Temirbayeva K.

Biogeography and phylogeography

Biogeography is the study of the patterns and causes of the distribution of living things. There are a number of approaches to solving biogeographical issues, including historical biogeography, ecological biogeography and phylogeography. Phylogeography is the study of the genetic and geographic structure of populations and species. Phylogeography usually uses genetic information to examine genealogical history and patterning within species and populations. This information is used to determine the relationships of biogeographical regions and species histories. Utilized genetic markers are often unitarily inherited, for instance, mitochondrial or chloroplast DNA sequences and such they track the genealogical history of either the maternal or the paternal lineage. In article was discussed the role of phylogeography in historical biogeography and some of its connecting functions within the framework of the biodiversity sciences.

Key words: biogeography, historical biogeography, modern biogeography, phylogeography, species distribution

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Темирбаева К.

Биогеография және филогеография

Биогеография бұл тірі ағзалардың таралу себебі мен заңдылықтарын зерттейді. Биогеографиялық, оның ішінде тарихи биогеография, экологиялық биогеография және филогеографиялық сұрақтарды шешуде бірнеше тәсілдер бар. Филогеография – бұл түрлер мен популяциялардың генетикалық және географиялық құрылымын зерттейді. Филогеография әдетте түрлер мен популяциялар ішіндегі паттерн қалыптасуы мен генеалогиялық тарихын зерттеу үшін генетикалық ақпаратты қолданады. Бұл ақпарат биогеографиялық облыстар мен түрлердің өзара байланысын анықтау үшін қолданылады. Генетикалық маркерлер бірыңғай түрде беріліп отырады, мысалы, митохондриялық немесе хлоропластық ДНҚ тізбектері, олар аналық немесе аталық жағынан генеалогиялық тарихты қадағалайды. Мақалада филогеографияның тарихи биогеографиядағы орны және оның биоалуантүрлілік туралы ғылымдар аясындағы байланыстырушы қызметтері қарастырылған.

Түйін сөздер: биогеография, тарихи биогеография, қазіргі биогеография, филогеография, түрлердің таралуы.

Темирбаева К.

Биогеография и филогеография

Биогеография – это изучение закономерностей и причин распределения живых существ. Существует ряд подходов к решению биогеографических вопросов, включая историческую биогеографию, экологическую биогеографию и филогеографию.Филогеография – это исследование генетической и географической структуры популяций и видов. Филогеография обычно использует генетическую информацию для изучения генеалогической истории и формирования паттерна внутри видов и популяций. Эта информация используется для определения взаимосвязей биогеографических областей и видов. Используемые генетические маркеры часто унитарно наследуются, например, последовательности митохондриальных или хлоропластных ДНК. Таким образом, они отслеживают генеалогическую историю либо материнской, либо отцовской линии. В статье рассмотрены роль филогеографии в исторической биогеографии и некоторые ее связующие функции в рамках наук о биоразнобразии.

Ключевые слова: биогеография, историческая биогеография, современная биогеография, филогеография, распространение видов.

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BIOGEOGRAPHY AND PHYLOGEOGRAPHY

Biogeography is a branch of geography that studies the past and present distribution of the world's many species. Biogeography has strong ties to biology, ecology, evolution studies, climatology, and soil science (Briney, 2017).

The study of biogeography gained popularity with the work of Alfred Russel Wallace in the mid-to-late 19th Century, who is often called the «Father of Biogeography». Today, biogeography isdivided into three main fields of study: historical biogeography, ecological biogeography, and conservation biogeography. Each field, however, looks at phytogeography (the past and present distribution of plants) and zoogeography (the past and present distribution of animals)(Briney, 2017).

Major historical factors that influence current distributions include vicariance and dispersal. Vicariance is the splitting of distributions, such as when ancient landmasses split and separate due to continental drift, or when mountain ranges divide lowland populations. Dispersal is movement of organisms or their propagules (such as seeds). The relative contribution of vicariance and dispersal to current plant distributions is much debated (Wiens, 2012).

