



Museum Visitor Studies, Evaluation & Audience Research

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Huntington Botanical Gardens

Summative Evaluation

Conservatory for Botanical Science

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SUMMARY AND DISCUSSION

This report presents the findings of a summative evaluation of the Conservatory for Botanical Science, conducted by Randi Korn & Associates, Inc. (RK&A), for the Huntington Botanical Gardens in San Marino, California. The Conservatory exhibits and this evaluation were funded by the National Science Foundation.

Data collection took place in December 2005. The summative evaluation examined visitors' affective and cognitive experiences in the Conservatory, using exit interviews and focused observations and interviews at select exhibits.

Selected highlights of the study are included in this summary. Please consult the body of the report for a detailed account of the findings.

VISITOR EXPERIENCE

Visitors interviewed and observed had positive experiences in the Conservatory. Exit interviewees praised the Conservatory for being educational and enjoyable, complimenting the beautiful building, realistic habitats, exquisite plants, and interactive exhibits. When asked specifically about the exhibits, nearly all exit interviewees reported using them, and most noted that the exhibits had enhanced their experience and worked well for adults and children. The focused observations and interviews revealed similar positive findings. Adults and children spent similar amounts of time using the exhibits, meaning the exhibits engaged a range of ages—contrary to other RK&A studies in which children tended to be the ones who used science interactives (2004a, 2003a, 2005). Additionally, seven of the eight Conservatory exhibits examined in the evaluation held visitors' attention for one minute or longer—a higher dwell time than RK&A has found for many science interactives (2000, 2002, 2005). Moreover, none of the observed visitors misused any exhibits, suggesting that the exhibits were not only easy to use but were also engaging, as misuse can indicate boredom. The interviews corroborated the observations—interviewees at each of eight exhibits expressed positive opinions about that exhibit, praising the interesting topics featured and interactive activities offered. Most interviewees said the exhibits were intuitive to understand and use, offering a few suggestions for fine tuning the experiences (see the recommendations made for each exhibit in section “III. Principal Findings: Focused Observations and Interviews”).

Wayfinding was not an issue for visitors. Nearly all exit interviewees said they did not have difficulty finding their way around the Conservatory. While most enjoyed simply wandering the Conservatory, several thought the building featured an adequate number of directional signs and a few oriented themselves using the map or the model. Most likely, visitors learned the names of the Conservatory's sections by reading the signs/banner and map, as only one-third of exit interviewees used the model. Those who used the model found it helpful; however, they offered a few suggestions for improving it: making the model better represent the Conservatory by illustrating the plants and its other features, including a “you are here” graphic, and angling the model at a 45 degree angle to increase its visibility from a distance. Because the model serves a limited number of visitors at present, Huntington staff may consider creating a touchable model—

with raised letters and Braille—which would work for visitors who are blind and visually impaired as well as visitors who can see. Many such models are sculpted from metal or plastic, which would work well in the Conservatory’s humid conditions.

SCIENCE SKILLS

The exhibits were overwhelmingly successful in engaging visitors in science, a core goal of the Conservatory. Observed visitors displayed a median of four science-related behaviors at each exhibit. In addition, more than one-half of visitors were observed smelling, measuring, observing, reading text panels, analyzing, comparing, engaging in exhibit-related social interaction, and using tools. Most important, adults and children alike demonstrated science skills. That is, RK&A found no statistically significant differences in the behaviors of visitors by age or group composition (i.e., attending the Conservatory with or without children). There may be two reasons for this finding: too few children or families were represented in the sample and, as such, statistical differences did not emerge; or adults and children behaved similarly. The exit and focused interviews support the latter reason, as visitors of a range of ages talked about how much they enjoyed using real scientific tools, making observations, and using their senses to explore the plants. Moreover, two-thirds of exit interviewees said the Conservatory engaged them in science—giving concrete examples from the exhibits.

Similar to findings from the formative evaluations (2003b, 2003c, 2004b), interviewees said the exhibits involving taking measurements with real scientific tools were most compelling. Visitors spent the most time at How Sweet Is It?, followed by Roots and Nutrients, and Digesting Insects. These exhibits also emerged in the exit interviews as peak experiences. In contrast, visitors spent the least time at Parts of an *Amorphophallus* (median time of 31 seconds). While specific recommendations for this exhibit are provided in the body of the report, it is worth discussing one possible reason for the short holding time: visitors did not know how to interact with the plants. Few visitors compared the *Amorphophallus* plants or read the plant tags. Additionally, a few exit interviewees noted that they were unsure whether they could touch plants and suggested that the Conservatory make its policy explicit to visitors. As such, staff should consider providing visitors with tips on how to interact with the plants, such as making careful observations of similarities and differences (e.g., field notes could direct visitors to compare leaf size and shape) or, when applicable, touching the plants (e.g., to examine the difference between the two sides of the zebrina leaf).

VISITOR LEARNING

As noted earlier, both sets of interviewees described their experiences in the Conservatory as educational. Most exit interviewees understood that the Conservatory message was about the diversity of plants—although none used the term “diversity.” Rather, one-half said the Conservatory presented tropical plants and their environments from different parts of the world and one-quarter said the Conservatory showed characteristics of different kinds of plants. Similarly, most visitors interviewed at exhibits understood the intended messages of those exhibits. One reason the exhibits successfully conveyed content is that most visitors were observed reading

the informational text panels, in addition to the instructional ones—in contrast to RK&A findings from other science exhibits (2004a, 2005). For the Conservatory as a whole, the humidity changes were key clues in visitors’ realizing they were visiting different habitats with different plants.

While more than one-half of exit interviewees said they learned something new about plants, fewer said the Conservatory changed how they thought or felt about plants. This is not surprising considering nearly all exit interviewees said they had positive attitudes toward plants before visiting the Conservatory. It is also difficult to measure attitudinal change after one experience. One-third of interviewees said their Conservatory experience allowed them to gain new insights through experiencing new habitats, seeing new kinds of plants, and becoming more aware of the plants’ behaviors and characteristics. This group said, as a result, they had a heightened appreciation of and respect for plants. These aspects—imbedded in the environment and experiences the Conservatory offers—will likely promote similar feelings in other visitors, as they return in the months and years to come.

REFERENCES CITED

Randi Korn & Associates, Inc. 2000. “Visitor Experiences in Four Permanent Galleries at The Tech Museum of Innovation.” Unpublished manuscript. San Jose, CA: The Tech Museum of Innovation.

Randi Korn & Associates, Inc. 2002. “*Exploring Life on Earth* Summative Evaluation.” Unpublished manuscript. Milwaukee, WI: Milwaukee Public Museum.

Randi Korn & Associates, Inc. 2003a. “*Greater Yellowstone Adventure* Summative Evaluation.” Unpublished manuscript. Cody, WY: The Draper Museum of Natural History, Buffalo Bill Historical Center.

Randi Korn & Associates, Inc. 2003b. “Select Conservatory Exhibits Formative Evaluation Round One.” Unpublished manuscript. San Marino, CA: The Huntington Botanical Gardens.

Randi Korn & Associates, Inc. 2003c. “Select Conservatory Exhibits Formative Evaluation Round Two.” Unpublished manuscript. San Marino, CA: The Huntington Botanical Gardens.

Randi Korn & Associates, Inc. 2004a. “*Strange Matter* Summative Evaluation.” Unpublished manuscript. Pittsburgh, PA: Materials Research Society.

Randi Korn & Associates, Inc. 2004b. “Select Conservatory Exhibits Formative Evaluation Round Three.” Unpublished manuscript. San Marino, CA: The Huntington Botanical Gardens.

Randi Korn & Associates, Inc. 2005. “*NetPl@net* Summative Evaluation.” Unpublished manuscript. San Jose, CA: The Tech Museum of Innovation.

INTRODUCTION

This report presents the findings of a summative evaluation of the Conservatory for Botanical Science conducted by Randi Korn & Associates, Inc. (RK&A), for the Huntington Botanical Gardens in San Marino, California. The Conservatory exhibits and this evaluation were funded by the National Science Foundation.

Data collection took place in December 2005. The summative evaluation examined visitors' affective and cognitive experiences in the Conservatory. Specifically, the evaluation analyzed:

- Visitors' overall reaction to the experiences the Conservatory provided;
- Main messages and concepts visitors gleaned from the Conservatory as a whole, and from specific exhibits;
- Visitors' awareness of plant diversity and its value;
- Visitors' perception of the Conservatory's habitat organization and effectiveness of the orientation model;
- Visitors' ability to use and understand eight key exhibits;
- The degree to which the Conservatory achieved its goals and objectives, in particular how well it motivated families to use science skills with the botanical collections and exhibits.

METHODOLOGY

RK&A used two data collection strategies to assess visitors' experiences in the Conservatory: uncued exit interviews and focused observations and interviews at select exhibits.

Exit Interviews

Open-ended interviews encourage and motivate interviewees to describe their experiences, express their opinions and feelings, and share with the interviewer the meaning they constructed from an experience. Open-ended interviews produce data rich in information because interviewees talk about their experiences from a personal perspective.

Upon exiting the exhibition, visitors nine years old and older were eligible to be selected, following a continuous random sampling method, to answer several questions about their experiences. In accordance with this method, the data collector stationed him/herself at the Conservatory's main entrance, and intercepted the first eligible visitor to exit. If the visitor agreed to participate in the study, the data collector conducted the interview. When the interview was complete, the data collector thanked the participant and waited for the next eligible visitor.

The interview guide was intentionally open-ended to allow interviewees the freedom to discuss what they felt was meaningful (see Appendix A for the exit interview guide). RK&A conducted interviews in English and a bilingual graduate student trained by RK&A conducted interviews in Spanish and then translated them. All interviews were audio-recorded with participants' permission and transcribed to facilitate analysis.

