

□ 특별논문

Natural History in Korea and Linnean Taxonomy with His Nomenclature Challenged by Phylocode*

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ABSTRACT

Early records of Korean cereal plants can be found in documents since the 3rd century. Medicinal plants were listed and described afterward, from the 13th

1 * The draft of this paper was presented at the Korean-Swedish Joint Symposium in Honor of Carl von Linné "Carl von Linné and His Impacts in East Asian Context", April 26, 2008, Seoul, Korea. The title, however, in the present one is modified along with the text improved and updated. I wish to offer my sincere thanks to Dr. Shin Dongwon (KAIST) and M.Sc. Shin Hyang-Suk (Jeonbuk National University) for providing many useful information and suggestions improving the paper. Special acknowledgements are also due to the two anonymous reviewers of the paper.

century, of their use for remedy purpose, which culminated in *Donguibogam* (*Golden Collection of Eastern Medicine*) in 17th century. It was followed by a variety of titles of encyclopedic nature building up natural history of its own as exemplified by *Jasaneobo* (*Register of Fishes*) in early 19th century. They were not revealing, however, anything to do with the Linnean taxonomy elaborated in the preceding period of the 18th century in Europe.

The Linnean taxonomy characterized by its hierarchy and nomenclature and of wide use until mid-20th century, nevertheless, contradicted with evolutionary concept of living organism conceived in *The Origin of Species* by Charles Darwin. It is even under the threat of total rejection by the advent of phylogenetic systematics (or cladistics) in mid-20th century by Willi Hennig who assumes that only monophyletic groups represent evolutionary reality. Combined with new science of molecular biology and information technology the cladistics are giving rise to different phylogenies with ever rapidly changing pace as new data as well as novel techniques become available. The Linnean taxonomy, all the more, with limited number of category, apparently, is losing, unable to cope with deep, complex and changeable phylogenies. To meet the need required by the recent trend and situation a new method of nomenclature has been suggested and being developed since the turn of the century, entitled Phylocode.

Key Words: natural history in Korea, Linnean taxonomy, phylogenetic systematics, cladistics, Phylocode.

I . Introduction

Naming plants and animals comes first when we do natural history and it came along with the early human history for the sake of procuring food, shelters and

clothes for survival. Its importance, moreover, is dramatically signified in an old Chinese saying “the beginning of wisdom is to call things by their right names.”

The classification of life today is developing fast. As new techniques reveal more about the phylogenetic relationships between taxa, the tree of life changes shape almost every other day. This constant change creates a need for stability and insight into the relationships between the classifications themselves.

On the occasion of the 300th year anniversary of Carl von Linné in 2007 and also for the 250th anniversary in 2008 of his monumental 10th edition of *Systema Naturae* (1758) it should be quite meaningful and worthwhile to take a look taxonomies back in the past and take them in the light of modern evolutionary world view. It will be of our keen interest also what kind of problems there occur and what efforts are being made to deal with the issues to meet demands and needs that the rapidly advancing evolutionary biology and systematics require today.

First I will give an overview of classification on living organisms in the local context, that is, in old Korean days, followed by Linnean taxonomy in Korea since mid-19th century. A brief account of the phylogenetic approach as an alternative to the Linnean nomenclature, the PhyloCode, which is being developed fast will be briefly given.

II. Early Records of Korean Pharmacology and Natural History

One of the early records of plants and animals in Korea is found from a Chinese book, *San Kuo Chih* (三國志 *Records of the Three Kingdoms*), in the 3rd century which mentions ‘five cereals and rice (宜種五穀及稻)’ occurring in former Korean countries, Buyeo (夫餘) and Byeonhan (弁韓). The ‘Five Sereals (五穀)’

normally indicate barley, millet, panic grass, hemp and soybean (麥, 黍, 稷, 麻, 菽). Some animals, in addition, like cow, horse, pig, dog, sheep, domestic fowl were presumably raised for their food and power source as referred to by the chief title of each tribe.²⁾

From a royal tomb at Tunggou (通溝) of Goguryeo (高句麗), called Muyongchong (舞踊塚, 'dance mound', ca. 400c) mural paintings show hunting sceneries featuring horses, tigers pursued by hunters, deers, hunting hounds and so on. In the paintings are touched a variety of colors which certainly are made of dyes from plant materials like lacquer tree (漆, 纈), indigo plant (藍, 靛), safflower (紅花, 罌粟), madder (茜, 靛末), redbud (蘇方木), etc.

In later days of Goryeo period (高麗, 918-1392) active trade either by commerce or exchange were taking place, especially with the Sung and Yuan dynasties. Livestock like cow, horse, pig, domestic fowl were included as trade items among others as well as raw material for paper, dyes, teas, medicinal herbs and so on.

