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ASTRONOMY-RELATED ORGANIZATIONS: GEOGRAPHICAL DISTRIBUTIONS, AGES AND SIZES

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Abstract. Graphical illustrations of geographical distributions, ages and sizes of astronomy-related organizations are presented from comprehensive and up-to-date samples extracted from master files with validated data (*StarGuides/StarWorlds*). More detailed results for professional institutions, associations, planetariums, and public observatories are also presented and commented, as well as specific distributions for astronomy-related publishers and commercial-software producers.

The geographical distributions display a highly uneven general pattern which is very much the same as it was at the beginning of the XXth century, in spite of the fact that there are more astronomy-related organizations nowadays – another illustration of the well-known socio-economic effect of self-reinforcement. Other geographical peculiarities (local concentrations, national cultures and policies, electronic astronomy, ...) are discussed in the paper, as well as the uneasy separation between amateur and professional astronomers in associations.

A number of events had a clear impact on the rate of foundation of astronomy-related organizations, such as the two World Wars, the beginning of space exploration, the landing of man on the Moon, the end of the Cold War, spectacular astronomical episodes (such as bright comets) and so on. However, as detailed in the paper, not all of them affected in the same way Western Europe and North America, nor the various types of organizations.

If the size of the vast majority of astronomy-related organizations is relatively small, there are however some differences between Western Europe and North America.

1. Introduction

In order to be reliable, studies of organizations in general, and of astronomy-related ones in particular, must be carried out from stable and exhaustive samples, the data of which must have been carefully checked and authenticated. We have been using here the master files for the directory (on paper) *StarGuides* of astronomy-related organizations and for its equivalent web resource *StarWorlds*. Those files have been updated and maintained since now about a quarter of century and are certainly the best ones available today in terms of accuracy, stability, homogeneity, exhaustivity, and geographical coverage.

The data and their context will be described in the next section. Then geographical distributions of astronomy-related organizations in general and for several specific categories described hereafter will be reviewed, as well as the corresponding rates of foundation and sizes. In each case, the specific data used will be explained and the main results will be illustrated.

This presentation is basically a descriptive snapshot of astronomy-related organizations world-wide at the first half of Year 2000. It updates some partial results already published (Heck 1998a&b, 1999) while including a whole set of new statistical figures and illustrations gathered together in a consistent synthesis. This paper should thus be considered as the corresponding reference for the end of the XXth century.

The importance of such an objective and factual report must be emphasized. We have been resisting pressures for studying productivity or impact, because the databases at hand do not contain relevant data for such investigations, but also because these would imply an underlying problematics involving criteria possibly leading to quantified results, but not necessarily objective ones. The adoption of the criteria themselves would indeed mean a number of *a priori* choices. Once more, the current study is independent from such *a priori* criteria and free from working hypotheses that would otherwise undoubtedly bias the presentation.

Except for one important case discussed below, comparisons with previous studies were not possible, because these were unfortunately inexistent. To the best of our knowledge, similar investigations have regretfully not been performed in other disciplines either, probably because lacking the vast amount of data necessary to obtain significant results (and collected through extensive, careful and painstaking long-duration maintenance). We have also been vainly looking for sociologists with experience in quantified studies of scientific organizations. Thus it seems that astronomers are once more pioneering a field.

Such an approach of the astronomy community should be repeated regularly in order to point out possible trends. One condition however will be to retain the highest quality possible as to the updatedness and completness of the information used, which implies a daily maintenance of databases.

2. The Data

2.1. GENERALITIES

The data used here have been extracted from the master files for *StarGuides* (see *e.g.* Heck 2000) and *StarWorlds*[1], the latter one being the WWW version of the former one which is a classical directory on paper (for a detailed presentation of those resources and of the associated ones, please refer to Heck 1997). They are gathering together all practical data available on associations, societies, scientific committees, agencies, companies, institutions, universities, etc., and more generally organizations, involved in astronomy and space sciences.

But many other related types of entries have also been included such as academies, advisory and expert committees, bibliographical services, data and documentation centres, dealers, distributors, funding agencies and organizations, journals, manufacturers, meteorological services, museums, norms and standards offices, planetariums, private consultants, public observatories, publishers, research institutions in related fields, software producers and distributors, and so on – all of these organizations being somehow linked to astronomy or of potential interest to astronomers.

Besides astronomy and related space sciences, other fields such as aeronautics, aeronomy, astronautics, atmospheric sciences, chemistry, communications, computer sciences, data processing, education, electronics, energetics, engineering, environment, geodesy, geophysics, information handling, management, mathematics, meteorology, optics, physics, remote sensing, and so on, were also covered when justified.

All categories of entries are flagged in a way that turned out to be very useful to sort out the entries as needed for the current study.

It is appropriate to remind here that we are dealing with validated and authenticated information (from signed and documented questionnaires), systematically compiled and presented, with a permament updating-process scheme. The expertise built up over now almost a quarter of a century in this exercise, as well as the overall stability of the master files, guarantee an excellent exhaustivity of the entries and an homogeneous coverage of the data gathered together. The files used are certainly the best sources available today for the studies at hand. It should also be recalled here that, contrary to most on-line resources, *StarWorlds* is not only WWW-oriented, but lists also all the organizations not yet on the web.

[1] `http://vizier.u-strasbg.fr/starworlds.html`

The first inclusion of an organization in the master files for *StarGuides/StarWorlds* is done via a standard questionnaire (Fig. 1) which has been adapted over time in order to take into account user feedback and evolution (introduction of fax numbers, e-mail addresses, World-Wide Web URLs, etc., as well as suppression of telex, FTS numbers, etc.).

Almost all data are then made available after some verification (see below) through the directories and the web (Fig. 2). Some pieces of information, albeit also included in the master files, are not directly available (data on last update and originator) or only indirectly available (categories of entries, languages used, indexing information, synonyms, and so on).

Systematic updating campaigns are taking place regularly via large-scale mailings and allow the organizations to check, correct, amend, complete, etc., their entry. More specific updating is carried out every time it is needed (for instance, restructuring of some organizations or of astronomy institutions within a country, introduction of new postal codes or of a new numbering for phone/fax in some country, and so on), not to forget major historical events such as the breakup of some countries and the birth of new ones. Individual checks are requested whenever verification is needed following some incoming information.

2.2. OVERALL QUALITY

The quality of results cannot be better than that of the corresponding input data. Therefore we devoted special care to ascertain authenticity, correctness, completeness and homogeneity of the data included in the master files, of course within the pragmatic constraints of such an endeavour and starting from whatever was delivered on the questionnaires and updated forms.

As it can be seen on Fig. 1, a signature and the identification of the originator are requested on our forms. Apart from a basic authentication of data and the need for a contact person in case of questions on the data themselves, such a requirement is also conditioned by the fact we want someone to take responsibility for whatever is published. Such a measure helped also in various instances to settle complaints from one organization against what was published on a rival one. In such situations, we use also independent informers and referees.

Some documentation supporting the existence of actual activities and of the organization itself is also requested in order to detect possible ghost organizations. This is specially needed nowadays when anyone is able to set up impressive web sites with nothing else behind than the designer himself or herself. Such precaution is also of application in professional circles since, in a couple of instances, a scientist claimed he was heading a group that

Data to be published in the next releases of the **Star*s Family of Astronomy and Related Resources**:

- Full name (1) ....:
- Abbreviation (2) ......:
- English translation of name (3)
- Address ....:

- Postal address (4) .....:

- Country ....:

- -

Indicate to which category/categories your organization belongs:

o academic or educational institution	o journal	o public observatory
o academy or learned society	o manufacturer	o publisher
o advisory or expert committee	o meteorological office	o research inst. (astronomy)
o association, club or society	o museum	o research inst. (Earth)
o data or documentation centre	o norms and standards office	o research inst. (space)
o dealer or distributor	o planetarium	o research inst. (other – specify)
o funding agency or institution	o private consultant	o software producer/distributor (specify)
o other (specify):		

- -

- Telephone number (5) . : - Telefax number (5):
- E-mail address(es) (6) . :

- WWW (7) ....:

- -

- Foundation year (8) ...:
- Members or staff (9) ...:
- Major activities (10) ...:

- Periodicals (11) ....:

- Awards (12) ....:

- Coordinates (13) ......:

- Planetariums (14) .....:

- -

Person who filled in the questionnaire:

Full name and position : ....

E-mail: ....

Signature: .... Date: ....

NOTES:

(1) Full name of the organization.
(2) If used.
(3) If applicable.
(4) If different from previous item.
(5) Including the area code (not the country code).
(6) Electronic mail addresses (including names of networks).
(7) Uniform Resource Locators for World-Wide Web access.
(8) Specific to the organization, department, unit, ...
(9) Number of members or of staff on premises.
(10) Maximum 20 (key)words.
(11) If applicable, titles, ISS-Numbers, frequencies and circulations of periodicals PUBLISHED BY the organization.
(12) If applicable, prizes, distinctions, etc. AWARDED BY the organization. Please indicate also their frequencies.
(13) Geographical coordinates of observing sites BELONGING TO the organization or of the organization main office/centre of activities. Please indicate the longitude and latitude in degrees, minutes, seconds, and the altitude/elevation in meters.
(14) If applicable, names of planetariums BELONGING TO the organization. Please indicate also their addresses if different.

Figure 1. Sample questionnaire sent to all organizations

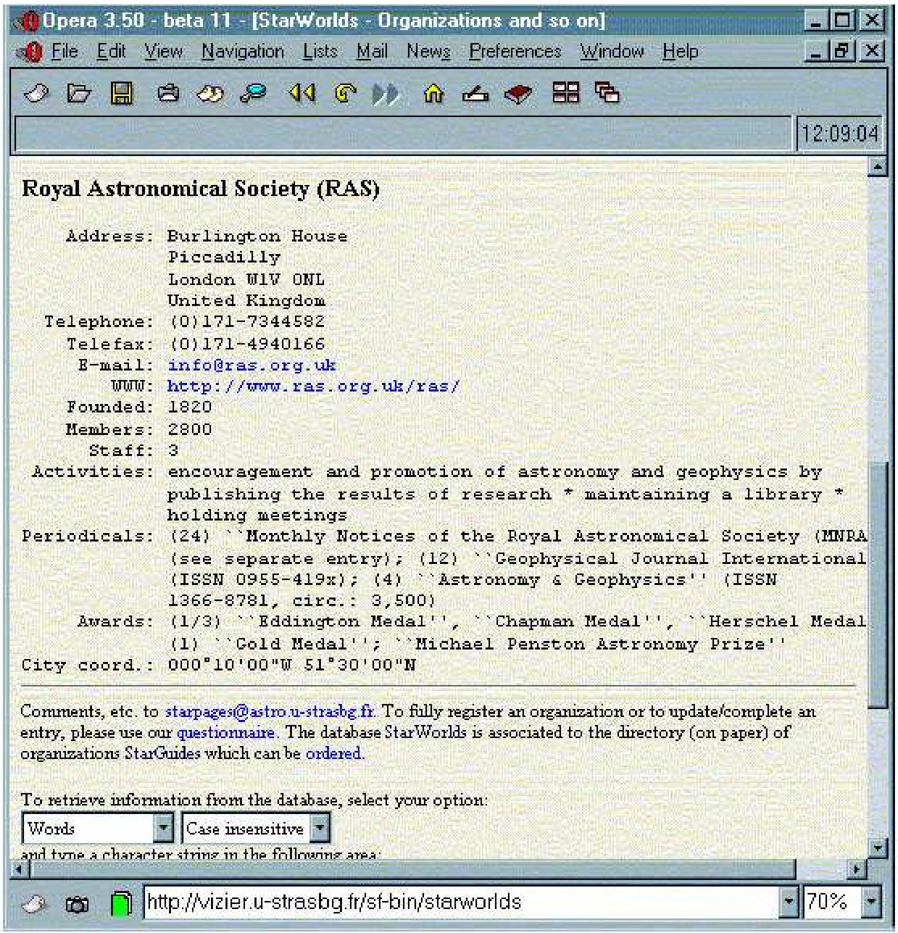


Figure 2. Example of presentation of the data in the database StarWorlds.

was existing only in his head. Again here, in case of doubt, we validated the information published by using independent informers and referees.

The documentation is also often useful to correct or to complete questionnaires badly filled in. It is always surprising (but is it really?) how poorly the characteristics of some organizations are known by people actively involved with them. And one learns definitely a lot on the human nature through such an exercise!

2.3. SPECIFIC DATA USED

2.3.1. *Positions*

Sets of coordinates for observing/receiving stations (belonging to or run by the organizations) are explicitly requested on our questionnaires and updating forms, but less than a third of the organizations registered some. This gives already an idea of the proportion of organizations actually involved in active astronomical observing.

In order to be able to study geographical distributions with all the entries in a systematic way, we had then to enter for each of them a position based on the location of the organization head office or main centre of activities (hereafter called 'city reference coordinates'). The coordinates were taken from a *Rand McNally International Atlas* (1969) (160,000 entries) and a *Times Atlas of the World* (1994) (210,000 entries) which appeared to usefully complement each other and to be consistent as to their reference frame. A *Rand McNally Zip Code Finder* (1995) (for the USA) as well as *Michelin* and *Kümmerly+Frey* road maps (essentially for European countries) were very helpful to locate from their postal codes small places not listed in the atlases. In such cases, the coordinates of the closest larger cities were recorded and explicitely mentioned as such in the master files. Complementary queries by post and e-mail solved a few additional cases. Finally only 15 entries (0.24%) were left without coordinates, in other words a negligible subset.

The samples based on the geographical positions are listed in Table 1 for the various categories defined in Sect. 2.4.

TABLE 1. Geographical distributions – Samples and properties

Sample	Description	Number of entries	Figures
G1	Total	6762	3-6
G2	Institutions	1177	7-11
G3	Associations	1312	12-14
G4	Planetariums	491	15-17
G5	Public observatories	352	18-20
G6	Publishers	161	21-23
G7	Software producers	152	24-26
G8	Internet presence	3740	4
G9	Observational professional facilities	742	8-9

2.3.2. *Foundation years*

This part of the study is based on the foundation years registered by the organizations in the databases mentioned above. Therefore it should be kept in mind that we are not investigating the foundation pattern of astronomy-related organizations in general over the past centuries, but the *ages* of the organizations still existing and active nowadays.

A foundation year is explicitly requested on our questionnaires and updating forms. However, when we decided to tackle this study, only 64% of the organizations had registered one. Therefore we initiated an updating campaign specifically targeted at the database entries without registered foundation year. Additionally and whenever possible, we visited the web sites of the organizations who maintained one and/or issued e-messages requesting explicitely those foundation years. This had a very beneficial impact as the proportion of available foundation years increased to 86%, i.e. 4371 foundation years for a total of 5065 effective database entries (*i.e.* excluding the cross-references). Thus we believe that a study based on such an amount (and such a percentage of the database contents) can lead to quite significant results.

For most organizations (associations, companies, publishers, and so on), the concept of foundation year is an unambiguous one as it corresponds to an official act. For academic institutions, we met some unexpected complications as some of our e-correspondents were looking for the earliest traces of physics/astronomy education in their institutions (as if we had launched a competition for the oldest such teaching in the world). No, our main purpose was to give a faithful picture of the organizational situation as it is today. Therefore the foundation years entered in the database correspond as far as possible to the entities mentioned and not to possible forerunners. Sometimes however, additional information is given when the local situation or history justifies it. It was again surprising here how poorly the history of some organizations is known by people involved with them.

Table 2 describes the samples based on the years of foundation for the various categories defined in Sect. 2.4.

2.3.3. *Sizes*

This part of the study is based on the sizes (number of members and/or of staff on premises) registered, at the time of writing, by the organizations in the databases mentioned above. Therefore it should be kept in mind that we are not investigating the fluctuations over time of the sizes of astronomy-related organizations, but the distribution of sizes of the organizations existing and active nowadays.

