

THE ANIMAL EMBRYO TRANSFER INDUSTRY IN FIGURES

A report from the IETS Data Retrieval Committee

By Professor Michel THIBIER – Chairperson.

SUMMARY

The Committee met early 2000 at the IETS 2000 venue. It had made comments on the previous year report and tried to design a plan of action to improve the collection of data where missing. The set of data of this 2000 year here reported, shows that some progress is still very much possible from certain areas in the world such as Asia and Oceania.

On the whole, bovine in vivo derived embryo transfer has been stable in 2 000 with contrasted areas: some increasing, others decreasing. The number of such embryos transferred this year is 530,000. Bovine in vitro embryos continue gradually to increase in some parts of the world; the number of such embryos transferred is over 40,000.

For other species, although exhaustive collection of data is still very difficult, the data collected indicate that the number of in vivo embryos transferred in small ruminants including the cervids remain in the same order of magnitude than that of last years: about 5 to 10,000 in sheep, 30,000 in goats and 1,000 in deer. The equine and swine ET industries are also quite active, the former claims 3,000 embryos transferred and the latter, although yet mainly experimental, particularly in Asia, is in the order of 7,000.

In conclusion, although the year 2000 was characterized by some environmental (disease outbreaks) or economical negative influences, the ET industry has seemed to be able to adapt and cope with these events. Its overall activity has been stable in some parts of the industry while still increasing in others, reflecting the good understanding of some farmers to the benefits that such technologies can offer to them.

INTRODUCTION: CRITICAL INTEREST FOR THE INDUSTRY TO PARTICIPATE TO THIS IETS DATA RETRIEVAL NETWORK.

For the 10th year in a row, the IETS data retrieval Committee has been able to gather the information in numbers of embryos collected, handled and transferred in most of the species of farm animals. Although aged of more than 10 years now, this Committee has still a lot to progress. It met at the 2000 venue of the IETS Conference in Omaha (USA) where more than 25 members from all parts of the work attended. It was then recognized that this set of collected data was very useful to the industry and probably one of the most efficient means of promotion, certainly at least of information to the public and national or international institutions (Universities, Agencies of the United Nations and others...). The Board of Governors of the IETS has at all time and under each and every President encouraged this Committee to pursue its task to the benefits of the IETS members. The Committee is happy to do so, whatever burden it is, all the year around, in some cases to beg the data to some of the colleagues who do not want to see the retroactive interest to their own business. A Cooperative spirit is requested from all practitioners to make the task easier for the national or regional collectors of data. We will not go through again on the system put in place and the absolute confidentiality of the data, but just to recall that we have had no example whatsoever in 10 years time that any information that could harm someone had passed through. This is important to recall and to claim particularly to the new private operators in species that have been involved in ET more recently. Some are not quite aware of our system and are anxious to release any information. On the contrary, it is to our mutual benefit to let the world know about what is done in numbers, which prove that there is a market and producers interested in the business.

Another problem, not new, concerns some countries, which have a lot difficulty finding a national or regional collector that can have reliable figures put together and report on. This regards mainly Asia, and the IETS members should help in identifying such persons that, we are sure, exist. It is true to say that it is not always immediately available because of some interference with the government administrative authorities or with competitive businesses. People from Universities devoted to our industry and having evidently no personal interest in collecting privileged information are those people to try to insert in the network. This year, thanks to some of IETS members that are commercially involved in the ET industry, we have been able to have some estimation, but should I recall that at the onset of the Committee, we aimed and are still aiming in having true reliable additions of numbers, as the previous experience of survey was shown to be a failure because of unreliable methodology to make such surveys informative and descriptive of the reality. In fact the present system has proved over the 10 years to serve us well, but all the members with operations in those countries should commit themselves to try to help so as to have even a more accurate and hence even more reliable system of data. Another

pattern is found particularly in Australia where the national association has a very difficult time to retrieve data from individual practitioners. Special action could easily be taken such as what have the Canadians put in place, which allows everyone to have the information with little constraint on individual practitioners from an officially approved team.