It was during the period, specifically, under the reign of the King Gojong (高宗, 1214-1259) that a medical book called *Hyangyakkugeupbang* (鄉藥救急方) was published which may be literally translated into "Emergency prescriptions using domestic medicines." Number of medicinal materials given was 180 kinds including 26 of animal source. All the materials were Korean products and described after Idumun (吏讀文) which is a way of putting in Chinese characters for their Korean names but following their sound in Korean. For example, antlers of deer Nokkak (鹿角) described in "Colloquial word referring to horn of deer (俗云沙蔘矣角)." The materials were arranged in the order of plants, animals and minerals. Plants were given as herbs (草), trees (木), cereals (穀) followed at last by vegetables (菜). As far as animals and minerals are concerned, they were not

2) Lee Deog Bong, "History of Biology in Korea," in *Encyclopedia of Cultural History of Korea 5: History of Science and Technology* 1 (1971), pp. 285-451. [李德鳳 "韓國生物學史", 韓國文化史大系 5: 科學·技術史 上 (高麗大學校 民族文化研究所, 1971), 285-451쪽.]

put in a certain order, all in a random way.

This book, however, is characterized by the use of only domestic products and, in addition to the phonetic wording of the materials, it is the oldest publication of this kind in Korea which signifies its uniqueness and priceless value. The book was reprinted in 1417 under the reign of King Taejong (太宗) of the Joseon Dynasty.

Next came a similar book *Hyangyakjipseongbang* (鄉藥集成方) which means a collection of prescriptions with domestic medicines, in 1433, under the reign of the Great King Sejong (世宗大王) of the Joseon Dynasty. The phonetic wording for the medicinal materials was employed as in the previous one during the Goryeo dynasty. It enumerates about 800 kinds of medicinal materials arranged by the order of stone, herb, tree, man, beast, bird, worm-fish, fruit, rice-cereals and vegetables. Those from animal source are given in the order of sections representing man (人部), beasts (獸部), birds (禽部) and worms-fishes (蟲魚部), enumerating 19, 84, 45 and 80 kinds each, making the total of 228.

The classification of the medicinal materials are known to have taken that of a Chinese medicinal book *Pharmacology in Sung Dynasty* (宋本草). Seeing that they are arranged as like from stone to plant, man, animals and again to plant there seemed to be no systematic or scientific scheme of arrangement whatever way it may be. As far as animals are concerned, nevertheless, man came first and is followed by beasts, birds and worm-fishes giving an impression that the idea of 'from complex to simple' worked in some way or other.

It was some 180 years afterward that one of the most highly valued medicinal book throughout the Korean history came to light in 1613 in 25 volumes, entitled *Donguibogam*, literally meaning *Golden Collection of Eastern Medicine* (東醫寶鑑), under the reign of the King Gwanghaegun (光海君). It was originally initiated by the preceding King Seonjo (宣祖) in 1596 and written by a royal doctor HUH Jun (許浚) taking more than ten years.

In the three volumes dealing with boiled extract (湯液編), about 1400 kinds of medicinal materials were given with their clinical use and arranged by sections as follows: In Vol. I. water (水部, 33 kinds), soil (土部, 18), cereal (穀部, 107), man (人部, 23), bird (禽部, 107), beast (獸部, 236); Vol. II. fish (魚部, 53), worm (蟲部, 95), fruit (果部, 91), vegetable (采部, 123), herb part I (草部 上, 79); Vol. III. herb part 2 (草部 下, 188), tree (木部, 158), jade (玉部, 4), stone (石部, 55), metal (金部, 33). The divisions followed the Chinese medicinal book 宋本草 as in the book *Hyangyakjibseongbang* (鄉藥集成方) but still classified more in detail with some difference in arrangement.

The reason why 'water' and 'soil' came first may be ascribed to Chinese natural philosophy, Taoism, as well as Buddhist idea postulating water and soil as the base of everything and life. For the rest we do not see any systematic arrangement since minerals come first as well as at last, that is, in the Vol. I and Vol. III as do plant materials. As far as animals and man are concerned, nevertheless, they are put in the sequence: man, bird, beast, fish and worm, apparently arranged by the order of complexity in almost similar way to the previous books and also depending on importance from human point of view.

It must be of worth as well as interesting to take a look at the classification more in detail and to see what living organisms comprise these groups in view of modern taxonomy.

'The Section Bird' included not only birds but also bats whereas 'the Section Fish' contained also octopuses in addition to fishes. 'The Section Worm' was assigned to a variety of taxa in modern sense like nematodes, annelids, mollusks, arthropods and even fishes, amphibians, reptiles and edentates (e.g. anteaters) belonging to mammals! Similar comprehensive groupings were made for sections of plant source like fruits, vegetables, herbs and trees.