The staff and/or membership size is explicitly requested on our questionnaires and updating forms. However, when we decided to tackle this

TABLE 2. Ages – Samples and properties

Sample	Description	Number of entries	Oldest org. (*)	Cumulative total	Figure
A1	Total	4371	1279	4286 (**)	5a
A2	Total (Western Europe)	1734	1410	1704 (**)	5b
A3	Total (North America)	1728	1746	1701 (**)	5c
A4	Institutions	1066	1279	979 (**)	10a
A5	Institutions (Western Europe)	305	1410	299 (**)	10b
A6	Institutions (North America)	365	1746	356 (**)	10c
A7	Associations	1019	1820	1007 (**)	13a
A8	Associations (Western Europe)	536	1820	536	13b
A9	Associations (North America)	342	1862	331 (**)	13c
A10	Planetariums	416	1889	408 (**)	16
A11	Public observatories	308	1675	308	19
A12	Publishers	144	1478	127 (**)	22
A13	Software producers	157	1946	154 (**)	25

(*) Oldest organization registered in the corresponding sample. For each sample, the most recent foundation year is 1998, except for the 'publishers' group where no foundation year more recent than 1995 has been registered.
(**) A value lower than the size of the corresponding sample indicates that some duplications of entries for the same organizations (at different locations, but with the same foundation year) have counted only for one occurrence (see text).

study, only 56% of the organizations had registered one. Therefore we initiated an updating campaign specifically targeted at the database entries without registered size. Additionally and whenever possible, we visited the web sites of the organizations who maintained one and/or issued e-messages requesting explicitely those sizes. This had a beneficial impact as the proportion of available sizes increased to 68%, i.e. 3408 membership and staff sizes for a total of 5007 effective database entries (*i.e.* excluding the cross-references) at the time of writing. Thus we believe that an investigation based on such an amount (and such a percentage of the database contents) can lead to significant results.

For most organizations (associations, companies, publishers, and so on), the concept of size is an unambiguous one. In universities, astronomy is often associated with physics in self-standing departments and the total staff (corresponding truly to the entry denomination) is what is mentioned in the database, with sometimes additional explanations when the local situation allows it or requires it.

A few of our correspondents in academic circles would have preferred a breakdown between astronomers, other scientists and other supporting staff. This has not been done because the questions on the forms were the same for all categories of entries and the answers had to be treated consistently. Doing so would have also led to samples that would be too small to enable the derivation of statistically significant results. We do not exclude however carrying out a specific study after extensive collection of the necessary data from the concerned entities. This is however much more complex than it might seem *a priori*: not unfrequently, people with similar titles in different countries have different statuses and job profiles. This might also be true within a specific country for people belonging to different organizations or structures.

In another register, a few commercial companies – typically in the USA – refused to disclose even approximate figures as to their staff size, in order not to give an advantage – or an edge – to the competition (*sic*).

Table 3 describes the samples based on the (total) sizes for the various categories defined in the following section.

2.4. CATEGORIES OF ORGANIZATIONS

It seemed appropriate to consider, beyond the whole sample, subsets corresponding to several basic categories: institutions, associations, planetariums, public or popular observatories, publishers, and finally software producers. All these categories are listed on the questionnaires (Fig. 1) and *a priori* they are the most interesting ones to be studied here while leading to samples larges enough for deriving significant statistical results.

TABLE 3. Sizes – Samples and properties

Sample	Description	Number of entries	Figure
S1	Total	3408	6a
S2	Total (Western Europe)	1397	6b
S3	Total (North America)	1211	6c
S4	Institutions	812	11a
S5	Institutions (Western Europe)	262	11b
S6	Institutions (North America)	286	11c
S7	Associations	866	14a
S8	Associations (Western Europe)	469	14b
S9	Associations (North America)	276	14c
S10	Planetariums	299	17
S11	Public observatories	244	20
S12	Publishers	82	23
S13	Software producers	92	26

A few comments might be in order as to the exact meaning of the categories (even if we very rarely experienced any problems with the organizations having to classify themselves):

- the *institutions* are the academic organizations who clearly indicated astronomical research and/or education activity; some borderlines had to be adopted and we did it by making the best usage of the registered profile of activities and of the information provided by the organizations themselves (as part of the authentication/verification process, we request a report of activities); this is basically where professional astronomers are located;

- the *associations* are those who clearly indicated an activity in astronomy; they can be associations of amateur or professional astronomers, or of both together; we shall come back hereafter on this separation between amateur and professional astronomers that is much less easy to be performed than expected;
- the *planetariums* are organizations whose main activity is statutorily to run planetarium shows for the public and/or for visiting schools; we are not including here portable planetariums owned by institutions, associations or other organizations and used occasionally in special events;
- the *public observatories* are organizations whose main activity is statutorily to organize observing sessions for the public and groups; we shall see they are more frequently found in some countries and are sometimes called *popular* observatories; again here, we are not including in this category organizations setting up occasional observing parties;
- the *publishers* are the publishing organizations producing astronomy-related books, journals and/or magazines;
- the *software producers* are the commercial software producers putting on the market astronomy-related packages; specific non-commercial packages produced by agencies, scientific institutions or other organizations were not considered here.

In each case, the organizations were categorized on the basis on their main activity, justifying their existence. Exceptions to this were for instance organizations having several activities roughly dealt with on a par, such as the *Volkssternwarte und Planetarium Drebach* with both 'public (popular) observatory' and 'planetarium' as *raisons d'être*. Such organizations belong then to both categories. The documentation received with the questionnaires and updating forms was also used to cross-ckeck all classifications.

If a specific organization may belong to several categories (typically a popular observatory hosting a planetarium and *vice versa* a planetarium offering observing facilities to the public), other organizations (typically commercial ones) may have several branches at different locations registered with the same foundation year. In this case, we counted only one single occurrence in the statistics. This applied also to large scientific institutions with several entries (divisions, departments, and so on) in the databases.

2.5. PROFESSIONAL VERSUS AMATEUR ASTRONOMERS

What is an astronomer? This question can receive quite different answers. Our personal (and rather large) understanding of an astronomer is that of a person contributing to a better understanding of the universe and consequently to a better comprehension of the place and rôle of man in it.

Astronomy has penetrated the general public remarkably with an extensive network of associations and organizations of aficionados all over the world. Some of them are well equipped for observing and occasionally become involved with professional research. The deep human need to understand the universe has also led organizations and governments to set up public observatories and planetariums that fulfill academic requirements as well as public educational and cultural interests.

The distinction between professional and amateur astronomers is generally made nowadays on the basis that the former ones are making a living out of their astronomy-related activities, being paid by some official organization, carrying out some research or participating to some project linked to the advancement of knowledge. Amateur astronomers are themselves classified in two categories: the active and the armchair amateur astronomers. While the latter ones have generally a passive interest in astronomy (reading magazines, attending lectures, and so on), the former ones carry out some observing, often with their own instruments, and such activities can be useful to professional astronomy.

It would be a mistake to ignore that some professional astronomers are strongly resenting the possibility of being mixed with amateur astronomers, especially in associations (the other categories of entries do not present any problem in this respect). While some professional associations are strictly excluding amateur astronomers (prospective members must have adequate degrees and be proposed by peers), other societies are more or less open to qualified amateurs.

To complicate things, even if they wanted so, most associations and societies would be unable to produce figures on their respective professional and amateur membership, simply because they do not hold the data. Table 4 give a few examples from a quick survey carried out by e-mail specifically for this paper. In line with the previous comment, the listed figures should be taken with caution and as *bone fide* indications of magnitude. Probably few professional astronomers know that amateur astronomers outnumber professional ones in an association so active and so important for professional astronomy as the *Royal Astronomical Society (RAS)* (McNally 1999).

The *Astronomical Society of the Pacific (ASP)* has 'only' about 25% of professional astronomers (Havlen 1999), while it produces a top-quality professional journal and impressive series of professional books and proceed-

TABLE 4. Amateur and professional astronomers – A few examples

Society (*)	Membership (**)	Comment (***)	Source
AAS	5600	a couple of dozen amateurs	Milkey (1999)
AAVSO	1100	9% are professionals	Mattei (1999)
AG	800	about 2% are amateurs	Schielicke (1999)
ASA	305	less than 1% are amateurs	Duldig (1999)
ASJ	2800	about 2,000 amateurs	Ohishi (1999)
ASP	7000	about 25% are professionals	Havlen (1999)
CASCA	360	no amateur	Demers (1999)
EAS	1500	less than 10% are amateurs	Palouš (1999)
IAU	8500	minute population of amateurs	Andersen (1999)
RAS	2800(+)	about 55% could be amateurs	Wiltshire (1999)
SAB	460	no amateur	Gregorio-Hetem (1999)
SAF	2500	less than 5% are professionals	Ferlet (1999)
SF2A	520	less than 10 amateurs	Thévenin (1999)
SGAA	140	less than 2% are amateurs	Buser (1999)

(*) The acronyms expand as follows:
AAS = American Astronomical Society (USA)
AAVSO = American Association of Variable Star Observers (USA)
AG = Astronomische Gesellschaft (Germany)
ASA = Astronomical Society of Australia
ASJ = Astronomical Society of Japan
ASP = Astronomical Society of the Pacific (USA)
CASCA = Canadian Astronomical Society – Société Canadienne d'Astronomie (Canada)
EAS = European Astronomical Society
IAU = International Astronomical Union
RAS = Royal Astronomical Society (UK)
SAB = Sociedade Astronômica Brasileira (Brazil)
SAF = Société Astronomique de France
SF2A = Société Française d'Astronomie et d'Astrophysique (France)
SGAA = Schweizerische Gesellschaft für Astrophysik und Astronomie (Switzerland)
(**) As recorded in *StarWorlds*.
(***) Courtesy the society's official mentioned in the last column.
(+) Includes about 250 geophysicists (Wilshire, 1999).

ings. Now it is also the official publisher of the *International Astronomical Union (IAU)*, the corporate body of professional astronomers world-wide.

Remember also that, in many instances, professional astronomers supervise so-called amateur societies, that they are frequently involved in planetariums and in public observatories, and that they work often in or with publishing and software producing companies. Keep also in mind that some amateur organizations are deeply involved in activities useful to professional astronomy (especially via observing, but also through education and popularization). The spectrum of quality is very broad of course, but it is a continuous one from the very low level up to the very advanced one. And to be honest, we should also appreciate that, in some universities, astronomy is of a level that would be considered as a good amateur one in other places.

In conclusion, apart from a few clear cases of exclusively professional societies and a pleiad of small clubs of aficionados, the vast majority of associations are mixtures of amateurs and professionals, the ratio of which is simply unknown.

2.6. REASONABLY UNBIASED DATA

Over time, we have put all our experience as statistician to avoid significant biases in the collected data, together with an appropriate phrasing of the questionnaires, the practice of several languages, and also by working from bases in different countries over the years.

The publication of maps displaying geographical distributions of astronomy-related organizations regularly triggers reactions from people feeling that their area has been left out, especially at the level of amateur astronomers (see *e.g.* Xie 2000).

The actual situation is somewhat different and, when asked for precise data (addresses, etc.), those persons writing to magazines are routinely unable to provide more than vague indications and general considerations – in other words, something totally useless for the kind of project at hand. Promises for detailed information rarely materialize.

Next to the master files of data used for this paper (roughly 6,000 entries), there is an unpublished database of about 12,000 addresses, all of which have received our questionnaire at a time or another, often several times with a gentle reminder (as far as possible in the native language) requesting their data for publication in our directories and databases. Even if we take into account the fact that several addresses may relate to the same organization (often in the case of amateur groups), it is obvious that a significant fraction of those addressees never returned any data (about 50%!).

This can be interpreted in various ways:

- the address is wrong[2];

[2]The postal services sometimes return letters sent to addresses that are definitely wrong, occasionally with helpful information (such as the 'new address' printed by *US Mail* on stickers put on the returned mail). But it often happens that the address is genuine, but that the adressee is not related to the organization anymore, sometimes badly fighting with it, in which case it is of course totally hopeless to expect a return.

- our request is not understood;
- the organization is not active anymore;
- the addressee does not think it is important the organization appear in our resources;
- the organization definitely does not want visibility through our resources.

Be it what it is, it means in most cases that those organizations are not ready nor suitable for (in any case, international) contacts or collaborations.

A last word is in order on amateur groups that we have been observing (and frequently working with) during half a century. The volatility of such groups, especially the smaller and the younger ones, is well known. It is not unfrequent that, years later, groups since long gone are still appearing on impressive lists compiled for various reasons but far from being updated[3]. This is why we systematically exclude from our master files of data entries corresponding to organizations not giving signs of life over a couple of years.

We also fight against and exclude ghost organizations where typically there is only one individual behind impressive web sites.

3. Presentation of results

3.1. GENERALITIES

When dealing with this kind of statistical distributions, it is important to refrain from pushing the analysis of the data too far and to stay at an appropriate level: a global analysis, rather than a location-per-location perusal – and this is especially true for the smaller samples.

3.2. MAPS

Maps were drawn by using a recent IDL package (with up-to-date European borders) (RSI 1998) and we are presenting here the most interesting ones:

- the world with a classical oblique Mercator projection centered on the most populated (astronomy-wise) regions of the world, *i.e.* Western Europe and North America;
- Western Europe in a cylindrical projection;
- North America in a cylindrical projection;
- for the total sample only, a stereographic South polar projection giving a good view of astronomy-related settlements in this part of the world (Chile, Australasia, Antarctica, ...).

[3]These are the kind of lists that always grow: all candidates in, never anyone out. Typical examples are the cases presented by regional cultural bodies applying for subventions, and including as appendices huge lists of local organizations who happened to exist in the area (be it only for a few weeks).

Ideally those maps should be convolved with world demographic distributions, but the conclusions of the present study would not be substantially modified.

3.3. AGES

Cumulative distribution curves have been used for a better legibility of the significant events. The scale of the abcissa (time/years) has also been chosen for the best legibility of the curves. The ordinate scale has been automatically adapted to the sample size.

Surges or ruptures of the slope gradient are interesting features as well as plateaux in the otherwise always increasing cumulative curves. *A priori*, the following periods of time should be perused: World War I (1914-1918), World War II (1939-1945), the launch of Sputnik I (1957) and the landing on the Moon of Apollo 11 (1969), especially for the organizations linked to the public and/or amateurs.

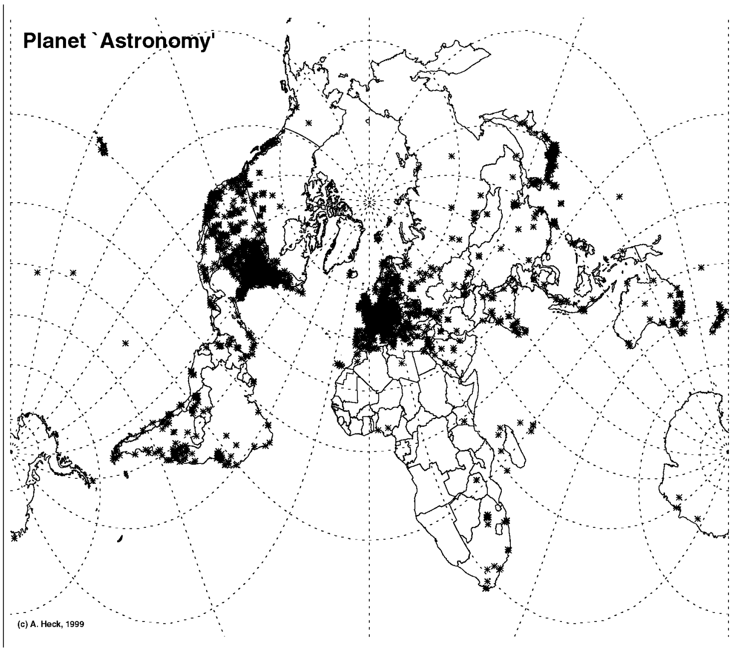
Spectacular celestial phenomena may have also played a significant rôle in this case, especially large and bright comets who brought the public attention back to the skies. It is probably premature to assess today the impact of the bright comets of this ending decade such as Shoemaker-Levy (with the fall of its fragments into Jupiter in July 1994), Hyakutake (1996) and Hale-Bopp (1997). The two appearances of Halley Comet in this century (peaks in 1910 and 1986) should probably be looked at, as well as the series of five bright comets visiting us between the mid-fifties and mid-seventies: Mrkos (1956), Arend-Roland (1957), Ikeya-Seki (1967), Bennett (1970), and West (1976). All this should of course be convolved with the mass media hype and influence that increased dramatically in the last decades.

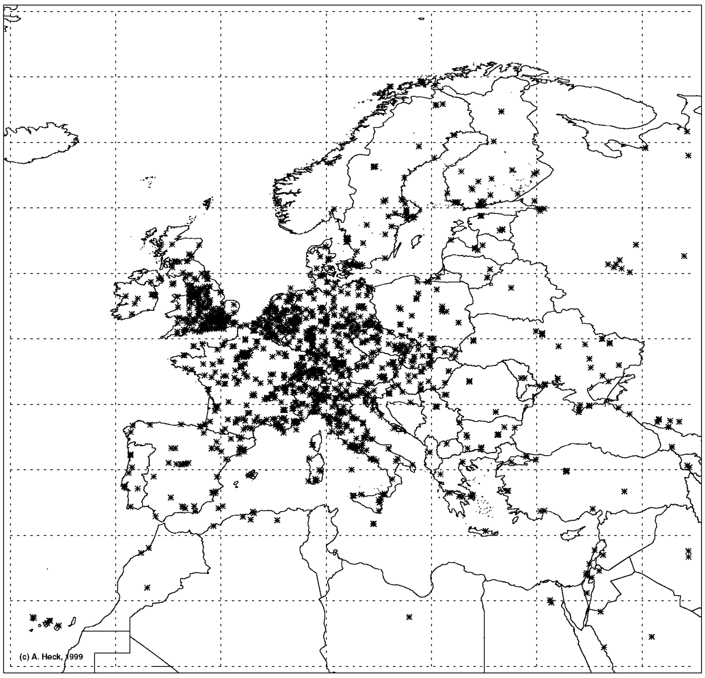
It is still too early to assess totally the impact of the end of the Cold War, though the flattening of the curves in the last decade seems to clearly indicate that less funding is now available for astronomy-related activities.