Focused Observations and Interviews

Focused observations and interviews provide staff with an in-depth understanding of how visitors use specific exhibits, how they respond both cognitively and affectively to an exhibit's content and display techniques, and what they learn from an exhibit. Huntington staff selected eight exhibits for the focused observations and interviews: Helicopters, Flutterers, and Parachutes; Fragrant Flowers; Leaves are Full of Holes; Roots and Nutrients; How Sweet Is It?; Parts of an *Amorphophallus*; Digesting Insects; and Orchids That Look Like Insects.

RK&A followed an uncued testing strategy. Data collectors were stationed at one of eight exhibits and unobtrusively watched visitors as they used the exhibit, recording their behaviors on a standardized observation form (see Appendix B for the observation forms). After the visitors finished using the exhibit, the data collector asked them to participate in an interview (see Appendix A for the exhibit interview guide). Again, all interviews were audio-recorded with interviewees' permission and transcribed to facilitate analysis

DATA ANALYSIS

Qualitative Analysis

The interview data are qualitative, meaning that results are descriptive, following from the interviews' conversational nature. In analyzing the data, the evaluator studied responses for meaningful patterns, and, as patterns and trends emerged, grouped similar responses. To illustrate interviewees' thoughts and ideas as fully as possible, this report includes verbatim quotations (edited for clarity).

Quantitative Analysis

RK&A quantitatively analyzed the observational data. By collecting the observational data using a standardized form, RK&A could combine data from all eight exhibits and statistically analyze it as one large data set. The observational data were entered into a computer and analyzed statistically using SPSS for Windows, a statistical package for personal computers. Frequency distributions were calculated for all categorical variables (e.g., gender). To examine the relationship between two categorical variables (e.g., behavior and age group), cross-tabulation tables were computed to show the joint frequency distribution of the two variables, and the chi-square statistic (X^2) was used to test the significance of the relationship.

Summary statistics, including the mean (average), median (data point at which half the responses fall above and half fall below), and standard deviation (spread of scores: "±" in tables), were

calculated for the time data.¹ To compare the medians of two or more groups, non-parametric Mann-Whitney U or Kruskal-Wallis H tests were performed. The level of significance was set at 0.05 because of the moderate sample size. When the level of significance is set to $p = 0.05$, any relationship that exists at a probability (p -value) of ≤ 0.05 is termed “significant.” When a relationship has a p -value of 0.05, there is a 95 percent probability that the relationship being explored truly exists; that is, in 95 out of 100 cases, there would be a relationship between the two variables (e.g., gender and preferences for visiting). Conversely, there is a 5 percent probability that the relationship does not really exist; in other words, in 5 out of 100 cases, a relationship would appear by chance. Within the body of the report, only statistically significant results are discussed.

REPORTING METHOD

The data in this report are both qualitative and quantitative. Interview data are presented in narrative. The interviewer’s remarks appear in parentheses, and, for visitors, an asterisk (*) signifies the start of a different speaker’s comments. Trends and themes in the interview data are also presented from most- to least-frequently occurring.

For the quantitative data, tables and graphs display the information. Percentages within tables may not always equal 100 owing to rounding. The findings within each topic are presented in descending order, starting with the most frequently occurring.

Findings in each report are presented in three main sections:

- I. Exit Interviews
- II. Summary Observations
- III. Focused Observations and Interviews

¹ For the most part, medians rather than means are reported in this document because, as is typical, the number of components used and the time spent by visitors were distributed unevenly across the range. For example, whereas most visitors spent a relatively brief time with exhibition components, a few spent an unusually long time. When the distribution of scores is extremely asymmetrical (i.e., “lopsided”), the mean is strongly affected by the extreme scores and, consequently, falls further away from the distribution’s central area. In such cases, the median is the preferred measurement because it is not sensitive to the values of scores above and below it—only to the number of such scores.

I. PRINCIPAL FINDINGS: EXIT INTERVIEWS

RK&A and two graduate students, including one who was bilingual in English and Spanish, conducted open-ended interviews with visitors immediately as they exited the Conservatory to gather information about visitors' perceptions, opinions, and understanding of the Conservatory. Evaluators conducted 82 interviews—78 in English and four in Spanish—with 151 visitors. Of 116 visitor groups approached, 34 refused to participate, making the refusal rate 29 percent, which is a typical refusal rate for museum studies.

The sample was comprised of 93 adults and seven children. More than one-half of interviewees were female (53 percent) and less than one-half were male (47 percent). Adults ranged in age from 18 to 90 years, with an average age of 49 years. Children ranged in age from 9 to 17 years, with an average age of 12 years.

About three-fourths of interviewees (76 percent) had visited the Huntington before the day of the interview, while one-quarter (24 percent) were visiting for the first time. Of the repeat visitors, nearly one-half (45 percent) had visited the Huntington three or more times in the previous 12 months.

RESPONSES TO THE CONSERVATORY

Overall Opinion

All the interviewees expressed positive opinions about the Conservatory. Many praised the Conservatory as a unique experience; as one interviewee stated, "It's fantastic, quite lovely and different." Several described it as "informative and interesting," appreciating its educational aspects. In contrast, several others had slightly more tempered opinions. Three enjoyed the Conservatory but noted that the plantings were "a bit sparse." They did acknowledge the recent opening of the Conservatory and anticipated that the plants would become more robust over time. A few others liked seeing the tropical plants but had difficulty dealing with the Conservatory's humidity.

Favorite and Least Favorite Aspects

When asked to identify their favorite aspects of the Conservatory, interviewees' comments were nearly evenly divided among the exhibits, the habitats, or specific plants. More than one-third of interviewees said the interactive exhibits were their favorites. These interviewees thought the exhibits added an additional dimension to the Conservatory, making it more educational, interactive, and appealing to children and adults (see the two quotations below).

(What did you like most about the Conservatory?) *I would say the interactives . . . [They] were really fun and mature, too. **It appealed both to the adults and the child. *Yes. **And everything's plain for the children. *Yeah, but it captivated me. I love to garden and there [were] a lot of things that you don't realize are going on right under your very nose. I guess for me—that would be my favorite part. I always love the plants,

but to actually see how the different roots grow and the different algae, the way spores are created, and stuff like that—it was just really nice. I liked it. [male, 51 years and male, 60 years]

(What did you like most about the Conservatory?) One place that I particularly liked and was pleased with was the Plant Lab because it showed me the way plants come to form life and the microscopes show you the different shapes of the seeds, the leaves, the roots—so many things that I didn't know before . . . I came here and many of them refreshed my memory of when I was a child and took classes at school. [male, 28 years; translated from Spanish]

Another one-third of interviewees said they were impressed with how the Conservatory recreated specific habitats. Many made somewhat general comments, while several others praised the Cloud Forest or the Bog (see the first three quotations below). Less than one-third of interviewees simply appreciated the variety of plants the Conservatory featured or had particular favorites, such as carnivorous plants or orchids (see the fourth and fifth quotations).

(What did you like most about the Conservatory?) The unusual plants, interesting groupings. (And why is that?) Because they're not ones you normally see in the garden or in life. *It's . . . nicely planted. I think it's most spectacular if you want to see such a variety of plants and their habitat—like . . . you'd see if you visited these different countries. [female, 40 years and male, 47 years]

(What did you like most about the Conservatory and why?) My favorite part was the Cloud Forest. I really just love the intricacy of all these species that were in there, and finding the orchids and all the rare plants hiding up in the limbs of the tress. It was really great. [female, 35 years]

(What did you like most about the Conservatory?) Probably the Bog. (The Bog? Any particular aspect of it?) Just because it's unusual. I've seen other . . . conservatories before and . . . I'd never seen a bog, yet. [male, 52 years]

(What did you like most about the Conservatory and why?) Probably the variety of species. You have some really beautiful plants in here. It just made it more interesting. And there were a lot of things we hadn't seen before. [female, 62 years]

I most of all liked the flycatcher plants—how they eat the bugs and how they [the insects] don't get out anymore. I liked that part. [female, 9 years]

Three-quarters of interviewees could not identify a least favorite aspect of the Conservatory. Of the one-quarter of interviewees who critiqued some aspect of the Conservatory, a few said they did not like the interactive exhibits either because they perceived the exhibits to be only for children or because the exhibits were “too much like school.” The remaining responses were idiosyncratic, such as suggestions that all plants be labeled with scientific and common names, that the kaleidoscopes along the railing be replaced with binoculars, and that the microscopes and magnifying glasses needed cleaning.

Reaction to Interactive Exhibits

Nearly all visitor groups interviewed reported that they used the interactive exhibits, and most of these interviewees said the exhibits enhanced their experiences in the Conservatory.

Specifically, many said the exhibits worked well for children, while others praised the exhibits for being engaging and educational for both adults and children (see the two quotations below).

(Well, one unique aspect of this Conservatory is that it has hands-on activities. Did you happen to use any of them?) Yes, a few. (What is your opinion of having activities like this available?) That's wonderful. I'm really glad, especially that it's so close to the Children's Garden, because it's a really great way to get kids to interact and learn about the different species of plants. I saw that there's a pollination one [and] certainly the carnivorous plants and the bogs—these [exhibits] will really help kids see how plants work. [male, 22 years]

(Well, one unique aspect of this Conservatory is that it has hands-on activities. Did you happen to use any of them?) Oh yes, I looked in [the] microscope at spores and algae. You learn—it's amazing. . . . I'm going on 74 and . . . and you're learning something new everyday. And when you see a statement like scientists still don't agree about algae whether they're plants. You know they work a little like a plant but then they don't and so some say, 'yes it is' and some say 'no it isn't.' I'm looking at the spores—amazing tiny little specimens underneath the microscope—the variety. It's quite intriguing. I think anyone would find it interesting. [male, 73 years]

In contrast, six visitor groups did not use the interactive exhibits. They offered a variety of reasons for not doing so: they do not like to use exhibits, they would have used the exhibits had they been accompanied by a child, or they were rushed for time.

