

**REPORT OF THE 5th EVALUATION
OF THE BIOTA-FAPESP PROGRAM
BY THE SCIENTIFIC ADVISORY COMMITTEE**

15 to 20 November 2005

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Hotel Majestic, Águas de Lindóia– 15 to 21 November 2005**

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Contents

Members of the Scientific Advisory Committee.....	2
Contents	3
Executive Summary.....	4
Major Recommendations	5
Introduction	7
Methodology followed by the Evaluation Committee.....	7
General Issues	7
Recommendations	9
Data Basing and Infrastructure	9
SinBiota.....	10
SpeciesLink	11
BIOprospectTA	11
Biota Neotropica	13
Collection Infrastructure	13
Human Dimensions, Conservation and Climate Change	14
Climate Change, Land Use Change and Biodiversity	14
Human Dimensions of Biodiversity and Conservation.....	15
Bioprospecting	17
Other Issues	19
Gaps in coverage.....	19
Evaluation Committee	19
Biota International Publications and Young Investigators	20
Young Investigators	21
Legal Instruments	21
Conclusions	22
Appendix: Previous Recommendations	23
Recommendations for FAPESP	23
Recommendations for Coordenação Biota.....	23
Recommendations for the Biota Research Community	24

Executive Summary

1. The Committee applauds the emergence of BIOTA as one of the premier biodiversity science programs in the world. The scope, publications, and impact of the program in just six years is enormous and is a resource not just for Brazil but for the world. The science in most BIOTA projects is of high quality equivalent or exceeding that in other countries, and in several projects it is of outstanding quality—at the cutting edge of international efforts. In many respects the Biota program provides an example, and sets standards, that many countries would be happy to follow. We would respectfully suggest that there might be benefit in the Brazilian Federal Government looking at the Biota Program as an example and possible template for stimulating similar Programs covering other regions of Brazil.
2. It is essential that the long-term funding of several infrastructure projects such as the SinBiota database, SpeciesLink, the new BIOprospecTA database as well as the e-journal, *Biota Neotropica* will need to be considered and acted upon in the coming years. These infrastructures are core to the continuance and continued success of the program and are relied upon by all the projects. It is unproductive to develop such databases and then not to provide funding for the continued maintenance and development as well as the open access, long-term maintenance, archiving and support for the very valuable resource held therein. The data are a major asset of any program such as this, and like all assets require regular maintenance if that asset is to be preserved. The National Science Foundation in the USA and several other organizations are attempting to address this matter and have recently produced a number of papers on this subject (see under Paragraph 15, below).
3. Human activities are the greatest force acting upon the environment (at least as great as climate change), and already account for the greatest impacts on ecosystems, the cycle of nutrients, and the survival of species through habitat alteration. If the goals of BIOTA are to be achieved—especially its very first goal (to understand the processes that maintain biodiversity or lead to the loss of biodiversity)—it is urgent that BIOTA projects begin to address how human activities impact the biodiversity being studied and documented. Existing projects should begin to address this urgent need to examine the human dimensions of biodiversity by looking at the areas around conservation units where a lot of the current work is concentrated. By taking on the surrounding landscape, often with a more anthropic character, it will be possible to examine fundamental questions of interest to existing projects and begin to address this urgent need to examine the human dimensions of biodiversity.
4. The most valuable resources of the country are its natural resources, and Brazil is not currently benefiting from the development of those resources. Current laws on collecting in Brazil are restricting Brazilian science, and Brazil's opportunities to benefit by biotechnology through not being able to patent new discoveries, compounds and proteins in Brazil. We suggest to FAPESP that they help alleviate this situation by lobbying government to free up laws that currently restrict scientific activities, and for the implementation of laws that allow for the patenting of novel products that are discovered and developed in Brazil. It is only in this way that the benefits of Brazil's science will flow back to the country.
5. The evaluation committee views BIOTA as being at a point in its development when it must strengthen its coordination and association with its universities. This is one way in which it may be possible to meet its fundamental support for researchers, discussed elsewhere in this evaluation, such as technical editorial support, funding for databases, and other resource needs. A good model for this may be the US National Science Foundation Science and Technology Centers. These Centers of excellence

usually address a broad topic, such as BIOTA does, and is also made up of a large portfolio of projects. What makes it work well is that they require universities where scientists are located to make substantial matching contributions to the NSF funds. These matching fund contributions tend to be allocated to personnel and other activities not easily fundable by NSF. Normally, for example, NSF requires that there be a full time Science Manager or Coordinator (other than the Principal Investigator) who is a PhD scientist with management obligations to coordinate the diverse and widely dispersed projects. Also funded by the universities are positions such as a technical editor, postdocs assigned to particular labs, and secretarial support. From our discussions with BIOTA scientists it seems that they see difficulty in being able to hire these sorts of personnel needed to hold BIOTA together as a coordinated research effort because of the FAPESP research project structure. However, it may be necessary to have FAPESP work together with universities which receive BIOTA funds to ensure that universities begin to make matching contributions to FAPESP grants by hiring key personnel that would provide BIOTA with the support for keeping these disparate projects together and to ensure that BIOTA scientists interact with each other and with other areas of research, such as climate change and conservation; and so that more papers can be technically improved to allow a greater number of submissions to prestigious international journals.

6. The Advisory Committee was presented with a list of 365 refereed publications that had arisen from the BIOTA Program over the past five years, along with a set of statistics based on those. It became apparent during the evaluation that a number of projects had not yet entered their publications into the BIOTA Publications database. This included one project that had over 100 additional refereed papers not included, and other projects that mentioned that they also had more to add. The list of papers included a number published in well-respected international journals, including *Science* and *Nature*. The Evaluation Committee believes that not all researchers should be expected to publish in these two journals as papers are often solicited, require major breakthroughs in science, and usually require international recognition of the researcher before acceptance. We would also suggest that the Impact Rating is not the only way (and not always the best way) of ranking journals or papers. Other methods include the rejection rate of journals and the number of citations in Citation Indexes. We urge, however, that researchers in the BIOTA program seek publication of more of their papers in journals at the next level of impact (e.g. *Quarterly Review of Biology*).