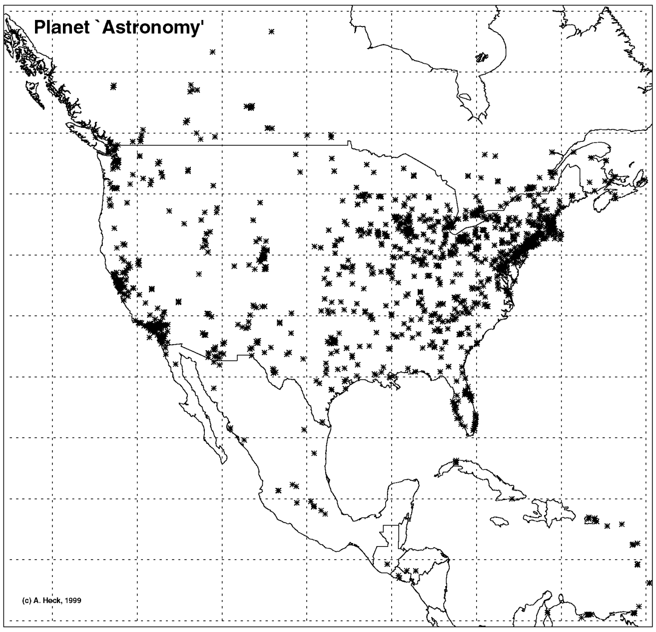
When the world-wide sample was large enough (total sample, institutions, associations), we also considered two geographical subsets: on one hand, a *West European* one consisting basically of all European-Union countries, plus Iceland, Norway, Switzerland and Turkey[4], and, on the other hand, a *North American* one made of entries from Canada, Mexico and USA. As seen from Table 2, such grouping gives samples of similar sizes in two cases out of three (and thus the results of these are directly comparable).

There is no special discrimination in leaving out the East European countries (*ex* Socialist Republics): simply those countries have not yet com-

[4] In line with the current practice of most official statistical services.


Planet `Astronomy'
(c) A. Heck, 1999


(c) A. Heck, 1999



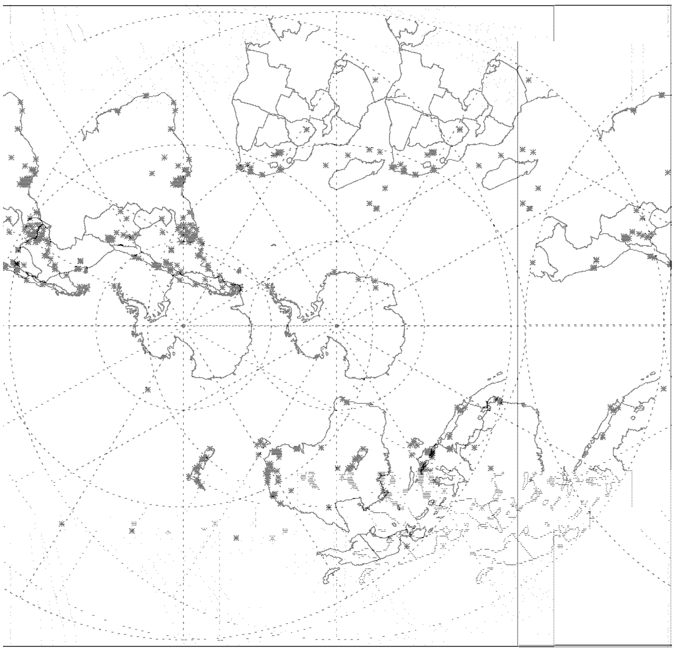


Figure 3 – 'Planet Astronomy' (a: World, b: Western Europe, c: North America, d: Southern countries – see text).

pleted their restructuring following the fall of the iron curtain as we experience it daily when updating the databases. Also obtaining reliable and complete data remains a problem as of today in some of these countries. We should also keep in mind that, for instance, the right of association was severely restricted in those countries during the communist period and that it will take at least a generation to fully re-create the initiatives of setting up freely societies and associations.

3.4. SIZES

Cumulative distribution curves (corresponding to the left ordinate axis) have been used for a better legibility of the graphs. For the same reason, the largest organizations have been left out of the frames. Frequency of individual sizes (triangles) are displayed for completion and correspond to the right ordinate axis. Large values of these correspond to ruptures of continuity (surges) of the curves and they are thus the features to be looked for.

When the world-wide sample was large enough (total sample, institutions, associations), we also considered the same geographical subsets as in the previous section. As seen from Table 3, such grouping gives samples of comparable sizes in two cases out of three (and thus the results of these are directly comparable).

4. Total sample – 'Planet Astronomy'

4.1. GEOGRAPHICAL DISTRIBUTIONS

At the time of writing, there were about 6160 entries in the master files, out of which about 1070 were simple cross-pointers. Thus the total number of effective organizations gathered together was about 5090.

The total number of positions available from the files amounted to 6762, including the positions registered by the organizations for their observing/receiving stations. For the record and as background references, Figs. 3a-d give the overall world distribution with blowups for Europe and North America, together with a stereographic view from the South Pole. These are all the geographical locations recorded in our files, what we call StarGuides/StarWorlds' world (or *'Planet Astronomy'*) at the end of 1999.

However there were only 3510 physically distinct locations because of a significant number of redundancies. For the sake of legibility of the maps, the size of the symbols (asterisks) has been kept the same, even if several points were superimposed. Some cities present a significant concentration of entries such as (by decreasing order) Paris, France (76), Washington, USA-DC (58), London, UK (46), Tokyo, Japan (39), Tucson, USA-AZ

(36), Moscow, Russia (33), New York, USA-NY (28), Boulder, USA-CO (27), Cambridge, USA-MA (26), Pasadena, USA-CA (24), Brussels, Belgium (23), Ottawa, Canada (21), Rome, Italy (21), just to take those over twenty occurrences (of, we repeat, all kinds of organizations listed in the database).

Thus Paris ranks first and a blowup centered on France (not reproduced here) would also show a strong concentration around Paris itself (the 'Île-de-France' region). An area of one square degree centered on Paris contains 143 organizations and a four-square-degree area, 158 organizations – another illustration, if needed, of the French centralization, also clearly visible on all European maps. Washington is ranking second, but it should be noticed that quite a few organizations have been moving over the past years to nearby Virginia, in such a way that the whole area around the USA federal capital displays also a strong concentration, but less sharply marked than around Paris (a one-square-degree area around Washington contains 168 organizations, while a four-square-degree one contains 184 organizations). Locations are definitely more spread out in countries such as the UK and Germany for instance.

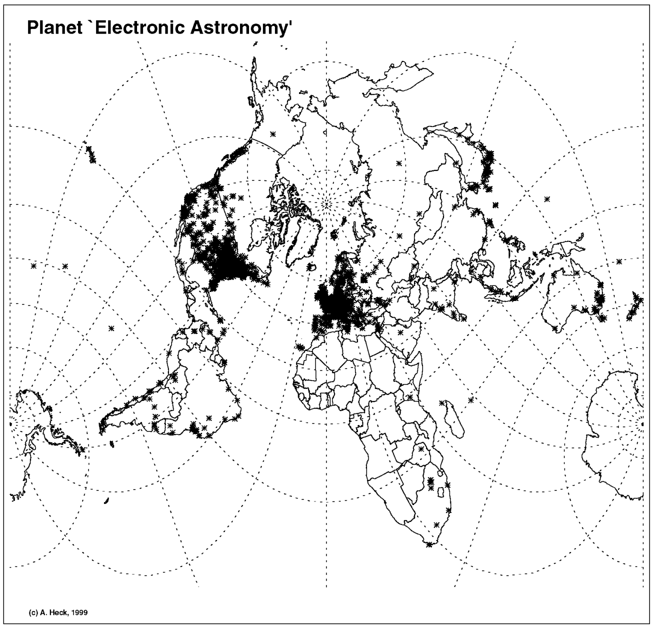
At a much larger scale, the strongest concentrations of astronomy-related organizations are located in Europe and the USA (Northeast and California), with a few nuclei in Japan, Australia, New Zealand, India, as well as a few spots in South America. Apart from strong densities in Europe and the Eastern half of the USA, the most striking feature – common to all categories – is the desperate emptiness of most of the African continent. A similar comment is also of application to quite a number of the so-called third-world countries.

The general aspects of the corresponding distributions between the various categories considered in this study are similar, with some nuances though as we shall see later on.

4.2. 'PLANET ELECTRONIC ASTRONOMY'

Before going on to more specific distributions, it seemed interesting to have a look at the distribution of organizations who have an Internet presence, *i.e.* an electronic address or at least one page on the World-Wide Web (WWW), about six years after this medium started spreading quickly over the world. Our master files have also reached an acceptable maturity and exhaustivity in this respect with about 5400 URLs since quite some time already (a figure which is only very slowly increasing now compare with what was happening a couple of years ago). This corresponds to 3740 organizations.

Figs. 4a-c give the world distribution of entries with an Internet pres-



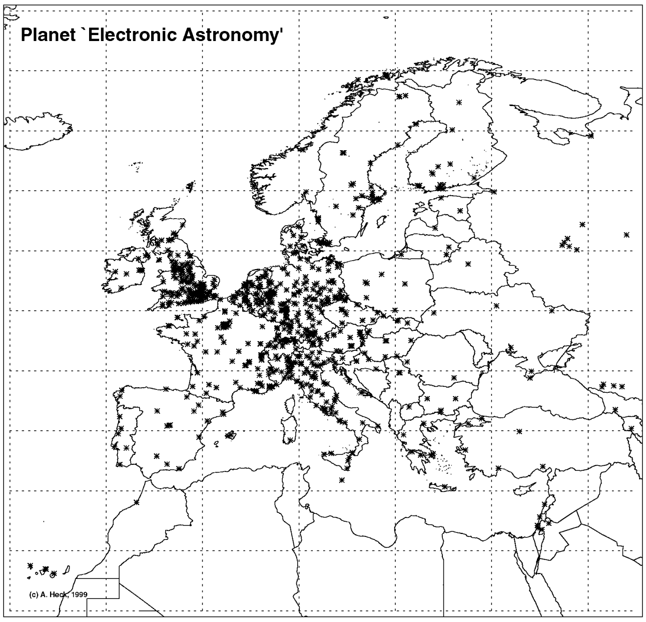
ence, with enlargements for Europe and North America. It is striking how France, Spain and Portugal have significantly much lower densities than their European neighbours, obviously lagging behind as to the penetration of e-mail and the WWW.

Such distributions should of course be compared with the maps for the whole sample and it is obvious that, for France for instance, the centralized pattern of the whole sample can only lead to similar ones for all subsets. The case of France is specially interesting and calls for at least another comment. This country was a leader in communications with the introduction in 1981 of the Teletel/Minitel (in practice, a small terminal delivered with each telephone set). Since thousands and thousands of services have been provided since then through Teletel, the pressure was not as high in France as in other countries to jump onto the WWW when it became available. Of course, the Teletel services are now progressively duplicated on the WWW.

In any case, it would be interesting to draw similar maps again in five or ten years from now.

4.3. AGES

The cumulative distributions for the total sample are illustrated in Figs. 5a-c (World, Western Europe, North America) from 1900 onwards.



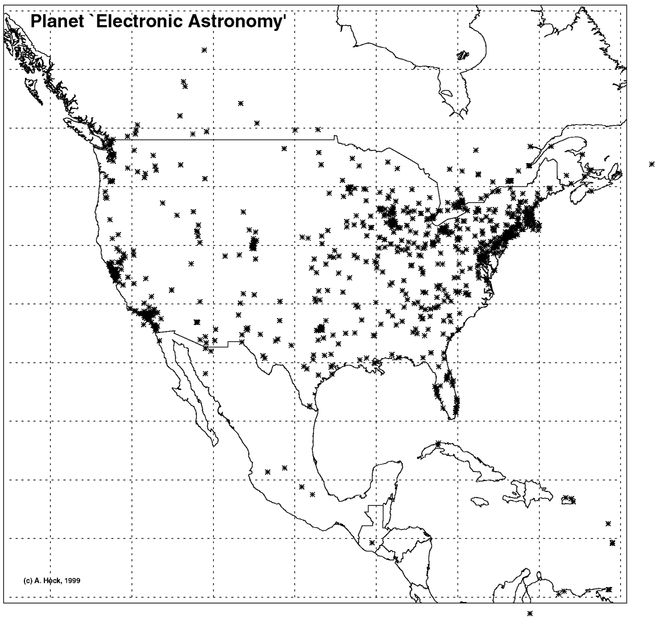


Figure 4 – 'Planet Electronic Astronomy' (a: World, b: Western Europe, c: North America – see text).

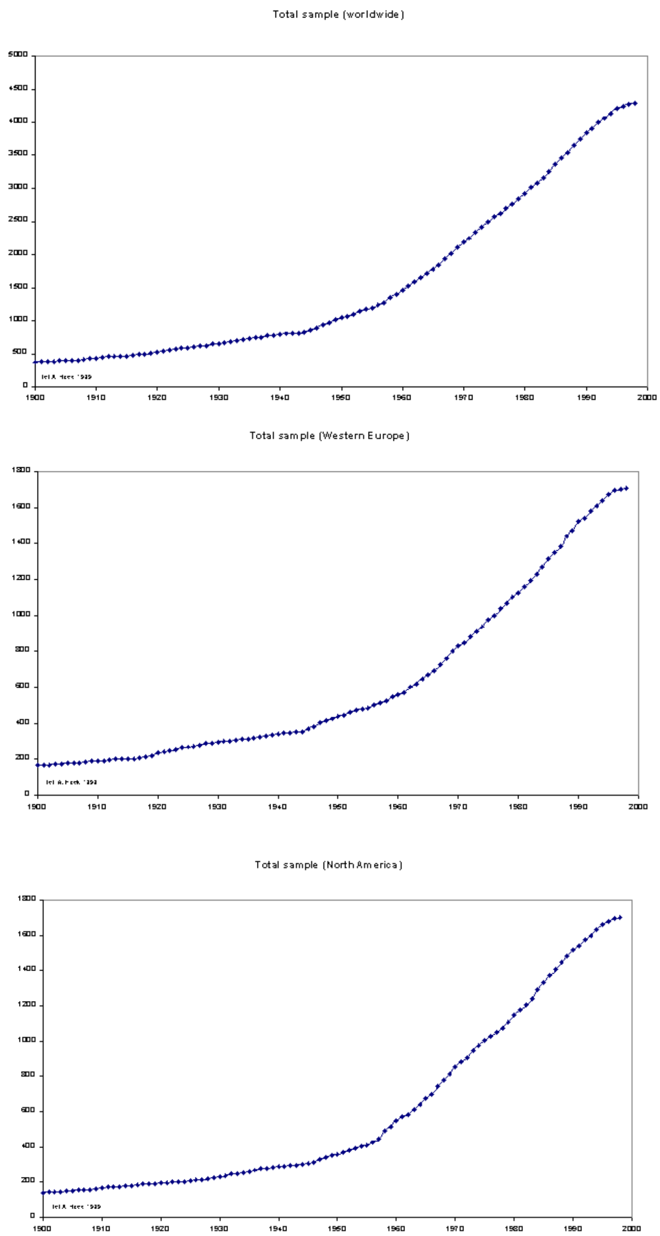


Figure 5 – Cumulative distribution of fundation years for the whole sample (a: World, b: Western Europe, c: North America – see text and Table 2).

