CONTRIBUTION TO THE ZOOGEOGRAPHY OF ASIA MINOR BASED ON THE DISTRIBUTION OF *DRUNELLA* SPECIES (EPHEMEROPTERA : EPHEMERELLIDAE)

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ABSTRACT

The genus *Drunella* is represented by two species in Anatolia. *Drunella euphratica* (Kazancì, 1987) occurs in Eastern Anatolia while *Drunella karia* (Kazancì, 1990) in Western Anatolia. This interesting distribution of two *Drunella* species gives us some remarkable information about the zoogeography of Anatolia.

INTRODUCTION

After the start of the glacial period during the Pleistocene, faunal elements from North and Middle Europe descended to the South and settled in refugia (one in Western, the other in Eastern Anatolia) together with Siberian elements. The other refugium is Spain in which another *Drunella* species, *Drunella paradinasi* (Gonzales del Tanago and Garcia de Jalon, 1983) occurs. Many of these species re-occupied Europe during the postglacial period but some of them, like *Drunella*, had adapted to high temperature and did not settle in Europe. Most probably the origin of the groups of species which are distributed in West Anatolia entered the territory through the Balkans, whereas the groups of species settled in East Anatolia came through the Caucausus. These two populations were separated by the central Anatolian lake for which the boundaries are still disputable. This natural barrier inhibited any kind of mixing and genetic interaction. As a result, many species and subspecies in the two regions diversified independently from each other. The diversification exhibited by *Drunella* species could be generalized for the other Ephemeroptera species in Turkey.

Even though turkey can be included in the Palaearctic Region, a number of faunistic elements of other zoogeographic regions occur in it (Kosswig, 1955).

DISCUSSION

Turkey is a natural bridge between Asia and Europe. It also has transitional zones connecting with other zoogeographic reigons. For example the Kars-Erzurum Plateau is the passage to the Caucasian fauna in the North-East; the Hakkari-Van Plateau is the passage to Mesopotamia in the South-East; the fauna of the Hatay-Amanos Mountain chain has similarities with African fauna,and the Istranca Mountain in the Thracian basin shows the transition to the European fauna (Fig.l).

The isolated areas with boreal climate existed in the above mentioned transitional areas, the Eastern Black Sea Mountains, Ilgaz Mountain, Uluda Mountain, Erciyes Mountain, Kazdai Mountain, Bozda Mountain, Sultan Mountain, The Taurus Mountains (Fig.l).

Turkey has various climatic belts as follows: in the North-East and in the East there are some kinds of Siberian climate; the North is temperate; in the Middle and South there is desert and steppe climate; the South and South-West display Mediterranean and subtropical climate (Demirsoy, 1979).

It is very difficult to resolve Turkey's zoogeography due to the following reasons:

1. It is a bridge between two continents.
2. It is a large country covering an area of 765.000 km2.
3. The geographic structure becomes more complex from west to east with high mountains eroded by river systems. Various microclimatic areas exist with their isolated population pools of animals in this geographic structure.
4. There are certain areas that could be considered as transitional regions connecting with other climatic and zoogeographic belts.
5. Turkey provided refuges in the glacial period. The speciation of the isolated population pools of animals of Palaearctic immigrants in these refuges diversified the species composition of Anatolia.

Systematic and faunistic studies should be helpful in revealing the continental zoogeographic structure of Anatolia. Zoogeographical studies are aided by animal groups which are well isolated, phylogenetically ancient, have weak migration ability, and are well distributed in the study areas. One animal group that shows such characteristics is the Ephemeroptera order.

The distribution of genus *Drunella* was described by Allen (1980) for North America, Asia and Japan. Gonzales del Tanago and Garcia de Jalon (1983) have recorded the genus *Drunella* with an endemic species *Drunella paradinasi* for Spain.

In Turkey, the genus *Drunella* was recently recorded with two new species, one in Eastern Anatolia, *Drunella euphratica* Kazanci, 1987 and the other in Western Anatolia. *Drunella caria* Kazanci, (1990) (Fig.l). *Drunella paradinasi, Drunella euphratica,* and *Drunella caria* are related to *Drunella grandis grandis* which occurs in the Western North American region.

Ephemeroptera are phylogenetically very ancient, and the oldest winged insects have been known since Carboniferous and Permian times (Illies, 1968), so they existed before the continents and took on their present shape.

Therefore the genus *Drunella* occurred throughout North America, Europe, and Asia before the ice age.

