

Cracking Open a Cold One with the Flies

ELISE CUTTS
Office of Strategic
Communications

Crack open a beer outside and it is a safe bet that you will soon be defending it from a few unwelcome drinking buddies. Fruit flies have a knack for appearing whenever someone opens up a can of beer or a bottle of wine, but how do they do it? In a study spanning six years and thousands of experiments, Caltech scientists discovered that fruit flies are attracted to carbon dioxide (CO₂), a gas associated with their favorite foods—and some of our favorite beverages. The research overturns earlier scientific consensus that flies avoid CO₂.

The work was done in the laboratory of Michael Dickinson, the Esther M. and Abe M. Zarem Professor of Bioengineering and Aeronautics. A paper describing the research appears in the November 21 issue of the journal *Nature*.

The study, led by former postdoctoral scholar Floris van Breugel (PhD '14), now an assistant professor at the University of Nevada, Reno, resolves a paradox surrounding fruit flies' response to CO₂ that had puzzled scientists for decades.

"The scientific literature about insects broadly shows that CO₂ is a universal attractant," explains



Credit: Floris van Breugel

Dickinson. "But a long series of papers claimed that fruit flies are averse to CO₂. They're basically the only insect for which that was reported."

That fruit flies would avoid CO₂ was especially confusing because flies eat yeast, single-celled fungi that produce CO₂ as they ferment sugars. "Drosophila melanogaster, the standard laboratory fruit fly, evolved to eat the yeast that lives in fermenting fruit. It is a yeast specialist, and not just a yeast specialist but basically a brewing yeast specialist. The flies co-evolved with humans to live off of what we use to make beer and wine," says Dickinson.

Appropriately, it was a home-brewing project that inspired van Breugel to pursue this line of inquiry: As he thought more about fermentation, he began

to believe that, contrary to the findings of other scientists, flies ought to be attracted to CO₂. Van Breugel set up a preliminary experiment that confirmed his hunch and drew him further into the problem.

Van Breugel was working with mosquitoes at the time, doing experiments in the Dickinson Lab wind tunnel, a large, open chamber within which mosquitoes or flies could fly around or land on a platform from which plumes of CO₂ are released. Cameras tracked the insects' movements within the tunnel and over the platform. "I thought, 'Why don't I put some flies in the same arena and see what they do?'" van Breugel says.

"After I ran the experiment, I found that the flies had actually

crawled through the tube where the CO₂ was being emitted into the wind tunnel—they just kept crawling! So that confirmed that they are, indeed, attracted to CO₂ and that I should really investigate that more closely," he says.

After this first experiment, van Breugel and his co-authors continued studying flies in the wind tunnel and in other experimental setups designed to test how factors like time of day and wind speeds impacted their CO₂ response. The researchers found that flies seek out CO₂ when in an active state but avoid it while sluggish—for example, when they are sleepy or simply moving slowly because of factors like high winds or hunger. This observation resolved the apparent contradiction between the Dickinson Lab's results and those other studies showing that flies avoided CO₂; the setups of earlier experiments likely caused the flies to become inactive.

To van Breugel, this experiment is an important lesson for researchers: "If we want to understand how an animal functions, how the brain works, or even how genes function, we can't just be looking at animals in some very artificial laboratory environment. If you're going to do neuroscience, you need to make sure you're considering the behavioral and ecological context of the animal."

Why do flies avoid

CO₂ when less active? Dickinson sees the behavior as a balance between the reward of proximity to food sources and the risk of danger. For example, since CO₂ is produced by animals when they breathe, it attracts predators like parasitoid wasps, which lay their eggs on fruit fly eggs, larvae, and adult flies. "So, if a fly is going to sleep and not trying to find food, it wouldn't want to be near a gas that is going to attract things that are trying to eat it and its babies," he says.