Major Recommendations

- i. *FAPESP consider how funding can be provided for the long-term funding for the maintenance of databases and the Biota infrastructure, As a first step set we suggest the setting aside of a percentage of each project's budget, up-front, for CRIA and SinBiota to ensure that there is no lack of resources to Coordenação BIOTA to maintain the database and ensure their continued development.*
- ii. *We recommend that FAPESP leadership work together with universities which receive BIOTA funding, and with the Coordenação BIOTA to develop a means of ensuring that universities begin to make matching contributions to FAPESP/BIOTA grants by hiring key personnel that would provide BIOTA with the "glue" to hold these disparate projects together and ensure that BIOTA scientists interact with each other and with other areas of science. This may be somewhat akin the Science and Technology Centers of the NSF.*

- iii. *Coordenação BIOTA should encourage the scientific community to prepare new grant proposals that focus on human dimensions of biodiversity and to develop these proposals with close collaboration of biological scientists and social scientists with the competence to address, in a sophisticated manner, these human dimension questions.*
- iv. *Coordenação BIOTA encourage the development of at least one major thematic grant on the human dimensions of biodiversity that would focus on the optimal use of existing biodiversity research and its human dimensions.*
- v. *FAPESP lobby the Brazilian Government to make sure that new laws on the environment do not restrict the very good biological research that is occurring in Brazil, and that laws on Patent protection be enacted to ensure that the benefits of scientific discoveries in Brazil, in the way of active compounds, can be protected.*
- vi. *We encourage BIOTA researchers to seek to submit more of their papers to internationally recognized journals, and journals with high impact ratings, and/or high rejection rates.*

Introduction

1. As part of its review and quality assurance policy the FAPESP-Biota Program has its achievements evaluated by an international committee of independent experts. This report is the fifth review by such a committee.
2. The BIOTA Program has grown dramatically between 2003 and 2005 – from 46 to 74 projects in 42 themes, from 800 to 1308 researchers and students with participation of 36 national and 14 international institutes and organizations. The project has generated 67,466 (up from 38,000) records in its central SinBiota databank, and increased links from 12 to 41 distributed databases via *speciesLink*. These figures indicate that there has been a huge increase in the program over the past two years. This will continue to put a strain on the databases and on the Coordenação Biota as the program expands.
3. The introduction of new projects and of the subprogram BIOprospectA to the BIOTA Program as more projects have been added has led to continuing change in the direction of the Program and to high levels of energy and enthusiasm as new participants come into the program.
4. The evaluation took place simultaneous with the V. Biota Symposium in Águas de Lindóia, visited by 300 participants of which around 170 participated in mini courses.

Methodology followed by the Evaluation Committee

5. The evaluation committee was only able to spend a brief period examining the Biota Program between Nov. 15 and 20 during the V Symposium of BIOTA and the associated Evaluation meeting. It established its opinion through attending:
 - presentations of the results of running projects,
 - poster sessions presented to the meeting by both the students and project leaders,
 - presentations of the new and continuing projects accepted since the last evaluation meeting in 2003.
 - Interviews held with the members of the Coordenação Biota (Professor Ricardo Rodrigues - Program Leader), Dr Carlos Joly, Dr Vanderlei Perez Canhos, Dr Naércio A. Menezes), the director of FAPESP (Professor Carlos de Brito Cruz), and project leaders, students, and presenters at the symposium.
 - A visit to CRIA by one of the committee, where the Informatics core of the project was demonstrated (SinBiota, SpeciesLink).
 - Studying information offered via the Internet, especially the Biota website, Biota Neotropica, SinBiota, SpeciesLink and associated web sites as well as the FAPESP website.
 - Examining and discussing various aspects of the program in the light of previous evaluations, recommendations and goals set out by BIOTA at the beginning of the program.
 - Placing its findings in a context of international endeavors with respect to other biodiversity projects.
 - Using personal expertise of committee members.

General Issues

6. One of the Committee members attended the International Botanical Congress in Vienna in June 2005, and noted with pleasure and pride, the number of high quality poster presentations that carried the BIOTA/FAPESP logo. Such participation in

International meetings needs to be encouraged further to ensure high visibility for the program.

7. The Coordination Committee needs to establish a regular rotation to ensure that scientists from a range of communities contribute to the dynamism of the BIOTA program.
8. The evaluation committee views BIOTA as being at a point in its development when it must strengthen its coordination. Issues such as being able to meet its fundamental support for researchers, discussed elsewhere in this evaluation, such as technical editorial support, funding for databases, and other resource needs. A good model for doing this may be the US National Science Foundation Science and Technology Centers. These Centers of excellence usually address a broad topic, such as BIOTA does, and is also made up of a large portfolio of projects. What makes it work well is that they require universities where scientists are located to make substantial matching contributions to the NSF funds. From our discussions with BIOTA scientists it seems that they see difficulty in being able to hire and fund, personnel needed to hold BIOTA together as a coordinated research effort because of the FAPESP research project structure. However, it may be necessary to have FAPESP work together with universities that receive BIOTA funds to ensure that these universities begin to make matching contributions to FAPESP grants by hiring key personnel that would provide BIOTA with the support for keeping these disparate projects together. This would ensure that BIOTA scientists interact with each other and with other areas of research, such as climate change and conservation; and that more papers can be technically improved to allow a greater number of submissions to prestigious international journals.
9. There are a number of coordination issues that still need resolving or that need continual assessment. These include the relationships between FAPESP BIOTA and the FAPESP Biological Sciences Programs. There continues to be some overlap between projects within these two Programs—and no apparent mechanisms for their regular interaction. It is important for the long-term aims of the BIOTA Program that projects funded under these two or other biodiversity programs, continue to be brought under the broad umbrella of the BIOTA Program with the approval of the Coordenação Biota. The Committee suggests that FAPESP consider giving one of its current advisors the role of bridging these two programs where appropriate, and of organising a meeting between the Coordinating Committees of both programs to begin to bridge this current gap.
10. The thematic meetings are central to the intellectual development of BIOTA, however, as the number of projects rises beyond 70 it is an insufficient way to bring coherence to that many projects. It is important that a **matrix** be developed by Coordenação BIOTA that would serve as a better way to organize the projects into families of projects, and cross-cutting themes. Some could maintain the current thematic order but also provide a richer and more problem-oriented focus that cuts across the current thematics: e.g. sustainable development, modelling, evolution & ecology, conservation, etc.
11. There would be benefit to BIOTA in seeking out DIVERSITAS scientific leaders to offer its 74 projects to that community and to become active as both scientists and leaders within DIVERSITAS. This would also link the Program to other major IGBP projects such as the Global Land Project. Some particularly large projects might seek endorsement from DIVERSITAS as this leads to later invitations to synthesis workshops that would then feature BIOTA research at global scale. Apparently,

DIVERSITAS plans to open an office in Brasilia in the near future, but BIOTA scientists have not yet been involved in this development.