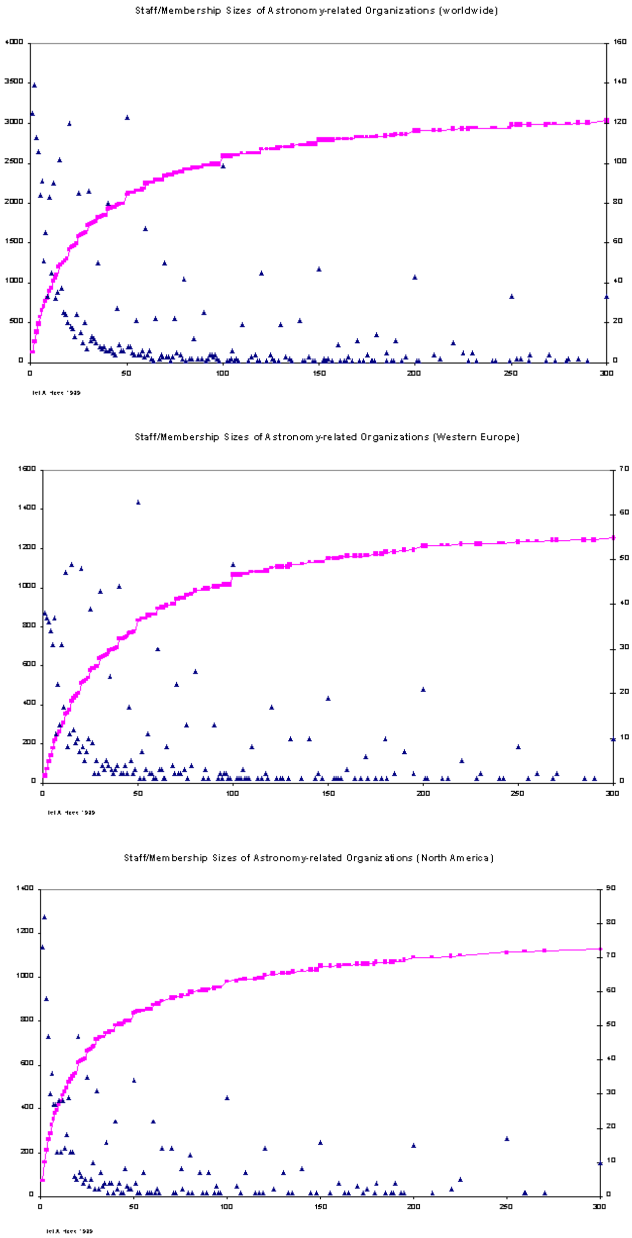
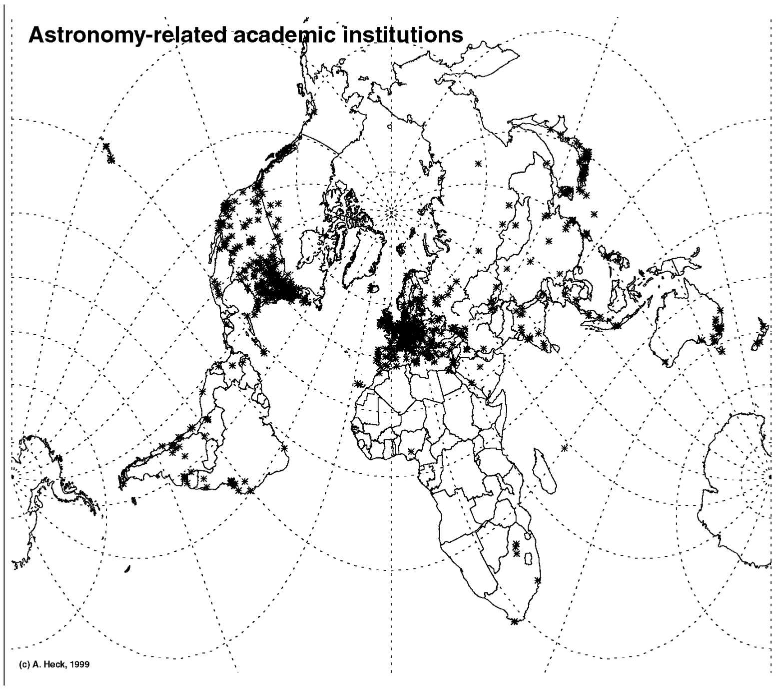


Figure 6 – Cumulative distribution of sizes (abcissa) for the whole sample (a: World, b: Western Europe, c: North America – see text and Table 3). The left coordinate corresponds to the cumulative distribution (squares) and the right ordinate, to the frequency of sizes (triangles).

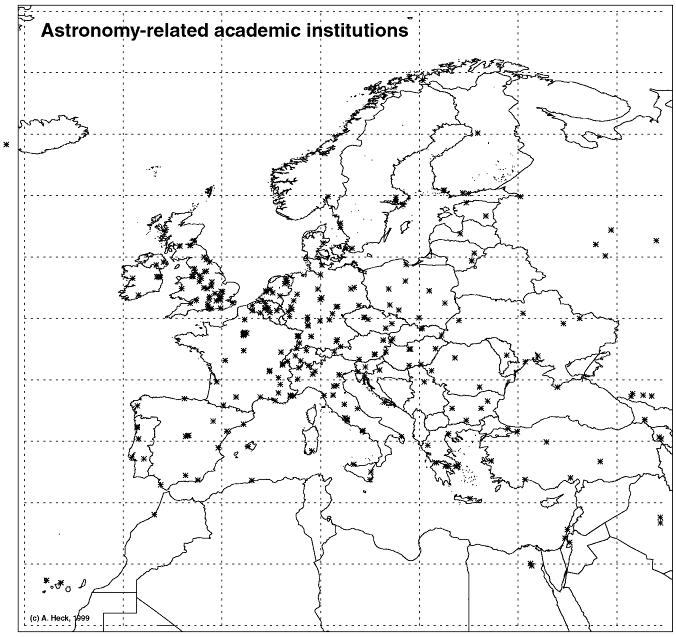


The effect of WWI is noticeable on the West European curve, while the impact of WWII is clearly visible on all curves. A surge at the end of the fifties (Sputnik I) is striking on the North American curve which is much steeper from then on. The effect is smoother on the West European curve, but the change of steepness is definitely there too. We shall try to identify more precisely those effects in the following sections.

4.4. SIZES

The distributions for the total sample are displayed in Figs. 6a-c (respectively World, Western Europe, North America). Watch the different ordinate scales as they have been automatically adjusted for an optimum legibility of the graphs.

The data for the world-wide sample are naturally a cumulation of those relative to the West-European and North-American ones (together 79% of the total sample). The two sub-samples display however striking differences: while the North-American one has peaks corresponding to organizations made of only a few persons (260 organizations or about 20% of the sample have up to 4 members), the West-European distribution has its highest peak around 50 persons and one has to include all organizations up to 11 persons to reach about 20% of the sample.



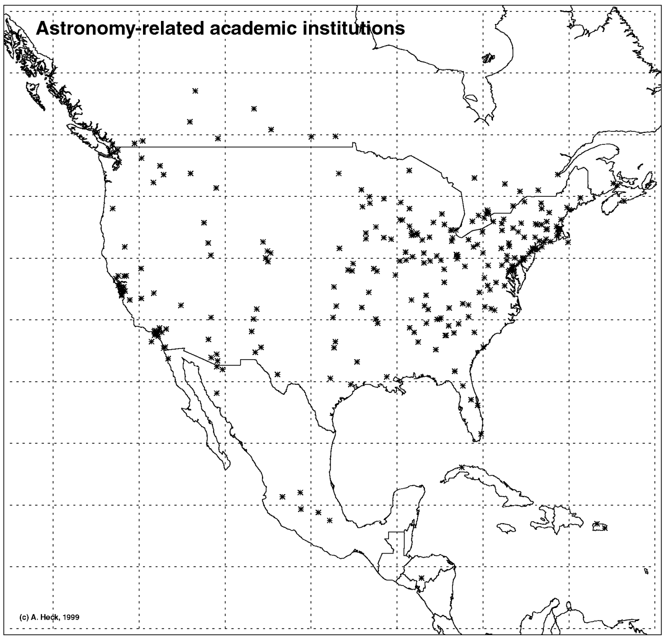


Figure 7 – Distribution of astronomy-related academic institutions (a: World, b: Western Europe, c: North America – see text).

Since the total sample is a combination of all kinds of organizations, it is preferable to leave a finer analysis for the subsequent sections. Note however that because people tend quite naturally to round off numbers when giving sizes of staff or membership, round figures tend to give higher frequencies.

5. Academic institutions

5.1. GEOGRAPHICAL DISTRIBUTIONS

That sample provided 1177 city reference positions and their distribution is illustrated by Figs. 7a-c. Strong concentrations are located in Europe and in the Eastern half of the USA, with nuclei in California, Japan and Australia, plus a few spots in New Zealand, India and South America.

5.2. A CENTURY-SPANNING COMPARISON

An interesting comparison – and apparently the only possible one – can be made with a map published by Stroobant *et al.* (1907) following a survey they carried out at the beginning of the century. This map is reproduced here as Fig. 8.

Because Stroobant *et al.* considered only actual observatories, we had also to restrict our sample to observing/receiving facilities of professional institutions. The resulting world distribution (742 positions) is illustrated by Figs. 9a-c. In spite of the different projections, immediate conclusions can be drawn.

The higher densities in Europe and the Eastern half of the United States are already there, as well as the emptiness of Africa. Little changed during the past century and such a persistence is disturbing. Countries elsewhere in the Third World fared no better. This is another example of the well-known socio-economic effect of self-reinforcement: those who were rich got richer; those who had nothing remained poor.

Over time one would expect some homogenization (or some trend towards it), and particularly so, since this century has seen so much activity in setting up assistance programs of all kinds for developing countries. Obviously astronomy did not benefit from possible improvements in education in those countries. Climate cannot be blamed, since cloudy skies and rainy weather were no hindrance to establishing public astronomical observing facilities in Europe and the Northeastern United States.

Professional astronomical activities are certainly linked to a relatively wealthy level of economies (in the socio-historical context) reached by countries or societies who have always more urgent priorities to be satisfied first. What is really alarming though, is that, if we compare the current distribu-

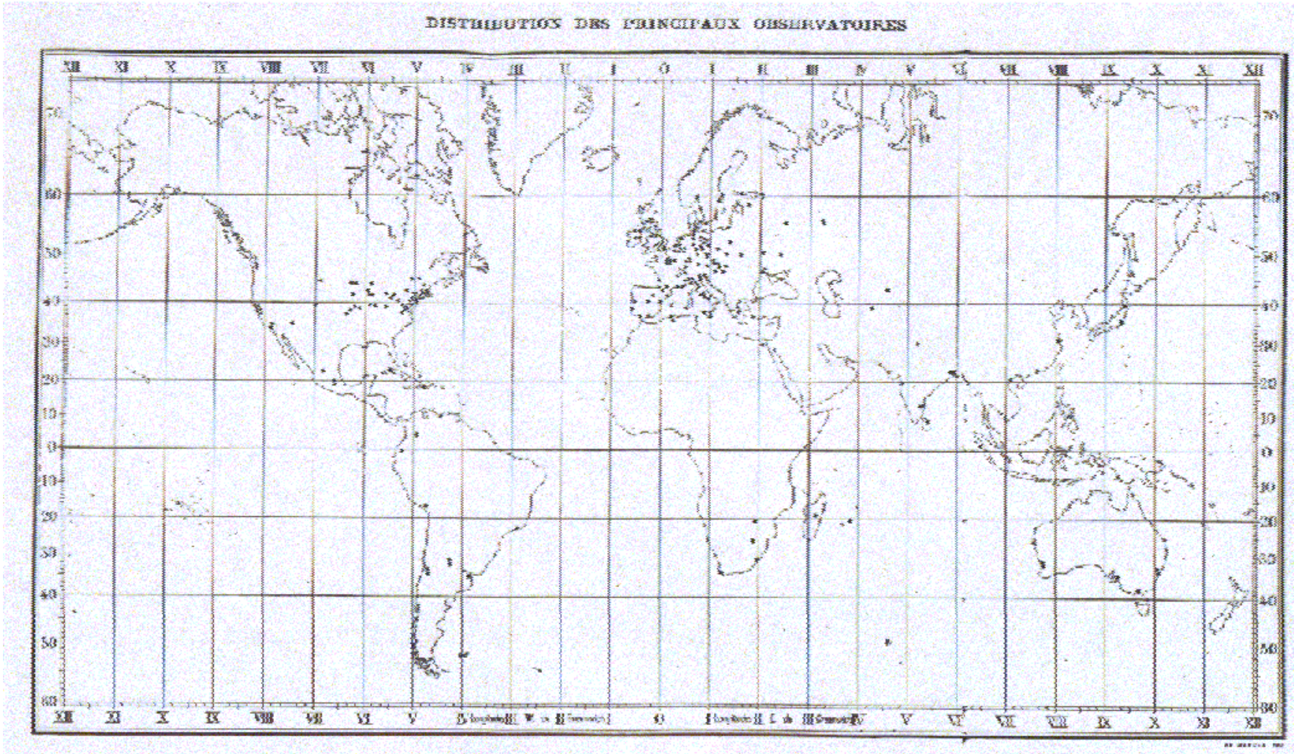
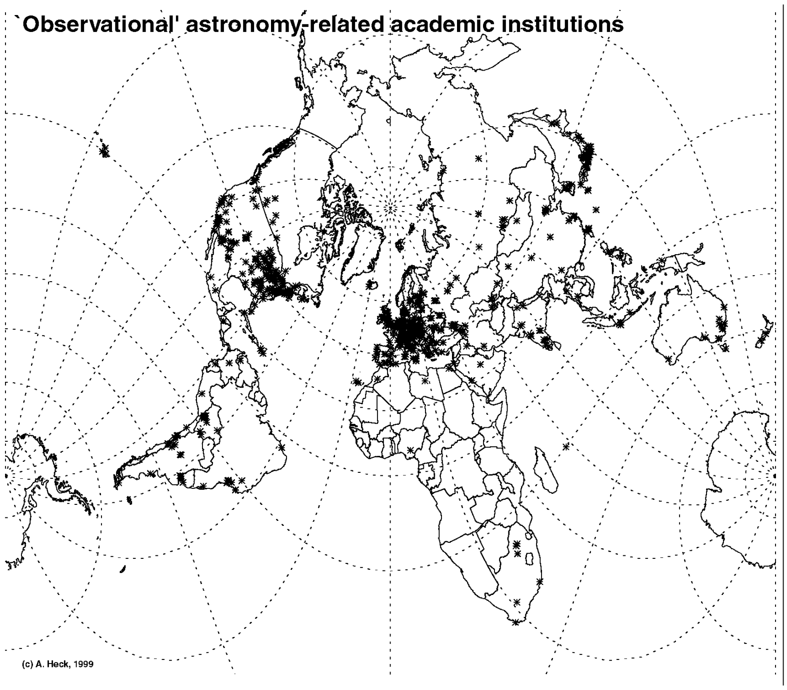
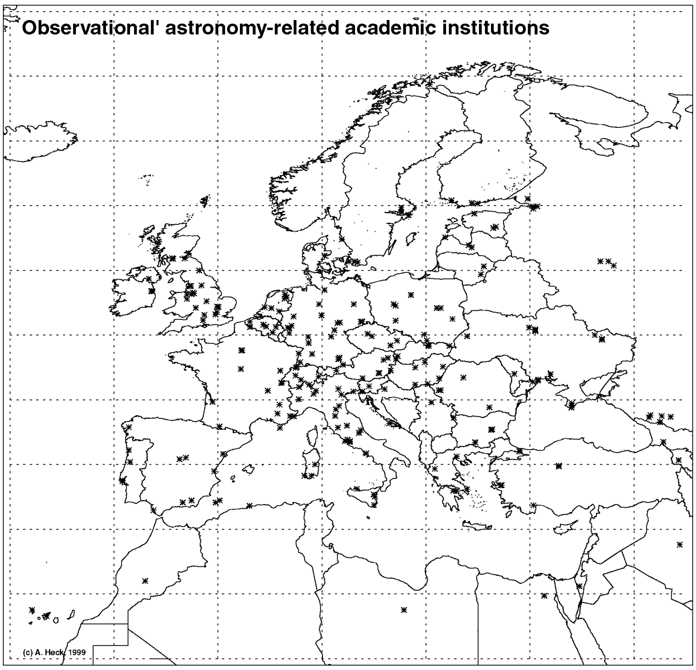


Figure 8 – World distribution of observatories by Stroobant *et al.* (1907).