Europe had a tropical climate at the beginning of the Pliocene, later changing to temperate and continuing to cool down until the glacial age.

The climatic changes and variations and the oscillation of ice masses in the Pleistocene epoch of the Quaternary period (beginning about 2×10^6 B.C) shaped the distribution of animals and plants which adapted to a warm Tertiary climate from north to south or vice versa (Flint, 1971).

The pleistocene is divided into preglacial times and four glacial stages :

1. Glacial stage (Günz) : $600\text{-}540 \times 10^3$ B.C
1. Interglacial stage : $540\text{-}480 \times 10^3$ B.C
2. Glacial stage (Mindel) : $480\text{-}430 \times 10^3$ B.C
2. Interglacial stage : $430\text{-}240 \times 10^3$ B.C
3. Glacial stage (Riss) : $240\text{-}180 \times 10^3$ B.C
3. Interglacial stage : $180\text{-}120 \times 10^3$ B.C
4. Glacial stage (Würm) : $120\text{-}8 \times 10^3$ B.C
4. Postglacial stage : $8 \times \times 10^3$ up to now

The Riss and Würm glaciations shaped the present Palearctic fauna of Ephemeroptera. During these glaciations faunal elements from Northern and Middle Europe, together with Siberian elements descended to the south and settled in refuges. One of them is the Macedonian-Thrace Refugium extending to Spain in South-Western Europe. The other is the Eastern, Irano-Caspian Refugium covering areas from North Eastern Anatolia to the Caspian Sea (Fig.2). Anatolia offered two refugia during the Pleistocene epoch. One is in West Anatolia the other is in East Anadolia (Fig.1).

The faunal elements distributed in West Anatolia entered the refugia through the Balkans from the Macedonian-Thrace refugium, whereas the groups of species settling in the East Anatolia came through the Caucasus from the Irano-Caspian refugium (Fig.1). These two refuges were separated by the Central Anatolian Lake or Lake System for which the boundaries are still disputable. This lake system and other natural barriers of high mountains in the north (the North Anatolian Mountain Chain) and in the south (The Taurus Mountain Chain) prevented any kind of mixing and genetic interaction (Kosswig, 1955) (Fig.1). As a result, many species and subspecies in the two regions diversified idependently from each other.

The occurrence of *Drunella* in Spain and Turkey provides us with traces of the distribution of Pleistocene fauna within the Palearctic towards the refuges. Many of the glacial immigrant species reoccupied Europe during the postglacial period, but some of them, like the *Drunella* species, had adapted to high temperatures and did not resettle in Europe.

We can see a parallellism between the recent Palaearctic distribution of *Drunella* species and the boundary of the ice sheet in the Palaearctic in Pleistocene.

The speciation pattern of *Drunella* species in two refuges in Anatolia may be similar to that of other Ephemeroptera species, according to Ephemeroptera (data) from the whole of Turkey. Studies continue with animal groups whose active and passive migration is limited.

Anatolia provides an example of a mosaic of isolates inhabited by different subspecies and species evolved from one master species. This holds true not only for Ephemeroptera but also many other biota.

