Variations of free and triglyceride fatty acids in phloem of **Pinus taeda** infected by **Ceratocystis minor** *[1/]

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COMPENDIO

Ceratocystis *spp. (Ascomycetes, Sphaeriaceae) los agentes causales de las enfermedades de manchas azules de los pinos, son transmitidos por gorgojos (Scolytidae) Se supone generalmente que los gorgojos se benefician en esta asociación porque los hongos crean condiciones nutricionales y físicas más favorables. Sin embargo, los cambios bioquímicos que éstos hongos causan en el floema no son conocidos y este estudio fue conducido para determinar los cambios en las concentraciones de los lípidos*

El floema de rollizos de Pinus taeda *L. fue inoculado con* Ceratocystis minor *(Hedgcock) Hunt El floema infectado fue analizado para ácidos grasos de libres y de triglicéridos de dos y cinco semanas después de inoculación y los resultados fueron comparados con análisis similares de floema no infectado y del micelio de C.* minor *que fue cultivado por dos semanas en un medio definido químicamente. De los 14 componentes en el floema infectado y no infectado, con caracteristicas de ácidos grasos, separados por cromatografía gas-líquido, siete fueron identificados como ácidos linoléico, oléico, palmítico, linolénico, mirístico, esteárico y palmitoléico Solamente los siete ácidos grasos identificados estaban presentes en el micelio. Los contenidos totales de ácidos grasos libres y de triglicéridos disminuyeron en ambos floemas, no infectados e infectados, entre los análisis de dos y de cinco semanas, pero esta disminución fue más grande en el floema no infectado El contenido total del ácido graso triglicérido fue más grande que el contenido de ácido graso libre en el floema no infectado en ambos periodos El contenido de ácido graso libre del floema infectado fue más grande que aquel del floema no infectado en ambos periodos Generalmente los cambios en las concentraciones de los ácidos grasos individuales coincidieron con los cambios en las cantidades totales Se notaron diferencias en los esteroles, resinas y contenido de agua del floema*

Como aparentemente los insectos no pueden sintetizar ácidos grasos poliinsaturados, estos resultados refuerzan la hipótesis de que Ceratocystis *mejora las dietas de los gorgojos de pinos También los datos aumentan nuestro conocimiento bioquímico de* Ceratocystis *sometido a dos régimenes diferentes*

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Introduction

THE BLUE stain fungus, *Ceratocystis minor* Hedgcock) Hunt, is commonly associated with *Dendroctonus frontalis* Zimmerman, a very destructive pine bark beetle occurring in both North and Central America It is one of many symbiotic species of

Ceratocystis Ellis and Halstead that is transmitted to host trees by scolytid bark beetles (13, 14). These symbioses are little understood and the degree of interdependency may vary with the specific fungus- beetle association and ecological conditions. Both the fungi and the scolytids can live alone but very rarely do so in nature.* The fungi benefit because they are disseminated and carried into the trees by the scolytids (13). It is generally believed that the fungi benefit the scolytids through favorable physical or nutritional changes. Leach (13) considered the association to be truly mutualistic because *Ceratocystis* weakens the tree, reduces the water content of the tree, and modifies the microenvironment of the developing brood of beetles. Several researchers (3, 4, 5, 8, 15, 18, 19) concluded that the rapidity of drying of infested pine trees caused by blue stain infections is advantageous to bark beetle broods. Reid (23) correlated a decrease in sapwood moisture with an increase in blue stain infection and concurrent successful development of *Dendroctonus monticolae* Hopkins. Hodges *et al.* (11) suggested that the increase of insoluble N (protein) in phloem caused by *C. minor* might aid the development of *D. frontalis*. On the other hand, Barras and Hodges (2) speculated that a low C/N ratio in blue-stained phloem might adversely affect brood development or reproduction. Yearian *et al.* (31) found that the development of 3 species of *Ips* was not affected by *C. ips* Rumbold when the adult beetles and the fungus were introduced together in pine bolts. They (with *Ips spp.*) and Barras (1) (with *D. frontalis*) reported that *Ceratocystis* infections were detrimental when adult beetles were introduced into bolts experimentally infected at least 7 days beforehand, a condition unlikely to occur in nature. Norris *et al.* (21) found a nutritional dependency by the scolytid *Xyleborus ferrugineus* (F.) on its symbiotic fungi [e.g. *Fusarium solani* (Martius) Appel and Wollenweber] for ergosterol which this beetle requires for pupation.

