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得獎著作：

- Abe G, Lee SH, Chang M, Liu SC, Tsai HY, Ota KG, 2014, “The Origin of the Bifurcated Axial Skeletal System in the Twin-Tail Goldfish.”, *Nature Communications*, 5, 3360.

得獎簡評：

太田欽也助研究員(Kinya Ota)在日本綜合研究大學院大學(SOKENDAI)獲得博士學位(2002)後，至日本理研所的發育研究中心擔任研究員(2004-2011)，2011 年延聘至中央研究院細胞與個體生物所擔任助研究員。他這幾年已經建立自己團隊探討魚類演化生物學。

太田欽也博士專長於發育生物學，特別興趣於魚類的演化生物學。代表作(通訊作者）發表於 *Nature Communications*，論文為其團隊對金魚的特殊品種(twin-tail goldfish)如何演化而來有明確論証，發現二套 chordin 基因的其中一套突變在 E127X(stop codon)而造成胚胎 dorsal-ventral patterning 改變，形成 bifurcated caudal axial skeleton。這突變可能發生在 600 年前。

此篇論文具有高度的原創性，也說明演化過程中的突變造成生物界形態變化的最佳範例。

得獎人簡歷：

I am the assistant research fellow of Marine Research Station, Institute of Cellular and Organismic Biology, Academia Sinica and the joint appoint assistant

profess of Taiwan International Graduate Program and National Taiwan Ocean University. Previously, I was Research Scientist in CDB, RIKEN, Japan (2004-2011) and Research Fellow of Japan Society for the Promotion Science (2002-2004). I completed my PhD at the Department of Genetics, School of Life Science, The Graduate University for Advance Studies (SOKENDAI) in the laboratory of Professor Takashi Gojobori, where I studied the evolution of sex chromosomes in the deep-sea- and shallow water marine teleost fishes. I was awarded the Career Development Award, Academia Sinica (2014) and Encouraging prize of Zoological Society of Japan (2007). My research interest is Evolutionary Developmental Biology (Evodevo) in the vertebrates. I seek to understand how highly sophisticated morphology and its developmental mechanism have evolved and diverged from the common ancestor. For this purpose, I applied anatomy, histology, embryology and molecular biology to different early vertebrate species.

In particular, I contributed to the progress of the hagfish Evodevo from 2007 to 2011. Hagfish has been recognized as one of the most important animal for the understanding of the common ancestral features of vertebrates because of its apparently primitive morphology and significant phylogenetic position. However, due to the difficulty of obtaining the embryos, there has not been progress in the developmental biology of the animal for a century. To provide further progress, I employed the Japanese shallow water hagfish (*Eptatretus burgeri*) to my research and succeeded in obtaining the hagfish embryos. Using the obtained embryos, I reported that the same molecular mechanisms for the development of the neural crest cells and vertebral elements are shared between the jawed vertebrates and hagfish, suggesting that their origin can be date back to 500 million years ago. These researches were published in *Nature* as Ota et al., 2007 and in *Nature communications* as Ota et al., 2011.

Moreover, I recently studies on the goldfish to answer to the question how evolution, development, and artificial selections are related. Especially, my twin-tail goldfish study provided an insight into the drastic morphological evolution occurred under the artificial selections.

得獎著作簡介：

Twin-tail goldfish possess a bifurcated caudal axial skeleton. The scarcity of this trait in nature suggest that a rare mutation, which drastically altered the mechanisms underlying axial skeleton formation, may have occurred during goldfish

domestication. However, little is known about the molecular development of twin-tail goldfish. Here we show that the bifurcated caudal skeleton arises from a mutation in the *chordin* gene, which affects embryonic dorsal-ventral patterning. The phylogenetic and embryological proximity of goldfish and zebrafish suggest the possible existence of a zebrafish mutant with a phenotype similar to that of twin-tail goldfish. To identify such a mutant, we compared embryonic and adult twin-tail goldfish with previously identified zebrafish mutants. We report that twin-tail goldfish share several representative phenotypes with *dino* zebrafish mutant; the mutated gene in the *dino* mutant is *chordin*, a key player in dorsal-ventral patterning. Our molecular cloning revealed that goldfish revealed has at least two closely related *chordin* genes (designated as *chdA* and *chdB*), which may be consequence of a recent genome duplication. More significantly, we identified two alleles of the *chdA* gene; one allele (designated as $chdA^{wt}$) contains the wild-type codon at the 127th amino-acid site, while the second allele (designated as $chdA^{E127X}$) contains a stop codon at the same position. Sequencing of PCR amplicons revealed that eight morphologically and genetically diverged different goldfish strains are homozygous for $chdA^{E17X}$, while all allelic combinations were observed in wild-type goldfish populations. Moreover, our backcross analysis strongly suggests that homozygosity for the $chdA^{E127X}$ allele is essential for the development of the bifurcated axial skeletal system in twin-tail goldfish. Moreover, injection of $chdA^{wt}$ mRNA into twin-tail goldish embryos resulted in a dose-dependent rescue of the phenotype. These results suggest that $chdA^{E127X}$ allele causes the twin-tail goldfish phenotype. The similarity between the *chdA* and *–B* sequence suggests they may have redundant functions, potentially implicating *chdB* in the twin-tail goldfish phenotype as well. To examine this hypothesis, we compared the function and expression patterns of the *chdA* and *–B* genes in goldfish embryos and revealed that their function and expression patterns are partially redundant. To more precisely determine how the functional redundancy and partially overlapping expression patterns of the goldfish *chordin* genes contribute to dorsal ventral patterning in twin-tail embryos, we examined the expression patterns of ventral embryonic tissue markers (*eve1*, *sizzled* and *bmp4*) and a hindbrain marker gene (*krox20*). The analyses of the expression patterns of these marker genes suggest the partially overlapping expression patterns of *chdA* and *–B* appear to enable wild type-like anterior-dorsal tissues and *dino*-like ventralized gene expression pattern to coexist in twin-tail embryos. Analysis of Chinese archives indicate that goldfish domestication for ornamental purpose began at around 1000 Common Era (CE) in Song dynasty China and twin-tail goldfish appear

in Ming dynasty archives in 1596 CE. From these historical documentations, the *chdA*^{E127X} was selected during 600 years of domestication and became fixed in the common ancestor of twin-tail strains. Our results also provided into the evolution of the robust and highly conserved developmental mechanisms controlling dorsal-ventral patterning. Large-scale morphological changes, which require extensive modification of such developmental mechanisms, are often presumed to require a relatively long period of evolutionary time. However, here we have identified that a drastic morphological and developmental change occurred in goldfish in a period of only 600 years, as a consequence of a recent gene duplication and subsequent artificial selection.

得獎感言：

很榮幸獲得 2016 年中研院年輕學者研究著作獎，感謝所有審查委員。我要謝謝來自宜蘭臨海研究站的幫助，我的實驗室團隊、行政室以及養殖室的所有人。特別要感謝我的前博士後研究員，阿部玄武，他對於雙尾金魚研究貢獻良多。

最後，我想對一直支持我的家人表達最大的感激。謝謝!