12. Such international collaboration can later form the basis for international grant applications to support such collaborations, e.g. with the EU-programs for international collaborations. These programs strongly focus on environment and health, and thus could match quite well with the objectives of BIOTA.
13. Internationalization should be a major goal. Making the data available to the international scientific community will also result in more studies by other researcher world over, and thus increase the value of the efforts already made. The BIOTA program, through its speciesLink database is an excellent place to provide links to many (currently 41) collections in the State of São Paulo to the GBIF network once Brazil becomes a member of GBIF.

Recommendations

- i. *We suggest that the Coordenação BIOTA begin to rotate members by having at least two current members rotate out and two new ones rotate in, and that this process take place either annually or biannually.*
- ii. *It is important that a matrix be developed by Coordenação BIOTA that would serve as a better way to organize the projects cross-cutting themes. Some could maintain the current thematic order but also provide a richer and more problem-focus that cuts across the current thematic: e.g. sustainable development, modeling, evolution & ecology, conservation, etc.*
- iii. *We recommend that FAPESP leadership work together with universities which receive BIOTA funding, and with the Coordenação BIOTA to develop a means of ensuring that universities begin to make matching contributions to FAPESP/BIOTA grants by hiring key personnel that would provide BIOTA with the means of bringing these disparate projects together and ensure that BIOTA scientists interact with each other and with other areas of science. This may be somewhat akin the Science and Technology Centers of the NSF.*
- iv. *We recommend that BIOTA seek out DIVERSITAS scientific leaders and other international organizations to seek collaborations with them.*

Data Basing and Infrastructure

14. The databases being used by the BIOTA Program are world class and have set a standard for dealing with biodiversity information management. Data cleaning and quality control tools that have been developed by CRIA and that are being used by the SinBiota and speciesLink databases are now being adapted for use by the Global Biodiversity Information Facility, and have led to CRIA being included in a major multi-institutional grant through the Gordon and Betty Moore Foundation to develop tools for georeferencing biodiversity information.
15. It is essential that the long-term funding of these infrastructure databases such as the SinBiota, SpeciesLink, the new BIOprospecTA as well as the e-journal, *Biota Neotropica*, be considered and acted upon in the coming years. These infrastructures are core to the continuance and continued success of the program and are relied upon by all the projects. It is unproductive to develop such databases and then not to provide funding for the continued maintenance and development as well as the open access, long-term maintenance, archiving and support for the very valuable resource

held therein. The data are a major asset of any program such as this, and like all assets require regular maintenance if that asset is to be preserved. The National Science Foundation in the USA is attempting to address this matter and has recently produced a paper on this subject. The Commission on Data for Science and Technology (CODATA) (as part of World Summit on the Information Society), the International Council for Science (ICSU) and the OECD are also examining this issue and issues of access to scientific information and the long-term archiving of scientific data and have recently published papers on these subjects. We refer FAPESP to these documents:

- a. NSF (Sep. 2005). Long-Lived Digital Data Collections: Enabling Research and Education in the 21st Century. (National Science Board).
<<http://www.nsf.gov/pubs/2005/nsb0540/nsb0540.pdf>>
 - b. ICSU (2004). *Priority Area Assessment on Scientific Data and Information*. "Scientific Data and Information". Report of the CSPR Assessment Panel. December, 2004
<http://www.icsu.org/Gestion/img/ICSU_DOC_DOWNLOAD/551_DD_FILE_PAA_Data_and_Information.pdf>
 - c. CODATA (Nov. 2005). Global Project seeks to promote access to science. *Science and Development Network* (with links to several documents)
<<http://www.scidev.net/content/news/eng/global-project-seeks-to-promote-access-to-science.cfm>>
 - d. OECD (2004). Science, Technology and Innovation for the 21st Century. Meeting of the OECD Committee for Scientific and Technological Policy at Ministerial Level, 20-30 January 2004. Final Communiqué.
<http://www.oecd.org/document/0,2340,en_2649_34487_25998799_1_1_1_1,00.html>.
16. CRIA has managed and developed these tools and has become a well-respected organization internationally and has been able to attract international funding for a number of its initiatives.
17. In spite of its small number of staff and limited budget, CRIA has been able to achieve much over the past 3 years since separating from BDT. The databases are well managed, use open-source software, are efficiently designed and managed and have user-friendly interfaces. Virtually all projects mentioned the value of the databases to their projects with many commenting on the professionalism with which they were run. Already CRIA maintains a back up or mirror copy of the BIOTA data currently held only at CRIA at the University of Campinas. Perhaps this arrangement needs to be formalized with FAPESP with a Memorandum of Understanding if such is not already in place. This would of course also imply that University would be expected to assist CRIA and to be responsible for the maintenance of the mirror copy.

SinBiota

18. Entering data into SinBiota needs to be made a continuing part of the Biota culture and it is important that the new projects are well aware of this. It would be ideal if there were a map of the geographic boundaries of all projects on SinBiota: (a) to help new projects to quickly find out what projects are in their area, and (b) to be part of justification within project submission. Similarly this could be done with the taxa covered. It is pleasing to the committee that comprehensive on-line usage statistics are now made available from the SinBiota and other projects (<http://sinbiota.cria.org.br/indicadores>). In order to maintain this important data base, as well as CRIA, it may be desirable to have FAPESP take, say 2% or some appropriate amount, of each project's budget up-front and set it aside for the BIOTA Coordenação to ensure continuing support for CRIA and SinBiota, rather than rely on

voluntary contributions as at present. There is too much pressure on individual projects to allocate all their funds to research, which hurts a key resource that all benefit from.

19. As mentioned in the 4th SAC Report, one area of increasing concern is the ability to store information about absences. Some of the better modelling software requires absence information to accurately predict likely occurrences. However, very few databases are able to store this type of information. At least one project mentioned that they were beginning to collect absence information and SinBiota may need further development to cater for them.