1. AN OVERWHOLE STEADY STATE OF THE BOVINE IN VIVO DERIVED EMBRYO TRANSFERS: A TOTAL OF 530,000.

Globally speaking, the number of bovine in vivo derived embryos transferred in 2000 is in the order of magnitude of 530,000. This would have set a new record, because it is an increase of 1% more than last year, itself the record. This **530,000** figure is the reference for 2000 to consider, however its limit of confidence is less than the years before for the following reasons. As explained above, the Committee has some difficulty to gather accurate and precise data from the ET teams themselves in some countries where there is quite an active ET industry; this refers particularly to countries like India, Bangladesh and Pakistan. Thanks to our colleagues involved in some commercial relationship with some of those teams some estimation could be made that are probably not far from the reality, but again not exact figures. It should also be kept in mind that this figure is certainly somewhat conservative as in some countries the ratio of responses may vary between 75 and 90% of the total. But this is so every year so that the trends can be evaluated over the years. Besides a couple of years in the first half of the nineties, one can then see that there is a gradual increase of a 1 or little more % in the numbers of ET every year and this is remarkable as being an industry that requires sometimes significant investments in some parts of the world.

This global overwhole increase is however contrasted as shown in table 1, according to regions or continents. There is an increase of 10% or so, in Africa (essentially the Republic of South Africa), North America and Oceania. The numbers of bovine in vivo derived embryos transferred have remained similar from last year to 2000 in Asia but has significantly decreased in South America and in Europe. In this latter case, there is a special note to add to modulate such a statement because the United Kingdom has reported no data at all, due to their Foot and Mouth Disease outbreaks in early 2001 that prevented them to collate their data. The numbers of embryos transferred in the UK would take into account more than half of the decrease observed, but still decrease in the activity there has been in 2000 in Europe. Details in table 1 show that again more than 110,000 cows have been flushed in 2000, resulting in more than 650,000 embryos of transferable quality (i.e. a mean of 5.9 transferable embryos per collection) out of which 528,000 were transferred. As shown in one of the footnotes of table 1, the additional 11,500 ET come from estimations that were not computed in the table. This leads to a calculated figure of 539,000 embryos that we have rounded up for official record to **530,000**, because of the uncertainty of those latter estimated figures. It can be observed that from the whole data, the percentages of fresh and frozen embryos transferred are quite close to 50%, 47% fresh and 53% frozen. There is a little variation according to continents and Africa, South America and Oceania transfer slightly more fresh than deep frozen embryos.

Table 1. Overall Activity of *In Vivo*-Derived Bovine Embryos in 2000.

| CONTINENTS | FLUSHES | TRANSFER | NUMBER OF TRANSFERRED | | |
|--------------|----------------|-------------------|-----------------------|----------------|----------------------|
| | | -RABLE EMBRYOS | FRESH | FROZEN | TOTAL |
| AFRICA | 1,205 | 7,049 | 3,566 | 3,197 | 6,763 (1.3%) |
| N. AMERICA | 50,527 | 287,460(*) | 102,285 | 122,166 | 224,451 (42.5%) |
| S. AMERICA | 9,327(*) | 56,645 | 45,679 | 38,842 | 84,521 (16.0%) |
| ASIA | 12,225 | 89,063 | 15,046 | 43,925 | 58,971 (11.1%) |
| EUROPE (**) | 22,734 | 125,035 | 47,270 | 58,698 | 105,968 (20.1%) |
| OCEANIA(***) | 17,040 | 99,068(*) | 32,410 | 15,456 | 47,866 (9.0%) |
| TOTAL | 113,058 | 664,320 | 246,256 | 282,284 | 528,540(****) |

(*) Data extrapolated for one country of the group.

(**) Those European data are derived from the statistics of AETE, 2000.

(***) Due to the low number of teams that responded in Australia, in accord with the AETA, we have extrapolated the data from those few teams to all the member teams of that association, so as to give sense to the 2000 results.

(****) A rough estimation of the numbers of ET's that were not officially recorded and hence not incorporated in the table above leads to about 11,500 more embryos transferred in ASIA (Bangladesh, India, Pakistan), which leads to the total number of in vivo derived embryos transferred in year 2000 = 539,000, rounded up for official records to 530,000.

The regional distribution this year has changed a little due to those contrasted evolutions. North America takes now into account more than 43% of the total of this sector and yet Mexico was not in a position this year to forward their data, which would have resulted in even higher a percentage by roughly one point. Europe ranks second in the continental distribution with 20% of the activity followed by South America, Asia and Africa. It is true to state here that as some major countries of Asia were only estimated, their numbers have not been taken into account in this percentage calculation. The reality if incorporating those estimations, would then be that Asia would be closer to South America but still with a few points of percentage less than the latter.