Dickinson and other researchers are still working to determine the biological clockwork underpinning how flies and other animals make "choices" like this one. "Our research lays the groundwork for experiments that will help us understand how decision-making happens in a fly, which is a good model for making a first pass at how decision-making might happen in other kinds of animals, eventually even humans," says van Breugel.

The paper is titled "Distinct activity-gated pathways mediate attraction and aversion to CO₂ in *Drosophila*." Ainul Huda, manager of the Dickinson Laboratory, is also a co-author. Funding was provided by the National Institutes of Health and the Simons Foundation. Michael Dickinson is an affiliated faculty member of the Tianqiao and Chrissy Chen Institute for Neuroscience at Caltech.

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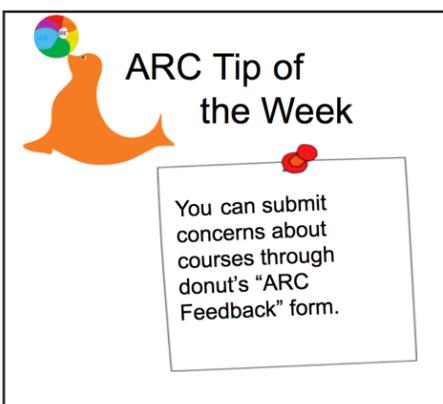
ARC Minutes

Meetings are every week in SAC 13

ARC Meeting Minutes – Retreat 11/30-12/2

Present: Erika Salzman, Arushi Gupta, Daniel Neamati, Alice Jin, Alycia Lee, Alejandro Lopez, Kavya Sreedhar, Simon Lequar

1. SFC
 - a. Will be held Friday, March 8
 - b. Topics for morning session to be announced soon!
 - c. Option committee sessions are being planned by their respective chairs
2. Unit Caps
 - a. Plan to survey people on opinions about new unit cap system, which was put in place at the beginning of the 2016-2017 school year
 - b. Wondering if this has allowed people to do more research and extracurriculars, or if people are just sitting in their rooms watching more Netflix
 - c. Opinion of whether they liked it or not and what reasons
 - d. What did they do afterwards? Petition, just accept it? Planning to take more classes? Did you feel like you had more free time/get more involved in clubs?
3. Academic Year Research
 - a. Research list
 - i. Last year there was a research list, asking faculty members if they would be interested in having undergrads working in their labs during the academic year
 - ii. Idea: reach out to grad students as well as professors – know what sort of projects they will be working on, or more specifics
 1. Can get responses through GSC
 2. Get people to bring it up in a group meeting, and write a short blurb for the list
 3. Grad students would need to go to PI anyway before answering form
 4. Send it to one point person grad student who can share with the rest of the lab? This would be a lot of work on our part
 5. Put responsibility to ask PI on the grad student, like “be sure your PI is ok with this”
 6. Have SFC option committees bring this up with faculty in that department? Ask if this is the best system to do it
 7. Some professors are involved and would meet with them 1-1, but many won’t
 - iii. Event or mixer to find people, instead of having a list?
 1. Hard to get people to show up to an event
 2. People looking for research during different terms
 - iv. Have option reps send it out in the department, instead of provost’s office
 - v. Facilitate ease of grad students to do this or talk to PI about this
 - vi. Announcement of opportunity page for SURFS lists type of project rather than list of professor
 1. Some professors value barrier to entry of having students actually do research
 2. Grad students would have a specific project/description in mind
 3. Description of research field may fulfill this role; hard to get profs to be more specific or do more
 4. Have research blurb on list?
 - b. Another idea is making a FAQ list of how to get research and logistical questions of how things work
 - i. How to email profs, etc.; how the academic world works if your parents weren’t PIs or whatever
 - ii. Put together a list just on the ARC website – low effort and might be helpful (nice small project)
 - iii. People tend to rely on upperclassmen
 - iv. Some questions:
 1. How do I write an email to a professor?
 2. What do you do in a lab? General structure? (varies)
 - a. Difference between professors, post docs, associate professors, etc.
 - v. List of undergraduate students who have worked in a lab? Just people who are willing to talk about lab culture and stuff
 - vi. What is okay in labs? Overstepping bounds and things? Power dynamic/work experience – could go under a culture discussion
 - vii. What kind of training do I need? Animal research paperwork. Wearing long pants on a lab tour
 - viii. How you can be compensated? Credit or payment
 - ix. How to first reach out to your grad student mentor?
 - x. How to find a lab? Transition from pizza class to lab opportunity?
 - xi. Timescales; you won’t get a lot done if you are only planning to be there for three months (things take longer as you get more towards life sciences); funding operates on a different timescale, may have funding in one term but not in another
 - xii. Levels of how involved you get; CS students getting code monkey jobs in other departments (coding project could also be useful for internship experience) – difference between CS SURFs and SURFs using CS (just coding)
 - c. Some departments allow research credits to count for major (e.g. BioE allows 9 to replace an elective)
 - d. Potentially bring this up in the SFC
4. Posting grades
 - a. Some way to get midterm grades required, or having some way of knowing how you are doing as the term progresses
 - b. Way to get numbers for every assignment (it’s already written somewhere, would be ideal if we could get it posted online)
 - c. Asking people to post information on moodle?