SpeciesLink

20. SpeciesLink has expanded greatly since the last evaluation, moving from 12 linked databases to now having 41, with 40 of those in the State of São Paulo. The system is now linking to over 720,000 specimens from museum and herbarium collections. This means that centuries of historic data can be integrated with new data being generated by the BIOTA programs.
21. Recent exciting developments include the incorporation of innovative data cleaning tools into the speciesLink database, and these are beginning to prove a major boon to institutions in being able to drastically improve the quality of biodiversity information in the State's databases. These data cleaning tools have recently received recognition internationally, and lead to collaboration between GBIF (Global Biodiversity Information Facility) and CRIA in developing more universal tools for use by GBIF on its data portal.
22. Participants in many of the Biota projects identified BIOTA informatics initiatives as being core to the whole program. A number of people stressed the necessity for them to continue and to be funded in a core way to ensure their continuity. Many believed, that without this core infrastructure, the program would have difficulty in being able to continue as an effective program
23. The incorporation of the data through linked systems such as SinBiota and speciesLink will allow for the development of integrated conservation studies and allow for robust assessment of conservation priorities. Other countries have shown, that without such databases, conservation assessment is a much more difficult (if not impossible) process to achieve.
24. The informatics projects have now accumulated a significant amount of data and information, and this is likely to increase many-fold as new projects come on line and existing projects are completed. Consideration now needs to be given to the long-term storage and archiving of this information. See papers cited earlier under Paragraph 15.

BIOprospecTA

25. The Bioprospecting database is in a first stage of development after extensive consultation with the groups working in the field. A clear structure is devised in which activities of extracts, fractions, and pure compounds can be introduced to the database. Also DNA data can be introduced. The database seems to have been developed, however, without reference to other databases that have been built elsewhere. This includes one in Australia. The Australian Government recently called for submissions on its National Collaborative Research Infrastructure. One

submission proposed development of a National Compound Library and Screening Network. The aim of the NCLSN is

The proposed National Compound Library and Screening Network (NCLSN) is designed to underpin and facilitate Australian research efforts to identify lead compounds that could be developed into a marketable pharmaceutical, veterinary or agrichemical product. The ultimate goal is to bring an innovative, totally home-grown product to the international market through existing efforts and the NCLSN.

This proposal would seem to be similar to what is being proposed and developed here, and there may be benefits in collaborating with them to develop a consistent approach. The report can be found on the Internet at www.dest.gov.au/sectors/research_sector/policies_issues_reviews/key_issues/ncris/documents/n13_rtf.htm.

26. There are a number of areas that appear to be missing. These include:
- A link to the organism (plant, animal, etc.), along with the part of the organism (leaf, bark, stem, root, etc.) that the extract has arisen from. We believe that this is one of the most important links for such a database to have – a link to a voucher specimen in a herbarium or museum (which may only be institution and institution id as a minimum) so that identifications can be confirmed.
 - Traditional knowledge about uses of organisms. An important source for information in searching for novel lead compounds for drug development is traditional knowledge. Such information is already available and is being collected, but in the present project it is not centralized into one database. Such a database would be very useful for bioprospecting, and could eventually serve as a source of income for indigenous people. Clear rules for the use of traditional knowledge should be formulated, to avoid any ambiguity concerning possible biopiracy.
- Some other missing areas could be achieved by linking to existing databases such as:
- Proteins;
 - for pure compounds, data on physical characteristics, 2D and 3D structures;
 - known biological activities for known compounds.
27. A direct link should be made with the SinBIOTA database for the collection details and other external links should be considered (e.g. to the Dictionary of Natural Products). This will avoid large investment in time for completing data sheets. For biological activities from literature a structured list of acceptable keywords should be provided to avoid difficulties in searching the database. The same keywords should be applied for indexing test systems used.
28. To create a virtual library of extracts, fractions and pure compounds, a system with barcodes for all tested materials should be considered for ease of back tracking these to the storages of the partners. The NCI and Astra-Zeneca bioprospecting projects could serve as examples. The DNA data may go out of hand with the rapid increase of the speed of cloning genes. What is the added value of DNA data in the database compared with existing international databases with all sequences? Again a link to such databases would be the preferred way, as any DNA sequence found has to be introduced in the international database anyway.

29. Long-term access conditions for the database are not clear. For example, Pharmaceutical companies might be willing to pay for access. Open access on the other hand, would affect patents rights of any interesting activity found.

Biota Neotropica

30. The *Biota Neotropica* e-journal has become not only a major resource of the Biota program but has expanded well beyond to become a major National resource. Recommendations made in the last report about the inclusion of special editions have been realized with Vol. 5.1a on Spiders, and the editorial board expanded to include non São Paulo members. The impact is already excellent and nearly 70% of submissions and publications are now from non-BIOTA researchers.
31. Now that *Biota Neotropica* journal has reached its fifth anniversary, the Editorial board is able to apply for the journal to receive an Impact Rating. We understand that this has now been done and if rated, the journal's value in providing a vehicle for BIOTA publications will be increased.
32. We feel that the Journal could be made even better by:
 - Applying open access protocols
 - Adopting on-line submission and review by using technologies such as the Open Journal System (OJS). See for example the Journal of Biodiversity Informatics (<http://jbi.nhm.ku.edu/index.php>).

Collection Infrastructure

33. Within the State of São Paulo there are a number of special collections that require immediate attention. These include, but are not limited to the pollinating bee-collection of J.M. Camargo (USP-Ribeirão-Preto) and the bird-song collection of J. Veillard (UNICAMP). These are both unique resources. For example, the bird-song collection contains the only recordings of species that have gone extinct in São Paulo State and in other parts of Brazil and includes around 25,000 magnetic tapes that urgently need digitizing before they deteriorate beyond repair. For a variety of reasons, proposals that have been submitted to curate, preserve and digitise these collections have not met with good reception in the reviewer community. We urge a broader view and that FAPESP consider positively the attempts to protect these threatened resources before unique and critical information is lost.
34. In addition, the new BIOprospecTA subprogram is going to require a number of laboratories that will be expensive to maintain over the long-term. Long-term funding will need to be found for the continued maintenance and operation of these laboratories. This may be one of the issues that could be addressed through University co-funding.
35. As mentioned in earlier reports, the biodiversity research resources as well as digitised collections are in the national interest as well as in the interest for the State of São Paulo. It may be possible for FAPESP to seek a partnership with the national government to provide long-term funding or to seek international funding (e.g. through GEF) to accomplish the goals.

