札幌市 定山渓温泉 鹿の湯
SHIKA-NO-YU Hot Spring Hotel, Jozankei, Sapporo

2016 年 11 月 3–5 日
November 3-5, 2016

The 32nd Annual Meeting of the Society of Population Ecology

第 32 回 個体群生態学会大会
プログラム・講演要旨集
Meeting Program & Abstracts

ORGANIZER: The Organizing Committee of the 32nd Annual Meeting
SPONSOR: Springer Japan

Cover photos (location)

1: Mt. Yotei (Niseko), 2: Whooper swan *Cygnus cygnus* (Nemuro), 3: Soft windflower *Anemone flaccida* (Ebetsu), 4: Hammerhead worm *Bipalium* sp (Ebetsu), 5: Mycoheterotrophic orthid *Cytosia septerntrionalis* (Ebetsu), 6: Rooting poison pie *Hebeloma radicosum* (Ebetsu), 7: Slime mold *Stemonitis acifera* (Ebetsu), 8: Eurasian red squirrel *Sciurus vulgaris orientis* (Ebetsu), 9: Sika deer *Cervus nippon yesoensis* (Nemuro).

Design and photos by Shinnosuke Kagiya (Poster presentation P-44)

C o n t e n t s

General information

Registration　受付
The Registration Desk is available from 15:00 to 17:45 on Thursday November 3, in the lobby (1F of the hotel). Make sure to receive your name tag, program booklet and a dinner ticket for November 3.

11/3 15:00-17:45 はホテル鹿の湯 1F ロビーに個体群生態学会参加受付デスクを設けます。この日時以降に到着の方は、3F 学会会場へ直接お越しの上、スタッフ名札を着けた者を通じて受付担当・谷川をお呼び出しください。

Check-out (November 5)　チェックアウト（11 月 5 日）
Return your room key to the front (1F) and bring your baggage to Main Hall (3F) by 8:30.

5 日（土）8:30 までにフロントに各部屋の鍵を返却してチェックアウトしてください。荷物は主会場「寒翠の間」（3F）にお持ちください。

Wifi connection　インターネット接続
Free wifi connection is available in the lobby (1F). The temporal wifi connection will also be set up in Main Hall (3F) for the meeting participants. The connection point, password etc. will be displayed in the room.

無料 wifi はホテル 1F ロビーにてご利用いただけます。学会大会参加者用の主会場「寒翠の間」（3F）接続ポイントについては会場内の掲示をご確認ください。

Photo　会場内での撮影・記録
Please be advised that you are responsible for the copyrights or portrait rights of photos and videos that you take during the meeting. Regardless of the presentation type, all photo-takers should be meticulously careful not to cause any inconvenience to scientific activity of the presenters.

著作権、肖像権を侵害しない範囲で行ってください。シンポジウム講演、ポスターなど、すべての形態の研究発表について、発表者に不利益が生じるかたちでの記録を決して行わないようにお願いいたします。

Executive Committee meeting　理事会
The committee meeting will be held from 14:00 on Thursday November 3 in Room 302. The Executive Committee members are expected of attendance.

3 日（木）14:00 から 302 号室で開催します。理事の方はご出席ください。

PES general business meeting　総会
The general business meeting will be held from 17:00 on Friday November 4 in Main Hall. All PES members are highly encouraged to attend the meeting!
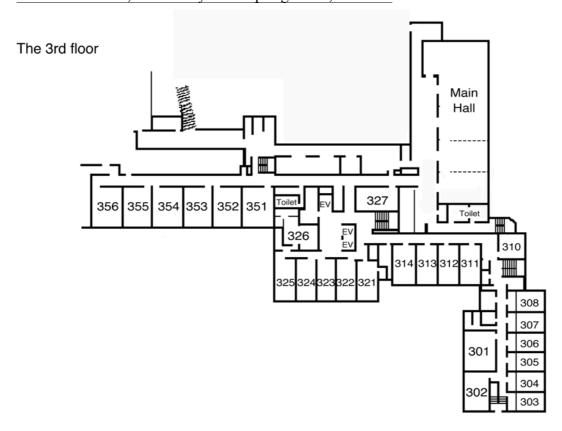
4 日（金）17:00 から主会場「寒翠の間」で開催します。今回の大会参加を機に入会された方々を含めて会員の皆様におかれましては、ぜひご参加いただきますようお願いいたします。

Schedule

Thursday, November 3		
15:00-17:45	Registration	Lobby (1F)
16:00-17:45	**Organized session**: *Invitation to Young Ecologists: Enthuse over Your Research and Amuse Your Audience – part 1* (English presentation and Japanese talk)	Main Hall (3F)
18:00-19:00	Dinner	Restaurant (4F)
19:00-21:00	**Contributed presentations** (Poster in Japanese and English)	Main Hall (3F)
21:00-23:30	Drinking party (Discussion time!)	Room 301
Friday, November 4		
7:00- 8:30	Breakfast	Restaurant (4F)
8:30-11:30	**Plenary symposium**: *Evolutionary demography: the dynamic and broad intersection of ecology and evolution* (English)	Main Hall (3F)
11:30-12:30	Lunch	Restaurant (4F)
12:30-15:00	**Organized session**: *Invitation to Young Ecologists: Enthuse over Your Research and Amuse Your Audience – part 2* (English presentation and Japanese talk)	Main Hall (3F)
15:00-16:00	**Contributed presentations** (Posters in Japanese and English)	Main Hall (3F)
16:15-17:00	**Lecture by the 10th Population Ecology Young Scientist Awardee**: *How does rapid evolution alter the theory of population ecology?* by Dr. Masato Yamamichi (English)	Main Hall (3F)
17:00-18:00	**General business meeting of the Society**	Main Hall (3F)
19:00-21:00	**Banquet**	Shoun-no-ma (4F)
21:00-23:30	Drinking party (Discussion time!)	Room 301
Saturday, November 5		
7:00- 8:30	Breakfast	Restaurant (4F)
- 8:30	Check out (return the room key to the front)	
8:30-11:30	**General symposium**: *New horizons in time series analyses* (English)	Main Hall (3F)
11:30-12:30	Lunch	Restaurant (4F)
12:30	Closing of the Meeting	

Venue and Access

<u>Venue: 3rd Floor, Shika-no-yu Hot Spring Hotel, Jozankei</u>

The 3rd floor

Make yourself at home on the 3rd floor which is booked out for the PES 32 Meeting, including Main Hall for the Sessions and guest rooms. The restaurants are located on 4F (see p.5) and the Large Bath (spa, open 13:00-3:00 and 4:00-9:30) on B1F.

* <u>Only one key is available per guest room</u>. Bring the key to the front every time you lock the room, and pick it up when you return. (Alternatively, nominate a 'key person' to carry the key around.)
* You can wear slippers and yukata (summer kimono/casual onsen wear) in the hotel.
* Yukata of different sizes are available by the elevators near the front on 1F.
* Bring the towels from your room to the Large Bath. If necessary, ask to change for a new (clean/dry) towel at the front.

主会場「寒翠の間」と客室がある 3 階は個体群生態学会の貸切です。各食事会場は 4 階（p.5 参照）、大浴場（入浴時間 13:00-翌 9:30（3:00-4:00 除く））は地下 1 階です。
* <u>鍵は各客室につき一つです。食事・入浴の際は鍵をフロントにお預けください。</u>
* 館内はスリッパ、浴衣でご利用いただけます。
* 1F フロントそばエレベーター前に各サイズの浴衣が用意されています。（客室用意の
　浴衣のサイズが合わない場合は、そちらでお取り替えください。）
* 客室用意のタオルを大浴場にお持ちください。（大浴場内にはタオルはありません。）
　フロントで新しいタオルとの交換を承ります。

Meals

	Breakfast	Lunch	Dinner
Thursday Nov. 3			**18:00-19:00 (fixed time)** Buffet-style, <u>ticket required</u>[1] (Restaurant 華宴, 4F)
Friday Nov. 4	**7:00-8:30** Buffet-style (Restaurant 華宴, 4F)	**11:30-12:30** Pre-order[2] (Restaurant 華宴, 4F)	**19:00-21:00** Banquet (Shoun-no-ma I & II 翔雲の間 I & II, 4F)
Saturday Nov. 5	**7:00-8:30** Buffet-style (Restaurant 華宴, 4F)	**11:30-12:30** Pre-order[2] (Restaurant 華宴, 4F)	

1 A dinner ticket (provided at the registration) will be checked at the restaurant.

2 Pre-order lunch is available only with advance booking.

Room list

Room	Name			
303	Y. Morii	Squires	H. Mizumoto	Kawai
304	K. Morita	Oizumi	Nagamitsu	
305	Takada	Nishimura	Hirakawa	
306	Noda	K. Sato	Fukaya	
307	Okano	Nishiguchi	Mizuno	
308	Hase	Yashima	Watanabe	
310	Sakata	M. Hashimoto		
311	Yamaguchi	Tanigawa	Kazila	Chui
312	Morimoto	A. Fujiwara	Oyake	Nakazawa
313	Saitoh	Kishida	Araki	Utsumi
314	Takatsu	Kagiya	Murakami	Okuzaki
321	Kawatsu	Yamanaka		
322	M. Fujiwara	Shefferson	M. Morita	
323	Salguero-Gómez	Davis		
324	Liebhold	Johnson		
325	Ikegawa	Fujii	Sudo	
326	Takimoto	Asami	M. Kondoh	
327	H. Kato	Atsumi	Tanio	K. Hashimoto N. Mizumoto
351	Yamamichi	Takahashi	Dobata	Tachiki
352	Shimada	Yamauchi	Yamamura	Ohgushi
353	Matsuda	Tsubaki	Ishihara	Namba
354	Kobayashi	Kishi	Katayama	Hattori
355	Sahashi	Bessho	H. Kondo	Isaka
356	M. Katoh	Uno	T. Sato	K. Morii

Access to Shika-no-yu Hot Spring Hotel, Jozankei in Japanese only

　学会大会開会・閉会に合わせた会場の札幌定山渓・ホテル鹿の湯への交通は次の通りになります。1 については実行委員会への事前申込が必要で、先着順受付、定員になり次第締め切ります。2, 3 については各自で詳細確認の上、ご利用ください。

11/3（木・祝）　現地受付　15:00-17:45	11/5（土）　現地解散（昼食後）　12:30
1. 学会専用バス（鹿の湯提供・無料・要事前申込） ご利用希望の方は実行委員会まで、お名前・参加登録番号・希望日（3 日/5 日）とともにお申し込みください。（先着順・定員になり次第締切）	
14:00　北海道大学南門出発 　 --> 　15:30　鹿の湯到着予定 定員：30 名（「若手の学校」参加者を除く）	12:40　鹿の湯出発 　 --> 　13:40　札幌駅北口到着予定 定員：50 名
2. 新千歳空港-定山渓直通バス（北都交通・1,650 円・予約不要） http://www.hokto.co.jp/b_yuttari.htm	
14:00　新千歳空港国内線ターミナル 21 番乗り場 --> 　（所要約 100 分）15:40 頃　「定山渓湯の町」停留所下車	（定山渓午前中出発のため、利用不可）
3. 札幌駅-定山渓間のバス利用（じょうてつバス・770 円） 下記 a,b いずれでも、札幌駅は 12 番乗り場、鹿の湯は「定山渓湯の町」停留所利用 http://jotetsu.co.jp/bus/noriba.html	
a. 「かっぱライナー号」（直通・予約制） http://jotetsu.co.jp/bus/kappa_liner/kappa_liner.html	
14:00-14:58 15:00-15:58	12:39-13:38 13:39-14:38
b. 快速 7（所要約 70~80 分）	
14:30-15:40　「定山渓温泉」行 15:30-16:38　「豊平峡温泉」行 16:00-17:08　「豊平峡温泉」行	13:02-14:17 14:36-15:51 15:36-16:54

＊札幌市内で地下鉄を利用し、地下鉄南北線真駒内駅から定山渓へバスを利用することも可能です。札幌市内の詳しい交通案内については次のサイトをご参照ください。

http://ekibus.city.sapporo.jp/

＊各交通機関は時間の余裕を持ってご利用ください。

＊駐車スペースが限られているので自家用車でお越しはできるだけご遠慮ください。特別のご事情がある場合は、10 月 31 日までに実行委員会事務局にお申し出ください。

Instructions for Poster Presentations

Presentation and display

The Poster presenters can display their posters from 15:00 on Thursday November 3 to 19:00 on Friday November 4.

Each poster must be displayed on the assigned poster board. Please check your poster presentation ID number.

Each poster must be placed within the 90 cm wide by 182 cm high space provided. Push pins are provided by the committee.

Poster presentation time: 19:00 – 21:00 on Thursday November 3, and 15:00 – 16:00 on Friday November 4.

Poster Awards

The Society of Population Ecology will award young researchers presenting excellent posters. Graduate students and researchers who have received his/her Ph.D. degrees within two years are eligible for the competition. The entrants for poster awards are indicated with # (on the poster board and the program).

All the participants are cordially invited to vote for the poster award. Each participant will receive one voting slip at the meeting registration.

Please choose one excellent poster and write the poster presentation ID number on the voting slip.

The ballot box will be located on the 3rd floor around the poster presentation area. Cast your vote by 16:00 on Friday November 4.

One Best Poster and several Excellent Posters will be awarded based on the vote. The winners will be awarded in the banquet (19:00-21:00 on Friday November 4).

Program

Lecture by the 10th Population Ecology Young Scientist Awardee

16:15-17:00, November 4, 2016

[YSA] How does rapid evolution alter the theory of population ecology?
    Masato Yamamichi (Kyoto University)

Plenary symposium: *Evolutionary demography: the dynamic and broad intersection of ecology and evolution*

Orgainizers: Takenori Takada (Hokkaido University, Japan)
                Richard P. Shefferson (University of Tokyo, Japan)

8:30-11:30, November 4, 2016

Thirty years ago, Silvertown wrote, "Fitness is a relative measure of evolutionary advantage which is based upon the survival and reproductive success of individuals with different phenotypes. Natural selection is a demographic process". Demography is therefore central to understanding evolution. "Evolutionary demography" is an emerging research field that, in short, reconsiders the data on demographic rates and processes from the point of view of evolution. It enables us to understand comprehensively not only the life histories of species, but also the evolutionary origins of the underlying mechanisms at the heart of population and community dynamics. Furthermore, the databases named COMPADRE and COMADRE are now available on the Internet, which contain demographic data on about 1100 plant and animal species. It is now the right time to address key evolutionary questions with such big data. We, in this symposium, introduce the studies in evolutionary demography, such as the study on eco-evolutionary conservation and studies using human demographic data and the database of plant and animal species.

