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Biochemical Traumatology as a Potent Tool for Identifying Actual Stresses Elicited by Unidentified Sources: Evidence for Plant Metabolic Disorders in Correlation With a UFO Landing

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Abstract—Followingan accurate testimony of a "UFO" landing, samples of a wild strain of Alfalfa were collected at the epicentre and at various increasing distances of the trace left on the ground 4 and 40 days after the observation. An additional batch of similar samples collected 730 days after the observation was then used as an a posteriori control of the natural variability on the same area. Biochemical determinations included: photosynthetic pigments, free carbohydrates, and free amino acids. Statistically, significant results were observed by plotting concentrations versus distances from the epicentre, and various characteristic subtypes of dose/effect relationships were evidenced. Functional relationships between photosynthetic pigments, amino acids and carbohydrates, were reversed at D + 40 by comparison with D + 730 samples which exhibited a normal shape. Thus, the described principles of Biochemical analysis give evidence: (a) that something did happen; (b) that the influence of the unidentified source decreased with increasing distance from the epicentre; (c) of accurate symptoms that can be further compared with those elicited by known causes.

Introduction

One of the most challenging aspects of anomalous phenomenon studies is the question of their reproducibility, which is often considered as a condition for a study to be considered scientific. Another critical aspect in such a study is the validity of human testimonies, which is the object of some specific branches of human sciences and has led to a number of famous controversies in terms of what is science (Abelson, 1974; Bauer, 1979) or what the value of testimonies is (Loftus 1979). [See: Sturrock, 1987, for review in a similar area.]

Nevertheless, there are several scientific domains, undoubtedly accepted as full sciences, that do not actually need any experimental reproducibility. For instance, in paleontology, no one can say when and where the next

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discovery of an Australopithecus skeleton will occur, although this is never depicted in a joking manner as, for instance, observations (even including material evidence, such as photographs or sonar recordings) concerning the Loch Ness Monster (see Bauer, 1987, for review).

Now the major problem is to record indisputable traces of something that is presently interpreted as an unknown or anomalous event, in view of further classification after more knowledge has been received by the scientific community.

The aim of this paper is to give an example of how to study the effects of a phenomenon of unknown origin (of the UFO-type) on the biochemistry of living nonhuman organisms (i.e., on facts that cannot be suspected of lacking objectivity). The question of comparison with controls arises, and will also be dealt with in this study; despite the fact that one cannot know where and when such phenomena will occur, so that no experimental protocol and planning can be actually organized in view of the comparison of "treated" organisms with untreated ones in as exactly similar conditions as possible.

The particular case that will be analyzed here has been widely reported by French newspapers, radio, and TV as the "Trans-en-Provence UFO landing." A preliminary report on a first set of experiments was published in the CNES/GEPAN Technical Notes (Bounias, 1983a), but major and entirely new aspects of this work had not yet been reported.

Material and Methods

Principles of Sampling Procedure

The first point to be clarified is the exact area where the unknown event (UE) has landed or been in the closest contact with the environment. In the present case, this was the object of a police report referred to as P.V. nr. 28, 9-1-81, relating a visible circular trace on the ground.

Then, an ecological axis should be chosen, along which, a series of plants or sedentary animals belonging to the same species can be found at intervals. This axis should go across the "contact area" of the UE and preferably join the epicentre.

The landing area, visible on the ground, was about 2.5 to 3 m in diameter and plants of a wild strain of alfalfa, *Medicago minima,* were found inside, on the trace, and throughout the surrounding area. This species was thus chosen as the biological model.

The first samples were collected by the local police on the border of the trace (point A) and at a point situated at 20 m (point B) for controls by four days after the observation of the UE.

The second batch of samples (points C to G) were collected by 40 days after the day of observation by a team of technicians of the National Space Research Center. It should be noted that nobody other than the author was aware in advance of when, where, and what was to be collected. This decreases the risk that artifacts could be produced by hoaxers.

A last batch of samples (points H to L) were then collected along the same axis, but two years later, (i.e., in February 1983) the same plant species were growing on the site, but, of course, samples could not be collected at exactly the same distances. Table 1 indicates the position of the various samples along the axis.

Living plants were taken with a large clod of earth and immediately driven to the laboratory and frozen, except sample (A, B), which was transported by policemen in paper sacks.

In sample (A, B), the plants looked rather dry, but without any sign of burning. In all other samples, the alfalfa leaves, of various size, were quite similar in aspect. No visible morphological alteration was discernible after examination under a Meopta DM23 binocular microscope.

Biochemical Procedure

Samples of 100 mg (fresh weight or equivalent) of young leaves (2 to 3 mm with 7.0 ± 3.6 mg average weight by leaf) were ground in Potter homogenizers with chloroform. Older leaves, which were present in samples A and B, were also analyzed. After 5 mn centrifugation at 5,000 g, the lipid phase was recuperated and concentrated under low pressure to a final volume of 5 μl per mg. These extracts were spotted on thin layer plates, and the various pigments (chlorophylls and derivatives, carotenoïds, quinons, and chromenols) separated according to the previously described techniques. Chromatograms were recorded at 425 nm using a CS920 densitometer.

The pellets were resuspended and homogenized in a mixture of water-ethanol-pyridine-aceticacid (80-10-5-5 v/v) for extraction of carbohydrates and free amino acids. Volumes were adjusted to 0.5 μl per mg. Quantitative thin layer chromatographies were performed as previously described for carbohydrates (Bounias, 1976, 1980a) and amino acids (Bounias, 1980b).

The pH of the soil was determined after homogeneization of 5 g of the earth clod in 100 ml water.

TABLE 1
Characteristics of the different analyzed samples collected along the ecological axis passing by the epicentre to the trace

Code Letter	Date from Landing (days)	Distance from Epicentre (m)	Classification
A	$D + 4$	1.5	exposed
B	$D + 15$	20.0	control
C	$D + 40$	0.0	exposed
D	$D + 40$	1.5	exposed
E	$D + 40$	2.1	exposed
F	$D + 40$	3.5	exposed
G	$D + 40$	10.0	control
H	$D + 730$	0.5	control
I	$D + 730$	3.8	control
J	$D + 730$	6.0	control
K	$D + 730$	8.8	control
L	$D + 730$	15.4	control

Statistical Methods

Means and SD calculated from (N) determinations were used in student's *t* test for comparisons. Variances were compared using Fisher's F test. The probabilities of significances corresponding to these comparisons and to the correlation and regression (least square method) calculations, were determined from the equations of distribution of t and F. For correlation coefficients (p), the "t" value was calculated from: $t = [\gamma \cdot \rho^2/(1 - \rho^2)]^{1/2}$ where v = degree of freedom = N – 2. The standard deviations of the regression slopes (b) was calculated from: a, $= [(b/\rho)^2 - b^2)/v]^{1/2}$ The slopes corresponding to two aleatory variables plotted together are given by $d = b/\rho$.