Recommendations:

- v. *FAPESP consider how funding can be provided for the long-term maintenance of databases and the Biota infrastructure.*

- vi. *That FAPESP set aside, up front, 2% or some appropriate amount of each project's budget for CRIA for maintenance of SinBiota and speciesLink to ensure that there is no lack of resources to Coordenação BIOTA to maintain the databases and ensure their continued development. In exchange for this security of funding, it is reasonable to expect CRIA to back up all these data at one of the BIOTA partner institutions to ensure its security under worst case scenarios.*
- vii. *The BIOprospecTA database will be very important for future industrial development of promising products. It is recommended that after the first phase of designing the database the desirable external links are discussed, as well as who will have access to the data.*
- viii. *We recommend that those responsible for the BIOprospecTA database consider collaboration with Griffith University in Australia with the aim of developing a consistent approach for the development of compounds databases in the two countries.*
- ix. *Biota Neotropica be improved through updating to allow for on-line submission and refereeing of articles and to introduce open access protocols.*
- x. *FAPESP develop, and initiate a long-term strategy and funding program, to support the physical facilities (collection facilities and laboratories), digitization, and additional technical personnel to protect biodiversity collections in the State of São Paulo for perpetuity and to bring their crucial information on line. This strategy should be formulated with leaders from the collections community, in collaboration with FAPESP, through occasional calls for proposals to maintain research collections—very much like NSF does on a regular basis, outside the normal research grant competitions*
- xi. *Attempts should be made to enjoin the federal government as a partner for long term funding of collections facilities, personnel and digitization proposals and of chemical laboratories.*
- xii. *Consideration be given to developing and/or expanding a 'software links' site on the SinBiota website for linking to appropriate museum/herbarium databasing software, multimedia software, computer-assisted key generation software, data standards, etc.*

Human Dimensions, Conservation and Climate Change

Climate Change, Land Use Change and Biodiversity

- 36. Climate change is a new program being developed under FAPESP and it is indeed a very important program. Climate change in a globally warming world is a certainty and predicting what those impacts may be on environment and society must be a priority.
- 37. One of the greatest impacts of climate change will be on the spatial distribution of the earth's ecosystems and its biota. It is necessary, therefore, that this new program develop effective mechanisms to interact with BIOTA, as this will benefit both programs. This need not be burdensome or costly. Minimally, the Coordinators of the two programs should meet regularly to discuss the portfolio of projects. There should be some effort made to organize joint workshops and meetings that bring at least part of these two research communities together. Both programs may also want

to consider having some projects that address the Climate Change Dimensions of Biodiversity as a way of having on-the-ground projects that deal with what are, up to now, different communities which rarely interact. This interaction occurs internationally under the umbrella of the International Geosphere Biosphere Program, and there is no reason why FAPESP cannot serve a similar role, as it funds both.

38. One obvious project that could be encouraged by the Coordinators of both programs and by FAPESP, is one on modeling climate change and the impact of different scenarios on the spatial and temporal distribution of a range of species present in São Paulo and the Neotropics. Associated with this might be focussed attention to land use change as an intermediary in these interactions between climate and biodiversity. Land use is the most important human-driven activity affecting the earth's ecosystems, and they are likely to change in spatial and temporal occurrence under the combined impact of land use change and climate change. For this reason, a project examining how land use change is affecting ecosystems and biodiversity across the state of São Paulo and adjacent areas, under a range of climate change scenarios, and the impact on biodiversity would be scientifically ground-breaking and an important input into future conservation and land use decisions.

Human Dimensions of Biodiversity and Conservation

39. Over the past 6 years, BIOTA has assembled a rich set of accessible collections based on both new field work and on existing collections that had not previously been made available in databases such as SinBiota. The taxonomic work is impressive and BIOTA is now well positioned to assist the research and conservation community with the baseline work that has been done to date and that will continue to be done. It is now the time to begin to encourage new grant applications, and also to complement on-going work that begins to address the human dimensions of biodiversity and conservation.
40. Human activities are the greatest force acting upon the environment. They are at least as great as climate change, and already account for the greatest impacts on ecosystems, the cycle of nutrients, and the survival of species through habitat alteration. If the goals of BIOTA are to be achieved—especially its very first goal (to understand the processes that maintain biodiversity or lead to the loss of biodiversity)—it is urgent that BIOTA projects begin to address how human activities impact the biodiversity being studied and documented.
41. Human activities bring about changes in the environment through agriculture, logging, urban development, habitat fragmentation, creating Unidades de Conservação, use of fire, road building, promotion of recreation and tourism in natural areas, fishing and hunting, changes in enforcement of environmental regulations, etc. All these forms of impacts and their spatial distribution can be made a part of existing projects as a way of ensuring not only that the documented biodiversity is known. In addition, the urgency of the threat to biodiversity, and the best ways to conserve it, needs to be part of projects, along with how local people interacting with the biodiversity in question are protecting or threatening the biodiversity.
42. While humans threaten biodiversity through their many activities, they are also the only ones who can make decisions to reduce those threats and to positively conserve it. Understanding the motivations, the traditional knowledge, the social organization and economy of families and communities in conservation areas, and what forces lead them to conserve or threaten biodiversity needs to be addressed. For example, what motivates fishermen along the coast of São Paulo to have stable fishing spots over

decades? Under what conditions might some communities of fishers decide to abandon this stable relation to other fishers and start poaching on others' territories and drive down the fish population? Under what conditions do communities abandon the traditional use of fire as a management tool in their land use? How do shifts in commodities cultivated by the agricultural sector affect biodiversity in terrestrial and aquatic environments as a result of shifts in the movement of water and nutrients across the land surface, the amount of fertilizer use, and the intensity of cultivation?

43. One interesting step for existing projects to begin to address this urgent need to examine the human dimensions of biodiversity is by looking at the areas around conservation units where a lot of the current work of BIOTA is concentrated. By taking on the surrounding landscape, often with a more anthropic character, it will be possible to examine fundamental questions of interest to biodiversity such as the difference in biodiversity within and outside UCs, the role of adjacent landscapes (such as agricultural fields, tree plantations, pastures, cities) on the population ecology of organisms of interest. It is likely that many, but by no means all, species will make use of areas within and outside UCs to ensure their survival and the role of these varied environments on species survival and change will inform conservation efforts.

