

**An application of the Quentin/80 software
to the study of the manuscript tradition
of the *Appendix Vergiliana***

(semi-automatic construction of the *Stemmata Codicum*)

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This study is to be placed in the field, widely dealt with by now, of computer applications to textual criticism, where contributions - prompted by Dom Froger's famous book *La critique des textes et son automatisation* (Froger, 1968) which was a starting point for all later work - have been numerous and useful. Ten years later, the publication of the Acts of the Paris conference on *La pratique des ordinateurs dans la critique des textes* (Glenisson *et al.*, 1979) provided a first significant weighing up of the work done, and gave an indication of the direction for research in the coming years.

We shall set out here the results of the experiments done in 1979-1980 on the poems of *Appendix Vergiliana* with the QUENTIN/80 system. This software for the automatic reconstruction of the genealogy of manuscripts was realized in 1976-1977 by Gian Piero Zarri and has been described elsewhere (Zarri 1977; 1979; etc.); it is based on perfecting and integrating the method suggested in Dom Quentin's *Essais de critique textuelle* (Quentin 1926).

It is widely known that the task of textual criticism is to reconstruct a text as close as possible to the original. The critic tries to eliminate (and at the same time to document) arbitrary alterations and deformations which have been introduced, over the years, into ancient or modern texts during their more or less extended diffusion. Thus the principles underlying textual criticism are of an historical nature; as had already noted Robert Marichal (Marichal, 1961), they are not, for this reason, a set of abstractly formalizable axiomatic rules.

One of the major obstacles for the philologist when trying to reconstruct the genealogy of the corruption process in ancient or medieval texts is contamination. This occurs when a manuscript uses, in a given variant-position, lessons provided by different currents of tradition without mechanically copying from its own model. It is obvious that this induces, especially when it happens frequently and involves several manuscripts of a given tradition, a widespread perturbation of the genealogical relationships; for this reason, it is often impossible to clarify the mass of such intricate links. Paul Maas's pessimistic remark about this is well known "*Gegen die Kontamination ist Kein Kraut gewachsen*"; contamination has always been considered by researchers as something abnormal which cannot be taken into account during the construction of the *stemma* and must be eliminated *a posteriori* in a totally empirical way.

We believe, on the contrary, that Dom Quentin's method is capable of taking contamination into account in a rational way during the construction of the *stemma*.

The main characteristics of the method suggested half a century ago by the French Benedictine monk are :

- the substitution of the notion of "error" by that of "variant" when identifying the primary elements on which to apply the calculation procedures : the choice of not distinguishing between correct and incorrect lessons, even if to do so is pragmatically useful, met with the

objection of philologists, see Timpanaro (1981 : 48);

- the substitution, as bare nucleus on which to establish the layout of the *stemma*, of the ternary relationship of the type : Y is intermediate between X and Z for the usual binary relationship : Y precedes (or follows) Z (or X), where the symbols used indicate any three exponents of the tradition being examined.

The search for the intermediate manuscript, in some ways the primary logical core of the method, is achieved by the wellknown calculation of the "characteristic zero" which has often caused ironical comments by the critics of the French monk. Using again the symbols X, Y, Z, we can say that a manuscript Y is intermediate if, and only if, two manuscripts X and Z are never in agreement (=zero) against it, when examining the variant-positions of a pre-established positive apparatus.

With Y as intermediate between X and Z we have individualized, according to Dom Quentin, an undirected stemmatic chain, see figure 1a, which, in the next phase of the operation, can give rise to the four oriented graphs of figure 1b, all compatible with the concept of intermediate and amongst which Quentin chooses on the basis of traditional philological criteria.

It is important to note that the fourth elementary stemmatic construction of figure 1b regards the possibility that the lessons of code Y may originate from contamination of X by Z. Thus is confirmed the statement we made earlier, according to which this method allows processing of contamination during the very construction of the *stemma*.

The calculation of characteristic zeros is the last step defined in some detail by Quentin. Indeed, for the synthesis of the final *stemma*, he uses the traditional philological procedures based on chronological and axiological criteria (and here the concept of error reappears). From this point onwards, the computer approach to the Quentian method is forced to proceede autonomously, completing and innovating with respect to the model. This is true, amongst others, at the key moment of the orientation of the *stemma*.