Additionally, in (D + 370) control samples ("H" to "L"), considered as likely representative of the natural biological variability on the site, correlations with distances to the epicentre were artificially increased by switching the values of the two parameters situated at the extreme parts (i.e., H and L) to their upper and lower possible values, (or reversally), taking into account the range of their standard deviation. Then, correlation calculations will give an estimation of what can be considered as the strongest "fortuitous" correlation, in conditions where no particular correlation is expected. The following notations will be used in the text for the regression slopes: b_E for exposed to the event (A to G); b_0 for controls (H to L); b_r for reconstituted theoretical extreme values in controls.

Only the major features will be represented here.

Results

Basic Data

Photosynthetic Pigments. Tables 2, **3,** and 4, respectively, give the results obtained in the various samples. It is noteworthy that, in samples A and B, all classes are decreased in exposed samples by an average coefficient which is similar (p = 0.68) in both younger (0.60 ± 0.22) and older leaves (0.66

TABLE 2
Photosynthetic pigments in younger and older leaves from exposed (A) and control (B) samples of *Medicago minima.* Means (nmol per mg) ± ***SD*** are given from N = 3 determinations.

	Younger Leaves		Older Leaves	
Pigments	A	B	A	B
Chlorophyll A	0.58 ± 0.13	0.87 ± 0.19	0.54 ± 0.12	0.81 ± 0.18
Chlorophyll B	0.45 ± 0.10	0.62 ± 0.14	0.37 ± 0.10	0.51 ± 0.11
Pheophytins	0.44 ± 0.10	0.73 ± 0.16	0.20 ± 0.05	0.29 ± 0.06
β Caroten	0.09 ± 0.02	0.21 ± 0.05	0.10 ± 0.02	0.20 ± 0.04
Lutein	0.28 ± 0.06	0.32 ± 0.07	0.24 ± 0.05	0.34 ± 0.08
Violaxanthin	0.03 ± 0.01	0.15 ± 0.03	0.11 ± 0.03	0.17 ± 0.04
Chl.A/Pheo.	1.31	1.19	2.70	2.79

TABLE 3
Photosynthetic pigments in *Medicago minima* leaves in exposed samples. Means (nanomols per mg) ± SD are given from duplicate determinations.

Pigments	Samples (distances in meters from epicentre)				
	C(0)	D(1.5)	E(2.1)	F(3.5)	G(lO.O)
Chlorophyll A	0.36t0.04	1.10kO.13	1.16 ± 0.14	1.2020.15	1.30 ± 0.03
Chlorophyll B	0.16 ± 0.02	0.26 ± 0.03	0.25 ± 0.03	0.19 k 0.03	0.16 t 0.02
Pheophytins	0.44t0.06	0.71 ± 0.09	0.7720.10	0.70k0.09	0.52 ± 0.02
β Caroten	0.09 ± 0.02	0.11 ± 0.02	0.12 ± 0.03	0.16 t 0.03	0.22 ± 0.04
Lutein	0.09 ± 0.02	0.09 2 0.02	0.12 ± 0.03	0.14 ± 0.04	0.23 ± 0.06
Chl.A/Pheo.	0.82	1.54	1.51	1.71	2.5

± 0.075). These coefficients significantly deviate from 1 in both young ($p = 4.81$) and old leaves ($p = 11.99$). In sample C (Table 2), levels are decreased by an average factor $C/G = 0.58$ relatively to sample G considered as reference. This factor, already significant ($N = 5$; $p = 0.056$), drops to 0.48 if chlorophyll B (particularly more stable than chlorophyll **A)** is discarded ($N = 4$; $p = 0.043$). In samples H to L, no statistically significant differences could be found.

Carbohydrates. Tables 5, *6*, and 7, respectively, give the results obtained in the three successive batches of samples, for the sole fractions which have been clearly identified in all cases. The most striking result is the observed increase of glucose concentrations in sample C (+158%; $p = 0.027$) and to a lesser extent in sample D (+32%; $p = 0.20$) relatively to F or G. By contrast, raffinose and sucrose are depressed in sample C relative to sample G ($p = 0.03$ and 0.04 respectively). This could not be found in plants sampled at D + 730, which proved to be remarkably homogeneous, all along the axis.

Amino Acids. Tables 8, 9, and 10, respectively, give the concentrations of the identified amino acids in the three series of samples. In the first one, it is

TABLE 4
Photosynthetic pigments in *Medicago minima* leaves in control samples. Means (nanomols per mg) ± SD are given from N = 7 determinations.

Pigments	Samples (distances in meters from epicentre)				
	H(0.5)	I(3.8)	J(6.0)	K(8.8)	L(15.4)
Chlorophyll A	0.89 ± 0.42	0.69 ± 0.30	0.69 ± 0.40	0.64 ± 0.20	0.65 ± 0.38
Chlorophyll B	0.45 t 0.15	0.41 t 0.10	0.40 ± 0.09	0.40 a 0.17	0.34 ± 0.17
Pheophytins	1.71 ± 0.54	2.30 ± 0.32	1.83 a 0.35	1.34 ± 0.26	1.30 ± 0.34
β Caroten	0.37 ± 0.07	0.32 ± 0.08	0.36 ± 0.07	0.25 ± 0.06	0.25 ± 0.07
Lutein	0.72 ± 0.17	0.71 ± 0.19	0.83 ± 0.29	0.62 ± 0.24	0.61 ± 0.15
Chl.A/Pheo	0.52	0.31	0.38	0.48	0.51

TABLE 5
Carbohydrate contents (nmol per mg) in younger and older leaves from exposed (A) and control (B) samples of *Medicago minima*. Means and *SD* are given from duplicate determinations. The total value includes an additional 14 unidentified fractions.

	Younger Leaves		Older Leaves	
	A	B	A	B
Raffinose	0.06 ± 0.01	0.08 ± 0.01	0.1 ± 0.006	0.1 ± 0.006
Maltose	0.06 ± 0.01	0.08 ± 0.01	0.03 ± 0.002	0.06 ± 0.004
Sucrose	6.1 21.0	4.4 ± 0.7	3.9 ± 0.6	4.8 + 0.8
Glucose	1.1 ± 0.08	1.5 ± 0.12	1.5 ± 0.12	2.0 ± 0.16
Fructose	0.9 ± 0.05	2.3 ± 0.11	1.0 ± 0.05	1.4 ± 0.07
Total	18.0	13.5	20.2	25.0

TABLE 6
Carbohydrate contents (nmol per mg) of the leaves of *Medicago minima* in samples C to G. Means and *SD* are given for 2 determinations. Total includes an additional 14 unidentified fractions.