The essentiality of certain lipids and non-essentiality of fat-soluble vitamins indicate that insects may have rather specific fatty acid requirements (10). Richeson *et al.* (25) found that *Ips calligraphus* Germar and its rearing medium, consisting mainly of phloem of *Pinus elliottii* Engelmann, contained similar fatty acids of which the 16:0 and 18:1 carbon acids dominated in the scolytid and 18:2 acids in the medium. Because most insects cannot synthesize polyunsaturated fatty acids (28, 29) Richeson *et al.* (25) concluded that the female adult required larger amounts of unsaturated acids (e.g.

The amounts of methyl esters of fatty acids dissolved in redistilled chloroform were determined by a modified gas-liquid chromatography (GLC) procedure (17). A flame ionization detector was used with helium as the carrier gas (flow rate of 60 ml/minute). The column was 152 cm long, 3.18 mm (1/8 inch) OD, stainless steel, and packed with 15 per cent diethylene glycol succinate on Gas-Chrom Q* (100-120 mesh). Isothermal parameters of the column, detector, and injector port were 180, 250, and 245°C, respectively. The amount of each fatty acid and unknown was calculated by the method of Kuksis (12) as indicated:

$$\text{mg FA}_{\text{total}} = \frac{\text{mg internal standard} \times \text{total FA area}}{\text{area of internal standard}}$$

The areas under the peaks were measured with a planimeter.

Resin acids were tentatively identified by TLC with abietic and pimaric acid standards. Before methylation these acids chromatographed with the FFA. However, they were separated selectively from the fatty acids at methylation because resin acids are not readily methylated with 14 per cent boron trifluoride as a catalyst (9, 17) nor resolved by the above GLC techniques unless methylated with diazomethane (20).

Results and discussion

Seven fatty acids common to *C. minor* and the phloem were linoleic, oleic, palmitic, linolenic, myristic, stearic, and palmitoleic (Table 1). Other fatty acids were not detected in the fungus. In addition, seven unidentified compounds were found in phloem samples of which the first four eluted from the GLC column were short chain compounds with less than 10 carbon atoms as indicated by retention times. Palmitic, stearic, oleic and linoleic acids and the predominance of unsaturated acids are common in fungi studied by others (7). Although cultured under somewhat different conditions, the fatty acids and their relative amounts in *C. minor* were similar to those reported by Sprecher and Kubeczka (27) in the mycelia of *Ceratocystis coerulescens* Stamm, particularly in mycelium they cultured under higher oxygen tensions. Unlike these authors, we found no fatty acids above 18:3. These seven fatty acids correspond to the fatty acids of *I. calligraphus* and its artificial diet with a base of phloem from *P. elliottii* (25).

Total TFA and, generally, the individual TFAS were greater than the amount of FFA in uninfected phloem and cultured fungus but FFA was greater in infected phloem. In other words, in the culture medium with a poor carbon source, *C. minor* synthesized fatty acids and stored them as TG whereas it predominantly produced FFA in phloem which has a large carbon source. In the latter, the fungus apparantly hydrolyzed the phloem TG or blocked the synthesis of TG by the phloem in addition to FFA synthesis. These results agree with the generalizations in fungal lipid metabo-

* Clark, E. W. Summary of the 1965 survey and biological studies on the southern pine beetle and its host in Honduras. 24 pp. + 18 illus. 1965. (Unpublished report of insect survey in Honduras in 1965 made by E. W. Clark, J. F. Coyne and W. B. Critchfield. Nº HON/TE/FO WCRF under the Expanded Programme for Technical Assistance financed by the United Nations Development Programme.) Clark found both *Ceratocystis* and *D. frontalis* alone.