ASCIT Minutes

Meetings are every week in SAC 13

ASCIT Board of Directors Meeting

Minutes for 30 November 2018. Taken by Rachel Sun.

Officers Present: Sakthi Vetrivel, Erika Salzman, Sarah Crucilla, Varun Shanker, Dana He, Alice Zhai, Rachel Sun

Guests:

Call to Order: 12:18 PM

President's Report (Sakthi):

- A survey was sent out regarding the budget to give feedback. There were a lot of people who had a lot of non-budget related issues. If anyone has any questions or issues, feel free to email Sakthi. We would like to thank the student body for giving us feedback on the budget.
- Meeting with Felicia on Wednesday regarding safety at interhouses. Page interhouse was cancelled because too many people were sent to the hospital and security was stretched thin. Orange watch ideas included incentives for people who volunteer and for them to patrol the houses.
- We would like to cut midnight pizza during prefrush weekend from the budget and have admissions cover it. We would fund alternative events during interhouses instead.
- ASCIT retreat is this weekend. We will have minutes from that retreat as well.
- For next term, interim social director is David Berger and interim treasurer is Irene Chang.

Officer's Reports:

V.P. of Academic Affairs (Erika):

- Student faculty lunches happened this week. About 60 undergrads and 8 professors attended.
- SFC special committee topics will be sent out and sign-ups will be sent out soon.
- ARC retreat is this weekend.
- Betty Wang volunteered to chair the SFC Social Sciences committee. Contact her if you have any questions or if you would like to be on the committee.
- A survey for course capture for 2nd term will be sent out soon.

V.P. of Non-Academic Affairs (Sarah):

- Talked about interhouse schedule. Avery is thinking of moving their interhouse date.
- Met with Orange Watch committee – we are focusing on 3 major topics:
 - o Write an MHF grant
 - o Make Orange Watch training better
 - o Oversee Orange Watch and parties a little more
- IHC will be looking over what their role will be (e.g. what they will be doing for the rest of the year).

Director of Operations (Varun):

- Nothing to report.

Treasurer (Dana):

- The budget was sent out to the student body. Further discussions about the budget will happen this weekend.

Social Director (Alice):

- LA Zoo Lights is happening tomorrow.
- Puppies/reptiles petting party in the RF courtyard is happening next Friday 12:30-2 PM

Secretary (Rachel):

- Nothing to report.

If anyone has any questions or concerns about a section of the minutes please email the appropriate officer. We are happy to answer any questions.

Meeting Adjourned: 12:49 PM

ASCIT Board of Directors Meeting – Budget Discussion

Minutes for 1 December 2018. Taken by Rachel Sun.

