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THE JUNIPERS (JUNIPERUS; CUPRESSACEAE) OF HISPANIOLA: COMPARISONS WITH OTHER CARIBBEAN SPECIES AND AMONG COLLECTIONS FROM HISPANIOLA

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Adams, Robert P. (Sciense Research Center at Salt Lake, Hardin-Simmons University, 360 Wakara Way, Salt Lake City, Utah 84108, U.S.A.) The junipers (*Juniperus;* Cupressaceae) of Hispaniola:, comparisons with other Caribbean species and among collections from Hispaniola. Moscosoa 2(1), 77-89, 1983. Samples from four populations of *Juniperus* were collected from Hispaniola and compared with *J. bermudiana* (Bermuda), *J. lucayana* (Bahamas and Jamaica), and *J. silicicola* (Florida). Principal coordinate analyses of morphological and terpenoid data indicate that the junipers of Hispaniola are quite distinct from the other Caribbean species. *Juniperus lucayana* (sensu Bahamas and Jamaica) was not found on Hispaniola. *Juniperus urbaniana* was not collected but is presumed to be extant at the type locality on top of Pic La Selle, Haiti. The junipers collected from Hispaniola appear to represent two species: *J. gracilior* from central-western Dominican Republica and *J. ekmanii* from Massif de la Selle, Haiti. Junipers from the Pelempito region of the Dominican Republic and from northern Haiti (Ennery region) are most closely related to *J. ekmanii*. All the junipers from Hispaniola should be considered endangered species.

Las sabinas *(Juniperus;* Cupressaceae) de la Española: comparaciones con las otras especies del Caribe y entre las colecciones de la Española. Muestras de cuatro poblaciones de *Juniperus* fueron recolectadas en la Española y comparadas con *J. bermudiana* (de Bermuda), *J. lucayana* (de las Bahamas y de Jamaica), y *J. silicicola* (de Florida, EE. UU. A.). Los analyses de coordinados principales de los datos de la morfologia y la química (aceites esenciales y terpenoides) indican que las sabinas de la Española son muy distintas de las otras especies del Caribe. *Juniperus lucayana* (como de las Bahamas y de Jamaica) no fue redescubierto en la Española. *Juniperus urbaniana* no fue recolectado pero presumiblemente existe todavía en su lugar típico en la cima del Pic La Selle, Haiti. Las sabinas recolectadas en la Española aparentan representar las dos especies: *J. gracilior* de la Cordillera Central de la República Dominicana y *J. ekmanii* de Massif de la Selle, Haiti. Las sabinas de la zona de Pelempito, Provincia Pedernales, República Dominicana y de la parte norte (cerca de Ennery) de Haiti son las relaciones más cercanas a *J. ekmanii*. Todas las sabinas de la Española están en peligro de extinción.

The native junipers of Hispaniola have been enumerated by Moscoso (1943) as *Juniperus ekmanii* Florin, *J. gracilior* Pilg., *J. lucayana* Britt., and *J. urbaniana* Pilg. and Ekman. As part of a reappraisal of the Caribbean junipers, collections were made in Hispaniola to examine both morphological and chemical (terpenoid) characters of these junipers and relate these data to their taxonomic relationship. Due to the rapid rate of destruction of the native flora of Hispaniola (particularly Haiti), the collection and analysis of these junipers are critical. There si little agreeement on how many junipers species are present in the Caribbean and that question will be addressed in a later investigation (Adams, in progress). In general, Florin (1933) will be followed in the interim. He recognized *J. saxicola* Britt. and Wils. from Cuba; *J. lucayana* Britt. from Cuba, Haiti, Jamaica, and the Bahama Islands; *J. gracilior* Pilg. from Haiti and Dominican Republic; *J. ekmanii* Florin from Haiti; and *J. urbaniana* Pilg. and Ekman from Haiti. I shall follow the original description of *J. bermudiana* L. (Linnaeus, 1753) for the name of the juniper from Bermuda. For the nomenclature of the coastal juniper of th southeastern United States, Zanoni (1978) will be followed who cited Small (1923) in recognizing *J. silicicola* (Small) Bailey as distinct from *J. virginiana* L. in the eastern United States and separate from the other junipers of the Caribbean.