Out of 1,400 kinds of medicinal materials in the book, the Chinese products enumerate only 102 and the most were from Korea and the prescriptions given

are based on clinical evidence which is quite suggestive of the uniqueness as well as originality of the book elaborated by the author. Each item ('kind'), moreover, was annotated in Korean using the Korean alphabet, Hangeul (e.g. 魚붕어, 蟹 게, 蜈蚣 진에, 雉肉 사냥의 고기 ...) which marks the first case ever made for medicinal prescriptions in Korean history.³⁾

This book, *Donguibogam*, has been appreciated as masterpiece of pharmacology throughout the East-Asia countries, having been printed a number of times not only in Korea but also in China and Japan.⁴⁾

Some twenty years after *Donguibogam* there came out *Jibong Yuseol* (芝峰類說, *Topical Discourses of Jibong*) in 1633 written by LEE Su-Gwang (李杲光).⁵⁾ It was a sort of encyclopedia of practical realism by nature, apparently, under the strong influence of western culture via Beijing, China. There were given 'Section Grass and Tree (卉木部)' and the 'Section Bird·Worm (禽蟲部)' among others, the latter section including 97 kinds of animals which are divided again and arranged in the order: Birds (鳥), Beast (獸), Scale·Shell (鱗介, e.g. fish, turtle), Worms·Snakes (蟲蛇). By describing not only shape of animals but also their habits, where they occur and relevant local stories it may be called one of the first document of natural history, not limited to accounts of medicinal use.

Some 120 years afterwards, under the King Sunjo (1801-1834), RYU Heui (柳僖, 1773-1837) published an encyclopedia *Mulmyung-go* (物名攷, *Catalogue of Name of Things*) listing 134 kinds in Part Grass·Trees (草木類), Part Birds·Beasts (鳥獸類) including 117 kinds and in Part Worms·Fishes (蟲魚類) with 117 kinds, among others in different Parts. About the same period but still somewhat later there came out similar publications like *Jaimulbo* (才物譜, 1789) by LEE Man-Yeong (李

3) Jeong Woo Yeal, "Ho Chun's Medical Thought in *Tongui pogam*," *J. Korean History of Science Society* 13 (1991), pp. 123-138.

4) Lee, "History of Biology in Korea," pp. 285-451; Shin Dong Won, Kim Nam Il and Yeo In Seok, *Donguibogam Read by One Copy* (Deulnyeok, 1999).

5) Lee Su-Gwang (李杲光), *Essentials of Jibong Yuseol* (芝峰類說 精選), (1633). [Annotated by JUNG Hae Yeom, (Hyeondaesilhagsa, 2000).]

晚永) and others.

Another encyclopedia of animal, entitled *Mulbo* (物譜, *Linage of Things*) drafted by LEE Ga-Hwan (李嘉煥) in ca. 1770 and completed by LEE Jae-Ui (李載威) in 1802. It is listing 179 kinds of animal in four parts in addition to the Part Plant coming first as like : Grass·Tree (草木部), Worm·Fish (蟲魚部), Worm·Snake (蟲蛇部), Bird·Beast (鳥獸部).⁶⁾ They were subdivided into 21 sections. The four parts may be put in modern scientific terms as like Kingdom Plantae - Kingdom Animalia (Pisces - Reptilia - Aves - Mammalia) which, apparently, corresponds to evolutionary 'sequence' in modern taxonomy. The contents of each part, to our surprise however, are not scientific because the 'Fish' contains clams, sea otters, octopuses, shrimps, frogs, leaches and so on, which renders it rather to mean aquatic animals. Similar 'mixture' is noticed in the Part Snake as well.

Early in 19th century, JEONG Yag-Jeon (丁若銓), a naturalist, published *Jasaneobo* (茲山魚譜, *Register of Marine Organisms*) in 1814, which he wrote while in exile for sixteen years at Heugsan-do (黑山島), a remote island in the South West of the Korean peninsula. He described 226 kinds of sea animals classified into four groups: 'animal with scales (鱗類)', 'animals without scales (無鱗類)', 'animals with shells (介類)', and 'miscellaneous (雜類)' which included sea grasses too.⁷⁾

To the first group 'animal with scales' are assigned normal fishes often annotated by their reproductive behavior of external fertilization but also described was ovoviviparity of shark (鯊魚). In the second one 'animal without scales', however, were given a variety of marine lives ranging from ray and skate to octopuses, sea cucumbers to whales and even 'man fish (人魚)' which certainly means pinnipeds like otters and not mermaid! The skates also are

6) Lee Ga Won, "Mulbo and Practical Realism," *Humanistic Sciences* 5 (Yonsei University, 1960). [李家源, "物譜와 實學思想", *人文科學* 5, (延世大學校, 1960).]