Officers Present: Sakthi Vetrivel, Erika Salzman, Sarah Crucilla, Varun Shanker, Dana He, Alice Zhai, Rachel Sun, David Berger, Irene Chan

Guests: None

Call to Order: 3:00 PM

Discussion of the budget survey concluded in:

- *MHF and Marsh funding has changed this year (it has been cut and our contributions have gone up to keep events running). Taking this into consideration, we have made the following decisions:*
- Giving \$200 (from \$0) to the BoC for basic operation needs.
- Keeping ditch day budget the same. We are maintaining the increase from two years ago.
- Doughnuts and pizza budget: overall goes down to \$4000
 - o Weekly donuts and bagels will be kept the same: \$1500
 - o Midnight Donuts: only spend \$600 next term, and \$900 third term for hosting Midnight Donuts during Prefrush Weekend (ASCIT will no longer be paying for pizza, and we will be looking for other funding sources for that).
 - o We will be buying fewer doughnuts and implementing methods to reduce the amount of wasted donuts.
- ASCIT Formal: the allotted budget is not changing as money was reallocated within this event; there will not be open bar at ASCIT Formal. We do not know how much money we will be getting from MHF, so the number for this event is tentative.

Meeting Adjourned: 4:01 PM

IHC Weekly Public Meeting

From the voting members of the IHC:

In the interest of properly representing our discussions without needing to summarize due to space restrictions, the IHC's meeting minutes will be published in full on our website at ihc.caltech.edu/minutes.html. We would like to make sure the reasoning behind our conclusions is portrayed in full and apologize for the inconvenience.

Upcoming Events

EDITORS-IN-CHIEF

The Upcoming Events column serves to inform students of upcoming events. The list is compiled by the Editors-in-Chief from information available around campus.

American Red Cross Blood Drive

Monday and Tuesday, January 7th and 8th | 12-6 PM | Holliston

To schedule an appointment, please log onto www.redcrossblood.org enter sponsor code: CALTECH or contact your American Red Cross Rep, James Terrones, at 626-437-7893 or James.Terrones@redcross.org

Streamline your donation experience and save up to 15 minutes by visiting RedCrossBlood.org/RapidPass to complete your pre-donation reading and health history questions on the day of your appointment.

1-800-RED CROSS | 1-800-733-2767 | RedCrossBlood.org | Download the Blood Donor App

Caltech Library Workshop: Overview of Library Resources

Wednesday, January 9th | 2 PM | Sherman Fairchild Library 328 (Multimedia Conference Room)

This class will give a quick overview of Library services, collections, and databases. We'll talk about DocuServe, CODA, finding print and eJournals, our locations and Open Access. Whether you're new to campus or have been here for years

this class will help you make use of all that the Library has to offer.

Register: <https://libcal.caltech.edu/event/4975524>

Tackle the Term - Workshop on productivity without procrastination

Friday, January 11th | 12 PM | Avery Library

Counseling Services is pleased to offer Tackle The Term, a 1-hour workshop for grads and undergrads to help you start the term off right. We'll focus on effective ways to keep a schedule, find an ideal place to work, decide how best to spend your time, and what to do when your plans fall off track. We'll also review some popular apps that can help you stay on top of your work and avoid procrastination. Free lunch is provided on a first-come basis! We'll meet from 12:00 - 12:55 in Avery Library.

Contact Lee Coleman at (626) 395-8331

How Learning Works: Creating Inclusive Environments in STEM (and Everywhere)

Monday, January 14th | 12-2 PM | Beckman Institute Auditorium

Decades of higher education literature have documented how the classroom climate can be "chilly" for various groups of students. We now have evidence that a chilly climate has an adverse impact on learning and other outcomes. In this workshop, we will use the principles of learning from the book *How Learning Works: 7 Research-Based Principles for Smart Teaching* as a lens of analysis, focusing on how climate can impact the

major determinants of learning. We will explore the research behind these claims, use the theories to ground our discussion of classroom case studies from STEM and other fields, and develop ways of creating an inclusive and productive climate for all students.