	C	D	E	F	G
Distance from Epicentre (m):	0	1.5	2.1	3.5	10.0
Raffinose	0.13 ± 0.02	0.31 ± 0.04	0.50 ± 0.06	0.50 ± 0.06	0.40 ± 0.05
Maltose	0.4 ± 0.02	1.4 ± 0.06	1.4 ± 0.06	0.8 ± 0.04	0.6 ± 0.03
Sucrose	190.11	3.3k0.19	5.5 ± 0.33	4.3 ± 0.26	2.9k0.18
Glucose	23.0 ± 2.5	11.6 ± 1.3	9.7 ± 1.0	8.8 ± 0.9	8.9 ± 1.0
Fructose	5.5 ± 0.3	6.4 ± 0.4	6.1 ± 0.4	6.0 ± 0.4	7.7 ± 0.5
Total	49.0	34.9	39.0	37.4	32.5

TABLE 7
Carbohydrate contents (nmol per mg) of the leaves of *Medicago minima* in samples *H* to L. Means and *SD* are given from duplicate determinations. The total includes an additional 17 unidentified fractions.

	H	I	J	K	L
Distance from Epicentre (m):	0.5	3.8	6.0	8.8	15.4
Raffinose	0.04 ± 0.001	0.08 ± 0.003	0.08 ± 0.003	0.21 ± 0.008	0.05 ± 0.002
Maltose	0.2 ± 0.03	0.4 ± 0.06	0.9 ± 0.15	0.6 ± 0.10	0.9 ± 0.14
Sucrose	2.8 ± 0.3	3.1 ± 0.3	4.6 ± 0.6	3.9 ± 0.4	2.6 ± 0.3
Glucose	2.3 ± 0.13	2.3 ± 0.11	3.2 ± 0.18	2.3 ± 0.14	2.6 ± 0.14
Fructose	4.5 ± 0.4	4.9 ± 0.4	6.2 ± 0.5	5.3 ± 0.4	5.8 ± 0.5
Total	23.7	25.8	33.7	29.3	26.9

TABLE 8
Free amino acids content of younger and older leaves of *Medicago minima* in the First series (A and B) of experiments. Means and SD (nanomol per mg) are given from duplicate determinations. (D + 4/D + 15 fom UE).

	Younger Leaves		Older Leaves	
	B	A	B	A
Distance (m) from Epicentre:	20 m	1.5 m	20 m	1.5 m
Lys	0.02 ± 0.007	0.14 ± 0.05	0.012 ± 0.004	0.25 ± 0.08
Arg	0.30 ± 0.09	0.40 ± 0.12	0.07 ± 0.02	0.17 ± 0.05
His	0.04 ± 0.01	0.01 ± 0.002	0.02 ± 0.005	0.07 ± 0.02
Ser	0.45 ± 0.12	0.57 ± 0.15	0.30 ± 0.08	0.20 ± 0.05
Asp	0.04 ± 0.009	0.09 ± 0.02	0.02 ± 0.005	0.03 ± 0.007
Asn	1.60 ± 0.53	0.74 ± 0.24	0.10 ± 0.03	0.35 ± 0.11
Glu + Gln	0.53 ± 0.05	1.44 ± 0.15	0.12 ± 0.01	0.10 ± 0.01
Thr	0.23 ± 0.03	0.23 ± 0.03	0.14 ± 0.02	0.17 ± 0.02
Ala	0.75 ± 0.19	1.70 ± 0.44	1.20 ± 0.31	0.94 ± 0.24
Val	0.80 ± 0.22	0.60 ± 0.17	0.33 ± 0.09	0.29 ± 0.08
Ile	0.24 ± 0.07	0.16 ± 0.04	0.17 ± 0.05	0.15 ± 0.04
Leu	0.23 ± 0.11	0.25 ± 0.12	0.14 ± 0.06	0.16 ± 0.08
Phe	0.30 ± 0.06	0.21 ± 0.04	0.05 ± 0.01	0.11 ± 0.02
Trp	0.18 ± 0.07	0.31 ± 0.13	0.14 ± 0.06	0.16 ± 0.06
Total*	8.4	10.4	5.2	5.7

* Including an additional 5 unidentified fractions.

TABLE 9
Free amino acids content of *Medicago minima* leaves in the second (C to G) series of samples (*D* + 40 from observation of the UE)

	C	D	E	F	G
Distance (m) from Epicentre:	0.	1.5	2.1	3.5	10.
Lys	0.22 a 0.015	0.07 ± 0.005	0.08 ± 0.006	0.12 ± 0.008	0.06 ± 0.004
His + Arg	0.40 ± 0.07	0.16 ± 0.03	0.37 ± 0.07	0.30 ± 0.07	0.27 ± 0.05
Ser	0.48 ± 0.02	0.28 ± 0.01	0.13 ± 0.01	0.41 ± 0.02	0.41 ± 0.02
Asp + Asn	0.25 ± 0.05	0.16 ± 0.03	0.15 ± 0.03	0.24 ± 0.05	0.25 ± 0.05
Glu + Gln	0.63 ± 0.06	0.87 ± 0.08	1.02 ± 0.09	1.15 ± 0.10	1.10 ± 0.10
Thr	0.16 ± 0.04	0.001 ...	0.001 ...	0.04 ± 0.01	0.11 ± 0.03
Ala	0.75 ± 0.08	0.98 ± 0.11	0.68 ± 0.07	1.07 ± 0.11	0.45 ± 0.05
Pro	0.01 ± 0.003	0.07 ± 0.02	0.07 ± 0.02	0.12 ± 0.04	0.19 ± 0.06
Val + Met	0.11 ± 0.03	0.24 ± 0.07	0.34 ± 0.10	0.26 ± 0.08	0.30 ± 0.09
Ile	0.11 ± 0.013	0.12 ± 0.014	0.17 ± 0.02	0.19 ± 0.023	0.20 ± 0.024
Leu	0.12 ± 0.03	0.20 ± 0.05	0.15 ± 0.04	0.21 ± 0.05	0.20 ± 0.05
Phe	0.25 ± 0.06	0.45 ± 0.10	0.39 ± 0.09	0.58 ± 0.13	0.26 ± 0.06
Trp	0.09 ± 0.016	0.17 ± 0.031	0.19 ± 0.034	0.24 ± 0.043	0.11 ± 0.020
Total*	6.3	7.2	8.1	9.8	8.0

* Including an additional 7 unidentified fractions.