Materials and Methods

Samples consisted of ten of twelve branchlets, 12 to 15 cm long from the following (Fig. 1) taxa or populations (acronym and number of plants sampled): *J. bermudiana* (BM, 15), John Smith's Bay, Bermuda, *Adams 2553-2567*, 12 Dec 1978; *J. ekmanii* (EK, 2), Mare Rouge, Massif de la Selle, Haiti, *Adams 3106, 3107*, 18 Feb 1981; *J. gracilior* (GR, 10), Constanza, Dominican Republic, *Adams 2785-2794*, 3 Apr 1980; *J. lucayana* (LB, 10), Pelican Lake, Grand Bahama Island, *Adams 2706-2715*, 27 Mar 1980, and (LJ, 10) Clysdesdale, Jamaica, Adams 2875-2884, 25 Apr 1980; *J. silicicola* (SI, 10), Oak Hill, Florida, U.S.A., *Adams 2775-2784*, 31 Mar 1980; Northern Haiti (NH, 10), cultivated, Dept. de l'Artibonite-Dept. du Nord boundary (lat. 19º33' N, Long. 72º28' W), Haiti, *Adams 2676-2685*, 19 Mar 1980; Pelempito, Dominican Republic (PL, 9), Isla, Pelempito, Pedernales, Dominican Republic, *Adams 3097-3105*, 12 Feb 1981. Samples of *J. virginiana* (VG, 15) were collected for comparison of leaf shape. These samples were collected near Washington, D.C., U.S.A., *Adams 2409-2423*, 29 Jan 1977.

Foliage samples from the Caribbean were frozen locally and then transported to the laboratory, where they were kept frozen (—20ºC) until morphological vouchers were taken and the balance of the foliage stem distilled to remove the volatile oils (see Adams 1975a for details). Voucher specimens are on deposit at SRCG.

The volatile terpenoids were analyzed by capillary gas/liquid chromatography and peak identifications were based on mass spectral-computer searches (Adams et al., 1979). Principal coordinate analysis (PCO) used an F—1(F from ANOVA) weighted Gower metric (Adams, 1975b, Gower, 1971) following the programs of Gower (1966) and Blackrith and Reyment (1971).

Morphological characters measured were: whip leaf glands visible (WGV) (scored as percent visible at 10 x, ranged as: 1=no visible glands to 10 = 100% visible); whip leaf margin (WLM) (20 x, 1 = smooth, 2 = small teeth, 3 = large teeth); scale leaf glands visible (SGV) (scored the same as WGV); scale leaf length (SLL) (avg. of five measurements in mm); scale leaf overlap (LOL) (average of five measurements

Fig. 1. Population locations of collections used for analyses. The location of the *J. silicicola* (SI) population (Oak Hill, Florida) is not shown.

in mm); branch width (BRW) (width of terminal leafy twigs, average of five measurements in mm); scale leaf overlap ratio (SOL) (average ratio of LOL/SLL) scale leaf length divided by branch width (L/B) (average of five ratios); scale leaf tips (SLT) (1.0 = obtuse, 2.0 = acute, 3.0 = acuminate); branching angle of ultimate twigs (BAN) (average of five measurements each to nearest 5 degrees). Although female cone characters would be very useful, these are not included because no fruit were found at most of the locations sampled.

In order to assess the affinities of the junipers of Hispaniola with the other taxa in the Caribbean and southeastern United States, ANOVA was performed on eight taxa (BM, EK, NH, GR, PL, LJ, and SI) for both the chemical and morphological data. The characters sets generated from these analyses (F ratios greater than 1.0) included 10 morphological characters (Table I) and 57 terpenoid characters (Table II). The morphological and chemical data sets were then separately used to compute F—1 weighted Gower similarity measures among the 8 taxa. These matrices were then factored using Principal Coordinate Analysis (PCO). Canonical variate analysis (CVA) was found to give similar results to PCO. However, CVA could not handle an ill-conditioned matrix encountered in a subsequent analysis (4-taxa case) and was discarded in favor of the apparently more robust PCO in order that all analyses could be compared using the same method. Analysis among the 4 Hispaniola collections involved ANOVA of both morphological and chemical data. The ANOVA resulted in nine morphological characters (Table I) and 33 terpenoids (Table II) with F ratios greater than 1.0. These character sets were then used to compute F—1 weighted Gower metric similarity measures among the 4 Hispaniola collections and PCO analyses.

TABLE I. MEANS FOR MORPHOLOGICAL CHARACTER AND F RATIOS 8P = ALL 8 TAXA USED IN ANOVA: 4P = 4 POPULATIONS FROM HISPANIOLA USED IN ANOVA.

