

様式 4

## 平成 27 年度 学術振興基金助成による成果報告書

平成 27 年 6 月 23 日

学 長 殿

所属部局・職名 共生システム理工学類教授

申 請 者 名 塘 忠 頭

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| 助成事業の区分<br>(該当するものに○印) | 研究協力に関する事業<br>(学術出版・叢書・○学会等)<br>学術振興に関する事業<br>(学生・事務職員・その他の特別事業)   |
| 事業名                    | 日本節足動物発生学会第 51 回大会及び本学会が本大会前に開催する公開講演会   |
| 事業実施期間                 | 平成 27 年 6 月 12 日 ～ 平成 27 年 6 月 13 日  |
| 成果の概要                  | <p>日本節足動物発生学会第 51 回大会は平成 27 年 6 月 12-13 日、福島県耶麻郡北塩原村の休暇村裏磐梯天文台ホールにて開催された。参加者は福島大学の他、筑波大学、愛媛大学、名古屋大学、自治医科大学、生物資源研究所、海洋研究開発機構、JT 生命誌研究館、横須賀市自然・人文博物館などに所属する 34 名の研究者・大学院生などで、講演題数は本大会前に開催した公開講演会における特別講演 2 題、本大会の一般講演 11 題、学会奨励賞受賞者による受賞講演 1 題の計 14 題であった(福島大学からは教員 3 名、大学院生等 8 名が参加し、教員 1 名、大学院生 2 名が研究発表を行った。)</p> <p>初日(12 日)の 13:00 からの公開講演会は、2 名の外国人研究者を演者に迎えて実施した。世界的に著名な昆虫形態学者である Prof. R.G.Beutel (ドイツ・イエーナ大学)は「The Evolution of Megadiversity in Hexapoda (Arthropoda)」とのタイトルで、新進気鋭の昆虫形態学者である Dr. A. Blanke (ドイツ・ボン大学)は「Mouthpart Evolution in Early Hexapoda」とのタイトルで、それぞれの分野における最新の知見を盛り込んだ非常にエキサイティングな講演をされた。</p> <p>学会大会は学会奨励賞を受賞した筑波大学菅平高原実験センター所属の PD 真下雄太氏による受賞者講演「Comparative Embryology of Zoraptera」、そして、昆虫の胚発生、形態の機能解析、遺伝子発現解析、節足動物の系統進化、新しい研究手法の導入など多様な分野にわたる一般講演が実施された。11 題の一般講演のうち 9 題のプレゼンテーションが英語で実施され、いずれもアクティヴなディスカッションが繰り広げられた。</p> <p>最後に学会の総会が開催され、2 日目(13 日)の 14:00 にすべてのプログラムが終了した。</p> |

日本節足動物発生学会第51回大会プログラム (福島・裏磐梯 2015年6月12-13日)  
Program of the 51st Annual Meeting of the Arthropodan Embryological Society of Japan  
Urabandai, Fukushima, Japan, June 12-13, 2015

6月12日 (金) June 12 (Friday)

12:00 受付開始 Reception

13:00 公開講演会 Special featuring lecture (Extension Lecture)

座長: 町田龍一郎 Chairperson, MACHIDA Ryuichiro

13:00-13:10 開会 小林幸正会長 Opening Address by Yukimasa KOBAYASHI (President of AESJ)

13:10-14:30 Rolf Georg BEUTEL /Institut für Spezielle Zoologie und Evolutionsbiologie, Friedrich-Schiller-Universität Jena  
The Evolution of Megadiversity in Hexapoda (Arthropoda)

14:30-15:10 Alexander BLANKE<sup>1,2</sup> /<sup>1</sup>Sugadaira Montane Research Center, University of Tsukuba, <sup>2</sup>Zoologisches Forschungsmuseum  
Alexander König, Rheinische Friedrich-Wilhelms-Universität Bonn

Mouthpart Evolution in Early Hexapoda

15:30 一般講演1 (座長: 内船芳江) General session 1 (Chairperson, UCHIFUNE Yoshie)

01 15:30 ○MASHIMO Yuta, MACHIDA Ryuichiro /Sugadaira Montane Research Center, University of Tsukuba  
A challenge to the subcoxal theories of pleural and sternal origins in insects

