazduha jednu stvar treba takođe naročito podvući, s obzirom na njen ogroman značaj. U odnosu na temperaturu površinskih slojeva zemljišta, temperatura vazduha na livadi (st. II) je znatno niža (čak i za čitavih 10° kod maksimalnih dnevnih temperatura). Nasuprot tome temperatura vazduha u munikovoj i jelovo-bukovoj šumi je viša nego temperatura površinskih slojeva zemljišta. U munikovoj šumi maksimalna dnevna temperatura vazduha viša je za oko 8° C od maksimalne dnevne temperature zemljišta na nivou od —2 cm, a u jelovoj šumi za oko 7° C. Ove značajne osobenosti režima temperature šumske i zeljaste vegetacije, vezane za različite vrednosti, odnose i tokove temperatura vazduha i zemljišta, u početku su već bile podvučene i tom prilikom je istaknuto da su uslovljene paravantnom ulogom šume u odnosu na zagrevanje zemljišta sunčevim zračenjem, to jest s jedne strane nemogućnošću da zemljište pod šumom u punoj meri to zračenje primi, i mogućnošću, s druge strane, da kretanjem vazdušnih masa, uz pomoć naročito konvektivnih i advektivnih strujanja, topao vazduh sa otvorenih prostora prodre u šumu i donese šumskom vazduhu jedan deo one sunčane energije koju je u velikoj meri primilo zemljište izvan šume, odnosno i spoljašnja površina same vegetacije.

Da bi se specifičnosti temperaturnog režima u vazduhu i zemljištu ispitivanih zajednica što jasnije istakle, date su na dijagramima 22 i 23 temperaturne krivulje za nekoliko slojeva vazduha i zemljišta, za svaku stanicu posebno, i to za dane 11 i 16. VII. 1958 (11. VII je izrazito oblačan dan, a 16. VII izrazito sunčan). Dijagram broj 23, koji se odnosi na jedan izrazito sunčan dan, jasno ističe suštinsku razliku u temperaturnom režimu zemljišta i vazduha između munikove i jelove šume s jedne strane i livade s druge. Pre svega jasno se vidi da je između njih u pogledu visine temperature bitna razlika u temperaturi zemljišta, i to naročito njegovih površinskih slojeva, dok se temperatura vazduha u sve tri zajednice drži u približno sličnom okviru. Ono što pretstavlja suštinsku razliku u temperaturnom režimu ovih zajednica jeste pojava da su na otvorenom polju daleko najtopliji površinski slojevi zemljišta (—2 cm i —5 cm), a u šumskim zajednicama, nasuprot tome, najtoplija je vazdušna sredina. Prema tome temperaturni režim šumske atmosfere i pedosfere pokazuje sasvim određenu inverziju u odnosu na temperaturni režim jedne niske livadske zajednice. Osnovni uzrok ovoj pojavi napred je već više puta istaknut.

Posmatranja u septembru pokazuju one iste zakonitosti koje su konstatovane i prilikom ranijih ispitivanja.