

## Insular distribution patterns of Gorovan Sands (Armenia) on the example of psyllid (Hemiptera: Psylloidea) fauna

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Under the equilibrium theory of island biogeography species richness on an island is a dynamic equilibrium between opposing rates of colonization and extinction [1]. However, this functional definition encompasses many other insular systems including alpine grasslands ('islands in the sky'), caves, salt-lakes, desert oases, and tropical mountaintops, etc. [2,3]. Although there are many biogeographical researches supported the nonequilibrium vicariance model [4]. The author of the present article is follower of this, latter viewpoint.

One of the clearly expressed insular system (nonequilibrium) represented in south part of the South Caucasus, Armenia, in middle reaches of the Aras River Valley – Gorovan (or Goravan) Sands (today Gorovan State Reservation) in the extreme southern part of the South Caucasus, bordering to Iran. This area (200 ha) is of particular interest first of all by its insularity and rich and rare biota differed significantly from the another arid sites (patches) of the South Caucasus. It is surrounded by clayey wormwood (*Artemisia fragrans*) semi-desert and rockland's phryganoid vegetations 'sea' [5,6,7]. The local 'sand-island' habitat is a home supporting about 160 species of vascular plants [8,9] and 36 species of vertebrate and invertebrate (Lepidoptera) animals [5,6,10,11]

Psyllids – a small group of sap-sucking insects – are trophically linked to the flowering plants. They occurred throughout all biomes (major climatic zones) of the world where suitable host plant are found [12]. There are 3850 described species [13]. In the Palaearctic Region, psyllids are most diverse in arid habitats. This is considerably well documented for Middle Asia [14]. The Caucasus (440.000 km<sup>2</sup>), with 212 species recorded [15], is a well studied area in the Northern Hemisphere [16,17]. Psyllid fauna of tribe Pachypsyllidini Log. is a Palaearctic taxa [18] with three genera: *Eremopsylloides* Loginova, *Pachypsyllodes* de Bergevin, and *Sureaca* Burckhardt and Ouvrard (former *Acaerus* Loginova) [19] associated with phogs (*Calligonum* spp.).

In the framework of a comprehensive work project on the psyllids of the Aras River Valley (head of the field expedition Dr. Gegechkori), this fauna was investigated in detail and mainly based on the results of five research trips in the years 1973-1974 during which targeted material – 11 species, over 200 specimen – has been collected by me [7].

Gorovan Sands is only place in South Caucasus where the psammophilous fauna of sandy desert habitat is represented by 4 species of psyllids of the tribe Pachypsyllidini: *S. turkestanicus* (Löw) (new for target area), *P. cornutus* Log., *E. mirabilis* Log., *E. fedtschenkoi* (Löw) (new for target communities) [20,14,7]. All of

four species occur in the Irano-Turanian subregion of the Sahara-Gobian biogeographic region of the Palaearctic Realm [21].

It is worthy to stress that endemic phog shrubs in the Caspian Sea shore sands of Azerbaijan, *Calligonum bacuense* and *C. petunnikovii* represented as a far more dense thicket and occupies incomparable large area [22]. These shrubs are not populated by the specific psammophilic species of psyllids (the explanation: [7]), while after disjunction within this country, two species (*P. turkestanicus*, *E. amirabilis*) out of four species, inhabiting of Gorovan Sands, occurring again in the sand habitats of the eastern North Caucasus (Stavropol Krai and Dagestan), then with a continuous, steadily distribution represented throughout Middle Asia's tremendous sandy deserts (Kyzyl-Kum, Kara-Kum) with a striking species radiation: 3 genera, 19 species, including all 4 species from the Caucasus [15].

Mentioned open, restrict area of Gorovan Sands is the relict of Late Tertiary time [23], harbouring specific species of vertebrate and invertebrate animals of the remote past. It is worthy noting one more phenomenon: there is no another example of similar isolation of a such tiny patch of sand desert populated with above mentioned vegetation and animal communities in the Caucasus consist of some endemic and other rare species. Despite of a such limited territory, Gorovan Sands does not lost its specific psammophilous psyllid fauna, vice versa, within this marginal areas of mention habitat, like the huge Turanian (Middle Asia) deserts, represented all three genera, whereas on endless territory of sandy deserts of Iran occurring 2 species associated with phogs without endemics, Central Asia (Mongolia) - 6 species with 3 endemics, North Africa - 2/0 and Arabian Peninsula - 1/0. It should be stressed that all four regions are lack the genus *Sureaca* [24,25,26,7,14]. It should be mentioned that the other sandy desert regions of Palaearctic region have the following number of psyllids on phogs: Middle Asia - 19/7 (center of diversity of modern fauna), Kazakhstan - 12/1, The Caucasus - 5/0, Israel - 4/2 [27,25,7,14].

From the historical point of view, it was suggested that sand desert patches of the Aras River Valley were refugia for mentioned taxa of the tribe Pachypsyllidini during Plio-Pleistocene time. Current distribution of desert's hot climate tolerant species linked with *Calligonum polygonoides* are widely disjunct from their main ranges—deserts of Irano-Turanian phytogeographical region. The separation of these taxa and modern geographic distribution pattern has been shaped under the waves of tectonic activities and climate deterioration that happened in different parts of Irano-Turanian region. For example, a sharp uplifting of the Kopet Dag and Zagros mountains considerably from Miocene time, and glaciations (Riss, Wurm) of East Zagros [24].

The geological history of the area has some significance to faunas distribution patterns. The first wave of expansion of desert's fauna into Caucasus took place from closest region, from Iran. Then, from the second half of the Pliocene (Cimmerian and Alpine orogeny about 2-3 mya) occurred uplift to the modern height of large Zagros Mts (total length of 1,500 km, peaks around 4,300m). After these changes in orography this southern way of migration of desert communities lost its important [15].

Several fluctuations of the Caspian Sea with numbers of the dramatic transgression and regression events of sea level rises that have occurred from the Pleistocene to the

present day [28]. These fluctuation events have been shaped with the floodplain by repeated dispersal and extinction events living organisms of the arid Caspian Lowlands in Transcaucasia [29]. Some migration waves of desert inhabitants from Central Asia (Turan) were more successful than the others, while older ones, like inhabitants of Gorovan Sands persisted in the refugial areas, become relictual species [15,24,7]. Finally, it must be emphasize that Gorovan Sands 'island' still include so charismatic and rather complete trophic levels despite human interference which continue till nowadays [30,11,31,7].

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