`Observational' astronomy-related academic institutions
(c) A. Heck, 1999


Observational' astronomy-related academic institutions
(c) A. Heck, 1999

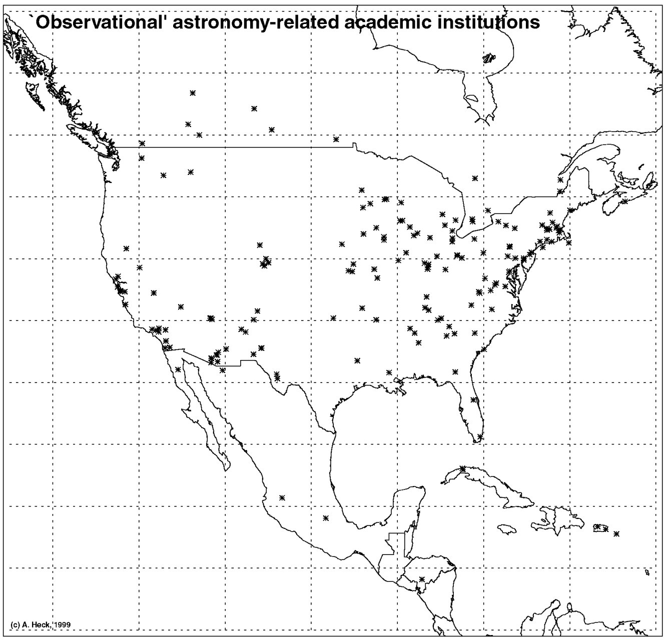


Figure 9 – Distribution of 'observational' astronomy-related academic institutions (a: World, b: Western Europe, c: North America – see text).

tions with that of Stroobant *et al.* (1907), the overall aspect did not change significantly over the past century. This should be a real concern not only for every astronomer, but well beyond our science, because it tells certainly something much more fundamental about long-term higher education in those parts of the world and on our way to deal with it even if, over the same range of time, a few additional observing facilities have been built in propitious parts of the world, especially in the Southern hemisphere.

Large astronomy facilities are now erected at isolated, dry, high-altitude sites (for optical and infrared astronomy) or those protected from interference (for radio astronomy). These new sites (including Antarctica) are visible on the contemporary maps, but they do not modify the overall distribution.

Most universities teaching astronomy have small observatories on their campuses. Such sites have increased markedly in the past 100 years, but again have grown insignificantly in developing countries. This evident stagnation echoes a fundamental shortcoming in long-term higher education in those parts of the world.

5.3. AGES

The cumulative distributions of ages is illustrated by Figs. 10a-c.

Certain events had a clear impact on the founding of these organizations, but not all of them affected Western Europe and North America in the same way. The North American surge at the beginning of the space age (1958) is a dramatic one, while the steepest increase takes place in the late sixties in Western Europe. In the mid-seventies, the slopes subside until another surge in the mid-eighties.

Western Europe seems to be more touched by the end of the Cold War than North America where fluctuations in the seventies and eighties might be due to general economic changes or large-scale funding decisions.

Among the oldest institutions, let us mention here: Beijing Astronomical Observatory (1279), Leiden University Observatory (1633), Utrecht University Observatory (1642), Uppsala University Observatory (1650), Paris Observatory (1667), Lund University Observatory (1672), and Astronomisches Rechen-Institut (1700).

5.4. SIZES

The distributions of sizes are illustrated on Figs. 11a-c.

Please note that, if the scales the West-European and North-American samples are comparable, those for the world-wide sample are naturally much larger. Remember also that round-off effects should be taken into account when examining the individual frequencies (triangles).

The North-American distribution displays sharper peaks at lower values than the West-European one. In North America, the highest peaks are reached for research groups with two to four members, As a result, 212 institutions (about 74% of the sample) have less than 30 staff members, while one has to include institutions with up to 50 members to reach such a percentage in Western Europe. Here, the highest peaks are reached for groups of ten to twelve people.

Western Europe and North America together constitute about 67% of the world-wide sample of astronomy-related institutions, which explains why the corresponding curve reflects fairly well the combination of their respective distributions.

Among the largest institutions (left out of the graphs), let us mention here: Beijing Observatory and Sternberg Astronomical Institute (400 persons), the Space Telescope Science Institute (STScI, 500), the Harvard-Smithsonian Center for Astrophysics (CfA, 600), and Paris Observatory (700).

There are of course much larger institutions registered in the database, especially agencies and space centres, but their scope is also much broader

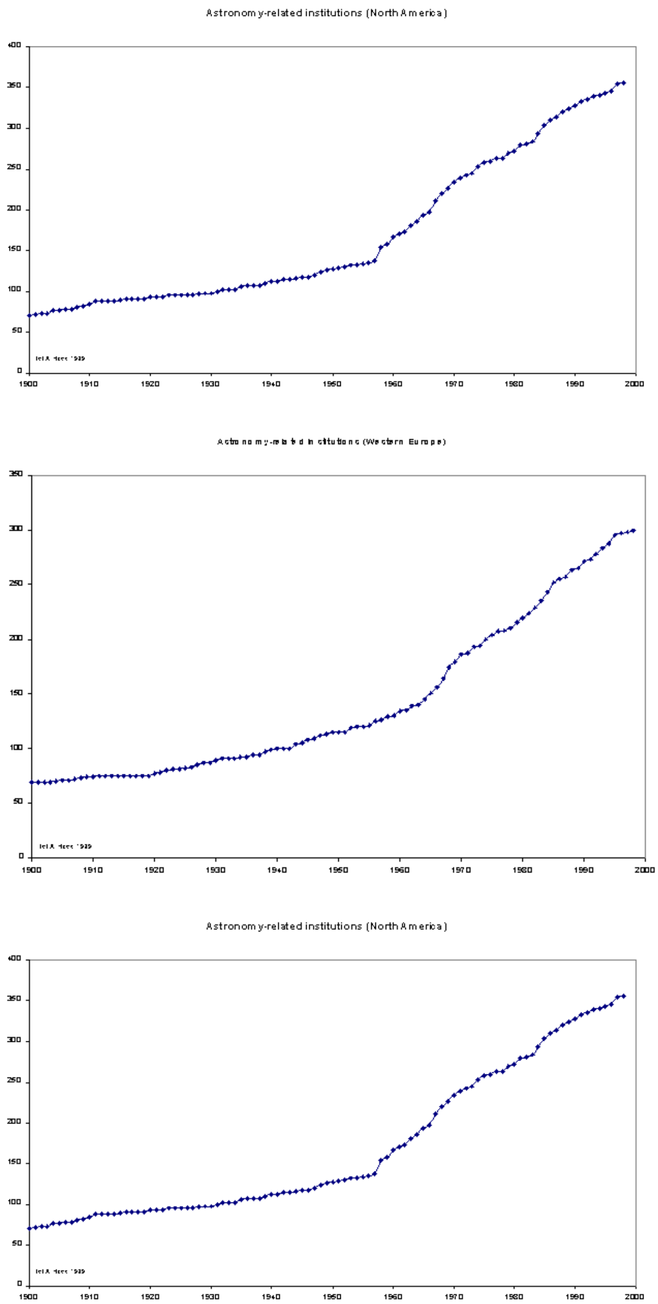


Figure 10 – Cumulative distribution of fundation years for the astronomy-related academic institutions (a: World, b: Western Europe, c: North America – see text and Table 2).

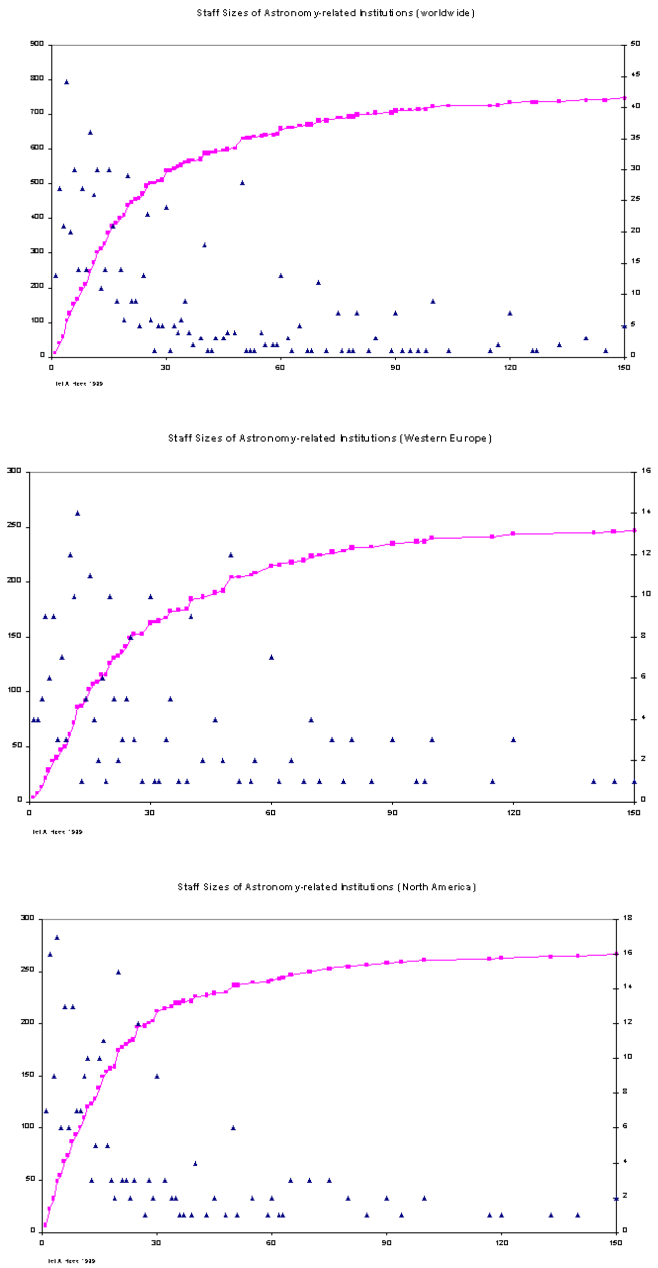


Figure 11 – Cumulative distribution of sizes for the astronomy-related academic institutions (a: World, b: Western Europe, c: North America – see text, Table 3 and the caption of Fig. 6).

than only astronomy and astrophysics: the Indian Space Research Organization (ISRO/Bangalore, 800 persons), Rutherford Appleton Laboratory (RAL) and the Brazilian Instituto Nacional de Pesquisas Espaciais (INPE/São José dos Campos, 1400), the Russian Space Research Institute (IKI, 1500), the French Commissariat à l'Énergie Atomique (CEA, 1800), the French Centre National d'Études Spatiales (CNES, 2400), and the Jet Propulsion Laboratory (JPL, 5000), just to quote a few among those who registered their staff size.

6. Associations

6.1. GEOGRAPHICAL DISTRIBUTIONS

We could use up 1312 city reference locations for the astronomical associations registered in the master files. Figs. 12a-c illustrates their world distribution with enlargements for Europe and North America.

In Europe, densities are stronger in regions such as Northern Italy, Switzerland, England, Western Germany, and the Benelux countries. Not too surprizingly, the USA nuclei are located in the Northeast and California, together with a definite one in Washington State.

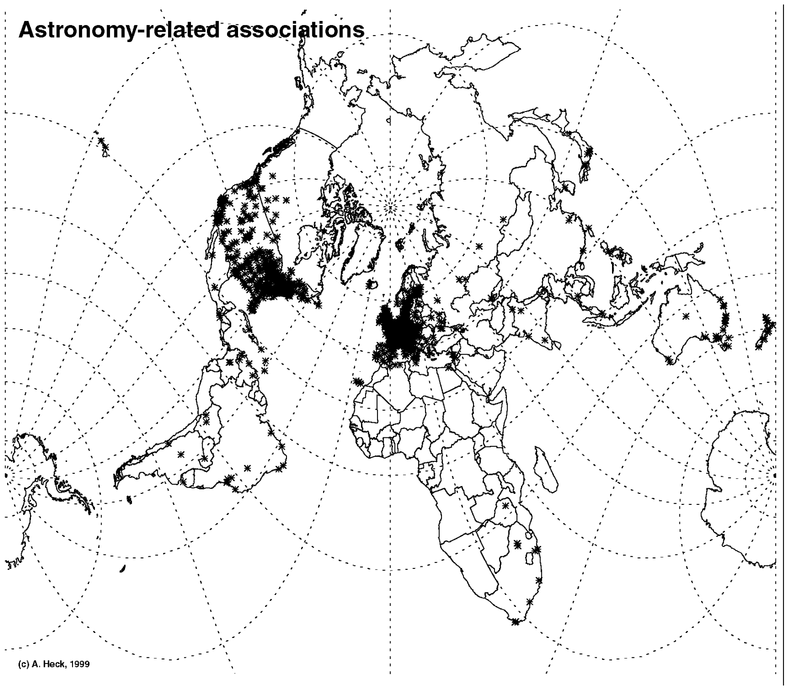
A comparison of these maps with the corresponding ones, much less populated, published in Heck (1998a) shows that the average associative activity is significantly away from observing (roughly one third of the associations practice active observing).

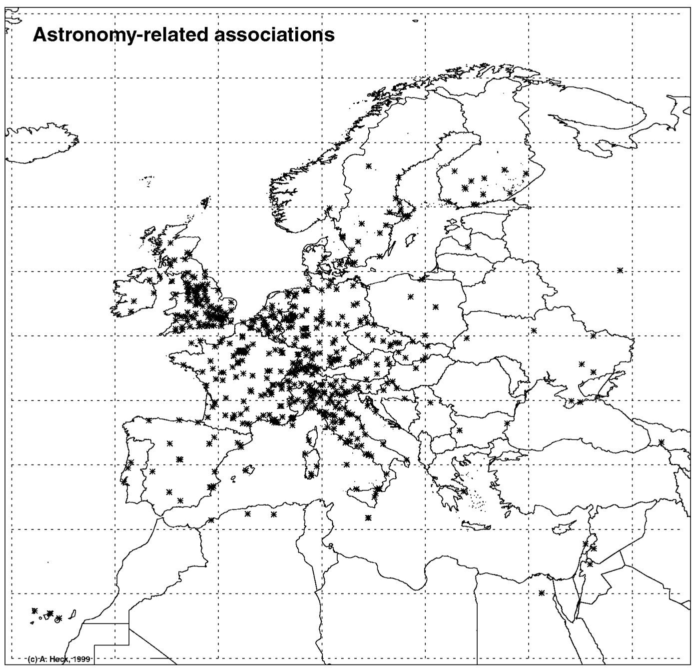
6.2. AGES

The cumulative distribution of ages is illustrated in Figs. 13a-c (World, Western Europe, North America) from 1900 onwards.

The curves display slight flattenings at the level of WWI and WWII. The West European curve is significantly smoother than the North American one. Caution however is needed with the different ordinate scales as the sizes of the samples are siginificantly different.

In other words, from comparable total samples (respectively 1734 and 1728 entries), there are 536 West European associations (31%), but only 342 North American ones (barely 20%). This could result from two effects: either the North Americans are less of the associative vein than the West Europeans, or the North American associations have a shorter lifetime. In the latter case, the curve should be much steeper in the recent decades, which does not seem to be the case, on the contrary. An investigation of weighted averaged foundation years confirms actually that the North American associations are older than the European ones.


Astronomy-related associations
(c) A. Heck, 1999


Astronomy-related associations
(c) A. Heck, 1999

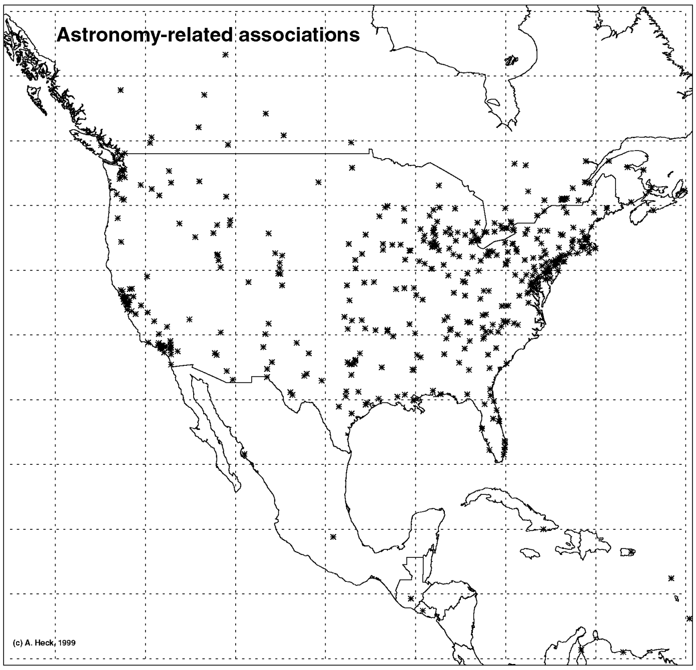


Figure 12 – Distribution of astronomy-related associations (a: World, b: Western Europe, c: North America – see text).

As far as surges are concerned, the West European curve shows a few of them, for instance after WWII, around 1970 (Apollo 11 landing on the Moon) and at the mid-eighties (Halley's Comet). The North American curve has rather the surges in the first half of the thirties, after WWII, in the second half of the fifties (Sputnik I) and perhaps at the end of the seventies and of the eighties.