CHARACTERS	BM	EK	NH	GR	PL	LB	LJ	SI	F RATIO (8P)	F RATIO (4P)
WGV	2.1	9.0	9.5	6.6	9.8	8.9	8.7	8.5	17.3	6.5
WLM	1.0	1.0	1.2	1.2	1.0	1.0	1.0	1.0	2.3	1.0
SGV	3.3	6.0	8.8	5.1	9.3	8.7	8.6	7.3	9.1	8.3
SLL	1.6	1.3	1.6	1.4	1.2	1.2	1.3	1.4	8.5	7.7
LOL	0.4	0.2	0.2	0.2	0.1	0.1	0.2	0.2	21.8	4.3
BRW	1.5	0.9	0.9	0.9	0.9	0.9	0.8	0.9	38.6	0.1
SOL	0.3	0.2	0.1	0.2	0.1	0.1	0.1	0.1	20.3	4.4
L/B	1.1	1.5	1.7	1.5	1.3	1.3	1.8	1.6	8.0	2.8
SLT	1.1	3.0	1.5	2.0	1.2	1.2	1.8	1.7	14.3	7.3
BAN	33.2	38.5	39.8	25.2	38.3	32.3	35.3	27.8	26.7	31.1

TABLE II. PERCENT YIELD, TERPENOID COMPOSITION AND F RATIOS 8P = ALL 8 TAXA IN ANOVA; 4P = 4 POPULATIONS FROM HISPANIOLA IN ANOVA

CHARACTERS	BM	EK	NH	GR	PL	LB	LJ	SI	F RATIO (8P)	F RATIO (4P)
% Yield	0.29	1.38	1.14	0.81	0.60	0.16	0.57	0.40	36.6	7.0
HA15	—	T	T	0.8	T	T	—	—	8.7	7.1
HA16	—	T	T	0.8	T	T	—	—	9.5	8.0
tricyclene	T	1.9	1.7	1.4	1.8	T	0.6	T	101.9	5.6
α -pinene	22.3	1.3	1.5	1.8	2.0	38.3	49.1	2.4	97.9	1.2
camphene	0.7	1.9	1.8	1.2	1.3	0.6	T	T	42.5	4.5
sabinene	2.8	5.0	3.6	10.1	11.8	1.1	9.7	T	8.4	4.1
β-pinene	0.6	T	T	T	T	1.1	1.1	T	34.4	—
7-octen-4-ol	1.0	T	T	T	T	T	T	0.9	15.5	—
myrcene	2.9	2.5	2.9	1.9	3.2	4.3	3.2	0.9	60.1	20.6
α -terpinene	T	0.9	0.6	1.7	1.3	T	T	T	11.3	3.7
ρ-cymene	0.5	0.5	T	1.4	0.9	T	T	T	6.1	2.7
limonene	35.3	9.6	13.6	7.3	11.2	26.9	25.9	33.3	20.1	14.3
γ-terpinene	0.7	1.7	1.1	3.5	2.5	T	0.8	T	12.1	4.1
(β-terpineol isomer)	—	0.9	0.7	1.1	0.8	T	—	—	52.7	3.8
terpinolene	0.8	0.6	T	0.9	0.7	1.0	1.0	T	7.3	4.8
linalool	1.1	0.6	0.6	2.6	1.1	1.8	—	1.5	6.7	14.1
HAX6	T	1.6	T	2.0	T	—	—	—	40.2	33.2
dihydro carveol isomer 1	—	0.5	T	0.8	0.5	—	—	—	21.8	3.0
camphor	6.5	5.8	1.4	1.1	0.9	T	T	T	33.9	26.8
trans-pinocarveol	1.1	—	—	—	—	—	—	—	67.4	—
dihydro carveol isomer 2	—	T	T	0.7	T	T	T	—	11.5	5.0
camphene hydrate	1.4	2.2	1.2	1.4	0.7	T	—	T	16.2	2.8
borneol	2.1	5.1	2.2	2.0	1.3	T	T	—	18.6	6.[illegible]
4-terpineol	1.4	6.2	3.7	11.6	7.5	1.0	1.6	T	17.5	5.0
myrtenal	0.7	—	T	—	—	T	—	T	54.7	—