Recommendations:

- xiii. *FAPESP leadership should bring together the Coordinators of BIOTA and the new Climate Change Program to discuss how their respective programs might maintain regular communication channels.*
- xiv. *Both program coordinators should encourage grant proposals that address the impacts of climate change and land use change on biodiversity.*
- xv. *FAPESP solicit Biota projects to protect and to digitize special collections of biodiversity research, such as the pollinating-bee and song-bird collections. FAPESP and the Coordenação Biota must recognize the unique and critical value of these and some other collections and overrule conflict in the reviewer community.*
- xvi. *Coordenação BIOTA encourage scientists currently funded to address threats to the species of interest, expand the study sites to encompass adjacent areas to UCs, and to include human dimensions in their projects.*
- xvii. *Coordenação BIOTA encourage the scientific community to prepare new grant proposals that focus on human dimensions of biodiversity and to develop these proposals with a close collaboration of biological scientists and social scientists with the competence to address, in a sophisticated manner, these human dimension questions.*
- xviii. *Coordenação BIOTA encourage the development of at least one major thematic grant on the human dimensions of biodiversity that would focus on the optimal use of existing biodiversity work and its human dimensions.*
- xix. *Coordenação BIOTA ensure that in the planning of the next symposium, groups be asked to address what they are doing to diagnose the threat to species studied, and the efforts of each group at addressing the conservation of those species.*

- xx. *the Coordenação Biota should be proactive with project solicitations and project design to stimulate more integrative research, cross-cutting themes, and important new areas such as human dimensions of biodiversity and conservation, taking full advantage of the achievements to date in BIOTA.*

Bioprospecting

44. There are now twelve projects concerning plants, micro-organisms and insects that fit under the theme of Bioprospecting. Of the groups active in these BIOTA projects some are specialized in phytochemistry and microbiology, others on biological activity.
45. Groups working in BIOprospecTA are of high international standard. They have already isolated numerous phytochemical compounds, some of which have interesting activities. They have published extensively in international peer reviewed journals with high impact factors for the field. Some semi-synthetic compounds with interesting activities were recently patented.
46. The BIOTA project has built up a platform that has led to extensive information being available about biodiversity in the state. These data are of great value for all kinds of future applications, from basic science to conservation and industrial. The development of the BIOprospecTA Subprogram provides an ideal opportunity for examining new industrial applications. One outcome of this is that single disciplines involved in collecting the data will be benefiting from the data, and new possibilities for interdisciplinary studies are possible. An important field in this context is the interactions between the various organisms – the (chemical) ecology. As well as being of interest as basic science, they also have value for conservation (interdependence of organisms in an ecosystem) and practical applications in novel areas such as crop protection, through exploration for novel biopesticides.
47. A future area for bioprospecting is on the level of genes and proteins. Genes that can be used in metabolic engineering of, for example, plants to make them more pest or disease resistant, to increase the yield of desired compounds, or to make novel compounds by overexpressing genes (randomly) cloned from sources such as plants, micro-organisms and soil samples (combinatorial chemistry). Proteins can also be used for all kind of purposes, from large-scale industrial applications (e.g. cellulose or lignin degrading enzymes). First steps in this direction are being made with some excellent biosynthetic studies aimed at the isolation of enzymes involved in the biosynthesis of bioactive compounds. The development of this technology is very useful.
48. Plant biotechnology is also part of the Program, and an important option in cases where the plant yielding interesting compounds, is rare. Plant cell suspension cultures offer the possibility of a completely controlled production of compounds which otherwise could not be produced in sufficient amounts (as has been shown before with the example of paclitaxel).
49. Several of the BIOTA project coordinators outside of BIOprospecTA suggested interesting sources for bioprospecting (e.g. marine and micro-organisms). The need for natural products chemistry was also apparent in case of analysis of toxins from algae that represent a health threat where blooming of such algae may contaminate seafood.
50. One of the new projects concerns the molecular genetic characterization of the variability of some threatened economic wild medicinal plant species. This project

also includes work on phytochemistry, aimed at identification of possible chemotypes and relates this to genetic information. This project shows nicely how molecular and chemical tools can be used for selecting plants for inclusion in a germplasma bank.

51. Further capacity building in the field of (plant) biotechnology, plant molecular biology and metabolic engineering for developing bio technological production of pharmaceuticals will be useful.

Recommendations

a. Organisation

- xxi. *The methodologies adopted by the various projects should allow for sample throughput of the various bioassays in order to decide which are suitable for primary screening of all extracts, and which should be only suited for selected extracts or compounds. Eventually this may lead to a better, more efficient, utilization of the available capacity.*
- xxii. *The possibility of commercialization, via a start-up company or foundation, of the products and concepts, including the extracts and compounds library, should be considered.*
- xxiii. *Effective commercialisation requires at least a professional business developer that can contact potential customers, and who can take care of contract negotiations needed and help guide the process of IP-protection. This should be coordinated project wide and perhaps by FAPESP itself through the recommended development of a Science and Technology Center.*

b. Future activities

- xxiv. *Project coordinators should consider developing an inventory of the available bioassays (e.g. molecular targets, in-vitro cell lines, in-vivo pharmacology), and based on this inventory, discuss other activities that would be of interest from a pharmaceutical point of view. It could then be decided if these should be implemented in the coming years, and whether groups could be found that have the necessary expertise for doing these assays.*
- xxv. *Areas other than medicines should also be considered, for example, cosmetics, biopesticides, flavors, fragrances and dyes. One of the new projects is a promising first step in this direction.*
- xxvi. *Studies in other BIOTA projects (such as on old varieties of food plants such as yam and sweet potato) could profit from the phytochemical knowledge in BIOTA for the analysis of the level of health promoting compounds such as carotenoids and anthocyanins. High levels of such compounds might be of interest for the health of the local people, and the plants might be of interest for breeding new varieties.*
- xxvii. *The Coordenação Biota should ensure that all projects collect their material according the protocols of BIOTA, including incorporation of data into SinBiota, so the collection remains traceable.*
- xxviii. *We suggest that some new projects should be instituted that cover issues of Chemical Ecology.*

Other Issues

Gaps in coverage

52. The following gaps were identified and should be included over time:
 - a) soil organisms (e.g., bacteria, nematodes, earthworms, crustacea, soil arthropods)
 - b) fungi
 - c) Arthropod groups: Coleoptera, Homoptera and Hemiptera
 - d) terrestrial Mollusca
 - e) secondary, regenerating and planted forests
 - f) marine organisms and ecosystems >45 m
 - g) aquatic micro-organisms
 - h) Use of marine organisms and micro-organisms for bioprospecting.