This work on automatic textual criticism applied to texts included in the corpus of *Appendix Vergiliana* is connected with previous experiments carried out on *Copa* alone (Zarri 1974; 1977); the choice of that corpus to test the usefulness of QUENTIN/80 for the study of difficult traditions is justified by the fact that the tradition of the *Appendix* is particularly intricate, with the obvious existence of contamination. Also, the relative shortness of these poems lends itself well to the still experimental nature of our work, in which each step is to be taken with careful attention to detail.

As reference example, we shall use the section of *Ciris*, the verses 454-97, which has been conserved by a stemmatically significant number of codex : the older manuscripts, G (*Fragmentum Graeciense* of the IXth century) and BR (*Bruxellensis* 10675-76 of the XIIth century); the group formed by the

humanistic manuscripts, H (*Helmstadiensis* 332), AR (*Arundelianus* 133), RH (*Rehdigeranus* 125) and RO, the first printed edition of the text (Romae 1471). There is an excellent annotated critical edition of *Ciris* published by Oliver Lyne (Lyne 1978) which we used to establish the positive apparatus. As appears in table 1, this section includes variant-positions which seemed to be a sufficiently significant sample of the stemmatic behaviour of the six "manuscripts".

Let us now follow the various phases of the application to this positive apparatus of the QUENTIN/80 system, which is written in APL and is based on the use of boolean matrices in the framework of an *ad hoc* utilization of graph theory.

The variant-positions of the positive apparatus are loaded into memory by the ENTREE module; their variants are recorded as positive integers which represent the order of appearance of each variant for each variant-position. For example, in variant-position n. 1, the codex G, BR and RO are represented by "1" (*solam* lesson), whilst H, AR, RH are represented by "2" (*sola* lesson); in variant-position n. 2 on the other hand, G and BR are represented by "1" (*fecisse*), H, AR, RH by "2" (*legisse*) and RO by "3" (*iesisse*). If a manuscript includes no data for a particular variant-position, it will be indicated by "0".

Table 2 shows a fragment of input in conversational mode : for each manuscript, the operator records a numeric vector where the *value* of each element corresponds to the position of the manuscript inside the variant-position, and where the *position* of the element in the vector corresponds to the index number of the variant-position being considered. The false position "99" marks the end of input for each manuscript. These vectors loaded in memory provide the lines of the matrix VAR, table 3, on which operate the rest of the functions of the system. As can be seen clearly in table 3 the ENTREE module, conformly with Quentin's indications, has automatically suppressed the "isolated variants", introducing a "0" in the place of the positive integer which represent that lesson. There is also a correction module, MODIF, which can be called at any time during the session at the terminal and which operates on VAR to substitute, insert or delete data in the initial positive apparatus. For this reason, the user does not have to repeat the input procedure which is nearly always more laborious than in the example shown here (note that MODIF was not used for *Ciris* but was used several times whilst working on *Culex*, *Moretum* and *Dirae*).

A brief word about the module TABLE which, as in Dom Quentin's original method, performs the statistical comparison taking the manuscripts two by two. We are only interested here in the fact that the system - using TABLE - records the coincidence over the whole length of the apparatus of BR with G and of RH with AR. The system thus avoids considering BR and RH when searching for the zeros, much simplifying the operation.

ZERO is the QUENTIN/80 command which performs the comparison of the codes in group of three to find the intermediate. Given that we are only examining here four manuscripts, the number of

triplets is $C^4_3 = 4$.

Table 4 shows the calculation of the zeros and the list of elementary chains each corresponding to a characteristic zero. The system keeps to the usual Quentian notation, using the brackets "<" and ">" where the pointed ends are towards the intermediate code. The chains $G - H - AR$, $G - RO - H$, $G - RO - AR$, $AR - H - RO$ are elementary stemmatic constructions, "undirected", in the sense that it is not possible to deduce the direction of the genealogical relationship. To group these chains into one schema, the ZERO module generates an intermediate result made up by a boolean matrix AM of dimensions $n \times n$ (where n is the number of manuscripts examined, 4 in our case). The construction rules that produce AM insert a "1" at the intersection of the line of manuscript X with the column of manuscript Y if the two manuscripts are adjacent at least once in the list of elementary chains, otherwise a "0" is inserted, see figure 2.