WAYFINDING AND ORGANIZATIONAL STRUCTURE

How Visitors Found their Way around the Conservatory

Nearly all visitors said they did not have any difficulties finding their way around the Conservatory. Most enjoyed wandering the building and did not need to use the map or signs provided (see the quotation below). Several found the signs helpful, while a few used the map or the model. Two visitors experienced wayfinding problems: one said the building was difficult to navigate because she did not see a map or the model until the end of her visit and the other was unable to locate the “stinky plant.”

(Some visitors had difficulty finding their way around the Conservatory. Can you tell me some of your experiences?) We weren't really goal-oriented. We were just kind of meandering around, so we didn't really have a real firm direction [in which] we were headed. We were just kind of milling around in whatever direction to the next thing that attracted us. [male, 35 years]

Use of the Model

About two-thirds of visitors did not look at the model of the Conservatory, while one-third did. Those who did not use the model said they either did not see it or purposefully bypassed it because they did not need directions. Most of those who used the model found it helpful and did not offer any suggestions for improving it, but several offered suggestions: three thought the model should look more “realistic” through illustrations or tiny replica plants, two suggested labeling the bathrooms in the model, two others suggested including a “you are here” graphic in the model, and another two suggested placing the model at a 45 degree angle to make it more visible from a distance.

Descriptions of the Conservatory’s Sections

All the interviewees said they noticed the Conservatory’s different sections, and nearly all provided accurate descriptions of the sections. Three-quarters of interviewees said the sections differed in climate and/or humidity: some simply stated that fact while others added that different plants live in different climates (see the first two quotations below). Several said the different sections represented different habitats (see the third quotation). A few offered general accounts, stating that the sections featured “different kinds of plants.” In contrast, six interviewees could not provide descriptions of the sections.

(Did you happen to notice the different sections?) Yes, immediately. You couldn’t help but notice the differences in humidity. (How would you describe the different sections?) One’s wet, one’s dry, and one’s normal. *So, one’s for bogs, one’s for mists, for example. [female, 40 years and male, 47 years]

(How would you describe the different sections?) Yeah, they were . . . different climate zones. . . . You have the rain forest, you have the cloudy misty area, and [in] each region different flowers and things grow. [female, 44 years]

(How would you describe the different sections?) The rain forest room is really . . . focused on . . . the different types of plants and . . . how the rain forest works. . . . When you go into the bog you [see] . . . the different parts of the bog, and . . . why it’s a . . . different kind of environment than the other ones. [male, 22 years]

As interviewees described the sections, more than one-half identified them by name. Visitors most often mentioned the Cloud Forest, followed by the Rain Forest, Bog, and Plant Lab. While most interviewees identified one or two sections by name, three interviewees named all four sections. Interestingly, none of these three interviewees reported using the model or the map, suggesting that they gleaned the section names from the signs and banners.

UNDERSTANDING CONTENT

Main Message

Interviewees offered a range of ideas when asked to describe the Conservatory's main message. About one-half of interviewees said the Conservatory presented tropical plants and their environments from different places in the world (see the first two quotations below). One-quarter said the Conservatory intended to show lifestyles and characteristics of different plants (see the third quotation). Several interviewees offered generic responses, stating that the Conservatory was about "plant life," "nature," or the "rain forest" and, even with further probing, did not further explain their responses. Several others said the Conservatory's purpose was to be "educational and fun." A few perceived an environmental message, stating the Conservatory promoted the "preservation of rare species."

(Based on everything you saw, read, and did here at the Conservatory, what would you say the Conservatory is about?) Plants that need a very specific type of climate. *I would say it's about plants [from] around the world. [It] shows you the different types of plants that grow in tropical climates and the kinds of places that they grow—just all the varieties of plants that are out there—things you don't normally see, at least here in southern California. [male, 45 years and male, 39 years]

(Based on everything you saw, read, and did in the Conservatory, what would you say it is about?) Understanding the ecosystems at work within the different environmental areas that are outlined with the Cloud Forest or the tropical landscape or the Bog. . . . [It shows] the humidity that those plants need, the different temperatures, and how different plants [are] in the different places. [female, 35 years]

(Based on everything you saw, read, and did here at the Conservatory, what would you say the Conservatory is about?) All about all kinds of plants—learning how plants grow, live, reproduce, and feed themselves. [male, 58 years]

New Information or Ideas about Plants

More than one-half of interviewees said they learned something new about plants while visiting the Conservatory. While learning was highly individualized and personal, all of these interviewees consistently referred to topics presented in the Conservatory exhibits and text. Several mentioned carnivorous plants, for example, and being surprised about the Venus flytrap's small size or the pitcher plant's feeding mechanism. A few expressed amazement by the water lily pollination story, while a few others appreciated experiencing a bog firsthand. Other topics mentioned by a few interviewees were: epiphytes ("plants can grow on top of other plants"), the co-evolution of plant nectar and pollinators ("different concentrations of nectar attract different animals"), the precipitation level of Los Angeles compared with a rain forest, and elephants as seed dispersers. The remaining responses were idiosyncratic; for example, one interviewee learned that "leaves have holes" and another that orchids are the source of vanilla beans.

In contrast, slightly less than one-half said they did not learn anything new about plants, but that the Conservatory reinforced things they already knew.

Attitudes Toward Plants

Nearly all interviewees said they had positive attitudes toward plants before visiting the Conservatory and, as such, two-thirds of interviewees said the Conservatory did not make them think or feel differently about plants. For the one-third who discussed new insights, several said they gained new appreciation for plants that they never knew existed (see the first quotation below). Several others also described having a greater respect for plants after visiting the Conservatory (see the second quotation). A few said the Conservatory made them realize the interconnectedness of plants and animals and, a few others said it helped them recognize that plants have specific temperature and humidity needs. Two said the Conservatory had increased their “sense of wonderment” about plants.

(In what ways, if any, did the Conservatory make you think or feel differently about plants?) I think it just expanded my awareness of the different varieties of plants. Also it helped me understand some things I hadn’t seen before like the Bog . . . and the carnivorous plants. They are really interesting, too. So I mean it just [enables you to see] different types of plants that you would not be able to experience out here [in Southern California]. [female, 41 years]

I learned all about plants—where they come from and how they live—so that makes me respect them [plants] more. [male, 50 years; translated from Spanish]

PERCEPTIONS OF SCIENCE

About two-thirds of interviewees said the Conservatory had engaged them in science and offered concrete examples of how it did so. Many said that using tools such as microscopes, magnifiers, and various measuring devices was doing science (see the first quotation below). Several said they engaged in science skills such as smelling, touching, and observing (see the second quotation). Several others offered more general responses, noting that all the exhibits in the Plant Lab were related to science (see the third quotation). A few noted that they “experimented” with the Venus flytraps by trying to trick them into closing.

(What are some of the things you did in the Conservatory that you’d call science?) To me science is looking and analyzing. Trying to find out answers that you don’t know. . . . The lab has [an] amazing variety of small displays that have . . . different types of plants, seeds, and spores. To see what they’re all about under the microscope—it takes me back to high school biology, and that’s a long time ago. [male, 73 years]

(What are some of the things you did in the Conservatory that you’d consider science?) Just touching, being able to touch the plants, and smell the plants, and get up to them and interact with them could be science. [female, 42 years]

(What are some of the things you did in the Conservatory that you'd consider science?)
In the Plant Lab everything has a part in science, [and] like I said before [it] educates [visitors]. [male, 28 years; translated from Spanish]

In contrast, one-third of interviewees either said they had done science in the Conservatory but could not describe specific activities or said they did not think the Conservatory had engaged them in science.

OTHER COMMENTS

When asked for final comments, interviewees gave a range of responses. Some said the Conservatory building was beautiful while others noted how helpful and pleasant Conservatory staff and docents had been during their visit. Not surprisingly, perceptions depended on the staffing level—several interviewees complained that there needed to be more docents to answer questions. A few said the Huntington entrance fee was too expensive. Another complained that the bathroom in the Conservatory was locked and that he had to ask the security staff to open it.

Several offered suggestions for improving visitors' experiences in the Conservatory. A few said that more plants needed to be labeled with scientific and common names. A few others said they were unsure whether they could touch the plants in the Conservatory and suggested that the "rules" be made more explicit to visitors. Two wondered whether the Conservatory would be able to keep the microscopes and other interactive elements well maintained, noting the frequency of broken exhibits at science centers. Two others said they would like to see more orchids displayed. Another two recommended adding ambient sounds to increase the realism of the environments.

II. PRINCIPAL FINDINGS: SUMMARY OBSERVATIONS

To provide Huntington staff with detailed information about visitors' experiences at eight select exhibits—Helicopters, Flutterers, and Parachutes; Fragrant Flowers; Leaves Are Full of Holes; Roots and Nutrients; How Sweet Is It?; Parts of an *Amorphophallus*; Digesting Insects; and Orchids That Look Like Insects—RK&A conducted uncued observations and interviews.

This section of the report summarizes the observations, analyzing the data for all eight exhibits as a single data set to examine broad visitor behavior trends. The section following this one analyzes the observational and interview data by each exhibit (see “III. Principal Findings: Focused Observations and Interviews”) and Appendix C provides tables with numerical data for each exhibit.

VISITOR DEMOGRAPHICS

RK&A observed visitors at eight exhibits in the Conservatory over three days (Friday through Sunday) in December 2005. The data collectors observed 80 walk-in visitors, ages nine years and older.

As shown in Table 1, the total sample of visitors observed included more females than males (55 percent and 45 percent, respectively). Most visitors observed (96 percent) were adults (18 years old and older), with the largest age group being 35 to 44 years old (29 percent).

Table 1
Visitor Demographics

Characteristic	%
Gender (n = 80)	
Female	55.0
Male	45.0
Age Group (in years) (n = 76)	
Children (under 18 years of age)	3.9
18 to 24	5.3
25 to 34	21.1
35 to 44	28.9
45 to 54	22.4
55 to 64	10.5
65 and older	7.9

Nearly one-half of observed visitors (46 percent) were visiting in adult-only groups, while one-third (33 percent) were visiting in multigenerational groups (i.e., groups including one or more adults and child) (see Table 2).