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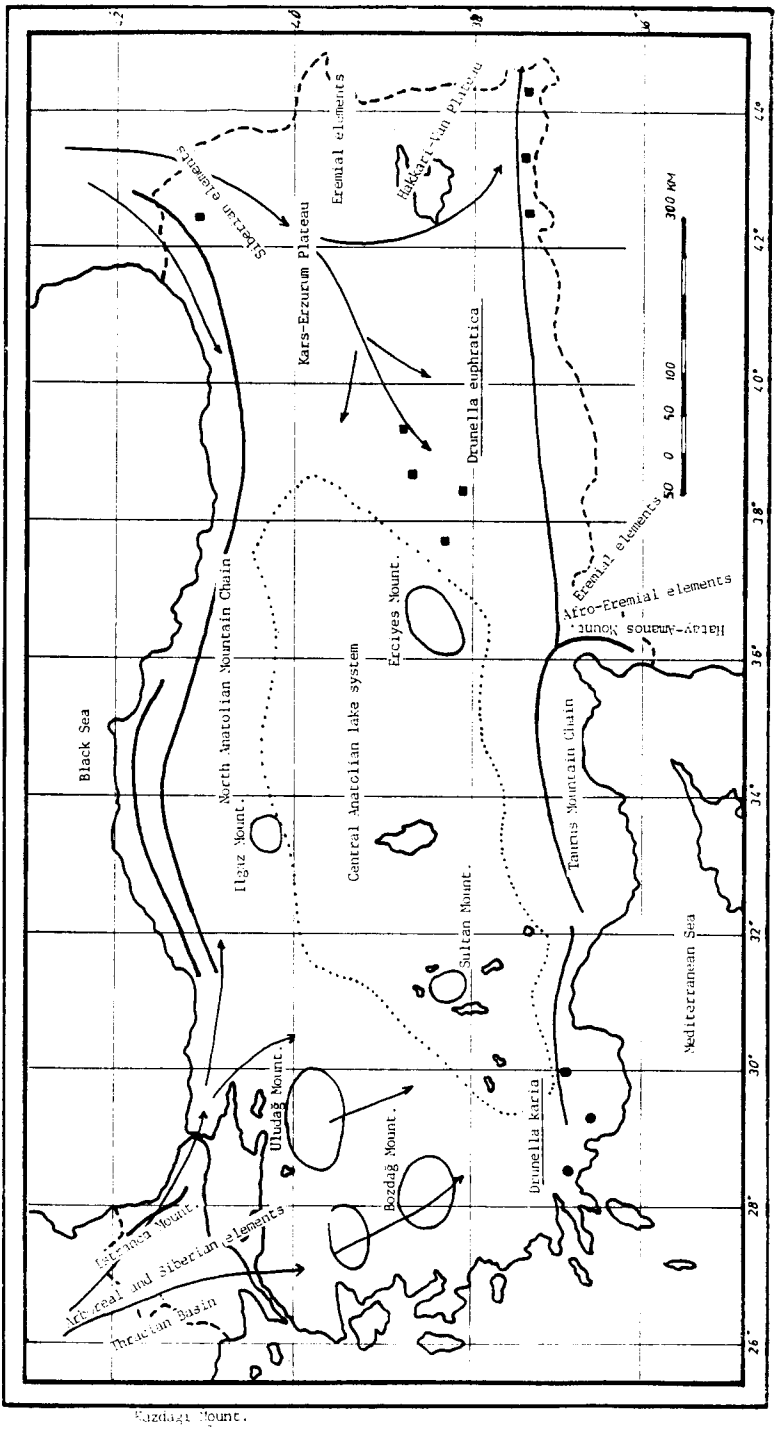

Fig. 1. Zoogeographical map of Turkey including distribution of *Drunella* species.

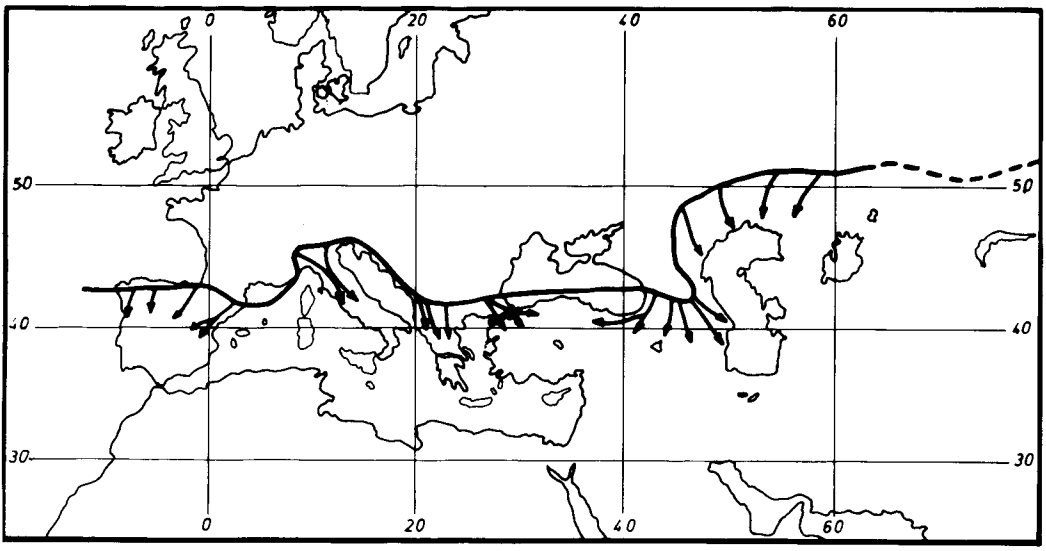

Fig. 2. The immigration routes of Siberian elements in the Western Palaearctic during the Pleistocene (De Lattin 1967).