[S-11] Introduction: Long and winding road from demography to evolution
    Takenori Takada (Hokkaido University)

[S-12] The diversifiers of life history strategies in plants and animals
    Rob Salguero-Gomez (University Sheffield, University of Queensland, Max Planck Institute for Demographic Research, Trinity College Dublin)

[S-13] The influence of time since introduction on the population growth of invasive species and the consequences for management

○Hiroyuki Yokomizo (National Institute for Environmental Studies), Takenori Takada (Hokkaido University), Keiichi Fukaya (The Institute of Statistical Mathematics), John G. Lambrinos (Oregon State University)

[S-14] Evolutionary approaches to human demography: case studies on fertility decline
○Masahito Morita (SOKENDAI [The Graduate University for Advanced Studies], Kyoto University), Hisashi Ohtsuki, Mariko Hiraiwa-Hasegawa (SOKENDAI [The Graduate University for Advanced Studies])

[S-15] Eco-evolutionary conservation: managing a changing landscape in an evolutionary demographic context
Richard Shefferson (University of Tokyo)

Organized symposium: *New horizons of time series analyses*

Organizers: Takehiko Yamanaka (NIAES, Japan)
             Kazutaka Kawatsu (Ryukoku University, Japan)

8:30-11:30, November 5, 2016

It has been nearly 100 years since population ecologists started analyzing population time series, searching for evidence of endogenous population regulation. Prior to the adoption of time series analysis, ecologists would simply formulate population models and calibrated parameters until they visually resembled real data, an approach referred to as "shooting = trajectory matching" (Bolker 2008). It may be possible to construct a complex model which resembles the behavior seen in real data, but it is questionable whether such a comparison indicates that the model captures key mechanisms compared with other candidate mechanisms. Another common analyses involves cutting time series into fragments of specific length and applying regression to them – i.e. analysis of a "moving window". It has become clear that such moving window analyses (i.e., autoregressive models) are quite effective for detection of internal population regulation but such methods do not clearly discriminate external noise from internal regulation.

Recent advances in computational power enable computations involving massive numbers of iterations using widely available software. Such computer power has allowed the practical implementation of new tools for contemporary time series analyses. For example, Bayesian approaches can effectively overcome challenges of uncertainty in population time series by segregating external noise from internal regulations (Hobbs & Hooten 2015). Empirical dynamic modeling can detect causal relationships and interaction strength between interacting species among the multiple time series using nonlinear attractor reconstruction (Sugihara et. al. 2012). Descriptive statistics based on non-parametric regression can flexibly detect synchrony among multiple time series and differentiate the impacts of dispersal vs. regional stochasticity as synchronizing mechanisms (Liebhold et al. 2004).

In this symposium we have invited two Japanese and two international specialists of the time series analyses. Presentations will introduce several new techniques and concepts, applying them to actual ecological time series. We intend for this symposium to assist researchers with growing interest in this field as well as graduate students to understand key ecological questions in time series analysis and provide insight into which methods can effectively identify endogenous mechanisms from the noisy data.

REFERENCES

Bolker, B. M. 2008. Ecological models and data in R. - Princeton University Press.

Hobbs, N. T. & Hooten, M. B. 2015. Bayesian Models: A statistical primer for Ecologists. Princeton University Press.

Liebhold, A. M., Koenig, W. D. and Bjørnstad, O. N. 2004. Spatial synchrony in population dynamics. - Annual Review of Ecology, Evolution, and Systematics 35.

Sugihara, G., May, R. M., Ye, H., Hsieh, C.-h., Deyle, E. R., Fogarty, M. and Munch, S. 2012. Detecting causality in complex ecosystems. - Science 338: 496-500.

[S-21] Allee effect in pine wilt disease

○Takehiko Yamanaka (National Institute for Agro-Environmental Sciences), Takehisa Yamakita (Japan Agency for Marine-Earth Science and Technology), Yutaka Osada (The Research Institute for Humanity and Nature), Etsuko Shoda-Kagaya (Forestry and Forest Products Research Institute), Andrew M. Liebhold (US Forest Service Northern Research Station)

[S-22] A Bayesian approach to quantifying spatial variation in Allee effects

Derek M. Johnson (Virginia Commonwealth University)

[S-23] Interspecific Synchrony Among Forest Lepidoptera

○Andrew Liebhold (US Forest Service Northern Research Station), Maartje Klapwijk (Swedish Agricultural University)

[S-24] Identifying critical interactions in complex competition dynamics between bean beetles

○Kazutaka Kawatsu (Ryukoku Univeristy), Shigeki Kishi (National Institute for Environmental Studies)

Organized session: *Invitation to young ecologists: Enthuse over your research and amuse your audience*

Organizers: Yutaka Okuzaki (Field Science Center, Hokkaido University)
Osamu Kishida (Field Science Center, Hokkaido University)

Since its establishment in 1961, the Society of Population Ecology has been a gateway to success for a number of ecologists. It is no doubt that the driving force has been presentation opportunities and frank and unrestricted discussions in annual meetings. This year we organize an oral presentation session by young ecologists. Each presenter will take an advantage of a 30-minute slot to publicize their research activities, and the audience are invited to join the discussions. It is the first lodging-style meeting after nine years (the last one in 2007, also in Jozankei). Let's make the most of this mingling (and no-curfew) style to enjoy discussions over the presentations in this session and empower young researchers who bear the future of the study of population ecology.

Part 1: 16:00-17:45, November 3, 2016

[Y-01] Body size differentiation by prey size and reproductive interference in the ground beetle *Carabus japonicus*
    Yutaka Okuzaki (Hokkaido University)

[Y-02] A challenge for developing the system that aimed to detect distribution and quantify biomass of endangered species Itou (*Parahucho perryi*) simultaneously by using eDNA technique
    Hiroki Mizumoto (Hokkaido University)

[Y-03] Mechanisms maintaining intraspecific variation of material use in case-bearing caddisflies
    Jun-ichi Okano (Kyoto University)

Part 2: 12:30-15:00, November 4, 2016

[Y-04] Intraspecific competition over mating promotes the stable co-existence of competitive species
    Kazuya Kobayashi (Kyoto University)

[Y-05] Temporal dynamics of resistance in an exotic plant *Solidago altissima*: geographic variation of plant-herbivore interactions in native and invaded range
    Yuzu Sakata (Akita Pref. University)

[Y-06] Change, chance, and challenge
    Yuichi Isaka (Hokkaido University)

[Y-07] The mechanism creating intraspecific variation of termite building structures provides the evolutionary perspectives of collective behavior
    Nobuaki Mizumoto (Kyoto University)

[Y-08] To migrate or not to migrate: a view based on inter-population variation in a threshold trait and ultimate mechanism in salmonid fishes
    Genki Sahashi (Hokkaido University)

Contributed presentations (Posters)

19:00-21:00, November 3, 2016
15:00-16:00, November 4, 2016

[P-01] An ecological mechanism of genetic variation maintenance in a finite population focusing the difference in inheritance system between mtDNA and nuclear DNA
   Takashi Saitoh (Field Science Center, Hokkaido University)

[P-02] 農業害獣の管理−捕獲と防御のバランス−
   山村則男 （同志社・文化情報）

[P-03#] Effects of spatiotemporal evenness of releases of sterile insects on control of pests with limited mobility
   Yusuke Ikegawa (Ryukyu Sankei Co. Ltd, Okinawa Prefectural Plant Protection Center, University of the Ryukyus)

[P-04] Long-term (2002–2016) change in population densities of native white-spotted charr, and introduced brown and rainbow trout in a Japanese stream
   Kentaro Morita (Hokkaido Natl. Fish. Res. Inst)

[P-05] Analysis of population dynamics containing twofold stochasticity by Tuljapurkar's approximation
   Ryo Oizumi (Ministry of Health, Labour and Welfare)

[P-06] Selection of life history strategies under food web interactions
   Masami Fujiwara (Texas A&M University)

[P-07] Forest landscape affects pollen use and provision mass of a solitary mason bee, *Osmia cornifrons*
   ○Teruyoshi Nagamitsu (FFPRI), Mika F. Suzuki (Tsukuba Univ), Shotaro Mine (Tokyo Univ), Hisatomo Taki (FFPRI), Kato Shuri (FFPRI), Satoshi Kikuchi (FFPRI), Takashi Masaki (FFPRI)

[P-08#] Relationships between life history traits and imidacloprid resistance in the brown planthopper, *Nilaparvata lugens*
   ○藤井智久・真田幸代・松村正哉 （九州沖縄農研）

[P-09#] Latrine site selection of raccoon dog and the relation between selection and distribution of latrine sites
   ○Yuko Nakazawa, Takashi Saitoh (Hokkaido University)

[P-10] Contacts with large, active individuals intensify the predation risk of small conspecifics
   Aya Yamaguchi, Kunio Takatsu, ○Osamu Kishida (Hokkaido Univ)

[P-11] オジロワシの生物学的潜在間引き数（PBR）と風力発電環境影響評価
   ○松田裕之・谷圭一郎 （横浜国大）・島田泰夫 （日本気象協会）

[P-12] Local variation of color polymorphism in *Mnais* damselflies: influence of neighbor relatives（カワトンボの翅色多型の地理変異：同所的近縁種の影響）
　　椿宜高（京都大学生態学研究センター）

[P-13] 多型の進化の生態的副産物とその過程依存性：ショウジョウバエを用いた検証
　　○高橋佑磨（千葉大・理）・田中良弥（東北大・生命）・鈴木紀之（University of California）・山元大輔・河田雅圭（東北大・生命）

[P-14#] 寄主植物の再成長が2種のアゲハチョウ間の資源競争を緩和する
　　○橋本洸哉・大串隆之（京大生態研センター）

[P-15#] The adaptive significance of male same-sex partnership in termites
　　○Nobuaki Mizumoto, Toshihisa Yashiro, Kenji Matsuura (Graduate School of Agriculture, Kyoto University)

[P-16] Timing, magnitude, and duration of resource pulses: propagating impacts on community dynamics through stage-structured consumer populations
　　○Gaku Takimoto (The University of Tokyo), Takuya Sato (Kobe University)

[P-17] 集団間交配による環境依存性決定から遺伝的性決定への進化の可能性
　　○岸茂樹（国立環境研）・高倉耕一（滋賀県大）

[P-18] Cooperator-cheater polymorphism in subdivided populations: does approximation to host-pathogen model explain the real data? 分集団構造下での協力・非協力戦略の共存：感染症モデル近似で実データは説明できるか？
　　Shigeto Dobata (Kyoto University)／土畑重人（京大・院農・昆虫生態）

[P-19#] The comparison of spatial and temporal niche between two related land snails in Hokkaido, Japan
　　Yuta Morii (Hokkaido Univ.)

[P-20] Habitat complexity gives rise to a stabilizing effect of food-web complexity
　　Akihiko Mougi (Shimane Univ), ○Michio Kondoh (Ryukoku Univ)

[P-21] Understanding environmental and genetic factors involved in the plant-insect invasion: An approach from multiple reciprocal transplant experiment
　　○Yuzu Sakata (Akita Pref. Univ.), Timothy Craig (Minnesota Univ.), Mito Ikemoto (CER, Kyoto Univ.), Takayuki Ohgushi (CER, Kyoto Univ.)

[P-22] An aquatic vertebrate can use amino acids from environmental water
　　○Noboru Katayama (Kyoto Uni., CER), Makoto Kobayashi (Hokkaido Uni, FSC), Osamu Kishida (Hokkaido Uni., FSC)

[P-23#] The impact of nonlinear relationship between population size and its index in a population dynamics model
　　○Hashimoto Midori, Okamura Hiroshi, Ichinokawa Momoko (NRIFS/FRA)

[P-24] 真社会性アブラムシを専食するゴイシシジミ幼虫における体毛の機能：兵隊アブラムシの攻撃を阻めるか？
○服部充 1・市野隆雄 2,3（1 長大院・水環、2 信大・理、3 信大・山岳）

[P-25] The evolution of relative assessment in status-dependent strategies under stochastic environment
○Yuuya Tachiki (Kyoto University, Kyushu University), Itsuro Koizumi (Hokkaido University)

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○別所和博（総合研究大学院大学、学術振興会特別研究員 PD）・佐々木顕（総合研究大学院大学）

[P-27#] Summary of the Range Expansion of Great Cormorant, *Phalacrocorax carbo*, into Hokkaido
Theodore Squires (Animal Ecology Lab, Graduate School of Agriculture, Hokkaido University)

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○Kazuko Hase (SOKENDAI, JSPS Research Fellow), Q-ichiro Nakayama (Katsushika-ku)

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[P-32] 動物 GPS データの時間軸分析
○平川浩文（森林総合研究所 北海道支所）・高畠千尋・瀧井暁子・泉山茂之（信州大学 山岳科学研究所）

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[P-35#] 近縁スジシマドジョウの繁殖地への侵入消長と再生産消長の不一致
○森井清仁（滋賀県大・環境）・中野光議（金沢大・環日本海環境研究センター）・高倉耕一（滋賀県大・環境）

[P-36#] ハクチョウ類およびウミワシ類の空間利用と飛翔経路の推定
○近藤博史・谷圭一朗・佐々木茂樹・松田裕之（横浜国立大学・院・環境情報）

[P-37] Differentiation in stoichiometry caused by cannibalistic polyphenism
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[P-38#] キアゲハの春型と夏型に見られる照度に対する選好性の違いとその意義
　　○西口泰平・石原道博（大阪府大院・理・生物）

[P-39#] 自切を誘発させたエンマコオロギにおける行動の変化
　　○水野俊樹・石原道博（大阪府立大院・理・生物）

[P-40#] 生活史の諸形質は遺伝的多様性のパターンを決定する　〜種横断的なメタ解析からの示唆
　　○八島亮子（武蔵野大学）・印南秀樹（総合研究大学院大）

[P-41#] Simulated verification of factors shaping population genetic structures by nDNA and mtDNA of Hokkaido voles
　　○村上翔大 (北大・環境科学院)・齊藤隆 (北大 FSC)

[P-42#] エゾシカ個体群の遺伝的な空間構造における境界の強度とその形成要因
　　○森本祥子・三澤桃（北大・環境科学院）・齊藤隆（北大・FSC）

[P-43#] 温帯性感染症媒介蚊の個体群動態
　　○渡邊江（早稲田大・人間科学）・福井眞（早稲田大・人間科学）・太田俊二（早稲田大・人間科学）

[P-44#] 植物－細菌共生系における遺伝的組み合わせのモザイク構造
　　○鍵谷進乃介（北大・環境科学院）・内海俊介（北大・FSC）

[P-45] 撹乱環境下での栄養繁殖
　　福井眞（早稲田大・人間科学）

[P-46] Eco-evolutionary feedback in the wild insect community
　　○Shunsuke Utsumi (Hokkaido Univ), Hirono Onodera (Hokkaido Univ), Masaki Yasugi (NIBB), Nagano Atsuhi (Ryukoku Univ)

[P-47] 生態系エンジニアによる環境・群集改変の地域変異
　　○岡野淳一（京都大学生態学研究センター）・奥田昇（総合地球環境学研究所）

[P-48] Analyzing elasticity of projection matrices with intra-/interspecific competition and phenotypic plasticity: experiments of two *Anisopteromalus* parasitic wasps
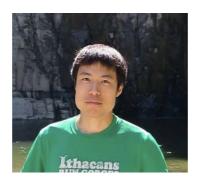　　○Masakazu Shimada, Yasuko Nagase, Minoru Kasada (Univ. Tokyo)

\# Entrants for Poster Award competition

[YSA]   How does rapid evolution alter the theory of population ecology?

10th Population Ecology Young Scientist Award

Dr. Masato Yamamichi (Kyoto University)

Increasing evidence suggests the prevalence of rapid contemporary evolution and the importance to consider evolution for understanding and predicting population dynamics. However, it is still unclear how rapid evolution and resultant feedbacks between ecological and evolutionary dynamics (eco-evolutionary feedbacks) alter the existing theory of population ecology. Here, I present an overview of recent findings from theoretical and empirical studies about (1) (de)stabilizing effects of evolution, (2) phase relationships between interacting species densities, (3) the maintenance of variation in fluctuating environments at genetic and population levels, and (4) extinction processes with evolution. Throughout these topics, I would like to emphasize the ongoing synthesis of population ecology and population genetics. Furthermore, I discuss future challenges to deepen our understanding of population, community, and ecosystem dynamics through the lens of eco-evolutionary feedbacks.