7) Jeong Mun Gi (trans.), *Jasaneobo* (茲山魚譜) (Seoul: Jisigsaneobsa, 1977). [In Korean with original text in Chinese characters.]

accounted by their reproductive behavior. The third one, 'animals with shells', contains turtles, crabs, abalones, bivalves, oyster and so on. The last one still is divided into 'sea worms (海蟲)', 'sea birds (海禽)', 'sea beasts (海獸)', and 'sea grasses (海草)'. 'Sea worms' refer to lygia (갯강구, isopod), neanthes (갯지렁이, polychete), and others.

The descriptions in *Jasaneobo*, nevertheless, deal not only with morphology in detail but also ecology and even taste and possible medicinal use. In this sense this book has been considered quite monumental in natural history of Korean marine organisms. In spite of the excellence with detailed description no drawings, however, were given and no trace of linking to Linnean taxonomy is revealed at all even though more than half a century had elapsed since *Systema Naturae* in 1758 (10th edition) in Europe.

The mode of classification in *Mulbo*, by contrast, is found to be quite different from *Jasaneobo*. As it may sound strange, the arrangement of the main parts in *Mulbo* in 1802 seems to be more 'systematic' in Linnean sense than that in *Jasaneobo* in 1814, the former, older than the latter by twelve years. Consideration would have to be taken, though, that the two are not comparable in strict sense since *Jasaneobo* covered only marine animals.

Whether *Mulbo* was influenced by any systematic idea or the *Scala Naturae* far in old days of Aristoteles by someway or other whereas *Jasaneobo* remained unaffected is a matter of wonder and subject to later studies for better understanding.

It seems quite interesting, though, that the 'vermes' in Linnean taxonomy which may be equivalent to 'worms (蟲)' in the Korean books were meant by not just worms, leeches and flukes but also slugs, sea cucumbers, starfish, barnacles and other sea animals. In the Korean *Donguibogam* (東醫寶鑑) in the early 17th century the 'worms (蟲)' included a wide range of animals like nematodes, annelids, mollusks, arthropods, fishes, amphibians, reptiles, edentates (e.g.

anteaters). In *Mulbo* ‘蟲 (worm)’ was meant, in a wider sense, by even birds and mammals. It may be a matter of semantics of the character ‘蟲’, even though literally designating ‘worm’ in modern days.

In this sense ‘worms’ in *Donguibogam* (東醫寶鑑) in the early 17th century and ‘vermes’ of the Linnean system might have meant something ‘miscellaneous’, shared by the two classifications in the east and west with an interval of more than 140 years.

On the whole, the classification systems in the Korean medicinal books seem to have taken after that in the pharmacological dictionary *Benchaogangmu* (本草綱目, 李時珍) late 16th century (ca. 1596) in China. Its comparison with *Jasaneobo* is given in detail by JEONG M. H. in his master thesis.⁸⁾

III. Linnean Taxonomy as Science

Carl von Linné (1707-1778) has been known ‘Father of Taxonomy’ but he is far preceded by a few Grecian philosophers in classification of animal and plants.

Aristotle (384-322 BC) classified animals as “bloodless” and “blooded” and the latter still subdivided into “four-footed”, “many-footed”, or “footless” and so forth. Followed by was the Greek botanist Theophrastus (371-287 BC) who made a system for the plants. He divided them into four groups: trees, bushes, small shrubs and herbs. Those groups were then further divided in sub groups depending on leaf shape, life span and where they grew. The system of Theophrastus included about 480 named plants. Around year 77 AD the Greek doctor Dioscorides employed the utility for mankind as a basis for a classification system. His groups included for example aromatic plants, vegetables and

8) Jeong Myung Hyun, “On the Natural Marine Historical Characteristics of the *Jasan Eobo*,” Master’s thesis, Seoul National University (2002). [정명현, “정약전(丁若銓, 1758-1816)의 硯山魚譜(硯山魚譜)에 담긴 해양 박물학의 성격.”]

medicinal plants. Dioscorides' system was used in books about herbs until the 16th century.

It was two centuries afterward that Carl von Linne founded a new classification system. In the Linnean taxonomy animals were organized into six classes: Quadrupedia, Aves, Amphibia, Pisces, Insecta and Vermes as shown in his monumental publication of *Systema Naturae* in 1735. The Class Quadrupedia was divided into a few four-limbed orders, including Anthropomorpha (primates and man), Ferae (canids, felids, bears) and so on. In the Amphibia were put frogs and snakes. The Vermes were meant as aforementioned by not only just worms, leeches and flukes but also slugs, sea cucumbers, starfish, barnacles and other sea animals. He divided each order again into genera and each genus into species.