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Table 1.—Free fatty acids (FFA) and triglyceride fatty (TFA)* in: mycelium of *C. minor* after 2 weeks in liquid culture; uninfected phloem after 2 and 5 weeks; and phloem infected by *C. minor* after 2 and 5 weeks.

Fatty acid	2 weeks		2 weeks				5 weeks			
	Mycelium		Uninfected		Infected		Uninfected		Infected	
	FFA	TFA	FFA	TFA	FFA	TFA	FFA	TFA	FFA	TFA
U**-1	0	0	0.01	0.02	0.01	***	0.02	0.01	***	0.01
U-2	0	0	0.12	0.02	0.01	***	0.04	0.02	***	0.01
U-3	0	0	0.12	0.16	0.01	0.08	0.16	0.08	0.12	***
U-4	0	0	0.20	0.08	***	0.32	0.16	0.08	0.08	0.02
Myristic	0.64	2.64	0.01	0.02	0.01	0.34	0.10	0.04	0.12	***
U-5	0	0	0.32	0.01	***	***	0.08	0.06	0.04	***
Palmitic	0.24	0.72	0.01	1.24	1.68	0.68	0.40	0.28	1.36	0.40
Palmitoleic	0.08	0.04	0.01	***	***	0.16	0.02	0.03	0.01	***
U-6	0	0	***	***	***	0.08	0.02	***	***	***
Stearic	0.24	1.12	0.16	0.30	0.40	0.12	0.10	0.24	0.48	0.16
Oleic	0.72	6.16	0.55	7.92	9.84	2.16	0.32	0.88	4.16	1.44
Linoleic	4.08	9.20	0.42	6.28	3.36	1.88	0.24	1.05	1.52	1.36
U-7	0	0	0.20	0.02	1.04	0.02	***	0.08	0.68	0.01
Linolenic	0.48	2.16	0.24	0.88	1.28	***	0.04	0.04	1.24	0.01
Totals	6.48	22.04	2.38	17.05	17.64	5.84	1.70	2.8	9.81	3.42

* Mean values (mg/g dry weight) from three replications.

** U = unknown

*** Less than 0.01 mg/g dry weight, the arbitrary lower limit of quantitation set for this study.

lism that the FFA content varies with cultural conditions and that the relative amounts of FFA increase with any factor that increases fat formation (7).

Decreases in total FFA and TFA occurred with time in both uninfected and infected phloem. However, the changes varied with the individual fatty acids, time, and presence of fungus. At 2 weeks, the total FFA of infected phloem was ca. 7 times and TFA ca. 1/3 of those amounts found in uninfected phloem. In the latter the total TFA was ca. 7 times more than the FFA content. Five weeks after inoculation this general relationship was the same. However, the total amounts of TFA and FFA had decreased appreciably, particularly TFA of uninfected phloem which dropped to ca. 1/6 the amount found in uninfected phloem at 2 weeks. The individual fatty acids usually followed this pattern. At 5 weeks, total FFA and TFA in infected phloem were ca. 5.8 and 1.2 times greater than those amounts found in uninfected phloem, the difference being attributed to the effect of the fungus.

Ceratocystis would definitely contribute to the nutrition of the female *I. calligraphus*, and presumedly other coniferous scolytids, if amounts of polyunsaturated fatty acids in addition to those present in healthy phloem are required for reproductive activities (25). For example, at the end of 5 weeks there was a total of 4.58 mg/g (dry weight) of unsaturated fatty acids in uninfected and 13.23 mg/g in infected phloem. Of the latter, 9.73 mg/g consisted of 18-carbon unsaturated fatty acids, an increase of ca. 74 per cent over the total in uninfected bark (an increase of ca. 67 per cent in total polyunsaturated acids). Hypothetically, the increase in the concentrations of fatty acids in infected phloem could improve the nutrition of *D. frontalis* and *Ips* spp. mass reared on bolts in the laboratory (6) because the techniques used are quite similar to those used herein to culture *Ceratocystis* on bolts. Under these conditions, and if the rates of decrease of fatty acids remained constant, uninfected phloem would have little or no fatty acids in ca. 42 days and the infected phloem would have none in ca. 63 days. Essential fatty acids in unin-

fected phloem might thus be depleted before the entire brood completed larval development, a period which usually requires 30 70 days in the mass-rearing technique The dominance of FFA in fungal-infected phloem also may be beneficial because it could simplify larval digestion