In North America, 48,223 and 176,228 bovine in vivo derived embryos have been transferred in Canada and in the USA respectively. The percentages of dairy and beef breed donors in Canada were respectively of 74% and 26% as opposed to the percentages reported by the US of 39% and 61% respectively for dairy and beef breeds. The Canadians report that the pregnancy rates from fresh and frozen embryos were respectively of 62.1% and 58.9%. They also report that from fresh embryos directly transferred (N= 22,072), a pregnancy rate of 57.6% was recorded. This country has some 40,000 embryos in storage. The US has indicated that their data were collected from 107 certified ET teams and 24 non-certified. The Canadians and the US have graciously released their numbers of exported and imported embryos. The former have exported 12,386 embryos and imported 667. The US have exported 10,774 embryos and imported 979 embryos. These numbers for export corresponds roughly to 25% and 6% of the total embryos transferred respectively for Canada and the USA. Unfortunately data for exports have not been recorded accurately for the other countries.

The trends of the activity of 2000 as compared to that of 1999 in European countries are reported in table 2. Again it shows a contrasting situation, Germany, the Netherlands, Ireland and Italy as well as Sweden have their numbers increased. France, the Czech Republic, Denmark and Spain remain stable while Belgium, Hungary (no more in the top twelve) and Switzerland slightly decrease.

Table 2. The Top Twelve European Countries Ranked According to Numbers of *In Vivo*-Derived Embryos Transferred In 2000 (AETE,2001).

| COUNTRIES | NUMBER OF FLUSHES | NUMBER OF EMBRYOS TRANSFERRED | |
|--------------------|-------------------|-------------------------------|---|
| FRANCE | 6,716 | 34,062 | ≡ |
| GERMANY | 3,942 | 24,062 | ↗ |
| NETHERLANDS | 4,600 | 20,616 | ↗ |
| UNITED KINGDOM (*) | | | |
| ITALY | 1,221 | 12,475 | ↗ |
| BELGIUM | 1,781 | 8,213 | ↘ |
| CZECH Republic | 1,027 | 4,928 | ≡ |
| IRELAND | 866 | 4,233 | ↗ |
| DENMARK | 741 | 3,568 | ≡ |
| SWITZERLAND | 311 | 2,451 | ↘ |
| SWEDEN | 294 | 1,683 | ↗ |
| SPAIN | 459 | 1,392 | ≡ |

(*) No answer due to major health problems (FMD) in this country at the time of the survey.

↗↘ Evolution as compared to the previous year

From the non European, non North American countries, it can be seen in table 3, that Brazil has seen its activity in bovine in vivo derived embryos slightly diminished with still however close to 70,000 embryos transferred, whereas those of Japan, Argentina and of the Republic of South Africa have seen their numbers increased. Data from the People Republic of China indicate a trend to an increase but it could not be possible to retrieve data from all the regions according to the collector. In numbers reported, the situation is close to that of last year. Interestingly, 43% of those embryos transferred were from beef breeds.

Table 3. The Top Five Countries Outside Europe and North America in 2000.

| COUNTRIES | NO. FLUSHES | NUMBER OF EMBRYOS TRANSFERRED | | |
|--------------|-------------|-------------------------------|--------|----------|
| | | FRESH | FROZEN | TOTAL |
| BRAZIL | 6,129 | 38,595 | 30,805 | 69,400 ↘ |
| JAPAN | 10,596 | 9,783 | 37,868 | 47,651 ↗ |
| ARGENTINA | 3,198 | 7,084 | 8,037 | 15,121 ↗ |
| P R of CHINA | 1,400 | 5,000 | 5,700 | 10,700 ≅ |
| SOUTH AFRICA | 1,205 | 3,566 | 3,197 | 6,763 ↗ |