CHARACTER	SM	EK	NH	GR	PL	LB	LJ	SI	F RATIO (8P)	F RATIO (4P)
α -terpineol	T	0.8	0.5	0.9	0.6	T	T	0.5	11.8	6.9
HAX9	—	T	T	1.2	T	—	—	—	10.1	4.4
carvone	1.0	T	T	T	T	T	T	T	17.4	—
citronellol	T	0.6	T	0.6	T	1.2	T	T	4.6	8.0
HA11	T	T	T	0.5	T	T	—	—	32.6	7.9
isosafrole	T	—	—	—	T	T	—	3.6	49.3	—
bornyl acetate	4.2	43.9	48.8	35.7	34.1	3.8	0.6	T	47.3	2.1
safrole	—	—	T	T	3.2	T	T	13.7	14.1	4.1
sabinyl acetate	0.7	T	—	T	—	T	—	—	1.9	—
nethyl eugenol	T	—	0.9	T	1.6	T	T	8.2	1.8	2.1
thujopsene	2.1	T	—	T	—	T	—	T	30.4	—
germacrene D	T	—	—	—	T	0.6	0.6	T	40.3	—
γ-cardinene	—	T	0.9	—	0.7	T	—	T	8.5	10.3
δ-cadinene	T	T	T	T	T	0.6	T	0.7	1.8	—
GAX1	—	—	—	—	—	0.6	—	T	16.6	—
elemicin	—	T	3.8	T	1.8	—	—	—	30.8	13.8
elemol	T	—	—	—	—	T	T	12.1	46.2	—
GAX2	—	—	—	—	—	0.9	—	0.9	10.7	—
α -cadinol isomer 3	—	T	T	T	T	T	T	0.8	9.1	—
YLI1	T	—	T	—	0.6	0.7	T	0.7	9.9	10.4
cubenol	T	T	0.8	T	0.8	T	—	0.7	9.4	5.6
γ endesmol	—	—	—	—	—	—	—	3.4	31.5	—
α -cadinol isomer	T	T	T	—	T	0.8	—	—	14.7	—
α -cadinol isomer 2	—	T	T	T	T	—	T	2.0	42.9	—
β-endesmol	—	—	—	—	—	—	—	2.8	28.6	—
α -endesmol	—	—	—	—	—	—	—	3.4	38.4	—
JLX2	—	—	—	—	—	—	0.5	—	89.0	—
BR13	T	T	T	T	T	1.3	—	—	22.8	—
BR15	T	T	T	T	T	1.1	T	T	9.9	—
acetate II	—	—	—	—	—	—	—	1.8	28.4	—
BL12	0.7	—	—	T	T	T	—	—	8.3	—

Results and Discussion

The basic morphology of the leaves is shown in Figs. 2-10. *Juniperus virginiana* (Washington, D. C.) has been added for comparison. The most obvious difference is the extremely large, obtuse (blunt) tipped leaves of *J. bermudiana*. Although the scale leaves of *J. lucayana* (LJ from Jamaica, LB from the Bahamas) are generally blunt (obtuse) tipped, many of the individuals in the Jamaica population have some (many) acute shaped scale leaf tips. This is seen in Table I (LJ = 1.8; where 1.0 = obtuse, 2.0 = acute, 3.0 = mucronate). The variation on a single twing can be seen in Figure 6 where mucronate tipped leaves are shown on the left side and obtuse tipped leaves are shown on the right side of the photograph. In this set of photographs (Figs. 2-10) the leaves from Pelempito, Dom. Rep. (PL, Fig. 4) look much like *J. lucayana* from Jamaica (LJ, Fig. 2). The sharp mucronate tipped leaves of *J. ekmanii* are apparent (Fig. 7, EK) as well as those of *J. gracilior* (Fig. 3, GR).

In an effort to more thoroughly evaluate the morphology, an analysis was performed using 8 taxa from the Caribbean, Bermuda and the southeastern United States (Fig. 1, Table I). The results of PCO with the 10 F—1 weighed morphological characters (Table I) revealed that 39% of the variation among groups was due to the separation of *J. bermudiana* from the other taxa (Fig. 11). The second coordinate accounted for 24% of the variance among the taxa and mostly separates *J. gracilior* (GR) from *J. silicicola* (SI) and these two taxa from the other Caribbean junipers (Figure 11). Since *J. bermudiana* (BM) was so distinct on the first coordinate axis, that axis was omitted from further plots. Figure 12 shows separation of *J. gracilior* (GR), *J. silicicola* (SI) on coordinate axis two and a splitting off of *J. lucayana* from the Bahamas (LB) with the juniper from Pelempito (PL) on the third axis (13%). *Juniperus lucayana* (LJ) from Jamaica clusters with *J. ekmanii* and the northern Haiti (NH) juniper *(J. bermudiana* (BM) should be ignored). The fourth axis accounted for 9% of the variation and shows a separation of NH and PL from other taxa as well as divergence of LJ (*J. lucayana,* Jamaica). Three taxa appear to be distinct in morphology: *J. bermudiana* (BM), *J. gracilior* (GR), and *J. silicicola* (SI). The other taxa (EK, LB, LJ, NH, PL) do not exhibit much divergence (particularly note Figure 11 which explains 63% of the variance).

