

GENERAL CONSIDERATIONS ON THE DISTRIBUTION OF COLEOPTERA IN THE AEGEAN ISLANDS

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Introduction

The Aegean archipelago consists of more than 3000 islands, mostly continental in their origin. They appear to be remainders of the Tertiary Aegeis, a continent extending from the Ionian Islands, across Greece to West Turkey and somewhat southern than Crete. Their separation began after the Middle Miocene, forming well defined island groups during the Pliocene. From that period on, their surface has undergone many transformations in concordance to sea level changes, for tectonic reasons as well as glacial.

These events have greatly affected the fauna of this area, especially the taxa of narrower ecological plasticity. This fauna now represents a combination of tertiary relicts and Near East as well as European colonizators, from which many endemic species have evolved.

This work represents a preliminary attempt to study the zoogeographical attributes and relationships of these islands. The main part of the study is based on clustering the islands according to their faunistic similarities. In addition to this, further ecological and zoogeographical considerations are also given.

The animal group that has been chosen as appropriate for this purpose, is the order of Coleoptera. They are a large and very variable group, possessing many slow dispersible species (apterous, ground-living, subterranean, etc.), while the literature on their presence in the East Mediterranean basin is quite extensive, satisfying our purpose.

It must also be pointed out, that the main purpose of this work was rather an attempt to collect all the existing data concerning the presence of Coleoptera in the East Mediterranean area, than to give final indices of their diversity and dispersal status.

Methods

Bibliographic and personal data on the presence of 1128 species on the Aegean Islands were used to study the zoogeographical relationships of these islands. So, similarity coefficient matrices between islands were constructed and then by cluster analysis, dendrograms were made, grouping the islands

in relation to their Coleopteran fauna. These statistical methods were carried out by the SPSS package of the University of Crete Computing Center.

The similarity indices used, were those of Jaccard, Czekanowski and Kulczynsky*. The clustering method was UPGMA**.

Results and Discussion

The results of the above analysis can be summarized in the following 4 considerations:

1. The dendrograms that appeared from the cluster analysis have shown a well defined grouping of the islands in the first level of discrimination, as well as in the second one. These are based on the Kulczynsky coefficient.

The first and more detailed clustering (Fig. 1) sets the Southern Cyclades in one group, the Northern Cyclades in another one, Lesvos, Chios, Samos and Ikaria in a third group, while the final group consists of Kasos, Chalki, Symi, Kalymnos and Karpathos. All the other islands except the small Northern Sporades cluster, were set separately.

The reasons for such separation are clear enough for almost all the islands. It is based mainly on the fact of the close setting of these islands with the continental parts of Greece and Turkey.

Finally we think that the problematic separation of Naxos and Syros was an expected fact, because of the following reasons: Syros has been a commercial port, since the 19th century and Naxos is the biggest island of the Cyclades. So, they have been the most frequently visited sites by foreign researchers for many years and the number of recorded species is closer to the real one, than for other Aegean islands.

A second level of clustering (Fig. 2), unifies more islands in a smaller number of groups. Now the main groups are only three: Cyclades, East Aegean and Northern Sporades. Astypalea, Samothraki, Thasos, Kastellorhizo, Makronisos

*Jaccard similarity measure, also known as the similarity ratio:

$$JACCARD(x,y) = \frac{a}{a + b + c}$$

Czekanowski similarity measure:

$$CZEK(x,y) = \frac{2a}{2a + b + c}$$

Kulczynski similarity measure:

$$Kl(x,y) = \frac{a}{b + c}$$

– (a: joint presence, b,c: presence in one, absence in the other).

** (Unweighted pair-group method using arithmetic averages)

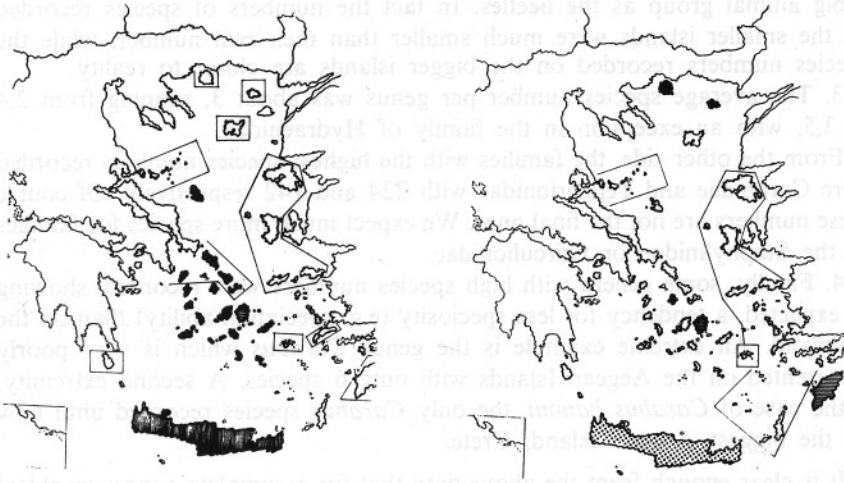


Fig. 1. Clustering of the Aegean Islands at the first level of discrimination.