TABLE 10
Free amino acids content of *Medicago minima* **leaves in the third (H to L) series of samples (D + 730 from** UE)

	H	I	J	K	L
Distances (m) from Epicentre:	0.5	3.8	6.0	8.8	15.4
Lys	0.14 ± 0.047	0.07 ± 0.024	0.10 ± 0.034	0.05 ± 0.017	0.07 ± 0.024
Arg	0.47 ± 0.052	0.33 ± 0.040	0.23 ± 0.025	0.06 ± 0.007	0.35 ± 0.038
His	0.09 ± 0.020	0.18 ± 0.040	0.12 ± 0.026	0.15 ± 0.033	0.12 ± 0.030
Ser	0.15k0.03	0.29k0.06	0.3040.06	0.30 ± 0.06	0.32 ± 0.07
Asp + Asn + Gly	0.54 ± 0.09	1.01 ± 0.18	0.91 ± 0.16	0.77 ± 0.14	0.82 ± 0.15
Gl + Gln	0.45 ± 0.05	0.32 ± 0.04	0.70 ± 0.08	0.47 ± 0.05	0.44 ± 0.05
Thr	0.17 ± 0.03	0.21 ± 0.04	0.14 ± 0.03	0.18 ± 0.03	0.20 ± 0.04
Ala	0.43 ± 0.13	0.49k0.15	0.54 ± 0.17	0.53k0.17	0.36 ± 0.11
Pro	0.07 ± 0.02	0.07 ± 0.02	0.10 ± 0.03	0.42 ± 0.13	0.32 ± 0.09
Val	0.25 ± 0.05	0.21 ± 0.04	0.17 ± 0.03	0.17 ± 0.03	0.13 ± 0.02
Ile	0.07 ± 0.012	0.12 ± 0.02	0.13 ± 0.02	0.14 ± 0.024	0.10 ± 0.02
Leu	0.08 + 0.02	0.06 ± 0.02	0.11 ± 0.03	0.10 ± 0.03	0.08 ± 0.02
Phe	0.15 k0.04	0.24k0.06	0.31 ± 0.08	0.20k0.04	0.25 ± 0.05
Trp	0.21 ± 0.04	0.29k0.06	0.36k0.08	0.29k0.06	0.23 ± 0.05

noteworthy that lysine (Lys) is increased in both younger and older leaves from plants sampled near the epicentre (A), but with low significance ($p = 0.097$ and 0.067 respectively). In the second series (D + 40), Lysine again appears as more concentrated at the epicentre, point (C), by contrast with proline (Pro) and isoleucine (Ile), whose concentrations increase with increasing distances from the epicentre. Lysine concentrations are significantly different between C and D ($p = 0.009$) and C and G ($p = 0.007$). Proline is depressed in sample C relative to samples D–E ($p = 0.06$), F ($p = 0.07$), and G ($p = 0.05$). Isoleucine is slightly depressed in sample C versus samples F ($p = 0.09$) and G ($p = 0.075$). No such differences could be found in samples from the last series (D + 730 from UE).

Incidence of Time-Proximity to the UE on the Biochemical Variability

The homogeneity of the distribution of biochemical parameters along the ecological axis may have been altered by an external factor. The variances calculated for the five samples at D + 40 and D + 730, respectively, have been compared by the "F" test. Significant differences have been noticed in the following 8 cases:

Chlorophyll A: $F = 8.5$ $P(F) = 0.03$

Chlorophyll A/Pheophytin: $F = 48.6$ $P(F) = 0.001$

Lutein: $F = 11.5$ $P(F) = 0.02$

Glucose: $F = 9.3$ $P(F) = 0.03$

Ribose-like*:	$F = 13.9$ $P(F) = 0.01$
Rhamnose-like*:	$F = 9.5$ $P(F) = 0.025$
Nr.14:	$F = 23.1$ $P(F) = 0.005$
Digitoxose-like*:	$F = 43.9$ $P(F) = 0.0015$
Nr.17:	$F = 42.3$ $P(F) = 0.0016$
Threonine:	$F = 54.8$ $P(F) < 0.001$

It is noteworthy that all of the four classes of biochemical compounds exhibit some differences corresponding to a significant increase of the variability at D + 40 by comparison with D + 730 samples.

Correlations With Distances: Various Kinds of *Dose/Effect* Relationships

Linear Correlations and Regressions. Plotting the concentrations versus distances from the epicentre of the UE gives rise to significant correlations. In all these cases, the slopes of the regression lines (bE) and (bo) corresponding respectively to (D + 40) and (D + 730) samples have been compared. In order to strengthen the significance of these comparisons, tests have also been performed versus the slopes at (D + 730) artificially increased by switching the extreme values (i.e., H and L) to their respectively minimum and maximum values, within the limits allowed by their SD (br).

The main results are summarized in Table 11. The most striking differences appear in photosynthetic pigments, which exhibit the largest susceptibility to the phenomenon.

However, a more accurate analysis of the observed relationships revealed some particular features that will now be examined.

Singular Aspects of *Dose/Effect* Relationships. The particular aspects concerning glucose, raffinose, ribose-like fraction, threonine, and serine demonstrate interesting features in dose/effect relationships.

Since no direct evidence of traumatism by contact (such as burning, charring, or visible damage on leaves) could be found, and some of the major alterations occurred in the samples situated nearer the epicentre of the UE, this may suggest the hypothesis that the observed effects are due to an energy source whose effects would decrease as a reverse function of distance (i.e., a radiative source).

The case of glucose is illustrated by Figure 1; the natural plot (Figure 1A) suggests a hyperbolic curve. If Ro is the response at d = 0 and Ri at di, the difference AR = Ro-R algebraically behaves as the velocity of an enzyme, (Bounias, 1979) according to the general equation

$$Ri = R_{Max} \cdot di^n/(L + di^n). \quad (1)$$

* Unidentified fractions of similar chromatographic mobilities as the indicated standards.

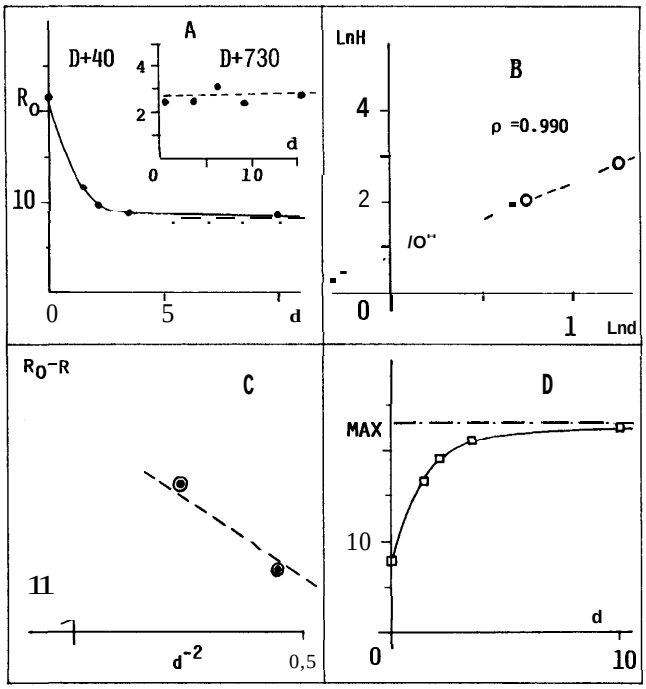

Fig. 1. An algebraic study of the response (Ri) of glucose concentrations at D + 40 according to the distance (di) to the epicentre of the U.E. A = natural units (the response at D + 370 is given for comparison). B = Hill plot (see text). C = differential response versus d^{-2}. D = theoretical differential response according to distance d.