Biography:

Dr. Michele DiPietro is the Executive Director for Faculty Development, Recognition, and the Center for Excellence in Teaching and Learning and a Professor in the Department of Statistics and Analytical Sciences at Kennesaw State University. They are also Chair of the Georgia Consortium of Centers for Teaching and Learning, a former President of the POD Network in Higher Education, the premiere faculty development association in North America, and a former Board Member of the International Consortium for Educational Development (ICED). With their former Carnegie Mellon colleagues, Dr. DiPietro is a co-author of "How Learning Works: 7 Research-Based Principles for Smart Teaching." The book was listed at #3 in a "Top 10 Books on Teaching" list on the Chronicle of Higher Education. Their scholarly interests include learning sciences, academic integrity, diversity and inclusion, the Millennial generation, statistics education, the consultation process in faculty development, and teaching in times of tragedy. They have presented hundreds of workshops and keynotes at numerous colleges and conferences, in the US and abroad, and some of their scholarship has been translated into foreign languages (Chinese, Hebrew, Italian, Japanese, Korean, Spanish, and Arabic). They won

the POD Innovation award for the online consultation tool "Solve a Teaching Problem." Their innovative course "The statistics of sexual orientation" has been featured on the Chronicle of Higher Education and several other magazines. Dr. DiPietro is the 2015 recipient of the Bob Pierleoni Spirit of POD award, the highest honor bestowed in the field of educational development for professional achievement and legacy to the field.

PART OF TeachWeek Caltech, a campus-wide celebration of teaching and learning, featuring events and discussions with Caltech faculty and students, as well as distinguished guest presenters. All events are open to the entire Caltech community.

This event is also part of the Inclusive Caltech Core project, a two-year initiative with support from the Association of American Universities.

Book Lovers' Soiree

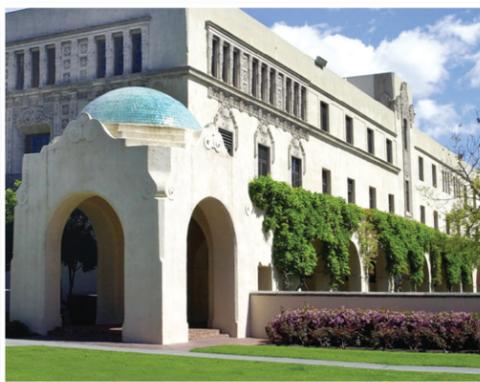
Monday, January 14th | 7:30 PM | Athenaeum

The evening book group meets on the second Monday of the month. We gather for a casual, informal discussion of the selected book from 7:30 to 9:00 pm at the Rath al Fresco during the summer months or the Rathskellar during the school year. Feel free to join us on a regular basis or just drop in occasionally for a particular book discussion.

January 14 - A Piece of the World by Christina Baker Kline

Contact Sonya Wierman sonyawierman@gmail.com

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Omer Tamuz,
Assistant Professor of Economics & Mathematics,
Caltech Division of the Humanities & Social Sciences

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-gocaltech.com

Women's Basketball Takes Oxy to Limit

GOCALTECH.COM

Actual Sports Content Editor

the second quarter.

PASADENA (Jan. 5, 2019) – For the second game in a row, the Caltech women's basketball team came within one basket of claiming its first SCIAC win of the year against visiting Occidental College on Saturday afternoon.

The Beavers got out to a great start, particularly on the defensive side of the ball. Caltech held its conference rival to just four points in the first quarter and eight points in the ensuing quarter. Meanwhile, the Beavers' offense began to pick up the pace with 15 points in the second quarter, taking a 23-12 lead into halftime. The Tigers battled back in the second half and ultimately came out on top with the game coming right down to the wire. The back-and-forth contest produced three lead changes, and the host Beavers led by as many as 14 points part way through

Two Caltech players found themselves in double-figures. Junior guard Grace Peng (San Ramon, Calif. / California) led the home team with 12 points and also helped pace the Beavers with six rebounds and three assists. Additionally, senior guard Nika Haleftiras (San Diego, Calif. / Our Lady of Peace) came on strong in the second half and finished with 11 points and three rebounds. Junior forward Alexa Lauinger (Ortonville, Mich. / Brandon) also played well, going 3-for-3 from the field without committing a turnover. Caltech also got the better of Oxy in the rebounding department with a plus-seven rebounding margin.