For the plant kingdom Linné adopted the so-called "sexual system" since he saw flowers as sexual organs, that is, stamens as male and pistils as female structures.⁹⁾ Plants were divided into 24 classes, of which 23 classes are classified according to the number, size and arrangement of stamens. To the classes were assigned names like Monandria (one stamen, that is, one husband), Diandria and Triandria likewise differing with the number of stamens or husband for one wife or pistil each. He broke then each class into orders based on their pistils. This monothetic 'sexual' approach resulted in a clear-cut and useful but highly unnatural system.

In Linnean system *Salvia* with two stamens, for instance, belonged to Class Diandria but it is now regarded as very closely related to *Ajuga* which was then put in Class Tetreandria in Linnean system due to its four stamens. It demonstrates merely one of many examples of unnatural as well as artificial grouping by Linné. We should not forget, nevertheless, that he did recognize many natural families that are still accepted today.¹⁰⁾ The 24th class, the last one

9) Wilfrid Blunt, *Linnaeus: The Compleat Naturalist* (Princeton University Press, 2001).

10) Erik F. Smets, "Impact of work of Linnaeus on modern plant taxonomy,"

in Linnean Plant Kingdom, was meant by the cryptogam, plants with hidden flowers.

Linné revised and expanded *Systema Naturae* of eleven pages in 1735 up to 13th edition (1770) as two fat volumes of three thousand pages. His binominal nomenclature transferred a pondweed known as *Potamogeton daule compresso*, *folia Graminis canini*, and so on to *Potamogeton compressum* whereas it changed *Ranunculus minimus septentrionalium herbido mucoso* flore for a musked herb with seven other names for the same plant (synonymes) to simply *Adoxa moschatellina* Linné.¹¹⁾

He was rather bold enough to include human being in the animal kingdom, which was named *Homo sapiens* in the *Order Anthropomorpha of the Class Quadrupedia*. Clumsy names became so simple with their position clarified in the hierarchy. This is the reason why Linné should be considered the pioneer of information architect in modern sense.

The Linnean taxonomy and hierarchy dividing Kingdom into Class, then to Order and Genus, then again to Species was meant by the downward classification as contrasted to the upward classification in modern taxonomy.

His passion for order made it possible to publish, after *Systema Naturae*, *Flora Suecica* (*Swedish Flora*) in 1745, *Philosophia Botanica* (1751), and *Species Planarum* (1753). His effort of using “natural method”, however, was to discover God’s own secret logic of biological creation but most were artificial classifications in fact. For him, especially, the genus was the God-given real unit of diversity.

He was caught in the framework of natural theology dominating England and the Continent that period. As essentialist his ultimate mission was to find the

Symposium: Mission of the National Institute of Biological Resources and Values of Biological Resources in the 21st Century (National Institute of Biological Resources, October 11-12, 2007, Incheon, Korea) pp. 17-27.

- 11) Fredrik Pleijel and Benoît Dayrat, “De l’évolution dans la nomenclature?” *La Recherche* 333 (2007), pp. 48-50.

order out of nature and fill up the gaps following the principle of plenitude. He stated that all taxa of plants have relationships on all sides as do neighboring countries on a map of the world.¹²⁾

In spite of something artificial with his taxonomy the Linnean system has been widely accepted in Europe as well as over the world and used as a convenient information-retrieval device as well as ‘finding order out of chaos’ for last almost three centuries. The number of plants and animals listed by him enumerated more than 12,000 which may be enough to deserve him to be named “Father of Taxonomy!”

IV. Linnean Taxonomy Comes to Korea

It was not until mid-nineteenth century that Korean plants and animals were reported using binominal nomenclature in the context of Linnean taxonomy, but mostly by European biologists.

T. Tatum of England was the first to publish Korean beetles in 1847. For plants, for instance, it was F. H. Miquel from the Netherlands who published his study on Korean specimens in 1865-1867 based on the materials collected by German, Baron Schippenbach in 1854. Later, under the Japanese occupation (1910-1945), the Korean materials were mainly studied by Japanese scientists, featured, for instance by Nakai Takenoshi (中井猛之進, 1882-1952) for plants and Mori Tamezo (森爲三) who published *The List of Korean Vertebrates* (朝鮮脊椎動物目錄) in 1916. The Korean Natural History Society (朝鮮博物學會) was the main stage of the Japanese scholars and some Koreans publishing papers on Korean fauna and flora. The first Korean biologist who published a book on Korean flora was JEONG Tae-Hyun (鄭台鉉, 1882-1971), entitled *The Outline of Forest Trees of*

12) Ernst Mayr, *The Growth of Biological Thought* (Harvard University Press, 1982).