Table 2
Group Composition
(*n* = 78)

Group Composition	%
Adults and children	33.3
Adults only	46.2
Alone	19.2
Children only	1.3

TIME DATA

Visitors spent a median time of 59 seconds at the Conservatory exhibits (see Table 3). The shortest time a visitor spent at an exhibit was 16 seconds and the longest time was more than seven minutes.

RK&A examined the time data by demographic characteristics and prior visitation to the Huntington. No statistically significant differences were found.

Table 3
Time Spent at Conservatory Exhibits
(*n* = 80)

Median	Minimum	Maximum	Mean	±
59 seconds	16 seconds	7 minutes, 25 seconds	1 minute, 20 seconds	1 minute, 5 seconds

BEHAVIORS

During the observations, data collectors noted several behaviors at each exhibit (see Appendix D for a definition of behaviors at each exhibit). Visitors displayed a median of four behaviors while visiting the select Conservatory exhibits (see Table 4). When RK&A examined the total number of behaviors observed at the exhibits by demographic characteristics and prior visitation to the Huntington, the evaluator did not find any statistically significant differences.

Table 4
Total Number of Behaviors Observed at Conservatory Exhibits
(*n* = 80)

Median	Minimum	Maximum	Mean	±
4.0	2.0	7.0	4.3	1.5

As shown in Table 5, visitors most often smelled, measured, observed, and read instructions (100 percent, 79 percent, 79 percent, and 77 percent, respectively). About three-quarters of visitors also read plant tags and analyzed (75 percent and 74 percent, respectively). The least common behavior was touching (4 percent). No visitors were observed misusing exhibits. When RK&A examined behaviors by demographic characteristics and prior visitation to the Huntington, no statistically significant differences were found.

Table 5
Behaviors at Conservatory Exhibits

Behavior	Number of Visitors Using Relevant Exhibit	% Displaying Behavior
Smelling	18	100.0
Measuring	29	79.3
Observing	67	79.1
Reading instructions	64	76.6
Reading plant tag	16	75.0
Analyzing	31	74.2
Comparing	57	68.4
Interacting socially	80	67.5
Reading main panel	74	66.2
Using tools	23	65.2
Touching	23	4.3
Misusing exhibits	80	0.0

III. PRINCIPAL FINDINGS: FOCUSED OBERVATIONS AND INTERVIEWS

RK&A conducted uncued observations and interviews at eight select exhibits—Helicopters, Flutterers, and Parachutes; Fragrant Flowers; Leaves Are Full of Holes; Roots and Nutrients; How Sweet Is It?; Parts of an *Amorphophallus*; Digesting Insects; and Orchids That Look Like Insects. Two RK&A evaluators conducted the exhibit observations and interviews over three days (Friday through Sunday) in December 2005.

While the previous section summarized the observations, this section provides detailed analysis of the observational and interview data for each exhibit. Appendix E provides the label text for each exhibit except for Parts of an *Amorphophallus*.

HELICOPTERS, FLUTTERERS, AND PARACHUTES

Description: Exhibit in the Plant Lab demonstrating how seeds of varying shapes take to the air.

General Goal: Visitors will learn how seeds of different shapes travel through the air and have a better chance of growing if they spread out to places with light, space, and water.

Specific Goals:

1. Visitors will demonstrate two science skills (i.e., observing and comparing).
2. Visitors will engage in social interaction related to the exhibit.
3. Visitors should be able to explain the exhibit’s primary message—how differently-shaped seeds travel through the air to spread out, thereby improving their chances of growing—after using it.

Visitor Response

The evaluator unobtrusively observed ten visitors at Helicopters, Flutterers, and Parachutes over two and one-half hours. Although most of the visitors who stopped at this exhibit did so either alone or in adult-only groups, two visited with children and one child visited alone. All of those who visited with others engaged in social interaction while using Helicopters, Flutterers, and Parachutes. Each visitor spent between 30 seconds and one and one-half minutes at the exhibit.

All nine adults and the one child participated in interviews about their Helicopters, Flutterers, and Parachutes experiences. Nearly all interviewees provided positive feedback about the exhibit with the majority describing it as “fun.” Other words that interviewees used to describe the overall exhibit included “educational” and “creative.”

Operational Functioning

Although all interviewees said they did not experience any problems using Helicopters, Flutterers, and Parachutes, several expressed concern about whether younger children could turn the crank (see the quotation on the next page). Readers should note, however, that visitors in the target age group (nine years of age and older) were able to operate the crank.

I think [the crank's] a little too hard for children to spin . . . [The crank] takes a lot of strength for me to turn it and my son isn't big enough yet [to turn the crank].

The evaluator did not observe any visitors misusing the exhibit. Instead, all observed visitors demonstrated observational skills (i.e., observed the seeds moving or at the bottom of at least one tube) and all but two compared the seeds by watching them fall in both tubes. The evaluator also observed about one-half of the visitors reading the plant tag, and two observed visitors reading the main exhibit panel.

Interviewees' descriptions of their exhibit activities mirrored the activities of observed visitors. For example, most said they first turned the crank or watched the seeds in motion after approaching the exhibit, whereas one interviewee said he read the information first.

Conveying Content

The majority of interviewees said they experienced no difficulty understanding Helicopters, Flutterers, and Parachutes. Furthermore, several interviewees said they did not read any panels because they understood the content just by doing the activity. However, several others said they would have liked additional panels to further explain the exhibit's content.

Nearly all interviewees correctly identified part of the exhibit's primary message: seeds travel through the air to spread out, thereby improving their chances of growing (see the first quotation below). However, the majority did not directly refer to either the seeds' different shapes or the resulting differences in their air travel, although a few mentioned these differences as part of the exhibit's primary message (see the second quotation). In addition, two interviewees said they did not know the intent of Helicopters, Flutterers, and Parachutes, whereas another said its intent was to demonstrate how some plants imitate animals in nature.

(What do you think this exhibit is trying to show or tell visitors?) The exhibit seems to be about how plants' chances to reproduce would be increased by dispersing seeds through whatever means, including through the air.

I guess the parachutes are going to travel more than, perhaps, the flutterers . . . because of the shapes, [the seeds] drop in different ways.

Overall, interviewees indicated they understood how plants benefit from producing seeds that float in the air. Many discussed the short-term benefit of seeds traveling by air—it enables the plant to spread out to new places—while others focused on the long-term benefit for a plant, to improve its chances for reproduction and survival. One interviewee said he did not know how floating seeds benefit plants.

Interviewees did not offer content-related suggestions for Helicopters, Flutterers, and Parachutes, except one interviewee who requested more information comparing the air travel speeds of the different seeds.

FRAGRANT FLOWERS

Description: Exhibit in the Plant Lab demonstrating how different flowers' smells attract different pollinators (animals).

General Goal: Visitors will learn that different flowers' smells attract different animals that pollinate the flowers.

Specific Goals:

1. Visitors will demonstrate four science skills (i.e., observe, smell, compare, and analyze).
2. Visitors will engage in social interaction related to the exhibit.
3. Visitors should be able to explain the exhibit's primary message—how different smells of flowers attract different pollinators (animals)—after using it.

Visitor Response

The evaluator unobtrusively observed twelve visitors at Fragrant Flowers over two and one-half hours. Nearly all of the visitors who stopped at this exhibit did so either alone or in adult-only groups. Most of those who visited with others engaged in social interaction while using Fragrant Flowers. Each visitor spent between 30 seconds and nearly two minutes at the exhibit. In contrast, some visitors scanned the area and then decided not to stop.

Of the twelve adults observed, nine agreed to be interviewed about their Fragrant Flowers experiences. All interviewees provided overwhelmingly positive feedback about the exhibit with most describing it as either “interesting” or “fun.” Several others said they liked Fragrant Flowers because the exhibit is both “educational” and “experiential.”

Operational Functioning

Overall, interviewees described few, if any, problems using Fragrant Flowers. In addition, no visitors were observed misusing the exhibit. The exhibit engaged visitors in science—all but one of the observed visitors demonstrated three or more behaviors related to science skills (i.e., observe, smell, compare, analyze). The evaluator noted that all visitors used their observational skills and sense of smell while most compared and analyzed. The evaluator also observed nearly all visitors reading the main exhibit panel, the instruction panels, or both types of panels.

Although none of the observed visitors incorrectly used Fragrant Flowers, a few described minor problems. For example, several said they could not smell the flowers (e.g., the cactus) and suggested the exhibit use stronger-smelling flowers (see the quotation below).

For the [flowers] that are chosen, maybe strengthen [their smell]. Because I picked [the cactus] up again and I still couldn't smell anything, and I'm pretty good with smells.

Other problems related to the exhibit's operational functioning included one interviewee's failure to notice or understand the significance of the lights on the pollinator wheels and another's lack of understanding about the relationship between the squeeze bottles and the flowers.

Recommendations

- Ensure that all displayed flowers emit strong odors and maintain their potency.
- Consider adding or enlarging the identification labels on the squeeze bottles and flower specimens, both to identify each and to reinforce their relationships.

Conveying Content

Interviewees indicated that their initial interest in and understanding of Fragrant Flowers' content primarily came from doing activities rather than reading text panels. For example, nearly all described first smelling or looking at the flowers, followed by squeezing the bottles or spinning the pollinator wheels, and then reading text panels. Once interviewees read the panels, all but one said they were easy to understand. In contrast, one interviewee said the text did not sufficiently explain first how to match the insects, such as the bee, to the flowers, and then how to check one's answers.

The majority of interviewees correctly identified Fragrant Flowers' primary message: how different smells of flowers attract different pollinators or animals (see the quotation below). One interviewee said the exhibit is meant to encourage visitors' use of smell when experiencing nature, while another said the exhibit helps visitors appreciate flowers and nature.

(What do you think this exhibit is trying to show or tell visitors?) [It shows] which insects or animals are attracted to different smells of the plants.