Plotting dn versus R/d^n with the upper 2 and 3 points give a fairly good estimation of $R_{Max} = 15.0 \pm 0.7$ units (nmol per mg). Then, the Hill plot:

$$\ln[Ri/(100 - Ri)] = n \ln di - \ln(L) \quad (2)$$

illustrated by Figure 1B gives n = 2.00 and L = 0.65 m. This reveals that the response varies according to d^{-2}, like most electromagnetic events. Accordingly, roughly representing the results as (Ro-R) versus d^{-2} would have given a fairly linear plot (p = −0.971; $p(t) = 0.02$; b = −6.59: Figure 1c) i.e. a much better correlation than using natural units (p = −0.580!). Then the theoretical curve would actually be:

$$Ri = 14.95 + 8\ di^2/(0.65 + di^2) \quad (3)$$

as illustrated on Fig. 1D.

Nothing similar could be obtained from control samples using plants extracted at (D + 730), as illustrated inside Fig. 1A.

Raffinose and ribose concentrations exhibit quite a different relation versus distances: minimum values occur at the epicentre, whereas maximum ones can be observed at an intermediate distance. Assuming that the energy

gradient can be roughly linearized in exponential units, and in a decreasing value from distances to the epicentre, one can replot the data using R versus e^{-d}. This leads to typical biphasic dose/effects relationships (Figures 2A and 2B) as encountered in ligand-receptor interactions (Bounias & Pachéco, 1972; Sanchez & Changeux, 1965) (Figure 2C).

The equation of such a phenomenon is rather complex (Bounias, 1987), but highly representative of a number of toxicological stresses in plants (Stevens & Merril, 1985) (Fig. 2d).

Threonine and serine exhibit a similar response, except that concentrations reach an intermediate minimum instead of a maximum value (Figures **3A** and B in small frames).

In this case, plotting Ro-R versus e^{-d} gives curves similar to those on Fig. 2, except that values reach zero for $e^{-d} = 1$ (Figures 3A and 3B). Similar features encountered under the stress of toxins or electromagnetic parameters are shown on Figures **3C** and 3D, respectively.

Alteration of Functional Relationships in Connection With the UE

It has been shown that the algebraic form of the relations between two biochemical parameters may prove to be a sensitive way for evidencing stress effects (Bounias, 1975; Bounias et al., 1986). This might allow the character-

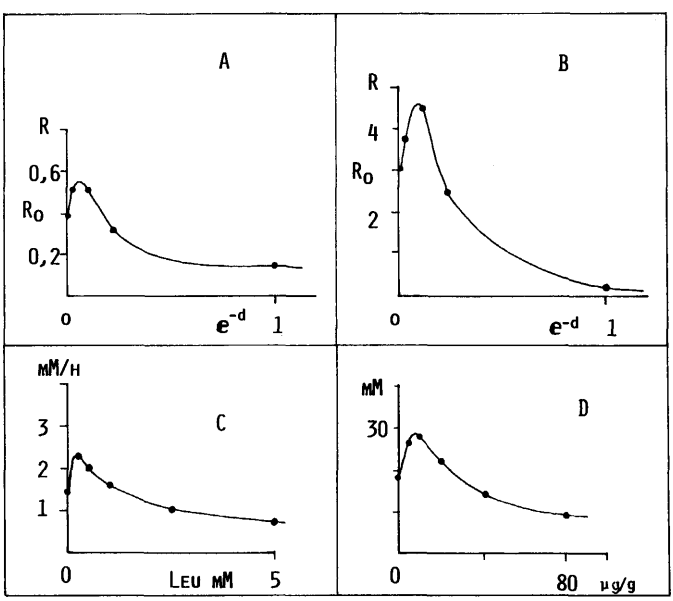

Fig. 2. Biphasic dose/effect relationships: A and B resp. = Raffinose and Ribose-like concentrations versus e^{-d}. C = control of Barley leaves phosphatases by L. leucine (Bounias & Pachéco, 1972). D = control of Lettuce roots growth (mm) by solstitiolide (μ/g). (Stevens and Merril, 1985).

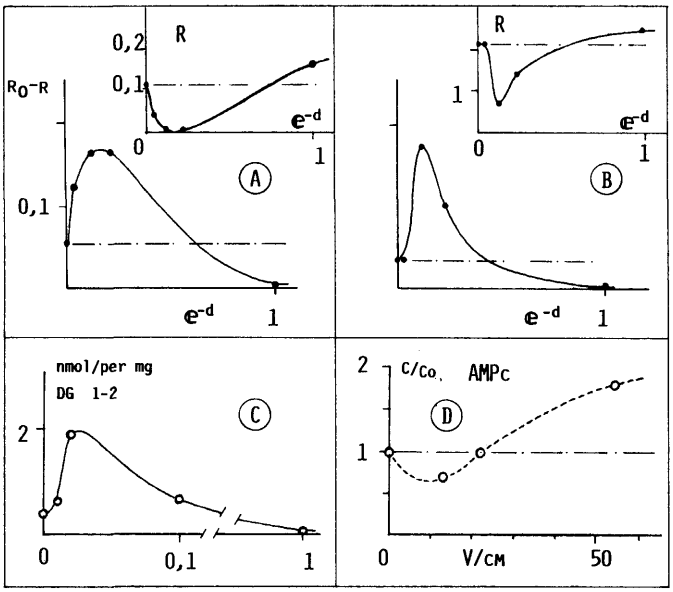

Fig. 3. Biphasic dose/effect relationships: A and B resp. = theonine and serine concentrations (in small frames) or differential levels (Ro-R) versus e^{-d}. C = action of a bacterial toxin on mosquitoes lipids (Nizeyimana et al., 1987). D = action of and incident electromagnetic field intensity on cAMP levels in cultured bone cells of rat (Somjen et al., 1982).