[S-11] Introduction: Long and winding road from demography to evolution

Takenori Takada (Hokkaido University)

Thirty years ago, Silvertown (1982) wrote, "Fitness is a relative measure of evolutionary advantage which is based upon the survival and reproductive success of individuals with different phenotypes. Natural selection is a demographic process". It suggests that life cycle schedule is a phenotype in a sense and that demography is a basis of evolution. How can we interpret statistics of demography, which is considered to be a set of parameters of population dynamics in the context of ecology, in the context of evolution? Therefore, senescence and semelparity have been studied through field studies and mathematical models.

As a simple example, I introduce a mathematical model using a partial differential equation to obtain the optimal size at maturity, one of the parameters in fertility schedule. The analysis of the model shows that the optimal size is affected by mortality schedule due to predation pressure and that the optimal size affects the rate of population growth (Fig. 1). The result also implies the interaction between ecology and evolution. However, the theoretical prediction has never been verified by the census data because the accumulation of demographic data of many species is necessary to verify it. That is a long and winding road from demography to evolution. Therefore, two questions arise: (i) if we reconsider the data on demographic rates and processes from the point of view of evolution, what kind of the interaction between ecology and evolution is revealed? (ii) what new finding and understanding are provided by the accumulation of demographic data? "Evolutionary demography" is an emerging research field that answers the questions.
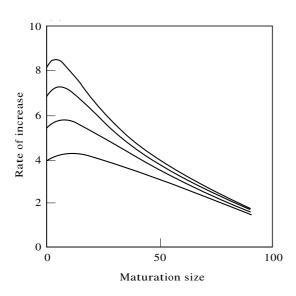

Fig. 1 Maturation size affects rate of increase

[S-12] The diversifiers of life history strategies in plants and animals

Rob Salguero-Gomez (University Sheffield, University of Queensland, Max Planck Institute for Demographic Research, Trinity College Dublin)

Life history traits are the events in our lives that control our demographic performance, our well-being and the well-being of societies. Examples include the age at maturity, reproductive window, mean and maximum longevity, post-reproductive lifespan, number of babies produced, and mortality rate, to mention a few. These factors, which are rather well understood and known to influence human population dynamics, our economics, insurance plans, and retirement funds, to mention a few, are not unique to *Homo sapiens*. Life history traits can be calculated for *any* population from *any* species where the individual can be clearly defined and where demographic information is available. The great potential for application of the tools that allow for the calculation of life history traits from a rich repertoire of organisms, from orchids to ferns to redwoods, to mice, bats, bears and *C. elegans* would allow evolutionary ecologists to tap into questions of global scope such as what strategies are most successful in what environments, what are the factors enhancing the diversification of life history strategies, and which one restrain them.

Up until recently comparative studies examining variation in life history traits had been limited mostly to mammals and birds, mostly due to the lack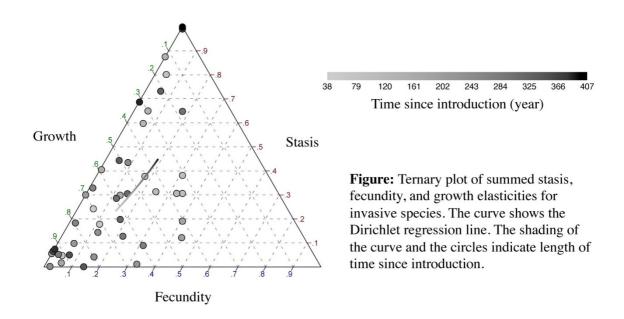 of comprehensive repositories for other taxonomic groups. Here I, introduce the COMPADRE Plant Matrix Database and the COMADRE Animal Matrix Database (www.compadre-db.org), which together contain high-resolution demographic data in the shape of matrix population models for over 2,500 animal and plant species around the globe. Here I use the demographic machinery developed in the last years to decompose biologically meaningful life history traits from these matrices to examine what are the phylogenetic and environmental factors driving the diversity in life history strategies across plants and animals.

[S-13] The influence of time since introduction on the population growth of invasive species and the consequences for management

○Hiroyuki Yokomizo (National Institute for Environmental Studies), Takenori Takada (Hokkaido University), Keiichi Fukaya (The Institute of Statistical Mathematics), John G. Lambrinos (Oregon State University)

Several processes likely act to change the demographic rates of introduced species over time, and this changing demography could influence the optimal management of invasive populations. Generally, optimal management strategies in the current time step should incorporate future population dynamics, including any changes in population growth rate or the elasticities of demographic processes. However, we have a poor understanding of the degree to which the demography of introduced species changes following initial introduction. We used published matrix population models of introduced plant populations to test how population growth rate and elasticity change with time since introduction. We did not find a significant relationship between population growth rate and time since introduction. However, elasticity to stasis increased while elasticity to growth decreased with time since introduction. Broadly, as time since introduction progressed the elasticities of the introduced plant populations became more similar to those that have been reported for native species. These results suggest that the optimal management strategy should be derived incorporating elasticity through time, especially when the time scope of management is long.

Figure: Ternary plot of summed stasis, fecundity, and growth elasticities for invasive species. The curve shows the Dirichlet regression line. The shading of the curve and the circles indicate length of time since introduction.

[S-14] Evolutionary approaches to human demography: case studies on fertility decline

○Masahito Morita (SOKENDAI [The Graduate University for Advanced Studies], Kyoto University), Hisashi Ohtsuki, Mariko Hiraiwa-Hasegawa (SOKENDAI [The Graduate University for Advanced Studies])

Recently, analyses of demographic data (especially secondary data) play an important role in human behavioral ecology and evolutionary anthropology (Stulp et al., 2016, *Hum Nat*). In our presentation, we show some case studies on fertility decline. Fertility directly affects one's reproductive fitness, so its decline is one of the most paradoxical phenomena in the evolution of human behavior and life history (Sear et al., 2016, *Phil Trans R Soc B*). In general, it is recognized that a notable feature of fertility decline is a non-positive relationship between one's socioeconomic success, such as income or education level, and reproductive success. Including our statistical analyses of Japanese data, we discuss the relationship. It is expected that parents in modern developed societies keep high socioeconomic status in order to provide much parental investment for their children. It is because, in a competitive environment, lower-quality offspring tend to lose in peer competition in labor and mating markets, and to result in lower reproductive success. In such an environment, parents should set a high value on parental investment and would aim to produce a small number of high-quality children. We also study a norm for the preference for the number of children. In modern developed societies, it is well known that couples prefer having two children. However, two is too small a number to be considered as a result of fitness maximization by parents. Our study presents a new quantitative piece of evidence of the two-child norm by showing that the presence of two children reduces the probability of further childbirth by one fifth in a Japanese sample. Additionally, we introduce our study that applies the theory of sexual conflict between mother and father (i.e., her husband) over reproductive decision-making within a couple to fertility decline, with a perspective of future studies using historical demographic data. We believe that evolutionary approaches provide a concise and rigid theoretical framework to demographic studies and enable us to consider ultimate factors (see also Sear, 2015, *Popul Stud*).

[S-15] Eco-evolutionary conservation: managing a changing landscape in an evolutionary demographic context

Richard Shefferson (University of Tokyo)

Eco-evolutionary dynamics is now redefining evolutionary and ecological theory, and causing empiricists to rethink their own systems. Conservation management for environmental sustainability is now ubiquitous. The ecological effects of these actions are well-intentioned and well-known. Although conservation biologists and managers increasingly incorporate evolutionary considerations into management plans, the evolutionary consequences of management strategies have remained relatively unexplored and unconsidered. Yet, the ecological ramifications of management can include evolutionary scenarios, and these may often be driven by demographic considerations. Here, I advocate a new research agenda focused on identifying, predicting, and countering the evolutionary consequences of conservation management.

I showcase a number of broad examples in which evolutionary considerations may make a large impact, including park creation and invasive species management. Park creation may cause selection for altered dispersal and behavior that utilizes human foods and structures. Management of invasive species may favor the evolution of resistance to or tolerance of control methods. I then describe some major mechanisms in which these impacts are likely to be felt, via demographic impacts due to the consequences of rapid life history evolution. I call for research focused on: 1) experimental predictions and tests of evolution under particular management strategies, 2) widespread monitoring of managed populations and communities, and 3) meta-analysis and theoretical study aimed at simplifying the process of evolutionary prediction. Ultimately, conservation biologists should incorporate evolutionary prediction into management planning to prevent the evolutionary domestication of the species that they are trying to protect. They should also incorporate eco-evolutionary and demographic considerations into their planning, particularly thinking about the long-term consequences of management beyond simple protection.

[S-21] Allee effect in pine wilt disease

○Takehiko Yamanaka (National Institute for Agro-Environmental Sciences), Takehisa Yamakita (Japan Agency for Marine-Earth Science and Technology), Yutaka Osada (The Research Institute for Humanity and Nature), Etsuko Shoda-Kagaya (Forestry and Forest Products Research Institute), Andrew M. Liebhold (US Forest Service Northern Research Station)

Pine wilt disease (PWD) has historically been a serious national issue in Japan. It is caused by the N. American pathogenic nematode, *Bursaphelenchus xylophilus*, that is transmitted the pine sawyer beetles. PWD is still active and causes serious problems in the northern part of Honshu. Previous theoretical studies revealed that the mutual relationship between the nematode and the sawyer and requirement of contact with host pines by the sawyer typically creates an Allee effect in sawyer populations, an increasing per-capita growth rate as population abundance increases but have not quantified actual Allee effects in the field.

In our study we used the PWD database from relatively recent invaded areas (1980 – 2008) to quantify Allee effects in sawyer outbreaks. The data was modeled using a state-space modeling framework which included both observational and latent processes. As for the observation process, observed levels of damage and of sawyer densities are calculated as a result of sampling from "true" abundances in the latent process. In the latent dynamics, the categorized sawyer density is updated by the transition probability and the level of PWD is updated by the sawyer density. The transition probability of sawyer is controlled both by the number of immigrants from adjacent villages and also by an external climatic index. We quantify an Allee effect in PWD dynamics in Tohoku and discuss how it affects the PWD invasion process.

[S-22] A Bayesian approach to quantifying spatial variation in Allee effects

Derek M. Johnson (Virginia Commonwealth University)

Over the last 20 years, a solid theoretical framework has been developed that illustrates the importance of Allee effects in population dynamics, particularly at species range borders and in rare species. In a theoretical model, for example, spatial variation in Allee effects not only affected the small-scale patterns of range expansion, i.e., faster spread through corridors of low Allee thresholds, but also resulted in large-scale spread rates that differed from those predicted by the average Allee threshold. With notable exceptions, however, linking Allee models to empirical systems has proven difficult, largely because of the inherent difficulties handling the large errors involved in measuring Allee effects in natural systems. In this study, my collaborators and I are applying Bayesian methods to estimate variation in Allee effects across heterogeneous landscapes. The advantage to this method is that the multiple sources of error that make estimating Allee effects difficult can be handled separately, each with a specified underlying distribution. The method can be used to identify natural and human landscape features that affect local Allee effects in a system. In the future, we will apply this method to empirical data from the gypsy moth invasion in North America, and will incorporate measures of moth dispersal through gene flow analyses. This method shows promise as an approach to better understand the underlying mechanisms of species border dynamics in a broad range of systems.

[S-23] Interspecific Synchrony Among Forest Lepidoptera

○Andrew Liebhold (US Forest Service Northern Research Station), Maartje Klapwijk (Swedish Agricultural University)

Over the last two decades, considerable work has focused on quantifying and understanding the causes of spatial synchrony, which refers to coincident fluctuations of populations of the same species located in spatially disjunct locations. Less attention has focused on a slightly different problem, interspecific synchrony which refers to coincident changes in the abundance of populations of different sympatric species. Like spatial synchrony, interspecific synchrony is common in many different types of organisms and may arise through several different ecological processes but it is very difficult to tease out the identity of these processes from commonly available data. Here we review the evidence for interspecific synchrony among sympatric forest Lepidoptera. This phenomenon has been observed in several different systems but the causes remain slightly mysterious. Synchrony may be driven by exogenous effects (e.g., weather) which affect different species in similar ways. Alternatively, numerical and functional responses of shared natural enemies may also drive interspecific synchrony. Finally, we illustrate a phenomenon of transient synchrony among forest Lepidoptera and speculate on its origin.

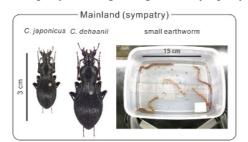## [S-24] Identifying critical interactions in complex competition dynamics between bean beetles

○Kazutaka Kawatsu (Ryukoku Univeristy), Shigeki Kishi (National Institute for Environmental Studies)

Interspecific competition includes various kinds of competitive behaviors. Understanding how those behavioral interactions drive the competition dynamics is the basic of basics in community ecology; however, it still remains difficult to identify critical interactions directly from the competition dynamics, because species interactions often produce complex dynamics in a nonlinear and state-dependent way. In this study, we addressed this issue using empirical dynamic modeling (EDM), which is an emerging nonlinear time-series analysis and is useful to detect causality and interaction strength. Specifically, we applied to EDM to time-series of an experimental competition between two *Callosobruchus* bean beetles, in which two behavioral interactions, that is, resource competition (RC) at larval stage and reproductive interference (RI) among adults, have been known as major competition drivers. By taking into account the difference in the time-lag from cause to effect appearance between RC and RI, we found that the switch of the critical interaction occurred between two competition experiments, where the competition winner differed. This finding well explained the difference in the competition outcome between two experiments. Then this study will offer a novel framework to link behavioral-level interactions to demographic-level effects in interspecific competition.

[Y-01] Body size differentiation by prey size and reproductive interference in the ground beetle *Carabus japonicus*

Yutaka Okuzaki (Hokkaido University)

Because body size of animals is involved in many ecological functions, adaptive evolution of body size is demonstrated by evaluating effects of body size variation on performances against different divergent selection. Body size of the carabid subgenus *Ohomopterus* (genus *Carabus*) is positively correlated with habitat temperature, exhibiting a converse Bergmann cline. *Carabus japonicus*, a species in *Ohomopterus*, has much larger body size than expected from temperature condition on some islands where large congener *Carabus dehaanii* is absence, suggesting that character release is taking place (Fig. 1). To demonstrate adaptive differentiation in body size of *C. japonicus*, we investigated life history, fecundity, prey availability, and frequency of reproductive interference in the populations with different body size. Laval period did not change by altitude, and the number of larval prey (earthworm) decreased rapidly after summer at low altitudes. Numbers of ovarioles increased with female body size. The converse Bergmann cline is thought to arise from maximizing fecundity within expected cumulative effective temperature. On the other hand, body size enlargement deviated from the temperature cline was confirmed at islands, where extremely large earthworm occurred. Both predation success in larval stage and frequency of interspecific mating with *C. dehaanii* increased with body size. The character release is thought to arise from both large prey in allopatry and large congener in sympatry.
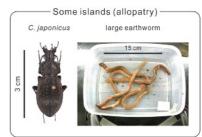

Fig. 1. Character release of *C. japonicus* in Kyushu, Japan.