Interviewees' descriptions of the relationship between flowers and animals varied when the evaluators asked them further questions. Some said flowers and animals are "codependent," including several who also explained that animals help to pollinate flowers and, in turn, flowers provide animals with food or nutrients. A few said the relationship results in the pollination of flowers but did not mention how it benefits animals. In addition, a few others expressed confusion, including one who said there was "no clear relationship" between flowers and animals, another who asked how bats benefit flowers, and one other who questioned whether animals and flowers' reproductive processes benefit from the relationship.

Recommendation

- Consider adding a text panel that addresses the question, "What's in it for pollinators?" Many interviewees alluded to the mutually beneficial relationship between the flowers and the animals' although the exhibit did not explicitly explain this. Others did not indicate they understood that nectar and/or pollen is an edible reward for some animals.

LEAVES ARE FULL OF HOLES

Description: Exhibit of a microscopic view of the underside of a zebra leaf in the Plant Lab that shows stomata.

General Goal: Visitors will use a microscope and/or video monitor to identify stomata on the underside of a zebra leaf and learn what stomata do for the plant.

Specific Goals:

1. Visitors will demonstrate three science skills (i.e., observe using the microscope or monitor, touch the plant, and draw conclusions).
2. Visitors will engage in social interaction related to the exhibit.
3. Visitors should be able to explain the exhibit's primary message—what stomata are and what they do for plants—after using it.

Visitor Response

The evaluator unobtrusively observed thirteen visitors at Leaves Are Full of Holes over two and one-half hours. About one-half of the visitors who stopped at this exhibit were adults with children, followed by some in adult-only groups and several adults who were alone. Nearly all those who visited with others engaged in social interaction while using Leaves Are Full of Holes. Each visitor spent between 25 seconds and nearly one and one-half minutes at the exhibit. In contrast, some visitors scanned the area and then decided not to stop.

Of the thirteen adults observed, eleven agreed to be interviewed about their Leaves Are Full of Holes experiences. All but one provided positive feedback about the exhibit, with most describing it as “interesting” and several indicating their appreciation of its aesthetic qualities (see the quotation below).

I liked [the exhibit] a lot . . . I loved the detail, how beautiful [the leaves] look.

Operational Functioning

Interviewees reported no problems using Leaves Are Full of Holes, although several added that they had little or no prior experience with microscopes and this resulted in some trial and error (e.g., focusing the lens, locating the light button). The evaluator did not observe any visitors misusing the exhibit. The exhibit engaged all visitors in observation, a behavior related to science skills—all but one of the observed visitors used the microscope and nearly one-half used the monitor. However, several said they failed to recognize that the video monitor and microscope displayed the same image because they focused on using the microscope (see the quotation below).

People might not realize when they're focused on [the microscope] that they can see [the image] on the [video monitor] screen, too. (Did you notice it on the screen?) My wife actually did; I didn't because I was actually looking through the microscope.

None of the observed visitors touched the plants—another behavior tied to scientific skills—in contrast to their widespread use of the microscope and/or video monitor. The evaluator also observed all but one visitor reading the main exhibit panel, the instruction panel, or both types of panels.

Recommendations

- Consider adding small, succinctly-worded labels on and/or next to the microscope to instruct visitors how to use the microscope (e.g., “Push here”) and to direct their attention to the video screen monitor (e.g., “Look up to see the microscopic view enlarged”).
- Consider adding a label on or close to the plant that instructs visitors to “please touch” and more prominently display the plant to facilitate such interactions.

Conveying Content

Interviewees indicated that they learned about the Leaves Are Full of Holes content by using the microscope and/or reading one or more text panels. Most described doing both activities to some extent, although the order in which interviewees did these activities varied. Among interviewees who read one or more text panels, all said they experienced little, if any, difficulty understanding the content (see the quotation below).

I didn't have any problems in understanding [the information]. I thought [the text] was very well written and fairly easy to understand.

Overall, interviewees demonstrated basic understanding of the Leaves Are Full of Holes content. Most interviewees described what stomata do for the plant using language used in the text panels when asked to explain the exhibit's primary message (see the quotation below). For example, many interviewees referred to the stomata as “pores” or “holes,” although none used the term “stomata.” Some also referred to the movement of oxygen, water vapor, and carbon dioxide “in and out” of the leaves' holes.

(What do you think this exhibit is trying to show or tell visitors?) Leaves are full of holes. (What do you think the holes do for the plant?) They store air and water. I think that's what [the text panel] said.

In contrast, several interviewees' responses indicated a lack of depth in their understanding of the exhibit's content (see quotation below).

(What do you think this exhibit is trying to show or tell visitors?) That some leaves have pores. (What do you think the holes do for the plant?) I don't know. I have no idea.

Recommendation

- If “stomata” is an important term for visitors to glean from the exhibit, consider printing the word in a different color to call attention to it in the label.

ROOTS AND NUTRIENTS

Description: Exhibit in the Plant Lab demonstrating how the presence or lack of nutrients and minerals affects two plants with visible roots growing in water.

General Goal: Visitors will learn that roots provide plants with the water, nutrients, and minerals necessary for their healthy growth.

Specific Goals:

1. Visitors will demonstrate three science skills (i.e., observe, measure, and compare).
2. Visitors will engage in social interaction related to the exhibit.
3. Visitors should be able to explain the exhibit’s primary message—that roots provide plants with the water, nutrients, and minerals necessary for their healthy growth—after using it.

Visitor Response

The evaluator unobtrusively observed ten visitors at Roots and Nutrients over two and one-half hours. Most visitors stopped at this exhibit either alone or in adult-only groups, although three visitors were in groups of adults and children. Most of those who visited with others engaged in social interaction while using Roots and Nutrients. Each visitor spent between 24 seconds and about two and one-half minutes at the exhibit. In contrast, some visitors scanned the area and decided not to stop.

Of the ten visitors observed, eight participated in interviews about their Roots and Nutrients experiences, including one older child. Most interviewees said they liked the exhibit, with some describing its content as either “cool” or “unusual.” However, several others said problems using the nutrient meter lessened their overall enjoyment of the exhibit.

Operational Functioning

Many interviewees said they did not experience any problems using Roots and Nutrients, although several discussed technical problems using the nutrient meter (see the quotation below). The evaluator observed no visitors misusing the exhibit.

I don’t think [the meter] was working properly. It looks a little old—like it may need new batteries.

Overall, the exhibit engaged visitors in science. Nearly all observed visitors looked at the plants, and most used the meter to measure nutrients, with all but one comparing the two plants by measuring both samples. Most visitors were observed reading the main exhibit panel, the instruction panels, or both types of panels.

Recommendation

- The light on the nutrient meter is somewhat hard to see. Consider stating in the instructions for the user to shield the light with his/her hand to make it more visible when it flashes.

Conveying Content

Interviewees indicated that their understanding of Roots and Nutrients' content came from a combination of observing the plants, doing the activity, and reading text panels. For example, nearly all described first reading text and/or looking at the plants, while several others said they smelled the plants first. As their next step, most interviewees said they "followed the instructions," using the meter to measure the nutrients (see the quotation below) but several others said they compared the plants by looking at each of them.

(What did you do at this activity?) I read the instructions and then I put [the meter] into the [sample] on the right.

Most interviewees said they had no difficulty understanding the information on the panels, except one who spoke English as a second language. However, two interviewees said they did not understand how to read the nutrient meter—both asked what unit of measurement the meter's "EC" markings represented, and one of them said it was unclear how to interpret the meter's readings (see the quotation below).

I didn't know what [the meter] is reading like the 1.4, 1.6 . . . I didn't understand what 'EC' stand for. [The instructions] need to explain what the actual measurement units are.

The majority of interviewees, including the child, correctly identified the primary message of Roots and Nutrients: roots provide plants with the water, nutrients, and minerals necessary for their healthy growth (see the quotation below). One interviewee said the exhibit showed visitors that a plant's health cannot be determined just by looking at it.

(What do you think this exhibit is trying to show or tell visitors?) It shows how plants need nutrients to make them grow, for life.

However, more interviewees said they compared the two samples' nutrient levels by observing the plants rather than reading the meter. Furthermore, some interviewees incorrectly identified the "brighter" plant as the one growing in the water with the nutrients because they assumed its light color indicated healthiness.

Recommendations

- Consider adding a flip-up panel that explains how to determine which plant is healthier (i.e., healthy plant characteristics). Some visitors mistakenly identified the lighter plant as growing in the nutrients because they thought the brighter color indicated healthiness and they could not check their answers.
- Consider adding an explanation of the nutrient meter's units of measurement to the instructional text panel. Although staff said they do not have this information, several visitors said they wanted to know the nutrient meter's units of measurement.

HOW SWEET IS IT?

Description: Exhibit in the Plant Lab demonstrating how different pollinators prefer different sugar levels in nectar through an activity measuring various flower nectars' sugar levels.

General Goal: Visitors will learn that different pollinators prefer different sugar levels in nectar.

Specific Goals:

1. Visitors will demonstrate four science skills (i.e., observe, measure, compare, and analyze).
2. Visitors will engage in social interaction related to the exhibit.
3. Visitors should be able to explain the exhibit's primary message—that different pollinators prefer different sugar levels in nectar—after using it.

Visitor Response

The evaluator unobtrusively observed nine visitors, including one child, at How Sweet Is It? over two and one-half hours. Most visitors stopped at the exhibit in groups of adults and children, while the remainder visited in adult-only groups. Every visitor engaged in social interaction while using the exhibit. Each visitor spent between one and one-half minutes and three minutes and 45 seconds at the exhibit, except for one visitor who stayed nearly seven and one-half minutes.

All nine interviewees participated in interviews about their How Sweet Is It? experiences. Nearly all provided positive feedback about the exhibit, with some describing it as either “educational” or “hands-on.” While many interviewees described minor difficulties using key exhibit components, they indicated the overall exhibit was easy to use and understand. However, one interviewee said she did not understand how to do the activity.