Here are the major associations founded last century and still active today: Royal Astronomical Society (1820), Chicago Astronomical Society (1862), Astronomische Gesellschaft (1863), Liverpool Astronomical Society (1881), Baltimore Astronomical Society (1881), Société Astronomique de France (1887), Astronomical Society of the Pacific (1889), Royal Astronomical Society of Canada (1890), British Astronomical Association (1890), Astronomical Society of South Africa (1892), Astronomical Society of Glasgow (1894), and American Astronomical Society (1899).

6.3. SIZES

Their distributions are displayed in Figs. 14a-c (resp. World, Western Europe, North America).

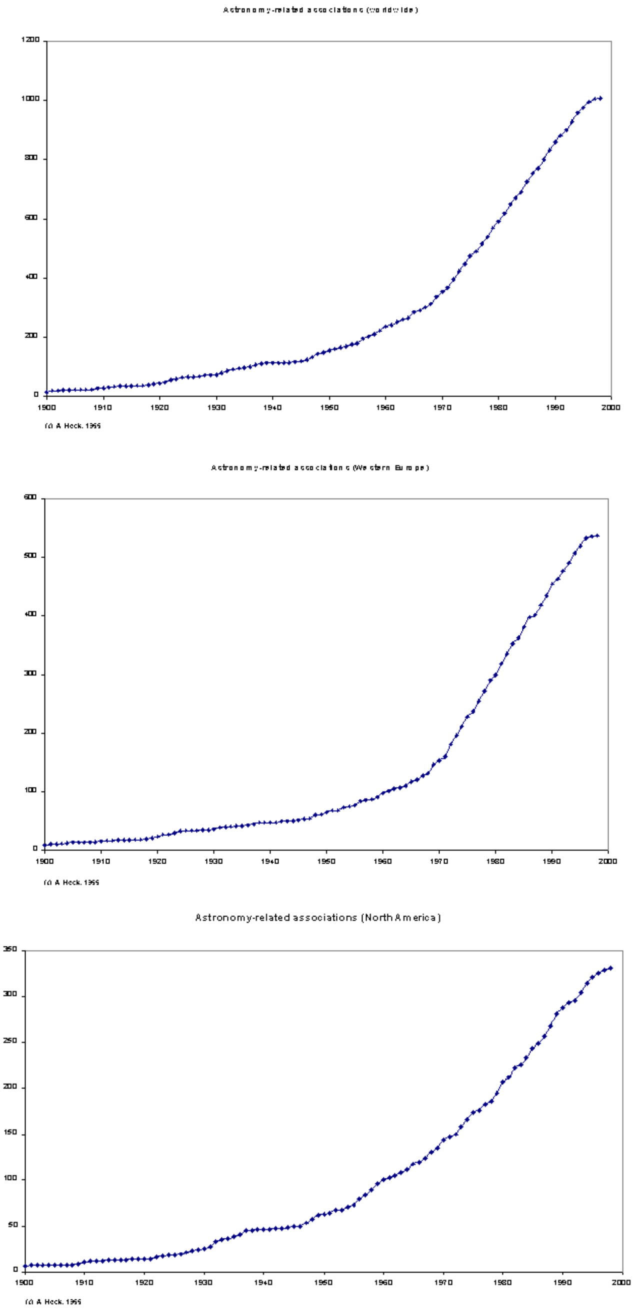


Figure 13 – Cumulative distribution of fundation years for the astronomy-related associations (a: World, b: Western Europe, c: North America – see text and Table 2).

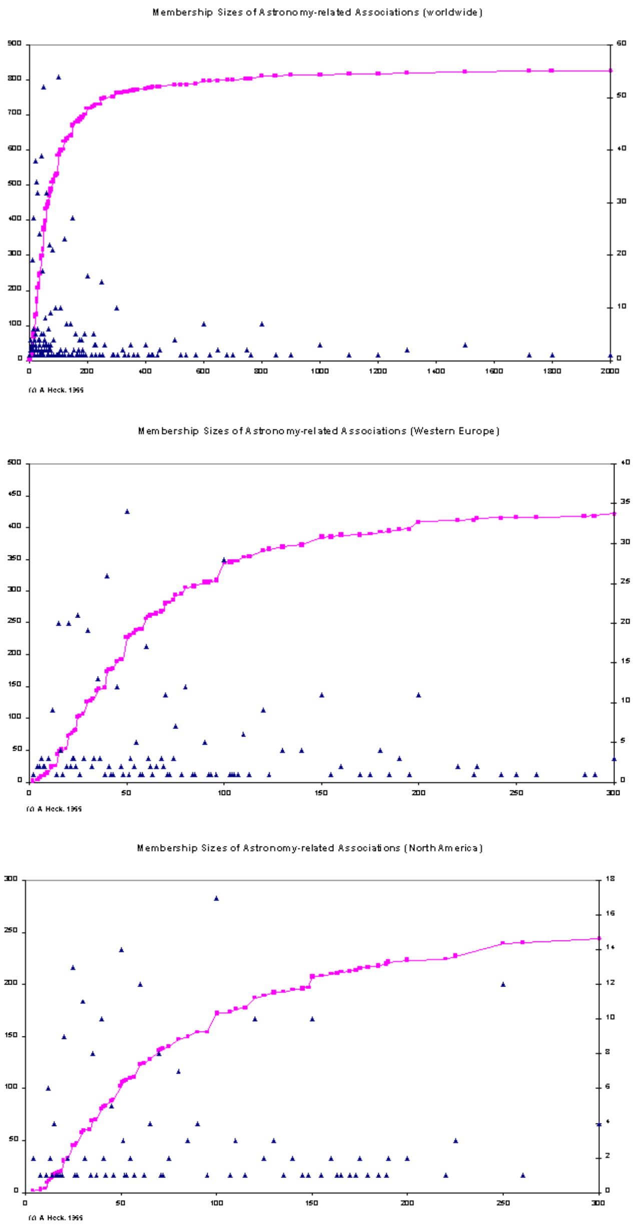
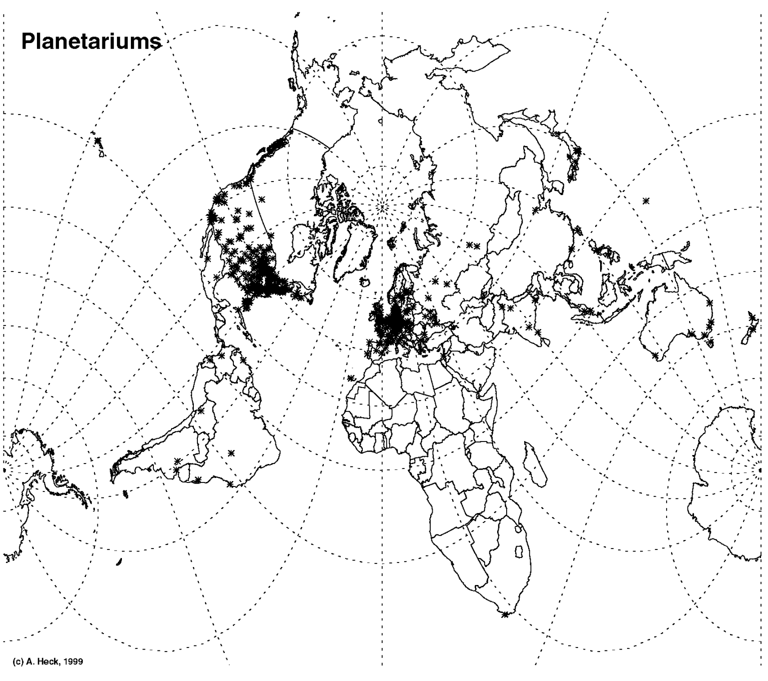


Figure 14 – Cumulative distribution of sizes for the astronomy-related associations (a: World, b: Western Europe, c: North America – see text, Table 3 and the caption of Fig. 6).



When comparing the graphs, please note the differing ordinate scales that have been automatically adjusted for ensuring the best legibility of the figures.

All curves display peaks around 50 and 100 members, although the second one is less pronounced in the West-European sample. The North-American distribution has additional secondary peaks around 120, 150 and 250 members. The West-European curve has secondary peaks, but much less marked, around 120, 150 and 200 members. Again round-off effects have to be taken into account.

Thus, if they are more numerous in Western Europe, the astronomy-related associations tend also to be smaller: 227 associations up to 50 members in Western Europe (48% of the sample), while only 103 in North America (37% of the sample). The percentages become respectively 73% and 62% of the corresponding samples when going up to 100 members. The distribution for the world-wide sample reflects fairly well the convolution of the previous ones as the West-European and North-American samples together represent 86% of the world-wide one.

Here are the astronomy-related associations who registered 3,000 members and over: the Pacific Space Centre Society in Vancouver, the Royal Astronomical Society of Canada, the (Dutch) Nederlandse Vereniging voor Weer- en Sterrenkunde, the (Swiss) Schweizerische Astronomische

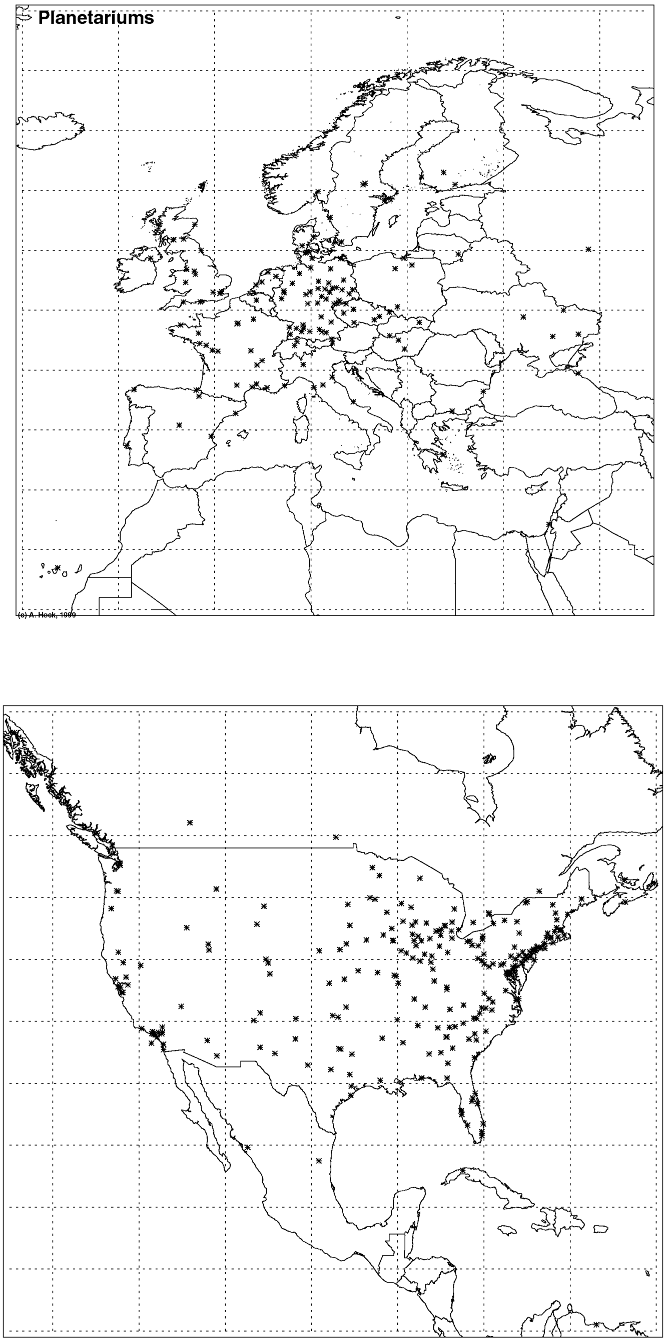


Figure 15 – Distribution of planetariums (a: World, b: Western Europe, c: North America – see text).

Gesellschaft, and the Thai Astronomical Society (3,000), the British Astronomical Association (4,000), the British Interplanetary Society (4,500), the American Astronomical Society (5,600), the Ursa Astronomical Association of Finland and the Stichting De Koepel of the Netherlands (6,000), the Astronomical Society of the Pacific (7,000), the Russian Astronomical-Geodetical Society (8,000), the International Astronomical Union (8,500), the Astronomical League (14,000), Earthwatch (70,000), and finally the Planetary Society claiming 100,000 members. These sizes should of course be taken as approximate ones and, in no way, this list should be considered as the result of a competition ...

7. Planetariums

7.1. GEOGRAPHICAL DISTRIBUTIONS

There were 491 city reference positions registered for planetariums in the master files and their distribution is illustrated by Figs. 15a-c.

7.2. AGES

The cumulative distribution of ages is illustrated in Fig. 16 from 1900 onwards.

Planetarium activities took off in practice with this century and accelerated at the dawn of the Space Age and lasted through the Apollo program. The subsequent long-term trend of the curve is subsiding.

7.3. SIZES

The data on sizes are illustrated in Fig. 17.

45 planetariums are manned by one person and 41 of them by two persons. This accounts for about 30% of the sample. Most of these are college or university planetariums managed directly by the instructors.

The largest planetarium-related organizations listed in the database are: Planetarium de Rio de Janeiro (40 persons), Pacific Space Center of Vancouver (46, but also museum and observatory), Planetariums of Kuala Lumpur, Kirov and Moscow (50), Manitoba Planetarium (76, but also museum), Fernbank Planetarium (81, but also museum), Musée de l'Air et de l'Espace du Bourget (100, but also museum), Adler Planetarium and Astronomy Museum (120, including museum), and Beijing Planetarium (130). In some instances, the bulk of the staff is made of volunteers, often employed on a part-time basis.

It is appropriate to repeat here that – as recorded on our questionnaires – a significant number of planetarium facilities are nowadays used also for

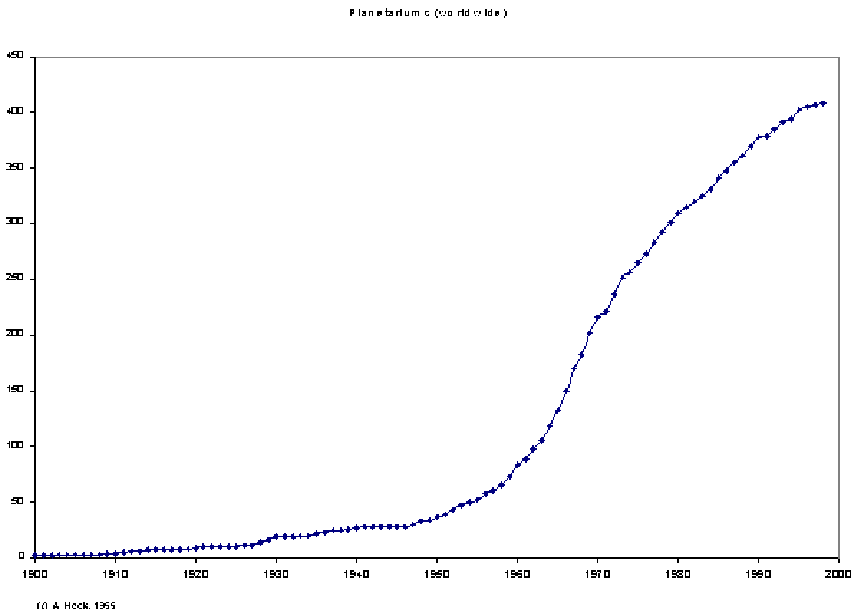


Figure 16 – Cumulative distribution of fundation years for the planetariums (all countries – see text and Table 2).

activities totally unrelated with astronomy (movies, laser shows, concerts, lectures, receptions, cocktails, book dedications, and so on).

8. Public/popular observatories

8.1. GEOGRAPHICAL DISTRIBUTIONS

There were 352 city reference positions in the master files registered for public and popular observatories and their distribution is illustrated by Figs. 18a-c.

The significantly higher density in countries such as Austria, Germany, the Netherlands, as well in the Czech and Slovak Republics, testifies of cultural components and/or deliberate policies. Knowing the dynamism, facilities, and the generally wealthy level in the USA, one would expect more observing sites linked to public observatories and associations, but – and this is another cultural component – more is carried out there at the individual level as examplified in each issue of magazines such as *Astronomy* and *Sky & Telescope*.