Matrix AM is already, in some ways, a global graphical representation of the relationship between the manuscripts. However, there may be some links in it which contradict the notion of "intermediate". For example, if there were a direct link between G and H , which did not include RO , the manuscripts G and H would have common lessons different from RO 's, which would render impossible the appearance of a characteristic zero under RO in the second chain of our list ($G - RO - H$). Thus it is necessary to pick out the couples of "non intermediate" manuscripts from the list of undirected elementary chains (in our case $G - AR$, $G - H$, $AR - RO$) and to turn into "0" the corresponding "1" in AM, see also Zarri (1977, 270-71). The system performs this reduction automatically and displays straight away the "reduced matrix" MR of table 5. By introducing at this point, without worrying about the direction, a direct graphical connection between two manuscripts each time we meet a "1" at the corresponding intersection in matrix MR, we obtain the undirected graph in figure 3.

Before going on to directing the graph, it is important to check if there are any variants in the initial positive apparatus that contradict this undirected graph. Such variants, known as "irreducible", would still be contradictory after execution of the final directing operations. It is thus advantageous here to discover them before going on to the last, long and costly phase, to be able to modify, if need be, the apparatus using the MODIF command. There exists a particular algorithm in QUENTIN/80 already described in a previous article (Zarri, 1976), which performs this check; thus we shall say no more about it. Note that in the positive apparatus of *Ciris* there is only one "irreducible" variant-position with respect to the graph in figure 3, variant-position n. 27, which anyway does not seem very significant from a philological point of view. G , BR and H could be in agreement because of polygenesis.

Let us go on now to the last phase of the processing : the ORIENT module deals with the directing operation. However, a deciding aspect of the above is left entirely to the human operator. Indeed, he chooses the "hook" on which hangs the undirected construction; this choice is to be made on the basis of operator's own philological knowledge. The computer extracts all the logical consequences

of this choice, and ensures that the directed graphs are not contradictory with the data of the apparatus.

In the case of our example, given the small number of manuscripts in question, it was easy to take each one in turn directly as "hooks", and then to place the hook on the links between them.

Thus we used the ORIENT command seven times, "hanging" the undirected graph successively on the manuscripts *G, H, AR, RO* and on the links *G - RO, H - AR, H - RO*; figure 4 shows the seven directed stemmatic constructions obtained. The choice of which to adopt as definitive can only, in this case, be made according to philological criteria, rather than purely logical. Thus, in accordance with the *stemma* provided by Lyne, see below, we decided on n. 5 (in figure 4) which has the advantage of clearly distinguishing the two branches of the *Ciris* tradition : the one of the *vetustiores* manuscripts (*G, BR*) on one side and the one of the humanistic manuscripts on the other. Table 6 shows the application of the command ORIENT which gave rise to the stemmatic constructions in figure 4. We shall not go into more detail here about the directing procedures performed by the system, see for this Zarri (1977, 271-76).

The final result for *Ciris* is shown in figure 5. It is the development of the fifth directed graph of figure 4, to which have been added the coinciding manuscripts *BR* and *RH*, and the lost hypothetical manuscripts $X_1 \dots X_n$ introduced to justify the isolated variants existing in various extents in all six testimonies. This construction, which contains the only "irreducible" contradiction of variant-position n. 27, corresponds perfectly with the one offered by Oliver Lyne in the introduction to his 1978 edition (Lyne 1978) : X_3 corresponds to *O*, "archetype" of all the humanistic manuscripts kept, and X_4 to *Z*, the direct antecedent of *H, AR, RH*.

Figures 6 and 7 show the final stemmatic constructions for *Culex* and *Dirae*; for details on the procedure followed to obtain these constructions and the final results for *Moretum*, see Borsetta (1980).

There are two philological remarks to be gathered from this semi-automatic application of Dom Quentin's method to a large part of *Appendix Vergiliana* :

- We obtained genuinely interesting stemmatic results, which largely agree with the result of recent studies by outstanding scholars such as Reeve (1975, 1976), Richmond (1976), Lyne (1978) and Courtney (1968), all very sceptical about the stemmatic part of the still worthy and fundamental Oxonian edition of 1966 (Clausen *et al.* 1966).