Operational Functioning

About one-half of interviewees reported problems using the exhibit's liquid dispensers. Some said they experienced difficulty figuring out how to squeeze liquid from the dispensers, including one who described the dispensers' design as “not intuitive.” Several others said no liquid came out of the dispensers even when they followed the instructions for the dispensers' use (see the quotation below).

I wanted to use the lavender [nectar] and the directions said, “Squeeze,” but when I was squeezing the lavender [dispenser], nothing would come out even though there was stuff in there. So I decided to use another one.

In addition, one interviewee said How Sweet Is It? was “not child-friendly” because her child required assistance to successfully squeeze liquid from the dispensers and use the refractometer. Similarly, another adult interviewee said she had difficulty reading the refractometer because it was “sticky.” Conversely, one interviewee described the exhibit as “straightforward” and “easy” to use, after some initial trial and error.

None of the observed visitors incorrectly used the exhibit, although many suggested improving the usability of the liquid dispensers. How Sweet Is It? engaged visitors in science: nearly all measured and compared the sugar levels of the various nectars.

The evaluator also observed all visitors reading the How Sweet Is It? instruction panels and more than one-half reading the main exhibit panel.

Recommendations

- Consider redesigning and/or labeling the liquid dispensers for easier use. Visitors did not intuitively recognize that the dispensers first needed to be flipped over, and then squeezed. Consider either simplifying the design so visitors only need to squeeze the dispensers, or adding labels that explicitly explain their usage (e.g., “flip and squeeze”).
- Consider elevating the plants and matching their colors to those of the dispensers to encourage visitors’ observation and identification of the plants. For example, the three liquid dispensers partially obscure their respective living plants in their current location. Also, color-coding the dispensers and flowerpots may visually reinforce their connections (e.g., purple flowerpot and purple-tinted liquid dispenser for lavender, etc.).

Conveying Content

Overall, interviewees indicated that they understood the exhibit’s content because they read the How Sweet Is It? instructional panels, many doing so before doing the activity. All nine interviewees reported reading the instructional panels and most said they read them and/or looked at the flowers before trying the hands-on activity. Several said they approved of the content with one interviewee describing the text as “nicely written.” In contrast, one interviewee said he understood the panel images better than the text.

Most interviewees correctly identified the primary message of How Sweet Is It?: that different insects prefer different sugar levels of nectar (see the first quotation below). In addition, most further explained that the exhibit demonstrated that flowers have different amounts of sugar in their nectars (see the second quotation).

(What do you think the exhibit is trying to show or tell visitors?) I think [the exhibit] is telling visitors which insects are more attracted to some plant types based on their [nectar]’s sweetness level.

[The exhibit shows] that the different flowers have different levels of sugar [in the nectar].

In contrast, several interviewees indicated some confusion in their understanding of the exhibit’s primary message when the evaluator questioned them further. For example, one interviewee described the relationship between flowers and animals as “the more sugar, the more animals are attracted to flowers” rather than that different animals prefer different levels of sugar.

PARTS OF AN *AMORPHOPHALLUS*

Description: Exhibit in the Rain Forest that demonstrates how plants belonging to the same genus differ and share similar characteristics. Exhibit includes a field guide, a smelling activity, and living plants.

General Goal: Visitors will learn that different plants belonging to the same genus share similar characteristics but also differ.

Specific Goals:

1. Visitors will demonstrate three science skills (i.e., observe, smell, and compare).
2. Visitors will engage in social interaction related to the exhibit.
3. Visitors should be able to explain the exhibit's primary message—that plants belonging to the same genus differ and share similar characteristics—after using it.

Visitor Response

The evaluator unobtrusively observed six visitors at Parts of an *Amorphophallus* over two and one-half hours. Three visitors stopped at this exhibit alone and the remaining three visited in an adult-only group. All three visitors who stopped with other adults engaged in social interaction while using Parts of an *Amorphophallus*. Five visitors spent between 16 seconds and 39 seconds at the exhibit; however, one visitor spent about one minute, 45 seconds at the exhibit. Most visitors who stopped at other exhibits in the Rain Forest either failed to notice the exhibit owing to its more isolated location or viewed it from a distance and then decided not to approach it.

All six adults observed agreed to be interviewed about their experiences using Parts of an *Amorphophallus*. Overall, interviewees provided positive feedback about the exhibit, with most describing their interest in smelling the “stinky” plant using the squeeze bottle. One interviewee alluded to the exhibit's poor location when asked about his overall opinion of it (see the quotation below).

I think [the exhibit] is cool but it's too far from the main walkway. People turn [the other way] so it's kind of off the path.

Operational Functioning

Interviewees said they experienced several problems using Parts of an *Amorphophallus*. For example, all but one described difficulty using and/or smelling the squeeze bottle. They said the box containing the bottle creates a physical barrier between the visitor and the bottle (see the quotation next page). In contrast, one person said the squeeze bottle functioned properly and easily.

I didn't smell anything—I guess I didn't squeeze it hard enough. *I don't think she realized that she had to push and collapse the bottle inside the box, behind that hard surface.

Interviewees also described another problem. Some said they failed to notice or more closely examine the plants because of their display at ground level and/or that the smelling activity focused their attention away from the plants. For example, one interviewee said that although he noticed the plants, he thought they should be more prominent than the smelling activity (see the quotation below). In addition, one interviewee added that the placement of the plants prevents visitors from taking a closer look at them.

The point [of the exhibit] is more to look at the specimen and try to relate it to [plants] around it. It's so interesting to play with the fragrance maker. But I think it would be better if [the visitor] had a better visual experience with the specimen and the fragrance business was secondary.

The evaluator also observed visitors' exhibit behaviors related to science skills. All six visitors used their sense of smell in the exhibit, four visitors looked at the plants to some extent, and two compared the field guide illustrations to the plants by looking back and forth at both. While all six visitors were observed reading the field guide, two turned the field guide's pages and only one read the plant tag. None of the visitors were observed misusing the exhibit.

Recommendations

- Consider additional lighting in the exhibit area to counteract the darkness created by the overhang. For example, a spotlight on the featured *Amorphophallus* plants or reading light above the field guide may attract more visitors to the area.
- Consider displaying one plant close to the squeeze bottle so visitors are more likely to connect the smell to its plant source. A plant tag that explains the plant's connection to the smell may also prompt visitors to interact more with the plant.
- Consider enlarging the size of and/or using fluorescent background colors for the plant tags to create a more eye-catching display.

Conveying Content

Interviewees said they had no difficulty understanding the information provided in either the field guide or, if applicable, the plant tags (see the quotation below).

[The information] is good, simple, and quick—the [exhibit]'s message gets driven home fast.

However, all interviewees, with one exception, incorrectly identified the primary message of the *Amorphophallus* exhibit. Although their explanations varied, none described or mentioned that all the plants were in the same genus, *Amorphophallus*, when describing the exhibit's message. For example, one visitor said the exhibit shows how seeds develop, another said its intent is to “pique curiosity” in visitors, and still another said it highlighted different plant structures. One interviewee later acknowledged that the exhibit is about a plant “species.”

However, interviewees' understanding of the shared plant characteristics described in the exhibit improved slightly when the evaluator further questioned them. Two interviewees said the plants all grow well in tropical or humid climates and several others said they all share the same "repulsive" smell. The two remaining interviewees indicated they did not think the plants shared any characteristics.

Recommendations

- Consider defining the meaning of "genus" in the field guide and illustrating it by posing a question such as, "How are plants in the same genus alike... *and* different?" Although some interviewees demonstrated awareness of shared characteristics among the plants, all but one failed to identify the various plants as members of one genus.
- Consider adding questions or activities to the field guide that help visitors compare the plants, such as "find the tallest *Amorphophallus*, then find the shortest one" then explain what those differences tell us about the plants' natural history.

DIGESTING INSECTS

Description: Exhibit in the Cloud Forest demonstrating how pitcher plants digest insects.

General Goal: Visitors will learn that pitcher plants trap and digest insects, by comparing the acid levels of water and pitcher plant juice and examining a pitcher plant.

Specific Goals:

1. Visitors will demonstrate four science skills (i.e., observe, touch, measure, compare).
2. Visitors will engage in social interaction related to the exhibit.
3. Visitors should be able to explain the exhibit's primary message—that pitcher plants trap insects inside, where digestive juices break down the prey—after using it.

Visitor Response

The evaluator unobtrusively observed ten adult visitors at Digesting Insects over two and one-half hours. One-half of the visitors who stopped at this exhibit did so in adult-only groups, whereas the other one-half stopped with children. Most of those who visited with others engaged in social interaction while using Digesting Insects. Each visitor spent between 45 seconds and nearly four and one-half minutes at the exhibit. In contrast, some visitors scanned the area and then decided not to stop.

Of the ten adults observed, eight agreed to be interviewed about their Digesting Insects experiences. Interviewees provided useful feedback about the exhibit. For example, while many said they enjoyed doing the experiment, including one interviewee who said Digesting Insects is "the best" of all the Huntington Conservatory's hands-on activities, many interviewees also indicated they did not connect the exhibit's experiment to the displayed pitcher plant.

Operational Functioning

One-half of interviewees said they either did not look for or recognize the pitcher plant displayed as part of the exhibit (see the quotations below). In contrast, the remaining one-half of interviewees said they easily located the pitcher plant. The exhibit engaged visitors in science to varying degrees, depending on the specific behavior (i.e., observe, touch, measure, compare). The majority of the observed visitors demonstrated two behaviors—observing the liquids in the test tubes and/or measuring the liquids with the acid scale—whereas one of the ten visitors touched the pitcher plant.

I didn't find [the pitcher plant] at all. I was intrigued with [the acid meter] measuring the acidity of the water and I wasn't aware that there was a plant.

We didn't realize that the plant hanging overhead is the pitcher plant that [the exhibit] is talking about.