Total extractive, as well as FFA and TFA, decreased in uninfected and infected phloem between the 2- and 5-week periods. However, more extractives were obtained from infected than from uninfected phloem, i.e. ca 40 per cent of the infected and 9 per cent of the uninfected phloem was extractable at 2 weeks, and 20 and 8 per cent respectively, at 5 weeks Only 3 per cent of the fungal material was extractable. A large undetermined amount of extractives with physical properties typical of resin acids, based on extraction, TLC, esterificaction, and other characteristics of the resin acid standards, was found in 2- and 5-week-old infected phloem, but only a trace was present in uninfected phloem After the removal of the fatty acids, this resin-acid component was, by visual estimation, more than the remaining combined polar and nonpolar compounds on the TLC sheets Thus, the variation between the amount of extractives in infected and uninfected phloem was largely attributed to resinosis caused by the fungal infection, a phenomenon reported to accompany the invasion of pine tissues by *Ceratocystis* (e g 3, 24, 26) Cursory TLC analyses showed sterols to be prominent in the extractives. Beta-sitosterol and a small amount of campesterol were present in both infected and uninfected phloem Traces of ergosterol and cholesterol were found only in fungal-infected pholem. Further investigations of resin acids and sterol were not undertaken

The moisture content decreased an average of ca 5 per cent between the second and fifth week in both uninfected and infected phloem It was ca 10 per cent lower in infected phloem than in uninfected pholem, the range in infected pholem being 70-80 per cent at 2 weeks and 60-70 per cent at 5 weeks. The additional moisture loss from infected bolts under standardized laboratory conditions indicates that blue stain fungus, in addition to blocking (longitudinal) water conduction, may increase radial water movement This process could occur through perforation of the sapwood as a result of the hyphal penetration of the pits and tracheid walls (30) or physiological activities of the fungus

Clark and Osgood (6) noted a similar moisture loss during the development of techniques for bark beetle rearing They found that lowered bark moisture definitely favors the development of *D. frontalis* larvae, i.e., for rearing, the upper phloem moisture limit was 80 per cent and the optimal range between 50-60 per cent.

In addition to improved physical conditions, it is conceivable that the decrease in moisture of food ingested by the scolytids might improve phagostimulation and the consumption and utilization of nutrients, and hence the rate of growth and development McKinlay and Randell (16) showed that removal of the high moisture content of food for *Melanoplus sanguinipes* (F) increased the intake of solids which increased survival and body weight

Conclusions

It is not known if *Ceratocystis* causes changes in the concentrations of fatty acids of phloem of bark beetle-infested trees similar to those occurring in bolts artificially infected with fungus in the laboratory. On the assumption that it does, concomitant growth of symbiotic fungi would, in addition to improving moisture conditions, maintain a minimum nutritional supply of fatty acids throughout the larval period. These results thus would support the hypothesis that *Ceratocystis* improves the dietary of pine bark beetles, in particular the speculation of Richeson *et al.* (25) that these symbionts contribute essential fatty acids to the beetle's diet. This study also increases our biochemical knowledge of *Ceratocystis* placed in two different environmental regimes

Summary

Ceratocystis spp (Ascomycetes, Sphaeriaceae), the causal agents of blue-stain diseases in pine trees, are transmitted by bark beetles (Scolytidae). It is generally thought that the beetles gain in this association by the fungi creating more favorable nutritional and physical conditions However, the biochemical changes that these fungi cause in the phloem is not known, and this study was conducted to determine the changes in lipids.