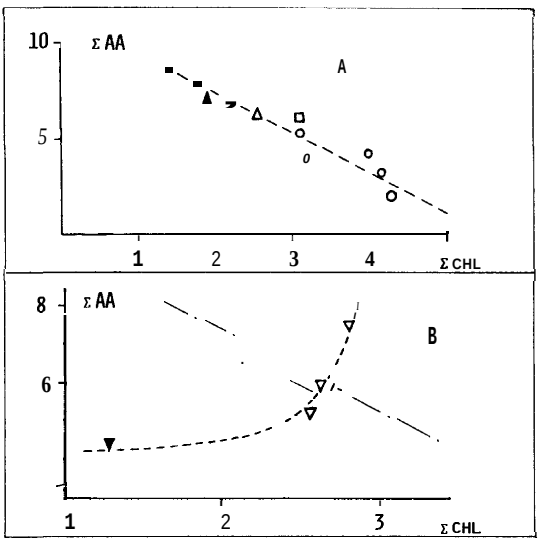

Fig. 4. Functional relationships between the sum of amino-acids concentrations (ZAA = Ser + Asp + Asn + Glu + Thr + Pro + Ile + Leu + Phe + Try + X1 + X2 + X5) and the sum of chlorophyll pigments (Chl.A + Chl.B normal and oxidized forms) + Pheophytins + chlorophyllids + Protochlorophyllids). A = normal relation: 0 = D + 730 series; □ =distance 10 m at D + 40; ▲ =distance 1.5 m at D + 4. △ =distance 15 m at D + 15.B = exposed points at D + 40: ▼ = point at epicentre of U.E. The axis line (– . –) on Fig. 5B indicates the position of the normal regression.

ization of stresses even in particular cases where no deviation of the concentrations from the normal range of natural values can be detected.

*The Functional Relationships Between Free Amino Acids And Chlorophyll Pigments (Figure*4). First suggested by Jain (1966), were pointed out both in dicotyledones and monocotyledones (Bounias, 1972–1975), following experiments conducted in controlled artificial conditions in growth chambers.

A detailed analysis of the biochemical content of samples collected at *D* + 730, show these functional relationships to be found again (Figure 4A).

This means that the deviations observed in the range of the natural variability do respect normal physiological law, despite uncontrolled (field) conditions.

Plotting the same parameters from samples collected at D + 40 surprisingly led to a completely reversed relation (Figure 4B).

It is noteworthy that not only the points situated far from the epicentre at

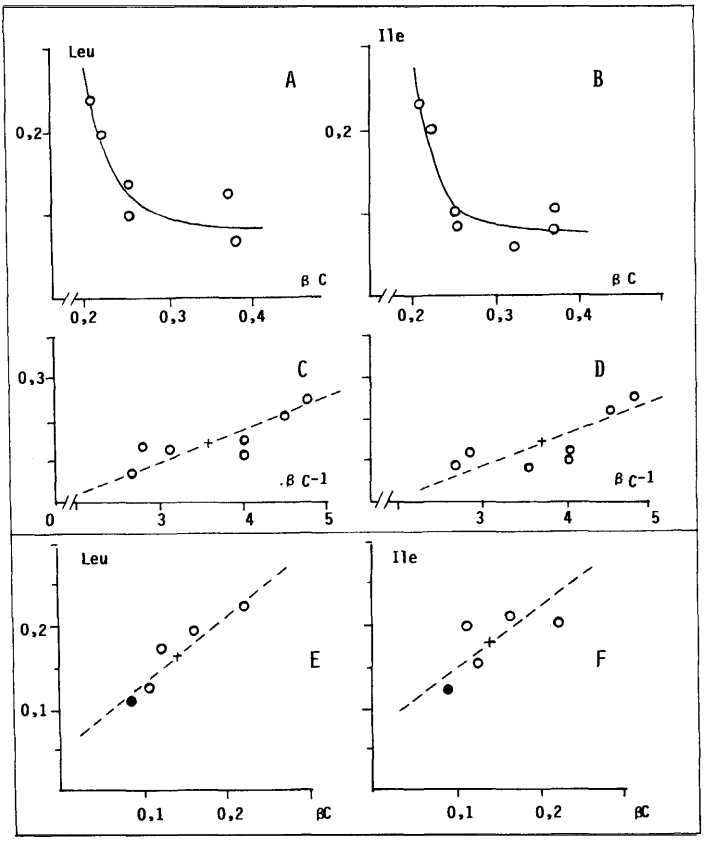

Fig. 5. Functional relationships between leucine **or isoleucine and** β **carotene concentrations (nmol per mg): A and B: control samples at D + 730 in natural units and C, D, in semi reciprocal units. E and F: samples at D + 40 in natural units; the solid dots represent the point at epicentre.**

TABLE 11
Comparisons of the regression slopes of biochemical levels versus distances from epicentre of the UE

Biochemicals	Correlations at: D + 40 p	D + 40 (P)	D + 730 p	D + 730 (P)	Comparisons of Slopes b_E	b_0	$P(b_E/b_0)$	$br \pm$	$P(b_0/br)$
β Caroten	0.90	(0.04)	–0.83	(0.08)	0.065	–0.027	(0.014)	0.047	(0.125)
Chl.A	0.84	(0.07)	–0.76	(0.13)	0.092	–0.019	(0.043)	0.036	(0.19)
Chl.A/Pheo	0.97	(0.004)	0.25	(0.68)	0.11	0.011	(0.006)	0.06	(0.04)
Lutein	0.98	(0.003)	–0.61	(0.27)	0.111	–0.014	(0.002)	0.032	(0.007)
Valine	0.53	(0.36)	–0.95	(0.015)	0.05	–0.04	(0.13)	0.02	(0.09)
Proline	0.96	(0.01)	0.75	(1.96)	0.17	0.11	(0.11)	0.016	(0.2)
Isoleucine	0.79	(0.11)	0.29	(>0.5)	0.05	0.01	(0.17)	0.01	—

D + 15 and D + 40 are situated well on the normal curve, but also the point corresponding to the epicentre at D + 40 clearly fits the same curve. The correlation being $y = -2.11x + 11.56$, for x = 1.9, the theoretical value for y (amino acids) is 7.55, whereas the observed value is 6.91 (i.e. a 8.5% deviation). This point is however situated at the extreme part (i.e., the lower chlorophyll concentrations and the higher amino acids ones).

A Particular Relation Between Leucine or Zsoleucine and β Carotene Was Also Found in Barley Leaves (Bounias, 1975). The same type of relation was found by plotting all the samples that could be considered as controls (Figures 5A and B). Taking into account the hyperbolic shape of the curves in natural units, plotting isoleucine or leucine versus the reciprocal of β carotene concentrations (Figs. 5C and 5D) led to positive correlations of higher significance (Table 12).