Korea (朝鮮森林樹木鑑要) in 1923, co-authored with a Japanese biologist, Ishido (石戸谷勉). In the animal part it was CHO Bok Sung (趙福成, 1905-1971) who contributed the paper “Lepidoptera from Ulnung Island (鬱陵島産 鱗翅目)” to the journal of the Society mentioned above, in 1929 which, in fact, comprises a first scientific paper ever published by a Korean biologist using Linnean taxonomy.

V. Taxonomy in Korea after World War II and New Taxonomy Afterward.

Freed from Japanese rule by the end of World War II in 1945 the Linnean taxonomy in Korea grew up gradually based on academic potentials of the few naturalists trained by Japanese scholars, like JEONG and CHO mentioned above.

The modern synthesis of evolution came to affect the taxonomy in Korea, however, bringing populational as well as genetic concept into taxonomy, especially by young biologists trained abroad after the Korean War. The Linnean system, however, could not catch up the more dynamic concept of new systematics and neo-Darwinism. How to reform the Linnean taxonomy and nomenclature to adopt evolution as reality mattered much. Darwin did not give any answer to it and it was not realized until almost a century later, in 1950, when an East-German entomologist, Willi Hennig elaborated phylogenetic systematics or cladistics.¹³⁾

The new approach originated in his idea that in natural classification every group in any hierarchial rank should be monophyletic, that is, consisting of an ancestor and all its descendants. The criteria of whether any group, for instance,

13) Willi Hennig, *Grundzüge einer Theorie der Phylogenetischen Systematik* (Berlin: Deutscher Zentralverlag, 1950); Willi Hennig, *Phylogenetic systematics* (University of Illinois Press, 1966). [D. Dwight Davis and Rainer Zangerl Urbana (trans.), *Phylogenetic systematics* (University of Illinois Press, 1999).]

a genus is monophyletic or not is determined by any derived character shared uniquely by the two daughter species, that is, 'synapomorphy'. From this standpoint, systematists came to find that many conventional groups or taxa were either 'paraphyletic' or 'polyphyletic', hence, 'not natural group' at all, contradictory to the principle of descent of cladistics. The Class Reptilia, for instance, encompasses dinosaurians, crocodiles, turtles, lizards and snakes. From cladistic point of view, notwithstanding, it is paraphyletic because it does not include birds which should be a sister group with Crocodilia by sharing a most recent common ancestor of fossils called Archosauria. Crocodilia, thus, is related to birds more closely than to snakes and turtles. In this respect the Class Reptilia should not be regarded a monophyletic group, henceforth, should be rejected.

The cladistics brought up soon a revolution in taxonomy, especially, combined with molecular biology and computer science enabling systematics to stand up as a science of its own, based on objectivity, testability and repeatability required by science first of all. Hennig, however, did not deal with overall change in taxonomy but only establishing the taxa, leaving intact the old nomenclature for Darwinian evolutionary groups.¹⁴⁾

In the meantime in Korea, new techniques in taxonomy of taking characters at chromosomal, isozyme and DNA levels were pursued rather actively by those who trained abroad like KOH Heung Sun (高興善), YANG Suh-Yung (梁瑞榮), CHUNG Pyung Rim (鄭坪林) and so on for animal materials since mid-1980s. For cladistics it was LEE Sang Tae (李相泰) who applied cladistics first for plant taxonomy¹⁵⁾ and for animals, LEE Byung-Hoon (李炳勳) likewise.¹⁶⁾

14) Pleijel and Dayrat, "De l'évolution dans la nomenclature?" pp. 48-50.

15) Lee Sang Tae, "A numerical cladistics of primitive angiosperm families based on the Stebbin's data," *Korean J. Plant Taxonomy* 10 (1980), pp. 1-5.

16) Lee Byung-Hoon, "Theory and Practice of Cladistics," *Symposium Modern Perspective of Phylogenetic Taxonomy* 6 (Korean Association of Biological Science, Nov., 11, 1985, Shuncheon, Korea), pp. 15-29. [이병훈, "분지系統學의 理論과 實際", 생물과학심포지엄 '系統分類學의 現代的 照明', (한국생물과학협회, 1985년 11월 9일, 순천),

VI. Phylocode as a Challenge to Linnean Taxonomy and Nomenclature

Even though modern biological taxonomy is widely considered evolutionary, its biological nomenclature are not necessarily based on evolutionary concepts.¹⁷⁾ Many of biological groups (taxa) are not reflecting monophyly as illustrated already, hence, they cannot be considered scientific entities which makes Linnean taxonomy a folklore in a sense. Consequently, Linnaean systems rarely demonstrate real phylogenetic relationship and meaningful categorical assignment either. The Linnean categories are, therefore, arbitrary in concept which means subjective and also not always corresponding each other between two taxa assigned to the same categorical rank. *Phyllodoce* (a marine polychaete annelid), for instance, is a genus but it is not comparable as much to *Homo* (a genus) as to Mammalia which is a class in fact.¹⁸⁾