2. A SIGNIFICANT INCREASE IN THE NUMBERS OF BOVINE IN VITRO PRODUCED EMBRYOS TRANSFERRED.

The IETS data retrieval network seems to have improved its efficiency to retrieve data from teams involved in in vitro production of bovine embryos, because this year, the total number (see table 4) has increased by 50% approximately. This essentially results from the figures recorded by Brazil, which reports having transferred more than 10,000 of such embryos. In total, 41,000 embryos were reported transferred with three main continents having the same order of magnitude, i.e. approximately 12,000 embryos produced and transferred in 2000: Asia, South America and Europe. The latter has its activity steady by contrast to those of Asia, mainly Japan and Korea and South America (Brazil). Oceania, here New Zealand, has also its activity increased this year. Interestingly, the deep frozen in vitro produced embryos have now their capacity to be transferred commercially at fairly large numbers. Europe has more embryos frozen than fresh and this comes primarily from Italy, which has transferred 5,270 frozen in vitro produced embryos this given year. The number of oocyte donors, which is the collecting data chart, has not been here reported because of the divergence in the understanding and this has to be discussed in our next Committee meeting. The Europeans report interesting data. From OPU, 1,035 oocyte donors have been recorded with 8,443 OPU sessions delivering 14,079 blastocysts produced. This number of blastocysts produced from abattoir material is 12,441 (total: 26,520). This means first that both techniques are being applied even if the later might be used more for experimental reasons and second that the numbers for each technology are quite close one to the other. Although the Canadian numbers are somewhat smaller (total 552), their report indicates 57% are fresh and results in a pregnancy rate of 48% as compared to 37% for frozen embryos. Japan reports having transferred 3,697 and 5,146 respectively fresh and frozen bovine in vitro produced embryos. All the in vitro produced embryos in Korea derive from abattoir material (14,158) but a sixth only of the transferred ones are frozen. In this country, there seems to be quite an active investigation on the nuclear transferred in vitro produced embryos as 2,526 of them have been transferred. It should be understood that some of those data might not be, at least in some country reports; all commercially transferred and some experimental embryos are most likely also incorporated in some reports. However, this increase in the bovine in vitro produced embryos seems to be real together with the significant increase in the frozen embryos that are subsequently transferred.

Table 4. The Number of Bovine *In Vitro*-Produced Embryos Transferred in 2000.

| | TRANSFERABLE | TRANSFERRED EMBRYOS | | |
|--------------|-------------------|---------------------|---------------|-----------------|
| | EMBRYOS COLLECTED | FRESH | FROZEN | TOTAL |
| AFRICA | 975 | 1 | 21 | 22 ↘ |
| ASIA | 97,011 | 6,680 | 5,684 | 12,364 ↗ |
| N.AMERICA | 1,741 | 1,382 | 533 | 1,915 ↘ |
| S.AMERICA | 12,667 | 12,527 | | 12,527 ↗ |
| EUROPE | 26,520 | 6,377 | 7,426 | 13,803 ≅ |
| OCEANIA | 1,358 | 930(*) | 130 | 1,060 ↗ |
| TOTAL | 139,372 | 27,967 | 13,794 | 41,761 ↗ |

(*) Only one country from this region has reported that figure

3. EMBRYO TRANSFERS IN THE OTHER SPECIES: STILL SOME PROGRESS TO BE MADE TO RETRIEVE THE DATA.

The IETS network has still to improve its performance in this area. The main reason is of course that this network relies essentially on the bovine industry and there are numbers of countries in which the relationship between the different species practitioners is not yet operational.

For the small ruminants (table 5), countries like Australia have not reported their figures, which contributes to some significant underestimation. In sheep, most of the activity recorded comes from the Republic of South Africa. However as correctly noted by the south african collector, a dramatic outbreak of Foot and Mouth Disease in their winter 2000 has resulted in a ban for export and has dramatically reduced the industry as two thirds of their embryos collected are exported. This activity is limited in North America and Europe with several hundreds of transfers reported in the North American countries and in Europe. For the latter, some transfers have been performed in some Mediterranean countries such as Greece and Portugal or in central Europe such as the Czech Republic, Hungary and Romania. In Asia, the P R of China has reported having collected close to 2,000 sheep transferable embryos. For goats, the picture is somewhat different as from the 10,000 embryos approximately transferred, essentially fresh, the USA have by enlarge the major contribution, but there is also quite an activity in New Zealand and the Republic of South Africa. The same European countries as for sheep and in Asia, the P R of China, Korea and Taiwan also have some hundreds goat embryos transferred like also Canada. In addition to the detailed figures given by the Chinese collector, it has been estimated indirectly that 10,000 goat embryos from various parts of China and from Mongolia have been transferred, hence giving an overwhole order of magnitude of 30,000 embryos transferred last year. The Cervids continue to be the subject of embryo transfers particularly in Canada, P R of China and New Zealand. More than 1,000 embryos have been transferred, approximately half fresh, half frozen. This number however is a little less than last year, the New Zealander having not reported any frozen embryo transfer this year, but they have some 200 of such embryos in store.