02 15:50 ○HARADA Atsuhiro, FUKUI Makiko /Graduate School of Science and Engineering, Ehime University  
Egg structure and egg tooth in Orthoptera (Insecta · Polyneoptera)

03 16:10 ○NIITSU Shuhei<sup>1,2</sup>, KAMITO Takehiko<sup>2</sup> /<sup>1</sup>Graduate School of Science and Engineering, Tokyo Metropolitan University,  
<sup>2</sup>Graduate School of Arts and Science, International Christian University  
Early cellular and histological changes induced by ecdysteroid in the pupal wing epithelium of the wingless-female winter moth

16:30-16:40 休憩 Coffee break

16:40-16:50 安藤 裕賞 表彰式 Ando Hiroshi Award Ceremony

16:50-17:30 安藤 裕賞 受賞講演 Ando Hiroshi Award Speech

04 16:50 MASHIMO Yuta /Sugadaira Montane Research Center, University of Tsukuba  
Ando Hiroshi Award Speech

18:00-20:00 シンポジウム (夕食付き) Symposium with Dinner

20:00- ワークショップ Workshop

6月13日 (土) June 13 (Saturday)

07:30-08:30 朝食 Breakfast

08:30- 一般講演2 (座長: 福井真生子) General session 2 (Chairperson, FUKUI Makiko)

05 08:30 ○FUJITA Mari<sup>1</sup>, NOMURA Shuhei<sup>2</sup>, MACHIDA Ryuichiro<sup>1</sup> /<sup>1</sup>Sugadaira Montane Research Center, University of  
Tsukuba, <sup>2</sup>National Museum of Nature and Science

Simple, artifact-free SEM observations of embryos: "Nano-suit method"

- 06 08:50 ○KOBAYASHI Yukimasa<sup>1</sup>, SUZUKI Nobuo<sup>2</sup>, SHIMIZU Satoru<sup>3</sup> /<sup>1</sup>Sayama-shi, <sup>2</sup>Japan Women's College of Physical Education, <sup>3</sup>Ueda-shi  
Labial egg burster of *Sialis japonica* and its possible phylogenetic significance: A comment on the article by Ando *et al.* (1985) (Megaloptera; Sialidae)
- 07 09:10 ○MTOW Shodo, MACHIDA Ryuichiro /Sugadaira Montane Research Center, University of Tsukuba  
Comparative Embryology of Plecoptera (Insecta)
- 08 09:30 ○KOJIMA Kazuki, MACHIDA Ryuichiro /Sugadaira Montane Research Center, University of Tsukuba  
Embryology of a "living fossil" beetle, *Tenomerga mucida* (Chevrolat, 1829) (Archostemata, Cupedidae)
- 09:50-10:00 休憩 Coffee break
- 10:00- 一般講演3 (座長: 内船俊樹) General session 3 (Chairperson, UCHIFUNE Toshiki)
- 09 10:00 ○KIMEZAWA Yurie<sup>1</sup>, KANEKO Shingo<sup>2</sup>, TSUTSUMI Tadaaki<sup>2</sup> /<sup>1</sup>Graduate School of Symbiotic Systems Science and Technology, Fukushima University, <sup>2</sup>Faculty of Symbiotic Systems Science, Fukushima University  
Molecular phylogeny of *Thrips* genus-group (Thysanoptera: Thripidae) based on nuclear 18SrDNA sequences
- 10 10:20 ○GOTOH Hiroki<sup>1</sup>, OKANISHI Masanori<sup>2</sup>, YAGINUMA Toshinobu<sup>1</sup>, NIIMI Teruyuki<sup>1</sup> /<sup>1</sup>Nagoya University, Bioagricultural Sciences, <sup>2</sup>Kyoto University, Field Science Education and Research Center  
Molecular phylogeny of genus *Cyclommatus* (Coleoptera, Lucanidae)
- 11 10:40 ○OHIRA Hajime<sup>1</sup>, KANEKO Shingo<sup>2</sup>, TSUTSUMI Tadaaki<sup>2</sup> /<sup>1</sup>Graduate School of Symbiotic Systems Science and Technology, Fukushima University, <sup>2</sup>Faculty of Symbiotic Systems Science, Fukushima University  
Molecular phylogeny of genus *Mundochthonius* (Pseudoscorpiones: Chthoniidae) reveals the existence of multiple cryptic taxa and their complex distribution pattern
- 12 11:00 SATO Koichi<sup>1</sup>, OHIRA Hajime<sup>2</sup>, TSUTSUMI Tadaaki<sup>1</sup>, ○KANEKO Shingo<sup>1</sup> /<sup>1</sup>Faculty of Symbiotic Systems Science, Fukushima University, <sup>2</sup>Graduate School of Symbiotic Systems Science and Technology, Fukushima University  
Intraspecific molecular phylogeny of putative parthenogenetic pseudoscorpion, *Microbisium pygmaeum* (Iocheirata, Neobisiidae)
- 11:20-11:30 休憩 Coffee break
- 11:30- 一般講演4 (座長: 山本大介) General session 4 (Chairperson, YAMAMOTO Daisuke)
- 13 11:30 TOMITA Shuichiro /National Institute of Agrobiological Sciences  
Regulatory role of homeotic genes in lepidopteran proleg development
- 14 11:50 HATAKEYAMA Masatsugu /National Institute of Agrobiological Sciences  
Roles of homeobox genes in the proleg development in the sawfly, *Athalia rosae ruficornis*
- 12:10- 閉会 塘 忠顕大会実行委員 Closing address by Tadaaki TSUTSUMI (Convener)