That traditional approach of Linnean taxonomy, moreover, is using several fixed levels of a hierarchy, such as Kingdom, Phylum, Class, Order, Family and Genus. Phylogenetic systematics (cladistics) does not put much meaning to those terms, because one of the fundamental premises of it is that the evolutionary tree is very deep and complex and it is not meaningful to use a fixed number of levels, as is obviously evidenced, for instance, by the Genetic Tree of Life based on rRNA sequences from 3000 species.¹⁹⁾ Furthermore, they

15-29쪽.]; Lee Byung-Hoon, "Cladistic analysis of Neanuridae (Collembola) using character weighted and character unweighted approaches," *Korean J. Syst. Zool.* 1 (1985), pp. 3-20.

17) Kevinde de Queiroza and Jacques Gauthierb, "Toward a phylogenetic system of biological nomenclature," *Trends Ecol. & Evol.* 9 (1994), pp. 27-31.

18) Pleijel and Dayrat, "De l'évolution dans la nomenclature?" pp. 48-50.

19) <http://www.zo.utexas.edu/faculty/antisense/DownloadfilesToL.html> (University of Texas, 2003).

are changeable all the time as new evidences made available, hence, giving rise to new phylogenetic trees as it happens quite often with ever advancing molecular systematics in combination with computer science. Linnean taxonomy and nomenclature cannot cope with rapidly changing trees of life which is deep and complex.

All these generate ambiguity, non-universality and instability of the Linnean classification and hierarchy.²⁰⁾

In order to overcome difficulties and problems arising from the mismatch between the Linnean taxonomy and Darwinian evolutionary groups it needed to put phylogenetic relationship into an appropriate tree of life and 'The International Code of Phylogenetic Nomenclature', known for short as the 'PhyloCode', was developed for a formal set of rules governing phylogenetic nomenclature.²¹⁾ The PhyloCode grew out of a workshop at Harvard University in August 1998 with the subsequent meeting for making the draft in 2000 and a second workshop at Yale University in 2002.

The First International Phylogenetic Nomenclature (IPN) Meeting, which took place in July 2004 in Paris, was the first open, multi-day conference that focused entirely on phylogenetic nomenclature, and it provided the venue for the inauguration of a new association, the International Society for Phylogenetic Nomenclature (ISPN). The ISPN membership elects the Committee on Phylogenetic Nomenclature (CPN), which has taken over the role of the advisory group that oversaw the earlier stages of development of the PhyloCode.

The PhyloCode will regulate phylogenetic nomenclature by providing rules for how to decide which combinations of names and definitions will be considered validly published (Ch. II), which of those will be considered homonyms (Art. 13)

20) Kelvin de Queiroz, "The Linnaean hierarchy and the evolutionization of taxonomy, with emphasis on the problem of nomenclature," *A/iso* 15 (1997), pp. 125-144.

21) Philip D. Cantino and Kevin de Queiroz, "PhyloCode," <http://www.ohiou.edu/phylocode/index.html> (2007).

or synonyms (Art. 14), and which one of a set of synonyms or homonyms will be considered valid (generally the one registered first).

Additionally, the PhyloCode will only allow the naming of clades (Art. 1.1), not of paraphyletic or polyphyletic groups, and will only allow the use of specimens, species, and apomorphies as specifiers (anchors) (Art. 11).

It was also proposed that phylogenetically defined species names consist of a single word (the epithet in the case of already existing names) plus the author of the name, year of publication (e.g. *sapiens* Linnaeus 1758) and (if necessary to ensure uniqueness) the page number where published.

The use of ranks (genus, family, order etc.), however, will remain permitted (Art. 3); ranks will only be prevented from having any influence on the spelling or application of names. In other words, ranks can be added after nomenclature has been done.

The second meeting of the ISPN took place June 28-July 2, 2006, at the Peabody Museum of Yale University. One of the proposal was that, the total clade of mammals might have the formal name Synapsida and the informal name pan-Mammalia (e.g., Synapsida and Pan-Mammalia).

The third meeting took place from July 21, 2008 to July 22, 2008 at Dalhousie University (Halifax, Nova Scotia, Canada). A published report is forthcoming.

The PhyloCode will go into operation in a few years, but the exact date has not yet been determined. It is designed so that it may be used concurrently with the existing codes based on rank-based nomenclature (ICBN, ICZN, etc.). Once implemented, the PhyloCode will be associated with a registration database, called RegNum, which will store all clade names and definitions that will be considered acceptable. It is hoped that this will provide a publicly-usable tool for associating clade names with definitions, which could then be associated with sets of subtaxa or specimens through phylogenetic tree databases (such as

TreeBASE).