Evaluation Committee

53. The Scientific Advisory Committee makes several suggestions for future evaluations to better carry out its work.
54. An early SAC made a recommendation that the Committee be provided with an office for two days following the evaluation meetings to allow the SAC to write up its report. This was done at the following meetings, but was not provided for with this evaluation. Not having such a provision has made it extremely difficult for the SAC to work together as a team to write up its report, and prepare for discussions with the Director FAPESP.
55. With the growth of BIOTA and the introduction of BIOprospecTA there is need to rethink the evaluation of the program. The SAC committee believes that there is sufficient difference between the core BIOTA and the BIOprospecTA projects that it is difficult for the same evaluators to adequately evaluate both programs. For this reason we suggest having different reviewers, but that the evaluations be held either concurrently, or adjacent so that the two committees can interact in the writing of the reports. This would give the two communities an opportunity to interact during the associated symposia.
56. The Committee would also urge the Coordenação BIOTA to better prepare the SAC members for the meeting by providing (at least one month before the meeting):
 - guidelines on what are the tasks to be achieved by the committee
 - a one to two page summary of projects with objectives, timing of the project, results, progress made, difficulties encountered, statistics on publications including rejection rates of the journals published in, number of citations in citation index where appropriate, number of records added to SinBiota, etc.
 - a proposed timetable should asking for approval of the agenda and asking for any suggested changes.
 - The timetable should include scheduled times, both at the beginning of the evaluation and at its end, for the SA Committee to meet with the program coordinators.
 - Links to relevant web sites (Biota, Biota Neotropica, BIOprospecTA, FAPESP, SinBIOTA etc.), including to the previous SAC reports.
57. Upon arrival the SAC should be scheduled to meet with all members of the Coordenação BIOTA to discuss the schedule for the meetings, review priorities for the review, look at the facilities arranged for the SAC to do its work, and make adjustments in the timetable and in meetings with scientists.

58. A final, wrap up session should be scheduled between the SAC and the Coordenação BIOTA at the end of the meetings with projects to allow the SAC to get clarification of points, to ask questions, and to provide a final opportunity for the Coordinators to share information necessary for the review, before undertaking their two day write up period. We suggest that it be considered that this write up take place at one of the universities with a substantial portfolio of BIOTA projects, or in São Paulo city, rather than at an isolated hotel facility. We further suggest that Coordenação BIOTA take a closer look at the hotel facilities for the symposium and evaluation not just at the rooms and prices, but at the infrastructure for internet, availability of fast printers, etc. as we found the facility this year to make it hard at times for the SAC to do its work efficiently. The SAC also recommends that presentations made at the Evaluation meeting be kept to about 15 minutes, in line with international standards. The longer presentations could continue to be made at the associated seminar sessions which we recommend be organised along the thematic lines used for the evaluation in 2005 and be attended by both researchers and students.
59. Not all evaluators should be required to attend the symposium sessions, as it is often hard for evaluators to spend a full week away from their teaching and other activities at the time of the evaluation meetings. In saying that, however, we believe that attendance at the seminars should be optional and encouraged, and that at least one of the evaluators should agree to attend the seminars where possible. . It is important the SAC have the opportunity for a scheduled long session with students in BIOTA projects to allow for a formal opportunity to exchange ideas, and to get a better sense of how the students feel about the current projects. A minimum two hour formal session is suggested be scheduled at the next SAC evaluation.

Biota International Publications and Young Investigators

60. As mentioned in the 4th SAC Report, an area of continuing concern is the issue of bringing high quality works to publication – monographs with lots of coloured illustrations, education materials, etc. The Biota program requires coordination of funding and support for the increasing number of high quality publications. It is extremely difficult, and usually not productive, for individual projects to have to seek this type of support for their publications. FAPESP, with its connections to industry, is probably in the best position to seek some form of sponsorship for the totality of publications that arise from the Project. This could be done through FAPESP itself, or through the hiring of an outside agent somewhat akin to how sporting organizations obtain sponsorship for sporting teams. At present individual book publication projects seek such sponsorship, there is no reason why this type of corporate sponsorship would not benefit BIOTA as a whole. Again, such a position could be part of a Science and Technology Center.
61. It is not uncommon for major research centres to have a professional or technical editor as part of their staff, particularly in those settings where the team has members whose native language varies. In this case, the very large BIOTA community would benefit immensely, and substantially raise its international profile, by having a technical editor available to researchers to ensure that the quality of English language submissions is high, thereby raising the acceptance rate of manuscripts and thus the international impact of BIOTA research.

Young Investigators

62. The coupling of the Young Investigator Award with BIOTA projects has been extraordinarily beneficial and should be developed further. We have little doubt that the future employability of these researchers will be greatly enhanced from the experiences provided from the combination of these programs. We encourage increasing the number of Young Investigator Awards with BIOTA projects to increase the number of highly trained young investigators that will then enter the university ranks. We also urge the Program to publicise these awards more widely, and encourage more young scientists to apply. The large investment of FAPESP in student masters and doctoral fellowships should be followed through with opportunities for postdocs, Young Investigator Awards and faculty positions to advance science and avoid the loss of this investment.

Legal Instruments

63. Brazil has many valuable natural resources but is not currently able to benefit from the development of those resources due to lack of adequate patent laws that allow the patenting of new discoveries, compounds and proteins.
64. In addition, current conservation laws are restricting scientific research through the difficulties in scientists being able to collect specimens in many areas. Indeed, a search of the speciesLink databases shows that very few collections have been made in many areas over the past two years. This lack of being able to collect is likely to restrict conservation efforts through the lack of data on which to base robust decisions.
65. We suggest to FAPESP that they help alleviate this situation by lobbying government to free up laws that currently restrict scientific activities, and for the implementation of laws that allow for the patenting of novel products that are discovered and developed in Brazil. It is only in this way that the benefits of Brazil's science will flow back to the country.