Since only 10 morphological characters were used and these have considerable intercorrelation, the analysis of a large set (57) chemical characters should yield a more robust sample of the genomes. In contrast to the morphological data, the terpenoids are clear even from examination of Table II. Note the amounts of tricyclene in the Hispaniola junipers (EK, NH, GR, PL), the low concentrations of α -pinene and the very large concentration of bornyl acetate (35.7 to 48.8% of the total oil). The divergence of the Hispaniola junipers is clear in Figure 14. The first coordinate (36%) clearly separates these junipers from the other taxa. The second coordinate axis (20%) distinguishes *J. silicicola* (SI). *Juniperus lucayana* (LJ and

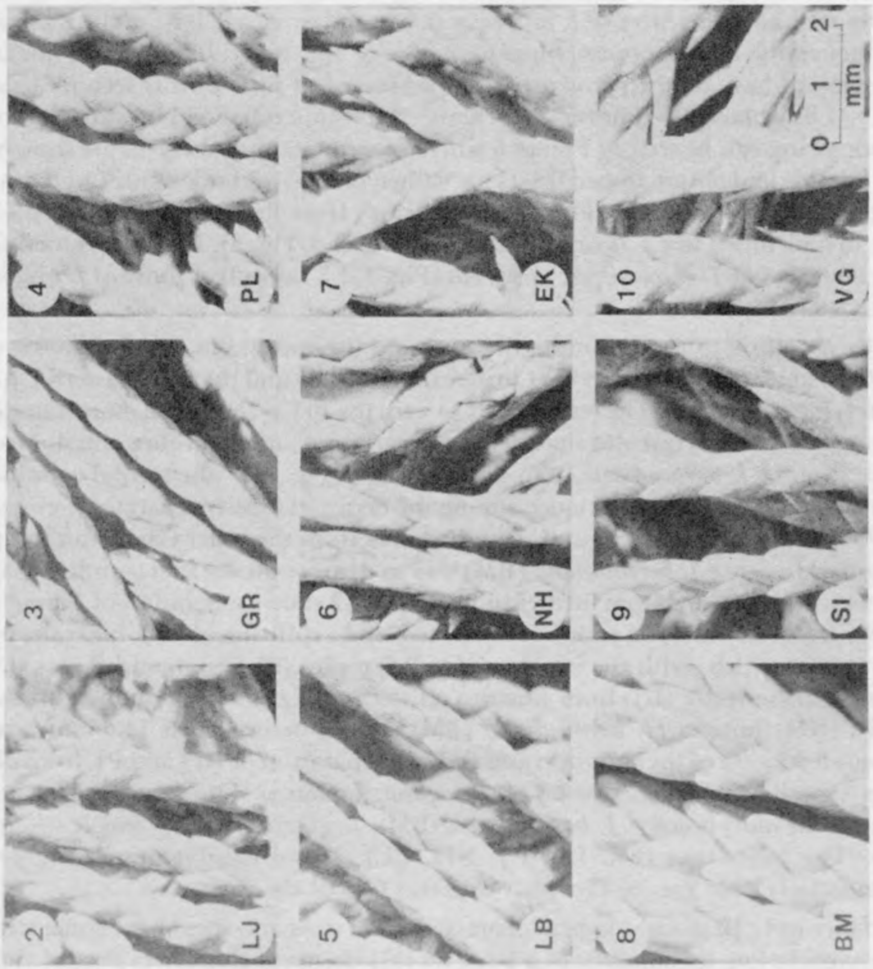
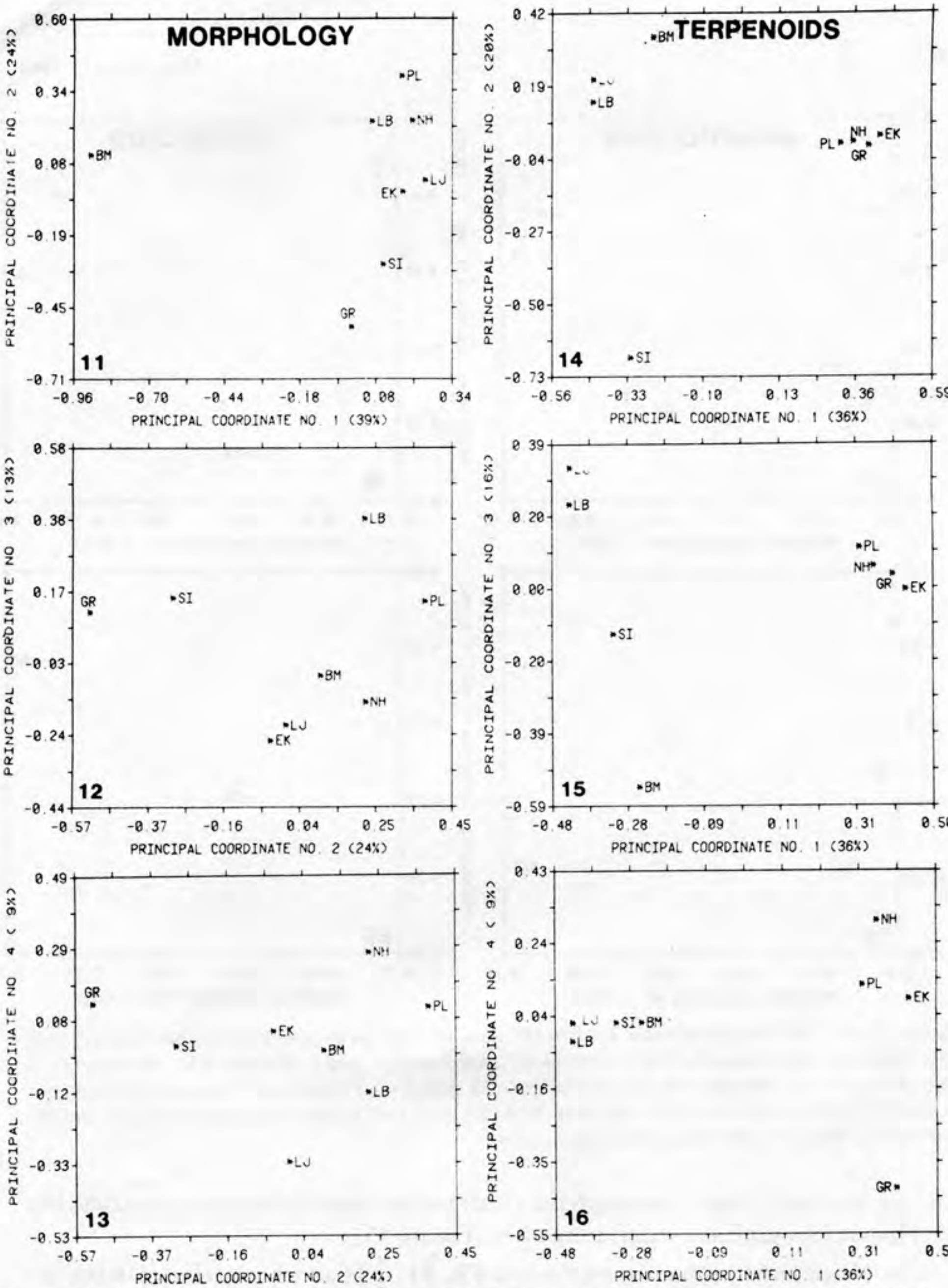
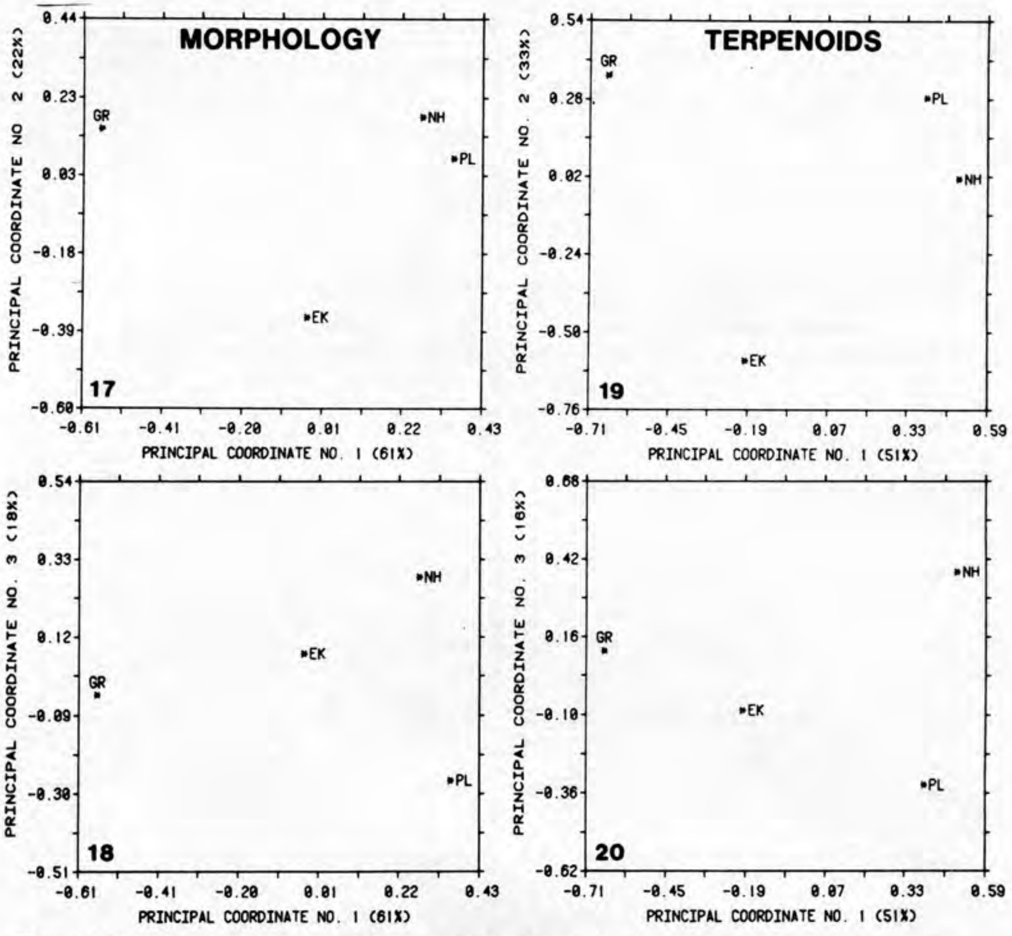