Modern biogeographic research combines information and ideas from many fields, from the physiological and ecological constraints on organismal dispersal to geological and climatological phenomena operating at global spatial scales, and evolutionary periods (Barryand Moore, 2005).

Modern biogeography often employs the use of Geographic Information Systems (GIS) to understand the factors affecting organism distribution, and to predict future trends in organism distribution. Mathematical models and GIS are employed to solve ecological problems that have a spatial aspect to them (Whittaker, 1998).

Recently, the number and variety of new approaches and methods in historical biogeography has grown steadily (Crisci et al, 2003; Lomolino et al, 2006; Wiens, 2012).One of the main topics of recent debate concerns the role within historical biogeography of phylogeography, the extraordinarily popular approach that began in the late 1980s (Avise et al, 1987). Avise (2000) defined phylogeography as «a field of study concerned with the principles and processes governing the geographic distributions of genealogical

lineages, especially those within and among closely related species. Phylogeography gained much of its current popularity by providing a linkage, via molecular population genetic and phylogenetic analyses, between those disciplines concentrating on population and species responses to relatively recent evolutionary processes or paleoclimatic events in Earth history with those that have traditionally been more concerned with the association between biological diversification and geological events in Earth history (Fig.1).

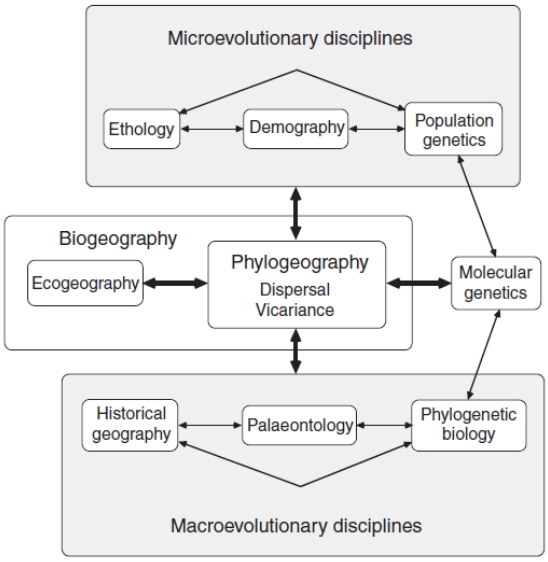

Figure 1 - The general place of phylogeography, and some of its empirical and conceptual bridging functions, within the biodiversity sciences (Avise, 2009)

Riddle and Hafner (2006) in their investigations considered a depiction of objectives and questions most appropriately addressed within the conceptually and analytically different arenas of statistical phylogeography, and area-based historical biogeography, and illustrating the «bridging» position of comparative phylogeography (Fig. 2, 3).

The main objectives of phylogeographic studies are:

•Sample many individuals within one or a few closely related species;

• Cover the species' geographic range;

• Sequence DNA;

• Analyze spatial patterns of genetic variation within and across species;

• Study migration and gene flow across a landscape;

• Investigate population fragmentation and speciation.

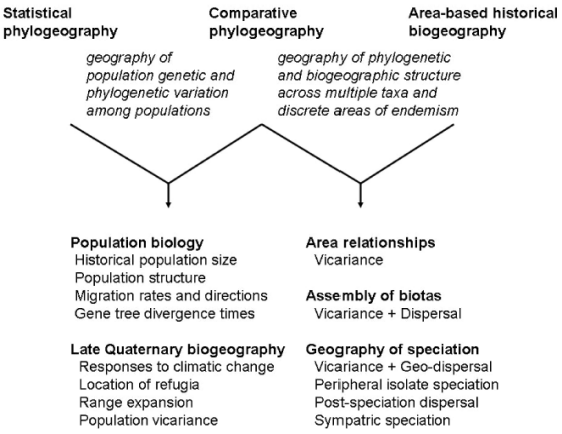

Figure 2 – «Bridging» position of comparative phylogeography (Riddle and Hafner, 2006)