The limits of the *recensio* approaches based, like that of Dom Quentin, on the concept of variant are confirmed. This approach is not able to account for, from a diachronic point of view, the process of progressive corruption of a given text. Indeed, it is enough that there should be a certain amount of agreement of little stemmatic weight on given textual forms, to justify certain links in the final constructions. And it is for this reason that we hesitated to

define our results as *stemma codicum*, preferring a more modest label, "stemmatic construction", see Zarri (1979). The fact remains, however, that a mechanized method, like Lachmann's method, based on the concept of "error" has still to come.

Finally, we shall make a point of a more general nature : if it is true that the results here exposed have no pretensions about being definitive, they do provide an interpretation *coherent*, from a logical point of view, and *useful*, from a pragmatic one.

The intervention of the philologist-humanist with his historical linguistic or literary background must however occur, not only at the end of the work, when he is called upon to decide for or against the results, but also during the course of the sessions at the terminal. The user can thus "backtrack" and modify the selection of "significant variants" or change the "hook" without having to repeat the whole task from the introduction of the data onwards. What we have is the expression in computer terms of the "petit coup de pouce" Dain talks about (Dain, 1932). One can imagine the virtuous contempt of a partisan of "scientific" mathematical abstraction faced with such a relaxed way of going about things. But we can see nothing shameful in keeping to a pragmatic principle in our attempts at mechanization in the humanities. We believe, in fact, that it is more valuable - whilst we wait for better times - to make banal our attempts by revealing their true "engineering" character than to try to raise them to the sublime under the guise of a very improbable "science".

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figure 1a

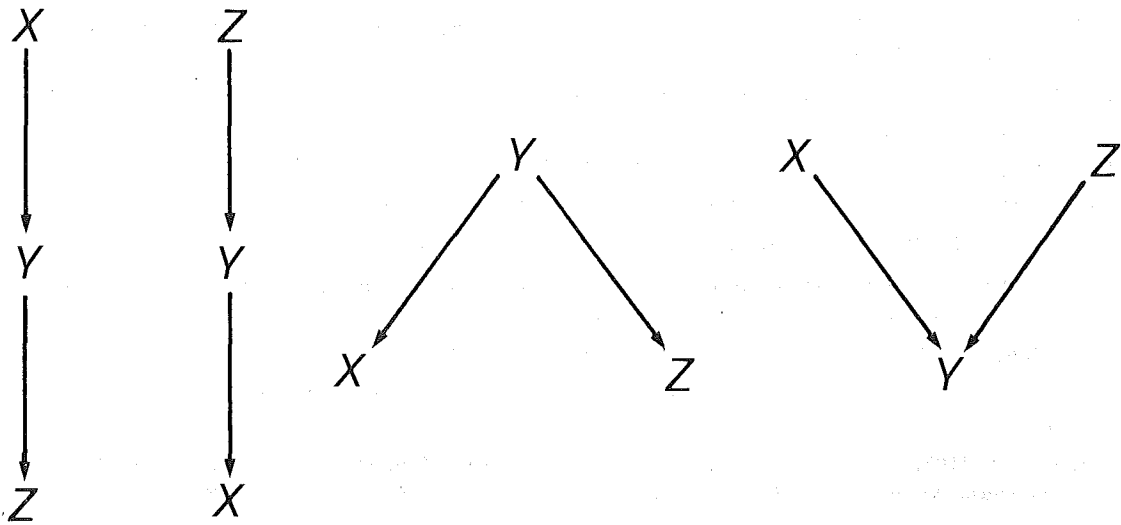


figure 1b

figure 2.

<i>G</i>	<i>H</i>	<i>AR</i>	<i>RO</i>	
0	1	0	1	<i>G</i>
1	0	1	1	<i>H</i>
0	1	0	1	<i>AR</i>
1	1	1	0	<i>RO</i>