Recommendations

- xxix. *It is not uncommon for major research centers to have a professional or technical editor. The Biota community would benefit immensely, and raise its international profile, by having a technical editor available to researchers to ensure that the quality of English language submissions is high, thereby raising the acceptance rate of manuscripts and the international impact of Biota research.*
- xxx. *FAPESP lobby the Brazilian Government to make sure that new laws on the environment do not restrict the very good biological research that is occurring in Brazil, and that laws on Patent protection be enacted to ensure that the benefits of scientific discoveries in Brazil, in the way of active compounds, can be protected.*
- xxxi. *FAPESP increase the number of Young Investigators posts and allow them to be linked with Biota Projects.*

Conclusions

66. The evaluation committee was impressed with the progress made by BIOTA as a scientific program. Several projects are of world-class quality that should allow scientists to become global leaders in the study of biodiversity. We urge FAPESP to continue to support this outstanding research program, and if possible expand it further given its quality, and the urgency of the issues it addresses. The program, moreover, is doing an outstanding job of education and training of a very large cohort of students at undergraduate, graduate, and postdoctoral levels—and through the Young Investigator Program beginning to also impact university faculties. The new BIOprospecTA program is likely to have a similar impact on the private sector particularly the drug and cosmetic industries.
67. The BIOTA program is at a key stage of its development, now with a large portfolio of 74 projects. This will require creative allocation of resources by FAPESP and projects to integrative management of databases, promotion of international publication, and outreach to the public to ensure maximum impact scientifically and educationally—and lead to the protection of biodiversity in the State. This means that resources need to be allocated to maintaining full functionality of the databases that are the foundation for all scientists and the public; assistance to researchers with publishing in English language publications for maximum international impact; and greater attention to the human dimensions of biodiversity by research projects and by associated efforts at conservation of biodiversity.
68. Further, universities that are the home of many BIOTA projects should provide matching funds that allow BIOTA to hire key personnel not routinely allowed by FAPESP project regulations. This will assist all projects in achieving greater integration, greater institutionalization, and increase their international projection. Some of these key personnel should include minimally a technical editor for publications in major international English language journals, a Science Manager to coordinate day to day the interaction of projects at the many BIOTA partner institutions, some of the support for the web site maintenance and development, and staff positions to assist project scientists with management and budgetary issues that currently sap the time of scientists.
69. We thank FAPESP for the opportunity to evaluate the BIOTA program and the Coordenação Biota members for their help, candor and time, and the project leaders and participants for their openness and willingness to share their ideas.

Appendix: Previous Recommendations

70. Previous SA Committees have made a number of recommendations that have either not been acted upon, or which need further attention. The 5th SAC endorses those recommendations but does not wish to elaborate on them further here. We draw the attention of Coordenação Biota, FAPESP and the Biota community as a whole to those recommendations.

Recommendations for FAPESP

- xxxii. *FAPESP fund a full-time program co-ordinator to work within the Biota program to liaise with project leaders to secure the agreed set of target coordination goals. (See earlier proposals for a Science & Technology Center).*
- xxxiii. *Discretionary funds be made available each year to the Director for targeted repair, linkage and co-ordination actions. After discussion with Coordenação Biota and the Program Coordinator, up to 4 assistants could be placed by the Director in particular project centers. (See earlier proposals for a Science & Technology Center).*
- xxxiv. *Public-private partnerships, sponsorship and consultancy are considered for developing and outputting products in the area of Public Education and Outreach.*
- xxxv. *The Coordenação Biota and FAPESP increase national and international publicity to assure better visibility of Biota and enhance links with other biodiversity programs outside Brazil, in particular those that may result in matching funds for Biota or exchange with foreign scientists.*
- xxxvi. *FAPESP develop programs to train and hire technicians and students to aid in the digitization of collections information without penalizing their future education.*
- xxxvii. *The Coordenação Biota and FAPESP give strong consideration to establishing a new sub-program within Biota to support the infrastructural needs of the Biota Program. These infrastructural needs include collection facilities, database and informatic projects (including the personnel). These are the core of the Biota Program.*

Recommendations for Coordenação Biota

- xxxviii. *As more projects are added to the Biota Program it is critical to maintain a high level of integration among the projects and among the sites that are selected for study.*
- xxxix. *Institute a management training course of 1-2 weeks for Biota students that may include*
 - *Program management*
 - *Grant and report writing*
 - *Staff and contract management*
 - *Ethics*
 - *Legislative environment*
 - *Opportunities outside the academy*
 - *Legal frameworks (IP, patents, traditional rights, benefit sharing, etc.)*
- xl. *Coordenação Biota identify ‘young star performers’ and encourage them to take roles within the program and/or to make further applications to develop their research. (Being done, needs to be continued).*

- xli. *Implement workshops for graduate students, post-docs, young investigators and professors on topics such as statistical analysis of spatial patterns, bioinformatics, environmental modeling and conservation selection.*
- xlii. *Develop programs to allow post-docs, young investigators and professors to study with scientists, national or international, that have expertise needed for projects in the Biota Program (e.g., reserve selection with Dr. C. Margules in Australia).*
- xliii. *Grant support for additional projects within BIOTA for developing a master plan on ecotourism for São Paulo. This should include travel to other states and/or countries to learn more about their experiences and techniques, with the objective of developing improved ecotourism.*
- xliv. *Coordenação Biota encourage projects to adopt existing multimedia, character-based, and computer-assisted key generation software where appropriate rather than develop their own and that Coordenação Biota institute training courses and/or workshops on these for the information of project participants.*
- xlv. *Coordenação Biota and FAPESP consider either running a workshop on conservation/reserve priority setting with invited international participants, or supporting the placement of one or two researchers with appropriate specialists overseas for a period of time in order to learn appropriate methodologies.*

Recommendations for the Biota Research Community

- xlvi. *Through intensive field courses, develop the breadth of natural history knowledge among students or junior researchers. This could be accomplished with a program of rotation through different projects for short periods.*
- xlvii. *Each database include a clearly displayed version number or edition number and date.*
- xlviii. *There be collaboration with State and National Park administrations to develop intensive training courses for local natural history guides and to make use of student assistantships to improve trail systems that maximize access to both characteristic and unusual habitats or organisms, especially old-growth forest. (Some projects are doing this, but needs more attention).*
- xlix. *Consideration be given to the inclusion of some form of completeness indicator or indicator of degree of certainty on records within the SinBiota database and which feeds into caveats on the maps.*