The evaluator also observed all visitors reading the main exhibit panel, the instruction panels, or both types of panels. When asked to describe how they used Digesting Insects, some visitors said they started experimenting with the acid meter before reading the text panels, whereas others did the opposite. Regardless, about one-half of interviewees described comparing the two types of liquids, which is another behavior related to science skills (see the quotation below).

First, I tested the water. It was so cool because on the acid meter it showed [the water's level] was 7.0, and the pitcher plant was 5.9 or something. (You compared the two of them?) Yes.

None of the interviewees or their older children experienced difficulty using Digesting Insects, although several adults said their younger children did not understand how to use the acid meter or connect the measuring activity to the pitcher plant. One interviewee also suggested providing both water and the pitcher plant juice at both experiment stations so that visitors could work independently from each other simultaneously.

Recommendation

- Consider hanging the pitcher plant at a lower level for greater visibility and including a label that instructs visitors to “please touch” the plant (if feasible) to facilitate such interaction.

Conveying Content

Most interviewees indicated that the acid meter experiment sparked their initial interest in Digesting Insects, whereas their understanding of the exhibit's content came from reading text panels. For example, several interviewees among those who first conducted the experiment said they only understand the information after reading the text panels (see the quotation below).

I did [the experiment] without reading anything, and then I read [the text labels], and then I understood what [the exhibit] is trying to show [visitors].

Once interviewees read the panels, all of them said the content was “clear” and easy to understand. Likewise, the majority of interviewees correctly identified the primary message of *Digesting Insects*: pitcher plants digest insects. Some interviewees further described how the exhibit compares the pitcher plant’s digestive system to that of a human (see the quotation below).

(What do you think this exhibit is trying to show or tell visitors?) [It shows] that plants are carnivores, too. They digest food about the same way people do.

Most interviewees expressed a basic understanding of the function of the liquid in the pitcher plant when the evaluator asked them further questions. For example, many said the liquid is “working as an acid” to “digest bugs” inside the pitcher plant, including several who also mentioned the importance of enzymes. However, several interviewees suggested displaying live or videotaped pitcher plants “trapping the insects” to help visitors connect the pitcher plant’s “real story” to the more abstract information learned by measuring the two liquids’ acid levels and reading the text labels.

Recommendation

- Consider adding images (e.g., photographs, video monitor, or living display) that show visitors the pitcher plant in action catching the insects to reinforce the connection between the plant and the exhibit’s interactive content.

ORCHIDS THAT LOOK LIKE INSECTS

Description: Exhibit in the Cloud Forest demonstrating how orchids have evolved to imitate female insects to attract male insects for pollination.

General Goal: Visitors will learn that orchids have evolved to imitate female insects to attract male insects for pollination.

Specific Goals:

1. Visitors will demonstrate two science skills (i.e., observe and analyze).
2. Visitors will engage in social interaction related to the exhibit.
3. Visitors should be able to explain the exhibit’s primary message—that orchids have evolved to imitate female insects to attract male insects for pollination—after using it.

Visitor Response

The evaluator unobtrusively observed ten adult visitors at Orchids That Look Like Insects over two and one-half hours. One-half of the visitors stopped at this exhibit in adult-only groups, while some visited in groups of adults and children, and several adults visited alone. Most visitors accompanied by others engaged in social interaction while using Orchids That Look Like Insects. Each visitor spent between 40 seconds and nearly one minute and 45 seconds at the exhibit. In contrast, some visitors scanned the area and then decided not to stop.

Nine of the ten adults observed agreed to be interviewed about their Orchids That Look Like Insects experiences. Most interviewees provided positive feedback about the exhibit, with several describing it as either “interesting” or “nice.” Conversely, some said the exhibit needs better labeling on the orchids because they had difficulty locating the living specimens highlighted in panel photographs.

Operational Functioning

Interviewees reported no problems using the exhibit, except for those who experienced difficulty locating the orchids. Several described the Orchids That Look Like Insects activity as “simple” to use. However, only two visitors used a magnifier to examine the orchids in detail, while more than one-half looked at the orchid without using the tool. The two visitors who used the magnifiers said the tool improved their ability to compare the orchid photographs to the living specimens (see the quotation below).

[The magnifier] showed the details from the [orchid] pictures compared to the plants.

The evaluator also observed nearly all visitors reading the Orchids That Look Like Insects instruction panels and more than one-half reading the main exhibit panel. Overall, observed visitors correctly used the exhibit and none offered suggestions for improving its functionality.

Recommendations

- Consider visually emphasizing the magnifiers through placement, labeling, and contrasting colors. For example, consider placing a basket labeled “magnifiers” at eye-level, and include in it fluorescent-colored magnifiers instead of black ones.
- Consider using removable labels to identify “dormant” orchids featured in panel photographs to indicate which ones are available for viewing.

Conveying Content

Nearly all interviewees described either “reading” text panels or “looking” at orchids as their first activity at Orchids That Look Like Insects, and about one-half said that afterwards, they lifted the panel flaps to “check answers.” Among these interviewees, several said they repeatedly answered incorrectly (see the quotation below).

I read the main panel and then I lifted the [panel]'s flap to see if I knew what I was talking about. (Then what did you do?) I always lifted the wrong panel.

Although most interviewees correctly identified the relationship between orchids and insects as the exhibit's primary message, many described the relationship in general terms without referencing the advantage of the orchids' mimicry (see the quotation below).

(What do you think this exhibit is trying to show or tell visitors?) To me, it's clearly showing the comparison of insects to the orchid.

However, when the evaluator questioned them further, all interviewees identified pollination as the purpose of the orchids' mimicry of female insects, although most did not directly refer to evolution. Additionally, about one-half correctly responded, "to mate," when asked to explain why insects visit orchids.

Overall, interviewees said the Orchids That Look Like Insects' content was "clear," although several indicated areas for improvement. For example, one interviewee said the panels' insect illustrations failed to attract his attention, and another said the exhibit should emphasize why orchids imitate insects. In addition, one interviewee requested information about each orchid's habitat (e.g., climate, geographic region), whereas another suggested limiting the number of flip panels to one to decrease the amount of panel information.

Recommendation

- Consider enlarging and labeling the insect illustrations on the exhibit's text panel. Most visitors indicated that they compared the living orchids to photographs of orchids whereas few discussed comparing the living orchids to insects. Increased visual emphasis on the insects may increase the latter comparison and draw greater attention to the underlying concept that orchids have evolved to attract male insects for pollination.

APPENDICES

APPENDIX A
Exit Interview Guide
Removed for proprietary purposes.

APPENDIX B
Observations Forms
Removed for proprietary purposes.

APPENDIX C
Behaviors at Each Exhibit

Table 6
Helicopters, Flutterers, and Parachutes (Plant Lab)
(*n* = 10)

Time	
Median time = 44 seconds	
Behavior	<i>n</i>
Observe	10
Compare	7
Read plant tag	6
Social interaction	6
Read main panel	2

Table 7
Fragrant Flowers (Plant Lab)
(*n* = 12)

Time	
Median time = 59 seconds	
Behavior	<i>n</i>
Observe	12
Smell	12
Read main panel	11
Compare	11
Analyze	11
Read instructions	10
Social interaction	7

Table 8
Digesting Insects (Cloud Forest)
(n = 10)

Time	
Median time = 1 minute, 11 seconds	
Behavior	<i>n</i>
Read main panel	9
Measure	7
Social interaction	7
Read instructions	6
Observe	6
Compare	4
Touch	1

Table 9
Leaves Are Full of Holes (Plant Lab)
(n = 13)

Time	
Median time = 47 seconds	
Behavior	<i>n</i>
Use tool (microscope)	12
Read instructions	10
Read main panel	8
Social interaction	7
Use tool (monitor)	6
Touch	0

Table 10
How Sweet Is It? (Plant Lab)
(n = 9)

Time	
Median time = 2 minutes, 56 seconds	
Behavior	<i>n</i>
Read instructions	9
Social interaction	9
Measure	8
Compare	8
Observe	6
Read main panel	5
Analyze	4

Table 11
Roots and Nutrients (Plant Lab)
(n = 10)

Time	
Median time = 1 minutes, 13 seconds	
Behavior	<i>n</i>
Observe	9
Social interaction	9
Read main panel	8
Measure	8
Compare	7
Read instructions	6

Table 12
Orchids that Look Like Insects (Cloud Forest)
(n = 10)

Time	
Median time = 57 seconds	
Behavior	<i>n</i>
Read instructions	8
Analyze*	8
Observe	7
Read main panel	6
Social interaction	6
Use tool	2

*Visitors analyzed a median of two sets of flip panels.

Table 13
Parts of an *Amorphophallus* (Rain Forest)
(n = 6)

Time	
Median time = 31 seconds	
Behavior	<i>n</i>
Read field notes*	6
Smell	6
Observe	4
Social interaction	3
Compare	2
Read plant tag	1

*Two visitors turned the pages of the field notebook.

APPENDIX D

Exhibit Behavior Definitions

Helicopters, Flutterers, and Parachutes

Read main panel: posture must demonstrate obvious reading and/or read aloud

Read plant tag: posture must demonstrate obvious reading (e.g., visitor holds plant tag) and/or read aloud

Observe: look at the seeds (moving or at bottom) in at least one tube

Compare: watch seeds falling in both tubes

Social interaction: exhibit related only (e.g., talking about the exhibit, using it with others)

Misuse: turning the crank without looking at the tubes

How Sweet Is It?