TABLE 12
Statistics parameters of Leucine and isoleucine correlations with β carotene concentrations in UE exposed (D + 40) and control (D + 730) samples

	Correlation Coefficient ρ	Significance $P(\rho)$	Regression d	Slope σ_d	
D + 730					
Natural plot					
Leu/β C	–0.674	0.037	–0.67	±0.42	*
Ile/β C	–0.746	0.006	–0.66	±0.34	
Semireciprocal plot					
Leu/β C	+0.760	0.003	+0.078	±0.038	*
Ile/β C	+0.801	0.0007	+0.070	±0.030	
D + 40					
Natural plot					
Leu/β C	+0.646	0.06	+0.75	±0.51	*
Ile/β C	+0.867	2.10^{-5}	+0.79	±0.26	

* Differences not significant at $(1 - P) < 0.01$.

The natural plots obtained from samples collected at D + 40 (Figs. 5E and 5F) exhibited positive, fairly good correlations. In all cases, leucine and isoleucine parameters are rather similar, without statistically significant differences.

A Positive Correlation Links Glucose to Chlorophyll *A* Concentrations in Normal Leaves of Barley (Bounias, 1975). Here also, using natural units, the concentrations of glucose are positively correlated to those of chlorophyll A, with all samples that can be considered as controls (i.e., B, G to L). For N = 9 pairs, p = +0.824 (p = 0.04), and b = 8.98 (ab = 3.56). Then, with the 4 most exposed samples of D + 40 (i.e., C, D, E, F,), there appears a significantly negative correlation: for N = 4, p = –0.906 (p = 0.06) and *b* = –19.6 (ab = 5, 3). The low variability of carbohydrate and pigment levels at D + 730 did not allow a better correlation to be observed because of the gathering of the points in one limited area. However, this basic phenomenon, which was repeatedly found because of stress conditions, was completely reversed in the samples most exposed to the UE (Figure 6). It is noteworthy that, again, exposed samples at D + 4 are well situated at an extreme (lower) part of the control curve.

Discussion and Conclusions

The level of photosynthetic pigments decreased in all samples collected at D + 4 and D + 40 near the epicentre of the UE. Then, at D + 40 only, glucose contents increased. These observations, strengthened by the significant increase of variability at D + 40 by contrast with D + 730, are characteristic of an early alteration of the photosynthetic apparatus, maintained and followed by a decrease in glucose utilization. It was doubtful that after a two-year delay, nothing could ever be related to the influence of anything situated at the point corresponding to the epicentre of the trace of the initial event. At this step, one can assert that something actually happened in the studied area.

Fig. 6. Functional relationships between glucose and chlorophyll A concentrations (nmols per mg). A = control sample (●) = distance 1.5 m at D + 4. B = 4 most exposed samples at D + 40.

The significant correlations obtained by plotting the results with distances from the UE epicentre, suggest that the "thing" that happened globally elicited biochemical effects as a reciprocal function of the distance from the source. It is noteworthy that in some cases, such as for glucose, a d^{-2} dependent relation was evidenced, consistent with a radiative energy emission.

Some apparent exceptions did occur for various carbohydrates and amino acids, but a more detailed algebraic study revealed that they were quite consistent with typical cases of biphasic dose/effect pharmacological or toxicological relations, including chemical but even physical (electromagnetic) sources of stresses (Somjen et al., 1982). This confirmed that the "thing" that happened did generate a distance–dependent energetic source of stress.

In a last step, it was clearly emphasized that dramatic changes from the natural features of functional relationships occurred in the samples that were the most exposed to the unknown event. Here, two phases were clearly distinguished; in the first one (D + 4), the metabolism of the most exposed samples was shifted to the most extreme parts of the normal equations, whereas in the second one it was situated on the extreme points of reversed equations. This indicates very deep, delayed physiological effects. Since chemical sources could hardly explain such a strong remaining effect after almost two months, the hypothesis of a wavy radiative source remains the more likely, since electromagnetic impulses are able to generate delayed responses (Gorczynska et al., 1982).

From a series of comparisons with known sources of stress (Bounias, 1972–1983c), it could be suggested that the observed effects of D + 4 might reflect a stress of the same type as would have caused a dim light shock, whereas at D + 40, the symptoms are partly—but only partly—consistent with an alteration of the oxidative phosphorylation mechanisms. None

TABLE 13

pH of the soil as determined according to the delay after solubilization in the clod-earth of D + 40 and D + 730 samples and in control soil samples treated with cement powder (P), cement supernatant (S) and liquid mortar (M), by comparison with controls

	pH at Time Zero	pH After 2 Hours	pH After 6 Hours	pH After 24 Hours
Controls	9.10	9.07		
C	8.78	8.31	8.09	7.94
D	8.93	8.48	8.09	8.05
F	8.86	8.39	8.23	8.10
G	8.43	8.02	7.93	7.66
H	9.10	8.58	7.94	7.62
I	9.15	8.12	7.79	7.56
J	9.16	8.65	8.12	7.77
K	8.75	8.20	7.88	7.67
L	8.92	8.45	8.07	7.65
P	10.91	11.22	—	—
S	11.03	11.14		12.80
M	10.15	10.67		12.70

could be clearly explained, for instance, by ionizing (Bounias, 1973) radiations, or thermic or water stresses (Bounias, 1983c).

It remains to examine the challenging hypothesis of a mystification by ill-intentioned people. One of the suggested explications was that somebody might have spread some cement on the area. In this case, the pH of the soil should have been modified; the results of pH determinations in the clods gave the results summarized in Table 13.

It is clear that no significant effect of either distance from epicentre or delay from D + 40 to D + 730 can be found ($p \geq 0.84$ and 0.52 resp. from variance analysis).

Moreover, nobody, except the author, knew in advance when and where or what was to be sampled and analyzed on the site. Thus, one can hardly imagine how anybody could have artificially elicited the observed results (except by invoking some ESP phenomenon!) so that the reliability of the results apparently remain significant.

It was not the aim of the author to identify the exact nature of the phenomenon observed on the 8th of January 1981 at Trans-en-Provence. But it can reasonably be concluded that something unusual did occur that might be consistent, for instance, with an electromagnetic source of stress. The most striking coincidence is that at the same time the French physicist J. P. Petit was plotting the equations that led, a few years later (Petit, 1986), to the evidence that flying objects could be propelled at very high speeds without turbulences nor shock waves using the magnetohydrodynamic effects of Laplace force action!

It should now be most interesting to determine a catalog of the biochemical effects of electromagnetic waves, particularly the spectra of the continuous effects of varying em parameters, such as frequencies, intensities modulation and pulses. A number of experimental data found in the literature (Bounias, 1984) and in theoretical studies (Veve & Bounias, 1987) suggest that such a program would be of wide importance not only for UFO studies, but also, for instance, in medicine (Douss et al., 1985; Somjen et al., 1982) and related areas.