The phloem of bolts of *Pinus taeda* L. was inoculated with *Ceratocystis minor* (Hedgcock) Hunt The infected phloem was analyzed for free and triglyceride fatty acids 2 and 5 weeks after inoculation, and the results were compared to similar analyses of uninfected phloem and mycelium of *C. minor* cultured for 2 weeks in a chemically defined medium Of the 14 fatty-acid-like components in both infected and uninfected phloem, resolved by gas-liquid chromatography, seven were identified as linoleic, oleic, palmitic, linolenic, myristic, stearic, and palmitoleic acids. Only the seven identified fatty acids were present in the mycelium The total triglyceride and free fatty acid contents decreased in both uninfected and infected phloem between the 2- and 5-week analyses, but this decrease was greater in uninfected phloem than in infected phloem. The total triglyceride fatty acid content was greater than the free fatty acid content in uninfected phloem in both periods. The free fatty acid content of infected phloem was greater than that of uninfected phloem at both periods. Generally, changes in the concentrations of the individual fatty acids coincided with the changes in the total amounts Differences in sterols, resin, and moisture content of phloem were noted.

Because apparently insects cannot synthesize polyunsaturated fatty acids, these findings support the hypothesis that *Ceratocystis* improves the dietary of bark beetles The results also increase our biochemical knowledge of *Ceratocystis* placed in two different environmental regimes.

Resumo

Os agentes causais das doenças de manchas azuis dos pinheiros, *Ceratocystis spp* (Ascomycetes, Sphaeria-

ceace) são transmitidas por besouros (Scolytidae). Supõe-se que os besouros levem vantagem nesta associação porque os fungos poderiam criar condições nutricionais e físicas mais favoráveis para os insetos. Como as transformações bioquímicas que estes fungos causam no floema não são conhecidas, conduziu-se este estudo para determinar as mudanças nas concentrações dos lipidos.

O floema de pedaço de caule de *Pinus taeda* L., com aproximadamente 20 cm de comprimento, foram inoculados com *Ceratocystis minor* (Hedgecock) Hunt. No floema infecto analisaram-se os ácidos graxos livres e os ácidos graxos triglicéridos nos períodos de 2 e 5 semanas seguintes à inoculação. Os resultados foram comparados com análises similares de floema não infectado e do micélio de *C. minor* que foi cultivado por duas semanas num meio definido quimicamente. Dos 14 componentes no floema infectado e não infectado, com as características de ácidos graxos separados por cromatografia gás-líquido, sete foram identificados como ácidos linoléico, oléico, palmítico, linolênico, mirístico, esteárico e palmitoléico. Somente estes setes ácidos graxos identificados estavam presentes no micélio. Os conteúdos totais de ácidos graxos livres e ácidos graxos triglicéridos 18:2) than supplied by the phloem, and that fungi and yeast associated with *Ips* might synthesize them. However, the influence of such microorganisms on the availability of dietary fatty acids during development of scolytids it not known. Because of our interest in the interrelationship of pine bark and their dietary, a study was conducted on the effects of *C. minor* on the free fatty acids (FFA) and triglyceride fatty acids (TFA) of the phloem of *Pinus taeda* L. under laboratory conditions, the results of which are reported herein.

Materials and methods

The research for this study was conducted in the Forestry Sciences Laboratory, USDA, Forest Service, Research Triangle Park, North Carolina, U.S.A. FFA and TFA were quantitatively analyzed in 3 regimes: mycelium, uninfected phloem, and phloem on which the fungus was cultured for periods of 2 and 5 weeks. The differences were then compared to determine the availabilities of these acids in the phloem on which *D. frontalis* feeds.

Fungus

C. minor, isolated from infected phloem of *P. taeda* attacked by *D. frontalis*, was maintained in stock culture on a malt extract agar medium (agar, 25 g; malt extract, 20 g; dextrose, 20 g; peptone, 1 g; and distilled water, 1000 ml). For fatty acid analyses, the fungus was cultured in the following liquid medium originally developed to culture *Hypoxylon pruinatum* (Klotzsch) Cooke (22):

Ingredient	*Quantity*
$MgSO_4 \cdot 7H_2O$	83 mg
KH_2PO_4	83 mg
KCl	42 mg
$FeCl_3 \cdot 6H_2O$	0.24 mg
$ZnCl_2$	0.15 mg
H_3BO_3	0.06 mg
$CuCl_2 \cdot 2H_2O$	0.05 mg
$MnCl_2 \cdot 4H_2O$	0.04 mg
$Na_2MoO_4 \cdot 2H_2O$	0.03 mg
glucose	10 g
asparagine	471 mg
thiamine	0.1 mg
biotin	0.005 mg
water to make	1 liter

The mediun was adjusted to pH 6.0 with glacial acetic acid.