餌サイズと繁殖干渉を淘汰圧としたヒメオサムシの体サイズ分化

奥崎穣（北海道大学北方生物圏フィールド科学センター）

　体サイズは多くの生態的機能に関わるため，その適応進化を実証するには体サイズ変異が複数の多様化淘汰に対するパフォーマンスに与える影響を評価する必要がある．甲虫オオオサムシ亜属の体サイズは生息地の気温と相関する（逆ベルクマン則）．さらに，その小型種ヒメオサムシは大型の近縁種オオオサムシが分布しない島の大型化する（形質解放）．この体サイズの適応分化を実証するため，体サイズの異なるヒメオサムシ集団において生活史，多産性，餌の利用可能性，繁殖干渉の頻度を調査した．幼虫期間は標高で変化せず，幼虫の餌であるミミズは夏以降減少した．卵巣小管数はメスの体サイズと相関した．逆ベルクマン則は期待される有効積算温量に対して多産性を最大にすることで生じていると考えられる．一方，逆ベルクマン則から逸脱した大型化は大きなミミズが優占する島で確認された．幼虫の捕食成功率とオオオサムシとの種間交尾頻度は体サイズによって増加したことから，形質解放は異所的地域の大きな餌と同所的地域の繁殖干渉から生じていると考えられる．

[Y-02] A challenge for developing the system that aimed to detect distribution and quantify biomass of endangered species Itou (*Parahucho perryi*) simultaneously by using eDNA technique.

Hiroki Mizumoto (Hokkaido University)

Itou (*Parahucho perryi*; aka Sakhalin Taimen) is one of the largest fresh water fish in the world and is a resident of Hokkaido. This species used to distribute not only all over Hokkaido, but also in a north part of Honshu. Currently, however, their distribution is very limited by human activity, such as agricultural development and river structuring. Consequently, they are assessed as Critically Endangered species (CR) by the IUCN extinction risk criteria. Furthermore, their up-to-date biological information (ie. current distribution, biomass, spawning area and seasonal habitat) is not well understood like other endangered species.
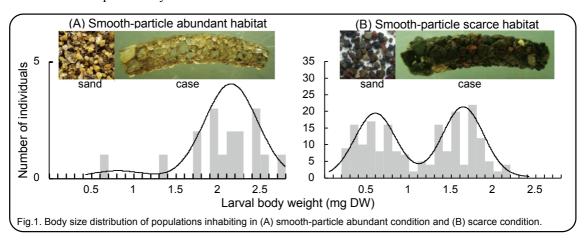
In this session, I will introduce our rearing experiments that aimed to quantify the biomass of Itou noninvasively by using environmental DNA (eDNA). The eDNA technique has been progressed remarkably and many papers reported high detectability of aquatic organisms. However, there is little knowledge about the ability of eDNA for quantifying biomass especially in natural environment. In my presentation, I discuss the possibility of eDNA for detecting distribution and quantifying biomass of Itou simultaneously based on our rearing experiment and field sampling.

[Y-03] Mechanisms maintaining intraspecific variation of material use in case-bearing caddisflies

Jun-ichi Okano (Kyoto University)

How resource use variation within a single population can be maintained? This question has been long discussed because such diversification may be of evolutionary significance as an initial step in the speciation process. The case-bearing caddisfly larvae of Odontoceridae build portable cases from sedimentary stream sands and often display size-dependent cannibalism.

It has been reported that they have a strong preference for smooth-surfaced sand particles (e.g. quartz), which improves their respiration efficiency and thus increasing growth rate and reducing mortality potential. However, because the availability of smooth particles is depended on the mineralogical/petrological origin of the sediment, there is a marked geographic variation in material choice. In streams with abundant smooth particles, larvae have a strong preference for it (specialists), as predicted by optimal theory. In streams with a paucity of smooth particles, less selective larvae (generalists) coexist with specialists within a population, which cannot be explained by simple optimal theory. Interestingly, larval population in streams with a paucity of smooth particles was typically characterized by bimodal age- and size-structure (Fig. 1). In this presentation, I will discuss (1) what factor determines population age- and size-structures, and a possibility that (2) the bimodal structures are important key to maintain material use variation.

Fig.1. Body size distribution of populations inhabiting in (A) smooth-particle abundant condition and (B) scarce condition.

可携巣トビケラにおける巣材利用変異の維持メカニズム

岡野淳一（京都大学生態学研究センター）

　個体群内における変異は種分化の初期段階であると考えられ、変異維持メカニズムについては長らく議論されてきた。私はこれまで、河川の砂を材料として持ち運びの巣を作る共食い性トビケラ、フトヒゲトビケラを対象とし、巣材選択の変異について調査を行ってきた。本種は巣内での呼吸行動を円滑に行うため、石英のような表面の滑らかな巣材を好んで使い、そのような巣材の質は成長率や生存率に確かに影響することが分かっている。しかし、滑らかな巣材の量は生息地の地質に依存しており、巣材利用可能性に応じて地理的な変異が生じる。石英が豊富な河川の集団は、最適理論で予測されるように滑らかな砂への選好性が非常に強い（スペシャリスト）。一方、石英が乏しい河川の集団は、選好性が低いジェネラリストとともにスペシャリストも共存しており、単純な最適理論では説明できない。興味深いことに、石英が豊富な河川では、集団の齢構成とサイズ構成は単峰型であるのに対して、石英が乏しい河川では、二峰化が認められた。そこでさまざまな室内飼育実験と野外調査の結果、（１）齢構成とサイズ構成の決定要因として共食い頻度が重要であること、（２）集団構成の二峰化と巣材選択変異とに密接な関係があることが明らかになってきた。

[Y-04] Intraspecific competition over mating promotes the stable co-existence of competitive species

Kazuya Kobayashi (Kyoto University)

Determining the factors that sustain species biodiversity is one of the core challenges of ecological research. Theoretically, the co-existence of competitive species requires niche differentiation; however, null models that assume no species differentiation have successfully recreated the species rank abundance distributions that occur in nature. Here, I show that sex allocation is the key to resolving this paradox. The sex allocation theory predicts equal allocations for dominant species and female-biased allocations for relatively rare species, which equalize reproductive rates among the species. Thus, the species differences disappear from the reproductive rates due to the adaptive sex allocation. A model incorporating this mechanism demonstrates that hundreds of species can co-occur over 10,000 generations, even in homogeneous environments, and reproduces the species rank abundance distributions that occur in nature.
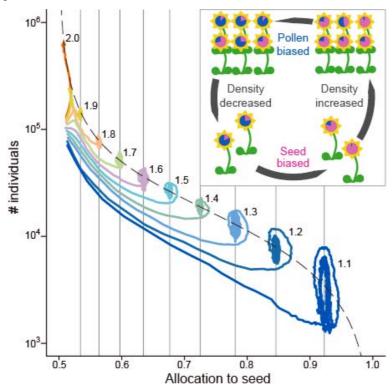

Figure. Simulation results showing evolutionary dynamics of sex allocation and demographics of 10 species that coexist over 2,000 generations.

[Y-05] Temporal dynamics of resistance in an exotic plant *Solidago altissima*: geographic variation of plant-herbivore interactions in native and invaded range

Yuzu Sakata (Akita Pref. University)

When the interactions are geographically widespread, species are subject to environmental gradients that can produce clines in adaptation and coadaptation. I studied the geographic variation in the abundance of the lace bug, *Corythucha marmorata*, and the resistance of the tall goldenrod *Solidago altissima* in native and invaded ranges, examining biotic and abiotic factors, including climate, herbivores, lace bug growth traits, and predators, that we hypothesized were causing differences in lace bug density between ranges. Lace bug abundance was high in populations with warmer climates and less foliage damage by other insects in both ranges, and was higher throughout Japan compared to the USA. Resistance of *S. altissima* to lace bugs varied geographically and was higher in populations with high lace bug densities than in populations with low or zero lace bug densities in both ranges. The developmental time of the lace bugs was shorter at higher experimental temperatures but the number of offspring did not differ between the USA and Japan. Overall, it is suggested that the new combination of environmental and genetic factors in the invaded range may weaken or strengthen their interaction between plants and herbivorous insects, emerging non-directional temporal dynamics of evolution in plant resistance.

原産地と侵入地における植物−植食者相互作用の地理的変異から外来植物の抵抗性の動態を解明する

坂田ゆず（秋田県立大学　生物資源科学部　生物環境科学科）

　生物間の相互作用は環境要因の地理的な違いに応じて変化するため、生物の形質に対して同種の集団間でも異なる選択圧が働き、多様な形質が進化する。本研究では、北米から日本に100年前に侵入したセイタカアワダチソウ（以下セイタカ）と、15年前に侵入し、セイタカに重度な食害をもたらしているアワダチソウグンバイ（以下グンバイ）を材料に用いて、セイタカのグンバイへの抵抗性の動態と、抵抗性の変異を生み出す環境要因の解明を行った。その結果、セイタカは日本に侵入することでグンバイから解放され、抵抗性が一旦は低下したが、グンバイと再会することで再び上昇したという時間的な動態が示された。日米のいずれも、年間平均気温が高く他の植食者による葉食害が小さいほど、グンバイの密度が高くセイタカの抵抗性が高かった。北米では、多様な分類群の植食性昆虫が見られた一方で、日本では植食性昆虫の種数は少ないが、グンバイの密度は高かった。以上のことから、日本では、北米に比べて気候条件が好適で、グンバイの競争者となる葉食者が少ないことにより、グンバイの密度が高く、セイタカに与える選択圧が強くなり、短期間の内にセイタカの抵抗性が上昇したことが示唆された。

[Y-06] Change, chance, and challenge

Yuichi Isaka (Hokkaido University)

Ecology is known as integrated science because lots of information on biotic and abiotic factors and processes are necessary to understand relationships among organisms and their surrounding environment. In other words, research of ecology uses various types of materials on which species, population, community and/or environmental factor are focused and employs multiple methods. Therefore, it is challenge for one researcher to understand all the aspects of ecology research comprehensively. I am currently studying multiple subjects including the evolution of sawflies based on molecular phylogenetic analyses, screening study for congenital virus infection dynamics among newborns using their blood, interaction between a number of amphipods and structural function of seaweeds on cobble in low shore, and the development of manipulation experiment system for ocean acidification in seagrass bed. These topics have not tight relationships to each other. When we are employed to any institute as researcher, most of us would need to change research themes. Changing the research theme is a great challenge especially for the young scientist who recently gained the Ph.D degree. However, it can also be a big chance. The opportunity would lead us to get new visions and methods for understanding ecological studies broader, and we would be interested in new theme even though we sometimes feel the change will retard the speed of the achievement (such as the publication of paper). In this presentation, I will try to discuss challenging to new research themes based on my experience.

研究テーマの変化のとらえかた

井坂友一（北海道大学北方生物圏フィールド科学センター）

生態学は，生物-環境間や生物間の相互関係を様々な生物的・非生物的な情報から解明を試みるので統合科学と認識される．これは生態学における何らかの課題に取り組む際，どの種・種群や環境要因を中心に据えるか，どう解析するかという視点と手法が多様であることを示唆している．その多様さゆえに，ひとりひとりが生態学を包括的に理解することは困難といえよう．分子系統学的解析によるハバチ類の系統進化，血液分析による新生児のウィルス罹患動態，潮下帯の転石上に付着する海藻類の機能構造とそこに存在するヨコエビ個体数の関係，海草藻場の海洋酸性化操作実験システムの開発，これら研究に演者は関わっているが，統一された題材とは言えない．我々が研究職として雇用される際，それまで関わってきた題材を継続できる者は一部で，大半がその変更を経験するだろう．一般的にそこには大きな不安とわずかな好奇心が交錯するが，研究テーマの変化はチャンスだ．研究を進めていく上での新たな視点や手法を獲得し広く生態学を理解するきっかけとなるだけでなく，始めてみたら意外と面白く，これまでの題材と関連するかもしれない．発表では演者の研究紹介を通し，新たな研究題材に挑戦する意義を考えたい．

[Y-07] The mechanism creating intraspecific variation of termite building structures provides the evolutionary perspectives of collective behavior

Nobuaki Mizumoto (Kyoto University)

Many of the collective activities performed by group living animals result in the formation of complex spatio-temporal patterns. In social insects, collective building often produce complex structures involving self-organization, where colony-level patterns emerge from local interactions among members. Although some studies have revealed the mechanism of building various structures, little is understood about its evolutionary perspectives. In this presentation, I first demonstrate that how intraspecific variation of structures in a termite can be generated by simply changing behavioral parameters of group members, even with the same building algorithm. Then from this results, I will introduce my hypothesis that the evolution of wide varying structures of termite species may be explained by the outbreak of one simple behavioral rule and the tuning or changing of behavioral and physical parameters. With this hypothesis, finally, I will show the results of the study on building behavior of a primitive termite which only build to plug the opening of their nests. By comparing the collective building of termite species, I will discuss how the self-organization works in the insect society and the evolutionary perspectives of collective behavior of group living animals.

　群れ行動や構造物、活動リズムのように、生物集団による行動は、時空間上に様々なパターンを作り出す。多数の個体を擁する社会性昆虫は、その生活史で様々なパターンを形成し、それは、簡単な行動ルールと個体間の相互作用から自己組織的に生じることが明らかになってきた。本発表では、シロアリの蟻道建設行動に着目して、集団が作り出す構造物の多様さが、個体レベルの相互作用から、いかに生じるかについての研究結果を紹介する。また、異なる構造物を同一のルールから生み出すことが可能であるという結果から着想を得た、シロアリの構造物の進化についてのアイディアについて発表し、特徴的な構造物を作らない、祖先的なシロアリの建設行動についての実験結果を示す。最後に、様々な集団によるパターン形成の進化について議論する。

▲ Shelter tube construction by termite *Reticulitermes speratus*

Building of nest walls by primitive termite *Zootermopsis nevadensis* ▶

[Y-08] To migrate or not to migrate: a view based on inter-population variation in a threshold trait and ultimate mechanism in salmonid fishes

Genki Sahashi (Hokkaido University)

Partial migration is one of the common forms of migration in which a population contains both migratory and resident individuals. Alternative migratory tactics (AMTs) of partial migration are often determined by polygenic threshold traits, and the divergence of AMTs is thought to depend on whether the size or growth rate at the time of the life-history decision exceeds a threshold size. However, few studies have examined the ultimate mechanisms that drive inter-population variations in threshold traits and the proportion of AMTs.

In this presentation, I will first explain a simple schematic model demonstrating that the position of the threshold trait is decided by fitness changes for each migratory tactic. Then, I will present two empirical studies in partial migratory salmonids to investigate the ultimate mechanisms. Specifically, I report that 1) migration costs become a convergent selective force that drives inter-population variation in threshold traits and the proportion of AMTs, and 2) the effectiveness of the schematic model by demonstrating inter-population variation in the threshold trait is induced by opposing natural and artificial selection.