References

Abelson, P. H. (1974). Pseudo science (Editorial). *Science*, 184, 1233.

Bauer, H. H. (1979). *Controversies on the fringes of science.* A.C.S. South East Regional Student Affiliates Meeting, Johnson City (TN), March; Sigma Xi, Bessemer City (NC), November.

Bauer, H. H. (1987). Society and scientific anomalies: Common knowledge about the Loch Ness Monster. *Journal of Scientific Exploration, 1,* 51–74.

Bounias, M. (1972). Relations entre les amino acides libres et l'équipement pigmentaire photosynthétique chez *Arabidopsis* (plants normaux et mutants viridis). *Arabidopsis Information Service,* (Gottingen), *9,* 13–15.

Bounias, M. (1976). Leucine effects in *Arabidopsis* biochemistry. I-Leucine and the photosynthetic apparatus. *2nd Int. Symp. Arabidopsis Res.,* J. *W.* Goethe University, Sept. 13–15, Frankfurt, Main, C.R. in: *Arabidopsis Information Service, 13,* 96–98.

Bounias, M. (1972). Etude biochimique et cytochimique de l'appareil photosynthetique chez des végétaux supérieurs normaux et mutés. *Thèse de Doctorat d'Etat ès Sciences,* Univ. Cl.

Bernard Lyon I—(n° Ordre 98), 146 p., 145 tableaux numkriques, 47 fig., 10 planches photographiques microscopiques, 255 rkf. bibliographiques.

Bounias, M. (1973). Equipement pigmentaire des cotylédons *d'Arabidopsis* aprks irradiation "gamma" des graines. *Arabidopsis Information Service (Gottingen),* **10,** 26–28.

Bounias, M. (1975). Modifications des relations quantitatives entre les pigments photosynthktiques et les acides aminés libres chez quelques mutants chlorophylliens d'Orge et d'Arabidopsis. *Canadian Journal of Botany,* **53,** 708–719.

Bounias, M. (1976). Microanalyse quantitative de quelques metabolites de l'hkmolymphe d'insectes. I—Les glucides libres. *Analusis,* **4,** 87–93.

Bounias, M. (1979). Variations in the Hill parameters of haemolymph alpha-glucosidase kinetics as compared by new algebraic methods at three nymphal stages of workerbees *(Apis mellifica, mellifica* L.). *Comparitive Biochemistry, 63B,* 407–417.

Bounias, M. (1980a). *N*(1-naphtyl) ethylenediammonium dichloride as a new reagent for nanoquantification of glucids on thin-layer plates by a mathematical calibration process. *Analytical Biochemistry,* **106,** 291–295.

Bounias, M., & Bounias, A. (1980b). Microanalyse quantitative de quelques mktabolites de l'hkmolymphe d'insectes. II—Les acides aminés libres. *Analusis,* **8,** 287–295.

Bounias, M. (1983a). Perturbations biochimiques décelées dans une luzerne sauvage (Medicago minima), en relation avec l'observation d'un phénomène akrospatial non identifié. *Note Technique CNES/GEPAN,* (ISSN 0750-6694), **16,** 41–64.

Bounias, M. (1983b). L'analyse biochimique quantitative par nano-chromatographie en couche mince. Masson Ed. (Paris).

Bounias, M. (1983c). Caractkrisation des traumatismes biochimiques vkgktaux. Application à l'ktude des dismetabolismes conskcutifs à evenement d'origine in connue. Rapport de fin de contrat: Ministére de l'Agriculture/Centre National d'Etudes Spatiales, Nr. 80-0796183-009, pp. 109.

Bounias, M. (1984). Dkterminisme klectromagnktique dans les fonctions biochimiques fondamentales: une nouvelle pharrnacologie. *Coll. Internat. de Biologie Thkorique,* (Sté Internat. de Biologie Mathkmatique, Fresnes, 6-12-84), 16 pp.

Bounias, M. (1987). Stimulation transitoire de l'activitk d'une enzyme par un effecteur. Dépôt sous pli cachetk, *Acadkmie des Sciences (Paris),* n° 16709.

Bounias, M., & Pachkco, H. (1972). Role de la L-leucine sur l'activitk phosphatasique alcaline chez l'Orge. *Comptes' Rendus de l'Acadkmie des Sciences (Paris),* **275,** 201–204.

Douss, T., Santini, R., Deschaux, P., & Pachéco, H. (1985). Augmentation du pouvoir immunogène de cellules canckreuses soumises à l'action des micro-ondes. *Comptes' Rendus de la Sociktk de Biologie,* **179,** 299–306.

Gorczynska, E., Galka, G., Krolikowska, R., & Werzynowicz, R. (1982). Effect of magnetic field activity of cytochrome oxidase not moved or moved relative to magnetic field lines. *Physiological Chemistry & Physics,* **14,** 201–207.

Jain, M. L. (1966). A biochemical study of yellow virescens and light green suppressors in Barley. *Genetics,* **54,** 813–818.

Loftus, E. F. (1979). Eyewitness testimony. Cambridge M.A.: Harvard University Press.

Nizeyimana, B., Bounias, M., & Vivarés, C. P. (1987). Manifestations biochimiques de l'intoxication des larves de Aedes aegypti (Insecte, Diptére) par la 6-endotoxine de *Bacillus thuringiensis israelengis.* II Les lipides abdominaux. *Comptes Rendus de la Sociktk de Biologie, 181,* 355–363.

Petit, J. P. (1986, September). Shockwave cancellation in gaz by Lorentz force action. Proc. 9th Meeting on Magnetohydrodynamic Electrical Power Generation, Tokyo.

Sanchez, C., & Changeux, J. P. (1966). Sur les propriétés de la L-thrkonine dksaminase de biosynthèse d'un mutant d'E. Coli K 12. *Bulletin de la Sociktk de Chimie Biologique,* **48,** 705–713.

Somjen, D., Korenstein, R., Fischler, H., & Binderman, I. (1982). Effects of electric field intensity on the response of cultured bone cells to parathyroid hormone and prostaglandin. *Excerpta Medica,* **589,** 412–416.

Stevens, K. L. & Meml, G. B. (1985). Sesquiterpene Lactones and Allelochemicals from *Centaurea* Species. In: *A.* C. Thompson (Ed.), *The Chemistry of Allelopathy,* (pp. 83–98).

Sturrock, P. A. (1987). An analysis of the condon report on the Colorado UFO Project. *Journal of Scientific Exploration, 1,* 75–100.

Vkve, J. C., & Bounias, M. (1987). Etude théorique de l'action des champs Clectromagnktiques sur les fonctions biochimiques. ler congrès international de Kinésithérapie énergétique, Tours, 17–18 Oct., 1987 (4 pp.).