Fig. 2. Clustering of the Aegean Islands at the second level of discrimination.

and Crete are set apart. Kos is unified now with the other East Aegean islands, while Naxos, Syros and Rhodos showed the same tendency to stay outside of the clusters they geographically belong, because of their special characteristics mentioned above, such as intensive collecting.

Separation of groups on a more detailed level was not possible with the data available, because most of the smaller islands have been surveyed incompletely.

It is also a point of interest that older clusterings of Aegean Islands on a phytogeographical basis, gave similar results, as the one by Rechinger in 1950.

2. According to the theory of McArthur and Wilson, the number of species on an island is proportional to the area. Regression between island area on the number of species recorded on each island has been carried out and the correlation coefficient was computed as 0,732 showing a satisfactory degree of correlation.

The theory of McArthur and Wilson also states that there is negative correlation between the number of species and the distance of the islands from the mainland. A regression analysis of our data showed very poor correlation of these two parameters, about 0,2. Multiple regression analysis of both area and distance on the number of species did not improve the correlation.

A plot of area on the number of species in logarithmic scale gave a very steep slope of about 0,9, not very common in similar conditions of continental archipelagoes. This fact can be explained by the incomplete data concerning the Coleopteran fauna of the smaller islands and the heterogeneity of such

a big animal group as the beetles. In fact the numbers of species recorded on the smaller islands were much smaller than their real number, while the species numbers recorded on the bigger islands are closer to reality.

3. The average species number per genus was about 3, running from 2,4 to 3,5, with an exception in the family of Hydraenidae.

From the other side, the families with the highest species numbers recorded were Carabidae and Tenebrionidae with 224 and 142 respectively. Of course these numbers are not the final ones. We expect much more species for families as the Staphylinidae or Curculionidae.

4. Finally, some genera with high species numbers were recorded, showing as expected, a tendency for less speciosity (e.g. speciation ability) than on the mainland. An extreme example is the genus *Carabus* which is very poorly represented on the Aegean Islands with only 6 species. A second extremity, is the case of *Carabus banoni*, the only *Carabus* species recorded until now on the biggest Aegean Island, Crete.

It is clear enough from the above data that for a complete zoogeographical analysis of the Aegean Archipelago, based on beetles, the following are needed:

- a. Complete survey of the Coleoptera fauna of all the islands, especially the small ones, and especially for those groups with low ability of dispersal.
- b. Revision of the older records.
- c. More detailed survey of ecological parameters and reconstructions of paleogeographic conditions, in order to explain the present distribution of the Coleopteran fauna.

Acknowledgement

We are very thankful to Mrs. Snežana Živanović for her assistance in the computer processing of the data.

Περίληψη

Τα νησιά του Αιγαϊκού αρχιπελάγους παρουσιάζουν ιδιαίτερο βιογεωγραφικό ενδιαφέρον, λόγω της θέσης των στην ανατολική Μεσογειακή λεκάνη και της γεωλογικής ιστορίας των.

Στην παρούσα εργασία, επιχειρείται μια προκαταρκτική ομαδοποίηση του Αιγαίου με βάση τα ζωογεωγραφικά χαρακτηριστικά των νησιών του. Για την ποσοτικοποίηση των ομοιοτήτων, χρησιμοποιήθηκε η τάξη των Κολεοπτέρων, σαν η πιο κατάλληλη ζωική ομάδα για αυτόν τον σκοπό. Τα έντομα αυτά συμπεριλαμβάνουν πολλά άπτερα (ή μειωμένης πτητικής ικανότητας) και βραδείας διασποράς είδη, δείχνουν ιδιαίτερα μεγάλη ποικιλομορφία, ενώ μια σχετική εκτεταμένη βιβλιογραφία αναφέρεται στην παρουσία τους στο Αιγαίο.

Κατασκευάστηκαν μήτρες δεικτών ομοιότητας μεταξύ των νησιών, βασισμένες σε βιβλιογραφικά και προσωπικά δεδομένα για την παρουσία ή απου-

σία πάνω από 1000 ειδών Κολεοπτέρων. Επειτα σχεδιάστηκαν δενδρογράμματα (με ανάλυση καθ' ομάδας – CLUSTER ANALYSIS), τα οποία δείχνουν τις ομοιότητες των Αιγαίων νησιών σε σχέση με την πανίδα τους.

Η ανάλυση τοποθετεί μαζί τα νησιά των Κυκλάδων, τα Δωδεκάνησα, τα νησιά του ανατολικού Αιγαίου, τα νησιά του βόρειου και κεντρικού Αιγαίου και τις βόρειες Σποράδες. Η Κρήτη, η Ρόδος, το Καστελλόριζο, η Μακρόνησος και μερικά μικρά νησιά τοποθετούνται ξεχωριστά.

Τέλος, συζητούνται μερικά σημεία γενικότερου ζωογεωγραφικού ενδιαφέροντος πάνω στην πανίδα των Κολεοπτέρων στο Αιγαίο.

REFERENCES

The literature that has been used for the study of the Coleopteran distribution in the Aegean Islands, was very extensive (over 70 publications). Space does not permit a complete listing. However, the basis material has been taken from the classic works of APFELBECK, CSIKI, D'ORCHYMONT, JANSSENS, KIESENWETTER, KOCH, KUHNELT, OERTZEN and others.