Head Coach Bridgette Reyes and the Beavers will return to action on the road this Wednesday when they take on the University of La Verne at 7 p.m.

Caltech Holds Unbeaten Oxy to Season-Low Total



Coach said to fake right and break left.

Photo by Bob Paz.

GOCALTECH.COM

Actual Sports Content Editor

PASADENA (Jan. 5, 2019) – The Caltech men's basketball team met up with Occidental College for the second time this season and once again held the undefeated Tigers to their lowest point total of 2018-19. The Beavers previously accomplished that feat in the 110 Rivalry game, as no team had held the Tigers to fewer than 68 points since. On Saturday, Caltech held its conference rival to 61.

"We are progressing," Head Coach Dr. Oliver Eslinger said. "Our league is very good and it's important we continue to stay the course. Our defense gave us a great chance tonight and we executed well. Our team knows we can compete with anyone and it's a really great group."

The Beavers effectively carried out their gameplan over the game's first 15 minutes, effectively attacking some of Oxy's top playmakers and handing out a couple early fouls while attempting to control the tempo. Through the first 13 minutes of action, the Beavers led the Tigers by one with both teams struggling to break the 20-point threshold. Both teams did well in taking care of the basketball but the Beavers succeeded in decreasing the turnover differential in their favor with just 11 turnovers to Oxy's nine.

The visiting team's length broke up the Beavers' ability to catch and shoot with Caltech assisting on just 10 baskets, although still finding ways to the basket. Three players finished in double-figures for the home team, including freshman

Noah Barnes (Springfield, Va. / Jefferson) and sophomores Marcus Gee (Santa Monica, Calif. / Santa Monica) and Spencer Schneider (Houston, Texas / Clearbrook) with the latter two each scoring 13 points. Each of the three also contributed with their own highlights. Barnes scored 10 of his points in the first half and used his athleticism to create open looks, while Gee had a career rebounding day with eight boards and Schneider created his own fast break, going between the legs off a steal to finish in transition.

Caltech needed to lean on its starters more than usual on Saturday, particularly in the second half but ultimately showed signs of improvement from last Wednesday's SCIAC opener at California Lutheran University. However, the Beavers still recognize there is still room to grow and work to be done, particularly on the glass.

"I think we could have rebounded a lot better, especially on the defensive side of the ball," Gee said. "That was a big emphasis going into the game and I think we did for stretches and it showed in the box. But when we didn't rebound as well, that's when they had their runs. We also just need to knock down the open shots. We got the looks this time, but just didn't knock down as many as we would have liked."

Eslinger and the Beavers will have a quick turnaround when they host defending conference champion Claremont-Mudd-Scripps Colleges in the annual Orange Out game on Monday, Jan. 7.