Two hundred and fifty ml of this medium were added to each of 4 culture flasks (2500 ml, low form), the flasks plugged with sterile cotton, capped by aluminum foil, and autoclaved at 1.05 kg/cm² for 15 minutes. They were then inoculated under aseptic conditions with 5 ml of an aqueous suspension of *C. minor* grown on the agar medium. These liquid cultures were incubated with no agitation in a darkened transfer room at 25°C. After 2 weeks the mycelia were filtered from the cultures, washed with distilled water, pooled, lyophilized, weighed, and stored at -15°C.

Pine phloem

Three 18-year-old pines *(P. taeda)* were felled in February 1970. The trunk of each tree was cut into 9 sections (bolts), approximately 20 cm in diameter and 60 cm long, which were numbered consecutively from the base upward. After sealing the ends with melted paraffin to inhibit moisture loss, the 27 bolts were held for 48 hours in the laboratory before inoculation.

Bolts 3, 6, and 9 of each tree were used as controls, and the remaining 6 were each aseptically inoculated on opposite sides with *C. minor*. At 15 cm intervals a small area of outer bark was smoothed, washed with 70 per cent ethanol, and a plug of outer bark was removed carefully with a sterilized cork borer (15 mm diameter). After the phloem was inoculated, each plug was replaced immediately and the area was sealed with melted paraffin. Both inoculated and control bolts were placed in 761 galvanized cans which were tightly covered to maintain bark moisture. Bolts 1, 5 and 7 were maintained at room temperature for 2 weeks and bolts 2, 4, and 8 for 5 weeks.

Samples of phloem from each bolt were collected at the end of the 2- and 5-week incubation periods. Selection of blue-stain infected phloem was by discoloration and presence of dark mycelia. These samples were weighed, vacuum-dried until weight loss was negligible, and ground in a small Wiley mill through a 20-mesh screen. From these samples, 4 composite samples (infected and uninfected phloem at 2- and 5-week periods) were then made and stored at -15°C.

Chemical analyses

Duplicate 500-mg samples of dried mycelium or phloem were extracted for FFA and triglycerides (TG) in a Soxhlet apparatus with diethyl ether for 24 hours.

After removal of the ether over a steam bath, the extracts were weighed, dissolved in redistilled chloroform and the internal standards *n*-heptadecanoic acid and triheptadecanoin added. They were then preparatively separated by thinlayer chromatography (TLC). The extracts were streaked on ChromAR 500 or 1000* sheets, developed with petroleum: ether-diethyl: ether-glacial acetic acid (90:10:1, v/v/v) for a distance of 15 cm. and the compounds were visualized with iodine vapor. Strips containing the FFA and TG were cut from the chromatograms and extracted with 100 ml of chloroform-methanol (1:1, v/v) in a Soxhlet apparatus for 6-8 hours. Total recovery was confirmed by air-drying the extracted strips and treating them with 3-5 per cent ethanolic phosphomolybdic acid. The solvent was removed from the extracts on a steam bath. The TG were saponified with 0.5 N methanolic NaOH for at least 6 minutes. FFA and TFA were methylated for 3 minutes with boron trifluoride-methanol (14 per cent, w/v) (17). Methylation, as determined by TLC, was complete except for the FFA fractions of infected phloem.

diminuiram em ambos os floemas infectados e não infectados entre as análises de duas e cinco semanas; mas esta redução foi maior no floema não infectado. O conteúdo total de ácidos graxos triglicéridos foi maior do que o de ácidos graxos livres no floema não infectado em ambos os períodos. A proporção total de ácidos graxos livres do floema infectado foi maior do que aquele do floema não infectado, em ambos períodos. Geralmente as variações nas concentrações dos ácidos graxos individuais coincidiram com àquelas nas quantidades totais. As diferenças nos esteróides, resinas e conteúdo de água do floema foram anotados.