The PhyloCode is still controversial. The number of supporters for official adoption of the PhyloCode is still small whereas many systematists view the Linnean taxonomy and nomenclature do well without causing particular problems.

It is, therefore, uncertain, as of 2008, when the code will be implemented and how widely it will be followed. Some supporters believe that it should only be implemented, at least at first, as a set of rules accompanying the associated registration database, RegNum, and that acceptance by the scientific community may proceed from the popularization of RegNum as a utility for finding clade names and definitions.²²⁾

VII. Conclusion

It was Carl von Linné who established binominal nomenclature as well as hierarchy for plants and animals giving 'order' out of chaos but with the aim of finding the order of the divine creation. The classification of living organisms, however, paved different ways in Europe and Korea in the respective continental context. No evidence of any relevant information flow between the two different 'worlds' was revealed until mid-19th century when western biologists initiated publication of Korean flora and fauna using Linnean system.

We are compelled, notwithstanding, to face problems arising from discrepancy and mismatch between taxonomy for classification in the past and rapidly changing phylogenetic trees today. This trend has been enforced mainly from the combination of phylogenetic systematics, or cladistics, with information technology as well as molecular biology, accepting only monophyletic groups as evolutionary realities.

22) PhyloCode: <http://en.wikipedia.org/wiki/PhyloCode>.

The PhyloCode, as an alternative to the Linnean nomenclature, has been actively developed last ten years since 1998. It is, nevertheless, still controversial and uncertain when the code will be implemented and how widely it will be followed. Some supporters believe that it should only be implemented, at least at first, as a set of rules accompanying the associated registration database, RegNum, and that acceptance by the scientific community may proceed from the popularization of RegNum as a utility for finding clade names and definitions.

It remains to be seen whether this new challenge go forward with a success or will take more than twenty years until it is accepted and in wide use as did phylogenetic systematics or cladistics during the latter half of the 20th century. It seems obvious, nevertheless, that the PhyloCode would be the only alternative to the Linnean nomenclature since the Linnean system does not guarantee any real entity in evolution and, furthermore, cannot keep up with fast changing phylogenies due to the floods of new evidences being made available by constantly emerging techniques and methodologies. Taxonomists or systematists, presumably, will have to be prepared for simultaneous use of the two systems from different paradigms in biological nomenclature for the time being and pay keen attention to the development of the PhyloCode.

<국문초록>

한국의 자연학에서의 분류와 분지계통학의 도전에 직면한 린네의 명명법

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중국의 삼국지에 부여와 변한에서 오곡(五穀)이 난다고 기록된 이후 고려시대에 향약구급방(鄕藥救急方)과 조선의 세종대에서 鄕藥集成方(鄕藥集成方) 그리고 그 후 東醫寶鑑(東醫寶鑑), 物譜(物譜), 物名攷(物名攷)와 茲山魚譜(茲山魚譜) 등이 나오므로써 한국 나름의 자연학 전통이 세워졌다. 그러나 분류상 나름대로의 체계를 볼 수 없을 뿐 아니라 린네의 이명법이 적용된 흔적도 찾아볼 수 없다.

다윈은 1859년에 출판한 종의 기원(種의 기원)에서 생물은 변이와 자연선택을 통해 신종을 만든다고 주장함으로써 종분화(種分化)의 진화적 개념을 확립하였다. 그러나 이러한 개념은 신의 섭리와 질서를 찾아내 생물을 배열한다는 린네의 분류체계와 상충되었다. 그러나 린네의 분류체계는 그 후 200여 년간 사용되었고 한국인 학자에 의해서는 20세기 초반에야 도입되었다. 20세기 중엽에 헤닉이 모든 분류군은 단계통성(單系統性)이어야 한다고 주장하며 새로운 계통분류학(또는 分枝系統學)을 제안하고 이 주장이 널리 수용되자 린네의 많은 분류군들이 단계통성이 아니고 측계통성이거나 다계통성임이 밝혀졌다. 따라서 이러한 분류군들은 진화적 실재가 되지 못함으로 폐기되어야 한다는 주장이 설득력을 얻어 린네의 분류체계와 이명법은 위기를 맞게 되었다. 2004년에는 ‘국제 분지계통학적 명명학회’가 결성되어 새로운 명명법인 “Phylocode”가

등장하였으며 현재 개선작업이 활발히 진행되고 있다. 모든 분류학자들은 이에 대해 합리적으로 판단하여 대비해야 할 것으로 본다.

주제어: 한국의 자연학, 린네식 분류학, 계통발생분류학, 분지계통학, 계통분류명명법.