SCORES

January 5, 2019

Women's Basketball vs. Occidental

L 45-47

Men's Basketball vs. Occidental

L 49-61

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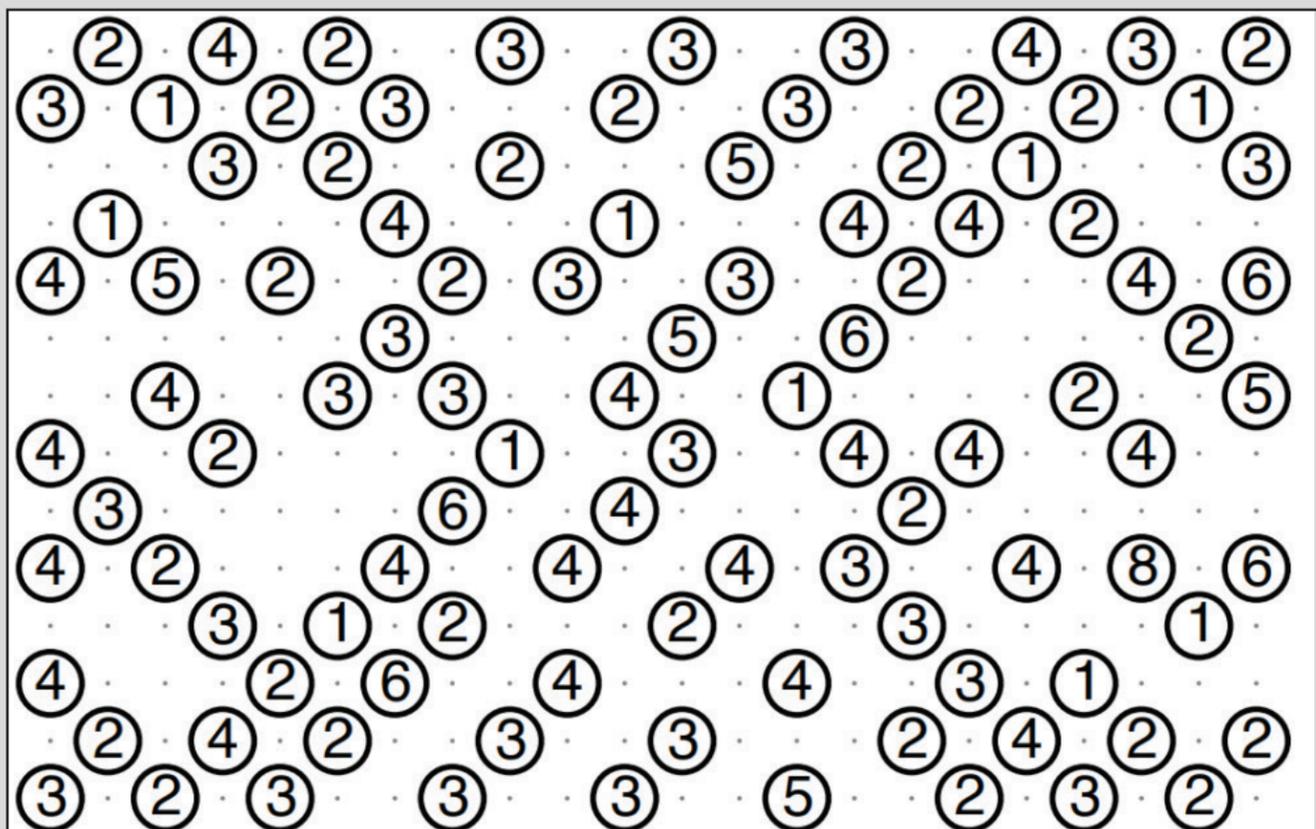
oh god how did i get here i am
not good at computer

Bridges

Got a new game here today that I wanted to see how people liked. It's called bridges or Hashiwokakero. The rules are as follows:

1. They must begin and end at distinct islands, travelling a straight line in between.
2. They must not cross any other bridges or islands.
3. They may only run orthogonally (i.e. they may not run diagonally).
4. At most two bridges connect a pair of islands.
5. The number of bridges connected to each island must match the number on that island.
6. The bridges must connect the islands into a single connected group.

Puzzles from crazydad.