Porque aparentemente insectos não podem sintetizar ácidos graxos poliinsaturados estes resultados suportam o hipótese que *Ceratocystis* melhora as dietas dos besouros de pinhos. Também os dados aumentam nosso conhecimento bioquímico de *Ceratocystis* mantido em dois regimes diferentes.

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Notas y Comentarios

Publicaciones

Veterinaria Tropical. El Fondo Nacional de Investigaciones Agropecuarias, de Venezuela, ha iniciado la publicación de una revista, *Veterinaria Tropical*. Substituye al antiguo *Boletín del Instituto de Investigaciones Veterinarias*, que apareció en 1942. El primer número contiene exclusivamente trabajos originales de investigación, en número de 11, que cubren 136 páginas. La revista tiene el tamaño y formato iguales a *Agronomía Tropical*. El coordinador es Juan E. Rodríguez, y la dirección es CENIAP, Apartado 70, Maracay, Aragua, Venezuela.

Mazingira. Con el apoyo del Programa de Naciones Unidas para el Medio Ambiente (PNUMA) se ha iniciado la publicación de una nueva revista trimestral, *Mazingira*, destinada a crear conciencia sobre la gran variedad de problemas ambientales que existen en nuestro planeta. *Mazingira* significa "medio ambiente" en swahili, que es la lengua bantú hablada en Nairobi, Kenia, donde está la sede del PNUMA. El primer número que tiene fecha de 1977, está dedicado en gran parte al tema del cambio climático. Se espera que en el resto del año se traten otros problemas como la desertificación, y el crecimiento en relación con el ambiente. La revista está editada por la Pergamon Press, en Oxford, su director es András Biró, y tiene ediciones en inglés, francés y español.

El Cacaotero Colombiano. Una nueva revista trimestral, *El Cacaotero Colombiano*, apareció con fecha junio de 1977. Es publicada por la Compañía Nacional de Chocolates, de Colombia. Está dividida en cuatro secciones: Producción y Consumo; Agronomía del Cultivo; Extensión y Fomento; y Técnica. El director es Luis Julián Moreno. La dirección es: Apartado Aéreo 717, Medellín, Colombia.

Coloquio Internacional sobre el Café

El Octavo Coloquio Científico Internacional Sobre el Café del ASIC (Asociación Científica Internacional del Café) se llevó a cabo con mucho éxito en Abidjan, Costa de Marfil del 28 de noviembre al 4 de diciembre 1977.

La Asociación tiene su sede en París y después de los dos primeros Coloquios llevados a cabo en dicha ciudad, los otros se han efectuado cada dos años en distintos países. Después del Coloquio de 1973 en Bogotá se decidió incluir aspectos agronómicos y botánicos además de los químicos dentro de los temas de discusión.

La apertura oficial del Coloquio se hizo por el Sr. Presidente de la República de la Costa de Marfil, Félix Houphouet-Boigny. Se notó en el curso de la reunión un número superior a doscientos delegados de más de 20 países. Los temas discutidos incluyeron: química, tostado, extractos, aroma, calidades organolépticas, efectos debidos a la cafeína, consumo de café y estado de salud, agronomía, fito-mejoramiento- innovaciones agrotécnicas en caficultura, riego, *Hemileia vastatrix* y *coffeicola*.

Hubo 15 conferencias plenarias y 28 comunicaciones sobre trabajos de investigación. Todo este material se publicará en las actas del Coloquio.

Se dedicó un día a la visita de una plantación y de un beneficio de café.

Reseña de Libros

JACKSON, I. J., Climate, water and agriculture in the tropics. London, Longman, 1977. 248 p.

Este libro cubre el clima en cuanto éste afecta el balance hídrico, el cual a su vez determina en muchas áreas del trópico el rendimiento de las plantas.

Los capítulos uno a cinco tratan el aspecto climatológico de la lluvia y la evaporación, cubriendo aspectos como el ciclo hidrológico, orígenes de la precipitación, variaciones estacionales, de intensidad, duración y frecuencia de la lluvia y por último la evaporación.