Fig. 2-10. Micrographs of juniper leaves, all photographed at the same magnification (X 10). 2 *J. lucayana*, Clydesdale, Jamaica. 3. *J. gracilior*, Constanza, Dominican Republic. 4. juniper from Pelempito, Dominican Republic. 5. *J. lucayana*, Grand Bahama Isl. 6. juniper from Northern Haiti. 7. *J. ekmanii*, Haiti. 8. *J. bermudiana*, Bermuda. 9. *J. silicicola*, Oak Hill, Florida. 10. *J. virginiana*, Washington, D.C.



Figs. 11-16. **Principal Coordinate Analyses (PCO) of eight taxa. 11. Morphological variation, Axis 1 vs. 2 shows the differentiation of *J. bermudiana* (BM) from the other taxa. 12. Axis £ vs. 3(morphology) separates*K. gracilior* (GR) and *J. silicicola* (SI) and depicts difference between *J. lucayana* (LB) and Pelempito (PL). 13. Axis 2 vs. 4 (morpholgy) shows overall divergence of all taxa. Note the loose association of NH and PL. 14. Terpenoid variation, Axis 1 vs. 2 reveals three groups: SI; LF, LB, BM; and PL, NH, EK, GR. 15. Axis 1 vs. 3 (terpenoids) shows a clear separation of BM (*J. bermudiana)* on axis 3. 16. Axis 1 vs. 4 (terpenoids) separates *J. gracilior* (GR) on the fourth axis.**



Figures 17-20. Principal Coordinate Analysis (PCO) of the four collections from Hispaniola. 17. Axis 1 vs. 2 (morphology) shows the differentiation of J. gracilior (GR) and J. ekmanii (EK). 18. Axis 1 vs. 3 (morphology) splits the NH and PL populations. 19. Axis 1 vs. 2 (terpenoids) suggests three groups: *J. gracilior* (GR); *J. ekmanii* (EK) and (NH, PL). 20. Axis 1 vs. 3 (terpenoids) splits the NH and PL populations as seen with the morphology.

LB) are separated from *J. bermudiana* (BM) on the third coordinate axis (16%) but the Hispaniola junipers remain together (Figure 15).