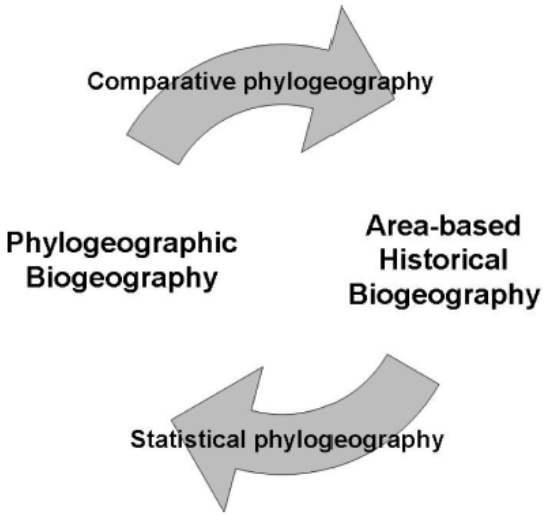

Figure 3 – Illustration of one depiction of the synergistic and reciprocal nature of phylogeographic biogeographic and area-based historical biogeographic perspectives and approaches, in which comparative and statistical phylogeography provide the hypothesis generating and hypothesis testing bridges, respectively, between the two approaches (Riddle and Hafner, 2006)

Phylogeography has a central role in evolutionary biology, at the boundary of microevolution and macroevolution, and this, in part, has led to the exponential increase in 'phylogeographic' publications since the first in 1987 (Avise et al. 1987). However, the success of phylogeography has not been due to academic interest alone, phylogeography also has proven an immensely useful approach to questions of species conservation and resource management. Phylogeography is a rich, integrative discipline

that demands consideration of, among others, paleontology, historical geography, molecular evolution, and ecology (Avise, 2000). It's application and products are of interest to ecologists, evolutionary biologists, conservationists, and managers of coastal resources alike.

References

1 Avise J.C., Arnold J., Ball R.M., Bermingham E., Lamb T., Neigel J.E., Reeb C.A. and Saunders N.C. (1987) Intraspecific-phylogeography – the mitohodrial-DNA bridge between population-genetics and systematics.Annual Review of Ecology and Systematics, 18, pp. 489-522.

2 Avise J. (2000) Phylogeography: The History and Formation of Species. Harvard University Press, Cambridge, MA.

3 Avise J.C. (2009) Phylogeography: retrospect and prospect. Journal of Biogeography, 36, pp. 3-15.

4 Barry C.C. and Moore P. (2005) Biogeography: an ecological and evolutionary approach. Malden, MA: Blackwell Publications.

5 Bermingham E. and Moritz C. (1998) Comparative phylogeography: concepts and applications. Molecular Ecology, 7, pp. 367-369.

6 BrineyA. (2017) Biogeography. An Overview and History of the Study of Biogeography.

7 Crisci J.V., Katinas L. and Posadas P. (2003) Historical Biogeography: an Introduction. Harvard University Press, Cambridge, MA.

8 Lomolino M.V., Riddle B.R. and Brown J.H. (2006) Biogeogtaphy, 3rd ed. Sinauer Associates, Inc., Sunderland, MA.

9 Riddle B.R. and Hafner D.J. (2006) Phylogeography in Historical Biogeography: Investigating the Biogeographic Histories of Populations, Species and Young Biotas. Pp. 161-176.

10 Whittaker, R. (1998). Island Biogeography: Ecology, Evolution, and Conservation.New York: Oxford University Press.

11 Wiens J.J. (2012) Why Biogeography matters: historical biogeography vs. phylogeography and community phylogenetics for inferring ecological and evolutionary processes. The International Biogeography Society – frontiers of biogeography, 4.3.