回遊すべきか、せざるべきか：サケ科魚類の閾値形質の個体群間変異と進化的機構から考える

佐橋玄記（北海道大学北方生物圏フィールド科学センター）

　個体群内に回遊を行う「回遊型」と回遊を行わない「残留型」の二型が生じる Partial migration は、幅広い分類群の動物に見られる一般的な回遊様式の1つである。この回遊様式に関わる二型の分岐機構は、主に閾値形質を用いて解釈され、ある時期の体サイズや成長条件が閾値形質の値を超えるか否かによって、いずれかの生活史になると考えられている。しかし、閾値形質や二型の頻度に個体群間変異をもたらす進化的機構を調べた研究は未だに少ない。

　本講演では、まず閾値サイズの位置が両生活史の適応度の変化とともに決まる、という概念モデルの説明を行う。その上で、演者が閾値形質や二型の頻度に個体群間変異をもたらす進化的機構を調べることを目的として、partial migration を行うサケ科魚類を用いて行った 2 つの実証研究を紹介する。具体的には、1.回遊コストの増減が閾値形質と二型頻度に個体群間変異を生む種間で共通の要因となること、2.逆方向に作用する人為選択と自然選択に応じた閾値形質の個体群間変異を調べ、概念モデルの有効性を明らかにしたこと、を報告する。

POSTER ABSTRACTS

[P-01]
An ecological mechanism of genetic variation maintenance in a finite population focusing the difference in inheritance system between mtDNA and nuclear DNA

Takashi Saitoh (Field Science Center, Hokkaido University)

In an idealized finite population, in which only genetic drift drives allele frequency changes, genetic variation is expected to decrease monotonically in the inverse proportion to effective gene number. Effective gene number may differ between mitochondrial DNA (mtDNA) and nuclear DNA (ncDNA) even in a same population. In mammalian and avian populations effective gene number of mtDNA is one-fourth of that of ncDNA, and thus mtDNA diversity should be lower than ncDNA diversity. A meta-analysis of mtDNA and ncDNA variation from published data on 100 mammalian and 152 avian populations provided the following results: (1) Haplotype diversity of mtDNA was higher than ncDNA diversities (heterozygosity) in most populations. (2) Most heterozygosities were included in a limited range between 0.4 and 0.8, showing a unimodal distribution, whereas haplotype diversity was widely distributed between 0 and 1 both for mammals and birds. (3) The frequency distribution of haplotype diversity was a u-shaped distribution for mammals, whereas a right triangle pattern for birds. These patterns differed from the theoretical prediction. Simulation analyses on the basis of an individual based model, considering effects of mutation, genetic drift caused by population fluctuation, and subpopulation structure, demonstrated that all those elements were needed to generate the empirical patterns. In particular, the subpopulation structure generated by sex-biased dispersal (male-biased dispersal in mammals and female-biased dispersal in birds) was essential to explain the contrastive patterns in the frequency distribution of haplotype diversity between mammals and birds.

[P-02]
農業害獣の管理−捕獲と防御のバランス−

山村則男 （同志社・文化情報）

　近年、シカ・イノシシ・アライグマなどによる農業被害が増加している。その対策として、狩猟やワナ・オリによる捕獲と、耕作地を囲う柵による防護がなされている。しかし、捕獲や防護にはコストが伴うので最適な投資を決定するための数理モデルを提唱する。モデルは、増殖（ロジスティク式）と捕獲投資に比例する捕獲率（密度効果を含む）から決まる害獣の密度の平衡点を計算し、耕作地への侵入率は防護投資の減少関数とする。そこで、年間の被害総額と捕獲投資および防護投資の和を最小とする最適投資を求める。
　パラメータの値によって、(捕獲投資金額、防護投資金額)は、(0,0),(0,+),(+,0),(+,+)のいずれかとなり、＋の場合はその最適値を計算することができる。例えば、増殖率の増加に対して捕獲投資は極大値を持つのに対して、防護投資は単調増加となる。モデルの結果を、シカ・イノシシ・アライグマについての大阪府立環境農林水産総合研究所による調査結果に基づいて検討する。

[P-03#]
Effects of spatiotemporal evenness of releases of sterile insects on control of pests with limited mobility

Yusuke Ikegawa (Ryukyu Sankei Co. Ltd, Okinawa Prefectural Plant Protection Center, University of the Ryukyus)

Sterile insect technique (SIT) is periodically releasing mass-reared sterile insects to control target pests by impeding their successful reproduction. In Okinawa Prefecture, Japan, the SIT is currently applied against West Indian sweet potato weevil which is a flightless agricultural pest of sweet potato. I examined effects of spatiotemporal evenness of sterile insect releases on regional eradication of the pest with limited mobility, by constructing a simple two-patch metapopulation model. I found that spatially biased sterile insect releases seriously inhibited regional pest eradication even if a large number of sterile insects released with short intervals. However, I also found that temporally balancing the spatially biased releases could greatly improve the negative effect and promote regional pest eradication. I illustrated that these outcomes were caused by too low mobility of the target insect.

I revealed that limited mobility of target pests crucially inhibits regional pest eradication due to spatiotemporally biased releases of sterile insects. Accordingly, I conclude that spatiotemporally even releases of sterile insects are requisite for regional eradication of less mobile pests, such as West Indian sweet potato weevil, irrespective of the other release strategies. Effect of limited mobility on outcomes of the SIT has been rarely argued in previous theoretical studies. Thus, I could provide new insights into how sterile insects should be released especially against less mobile pests.

[P-04]
Long-term (2002–2016) change in population densities of native white-spotted charr, and introduced brown and rainbow trout in a Japanese stream

Kentaro Morita (Hokkaido Natl. Fish. Res. Inst)

Invasion by introduced trout is thought to play an important role in diminishing the population size of native fishes such as the white-spotted charr (IWANA), which is endemic to Asia. Because ecological and evolutionary processes modulate the effects of invading species, their impact over time can only be assessed by a long-term study. I have assessed the changes in the fish assemblage in an 8-km reach of the Hekirichi River, Hokkaido, since 2002. Brown trout and rainbow trout were introduced to this system in 1990s. I established 30 study reaches and conducted fish counts in each reach by underwater observation with snorkeling gear each summer. Initially, white-spotted charr were the only native salmonid species in the study reach. However, the density of white-spotted charr decreased from 0.16 to 0.01 (ind./m) from 2002 to 2014. Conversely, the density of brown trout increased from 0.07 to 0.20 from 2002 to 2009, but decreased to 0.05 by 2016. The density of rainbow trout fluctuated annually until 2009, but increased from 0.05 to 0.30 from 2009 to 2016. Overall, the dominant species changed from white-spotted charr (64%) in 2002 to brown trout (78%) in 2009 and then to rainbow trout (82%) in 2016. Inter-specific competition was likely an important factor in causing the recent decline in the abundance of native white-spotted charr in this river.

[P-05]
Analysis of population dynamics containing twofold stochasticity by Tuljapurkar's approximation

Ryo Oizumi (Ministry of Health, Labour and Welfare)

Organisms are faced with various stochasticity. Stochasticity bringing uncertainty to life history has multiple scales from individual scale to population scale. The former scale yields heterogeneity which is referred to internal stochasticity. The latter is designated as external stochasticity which contains variable environments and demographic stochasticity [1]. In conventional transition matrix models, the internal stochasticity is deterministically included in each element of the models as a component of life schedule. On the other hand, under external stochasticity, those elements temporary fluctuate as random matrices. Tuljapurkar approximation is a mathematical method for examination to the effect of the fluctuation on population dynamics. In the case that environmental fluctuation is sufficiently small, this method revealed that variance of elements corresponding greater sensitivity with respect to the dominant eigenvalue of mean matrix contributes to significant reduction of the long term logarithmic population growth rates [2]. Then, it is known that sensitivity of each element is represented by the right and the left eigenvectors corresponding to the dominant eigenvalue [3].

In this study, we introduce a stochastic process which consists of mean matrix elements, and reconstruct Tuljapurkar's approximation by statistics of the stochastic process. Those statistics composes sensitivity and eigenfunctions in both discrete and continuous structured population models. Then, the population growth can be considered as dynamics of two-fold stochasticity. We would like to show that this perspective provides a novel framework to analysis of population dynamics and its evolution.

[1] R. Oizumi, T. Takada, Optimal life schedule with stochastic growth in age-size structured models: theory and an application, Journal of Theoretical Biology 323 (2013) 76-89
[2] S. Tuljapurkar, Population dynamics in variable environments. III. Evolutionary dynamics of r-selection, Theoretical Population Biology 21 (1) (1982) 141-165.
[3] H. Caswell, A general formula for the sensitivity of population growth rate to changes in life history parameters, Theoretical population biology 14 (2) (1978) 215-230.

[P-06]
Selection of life history strategies under food web interactions

Masami Fujiwara (Texas A&M University)

A food-web model with stage-structured populations was built, and demography of persisted populations was investigated. The model consisted of consumers with three developmental stages (larvae, juveniles, and adults), which feed on unstructured primary producers exhibiting logistic growth and/or other consumers. Both feeding interaction and energetic processes were based on the body size of individuals associated with each stage (body size of a stage). The model was simulated starting with randomly selected body sizes and randomly selected initial densities, and this was repeated until five consumers persisted in the system over 2,000 time units. The simulations resulted in 106 food webs that had five persisting consumers. The life expectancy at birth, generation time, duration in an adult stage, average age at maturation, percent survival to an adult stage, and fecundity of persistent populations were calculated. Then, principal component analysis was applied to these demographic properties. The first principal component (PC) was loaded high with duration in adult stage and generation time, indicating trade-off between semelparity and iteroparity. The second PC was loaded positively with percent mature and negatively with fecundity, indicating energetic trade-off between survival and reproduction during early stages. The third PC was loaded high with fecundity and the age of maturation, indicating the strategy to delay maturation to increase fecundity or vice versa. The result suggests that food web interactions are an important factor shaping the life history strategies of consumers.

[P-07]
Forest landscape affects pollen use and provision mass of a solitary mason bee,
Osmia cornifrons

○Teruyoshi Nagamitsu (FFPRI), Mika F. Suzuki (Tsukuba Univ), Shotaro Mine (Tokyo Univ), Hisatomo Taki (FFPRI), Kato Shuri (FFPRI), Satoshi Kikuchi (FFPRI), Takashi Masaki (FFPRI)

Habitat loss and fragmentation potentially affect the performance of bees that forage nectar and pollen in the habitats. In forest landscapes, silvicultural conifer plantations often have reduced and fragmented natural broad-leaf forests, which seem to provide more floral resources for bees than the plantations. We evaluated the effects of area, edge length, and tree size of broad-leaf forests affect pollen use and the effects of these forest characteristics and pollen use on provision mass of a solitary mason bee, *Osmia cornifron*, at 14 sites in a forestry region. Our results indicated that the forest characteristics and site elevations affect pollen use. *Prunus* and *Wisteria* pollen was frequently used in higher and lower elevations, respectively. *Rubus* and *Quercus* pollen was frequently used in small, fragmented broad-leaf forests. Provision mass decreased with decreasing area or increasing edge length of broad-leaf forests and with decreasing proportion of pollen use from *Wisteria*, *Rubus*, and *Quercus*. These findings suggest that loss and fragmentation of broad-leaf forests reduce foraging performance of the solitary mason bees, but that pollen use from *Rubus* and *Quercus* frequent in small, fragmented forests partially compensates the reduced performance.

[P-08#]
Relationships between life history traits and imidacloprid resistance in the brown planthopper, *Nilaparvata lugens*

○藤井智久・真田幸代・松村正哉（九州沖縄農研）

The brown planthopper *Nilaparvata lugens* (BPH) is the most important pest on rice throughout Asia. The field populations of BPH in East Asia and Vietnam developed imidacloprid resistance since mid-2000s. Susceptibilities to some other neonicotinoids have also increased by degrees. The resistant strain (Res-P) was established from a susceptible field population collected from Philippines in 2009, by exposing to imidacloprid with 50% lethal dose (LD50) for more than 20 generations. The control strain (Con-P) was only exposed to acetone. After selection, the susceptibilities to five neonicotinoids and fipronil were compared between Con- and Res-P using a standard topical application method. Life history traits were also compared between both strains in laboratory experiments. The LD50 values of imidacloprid, clothianidin and thiamethoxam in Res-P (4.0-36.0 μg/g) were 9.0, 12.1 and 16.4 times higher than those in Con-P (0.33-4.0 μg/g), respectively. These results suggest that the reduction of imidacloprid susceptibility positively correlated with susceptibilities against clothianidin and thiamethoxam, but not against other insecticides. Fecundity and female adult life span in Res-P were lower and shorter than those in Con-P, respectively. Thus, we concluded that fitness costs existed between imidacloprid resistance and life history traits in BPH.

[P-09#]
Latrine site selection of raccoon dog and the relation between selection and distribution of latrine sites

○Yuko Nakazawa, Takashi Saitoh (Hokkaido University)

Carnivores were thought to emit chemical signal by placing their feces or urine onto conspicuous objects, or on the substrate in a conspicuous manner. Many studies suggest that carnivores select the locations of defecation. However, in most of these studies, the methods to find defecation sites were biased by the researchers, leading to possible overlooking of some defecation sites. We examined the selection of defecation site of Raccoon dog (*Nyctereutes procyonoides*) with less biased methods in a natural forest of Hokkaido. To minimize the oversight of latrine sites, more than three researchers walked the study area in the line and the location of all latrine sites were recorded. We categorized the topographic feature of latrine sites into three types (mound, flat, pit) depending on the slope angle of the site. We also categorized randomly selected locations where no latrine exists in the study area to examine if raccoon dogs select latrine site. Canopy openness was also recorded in both latrine sites and random sites. We found that mound type substrate is selected for latrine sites, whereas others were avoided. However, the proportion of mound type to all three types did not explain the density of latrine sites in the whole area. This indicates that the forest-stand-scale distribution of latrine site was not affected by the small scale selectivity of topographic feature.

[P-10]
Contacts with large, active individuals intensify the predation risk of small conspecifics

Aya Yamaguchi, Kunio Takatsu, ○Osamu Kishida (Hokkaido University)

Size variation within a population can influence the structure of ecosystem interactions Although the impact of size variation in a predator species on the structure of interactions is well understood, our knowledge about how size variation in a prey species might modify the interactions between predators and prey is very limited. Here, by examining the interactions between predatory *Hynobius retardatus* salamander larvae and their prey, *Rana pirica* frog tadpoles, we investigated how large prey individuals affect the predation mortality of small prey conspecifics. First, in a field experiment, we showed that in the presence of large tadpoles the mortality of small tadpoles from salamander predation was increased. Next, in a laboratory experiment, we successfully uncovered mechanisms of the increased mortality of small tadpoles in the presence of large tadpoles. The active large tadpoles caused physical disturbances, which in turn caused the small tadpoles to move, and thus increased their encounter frequency with the predatory salamanders. In the size-structured populations, physical contacts among individuals may be an important factor causing inter and intra-specific interactions.