12:10-12:20 写真撮影 Taking Photos of participants

12:20-13:00 昼食 Lunch

13:00- 総会 General meeting of AESJ

51st Annual Meeting of the Arthropodan Embryological Society of Japan  
Urabandai, Fukushima

Arthropodan Embryological Society of Japan

## Special Featuring Lecture (Extension Lecture)

June 12, 2015

13:00 - 15:10 in Tenmondai Hall, National Park Resort URABANDAI

### PROGRAM

**13:00 Opening Address**

**Yukimasa KOBAYASHI** (President of AESJ)

**13:10 The Evolution of Megadiversity in Hexapoda (Arthropoda)**

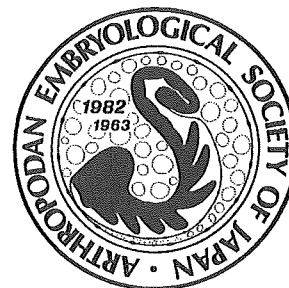
**Rolf Georg BEUTEL** (Institut für Spezielle Zoologie und Evolutionsbiologie,  
Friedrich-Schiller-Universität Jena)

**14:30 Mouthpart Evolution in Early Hexapoda**

**Alexander BLANKE** (Sugadaira Montane Research Center, University of  
Tsukuba, Zoologisches Forschungsmuseum Alexander  
König, Rheinische Friedlich-Wilhelms-Universität Bonn)

**Chairperson:**

**Ryuichiro MACHIDA** (Sugadaira Montane Research Center, University of Tsukuba)



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## The Evolution of Megadiversity in Hexapoda (Arthropoda)

Rolf Georg BEUTEL

*Institut für Spezielle Zoologie und Evolutionsbiologie,  
Friedrich-Schiller-Universität Jena, GERMANY*

With ca. 1.000.000 described species Hexapoda comprise more than half all known organisms. The topic of this presentation is the evolution of this unique diversity. **“Evolutionary szenarios” without sound phylogenetic basis are problematic.** Fortunately now a robust phylogeny for Hexapoda is available from the international 1KITE project.

Traditionally Hexapoda are placed in Tracheata with Myriapoda, suggesting that a common Silurian ancestor acquired terrestrial habits and specific adaptations (e.g. tracheal system). The well supported new Pancrustacea concept implies that hexapods and myriapods invaded land independently. Under similar selective pressure they independently evolved a tracheal system and other features. **Evolutionary szenarios are only as good as the underlying phylogenetic hypothesis. The picture can change radically when long accepted systematic concepts turn out as wrong.**

A conspicuous autapomorphy of Hexapoda is a tagmosis with 3-segmented thorax and 11-segmented abdomen. It is uncertain whether this has contributed to the evolutionary success. **If characters have independently evolved in non-related succesful groups, it is likely that they have played a role in the diversification.** As the tagomosis of Hexapoda is unique this does not help in this case. The division of labor within the body could be an advantage, with the thorax specialized on locomotion and digestive and genital organs concentrated in the abdomen. This has apparently not have caused a burst of diversification as the diversity of basal groups is low. However, the compact thorax was a necessary precondition for the evolution of flight.