2018-2019 ASCIT Budget

A. Rhoads

2018 - 2019 Budget

Operations \$2

Operational Costs \$0

ASCIT Teaching Awards \$0

IHC \$2

ARC \$0

ASCIT Screening Room Renovations \$0

Special Events \$0

Ditch Day \$0

Student Faculty Conference \$0

Social Events \$107,698

Donuts, Bagels, Pizza \$37,075

ASCIT Formal \$70,623

Interhouses \$0

ASCIT Social Events \$0

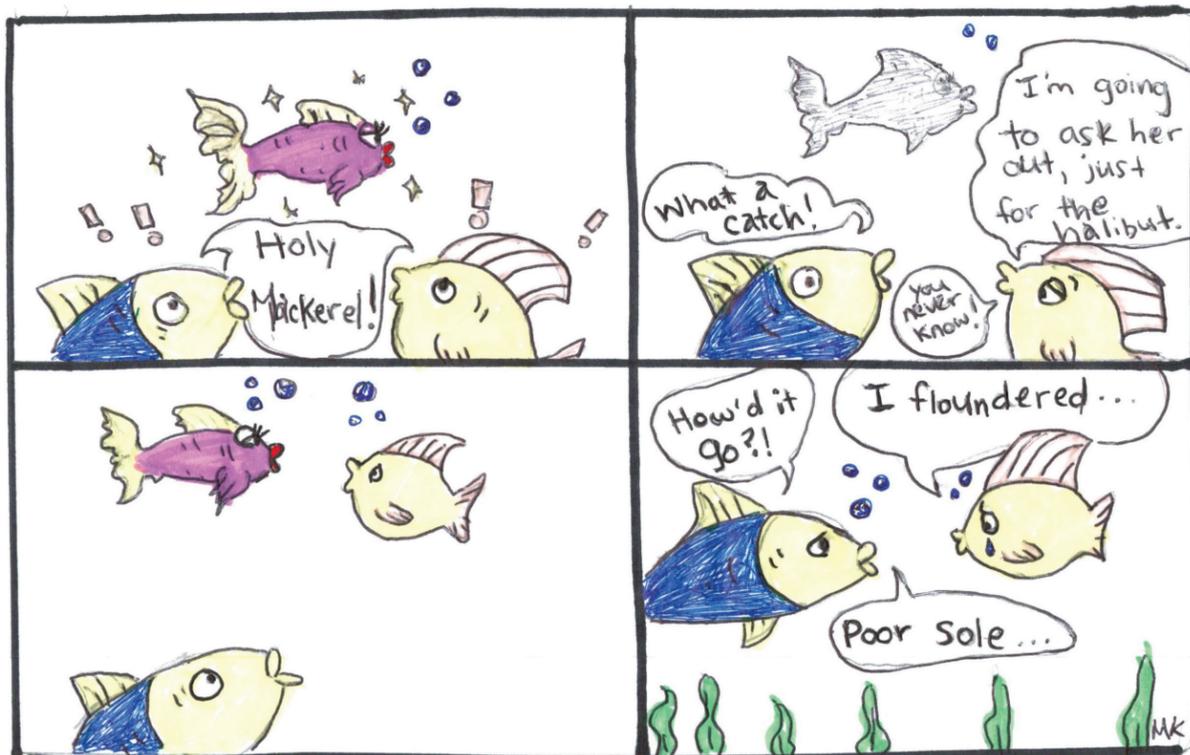
Other Events \$0

Senior Boxes \$0

Clubs \$0

Total \$107,700

Answers to Puzzles and Crossword:
<http://bit.ly/2rg25fr>



Meghan Kuroda (b. ????)
 CCF19112018.pdf, 2018
 Ink on paper.

The California Tech

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We are always accepting submissions for comics, and will pay you.

Letters from the Editors-in-Chief

Amrita Rhoads: hi fams! Since all y'all frosh are now eligible for campus jobs, I'd really encourage contacting us if you're remotely interested in working on the Tech!
 Sophie Piao:

Milan Roberson: I've gotten back into Pokemon Go recently. It's pretty fun and the game is more functional than

when it was first released. I saw that PVP was leaked on Twitter recently. Add me if you want to 1v1 IRL I guess: 3804 4322 4554. Also @ASCIT where's the article explaining the budget?

Dan Xu: I'm dying tonite

This week's recommended The California Tech usage after reading is: Keeping warm during the cold winter months with an official California Tech newsprint sweater.

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