[P-11]
オジロワシの生物学的潜在間引き数（PBR）と風力発電環境影響評価

○松田裕之・谷圭一郎（横浜国大）・島田泰夫（日本気象協会）

　近年、累積影響が環境影響評価（EIA）でよく議論されるようになったが、希少猛禽類オジロワシの衝突死が北海道全体でどこまで許容されるかは1事業者の裁量を超えており、本来国が指針を作るべきである。個体群の存続可能性への影響が重要とすれば、PBR（生物学的潜在間引き数）という指標がその目安となる。マガンについては実際の衝突事例がほとんどなく、PBR よりけた違いに少ないことは明らかだが、オジロワシについてはそうではない。留鳥と越冬群の扱い方、直接の知見のない自然増加率の値にもよるが、すでに PBR を超えた人為死亡があるとも言える。他方、越冬群だけでなく、留鳥も依然として増え続けている。本研究では、シナリオ別のオジロワシの PBR の試算を示し、順応的管理を含む今後の風発 EIA への適用方法を議論する。（詳細情報と English Abstract http://ecorisk.ynu.ac.jp/matsuda/2016/PE161103.html）

[P-12]
Local variation of color polymorphism in *Mnais* damselflies: influence of neighbor relatives（カワトンボの翅色多型の地理変異：同所的近縁種の影響）

椿宜高（京都大学生態学研究センター）

　色彩多型は有性生殖する生物に広くみられ、多様性維持や種分化のメカニズム研究にとって重要な現象と考えられている。わが国の固有種であるカワトンボ（*Mnais costalis* と *M. pruinosa* の2種）では1種だけが単独で生息する集団のオスに翅色多型（橙色翅と透明翅）が見られる。いっぽう、2種が同所的に存在する集団では両種オスの多型消失、一方の種の多型消失や偏った多型頻度など、多様な地理的変異が見られ、さらにはメスにも翅色多型が生じる場合がある。このような複雑な多型現象は、種内に働く多様化のプロセス（代替交尾戦略）と種間にはたらく単純化のプロセス（生殖隔離）の拮抗作用によって説明できる可能性がある。ここでは、両種の分布のほぼ全域をカバーする230集団から得られた標本について翅色多型の変異を調査し、2種の相対密度がオスの多型頻度、メスの多型頻度に及ぼす影響を分析する

[P-13]
多型の進化の生態的副産物とその過程依存性：ショウジョウバエを用いた検証

○高橋佑磨（千葉大・理）・田中良弥（東北大・生命）・鈴木紀之（University of California）・山元大輔・河田雅圭（東北大・生命）

　少数派の有利性（平衡選択）の存在により種内多型が維持される条件では、新たに集団に侵入した表現型の適応度は常に先住者よりも高いため、集団の平均適応度、すなわち増加率は、多様性の増加に伴って高くなると考えられる。一方、少数派の有利性が存在せず、移入と淘汰の平衡によって種内多型が維持される場合は、多様性の増加が集団の平均適応度を高めることはないはずである。本講演では、まず、多様性の成立過程とその人口学的帰結の関係の条件依存性について簡単なモデルを用いて示す。その上で、キイロショウジョウバエの*for* 遺伝子の変異に基づく採餌行動の平衡多型（*Rover* 型と *sitter* 型）を用いて多型の存在と集団の適応度の関係を検証した例を示す。具体的には、平衡選択が起きる条件と起きない条件を人為的に作り出し、各条件で集団の適応度の指標として生存率やバイオマスを測定したところ、平衡選択の存在する条件でのみ、多型の存在が集団適応度を高めることが支持された。

[P-14#]
寄主植物の再成長が 2 種のアゲハチョウ間の資源競争を緩和する

○橋本洸哉・大串隆之（京大生態研センター）

　植食性昆虫の摂食による植物資源の枯渇は頻繁には起こらないため、これまで植食性昆虫間の資源競争は弱いと考えられてきた。しかし、2 種のスペシャリスト（ホソオチョウとジャコウアゲハ）に利用されているウマノスズクサはしばしば高い被食レベルを示す。我々は、これら 2 種間の野外における資源競争の強さを検証した。京都府木津川において、河川堤防沿いの 8 地点で 4 年間にわたり両種幼虫の密度を記録した。さらに、2013 年と 2016 年の夏季には植物の葉数も記録した。調査地では頻繁に寄主植物の食い尽くしが観察された。両種の世代あたり個体群増加率は、自種の密度が高くなるほど低下したが、他種の密度の影響は有意でなかった。このことは、両種間の資源競争が弱いことを示している。葉数は幼虫の摂食によって減少したが、2-4 週間程度で元のレベルにまで回復した。また、両種の発生のピークは 3-4 週間程度ずれていた。これらの結果から、食害を受けた植物が両種の発生のずれの間に再成長することで、両種間の資源競争が緩和されていると考えられた。

[P-15#]
The adaptive significance of male same-sex partnership in termites

○Nobuaki Mizumoto, Toshihisa Yashiro, Kenji Matsuura (Graduate School of Agriculture, Kyoto University)

A wide variety of animals display same-sex behaviours, including courtship, copulation and pairing. However, these behaviours create a paradox, that is, the selection seemingly acts on maladaptive traits, and they have often been regarded as cases of mistaken identity, especially in invertebrates. Here we show that termite males perform nest establishment and pairing formation that usually occur in monogamous colony foundation and demonstrate how this contributes to their fitness. We found that pairs of male dealates stopped searching for females and established nests without females, although single males rarely ceased searching for mates. Males in these male–male pairings had much higher survival than single males. Our colony fusion experiment showed that only one male in a surviving same-sex pair can replace a male in an incipient colony and produce offspring. A mathematical model demonstrated that the observed strategy of establishing a male–male pairing instead of searching for females is advantageous when the risk of predation is high, even when colony fusion is very rare. Thus, same-sex pairing provides survival benefit to males and elongated survival sometimes can result in the opportunity of reproduction. These results indicate that, under certain ecological conditions, a cooperative same-sex pairing with a potential rival for reproduction can be adaptive. Our study implies the existence of various possibilities for explaining the adaptive significance of same-sex sexual behaviours.

[P-16]
Timing, magnitude, and duration of resource pulses: propagating impacts on community dynamics through stage-structured consumer populations

○Gaku Takimoto (The University of Tokyo), Takuya Sato (Kobe University)

Resource pulses are common across many ecological communities, having potentially strong impacts on community dynamics. Despite potential importance, theory about community-level impacts of resource pulses has been poorly developed. Recent empirical evidence suggests that temporal heterogeneity of resource pulses interacts uniquely with different stages of recipient consumer populations. Here, to develop theory on how stage-structured consumers utilize resource pulses and mediate their indirect effects, we build and analyze a simulation model of consumer-resource interactions. We assume two size classes, small and large, of a consumer population. The small-class consumers utilize resource to grow and mature into the large class. The large-class individuals consume and store resources for their reproduction. Resource competition is stage-dependent between and within size classes. When resource is low, large individuals monopolize the resource (no resource for small individuals) with resource allotment to each large individual determined on a capitation basis. With intermediate resource, all large individuals consume the resource to full stomach and small individuals share the leftover. When resource is high, all large and small individuals consume the resource to full stomach. Using this model, we test how the timing, magnitude, and duration of resource pulses affect consumer abundance. With total resource availability throughout the whole season fixed, we find that consumer abundance becomes highest when resource pulses occur during the mid-season. Earlier or later pulses tend to lower consumer abundance. Moreover, longer pulse duration of smaller magnitude tends to enhance consumer abundance more strongly. Based on these results, we discuss community-level impacts of resource pulses utilized by stage-structured consumer populations. Our results highlight that the interaction of timing, magnitude, and duration of resource pulses with stage-structured consumer populations is important to understand community-level impacts of resource pulses.

[P-17]
集団間交配による環境依存性決定から遺伝的性決定への進化の可能性

○岸茂樹（国立環境研）・高倉耕一（滋賀県大）

　生物の性決定様式には環境依存性決定と遺伝的性決定の２つがある。爬虫類の系統学的研究から、遺伝的性決定は環境依存性決定から独立に複数回進化したことが分かっている。しかし、遺伝的性決定がどのように環境依存性決定から進化したのかよく分かっていない。本研究では、温度依存性決定をする近縁な２集団が２次的に出会って交雑する場合を想定し、シミュレーションモデルを構築した。その結果、２集団のオスとメスの交配の組み合わせに応じて雑種の適応度低下が異なる場合、環境依存性決定から遺伝的性決定が進化した。雑種の適応度低下の方向性に応じて、確率的にメスヘテロとオスヘテロの遺伝的性決定が出現した。雑種の適応度低下に方向性があるとき、性に対する有利さが染色体に応じて異なるため、性染色体が温度に依存せずに性を一意に決定するように進化することで遺伝的性決定が成立した。

[P-18]
Cooperator-cheater polymorphism in subdivided populations: does approximation to host-pathogen model explain the real data? 分集団構造下での協力・非協力戦略の共存：感染症モデル近似で実データは説明できるか？

Shigeto Dobata (Kyoto University)／土畑重人（京大・院農・昆虫生態）

　　I developed a general demographic model for groups containing both cooperators and cheaters and fitted it to the empirical data obtained from the asexual ant *Pristomyrmex punctatus*, which is known to contain genetic cheaters in some field colonies. With the estimated parameters, we extended the model to entail gradual evolution of genetic cheaters from cooperator ancestors in subdivided populations. Extensive simulations found conditions under which cooperator-cheater polymorphism evolves. In *Pristomyrmex punctatus*, restricted migration between subpopulations (i.e., colonies) is possible, whereby cheaters can behave like pathogens by "infecting" into host colonies. Therefore, I approximated the subdivided population as a population of hosts, applied the SIO host pathogen model to investigate the conditions for persistence of "Infected" state in the host population (=cooperator-cheater coexistence) and compared the results with the evolutionary demographic simulations.

[P-19#]
The comparison of spatial and temporal niche between two related land snails in Hokkaido, Japan

Yuta Morii (Hokkaido Univ.)

Generally, closely related species cannot coexist, because they usually have negative interaction between these species, such as resource competition or reproductive interference. However, the distribution areas of the land snail species, *Ainohelix editha* and *Ezohelix gainesi* (Pulmonata: Bradybaenidae), are overlapped widely in Hokkaido Island, Japan, despite they are the most closely related sister species. They have very similar DNA traits (nuclear DNA ITS-1, 2 and mitochondrial DNA 16S rDNA) and genital morphologies, but the shell morphologies and size show big differences between these two species. Thus, it seems like this sympatric distribution pattern of these two species does not follow the ecological niche models, however the microhabitat of these two species have never been fully investigated. In this study, I compared the spatio-temporal niche between these two sympatric species. All individuals of *A. eidhta* and *E. gainesi* within three fixed quadrats (5m x 10m) at three different sites far distance away each other in Hokkaido Island (Nakatombetsu, Bibai and Otaru) were observed once a month for seven months in 2015 (from April to October), and recorded their shell size, height from the ground and other several ecological factors for each individual. Finally, I discuss the spatio-temporal niche and the evolutionary process of these two land snails.

[P-20]
Habitat complexity gives rise to a stabilizing effect of food-web complexity

Akihiko Mougi (Shimane Univ), ○Michio Kondoh (Ryukoku Univ)

What allows diverse species coexisting in nature has been a central question in ecology, ever since the theoretical prediction that a community with more species or interactions should be inherently less stable. Studies have consistently demonstrated that spatial complexity and heterogeneity, a general feature of natural ecosystems, promote species coexistence. Nevertheless, most previous studies were of relatively simple systems and the question of what, if any, contribution spatial structure has to the maintenance of complex food webs has been unexplored. Here, using a meta-community model of food webs, we show that the two different kinds of ecological complexity, meta-community complexity and food-web complexity, can interactively stabilize multi-species population dynamics. Meta-community complexity, measured by the number of local food webs and their connectedness, stabilizes as the spatial heterogeneity and resultant inter-food web immigration between local populations elicits a self-regulating, negative-feedback mechanism. This stabilizing force is stronger when the food web is more complex. More importantly, the meta-community complexity can reverse the otherwise negative relationship between food-web complexity and stability into a positive one. These findings imply that the stabilizing role of meta-community complexity should be more critical in real, complex food webs in nature than expected from theory based on simpler systems.

[P-21]
Understanding environmental and genetic factors involved in the plant-insect invasion: An approach from multiple reciprocal transplant experiment

○Yuzu Sakata (Akita Pref. Univ.), Timothy Craig (Minnesota Univ.), Mito Ikemoto (CER, Kyoto Univ.), Takayuki Ohgushi (CER, Kyoto Univ.)

Species traits are shaped by both their genetic variation and the environmental factors. Exotic plants often quickly evolve and adapt to new environments. The reciprocal transplant experiment is effective to detect local adaptation of exotic plants to the local abiotic and biotic environments. Performance of exotic plants differs within native and invaded ranges because the environment surrounding the populations may be highly variable at different sites. Comparing multiple sites is important in detecting local adaptation in invasive species.

Solidago altissima is a North American perennial plant that has extensively invaded abandoned fields in Japan. *Corythucha marmorata* (lace bug) is an herbivorous insect that feeds on *S. altissima* in North America and invaded Japan 15 years ago. We studied the differences in herbivore abundance of *S. altissima* including lace bugs in two sites in the USA and three sites in Japan. The lace bug density varied among gardens and was higher in the Japanese garden than USA garden. *Solidago altissima* from the USA had greater lace bug damage compared to Japan but varied among populations. The number of other herbivores excluding lace bugs was higher in the USA garden than Japanese garden, and was higher on Japanese plants compared to the USA. Overall, the resistance to lace bugs and other herbivores differed among plant populations, which differed between gardens. This suggests the importance of studies considering multiple populations within each range when comparing exotic plant between native and invaded ranges to detect evolution of plant traits.

[P-22]
An aquatic vertebrate can use amino acids from environmental water

○Noboru Katayama (Kyoto Uni., CER), Makoto Kobayashi (Hokkaido Uni, FSC), Osamu Kishida (Hokkaido Uni, FSC)

Conventional food-web theory assumes that nutrients from dissolved organic matter are transferred to aquatic vertebrates via long nutrient pathways involving multiple eukaryotic species as intermediary nutrient transporters. Here, using larvae of the salamander *Hynobius retardatus* as a model system, we provide experimental evidence of a shortcut nutrient pathway by showing that *H. retardatus* larvae can utilize dissolved amino acids for their growth without eukaryotic mediation. First, to explore which amino acids can promote larval growth, we kept individual salamander larvae in one of eight different high-concentration amino acid solutions, or in control water from which all other eukaryotic organisms had been removed. We thus identified five amino acids (lysine, threonine, serine, phenylalanine, and tyrosine) as having the potential to promote larval growth. Next, using 15N-labeled amino acid solutions, we demonstrated that nitrogen from dissolved amino acids was found in larval tissues. These results suggest that salamander larvae can take up dissolved amino acids from environmental water to use as an energy source or a growth-promoting factor. Thus, aquatic vertebrates may be able to utilize dissolved organic matter as a nutrient source.

[P-23#]
The impact of nonlinear relationship between population size and its index in a population dynamics model

○Hashimoto Midori, Okamura Hiroshi, Ichinokawa Momoko (NRIFS/FRA)

Relative index of population size is an important information source for population dynamics models. Although the index is usually assumed to be proportional to the actual population size, it is not always linear especially when the data are obtained from commercial harvest activities. In fisheries science, data from commercial fisheries are generally the most important source for population assessment and thus such a nonlinear relationship leads to biased and unstable population size estimates. In this study, we conducted simulation tests to examine the performance of population dynamics model with or without estimating the parameter related to nonlinearity in population size index. We attempted virtual population analysis (VPA), which is an age-structured cohort analysis widely used in fisheries science. In retrospective analysis for diagnosis of VPA, one datum is removed sequentially and the deviance between population sizes from full and thinned data is evaluated. Because a large retrospective pattern caused by incorrect assumption on the nonlinearity or model misspecification on the time-varying parameter implies large bias in the latest population size estimate, we also examined the retrospective patterns. The biases in the latest population size estimate due to disregard of the nonlinearity were significantly reduced by estimating the nonlinearity although the uncertainty tended to increase. The retrospective patterns were also improved by estimating the nonlinearity even when the model misspecification did not correspond to the nonlinearity.