Los capítulos seis a ocho cubren en forma muy generalizada la relación agua-planta con un enfoque basado en experiencias tropicales. El capítulo nueve y último estudia el impacto del hombre en el ciclo hidrológico.

La primera parte del texto puede servir de referencia en cursos de climatología general o agrícola pues se explica en forma concisa y clara los fenómenos que afectan la precipitación en los trópicos. La segunda sección podría usarse en el capítulo introductorio de cursos como Riego y Drenaje o Producción de Cultivos, todos a nivel universitario, en especial el capítulo siete que incluye las necesidades climáticas por cultivos.

El título del libro es muy ambicioso tanto que el texto cubre sólo un aspecto del clima (precipitación) y apenas si estudia el aspecto agronómico de la relación agua-planta.

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MEMENTO de l'Agronome; tecniques rurales en Afrique, 2a. ed. Paris, Ministére de la Coopération, 1974. 1591 p.

Ahora que está en marcha un proyecto de traducir al español este manual, adaptándolo a la América Latina, y que para esta tarea el gobierno francés ha destinado a un profesional, es conveniente mencionarlo como un breviario muy útil para el agrónomo. Los agrónomos que hemos visto con cierta envidia los gruesos manuales de trabajo, repletos de cifras y fórmulas, que ayudan tanto a nuestros colegas químicos, topógrafos y farmacéuticos, podemos tener una obra similar, en castellano, sobre agronomía tropical.

En más de 1500 páginas apretadas, el libro permite tener una visión resumida de las ciencias agrícolas, proporcionando un gran volumen de datos, evitando al profesional búsquedas largas en su biblioteca y libretas de apuntes.

Después de generalidades sobre el substrato de la agricultura, que abarca geografía y clima, el libro comienza con capítulos de suelos, fertilización y producción de materia vegetal. Siguen las ciencias de ingeniería auxiliares de topografía, teledetección (que incluye sensores remotos), irrigación y drenaje, conservación de suelos y mecanización. Entra después a los cultivos especiales (principalmente tropicales de Africa), alimentación animal, forrajes, zootecnia (que incluye sanidad y avicultura). Las ciencias económicas siguen después, separadas en general y rural. Termina el libro con sendos capítulos sobre estadística aplicada, informática, y unas 60 páginas de tablas matemáticas de conversión de medidas, actuariales y de cálculos simples.

Esperamos que llegue a cristalizarse con éxito la edición en castellano que se ha propuesto el gobierno de Francia.

INFORMACION BASICA del sector agropecuario de Costa Rica. San José, Oficina Planificación Sectorial Agropecuaria (OPSA), 1977. 107 p.

Este es un librito útil que reune información estadística sobre el sector agropecuario de Costa Rica que estaba dispersa en muchas publicaciones o que no estaba publicada. En 85 cuadros reune datos sobre aspectos generales de la macroeconomía del país, y estadísticas detalladas sobre su agricultura. Es el tipo de información que todo aquel que inicie un estudio sobre un país tiene que emplear tiempo y esfuerzo en recopilarla antes de entrar en el tema específico que le interesa. Es la parte básica desde la que el investigador se adentra en su exploración y que es conveniente tener ya preparada, como en este caso, para no duplicar una labor previa que otros pueden haber realizado ya. Como obra de consulta es invalorable para el que escribe sobre el país. La información es escueta y sin interpretaciones ni análisis, lo que se deja para que sea hecho por quienes la utilizan para fines específicos. No es difícil predecir que será sometida a una constante demanda, dentro y fuera del país.

Para responder a esta demanda, es conveniente reimprimir el libro con frecuencia, actualizando los datos que contiene. Si esto se piensa hacer, sugerimos se tenga más cuidado en la posición de los cuadros cuando se ponen de costado en una página (Números 20, 24 y 74 por ejemplo), y realizar una lectura más minuciosa de las pruebas; (en el Cuadro 56, hemos encontrado por lo menos 10 nombres científicos mal escritos en un total de 40 especies forestales). Queremos creer que este es el caso extremo y parece ser así; esperamos que para la próxima edición estas fallas desaparezcan para que el usuario de esta obrita de referencia tenga más confianza en los datos que allí encuentre.