Read main panel: posture must demonstrate obvious reading and/or read aloud

Read instruction panel: posture must demonstrate obvious reading and/or read aloud

Observe: look at flowers

Measure: use refractometer

Compare: measure more than one nectar sample with refractometer

Analyze: use flip panel to find out answer

Social interaction: exhibit related only (e.g., talking about the exhibit, using it with others)

Misuse: flipping the panels without purpose, playing with the supplies

Fragrant Flowers

Read main panel: posture must demonstrate obvious reading and/or read aloud

Read instruction panel: posture must demonstrate obvious reading and/or read aloud

Observe: look at flowers

Smell: smell flowers/scents

Compare: smell more than one flower/scent

Analyze: use wheel to find out answer

Social interaction: exhibit related only (e.g., talking about the exhibit, using it with others)

Misuse: flipping the wheels without purpose, playing with the supplies

Roots and Nutrients

Read main panel: posture must demonstrate obvious reading and/or read aloud

Read instruction panel: posture must demonstrate obvious reading and/or read aloud

Observe: look at plants

Measure: place nutrient meter in water for a few seconds

Compare: measure more than one sample with meter

Social interaction: exhibit related only (e.g., talking about the exhibit, using it with others)

Misuse: playing with the supplies

Parts of an *Amorphophallus*

Read field notes: posture must demonstrate obvious reading and/or read aloud

Turn pages in field notes: turn one or more pages

Read plant tags: posture must demonstrate obvious reading and/or read aloud

Observe: look at plants

Smell: smell scent

Compare: look back and forth between the field notes and plants

Social interaction: exhibit related only (e.g., talking about the exhibit, using it with others)

Misuse: flipping field note pages without purpose

Leaves Are Full of Holes

Read main panel: posture must demonstrate obvious reading and/or read aloud

Read instruction panel: posture must demonstrate obvious reading and/or read aloud

Touch: touch plant

Use tool: look in microscope and/or at monitor

Social interaction: exhibit related only (e.g., talking about the exhibit, using it with others)

Misuse: turning knob of microscope without looking in ocular; not turning on the light

Orchids that Look Like Insects

Read main panel: posture must demonstrate obvious reading and/or read aloud

Read instruction panel: posture must demonstrate obvious reading and/or read aloud

Observe: look at plants

Use tool: use magnifier(s)

Analyze: use flip panels to find out answer and note how many sets visitors used

Social interaction: exhibit related only (e.g., talking about the exhibit, using it with others)

Misuse: flipping the panels without purpose, playing with magnifiers

Digesting Insects

Read main panel: posture must demonstrate obvious reading and/or read aloud

Read instruction panel: posture must demonstrate obvious reading and/or read aloud

Observe: look at plants

Touch: touch plants

Measure: use acid meter to test at least one solution

Compare: measure both solutions with acid meter

Social interaction: exhibit related only (e.g., talking about the exhibit, using it with others)

Misuse: playing with supplies, not turning acid meter on

APPENDIX E
Exhibit Label Text

S-05: Helicopters, flutterers, and parachutes

A-panel:

Helicopters, flutterers, and parachutes

Seeds take to the air

Riding the wind to new places

Seeds have a better chance of growing if they travel to places with light, space, and water. Then they don't have to compete with their parents.

Shapes that float on air

Wind-dispersed seeds are either very tiny so they float in the air, or have special shapes to help them catch the breeze.

Labels to go with each tube:

#1

“Flutterers” have two wings that help them move like a butterfly.

Trumpet tree

Tabebuia chryotricha

to 50'

#2

“Parachutes” have feathery fibers that catch the air.

Salsify

Tragopogon dubius

to 3'

#3

“Helicopter” seeds have a single wing that makes them spin around.

Tipu tree

Tipuana tipu

to 40'

Also make one sign using:

“Helicopter” seeds have a single wing that makes them spin around.

Heteropteris purpurea

Climbing vine to 25'

F-15 Fragrant flowers

A-panel:

Fragrant flowers

Different smells for different pollinators

Scents attract

Flowers with strong smells, both sweet and stinky, attract animals that come for food or to lay eggs.

Smell the flowers. Turn the wheels to match each flower's smell with its pollinator. Bees like sweet smells. Bats like the smell of old fruit. Flies search for rotten meat, a good place to lay their eggs.

What's in it for flowers?

Flowers attract visiting animals that carry pollen from one flower to another. These flowering plants need their pollinators to reproduce.

Pollinator wheel labels:

Smell each flower, then match the pollinator with its favorite scent.

bee: likes sweet smelling flowers

fly: attracted to rotting meat smells

bat: visits flowers with fruity smells

C-101: Digesting insects

A-panel:

Digesting insects

How pitcher plants do it

Bugs fall in but can't get out

These plants trap insects in their pitchers, where a digestive liquid awaits the unlucky victims.

Digestive juices break down prey

Pitchers hold a mixture of water and digestive liquids. As a pitcher catches more insects, the plant secretes even more enzymes and acids to dissolve its prey. The acid levels in pitchers can come close to the levels in our own stomachs.

Measure the acid level of the pitcher juice in the test tube. Compare it with the pure water.

Text for *Nepenthes* cross-section drawing

Nepenthes cross-section

Glands release enzymes and absorb nutrients

Clipboard:

To use the acid meter:

(Integrate text with acid meter drawing):

- 1. Power button: turn the meter on if there is no number on the screen.**
- 2. Use an eyedropper to place 2-3 drops of pitcher juice on the acid sensor.**
- 3. (point at display screen) Once the number has stopped changing, read the acid level.**
- 4. Clean off the acid sensor with a new tissue.**
- 5. Repeat steps 1-4 using drops of the pure water for a comparison.**

Acid scale

The acid scale is a little tricky: the higher the number, the lower the acid level is.

See diagram

1.0 – 8.0

more acid to less acid

stomach acid

pure water

L-55: Leaves are full of holes

A-panel:

Leaves are full of holes

Tiny pores open and close

Doorways for water and air

Use the microscope to see the stomata in this leaf. Look for the green cells that surround each tiny pore.

Stomata open to let oxygen, water vapor, and carbon dioxide in and out. Without stomata, plants couldn't get the gases they use in photosynthesis to make their own food.

All leafy plants around you have stomata.

Clipboard:

Can you find the stomata under the microscope?

(with photos from microscope – field of stomata, and zoom shot)

- 100 times life size
- 200 times life size

Look for the slit openings. These are the pores called stomata.

Carbon dioxide enters through the stomata. Water vapor and oxygen escape the leaf through the same holes.

F-11: How sweet is it?

A-panel:

How sweet is it?

Sugary nectars

Flowers make nectar to attract animals

When animals drink nectar, they also collect pollen and carry it to other flowers. Plants use this pollen to make new seeds.

Some nectars are sweeter than others

Every pollinator has different sugar preferences. Bees need nectar with a very high percentage of sugar for energy and to make honey. Measure the sweetness of these nectars to find out which attracts bees.

Clipboard:

Use the refractometer to measure the amount of sugar in these liquid nectar samples. (This will take about five minutes.)

1. Open the plastic flap. Clean the flap and the blue window.
2. Place 2 drops of nectar on the blue window. Close the flap.
3. Hold the refractometer toward a light and look through the eyepiece.
4. Look for the line where the blue and white zones meet on the scale. This line shows the percentage of sugar.
5. Do this for each nectar sample.

(include illustrations in instructions)

Flip:

(Cover)

Which flower do bees prefer?

Lift for answer

(Inside)

Bees prefer lavender.

(Also include graphic with chart of sugar percentages & pollinator preference ranges. Line graph, showing overlapping ranges)

Add label for scale:

% sugar in nectar

O-34: Roots and nutrients

A-panel:

Roots and nutrients

Resources from soil and water

Supply lines

Most plants have their roots underground, absorbing water, nutrients, and minerals. Roots transport these necessary supplies to the rest of the plant.

Roots in water

These plants are growing in water so you can see their roots. One of these plants is growing in water that contains minerals and nutrients to keep it healthy. The other solution is purified water.

Clipboard text:

Measure the nutrient levels of both water samples.

With clipboard illustration:

- 1. Insert the meter in the sample area.**
- 2. Wait 5-10 seconds.**
- 3. Read the meter when the lights are flashing steadily. The higher the number, the more nutrients there are.**
- 4. Gently shake the meter before repeating the test for the second sample.**
- 5. Decide which plant is growing in water with nutrients. Does it look healthier?**

C-94: Orchids that look like insects

A-panel:

Orchids that look like insects

Fooling pollinators

Flowers in disguise

Some of these orchid flowers have evolved to look and smell like female insects. When a male insect tries to mate with a flower, the orchid glues pollen onto its back. If he visits another orchid flower that looks like a female insect, he'll deliver the pollen. The insect won't successfully mate, but the flowers will — by using the pollen to make seeds.

Flipbook #1

Large text panel:

(with illustrations of hairy fly – one large, and a “swarm” of them at actual scale)

Comparing insects to orchids

Choose the orchid that evolved to look like the hairy fly. Lift the flaps to check your answer.

Hairy fly

Door #1

Trichoceros tupaipi

You're right! This flower is imitating a hairy fly.

Text for illustration:

- wings
- hairy abdomen

Door #2

Pleurothallis aspergillum

Try again. Check a flower that has hairy-looking parts.

Door #3

Masdevallia exquisita

Try again. Which flower has petals that look like stubby fly wings?

Flipbook #2

Large text panel:

(with illustrations of tiny gnat – one large, and a “swarm” of them at actual scale)

Comparing insects to orchids

Choose the orchid that evolved to look like the tiny gnat. Lift the flaps to check your answer.

Door #1

Oncidium incurvum

Try again. Which flower has parts that look like gnat's wings?

Door #2

Lepanthes calodyction

You're right! This flower is imitating a tiny gnat.

Text for illustration:

- thorax
- wings
- legs

Door #3

Masdevallia wendlandiana

Try again. Can you find a flower that looks like it has the legs of an insect?

Flipbook #3

Large text panel:

(with illustrations of tropical bee – one large, and a “swarm” of them at actual scale)

Comparing insects to orchids

Choose the orchid that evolved to look like the tropical bee. Lift the flaps to check you answer.

Door #1

Masdevallia sanctae-inesae

Try again. Which flower looks like it has two bees visiting it?

Door #2

Pleurothallis pyrsodes

Try again. Look for a flower that has areas of color that match the bees.

Door #3

Trigonidium species

You're right! The flower of this orchid is imitating two shiny bees.

Text for illustration:

- two bee abdomens