[P-24]
真社会性アブラムシを専食するゴイシシジミ幼虫における体毛の機能：兵隊アブラムシの攻撃を阻めるか？

○服部充 1・市野隆雄 2,3（1 長大院・水環、2 信大・理、3 信大・山岳）

　食う－食われる関係で被食者は、自身の捕食圧を軽減できるような防衛形質を示すことがある。これに対し、捕食者は被食者の防衛形質を突破できるような形質を進化させることがある。ゴイシシジミの幼虫は、防衛個体（兵隊）を進化させているササコナフキツノアブラムシを主に捕食する。ササコナフキツノアブラムシの兵隊は、前脚で捕食者につかみかかることで防衛を行う。そのため、ゴイシシジミ幼虫は、兵隊からの攻撃を避ける何らかの形質をもっていることが予測される。本研究ではゴイシシジミ幼虫の体側面に存在する体毛がもつ兵隊からの攻撃を阻害する機能に着目した。そこで、ゴイシシジミ幼虫の体毛長を人為的に操作し、体毛長が兵隊の攻撃成功率に影響するか確かめた。その結果、体毛長が短い場合に体毛長が長い場合よりも兵隊の攻撃成功率が高いことが明らかになった。このことは、ゴイシシジミ幼虫の体毛に兵隊からの攻撃を物理的に防ぐ機能があることを示唆している。

[P-25]
The evolution of relative assessment in status-dependent strategies under stochastic environment

○Yuuya Tachiki (Kyoto University, Kyushu University), Itsuro Koizumi (Hokkaido University)

Animals often choose one of several tactics in their life history. The alternative migratory tactics in salmonid fishes are remarkable examples, in which some individuals in a population undergo feeding migration and others mature in their natal river without migration. To explain this phenomena, the status-dependent strategy has been proposed, in which a threshold value for individual status is considered, above and below which each individual should adopt either tactic to attain higher fitness. This model implicitly assumes the existence of an "absolute" value, so each individual chooses a tactic based only on its own status. It is also possible, however, that animals assess their status based on surrounding individuals. This "relative" assessment considers that a threshold value can change depending on individual situation. Here we incorporate Bayesian decision-making and adaptive dynamics to explore the condition for each assessment to be favored by natural selection. Our model demonstrates that absolute assessment is always favored under stable environment, whereas relative assessment can be favored under stochastic environments; mixed strategy was also selected as the intermediate. Our results underscore the need to better understand how individuals assess their own status to choose alternative life-history tactics.

[P-26]
紅藻類に見られる三相性生活環進化についての理論的研究

○別所和博（総合研究大学院大学、学術振興会特別研究員 PD）・佐々木顕（総合研究大学院大学）

　陸上植物や大型藻類では、有性生殖に伴う減数分裂と接合により、配偶体と胞子体の世代交代が観察される。紅藻類では、配偶体上で受精した細胞が、母親から栄養供給を受けることで果胞子体という多細胞化した世代に発達することが知られており、これは自由生活をする胞子体（四分胞子体）とは異なる世代であることから、三相性の生活環と呼ばれてきた。
　我々は、このような特殊な生活環が紅藻類のみで進化した理由として、これまで信じられてきた Searles (1980)による仮説を数理モデルで検証することに取り組む。そこでは、雌雄異株の配偶体と、胞子体の個体群動態を設定し、雌性配偶体による受精細胞に対する進化的に安定な投資量を、一遺伝子座二対立遺伝子モデルで調べた。結果、果胞子体の繁殖を配偶体の死亡率で割った、広義の意味での配偶体の期待繁殖量を最大化する栄養投資が進化しうることがわかった。

[P-27#]
Summary of the Range Expansion of Great Cormorant, *Phalacrocorax carbo*, into Hokkaido

Theodore Squires (Animal Ecology Lab, Graduate School of Agriculture, Hokkaido University)

Most research on the Japanese subspecies of Great Cormorant *Phalacrocorax carbo hanedae*, remains unpublished outside of Japan or is inaccessible in English. In the past year, efforts have been made to update the scientific community to progress in identifying the expansion of *P. carbo* onto the north Japanese island of Hokkaido. The gradual range expansion in the north has been noted in no English publications and remains unrecognized by important groups such as the IUCN and BirdLife International. Several ornithological groups and researchers were contacted in order to gather information about the current distribution and breeding activities of *P. carbo* in the region. Here the findings of Japanese research groups, translated publications, and direct observations are made available.

[P-28#]
Foraging traits of native predators determine toxic impact of an alien prey

○Evangelia Kazila, Osamu Kishida (Hokkaido University)

Consumption of toxic alien prey can be lethal for native predators, therefore increasing predator mortality. Toxic impact on predator mortality differs among species and has often been associated with the predator's ability to withstand alien prey's toxins. However, other predator traits that could affect toxic impact remain largely unexplored. For instance, toxic impact can be determined by foraging ecology of native predators. Foraging traits, such as predator activity, influence prey consumption rates, which in turn could affect toxic impact of alien prey. This study investigates foraging traits of native predators as potential factors affecting alien prey's toxic impact. We performed a series experiments on a system consisting of *Bufo japonicus* toad larvae - a toxic alien species - and two native predator species, *Hynobius retardatus* salamander larvae and *Rana pirica* frog larvae. Following consumption of toxic alien prey, native predator species experienced differential mortality. Toxic impact on predator mortality was largely determined by foraging traits of native predator species. Specifically, food sharing between conspecifics and carcass consumption of *R. pirica* resulted in higher toxic mortality of this species, compared to *H. retardatus*. Understanding the causes of differential toxic impact on native species is essential to predict the ecological consequences of toxic alien species invasion. To our knowledge, this is the first study to suggest that native predator vulnerability to toxic alien prey strongly depends on feeding ecology traits of native predator species.

[P-29]
Realistic dose-response model for pesticide resistance management

○Masaaki Sudo, Takehiko Yamanaka (NIAES)

　一遺伝子座上の抵抗性／感受性対立遺伝子（R／S）に起因する殺虫剤抵抗性を遅延するために、ヘテロ個体（RS）を排除し、同時に感受性個体の保護区を設けて抵抗性ホモ（RR）個体の出現を抑え、S に対する R の相対適応度を低く保つ戦略が提唱されてきた。実現手段としては単剤を高濃度で施用するか、複数剤の同時使用が検討されてきたが、従来の理論研究の主流である集団遺伝学モデルではヘテロの死亡率を優性度のパラメタで単純に定義するケースが多く、抵抗性遅延に十分な現実の薬剤濃度の決定は難しかった。一方、実用的な農薬の濃度を測定する毒性学では、剤の対数濃度とスケールされた死亡率（プロビット等）の回帰式を使う。本研究では両者を統合した濃度–死亡率–抵抗性発達速度のシミュレーションモデルを開発し、単剤の高濃度施用よりも 2 剤を同時施用するほうが、結果として農薬の総投入量を抑えつつ抵抗性発達を遅らせることなどを明らかにした。

[P-30#]
From tactics to strategies: a model-based verification for the evolutionary process of the male-dimorphism in reproductive behaviour

○Kazuko Hase (SOKENDAI, JSPS Research Fellow), Q-ichiro Nakayama (Katsushika-ku)

　　　Under the male-biased operational sex ratio, reproductive males face the high male-male competitions. To increase their fitness, the males must contend with competitors using their sex-specific traits (e.g, forelimbs of amphibians, weapons of insects) whilst maximizing adequate sperms. Some males possess alternative tactics in breeding behaviour (e.g., searching or struggling of male toads), whereas others exhibit alternative strategies (e.g., sneaker, hornless). Male-male competitions can arise male-dimorphism because there is just an evolutionary trade-off between sexual traits and testes sizes. To verify for the evolutionary process of the male-dimorphism, we developed an individual-based model consisted of two functions: a function for the acquisition of females and function for the investment of the sperm qualities. Each function was defined as exponential or sigmoid curves. Variation of individuals was determined by the relationship between body size and expression of the sexual trait. It indicates a reaction norm. Using this model, we observed the evolution of the reaction norm shapes for the males after 50000 generations. In this poster, we discuss evolutionary conditions for the divergence of reproductive strategies of the males in some species.

[P-31#]
ベイツ型擬態における頻度依存的捕食関係〜個体数と捕食痕の非線形な動態から相互作用を調査する〜

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　系統的に離れた無毒のミミックが有毒なモデルの持つ警告色と似た見た目を持つことで捕食を逃れるベイツ型擬態の進化過程には、頻度依存捕食（ミミックがモデルに比べ少ないときは、似た警告形質を示す両種（ミミックとモデル）への捕食圧が下がるが、ミミックの方が相対的に多くなると両種への捕食圧が上がる）が仮定されている。しかし、捕食者である鳥の移出入や世代交代、記憶の保持能力など、調査困難な"ノイズ"が多い自然環境下での証拠は乏しい。
　本研究では、非線形な2つの動態から因果関係を検出する手法（Convergent Cross Mapping）を用いて、ベイツ型擬態種とその「推定」モデル種との系の長期にわたる個体数と捕食痕保持個体数の野外観測データからベイツ型擬態特有の頻度依存捕食関係を検証した。

[P-32]
動物 GPS データの時間軸分析

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　GPS により定期的に取得した動物の位置データの変化を時間軸上で視覚化する手法を提案する。本手法により移動活動がどの時点でどう変化したかを直感的に把握でき、特定の移動パターンの抽出も可能となる。移動時刻分析にも応用できる。本手法は移動モデルを使わず、欠測の除外も補間もしない。このため、分析のために事実を歪める危険がない。
　分析は次のように行う。複数の測位区間を含む評価期間を設定、期間内の軌跡の特徴を数量化、評価期間を測位間隔分シフトしながら、その変化を視覚化する。これを評価期間の長さを変えて、複数の時間スケールで行う。数量化は複数の方法で行い、複数の数量の動きを併せて視覚化する。数量化は欠測の有無に拘らず行い、欠測率も併せて視覚化してその妥当性の判断を行うが、欠測率の変化自身も有用な情報となる。
　本手法は GPS データを無垢な目で眺めるための道具（広義の探索的データ解析）だが、特定目的を持つ分析の枠組みを的確に設定するためにも有用であろう。

レジームシフトを示す生態系の部分的管理

宇野文貴（東大農）

　生態系がある状態から別の状態へと急激に遷移する現象(レジームシフト)は、理論研究が先行した概念であるが、現在では陸域・水域両方の多くの生態系でそのような急激な変化の存在が確認されている。一度遷移した状態を元に戻す(逆方向の遷移を起こす)ためには、遷移が起きた時点での環境条件よりも更に良い条件へと改善する必要があり、これには大きな労力を要する。

　本研究ではこの逆遷移を起こすために必要な労力を低減する方法を模索することを目的とし、状態が悪化した生態系の部分的な管理により生態系全体の状態をより良い状態へと改善する方法をシミュレーションにより検討した。シミュレーションでは、採食圧の増加が餌生物個体数の急激な低下を引き起こす系を取り上げ、個々でレジームシフトが起きたパッチを格子状に配置した地域において部分的に採食圧を下げることにより、餌生物が絶滅寸前となった状態から全パッチで個体数を回復させる際に要する労力及び限度を調べた。その結果、採食圧を下げるパッチ(管理区)を飛び石状に散在配置する方が、大きな管理区を一つ配置する場合と比べて個体数を回復させる際に必要な管理区内の採食圧の減少幅が小さく、また非管理区の採食圧がより高い場合でも地域全体の個体数回復が可能であるということが分かった。これは、管理区を飛び石状に配置することで管理区から非管理区への分散によるレスキュー効果が増えることが関係していると思われる。レジームシフトを示す理論モデルは他にも知られており、これらのモデルでも同様の結果が見られるのかを調べ、今回の結果の一般性を確認する必要がある。

植物の自家和合性と生息域、種多様性との関係

佐藤雄亮（東大農）

　進化的袋小路とも言われる植物の自家和合性の生態学的維持機構には未解明な点が多い。近年の研究では自家和合性植物種は種分化率と絶滅率が高いために多様化率が低いことを示唆するものがある一方、その生息域は自家不和合性植物種より広いことを示したものもある。この一見矛盾する自家和合性植物種の特徴を説明するため、自家和合性植物種の定着可能性と進化可能性に着目した理論研究を行った。自家和合性があれば同種個体や送粉者無しでも繁殖でき、新たな生息地に定着しやすいだろう。しかし、自家和合性を持つ植物種では自家受粉による純化が起こりやすく、変動環境への適応可能性が低くなるだろう。こうした性質により、自家和合性植物種は生息域が広いにも関わらず絶滅率が高くなるとの仮説を立てた。進化シミュレーションの結果、種分化の数や生息パッチ数、絶滅数は自家和合性を持つ植物種で多く、種の多様化率は自家不和合性を持つ植物種で高くなり、仮説を支持した。これにより、定着可能性と適応可能性から、自家和合性植物種の一見矛盾する特徴を説明できる。

[P-35#]
近縁スジシマドジョウの繁殖地への侵入消長と再生産消長の不一致

○森井清仁（滋賀県大・環境）・中野光議（金沢大・環日本海環境研究センター）・高倉耕一（滋賀県大・環境）

　滋賀県にはオオガタスジシマドジョウ *Cobitis magnostriata*（以下、オオガタ）とビワコガタスジシマドジョウ *C. minamorii oumiensis*（コガタ）の2種が分布している。これまで、オオガタは5～6月に、コガタは6～7月に産卵を行うとされており、現在、両種が繁殖しているビオトープ池においても繁殖個体の繁殖地への侵入消長は上記の繁殖期と同様の結果を示した。しかし、両種の再生産個体は同時期にピークを迎え、コガタの本来の繁殖期であるはずの6～7月には、コガタの抱卵個体がいるにもかかわらず、コガタの再生産はほとんど行われていなかった。このことから、コガタは、比較的初期に産卵した個体のみが再生産を成功させたと考えられた。また、オオガタのオスは、自種メスがほとんどいなくなる7月にも、コガタのオスの6倍ほどの頻度で繁殖地に存在していた。したがって、オオガタからコガタへの繁殖干渉によりコガタの再生産に負の影響があったと考えられた。

[P-36#]
ハクチョウ類およびウミワシ類の空間利用と飛翔経路の推定

○近藤博史・ 谷圭一朗・佐々木茂樹・松田裕之（横浜国立大学・院・環境情報）

　風力発電は再生可能エネルギーの一つとして導入が促進されている。しかし、風力発電事業地は、希少猛禽類や渡り鳥などの生息地や中継地となっていることが多く、風車による衝突リスクが懸念されている。よって、それら鳥類について、時期の違いによる行動パターンの変化を把握することは、風力発電事業の環境影響評価や順応的管理を行うにあたり重要である。本研究では道北地域を対象として、時期毎の行動パターンをハクチョウ類とウミワシ類の実際の飛翔データを用いて地形要因や土地利用などの環境要因から解析した。その結果、今回はハクチョウ類では顕著な傾向が見られなかったが、ウミワシ類で、春の渡り、秋の渡りの時期のそれぞれで空間利用が明確に異なった。特に、秋は主要河川沿いで顕著に飛翔頻度が高くなった。一方で、春では草地や湿地・荒地などに強く影響して飛翔頻度が高くなる傾向があった。このように、時期により、飛翔頻度や行動に明確な違いがみられた。

[P-37]
Differentiation in stoichiometry caused by cannibalistic polyphenism

○Kunio Takatsu, Osamu Kishida (Hokkaido Univ.)