Table 5. Small Ruminants E T Activity in 2000.

| CONTINENTS | FLUSHES | TRANSFERABLE EMBRYOS | NUMBER OF EMBRYOS TRANSFERRED | | | |
|----------------|--------------|----------------------|-------------------------------|--------------|--------------|--------------|
| | | | FRESH | FROZEN | STORAGE | EXPORT |
| SHEEP | | | | | | |
| AUSTRALIA | n.d. | n.d. | n.d. | n.d. | n.d. | |
| CANADA | n.d. | 598 | 480 | 138 | | |
| P R CHINA | 300 | 1,800 | n.d. | | | |
| EUROPE | | 847 | 440 | | | |
| NEW ZEALAND(*) | 25 | 100 | 124 | | 100 | |
| SOUTH AFRICA | 2,514 | 15,093 | 477 | 1,480 | 3,660 | 9,370 |
| USA | 7 | 343 | 333 | | | |
| TOTAL | 2,846 | 18,781 | 1,414 | 3,472 | 3,760 | 9,370 |
| GOAT | | | | | | |
| AUSTRALIA | n.d | | | | | |
| CANADA | n.d. | 286 | 93 | 9 | | |
| P R CHINA | 500 | 4,500 | 500 | | | |
| EUROPE | | 243 | 145 | | | |
| KOREA | 431 | 2,000 | 482 | 24 | | |
| NEW ZEALAND | | | 1,000 | | | |
| SOUTH AFRICA | 344 | 2,245 | | 320 | 1,132 | 687 |
| TAIWAN | 28 | 347 | 55 | 109 | 183 | |
| USA | 201 | 1,871 | 7,782 | | | |
| TOTAL | 1,504 | 11,492 | 9,912 | 607 | 1,315 | |
| CERVIDS | | | | | | |
| NEW ZEALAND | 150 | 783 | 480 | | 210 | |
| P R CHINA | 20 | 60 | 50 | | | |
| CANADA | 204 | 656 | 213 | 521 | 75 | 252 |
| TOTAL | 374 | 1,499 | 743 | 521 | 285 | 252 |

(*) Much underestimated (from the collector's comment) (**) It is estimated although not officially recorded as such, that some 10,000-goat embryos from parts of the People Republic of China and about also 10,000 goat embryos from Mongolia have been transferred last year.

The equine embryo transfer industry is also active and more than 5,000 flushes have been reported (table 6). Most of them come from the USA but Brazil also invests in this area. Most of the embryos transferred are fresh and this is performed mainly in the US and also in Canada and in Europe. In the latter, five countries have reported some transfer in horses: Austria, the Czech Republic, Hungary, France and Italy. Some 100 frozen embryos are in store in the USA.

Table 6 - Equine E T Activity in 2000.

| CONTINENTS or COUNTRIES | TRANSFERABLE FLUSHES | EMBRYOS | NUMBER OF EMBRYOS TRANSFERRED | | | |
|-------------------------|----------------------|--------------|-------------------------------|-----------|------------|--------|
| | | | FRESH | FROZEN | STORAGE | EXPORT |
| BRAZIL | 400 | | | | | |
| CANADA | 65 | 101 | 54 | 25 | | |
| EUROPE | n.d. | 563 | 226 | | | |
| SOUTH AFRICA | 8 | 9 | 9 | | | |
| USA | 4,925 | 2,466 | 2,466 | 50 | 100 | |
| TOTAL | 5,398 | 3,139 | 2,755 | 75 | 100 | |