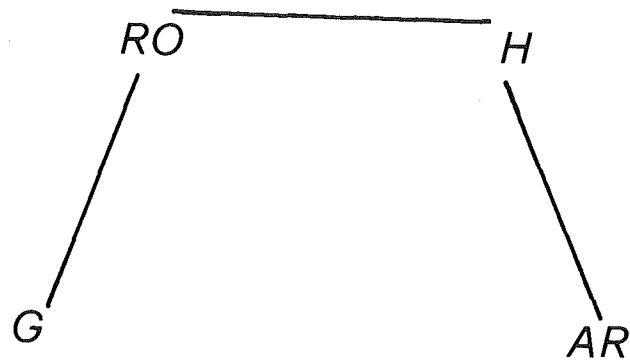


figure 3

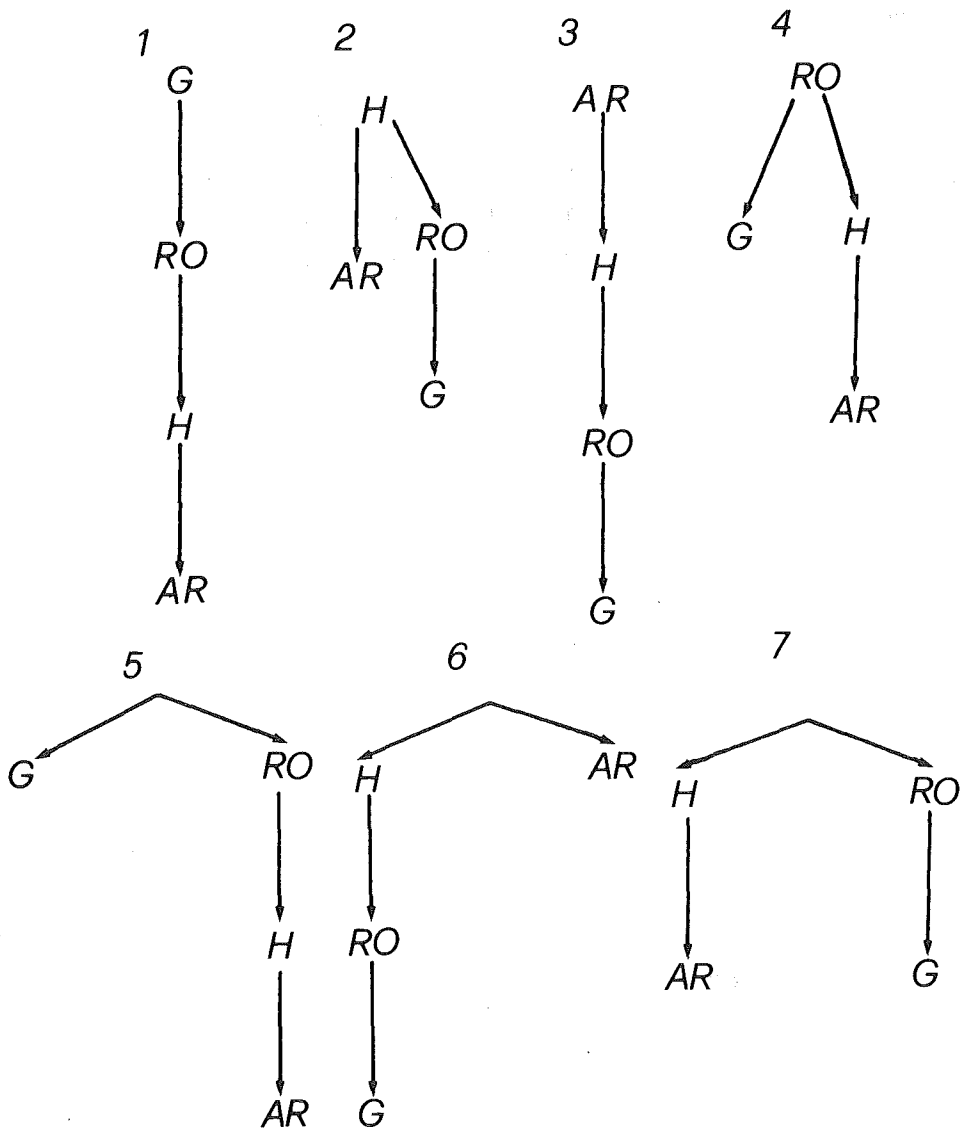


figure 4

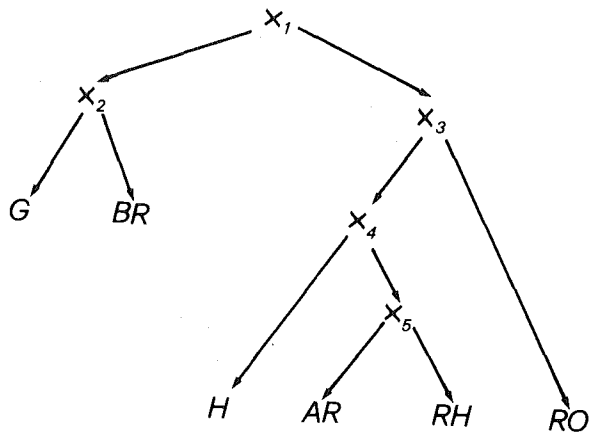


figure 5

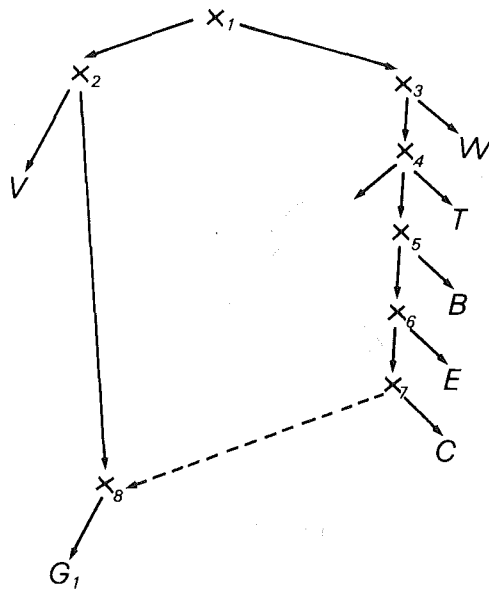


figure 6

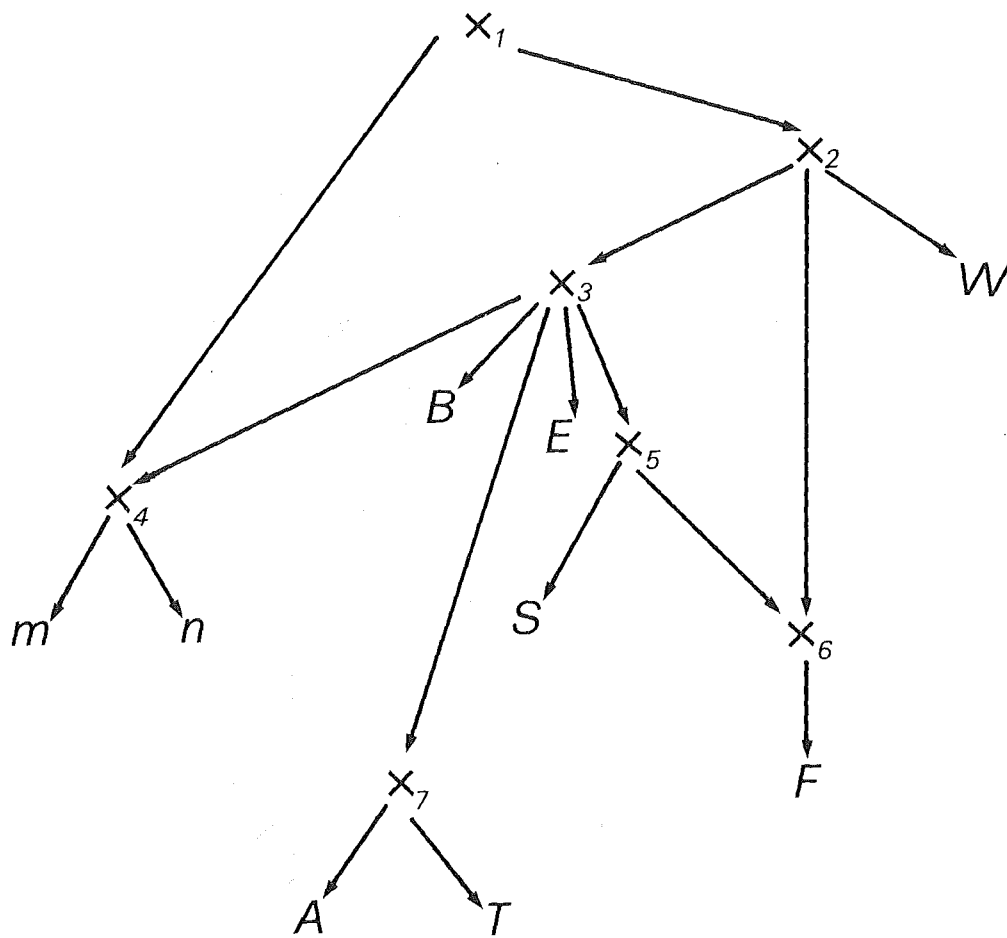


figure 7

"Ciris" (vv. 454-97), positive apparatus

G Fragmentum Graeciense

BR Bruxellensis 10675-76

H Helmstadiensis 332

AR Arundelianus 133

RH Rehdigeranus 125

RO editio Romana Vergilii a. 1471

variant- position	1	solam	G BR RO	v. 455
		sola	H AR RH	
var.-pos.	2	fecisse	G BR	v. 458
		legisse	H AR RH	
		lesisse	RO	
var.-pos.	3	ab	G BR H RO	v. 459
		a	AR RH	
var.-pos.	4	coro	H	v. 460
		choro	G BR AR RH RO	
var.-pos.	5	isthmon	BR RO	v. 463
		isthm..	G	
		istmon	AR	
		ismon	RH	
var.-pos.	6	Cypselide	RO	v. 464
		cy(i)pseid(a)e	G BR H AR RH	
var.-pos.	7	scironis	G BR	v. 465
		chironis	H AR RH RO	

table 1

var.-pos. 8	pireia pierida	G H AR RH RO BR	v. 468