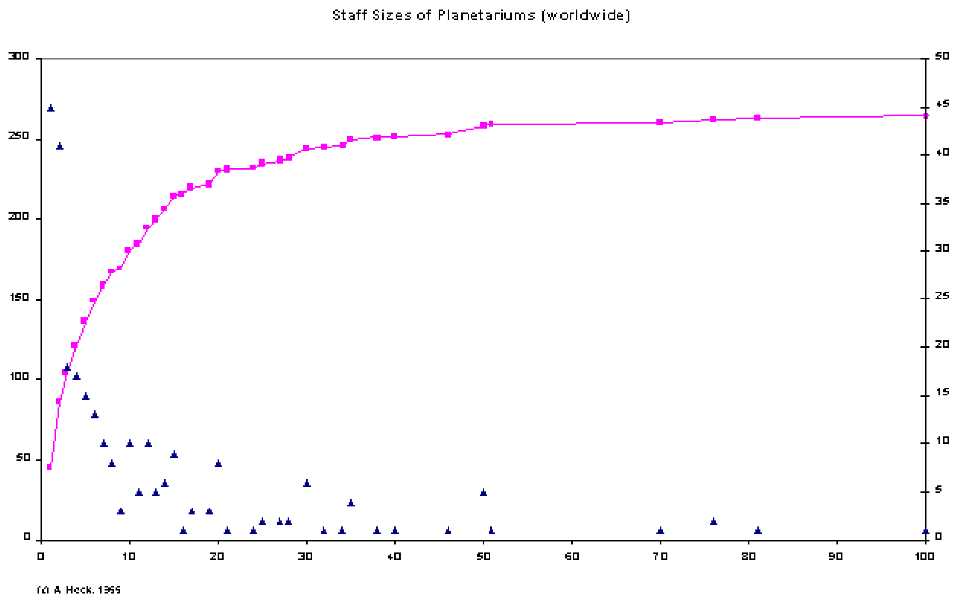
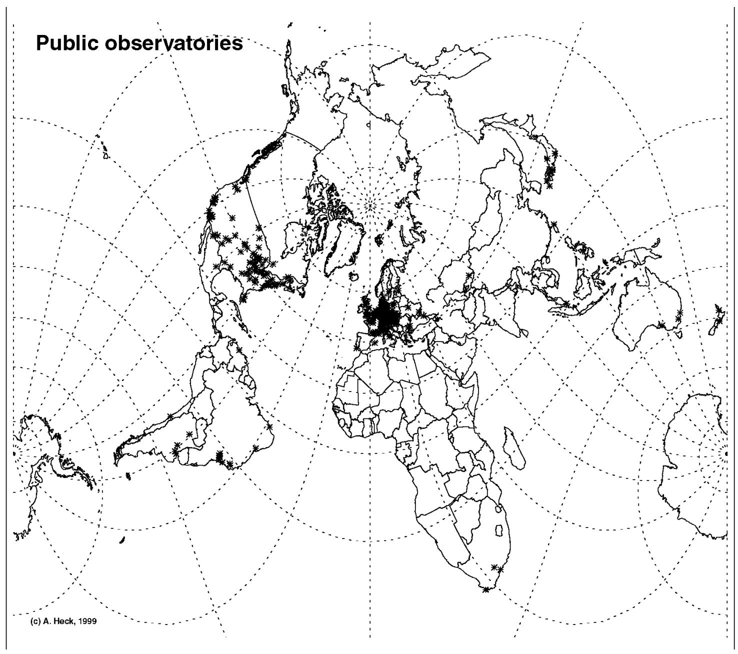
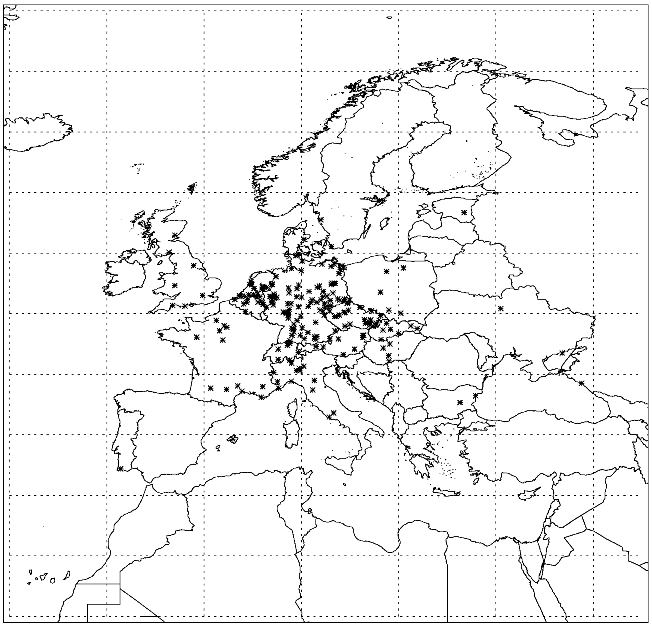


Figure 17 – Cumulative distribution of sizes for the planetariums (all countries – see text, Table 3 and the caption of Fig. 6).





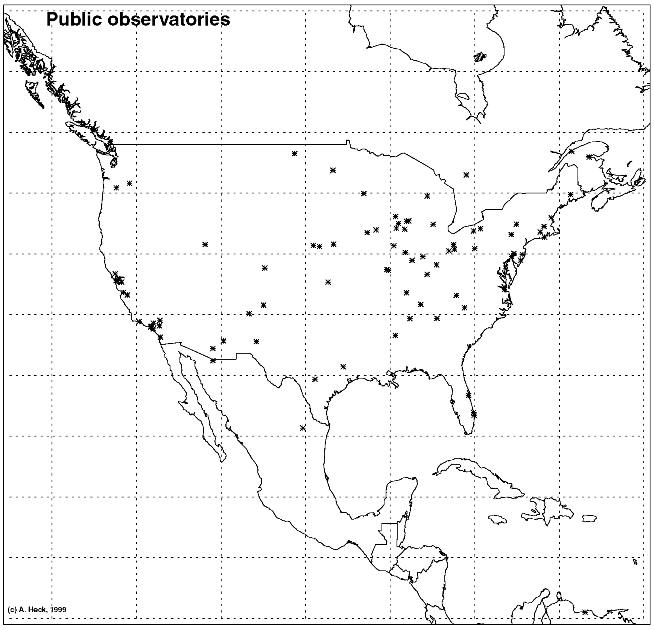


Figure 18 – Distribution of public observatories (a: World, b: Western Europe, c: North America – see text).

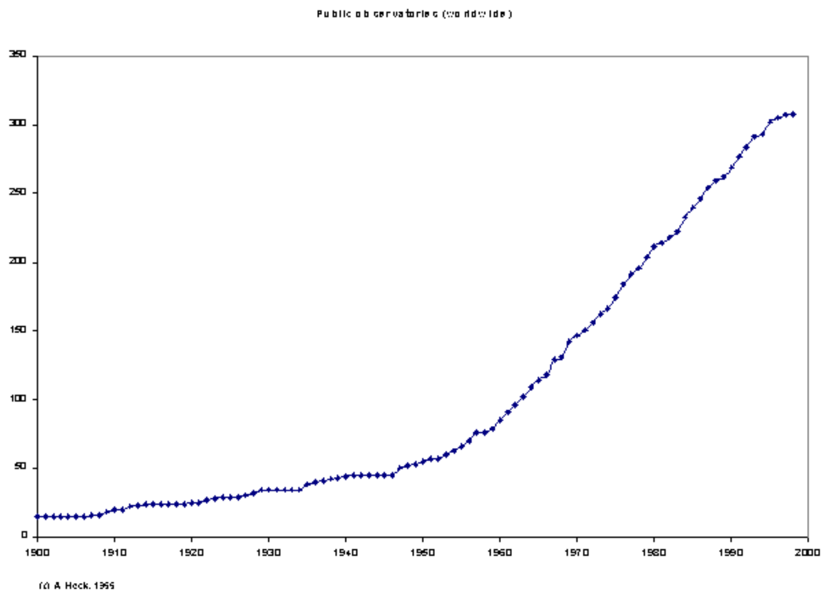


Figure 19 – Cumulative distribution of fundation years for the public observatories (all countries – see text and Table 2).

8.2. AGES

The cumulative distribution of ages is illustrated in Fig. 19 from 1900 onwards.

The oldest public observatory registered in the database is the York Observatory (UK/1831), followed by the Dumfries Observatory (UK/1836), Cincinnati Observatory (USA-OH/1845) and Sydney Observatory (Australia-NSW/1858).

Slight surges in the curve are noticeable after WWII, at the end of the fifties (Sputnik I) and of the sixties (Man on the Moon), as well as perhaps at the mid-seventies and mid-eighties (Halley's comet).

8.3. SIZES

The data for the sizes are illustrated in Fig. 20.

More than one third of the public observatories (88 out of 244) are run by a staff of one to three persons. For larger sizes, most of the staff seem often to be volunteers.

With this reservation in mind, the four largest public observatories appearing on the graph are the Observatorio Astronómico, Planetario y Museo

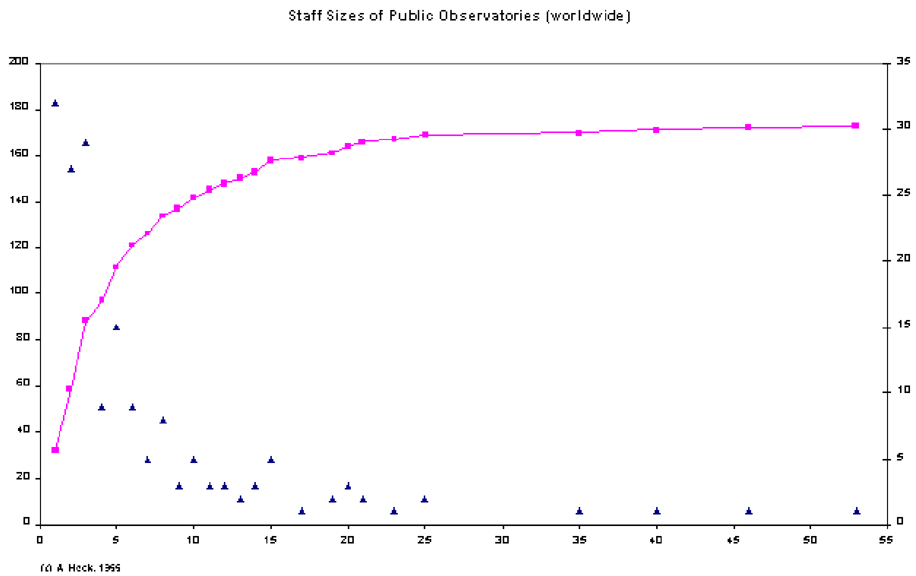


Figure 20 – Cumulative distribution of sizes for the public observatories (all countries – see text, Table 3 and the caption of Fig. 6).

Experimental de Ciencias de Rosario (Argentina, 35 persons), the Apple Valley Science and Technology Center (USA-CA, 40), the Pacific Space Centre (Canada-BC, 46), and the Kyiv Youth Palace Astronomical Observatory (Ukraine, 53). These organizations are also definitely more than purely public observatories and the larger staff is also explained by the other activities.

9. Publishers

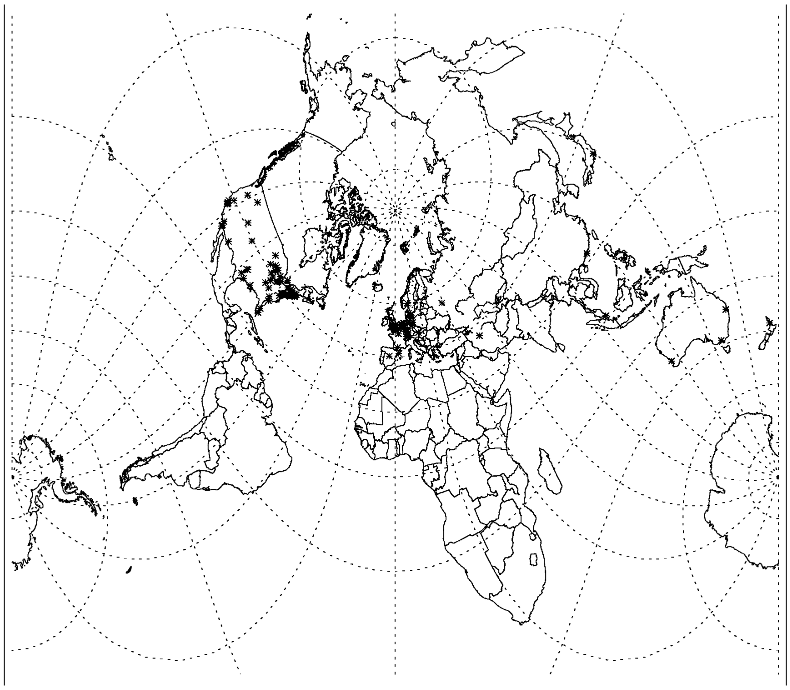
9.1. GEOGRAPHICAL DISTRIBUTIONS

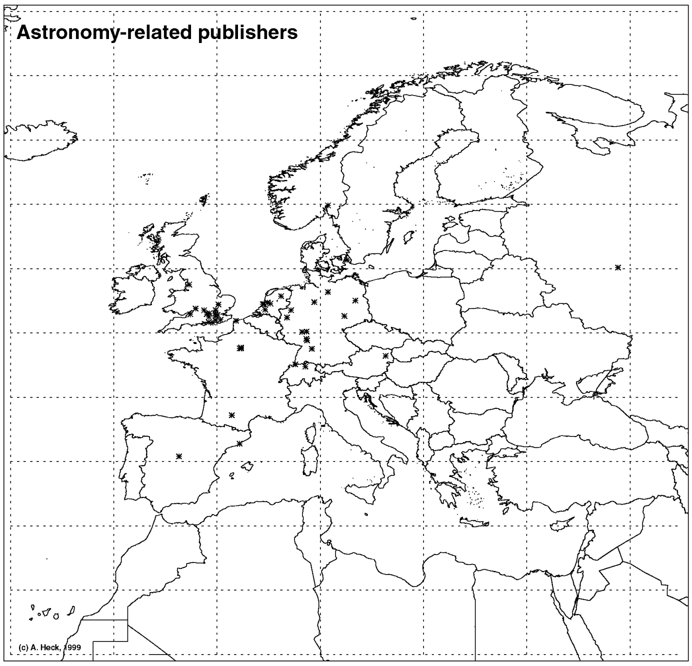
They are illustrated in Figs. 21a-c (161 positions in total).

Concentrations of astronomy-related publishers are to be found in and around London, Paris, Amsterdam, with some others in Germany and of course in Northeastern USA and California.

9.2. AGES

The cumulative distribution of ages is illustrated in Fig. 22 from 1900 onwards.




Astronomy-related publishers
(c) A. Heck, 1999

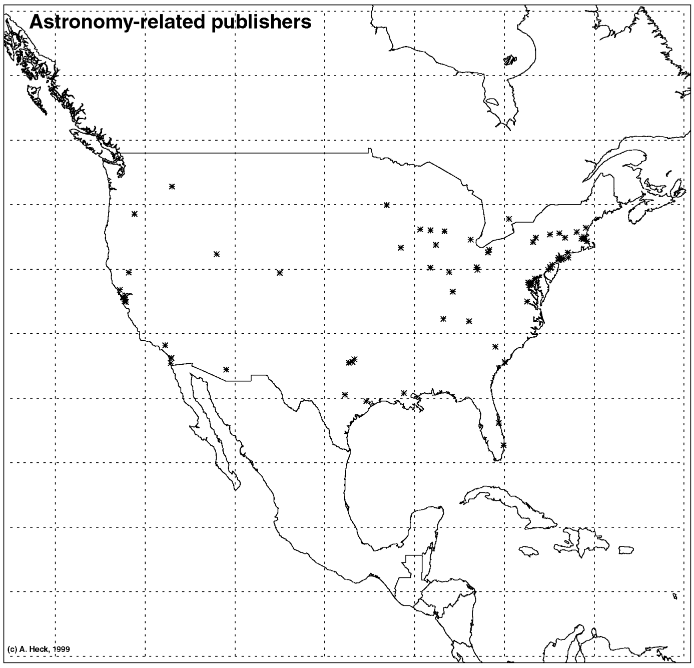


Figure 21 – Distribution of astronomy-related publishers (a: World, b: Western Europe, c: North America – see text).

Among the publishing companies founded earlier, one finds the Oxford University Press (1478), Cambridge University Press (1534), Johann Ambrosius Barth (1780), Friedrich Vieweg (1786), Taylor & Francis (1798), Masson Éditeur (1804), Wiley & Sons (1807), Springer-Verlag (1842), Hirzel Verlag (1853), and Cornell University Press (1869).

Astronomy-related publishing has been a steady activity. A few surges are however noticeable in the curve: in the first half of the twenties (after the plateau corresponding to WWI), in the second half of the forties (after WWII – notice however that the curve is not flat during the war), as well at the mid-sixties, mid-seventies and mid-eighties.

During WWII, Addison-Wesley was founded (1942), as well as Sky Publishing Corp. (1941), University of South Carolina Press (1944) and Vanderbilt University Press (1940), all in the USA. Note however that this country did not enter the war officially until 8 Dec. 1941 and that its mainland was not touched by the war.