Nutrients stored in and released from animal populations influence community structure because primary and secondary productions strongly depend on availability of nutrients. It should be noted that most of the past theoretical models predicting ecological consequences of nutrient compositions (i.e., stoichiometry) of animal body and excretion assume homogeneity of individual stoichiometries within a species. Here we report an empirical evidence of intraspecific differentiation in stoichiometry associated with cannibalistic polyphenism in larval salamanders, *Hynobius retardatus*. In a laboratory experiment in which occurrence of cannibalisms was manipulated, we found that cannibalistic salamanders with large body contain greater nutrients with richer phosphorus in their body and excretion than non-cannibalistic ones. Importantly, because of emergence of the cannibalistic salamanders, amount and composition of nutrients released from whole cannibalistic populations (i.e., excretion) was greater than and different from those of whole non-cannibalistic populations, respectively. Such differentiation in individual stoichiometry due to cannibalistic polyphenism may be a mechanism of variation in stoichiometry of wild salamanders; because phenotype-stoichiometry relationship observed in the wild salamander populations is similar to the one observed in the above experiment. These results emphasize needs to consider how ecology affects individual stoichiometry and its impacts on nutrients composition of animal populations to better understand roles of animal populations in nutrient dynamics in nature.

[P-38#]
キアゲハの春型と夏型に見られる照度に対する選好性の違いとその意義

○西口泰平・石原道博（大阪府大院・理・生物）

　キアゲハは季節多型を示し、夏型は春型よりも大型で黒色部分の割合が大きい。黒色は熱を吸収しやすく体温が上がりやすいため、気温の高い夏に出現する夏型は不利と考えられる。そのため、夏型は体温調節行動を多くとる必要があると考えられる。そこで日向と日陰に対する成虫の選好性を観察したところ、春型は常に日向へ向かったのに対して、夏型は日陰に置いた後は日向へ向かい、日向に置いた後は日陰へと向かった。夏型の行動は体温調節という可能性があるが、春型が常に日向へと向かったのは翅の明るい色彩が日向では背景と同化して保護色となるという可能性がある。そこで捕食者からの攻撃率に季節型間で違いがあるのかを検証するために、緑色の紙に翅を貼り付けた標本を野外に 3 日間置いて、翅の破損率を比較した。これを 6 月初めと 10 月初めの 2 回行ったが、いずれにおいても翅の破損率に季節型間で有意な違いはみられなかった。この結果からは、キアゲハの翅模様に保護色による捕食者回避が関与しているという根拠は得られなかった。

[P-39#]
自切を誘発させたエンマコオロギにおける行動の変化

○水野俊樹・石原道博（大阪府立大院・理・生物）

　コオロギ類は外敵に襲われた際に肢を自切して逃れようとする。一方で自切はその後の行動制限による捕食率の上昇や、交配成功率の減少など多大なコストとなる。そのため、自切のコストを補償する可塑性を持つことは適応的と考えられる。しかし、自切個体における捕食者回避行動や求愛行動の変化などの可塑性ついての研究例は少ない。本研究ではエンマコオロギを用いて、野外での自切率の現状を把握するとともに、自切個体と無傷個体とで行動を比較した。
　まず、野外において約 10 日おきにエンマコオロギをおよそ 100 個体ずつ採集し、発育段階と自切の有無を記録した。その結果、２齢から自切が確認され、自切率は９齢で１４％と最も高く、各齢を通して約３〜１４％であった。次に、自切個体と無傷個体を用意し、外敵の接近を疑似する人為的な刺激を容器に与え、エンマコオロギがシェルターに隠れる時間を測定した。シェルターに隠れる時間は自切個体と無傷個体の間で有意な差は見られなかった。

[P-40#]
生活史の諸形質は遺伝的多様性のパターンを決定する　〜種横断的なメタ解析からの示唆

○八島亮子（武蔵野大）・印南秀樹（総合研究大学院大）

　遺伝的多様性の高さや，集団間の違いなどを調査することは，その生物の個体群動態を調査する上で重要な知見となる．よって，多くの生物種でこうした遺伝的多様性のパターンが調査されてきた．また一方で理論的には，移住のパターンや集団サイズの大きさに関わる生活史の諸形質が遺伝的多様性のパターンに影響を及ぼすことが想定される．しかしながら，こうした遺伝的多様性のパターンは各生物種それぞれの解析に留まり，生活史の諸形質が実際に遺伝的多様性に及ぼす普遍的な影響については不明な点が多い．本研究ではまず，種内の遺伝的多様性を様々な種で比較することの有意性を確かめるために，移住のパターンがある程度予測される魚類種を生活域の違いによって分類し，検討を行った．結果として，集団構造ができやすい種と，分集団化がほとんど見られない種に二分され，それは，それぞれの種の生息域とそれによって決まる移住の範囲を考えるとかなり必然的に予想可能な結果であった．次に，このようなパターンが脊椎動物全体に当てはまるかを検討した．

[P-41#]
Simulated verification of factors shaping population genetic structures by nDNA and mtDNA of Hokkaido voles

○村上翔大（北大・環境科学院）・齊藤隆（北大・FSC）

　遺伝的集団構造は短い時間スケールにおいて、遺伝的浮動と遺伝子流動によって形成される。哺乳類を対象にした集団遺伝的な研究では、しばしば両性遺伝の nDNA と母系遺伝の mtDNA を遺伝マーカーに用いた場合に遺伝的集団構造に差異が見られるが、その決定要因については深く探求されていない。本研究では、まず北海道全島のエゾヤチネズミ (*Myodes rufocanus bedfordiae*)の集団遺伝解析を行った。両性遺伝マーカーにはマイクロサテライト 7 遺伝子座、母系遺伝マーカーには mtDNA Dloop 領域を用いた。固定指数 FST を指標とした集団構造は nDNA では F_{ST} の平均、分散は共に小さくなり、距離による隔離 (Isolation By Distance: IBD)が検出された。mtDNA では F_{ST} の平均、分散は nDNA よりも大きな値をとり、IBD は観察されなかった。次に、飛び石モデルを考慮した個体ベースモデルによって、距離の異なる仮想集団間の F_{ST} がどのようなパターンで出力されるかを調べた。シミュレーションの結果、マーカー間での F_{ST} の平均、分散の大小は再現されたが、IBD は両方のマーカーで検出された。実際の mtDNA の遺伝的集団構造を再現するには、他の生態学的な要因を考慮する必要がある。

[P-42#]
エゾシカ個体群の遺伝的な空間構造における境界の強度とその形成要因

○森本祥子・三澤桃（北大・環境科学院）・齊藤隆（北大・FSC）

　北海道のエゾシカ(*Cervus nippon yesoensis*)個体群は、マイクロサテライト DNA の解析により南北 2 つの分集団に分かれていることが明らかになっているが、その分集団の境界の強度や形成要因はまだ明らかになっていない。本研究では、境界付近のサンプルをさらに増やして同様の解析を行い、境界の位置をより明確にした遺伝的空間構造を推定した。また、分集団内と分集団間の個体の近縁度を算出し、物理的距離と遺伝的距離の関係を調べた。その結果、分集団間の個体同士の方が分集団内よりも遠縁であることが分かった。これより、エゾシカ個体群における境界は距離による見かけ上の境界ではないことが判明した。また、推定された境界と大まかに一致している道路等が見つかったが、他の道路と比較してエゾシカが関連する事故件数等に目立った特徴は見られなかったため、これらがエゾシカ個体群の障壁となっていると結論付けることはできなかった。今後は、境界の形成要因として生物学的な要因に注目していく必要があり、発表では著者の仮説を提案する。

[P-43#]
温帯性感染症媒介蚊の個体群動態

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　将来の気候変動は生物圏に様々な影響を与えるといわれ、なかでも人間の生活や健康を脅かす感染症の拡大は大いに危惧すべき問題である。本研究ではその中でも感染症媒介蚊の気候変動につれた個体群動態の変化に注目する。特に温度上昇幅の大きく季節的消長の変化や分布域の拡大が心配される温帯における動態を明らかにするため、温帯性の蚊の生理的特徴である休眠と降雨による幼生個体の流出を組み込んだ個体群動態モデルを開発した。シミュレーテッド・アニーリング法により尤度を指標としてキャリブレーションを行い、実測の個体数データを用いて不明確な蚊の生理的特徴に関わるパラメータを推定した。現在の気象データを入力としてシミュレーションを行うと、実測された個体数をよく再現できた。将来気候値を入力値として、将来予測への応用可能性が示唆される。

[P-44#]
植物－細菌共生系における遺伝的組み合わせのモザイク構造

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　群集遺伝学は遺伝子から群集や生態系までの異なる階層間の相互作用の解明を目的とする分野である。発表者はこれまでに、森林のケヤマハンノキで遺伝的に遠い集団ほど形成される昆虫群集がより異なることを見出した。この強固な遺伝効果が維持される要因として、ハンノキ属の共生細菌フランキアに着目した。野外において共生パートナーの質に遺伝変異があることが知られ、その実態の解明が共生関係の進化動態を理解するために重要視されつつある。共生パートナーの遺伝変異は、寄主の生存率に直接影響を与える、または寄主の形質を変える間接遺伝効果を与えることで、樹木-昆虫間の遺伝効果を生み出していると考えた。本研究では共生細菌の遺伝変異が寄主の生存率への影響と間接遺伝効果の検証を目的とする。まず野外複数地点から採取したフランキアを単離培養し、遺伝解析を行った。次に培養細菌を異なる母樹由来のハンノキ実生に接種し、共生関係の組合せ実験を行った。これらの結果、ハンノキ集団ごとに共生細菌の遺伝変異の効果が異なることが示唆された。

[P-45]
撹乱環境下での栄養繁殖

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　植物のような固着性生物は、移動という手段を持ち合わせないために環境の変動に対して脆弱であるが、次世代個体を種子散布などにより生産することでこの変動環境のリスクを回避することができる。種子生産をする植物のなかでもクローン成長で次世代生産を行うものがあるが、栄養輸送などの制約により、種子散布に比べると親個体周辺に分散距離が限られる場合が多い。よって種子による遠方への分散に加え、親個体周辺への次世代生産を同時に行うことになる。生育環境に撹乱が生じる変動環境下においては、栄養繁殖で生産される個体は親個体が被る撹乱の頻度に相当する割合で撹乱を受ける可能性が高い。それでもこの次世代個体生産様式が実現されるにはどのような背景があるのだろうか。本研究では、固着性生物の個体群動態を頻度依存の行列モデルで記述し、撹乱が繁殖戦略へ及ぼす影響を解析した。個体群維持には撹乱の制約を要することがわかった。さらに親個体から次世代個体への資源輸送により、親個体に蓄積されている資源量が変動する・しない場合についての違いを考察する。

[P-46]
Eco-evolutionary feedback in the wild insect community

○Shunsuke Utsumi, Hirono Onodera (Hokkaido Univ), Masaki Yasugi (NIBB), Nagano Atsuhi (Ryukoku Univ)

　　　It has been still poorly understood how complex ecological communities and rapid evolution of a community member influence each other within a similar time-scale in nature. This is because most of empirical eco-evolutionary studies have adopted a homogeneous experimental environment, clonal organisms, retrospective genetic variation, and a few community members. Here we examined eco-evolutionary feedback loop in the field. The willow leaf beetle *Plagiodera versicolora* and willow-associated arthropod communities provide a unique opportunity to investigate a reciprocal interplay between evolution in a non-model, sexually-reproducing species and ecological dynamics of a complex community. The leaf beetle individuals show a genetically-based specialist/generalist continuum, ranging from a specialist which exclusively feeds on new leaves to a generalist which displays non-preferential feeding for leaf-age types. This foraging trait and willow-associated arthropod community influence each other. In this study, first, we performed ddRAD-seq to reveal fine-scale standing genetic variation in the field. Second, we conducted a genome-wide association analysis for the specialist/generalist continuum to develop a specific SNP marker. Third, we constructed mescosms covering mature willow trees and performed manipulative experiments with naturally-colonized insect communities. The leaf beetle populations were inoculated into the mesocosms with three treatments: specialist-dominant, generalist-dominant, and mixed. We tracked community dynamics and leaf beetle evolutionary dynamics. Community structure of diverse insect species differentially developed on a tree crown, according to the initial beetle treatment. Furthermore, community divergence could feed back to rapid evolution.

[P-47]
生態系エンジニアによる環境・群集改変の地域変異

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　河川に生息する造網型トビケラは礫の間隙に網を張り、撹乱に強い河床環境を創出ことで、他種の底生動物にも安定的な生息地を提供している（生態系エンジニア）。一方、筒巣トビケラの造巣行動には、生息場所の環境に応じた地域的な変異があることが分かっている。そこでもし、造網型トビケラの造網様式においても地域的な変異が起こっていれば、環境改変や群集への影響の仕方にも違いがあるかもしれない。本研究では日本の河川に広く分布するヒゲナガカワトビケラの造網行動と、環境改変力に地域的な違いがあるかを実験的に検証した。その結果、１．流量変動が大きい河川に生息するヒゲナガカワトビケラほど、より多くの分泌絹糸で礫同士を強固につなぎ合わせること、２．強固な網巣を作るトビケラ集団が導入された河床ほど、撹乱に対してより安定的で砂礫が流されなくなり、３．同所する無脊椎動物の総個体数および種多様度が増加した。生態系エンジニアの種内変異によって、地域的特異的な環境・群集が創出される可能性が示唆された。

[P-48]
Analyzing elasticity of projection matrices with intra-/interspecific competition and phenotypic plasticity: experiments of two *Anisopteromalus* parasitic wasps

○Masakazu Shimada, Yasuko Nagase, Minoru Kasada (Univ. Tokyo)

　　　Elasticities of the Leslie matrix identify of which developmental stage(s) natural selection promotes with higher survivor and fecundity more advantageously. In nature, however, organisms show not only phenotypic plasticity in the life history but also have biotic interactions such as intra-/inter-specific competitions. Therefore, it is important to analyze the Leslie matrix in experimental systems that is controlled with phenotypic plasticity and biotic interactions, from the point of view of evolutionary demography.

　　　A pteromalid wasp, *Anisopteromalus quinarius*, was registered as a sibling, different species of *A. calandrae*. *A. quinarius* shows great phenotypic plasticities of life-history parameters, provided with honey. However, *A. calandrae* does not have any phenotypic plasticity of life history parameters because they suck host with straw they made using the ovipositor.

　　　We set two experimental conditions: low-density (2 females per cage) and high density (4 females). We analyzed intra-/interspecific competitive effects on their daily-based reproductive abilities and longevities in three weeks. Integrating the two parameters to the Leslie projection matrices, and estimated elasticity of eigenvalue. Both density conditions showed that elasticities of *A. quinarius* could *never* compete better than *A. calandrae*. Therefore, coexistence of *A. quinarius* with *A. calandrae* in Europa and Northern America widely suggests two maintenance factors: geographical isolations locally and non-equilibrium biotic interactions with surplus of resources availability.

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Acknowledgements