var.-pos. 9	eheu secum heu	G BR H AR RH RO	v. 469
var.-pos. 10	e fluctu salamina e (et H) fluctus alia minos effluxus Minoia	G BR H AR RH RO	v. 470
var.-pos. 11	respicit aspicit	G BR RO H AR RH	v. 470
var.-pos. 12	uenus illi strophadasque	G BR H AR RH RO	v. 471
var.-pos. 13	sunius sinus summus hinc sinus	G BR H AR RH RO	v. 472
var.-pos. 14	hermionea hermionia (-mon- H) hermiona	G BR H RO AR RH	v. 472
var.-pos. 15	cyntum cynthum chintum cyntum	G BR H RO AR RH	v. 475
var.-pos. 16	donytam donytan donisam (-sa H; -iss- AR RH)	G RO BR H AR RH	v. 476
var.-pos. 17	salutiferamque sementiferamque	G BR H AR RH RO	v. 477

table 1 (cont.)

var.-pos. 18	seriphum seriphon	G BR H RO AR RH	v. 477
var.-pos. 19	uexarier uexauit et uëxauerit	G BR H AR RH RO	v. 481
var.-pos. 20	undis (a)egros aegram	G BR H AR RH RO	v. 481
var.-pos. 21	miseros misero	G BR H AR RH RO	v. 482
var.-pos. 22	(a)eternam externam et rigidis	G BR H AR RH RO	v. 484