9.3. SIZES

The data for the sizes are displayed in Fig. 23.

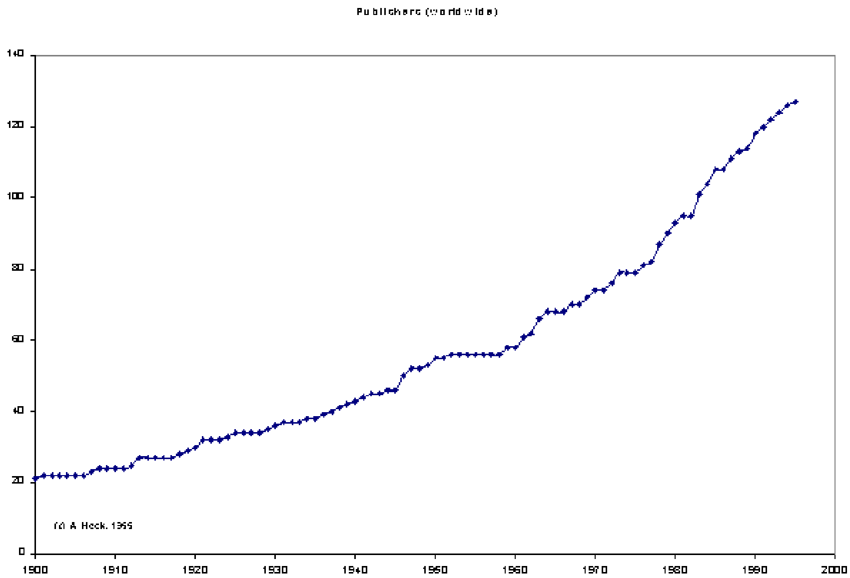


Figure 22 – Cumulative distribution of fundation years for the astronomy-related publishers (all countries – see text and Table 2).

A large number of publishing companies centered on astronomy have a staff of only a few persons: seven companies are single-person ones and the 25 smallest companies (30% of our sample) totalize only 97 persons, *i.e.* less than four persons on the average. Secondary peaks in the distribution are visible around 50 and 100 persons.

Of course, the larger the company, the more diversified is the production. Among the major astronomy-related publishers who disclosed their staff size, we could mention here: EDP Sciences (24 persons), Annual Reviews (32), Kluwer and Sky Publishing (50), Saunders College (55), IOP, Johns Hopkins, Princeton and MIT Presses (100), World Scientific (120), Blackwell (180), Wiley/UK and Plenum Press (300), Oxford University Press (800), Springer-Verlag (1230), and Elsevier (1600).

10. Commercial software producers

10.1. GEOGRAPHICAL DISTRIBUTIONS

They are illustrated by Figs. 24a-c (152 positions in total).

If the sample of astronomical-software producers is the smallest one (thus requiring more caution in statistical interpretation) and if the USA

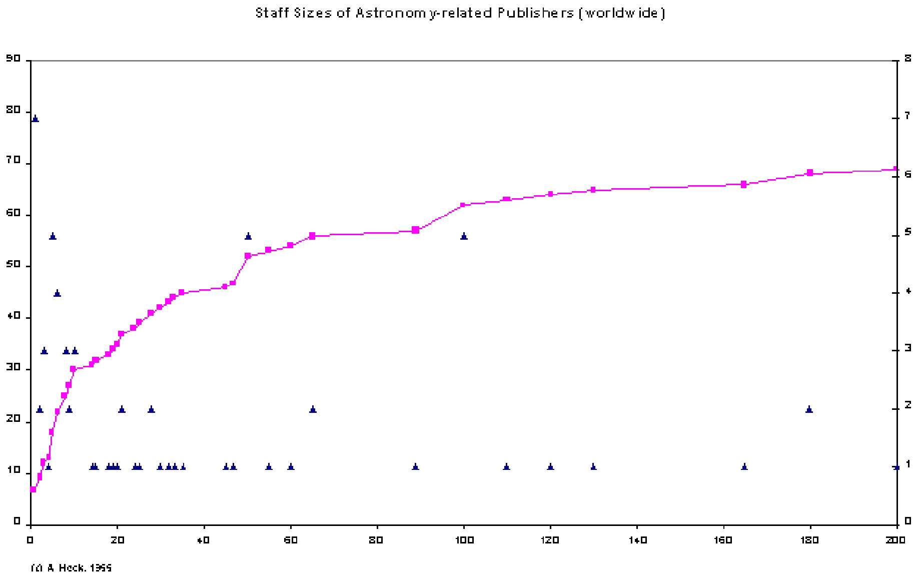


Figure 23 – Cumulative distribution of sizes for the astronomy-related publishers (all countries – see text, Table 3 and the caption of Fig. 6).

pattern is what can be reasonably expected, the European distribution is extremely surprising: mainly along a line from Dublin to Budapest.

10.2. AGES

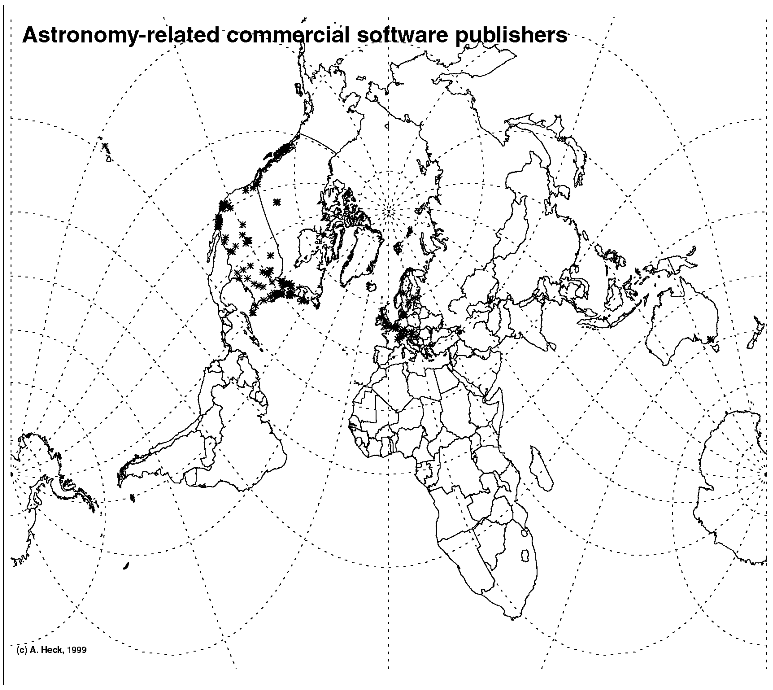
The cumulative distribution of the ages is illustrated in Fig. 25.

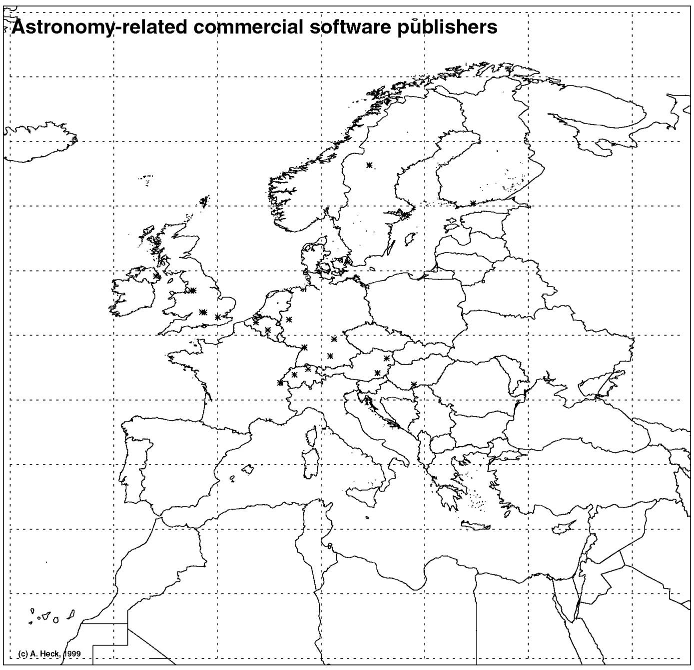
It calls for a very straightforward interpretation: the curve starts with the computer age (ENIAC's turn-on in 1946); a first surge is contemporaneous with Arpanet's commissioning (1969); after the mid-seventies, the electronic networks started spreading over the world; the eighties saw the popularization of the personal computers; and the first half of the nineties saw the advent of the WWW.

10.3. SIZES

The data for the sizes are displayed in Fig. 26.

The typical astronomy software company is also a very small one (1-3 persons). The larger the company, the more diversified is the range of activities, up to the well-known largest corporations who happen to include a couple of astronomy-related items in their product line.


Astronomy-related commercial software publishers
(c) A. Heck, 1999


Astronomy-related commercial software publishers
(c) A. Heck, 1999

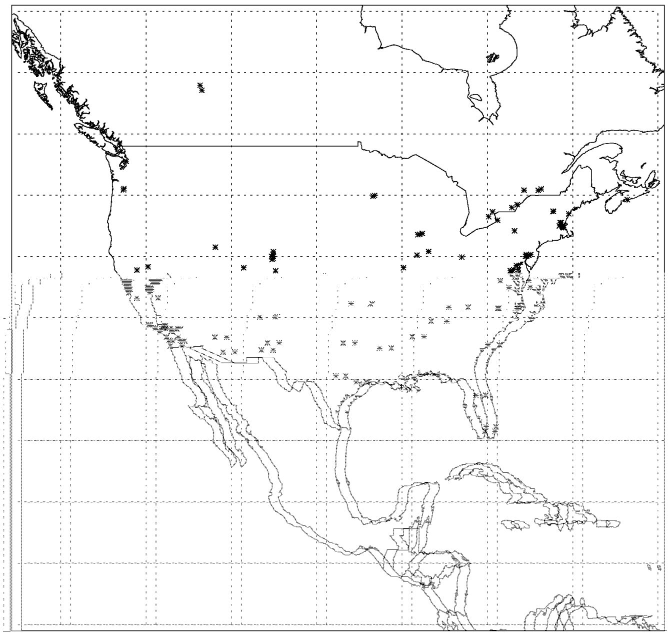


Figure 24 – Distribution of astronomy-related commercial software producers (a: World, b: Western Europe, c: North America – see text).

11. Final comments

As with other scientific and technical developments during this ending century, astronomy has made giant leaps forward in improving our understanding of the surrounding world. During the past decades, telescopes have grown larger, spacecraft have explored the solar system and investigated celestial objects in new wavelength ranges, detectors have become much more diversified and sensitive. As confirmed by the growth curves of this paper, the number of astronomy-related organizations has also grown steadily. However, as testified by the comparison with the distribution at the beginning of the century, where astronomy gets done did not change significantly. This might indicate the failure of developed countries to foster higher education, broad cultural activities, and research in the Third World.

Two candid comments are in order here:

- in order to issue some appreciation on the general development of astronomy-related activities, the curves displayed in this paper should be compared with similar ones for other disciplines or even more globally for research – unavailable so far to our knowledge;
- also if the rate of creation of astronomy-related organizations since the

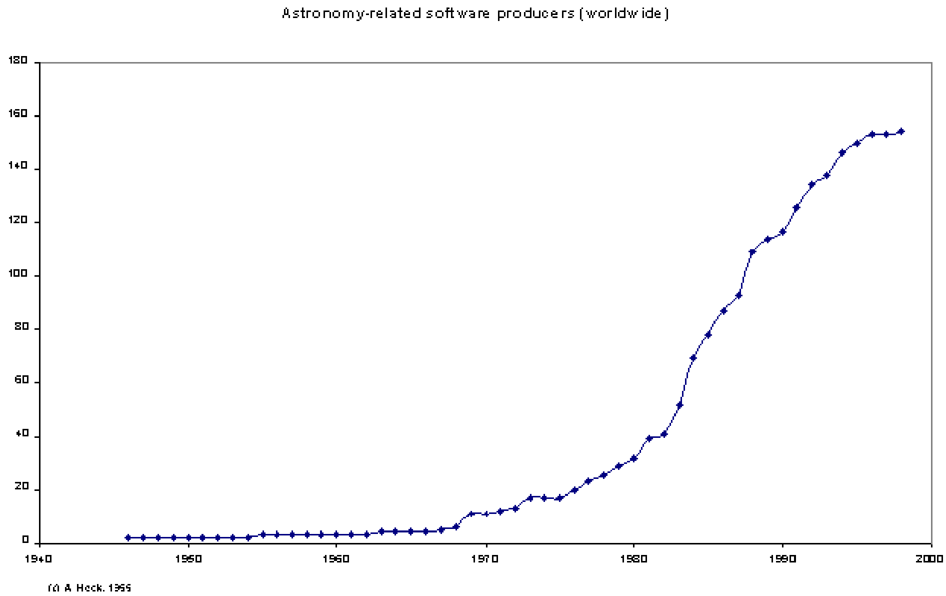


Figure 25 – Cumulative distribution of fundation years for the astronomy-related commercial software producers (all countries – see text and Table 2).

end of the fifties is really impressive, there is no indication that this should still go on that way half a century later, especially at a time when the society at large has other priorities (such as environment, health, security, unemployment) than space investigations or cosmological perceptions.

Not surprisingly, the second oldest sample on the average is the 'publishers' one (and with the second largest dispersion), while the software producers constitute the youngest one (and with the smallest dispersion). The second smallest dispersion corresponds to the 'planetariums' sample (as explained above, an activity born roughly with this century), while the largest dispersion is achieved by the West European institutions, making up the oldest sample on the average.

Because of the intense international relationships within the astronomy community, the impact of national factors and cultures are minimized. Some influences are however perceptible at the level of some categories of organizations (particularly public observatories within Europe), but they cannot distort the general conclusions brought forward as each national sample does not carry enough weight compare to the total one.

The investigations relating to public observatories, planetariums and associations have to be seen as much more than anecdotical. When we

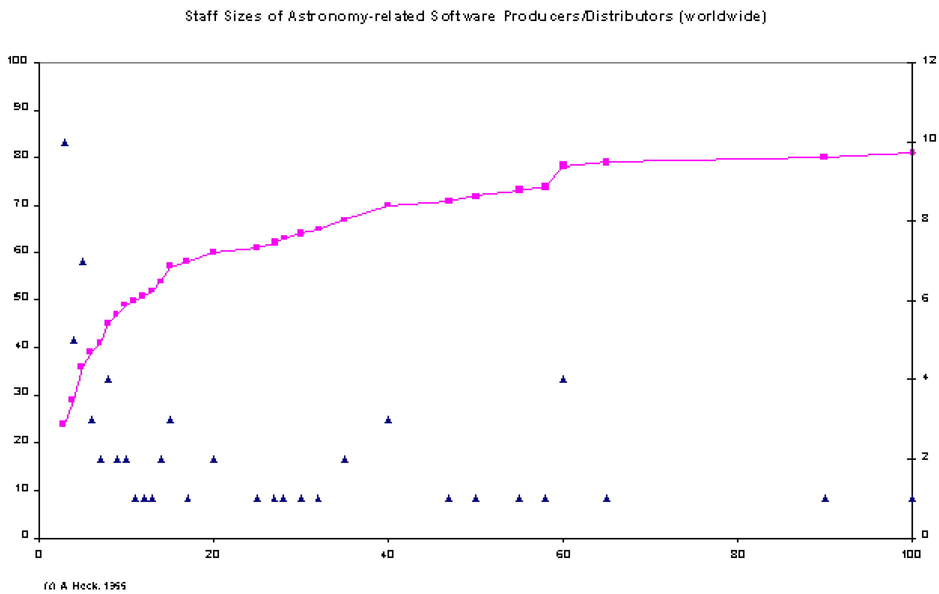


Figure 26 – Cumulative distribution of sizes for the astronomy-related commercial software producers (all countries – see text, Table 3 and the caption of Fig. 6).

were publishing two separate directories for the professional institutions and for the associations (respectively IDPAI and IDAAS, predecessors of the *StarGuides*), many professional institutions were purchasing a copy of the second one. Apart from a standard library acquisition, identified purposes were the organization of observational campaigns involving amateurs round the world and strong collaborations for educational activities as well as interface with the public and with official bodies. Also, in these times of restricted funding for the fundamental sciences, the critical importance of all these organizations must be – more than ever – fully appreciated.

Acknowledgments

We are very grateful to all persons and organizations who contributed over the past quarter of the century to the very substance of the master files used here by returning the questionnaires and updating forms, by providing the relevant documentation, by participating in the various procedures of maintenance, validation and verification of the information, or otherwise. We thank also Cl. Bertout and V. Trimble for interesting comments on some aspects of the work, as well as the various contributors mentioned in the bibliography for their personal communications of unpublished information.

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