The Hispaniola junipers are split into EK, PL, NH and *J. gracilior* (GR) by the fourth coordinate (9%, Fig. 16). Four major groups are apparent from analysis of the terpenoids; the junipers of Hispaniola (EK, NH, GR); *J. silicicola* (SI); *J. bermudiana* (BM); and *J. lucayana* (LB, LJ). A fifth subdivision appears to be the recognition of some divergence by *J. gracilior* (GR) from the other Hispaniola junipers (Fig. 16).

Thus, although the northern Haiti juniper collection shows some similarity in its scale leaves (Figs. 2-10) to *J. lucayana* (LB, LJ), it is clearly different in its terpenoides (Figs. 14-16). It appears that the Hispaniola junipers are all closely related (in comparison with the other Caribbean taxa) and none of the other Caribbean taxa examined are present in the collections from Hispaniola.

Examination of specimens *(Ekman 3258 and 3647)* at the Ekman Herbarium (EHH) in Damien, Haiti, collected from northern Haiti, revealed that these specimens do appear to be very similar to *J. lucayana* from the Bahamas. Field trips to the areas of collection (St. Michel de l'Attalaye and Bassin Blue) have been unsuccessful in finding any extant trees. The area has been thoroughly cut-over at least since 1965. It is likely the taxon identified (by Ekman) as *J. lucayana* can now only be found in cultivation in northern Haiti. Two collections were made near St. Michel. Both are cultivated plants transplanted from the surrounding region about 1965. The first site (NH) is at an abandoned monastary and the second site is in a church courtyard at Ennery. Discussions with local elderly men, who assisted in the original planting, revealed that the plants were transplated about 1965 from natural habitats approximately 4 km east of Ennery. No other junipers are known from northern Haiti. All natural populations are now thought to be extinct.

In order to further examine the relationships among the four juniper collections from Hispaniola, the analyses of the morphological and terpenoid data were recomputed using only the four Hispaniola population samples (EK, PL, NH, GR).

Analysis of variance of the morphological data (Table I), resulted in low F ratios except for branching angle (BAN, 31.1).

Principal coordinate analysis (PCO) using 9 morphological (Table I) characters (Branch width, BRW, F = 0.1, was omitted) shows three groups (Fig. 17) with *J. gracilior* (GR), *J. ekmanii* (EK) and the other two collections (PL, NH). The third coordinate (Fig. 18) shows differentiation between the PL and NH population. Principal coordinate analysis (PCO) using 33 terpenoids (Table II) resulted in almost identical results (Figs. 19, 20). These analyses suggest that there are two species: *J. gracilior* and *J. ekmanii* and that the two other populations (PL and NH) might be considered conspecific with *J. ekmanii*. Whether one should segregate and formally recognize the variation expressed in the Pelempito (PL) and northern Haiti (NH) populations will be deferred until more collection are made, including *J. urbaniana* from Pic la Selle. Obviously the morphological portion of this study is incomplete and additional research is needed. However, due to the close similarity of these junipers and the intra-tree variation in morphology, the terpenoid data must be given considerable weight in making any future taxonomic decisison.

The four populations of junipers collected on Hispaniola are all in endangered habitats. *Juniperus gracilior* has the least endangered habitat as it apparently occurs over a considerable area west and south of Constanza, Dominican Republic. This area is heavily used and many trees were being cut west of Constanza in 1980.

Only two trees of *J. ekmanii* were found in 1981. One of these was being used as a living fence post and the other was about 30m from a slash and burn operation for land clearing. Most of this region was apparently logged for timber about 1965. Foresters in the area pointed out of *J. ekmanii* with diameters up to 2m resulting from the 1965 logging operation. This species must be considered on the verge of extinction. The juniper from northern Haiti (NH) is being cultivated in at least two places. Whether it also exists in nature is not known. It should be considered endangered. The junipers from the Pelempito region borders on the northern part of the Alcoa mining area. Man-made fires appear to present a considerable danger to these populations. These junipers are found in small coppice areas in association with deciduous vegetation. These populations are certainly fragile and endangered.

A present, it appears that there are three species of juniper on Hispaniola: *J. ekmanii, J. gracilior* and *J. urbaniana.* No plants conspecific with *J. lucayana* (as found in the Bahamas and Jamaica) were found in northern Haiti, although the leaves of the cultivated northern Haiti plants do resemble *J. lucayana.* The specimens of Ekman from northern Haiti, previously identified as *J. lucayana*, appear to represent an underscribed intraspecific taxon of *J. ekmanii.* The biological status of *J. urbaniana* is not known.

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