var.-pos. 23	nimum est auidum pecus nimumque auidie regno	G BR H AR RH RO	v. 486
var.-pos. 24	tener(a)e teneres tener est	G BR RO H AR RH	v. 490
var.-pos. 25	primitus protinus	G BR H AR RH RO	v. 490
var.-pos. 26	animantur animantis	G BR H RO AR RH	v. 491
var.-pos. 27	mutabantur mutabuntur mutabatur	AR RH G BR H RO	v. 495
var.-pos. 28	et <u>omisit</u>	G BR H AR RH RO	v. 496

table 1 (cont.)

ENTREE

ENTREZ LES SIGLES DES MANUSCRITS SEPARES PAR DES VIRGULES
TERMINEZ PAR UN RETOUR-CHARIOT

G,BR,H,AR,RH,RO :

ENTREZ POUR CHAQUE MANUSCRIT LES VARIANTES SOUS FORME DE POSITIONS NUMEROTEES A
L'INTERIEUR DES DIFFERENTS LIEUX VARIANTES ; SEPARER CES POSITIONS PAR DES BLANCS
ET TERMINEZ POUR CHAQUE MANUSCRIT PAR UNE FAUSSE-POSITION '99'. SI LE MANUSCRIT
N'EXISTE PAS POUR UN CERTAIN LIEU VARIANT, INDIQUEZ '0' (ZERO) COMME POSITION.
LES VARIANTES ISOLEES SERONT AUTOMATIQUEMENT ELIMINEES PAR LE SYSTEME.