The swine industry is also investing in this technology; the problem to retrieve data here is that it is mainly performed by private companies that are not used to releasing their data yet (see above). It has hence been difficult to give an accurate image of where the technology stands in this species. One point is that it certainly increases and here more than 7,000 transfers were reported. Thanks to those countries that could manage to collect data, this report gives (table 7) for the second year in a row, some idea of what is going on. It should however be noted that not all those embryos are commercially used; many of them are still used at the experimental or at least pre-developmental stage. In Europe, the Netherlands as well the Czech Republic and Romania have reported figures of embryos transferred as fresh. So have the US and Canada. Korea and Taiwan have quite an active field of investigation in this area. In addition to in vivo derived embryos, the former reports having produced 18,700 in vitro embryos and 21,600 nuclear transferred ones. Some 5,500 swine in vitro produced embryos are currently stored. Similarly, Taiwan reports an active program of research at the Pig Research Institute of Taiwan which has included transfers of gene injected embryos in 184 recipients with a farrowing rate of 38.6% delivering 432 piglets born.

Table 7 - Swine E T Activity in 2000.

| CONTINENTS or COUNTRIES | TRANSFERABLE FLUSHES | EMBRYOS | NUMBER OF EMBRYOS TRANSFERRED | | | |
|-------------------------|----------------------|--------------|-------------------------------|--------|--------------|--------|
| | | | FRESH | FROZEN | STORAGE | EXPORT |
| CANADA | 2 | 85 | 5 | | | |
| EUROPE | 236(**) | 4,335 | 2,539 | | | |
| KOREA | 22 | 302(***) | 26 | | 5,830 | |
| TAIWAN | | 4,321(****) | 4,321 | | 80 | |
| U S A | | | 200(*) | | | |
| TOTAL | 260 | 9,043 | 7,091 | | 5 910 | |

(*) estimation

(**) Not all countries that responded gave this figure, so it is underestimated.

(***) To those in vivo derived, it should be here added 18,700 in vitro produced embryos and 21,600 nuclear transferred

(****) Including experiments on transgenic pigs

In **conclusion**, our network to retrieve data has produced a fairly accurate and reliable set of data, particularly in the bovine. Some progress can certainly still be made and requires the help of each and every IETS member to still improve this scheme. Although there has been several major events last year, related to the environment or to the economics of animal farming in some places in the world, yet perhaps announcing more dramatic ones in the year 2001, that could have compromise or mitigate the ET industry, the latter has seemed to cope appropriately with the environment, thanks to its great potential to the benefits of the farmers. In the bovine, the in vivo derived embryo line continues to progress gradually

with however contrasted evolution according to continents. The in vitro produced embryo sector has dramatically increased this year although the total numbers are not yet to match those of in vivo derived embryos (about one tenth!), there is some room for improvement. For the other species, it is rewarding to see that apart from some exceptions, the network gains in efficiency every year and allows the world community to be better aware of the potential of those technologies in those given species. It is in thousands now that embryos are transferred worldwide in small ruminants, horses and swine to the farmers' benefits.

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Publication of the Proceedings of the International Embryo Transfer Society

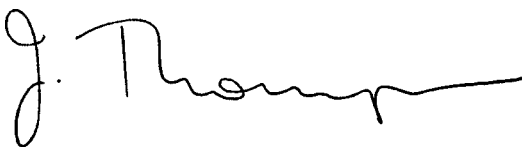
Within the Board of Governors the question has been raised if publication of the Society's proceedings within the journal, *Theriogenology*, is in the best interests of the IETS.

Motivation for examining the role of the publisher of the Society's proceedings has been promoted by both financial and copyright issues. Publication within *Theriogenology* represents a considerable expense to the Society. Furthermore, Elsevier (the European publishing house which owns *Theriogenology*) holds the copyrights to all of the printed matter within the proceedings.

However, both the journal and the Society have benefited from close association, which began back in 1978. *Theriogenology's* citation index and circulation are significantly influenced by the IETS's contribution and IETS has benefited from the exposure that the wide circulation of the Society's plenary papers and abstracts has brought, especially in the continued increase in numbers of delegates for our annual meeting.

The Board of Governors has formed an ad hoc committee, the "Proceedings Committee", to investigate what options are available to the Society. The Committee consists of Jeremy Thompson as Chair, Carol Keefer, Naida Loskutoff and Christine Wrenzycki. We invite you to make comment to this Committee regarding the role of the publisher of the Society's proceedings. Furthermore, some time will be spent on this issue during the Business Meeting in Brazil.

Yours truly,



Jeremy Thompson
Chair, Proceedings Committee

December 2001