Collembola are clearly the most diverse apterygote group. The jumping capacity (flight mechanism), the ecological versatility and the high reproduction rate have contributed to the diversification. An important evolutionary novelty of Insecta (=Ectognatha) is the ovipositor, linked with the capacity to deposit eggs in narrow crevices or plant tissue. The subdivided tarsus is a precondition for the development of tarsal attachment devices, which enable insects to walk efficiently on plant surfaces. The dicondylic manibular articulation is an important innovation of Zygentoma + Pterygota (Dicondylia). Due to reduced

degrees of freedom at the mandibular base more powerful biting movements are possible and a much broader spectrum of food can be processed.

The most important innovation in insect evolution was the development of wings. Pterygota comprise ca. 99% of all species. Advantages are the increased ability to escape predators and a greatly increased dispersal capacity. The latter also applies to the successful non-related spiders (Aranea) which fly as juveniles using silk rafts. In the Carboniferous - linked with the evolution of flight - the first great wave of diversification takes place. Another important novelty is internal sperm transfer. The increased reproductive economy has also contributed to the evolutionary success. The extreme diversity of the genitalia is mainly caused by sexual selection (female cryptic choice). An example of an **evolutionary arms race** is that females vary their genitalia to aggravate fertilization and that male genitalia vary to overcome the obstacles.

A key innovation of Neoptera (Pterygota excl. Ephemeroptera and Odonata) is the ability to fold back the wings, resulting in the ability to hide in narrow spaces, which means better protection and reduced water. Another apomorphy is the arolium, the first of several types of attachment devices. Plants modify their surfaces to prevent insects from walking and feeding on them and insects modify their attachment devices to overcome these obstacles. This is another example for an **evolutionary arms race**.

Neoptera are divided into 3 large groups, Polyneoptera, Acercaria and Holometabola. The strongly debated monophyly of Polyneoptera is now confirmed, especially by embryonic features. The only very diverse group is Orthoptera, characterized by jumping legs, acoustic communication, and primarily phytophagous habits. Insect-plant interrelationships have played a major role in the diversification of different groups. Two secondarily wingless groups, Grylloblattodea and Mantophasmatodea, comprise only ca. 50 species. An advantage in the former is the reduced risk to be drifted away by wind. The very low diversity is related with the drastically reduced dispersal ability.

A key characteristic of Acercaria (Psocodea, Thysanoptera, Hemiptera) is the piercing-sucking apparatus, but this is not a groundplan feature. Ca. 90% of the species (ca. 100.000) belong to Hemiptera. Phytophagous habits have triggered this megadiversification and highly diverse attachment devices enable them to move very efficiently on plant surfaces. The non-phytophagous Psocodea comprise only ca. 7.000 spp. Cicada (ca. 42.000 spp.) show evolutionary parallels to the successful Orthoptera, a very good jumping capacity and acoustic communication. Consequently both character complexes have contributed to the diversification in both groups.

Holometabola is extremely diverse with ca. 800.000 spp. The holometabolous development is an important novelty but has not triggered a major diversification in the early evolution of the group, as the diversity of several orders is low. The immobilized and unprotected pupa is a risk-factor in the life cycle (**evolutionary costs**). The ability of larvae and adults to use different resources is an advantage (decreased intraspecific competition).

Another key feature is the absence of external wing buds. It enables the larvae to penetrate under bark or to burrow in plant tissue, very narrow spaces not accessible for most predators. These factors do not sufficiently explain the extreme species richness. The diversification of the four extremely species rich orders ("Big4") was closely linked with the „angiosperm revolution“ (Cretaceous). New food sources became available. Reciprocally insects have immensely contributed to the dispersal and evolutionary success of angiosperms as pollinators. The positive evolutionary interaction resulted in ca. 200.000 spp. of angiosperms and the fantastic number of ca. 800.000 spp. in Holometabola. **This is probably the most important example of successful co-evolution.**