MANUSCRIT G

□: 1 1 1 2 2 2 1 2 1 99

MANUSCRIT BR

□: 1 1 1 2 1 2 1 2 1 1 1 1 2 1 2 3 1 1 1 1 1 1 1 1 1 1 1 1 2 1 99

MANUSCRIT H

□: 2 2 1 1 4 2 2 1 2 2 2 1 3 2 3 3 1 1 2 2 1 2 1 2 1 1 2 1 99

MANUSCRIT AR

□: 2 2 2 2 3 2 2 1 2 2 2 1 3 3 4 3 1 2 2 2 1 2 1 3 1 2 1 1 99

MANUSCRIT RH

□: 2 2 2 2 5 2 2 1 2 2 2 1 3 3 4 3 1 2 2 2 1 2 1 3 1 2 1 1 99

MANUSCRIT RO

□: 1 3 1 2 1 1 2 1 2 1 2 3 1 2 4 2 3 2 2 1 3 3 2 3 2 1 2 1 3 2 99

table 2

VAR

G	1	1	1	2	0	2	1	1	1	1	1	1	0	1	0	0	1	1	1	1	1	1	1	1	1	1	2	1	
BR	1	1	1	2	1	2	1	0	1	1	1	1	0	1	0	3	1	1	1	1	1	1	1	1	1	1	1	2	1
H	2	2	1	0	0	2	2	1	2	2	2	1	3	2	3	3	1	1	2	2	1	2	1	0	1	1	2	1	
AR	2	2	2	2	0	2	2	1	2	2	2	1	3	3	4	3	1	2	2	2	1	2	1	3	1	2	1	1	
RH	2	2	2	2	0	2	2	1	2	2	2	1	3	3	4	3	1	2	2	2	1	2	1	3	1	2	1	1	
RO	1	0	1	2	1	0	2	1	2	0	1	0	0	2	3	0	0	1	0	0	0	0	0	0	1	0	1	0	0

table 3

ZERO

CALCUL DES ZEROS

MANUSCRIT(S) NON CONSIDERE(S) DANS LE CALCUL: BR RH
NOMBRE DES TRIPLETS: 4

GHAR

GH>AR 3 18 26 27
G>H<AR 0
G<HAR 1 2 7 9 10 11 19 20 22

GHRO

GH>RO 0
G>H<RO 1 11
G<HRO 7 9 14

GARRO

GAR>RO 0
G>AR<RO 1 3 11 18 24 26
G<ARRO 7 9

HARRO

HAR>RO 1 11
H>AR<RO 3 14 15 18 26
H<ARRO 0

LISTE DES ZEROS

G-H-AR
G-RO-H
G-RO-AR
AR-H-RO

table 4

MATRICE REDUITE MR

G	H	AR	RO	
0	0	0	1	G
0	0	1	1	H
0	1	0	0	AR
1	1	0	0	RO

table 5

ORIENT

PROCEDURE D'ORIENTATION

INDIQUEZ UN SEUL MANUSCRIT SI CELUI-CI COINCIDE AVEC LE 'POINT D'ACCROCHAGE' ;
DEUX MANUSCRITS SEPARES PAR UNE VIRGULE SI CE POINT SE SITUE SUR L'ARC QUI LES RELIE :

G,RO

ARC(S) IMPLICITEMENT ORIENTE(S) :

A-G : 1
A-RO : 1

ARC(S) LIBRE(S) :

H-AR
H-RO

SI VOUS DESIREZ IMPOSER UNE ORIENTATION PARTICULIERE A CERTAINS ARCS, INDIQUEZ CI-DESSOUS LES
COUPLES DE MANUSCRITS CORRESPONDANTS. LES DEUX TERMES DE CHAQUE COUPLE DOIVENT ETRE RELIES PAR
UN TIRET ('-') ; SEPARER LES COUPLES PAR UNE VIRGULE (',') ; TERMINEZ LA DECLARATION PAR
UN RETOUR-CHARIOT. LA DIRECTION DE L'ORIENTATION EST DU TERME DE GAUCHE A CELUI DE DROITE DE
CHAQUE COUPLE. REPONDEZ PAR UN RETOUR-CHARIOT SI VOUS NE VOULEZ IMPOSER AUCUNE ORIENTATION.

PERMUTATIONS THEORIQUES POSSIBLES: 4

SOLUTIONS REELLES

A-G : 1
A-RO : 1
H-AR : 1
H-RO : 0

table 6